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<th>Title</th>
<th>Flowering Phenology and Anthophilous Insect Community in the Cool-Temperate Subalpine Forests and Meadows at Mt. Kushigata in the Central Part of Japan</th>
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<td>Author(s)</td>
<td>KATO, Makoto; MATSUMOTO, Masamichi; KATO, Tôru</td>
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<td>Citation</td>
<td>Contributions from the Biological Laboratory, Kyoto University (1993), 28(2): 119-172</td>
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Kyoto University
Flowering Phenology and Anthophilous Insect Community in the Cool-Temperate Subalpine Forests and Meadows at Mt. Kushigata in the Central Part of Japan

Makoto Kato, Masamichi Matsumoto and Tôru Kato

ABSTRACT We studied flowering phenology and anthophilous insect communities bimonthly in 1990-1991 in the primary cool-temperate subalpine forests and meadows at Mt. Kushigata, Yamanashi Prefecture, Japan. One hundred and fifty-one plant species of 41 families flowered sequentially from late May to mid September. A total of 2127 individuals of 370 species in eight orders of Insecta were collected. The most abundant order was Hymenoptera (35% of individuals) and followed by Diptera (33%), Coleoptera (28%) and Lepidoptera (4%). The number of species was highest in Diptera (47%) and followed by Hymenoptera (24%), Coleoptera (18%) and Lepidoptera (9%). The numbers of both species and individuals peaked in late July and early August. Bee fauna was composed of six families, nine genera and 34 species, lacking Xylocopinae and wild Apinae. The most abundant genus in bees was Bombus (76.7% of individuals) and followed by Lasioglossum (20.2%).

Cluster analysis on flower-visiting insect order spectra separated 30 plant families into four groups: nine families (Geraniaceae, Elaeagnaceae, Onagraceae, Ericaceae, Labiatae, Scrophulariaceae, Campanulaceae, Liliaceae and Iridaceae) were visited mainly by Hymenoptera, one (Violaceae) by Lepidoptera, five (Celastraceae, Umbelliferae, Polemoniaceae, Dipsacaceae and Gramineae) by Coleoptera and 15 by Diptera and/or various orders. Cluster analysis on flower-visiting insect order spectra of 91 plant species separated them into five flower guilds: hymenopterous (36 plant species), dipterous (30 spp.), coleopterous (14 spp.), lepidopterous (two spp.) and general flowers (nine spp.). Significant correlations were detected between violet flower color and hymenopterous flowers and between tubular corolla and hymenopterous flowers. Seventy-three % of hymenopterous flowers and 93% of dipterous flowers were visited by bumblebees and hoverflies, respectively. Cluster analysis on flower-visiting bumblebee species spectra separated 42 plant species into five flower guilds: longest-tongued bumblebee flowers (eight spp.), B. honshuensis flowers (eight spp.), B. ardens flowers (three spp.), B. beaticola flowers (15 spp.), B. hypocrita flowers (eight spp.). The number of coflowering plant species within each flower guild was usually kept less than five and, at most, eight in B. beaticola flowers which sometimes shared a few bumblebee species.

Flower-visiting patterns of anthophilous insects were compared among insect orders, families and bumblebee species. The most preferred plant family was Compositae in Hymenoptera, Diptera and Lepidoptera, and Saxifragaceae in Coleoptera. Niche segregation as to floral host utilization was detected among six bumblebee species, although there were overlaps. The two longest-tongued bumblebee species visited similar plant species, but the second longest-tongued B. diversus, was largely expelled from the flowers of the same guild by the longest-tongued B. consobrinus, and the flower-visiting pattern of B. diversus was rather similar to the third longest-tongued B. honshuensis. The high bumblebee species diversity and niche segregation among them are thought to be a reason of high species diversity of herbaceous plants at cool-temperate subalpine forests and meadows.

KEY WORDS flowering phenology/ anthophilous insect community/ bumblebee/ flower guild/ subalpine meadow
Introduction

Flowering phenology and flower-visitor community in a natural ecosystem are thought to have been formed interactively, at least in part, through competition of plants for pollinators (Zimmerman, 1980; Pleasants, 1980; Ranta et al., 1981a; Rathcke, 1988b) and competition of pollinators for flowers (Ranta et al., 1981b; Pyke, 1982; Obeso, 1992). In order to draw out a generalization from these competitively interacting systems between plants and flower-visitors, there are two approaches, i.e., experimental manipulation of some interacting species sets (e.g., Inouye, 1978; Bowers, 1985; Rathcke, 1988a) and description of the whole community (Kevan, 1972; Arroyo et al., 1982; Bauer, 1983; Herrera, 1988). The least tried approach is the latter, which this study aims at.

In Japan, studies on flowering phenology and community structure of flower-visiting insects on individual flower species have been carried out in an alpine meadow (Yumoto, 1986), temperate deciduous forests in Kyoto (Kato et al., 1990; Inoue et al., 1990; Kakutani et al., 1990) and a warm temperate evergreen forest in Yaku Is (Yumoto, 1987). In addition to these studies, quantitative surveys on bee fauna have been done at five localities in Japan: cool temperate forests in Sapporo (Sakagami & Fukuda, 1973) and Nikko (Nakamura & Matsumura, 1985), warm temperate forests in Wakayama (Matsuura et al., 1974), Kochi (Ikudome, 1978) and Kagaoshima (Ikudome, 1992). These studies clarified that there were great differences of bee communities among different localities with different floral environments.

It is cool-temperate subalpine forests and meadows where herbaceous floral diversity and bumblebee species diversity is nearly peaked in Japan. Nevertheless flowering phenology and flower-visiting insect community have been little studied there. Accordingly, we made a quantitative study on the pollination community at Mt. Kushigata, Yamanashi Prefecture, where primary cool-temperate forests and meadows were conserved, and many subalpine plant species including rare orchids grew.

In this paper, firstly, we describe flowering phenology, total anthophilous fauna, phenology of flower-visitors and flower-visiting insect communities on respective plant families and species, and show that the anthophilous fauna is predominated by bumblebees and hoverflies. Secondly, we examine the similarity of flower-visitor spectra among individual plant families and species using clustering procedure. Special attention was paid to floral host utilization pattern by individual bumblebee species. Thirdly, we compare flower-visiting patterns among insect orders, families and bumblebee species. Finally, we compare the anthophilous insect community (especially bee community) with those at other localities in different vegetation types, and discuss altitudinal gradient of flowering phenology and flower-visiting insect communities.

Study Site

Mt. Kushigata, a satellite mountain of Akaishi Mountain Range, is located 25 km west of Kofu, Yamanashi Pref., central part of Japan (35°35'N, 138°23'E; Fig. 1). The altitude of the peak is 2051.7 m. Flora and vegetation of this mountain are reported in Uematsu (1982). The higher part of the mountain (> 1900 m) is covered with subalpine coniferous forests dominated by Tsuga diversifolia and Abies veitchii (Pl. 52A, B), and deciduous oak
forests dominated by *Quercus mongolica* var. *grosse serrata*. The lower part (> 1900 m) is planted forests of larches, *Larix kaempferi*. The northern ridge of the mountain is wide and gentle and covered with meadows of *Trollius hondoensis*, *Spiraea japonica*, *Epilobium pyr richolophum*, *Ligularia* spp. and *Iris sanguinea* (Pl. 52C). Around the meadows, there are shrubby thickets of *Acer ukurunduense*, *Euonymus macropterus*, *Enkianthus campanulatus* and *Lonicera alpigena* var. *glehnii*. Along the ridge, there is a trail which traversed these coniferous forests, deciduous beech/oak forests, shrub by thickets and meadows.

Fig. 1. The location of Mt. Kushigata in the central part of Japan (left) and a magnified map of the study area (right). The sampling route is shown as a broken line.

**Methods**

Surveys on flowering phenology and insect visits to flowers were conducted bimonthly from late May to late September in 1990-91. Sampling dates and weather conditions on the days are shown in Table 1 (Sampling dates are coded in seasonal sequence). We started sampling of flower visiting insects at about 0900 hr and finished at about 1500 hr. We walked on the fixed route from the end of a forestry road (altitude 1850 m) to the northern meadow along a trail on the ridge (Fig. 1). When we found flowering plants, we netted in-
sect visitors for about 10 minutes per one location. In the first 8 minutes we caught only insects flying around and visiting to flowers, avoiding harmful effects on flowers. In the last two minutes, we completely swept insects on and in the flowers. Some endangered insect species were set free after recording the data of the flower visits.

All insect samples were pinned and labeled with the complete census data (date, locality and flower species visited). They are classified and identified at species level although some were unidentified. All the specimens are kept in Biological Laboratory, Yoshida College, Kyoto University. Statistical analyses were done by the SAS package (SAS, 1985) in the Data Processing Center, Kyoto University.

Results

1. Studied Plants

We recorded flowering of 151 plant species (41 families, 120 genera); nine trees, 17 shrubs and 125 herbs (Table 2). All plant species but naturalized *Poa pratensis* were native. Most species were hermaphrodites, four were monoecious (three *Acer* spp. and *Carex spectabilis*), and two were dioecious (*Reynoutria japonica* and *Arisaema serratum*). Flower shapes were classified into six. Open flowers with radiate dish-bowl corollas were most abundant (39.7% of species) and followed by tubular (29.1%), head (16.6%), cup (8.6%), apetalous flowers (2.6%) and spikelet (2.0%). Tubular flowers were subdivided into shortly, medially and longly tubular ones by the length of corolla tube (or spur); 0–5, 5–10, > 10 mm, respectively. Among various flower colors, white was dominant (36.4%) and followed by yellow (10.6%), yellow green (10.6%), violet (9.9%), mauve (7.9%), pink (7.3%), yellow white

Table 1. Sampling dates with weather condition and number of flower species on which insect visitors were collected.

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Flowering Phenology and Anthophilous Insect Community

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<th>Color</th>
<th>Habitat</th>
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Table 2. A total of 150 plant species grouped at family level (based on Cronquist, 1981) with Species code, Japanese names, life forms, breeding systems, flower shape, flower color, main habitats, number of flower-visiting insects collected and flower guilds.
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<th>Species</th>
<th>Japanese name</th>
<th>Life form</th>
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1 h, herb; s, shrub; c, tree
2 a, annual; b, biennial; t, biennial
3 s, succulent; a, annual; p, perennial
4 jk, yellow; y, yellow; b, brown; g, green
5 k, black; m, brown; m, male
6 Flower guild #1, derived from cluster analysis. #2, derived from cluster analysis.
Flowering Phenology and Anthophilous Insect Community

(4.0%), green (3.3%), red (2.6%) and brown (1.3%). On flowers of 91 plant species, at least one flower visitor was collected.

Distribution of flowering plants were very different among the four types of vegetation: coniferous forests, deciduous oak forests, shrubby thickets and meadows (Table 2). Coniferous forests were predominated by anemophilous trees and there were a few small herbs growing at the dark forest floor. Deciduous oak forests were also dominated by anemophilous trees but were accompanied by a few entomophilous trees such as Prunus spp. and Acer spp. At the forest floor, some herbaceous plants were growing. Shrubby thickets were composed of various entomophilous trees and shrubs of Rosaceae, Saxifragaceae, Aceraceae, Celastraceae, Ericaceae and Caprifoliaceae. In the meadows neighboring the shrubby thickets, there were the most species of entomophilous plants. The main habitats of 97 plant species (65%) was the meadows.

2. Flowering Phenology

Figure 2 shows the flowering phenology at Mt. Kushigata. Flowering of herbaceous plants was observed from May 26 to September 23. Flowering of tree and shrub species started in May, and terminated by mid August. The number of flowering plant species increased from late May to late June, slightly decreased in mid July, and again increased till late August, and then rapidly decreased (Fig. 3).

The mean flowering period of a single plant species was 22.0 ± 16.4 days (mean ± s.d.). The mean flowering period of herbs was 24.1 ± 16.8 days and was significantly longer than that of shrubs (10.1 ± 4.8 days; t = 3.196, df = 138, p = 0.002) and trees (12.9 ± 3.3 days; t = 2.060, df = 133, p = 0.041), while the difference between shrubs and trees was not significant (t = 0.932, df = 23, p = 0.363).

3. Flower-Visiting Insect Community

Fig. 3. Seasonal change in the number of plant species blooming at each sampling date.
Table 3. A list of insect families collected on flowers at Mt. Kushigata with the numbers and percentages of species and individuals.

Order   Family   Code   Species   Individuals
        Number   %   Number   %
Dermoptera Forficulidae For 1 0.27 1 0.05
            Thysanoptera Thripidae Thr 1 0.27 2 0.09
            Hemiptera Chinchidae Cin 1 0.27 1 0.05
                        Aphiidae Aph 1 0.27 1 0.05
                        Pentatomidae Pen 1 0.27 1 0.05
                        Pseudococcidae Psy 2 0.24 2 0.09
                        Miridae Mir 6 1.62 15 0.75
                        Scaphytopidae Sc 1 0.27 71 3.34
                        Scrobiculidae Sca 5 1.35 9 0.42
                        Buprestisidae Bup 1 0.27 1 0.05
                        Eleodesidae Ele 1 0.27 1 0.05
                        Ctenidae Cen 2 0.54 3 0.14
                        Meloidae Mel 1 0.27 1 0.05
                        Nididae Nid 3 0.81 75 3.53
                        Cryptococcidae Cry 1 0.27 1 0.05
                        Byrrhidae Bry 4 1.08 52 2.45
                        Biphyllidae Bph 11 2.97 1 0.05
                        Coccinellidae Coe 1 0.27 1 0.05
                        Latridiidae Lat 1 0.27 1 0.05
                        Mordellidae Moe 2 0.54 3 0.14
                        Oedemeridae Oed 3 0.81 64 3.01
                        Scolytidae Sco 1 0.27 163 7.67
                        Cerambycidae Cer 23 6.22 124 5.84
                        Clarysmeidae Chr 5 1.35 7 0.33
                        Attelabidae Att 1 0.27 1 0.05
                        Curculionidae Cur 2 0.54 5 0.24
                        Scalytidae Sco 3 0.81 6 0.28
                        Teuthrididae Ten 8 2.16 17 0.80
                        Braconidae Bra 3 0.81 3 0.14
                        Ichneumonidae Ich 7 1.89 10 0.47
                        Proctotrupidae Pro 1 0.27 1 0.05
                        Pseudopilidae Phe 3 0.81 3 0.14
                        Perlidae Per 1 0.27 2 0.09
                        Eulophidae Eul 12 3.24 13 0.61
                        Cynidae Cyn 1 0.27 2 0.09
                        Pomatiidae Pom 3 0.81 6 0.28
                        Eumenidae Eum 3 0.81 3 0.14
                        Vespididae Ves 5 1.35 36 1.69
                        Sphecidae Sph 2 0.54 3 0.14
                        Colletidae Col 2 0.54 2 0.09
                        Halictidae Hal 12 3.24 131 6.17
                        Andrenidae And 7 1.89 10 0.47
                        Megachilidae Meg 3 0.81 3 0.14
                        Anthophoridae Ant 2 0.54 2 0.09
                        Apidae Api 8 2.16 499 23.45
                        Mecopidae Mec 1 0.27 4 0.19
                        Diperae Dip 12 3.24 48 2.26
                        Panorpidae Pan 1 0.27 1 0.05
                        Empididae Emi 12 3.24 48 2.26
                        Pseudococcidae Pch 1 0.27 1 0.05
                        Tanaidiidae Tan 1 0.27 1 0.05
                        Simuliidae Sim 3 0.81 3 0.14
                        Acaridae Ac 1 0.27 1 0.05
                        Scoliidae Sco 1 0.27 4 0.19
                        Xylophagidae Xyl 1 0.27 2 0.09
                        Stratiomyidae Str 1 0.27 1 0.05
                        Tabanidae Tab 1 0.27 1 0.05
                        Acerotidae Acr 1 0.27 4 0.19
                        Bombyliidae Bom 1 0.27 1 0.05
                        Asilidae As 1 0.27 1 0.05
                        Syrphidae Syr 54 14.59 406 19.11
                        Conopidae Con 4 1.08 6 0.28
                        Tepridae Tep 1 0.27 1 0.05
                        Leucanidae Leu 2 0.54 5 0.24
                        Agromyzidae Agr 2 0.54 2 0.09
                        Chloropidae Cli 2 0.54 2 0.09
                        Drosophilidae Dro 4 1.08 6 0.28
                        Helomyzidae Hel 2 0.54 2 0.09
                        Sphaeroceridae Sphe 4 1.08 6 0.28
                        Scathophagidae Scat 2 0.54 2 0.09
                        Anthomyzidae Ant 29 7.84 113 5.32
                        Muscidae Mus 1 0.27 2 0.09
                        Calliphoridae Cal 15 3.25 29 1.37
                        Tachinidae Tac 22 5.95 45 2.12
                        Incurvaridae Inc 1 0.27 1 0.05
                        Yponomeutidae Ypo 1 0.27 1 0.05
                        Choresitidae Cho 1 0.27 1 0.05
                        Zygenidae Zyg 1 0.27 2 0.09
                        Pteromalidae Pyr 2 0.54 2 0.09
                        Phoropidae Phe 1 0.27 1 0.05
                        Hemerobiidae Hem 1 0.27 20 0.94
                        Pupaonidae Pap 3 0.81 5 0.24
                        Pleidae Ple 4 1.08 11 0.52
                        Lycidae Lyc 1 0.27 1 0.05
                        Lythididae Lyth 1 0.27 1 0.05
                        Nymphidae Nym 5 1.35 10 0.47
                        Sarcophagidae Sac 1 0.27 6 0.28
                        Oestridae Oes 5 1.35 7 0.33
                        Calipsoidea Cal 1 0.27 1 0.05
                        Sphaingidae Sph 1 0.27 1 0.05
                        Notonidae Noc 2 0.54 1 0.09

Total 370 2127

3-1. Faunal Makeup

A total of 2127 individuals of 370 species in eight insect orders were collected (Table 3). In Fig. 4, the number of species is plotted in octave of abundance, which is the logarithm of the number of individuals to base 2 (Preston, 1962; May, 1975). The curve is regarded as the truncated log-normal distribution of species abundance. When the data is applied to Fisher's logarithmic series (Fisher et al., 1943), the Fisher's index of diversity, α, was estimated to be 130.

The relative number of species was greatest in Diptera (47.1%), followed by Hymenoptera (23.1%), Coleoptera (17.0%), Lepidoptera (8.9%) and Hemiptera (3.1%, Fig. 5). On the other hand, the relative abundance of individuals was greatest in Hymenoptera (35.1%), followed by Diptera (32.6%), Coleoptera (27.5%), Lepidoptera (3.5%) and Hemiptera (1.0%). Accordingly, the mean number of individuals per species was highest in Coleoptera (9.6) and Hymenoptera (9.0), followed by Diptera (4.1), Lepidoptera (2.3) and...
Flowering Phenology and Anthophilous Insect Community

Fig. 4. The number of insect species plotted in the Preston's octave.

Fig. 5. The percentages of numbers of insect species (left) and individuals (right) in orders: Hym, Hymenoptera; Dip, Diptera; Col, Coleoptera; Lep, Lepidoptera; Hem, Hemiptera; Mec, Mecoptera; Thy, Thysanoptera; Der, Dermaptera.

Hemiptera (1.9).

3-2. Coleoptera

Dominant families were Scaptiidae (27.7%), Cerambycidae (21.2%), Nitidulidae (12.8%), Staphylinidae (12.1%), Oedemeridae (10.9%), Byturidae (8.9%) and Scarabaeidae (1.5%). Abundant coleopterous species were Anaspis funagata (Scaptiidae, number of individuals = 163), Meligethes morosus (Nitidulidae, 58), Eusphalerum parallelum (Staphylinidae, 71), Oedemeronia subrobusta (Oedemeridae, 48) and Byturus affinis (Byturidae, 42). Twenty-three cerambycid beetles were collected, most of which were pollen feeding species including 11 species of Pidonia.

3-3. Hymenoptera

The most abundant superfamily of Hymenoptera was Apoidea (87.0%), followed by
Vespoidea (5.2%), Chalcidoidea (1.8%), Tenthredinoidea (1.7%), Ichneumonoidea (1.5%), Formicoidea (0.7%) and Sphecoidea (0.3%; Table 3). In Vespoidea, Dolichovespula norvegicoides was most abundant (64.1% of Vespoidea), followed by D. adulterina montivaga (19.4%). Workers of both species were abundant especially from late July to mid August. In predacious wasps (Pompilidae, Eumenidae, Vespidae and Sphecidae), 83.8% of individuals were eusocial.

In Apoidea, thirty-four species and 647 individuals were collected. The relationship between number of bee species and octave of abundance is shown in Fig. 6A. The species-abundance distribution was highly skewed and the value of octave 1 was relatively higher than that of octave ≥ 1. In Apoidea, Bombinae was most abundant (76.8%), followed by Halictidae (20.4%), Andrenidae (1.5%), Megachilinae (0.5%), Hylaeinae (0.3%), Nomadinae (0.3%) and Apinae (0.2%, Table 4). No colletine and xylocopine bees were recorded. Fig. 7 shows the ranking of individual number of each bee species. The most abundant species was short-tongued alpine bumblebee, Bombus beaticola. The seven top species (six Bombus and one Lasioglossum) were eusocial bees. The percentages of eusocial, solitary and cleptoparasitic bee individuals were 87.8, 11.6 and 0.6%, respectively. The percentage of cleptoparasitic bee species was 11.8%, and comparable with those of the seven wild bee studies in the world (7.1–13.0%, Heithaus, 1979). Six Bombus species of five subgenera (Megabombus, Diversobombus, Thoracobombus, Pyrobombus and Bombus) and a cleptoparasitic species, Psithyrus (Fernaldaepsithyrus), were recorded. An individual of Apis mellifera was collected but wild A. cerana was not recorded.

3-4. Diptera

The most abundant family was Syrphidae (58.3% in Diptera), followed by Anthomyiidae (16.2%), Empididae (6.9%), Tachinidae (6.5%), Calliphoridae (4.2%), Conopidae (0.9%) and Sphaeroceridae (0.9%). The pattern of relative abundance for hoverflies is shown in Fig. 7B. The species-abundance distribution was more normal than that of bees. Hoverflies comprised 20 genera and 54 species. The most abundant species was Eristalis tenax (27.1%, Fig. 8). Larval feeding types of the hoverflies could be grouped following Owen & Gilbert (1989): predators (10 genera, 20 species, 142 individuals, 35.0% in number
Table 4. Relative abundance of bee genera at Mt. Kushigata.

<table>
<thead>
<tr>
<th>Family</th>
<th>Subfamily</th>
<th>Genus</th>
<th>No. of Species</th>
<th>No. of Individuals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colletidae</td>
<td>Hylaeinae</td>
<td>Hylaenus</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Halictidae</td>
<td>Halictinae</td>
<td>Lasio glossum</td>
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<td>131</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sphecodes</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Andrenidae</td>
<td>Andreninae</td>
<td>Andrea</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Megachilidae</td>
<td>Megachilinae</td>
<td>Megachile</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Anthophoridae</td>
<td>Nommadinae</td>
<td>Nomada</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Apidae</td>
<td>Bombinae</td>
<td>Bombus</td>
<td>6</td>
<td>496</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prythirus</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Apinae</td>
<td>Apis</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>34</strong></td>
<td><strong>647</strong></td>
</tr>
</tbody>
</table>

of individuals), saprophages (4 gen., 8 sp., 117 ind., 28.8%), phytophages (1 gen., 19 sp.,
124 ind., 30.5%), parasites (1 gen., 2 sp., 4 ind., 1.0%) and unknown ones (4 gen., 5 sp., 19
ind., 1.2%).

3-5. Lepidoptera

The most abundant family was Hesperiidae (26.7%), followed by Pieridae (14.7%),
Nymphalidae (13.3%), Geometridae (9.3%), Satyridae (8.0%), Papilionidae (6.7%) and
Noctuidae (5.3%). A skipper, Parnara guttata guttata, was the most abundant species
(26.7%), and a satyrid, Zophoessa callipteris, was the second.

4. Phenology of Flower Visitors

4-1. General Pattern

The number of sampled insects increased from May to early August and after then de­
creased (Fig. 9). The proportion of Coleoptera was high in May and rapidly decreased in
September, while those of Diptera and Hymenoptera were largely constant throughout the
census period.

4-2. Coleoptera

Seasonal pattern of coleopterous insects’ visits to flowers are shown in Fig. 10. Beetle
fauna on flowers was dominated by Staphylinidae and Byturidae in May, and by Cerambyci­
dae and Scraptiidae during July and August.

4-3. Hymenoptera

Anthophilous fauna of Hymenoptera was constantly dominated by Apoidea throughout
the flowering season. A slight increase of Vespoidae was observed in August. Most andre­
nid species were active only from June to mid July, excluding alpine species, Andrena (Euan­
drena) togashii which appeared in late August. Halictid bees appeared in May or June and
active till August or even September. Males of most halictid bee species appeared only af­
ter August. An eusocial halictid bee, Lasio glossum (Evylaenus) apristum appeared in late
May, and most abundant in August. Most hylaeine and Megachiliid bees appeared in Au­
gust.

Active periods of Bombus species started in late May or June, while no individuals of B.
diversus were recorded before early July. Worker production started earliest in B. ardens
and *B. beaticola* in May. The active period of *B. ardens* was confined before mid July. *Bombus beaticola* was active till end of August, while other species were active till late September. Bumblebee queens appeared in May and June although no queens of *B. diversus* were collected. In early July, eleven queen-sized individuals of *B. beaticola* were collected. They were nectar foragers and their hairs on thorax were worn out. Only one male of *Psithyrus norvegicus* was collected in early September. Females of *P. norvegicus* might invade colonies of host species, *B. beaticola* in June and July.

4-4. *Diptera*

Dominant hoverfly species were active almost over the flowering season, whereas active
periods of some *Cheilosia* species were confined in spring. In *Calytrata*, anthomyiid and tachinid flies were active from July to early September whereas active period of calliphorid flies was about one month from early August to early September.

5. *Anthophilous Insect Communities on Individual Plant Families and Species*

5.1. *Analysis at Insect Order Level*

A great variation was observed in flower-visiting insect order spectra (sorted by insect

![Graph 1](image1)

**Fig. 9.** Seasonal change in the number of insects collected on flowers at each sampling date. Insects are sorted by orders.

![Graph 2](image2)

**Fig. 10.** Seasonal change in the number of coleopterous insects of six dominant families collected on flowers at Mt. Kushigata.
Fig. 11. Seasonal change in the number of bumblebees collected at Mt. Kushigata. Solid, shaded and dotted columns denote queens, workers and males, respectively.
orders) among plant families (Fig. 12). The flower-visitor spectra were examined by cluster analyses (Ward’s method). Statistics were the percentages of individuals in respective insect orders (orders other than Coleoptera, Hymenoptera, Diptera and Lepidoptera were merged into a group). At a prediction ratio of 75% (semi-partial $R^2 = 0.2$), 30 plant families were divided into two clusters, indicating that 75% of the total sum of squared distances among all families can be explained by separation of the two clusters. Cluster 1 (CL1) was separated from others by predominance of Hymenoptera. The latter cluster was sub-divided into three clusters (Cluster 2–4) at a prediction ratio of 0.6. Cluster 2 was composed of only Violaceae and was separated from others by the dominance of Lepidoptera. Cluster 3 was composed of Asclepiadaceae, Caprifoliaceae, Pyrolaceae, Oxalidaceae and Saxifragaceae, and was characterized by dominance of Coleoptera. Cluster 4 composed of 16 plant families was characterized by high proportions of Diptera.

Next cluster analysis was applied to flower-visiting insect order spectra of individual plant species (Appendix 1). Ninety-two plant species were separated into five clusters at a prediction ratio of 0.5 (Fig. 13). Anthophilous fauna of Cluster 1 was dominated by Hymenoptera, and 37 plant species were grouped in Cluster 1. The following nine species were visited only by Hymenoptera: Aconitum senanense, Rubus idaeus, Menziesia pentandra, Meehania urticifolia, Pedicularis resupinata, Cacalia hastata farfaraefolia, Hosta sieboldiana and Polygonatum lasianthum. Cluster 2 was composed of two species (Arabis hirsuta and Viola grypoceras), which were visited only by Lepidoptera. Cluster 3 was composed of nine species and the flowers of the cluster were visited by various orders including Hemiptera and Thysanoptera. Cluster 4 was composed of 14 plant species and was characterized by dominance of Coleoptera. Three species, Viburnum furcatum, Picris hieracioides japonica and Gymnadenia conopsea, were visited only by Coleoptera. Anthophilous fauna of Cluster 5 was dominated by Diptera. In 28 plant species in Cluster 5, the following ten species were visited only by Diptera: Pseudostellaria heterantha, Thalictrum filamentosum tenerum, Prunus maximowiczii, Rhododendron degromanum, Euphrasia maximowiczii, Achillea alpina, Cirsiun effusum, Veratrum album oxysepalum, Agrostis clavata and Poa pratensis. Among 28 dipterous flowers, all but two species (Acer ukurundense and Prunus maximowiczii) were visited by at least a hoverfly. These clusters can be regarded as flower guilds based on flower-visitation by insect orders.

5.2. Analysis at Hymenopterous Family Level

Twenty-seven plant families were visited by at least an individual of Hymenoptera. Figure 14 shows the hymenopterous flower-visitor spectra of the 27 plant families. Twenty families were visited by at least an individual of Apidae, but other seven families were visited by only other families. Celastraceae was visited only by Andrenidae, Oxalidaceae by Tenthredinidae.

At plant species level, 67 plant species were visited by at least an individual of Hymenoptera, and 42 species (72.8%) were visited by at least an apid bee. Of 25 plant species which were visited only by hymenopterous insects other than apid bees, 16 plant species were mainly visited by halictid bees (≥ 50% of total hymenopterous insect visits). The following 13 plant species were visited only by halictid bees: Philadelphus satsumi, Fragaria nipponica, Potentilla freyniana, Adenophora triphylla, Anaphalis margaritacea, Aster ageratoides
Fig. 12. Dendrogram of 30 plant families (right) derived from cluster analysis on flower-visitor spectra sorted by order (left). Plant family codes are shown in Table 2.
Flowering Phenology and Anthophilous Insect Community

leio phyllus, A. a. ovatus, Cacalia adenostyloides, Ligularia dentata, Senecio cannabifolius, S. nemorensis, Solidago virgaurea asiatica and Taraxacum hondoense. Nine species of them were Compositae.

5.3. Analysis at Bumblebee Species Level

Twenty plant families were visited by at least an individual of Apidae. Patterns of apid bee visits to plant families are shown in Fig. 15. Bee faunae on Ranunculaceae, Campanulaceae and Liliaceae were dominated by longest-tongued bumblebee species, B. consobrinus. Aceraceae and Asclepiadaceae were visited by only B. ardens. Most plant families were visited by more than two bumblebee species.

Next, flower-visiting bumblebee species spectra were examined by cluster analysis (Ward's method). Statistics were the percentages of individuals in respective bumblebee species (including an individual of Apis). At a prediction ratio of about 0.75, 42 plant species were divided into three clusters (Fig. 16). Cluster 1 was composed of eight plant species (all were herbs) and was characterized by high proportion of B. hypocrita. Cluster 2 is characterized by predominance of two longest-tongued bumblebees (B. consobrinus and B.
diversus) and by absence of other bumblebee species. This cluster was composed of eight plant species: Aconitum senanense, Aconitum japonicum montanum, Aquilegia buergeriana, Polygonatum macranthum, Campanula punctata var. hondoensis, Weigela decora, Synurus pugens and Hosta sieboldiana, all of which but W. decora were herbs. All these plant species had longly tubular flowers (Table 2). The third cluster was subdivided into three clusters (Cluster 3–5) at a prediction ratio of about 0.5. Cluster 3 was characterized by predominance of short-tongued alpine bumblebee, B. beaticola, and was composed of 15 plant species (eight herbs, six shrubs and one tree). Although four plant species (Menziesia penticandra, Rubus idaeus f. marmoratus, Clinopodium chinense grandiflorum and Patrinia triloba palmata) were visited only by B. beaticola, other species in the cluster were also visited by B. hypocrita, B. honshuensis and/or B. ardens. Cluster 4 was composed of eight plant species (seven herbs and one shrub) and their flowers were mainly visited by B. honshuensis, occasionally by B. diversus, B. beaticola and/or B. hypocrita. Cluster 5 was composed of three plant species (one herb, Cynanchum ascyrifolium, and two trees, Prunus nipponica and Acer shirasawanum) and was separated from others by predominance of B. ardens.

5.4. Factors Determinating Flower Guilds

Fig. 15. Flower-visitor spectra (sorted by apid bee species) of plant families. Plant families are arranged as in Table 2.
Fig. 16. Dendrogram of 42 plant species (right) derived from cluster analysis on flower visitor spectra (sorted by apid bee species) of plants (left). Plant family codes are shown in Table 2.
Table 5. Numbers of plant species in two series of flower guilds (#1 and #2) sorted by life form. Homogeneity of the frequency distribution among guilds was examined by chi-square test: ***, p < 0.001.

<table>
<thead>
<tr>
<th>Life form</th>
<th>Flower guilds #1</th>
<th>Total</th>
<th>χ²</th>
<th>Flower guilds #2</th>
<th>Total</th>
<th>χ²</th>
</tr>
</thead>
<tbody>
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<td>herb</td>
<td>1 2 3 4 5</td>
<td>71</td>
<td>1.1</td>
<td>1 2 3 4 5</td>
<td>1.7</td>
<td></td>
</tr>
<tr>
<td>shrub</td>
<td>7 2 1 2</td>
<td>11</td>
<td>6.3</td>
<td>0 1 5 0</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td>tree</td>
<td>1 0 2 4</td>
<td>9</td>
<td>4.1</td>
<td>0 0 0 2</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>36 9 14 30 91</td>
<td>15</td>
<td>3 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#1, clusters derived from flower-visitor spectra sorted by insect order: 1, hymenopterous flowers; 2, lepidopterous; 3, general; 4, coleopterous; 5, dipterous.

#2, clusters derived from flower-visiting bumblebee spectra: 1, B. hypocryta flowers; 2, long-tongued bumblebee; 3, B. beatricola; 4, B. honshuensis; 5, B. ardens flowers.

In order to detect the factors determining flower guilds, effects of life form, flower shape and flower color on flower guilds were examined. We compared the frequencies of plant species in each flower guild among life forms, and examined homogeneity of these frequencies by chi-square test (Table 5). There was no significant correlation between plant life forms and flower guilds #1 based on flower-visitaton pattern of insect order. There was a tendency that shrubs are hymenopterous flowers rather than dipterous flowers although the correlation was not significant. Between plant life forms and flower guilds #2 based on flower-visitation of bumblebee species, however, there was found a correlation that trees are likely to be B. ardens flowers.

Some significant correlations between flower shapes and flower guild #1 were detected (Table 6). Cup flowers were likely to be hymenopterous or general flowers, and longly tubular flowers were likely to be hymenopterous flowers. When short-, middle- and long-tubed flowers are merged as tubular flowers, the correlation with hymenopterous flowers was significant (χ² = 16.7, p < 0.01). Open flowers had a tendency to be dipterous flowers but the correlation was not significant. By an analysis on flower guilds #2, a significant correlation was detected between long-tubed flowers and longest-tongued bumblebee flowers. Other flower shapes, however, did not have significant correlations with specific flower guilds.

Table 7 shows the relationship between flower colors and flower guilds. Significant correlations were detected in the following two pairs: violet color vs. hymenopterous flowers and yellow-green color vs. general flowers. When colors with purplish tints (mauve, pink, red and violet) were combined, correlation with hymenopterous flowers was significant (χ² = 15.5, p < 0.01). Pyrola species had poricidal anther and were mainly buzz-pollinated by bumblebees. Pyrola alpina with white petals were visited by many cerambycid beetles, whereas P. incarnata with pink petals were visited almost only bumblebees. Flower guilds #2 in Table 7 based on flower-visitation pattern by bumblebee species had no significant correlations with specific flower colors.

6. Floral Hosts of Anthophilous Insects
6.1. General Pattern
The plant families which were most frequently utilized by insects was Compositae (15.9%) and Saxifragaceae (15.8%), followed by Rosaceae (11.2%), Caprifoliaceae (6.9%), Ranunculaceae (6.7%), Polygonaceae (5.3%), Scrophulariaceae (4.9%), Umbelliferae
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Table 6. Numbers of plant species in two series of flower guilds (#1 and #2) sorted by flower shape. Homogeneity of the frequency distribution among guilds was examined by chi-square test: *, p < 0.05; **, p < 0.01.

<table>
<thead>
<tr>
<th>Flower shape</th>
<th>Flower guilds #1</th>
<th>Total</th>
<th>χ²</th>
<th>Flower guilds #2</th>
<th>Total</th>
<th>χ²</th>
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<tr>
<td></td>
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<td>2</td>
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</tr>
<tr>
<td>long-tubed</td>
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</tbody>
</table>

#1, clusters derived from flower-visitor spectra sorted by insect order: 1, hymenopterous flowers; 2, lepidopterous; 3, general; 4, coleopterous; 5, dipterous.
#2, clusters derived from flower-visiting bumblebee spectra: 1, B. hypocryta flowers; 2, long-tongued bumblebee; 3, B. beaticola; 4, B. honshuensis; 5, B. ardens flowers.

Table 7. Numbers of plant species in two series of flower guilds (#1 and #2) sorted by flower color. The homogeneity of the frequency distribution among guilds was examined by chi-square test: *, p < 0.05.

<table>
<thead>
<tr>
<th>Flower color</th>
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<th>χ²</th>
<th>Flower guilds #2</th>
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<td>3</td>
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<tr>
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<td>0</td>
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<td>2</td>
<td>9</td>
<td>14</td>
<td>29</td>
<td>91</td>
</tr>
</tbody>
</table>

#1, clusters derived from flower-visitor spectra sorted by insect order: 1, hymenopterous flowers; 2, lepidopterous; 3, general; 4, coleopterous; 5, dipterous.
#2, clusters derived from flower-visiting bumblebee spectra: 1, B. hypocryta flowers; 2, long-tongued bumblebee; 3, B. beaticola; 4, B. honshuensis; 5, B. ardens flowers.

(4.7%), Dipsacaceae (4.7%) and Geraniaceae (4.1%). Figure 17 shows a comparison of flower visiting patterns among four dominant insect orders. Lepidoptera showed preference of Compositae and Scrophulariaceae. Flower-visiting pattern of Hymenoptera was slightly similar to that of Lepidoptera, although the preference of Compositae and Scrophulariaceae was not so clear in Hymenoptera. Floral hosts of Diptera were largely similar to those of Hymenoptera, but distinguished from the latter by the preference of Dipsacaceae, Rosaceae, Saxifragaceae and Umbelliferae. Flower visiting pattern of Coleoptera was very different from other insect orders and characterized by a high proportion of visits to Caprifoliaceae and Saxifragaceae. Floral hosts of principal anthophilous insect species are listed in Appendix 2.

6.2. Floral Hosts of Coleoptera

Six dominant coleopterous families showed their respective flower preferences. Staphyliniidae mainly visited Rosaceae (42% of total visits) and Oxalidaceae (32%), Nitidulidae did Saxifragaceae (41.3%), Caprifoliaceae (22.7%) and Rosaceae (15.3%), Byturidae did Capri-
foliaceae (80%), Oedemeridae did Compositae (29.7%) and Ranunculaceae (20.3%), Scaptiidae did Saxifragaceae (91%), and Cerambycidae did Saxifragaceae (42.7%), Rosaceae (10.4%), Pyrolaceae (9.6%) and Dipsacaceae (8.9%).

6.3. Floral Hosts of Hymenoptera

Flower-visiting patterns were very different among seven anthophilous families in Hymenoptera (Fig. 18). Vespidae frequently visited Umbelliferae, Saxifragaceae and Ranunculaceae, which had flowers with exposed nectaries. Although the numbers of collected individuals of Colletidae, Megachilidae and Anthophoridae were very few, uniqueness of their floral hosts in Apoidea was detected. Floral hosts of Halictidae, Andrenidae and Apidae largely overlapped. Halictidae and Andrenidae were distinguished from Apidae by preference of Polygonaceae and by nonattendance at Geraniaceae and Iridaceae.

Flower visiting records were compared among apid bee species (Fig. 19). Excluding Psithyrus norvegicus and Apis mellifera both of which were collected only once, six bumblebee species visited various plant families. The flower-visiting patterns were examined by two series of cluster analyses (Ward’s method), statistics of which were percentages of bumblebee visits to individual plant families and those to individual plant species, respectively. At plant family level, bumblebee species were divided into three clusters, B. ardens, B. hypocrita and other species at a prediction ratio of about 0.9 (Fig. 20A). Each bumblebee species showed different flower-visiting patterns and every two species were never clustered well. The dendrogram derived from the analysis at plant species level (Fig. 20B) was slightly different from that at plant family level. At plant species level, B. ardens was clustered with B. beaticola. Although the two long-tongued species, B. consobrinus and B. diversus, visited common flower species as shown in Cluster 2 of Fig. 16, they did not form a cluster in flower-visiting patterns and B. diversus was clustered rather with B. honshuensis.

Fig. 17. Flower spectra (sorted by family) of the four dominant insect orders. Plant family codes are shown in Table 2.
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Fig. 18. Flower spectra (sorted by families) of seven hymenopterous families (one in Vespooidea and six in Apoidea). Plant family codes are shown in Table 2.

Fig. 19. Flower spectra (sorted by family) of eight apid bee species. Plant family codes are shown in Table 2.

6.4. Floral Hosts of Diptera

We compared flower-visiting pattern of hoverflies which comprised 58.6% of total dipterous flower-visitors. Dominant hoverfly species did not specify their floral hosts and visited many plant species (Fig. 21). The flower-visiting patterns varied with species even in the same genus (Cheilosia, Meliscaeva and Syrphus). Two Meliscaeva species visited not only entomophilous flowers but also anemophilous ones such as Gramineae.
Fig. 20. Dendrograms of bumblebee species, derived from cluster analyses on the flower spectra sorted by plant family (A) and plant species (B).

Cheilosia sp.1
C. sp.3
C. sp.11
C. sp.15
C. motodomariensis
Didea fasciata
Eristalis tenax
Meliscaeva cinctella
M. transversium
Syrphus ribessii
S. vitripennis

Fig. 21. Flower spectra (sorted by plant family) of hoverfly species with ≥28 individuals collected. Plant family codes are shown in Table 2.
Among studies on anthophilous insect communities in Japan, this is the only study carried out in the subalpine coniferous forest zone where bumblebee species diversity is peaked (Fig. 22). We discuss altitudinal gradient of flowering phenology, anthophilous insect community and flower guilds. In Fig. 23, the flowering pattern at Mt. Kushigata was compared with those of Ashu in beech forest zone (Kato et al., 1990) and Kibune in deciduous oak forest zone (Inoue et al., 1990). The half points of the cumulative flowering curves were almost the same (in early July). At Mt. Kushigata, the flowering rate was constantly high from late May to late July and decreased after early August. In Ashu, the flowering rate was high from late May to mid July, kept low till late August, and then increased again. At Mt. Kibune, the flowering rate was high from April to early June, and was kept low till late August. The reduction of flowering rate in summer, which was observed at Ashu and Kibune but not at Mt. Kushigata, resulted in the shortage of flowers in summer at lower elevations. From May to August, the number of flowering species was constantly greater at Mt. Kushigata than at Ashu and Kibune, and this may be a reason why six bumblebee species can coexist at Mt. Kushigata.

The dominance of Hymenoptera in abundance and the dominance of Diptera in species number in anthophilous insect community (Fig. 5) are also recorded in Ashu and Kibune (Kato et al., 1990; Inoue et al., 1990). The high number of individuals per species in
Hymenoptera resulted from the dominance of eusocial bees in bee fauna. The number of bee species was highest at Kibune (400 m in altitude) and decreased as altitudes increased or decreased (Fig. 22). The decrease at higher altitudes is steeper than that of hoverflies and cerambycid beetles, and might be caused partially by competition with homoiothermal bumblebees prevalent in higher altitudes. In contrast with the bee species number, bumblebee species number peaked at intermediate altitudes (1500-2200 m) in Honshu as in the Iberian peninsula (Obeso, 1992), where much more bumblebee species coexist.

Next, we compare bee communities among localities of various altitudes, latitudes and vegetation. The abundance patterns of bee subfamilies strikingly varied with localities (Fig. 24). Bee community in a cool-temperate zone at a low altitude in Hokkaido (Sapporo) was dominated by Halictidae and accompanied by many subfamilies (Sakagami and Fukuda, 1973). Bee community at alpine zone at Mt. Kiso-komagatake (3000 m a.s.l.) appears to be predominated by bumblebees, although quantitative data is lacking (Yumoto, 1986). At Kushigata (2000 m), bee fauna was dominated by Bombinae and followed by Halictidae. At Nikko (1500 m), Halictidae was also the most abundant and Bombinae was the second (Nakamura and Matsumura, 1985). Bee communities in warmer-temperate forests at lower altitudes (100–600 m) were composed of various subfamilies and showed no predominance of a single subfamily except for Kagoshima where Halictidae comprised 77% of total bees (Ikudome, 1992). The proportion of bumblebees in bee community decreases as descending along the altitudinal gradient.

Anthophilous insect communities greatly varied with both individual plant families and species. Of 91 plant species studied, 37 species (42%) were mainly visited by Hymenoptera, 28 species (31%) by Diptera, 14 species (16%) by Coleoptera, 2 species (2%) by Lepidoptera and nine species (10%) by various orders (Fig. 13). Seventy-three % of hymenopterous flowers were bumblebee flowers and 93% of dipterous flowers were hoverfly flowers. The proportions of bumblebee flowers (30%) and hoverfly flowers (29%) are less than those

Fig. 23. Seasonal changes in cumulative numbers of flowering plant species at Mt. Kushigata (A), Ashu (B) and Kibune (C).
Fig. 24. A comparison of relative abundance of bee subfamilies among nine localities in Japan. Data sources are as follows: Sapporo, Sakagami & Fukuda (1973); Nikko, Nakamura & Matsumura (1985); Mt. Kushigata, this study; Ashu, Kato et al. (1990); Kibune, Inoue et al. (1990); Kyoto, Kakutani et al. (1990); Wakayama, Matsura et al. (1974); Kochi, Ikudome (1978); Kagoshima, Ikudome (1992). These localities are arranged in the order of latitude (from up to down, north to south).

at Mt. Kiso-komagatake, where 47.8% of total species studied were mainly visited by bumblebees and 52.2% by hoverflies (Yumoto, 1986). At Ashu and Kibune in lower altitudes, the percentages of bumblebee flowers (23% and 10%, respectively) and hoverfly flowers (13% and 14%) are lower and, in turn, that of small solitary bee flowers (21% and 17%) is higher than Mt. Kushigata (2%; Kato et al., 1990; Inoue et al., 1990).

Contrasting with the lack of clear division of floral hosts among hoverfly species (Fig. 21), bumblebee species showed clear niche segregations as to floral host plant utilization (Fig. 19). Cluster analysis on flower-visiting bumblebee species spectra of 42 plant species suggested that there were five flower guilds: (1) longest-tongued bumblebee flowers, (2) B. honshuensis flowers, (3) B. ardens flowers, (4) B. beaticola flowers and (5) B. hypocrita flowers, where mean tongue lengths are as follows: B. consobrinus > B. diversus > B. honshuensis > B. ardens > B. beaticola (Inoue and Kato, 1992). It is interesting that floral hosts of two longest-tongued bumblebee species were so resembling that flower guilds that were visited only by the one were not be separated. Number of plant species in each flower guild was from 8 to 15 excluding three species of B. ardens flowers, flowering of which were confined in early season before June. The total number of coflowering bumblebee plant species was less than five before June but increased to more than nine in July and 16 species in August. The number of coflowering species in each flower guild, however, was usually less than five (less than nine in only B. beaticola flowers; Fig. 25). This suggests that each plant species does not compete with every coflowering species but only with members of the same flower guild. Ranta et al. (1981) reported that most of the plant species pairs having...
high overlap in bumblebee pollinators did not show overlap in their flowering period in Fennoscandia. This was not the case in Japan, where the number of bumblebee species is less than Fennoscandia and about 3–5 flower species sharing common bumblebee pollinators were coflowering.

The two longest-tongued bumblebee species, *B. consobrinus* and *B. diversus*, visited almost similar plant species in a common flower guild (Fig. 16), but the flower-visiting patterns were very different as shown in Figs. 19 and 20. Most plant species in this flower guild were dominated by *B. consobrinus*, and the essential floral hosts of *B. diversus* largely overlapped with those of *B. honshuensis* (Fig. 19). In the localities where *B. consobrinus* is not distributed, those plant species visited by *B. consobrinus* at Mt. Kushigata are visited by *B. diversus* and niche segregation between *B. diversus* and *B. honshuensis* is clearer (Inoue and Kato, 1992). *B. consobrinus* which had proboscis longer than *B. diversus* might be competitively superior to the latter, and expelled *B. diversus* from these plants in the same flower guild.

Analysis on the relationship between flower morphological characters and flower guilds

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**Fig. 25.** Flowering phenology of bumblebee flowers at Mt. Kushigata, sorted by the clusters in Fig. 16. Flower species are also sorted by life form; S, shrub; T, tree; others without any letters, herb.
detected that purplish tints of color are correlated with hymenopterous flowers (especially bumblebee flowers) although hymenopterous insects visited flowers with various colors other than green and yellow-green (Table 7). This correlation is thought to result from the sight sense of bumblebees. The proportion of purplish flowers (including mauve, pink, red and violet) was higher (33.6%) at Mt. Kushigata than Mt. Kiso-komagatake (17.4%), Ashu (28.6%) and Kibune (22.6%).

Various morphological types of flowers were utilized by hymenopterous and dipterous insects, but tubular flowers were usually visited only by the former (Table 6). Bumblebees can forage for pollen and/or nectar from a large variety of morphological diverse flowers (Heinrich, 1976). Among bumblebee species, however, only two longest-tongued bumblebee species could utilize long-tubed flowers. The proportion of long-tubed flowers was 8.6% at Mt. Kushigata, being higher than at Kibune (6.9%) and Mt. Kiso-komagatake (4.2%) but lower than Ashu (12.1%). At lower altitudes, long-tubed flowers are visited and pollinated by *B. diversus* (Inoue and Kato, 1992), and at higher altitudes where only *B. beaticola* and *B. hypocrita* are distributed, the single species of long-tubed corollas (*Aconitum*) is visited by *B. beaticola* (Yumoto, 1986). As bumblebee guild structure changes along an altitudinal gradient, flower guild structure also changes. The altitudinal change in flower guild might be mitigated by behavioral plasticity and competitive release of bumblebees.

**Acknowledgments**

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M. Kato et al.


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APPENDIX 1

A List of Flower-Visiting Insects Collected on 91 Plant Species at Mt. Kushigata

Plant species are arranged in the order of Table 2. Flower visitation records are arranged as follows: insect species, (family: order), date, and (number of individuals collected). Insect taxa are arranged in the order of Table 3. Unidentified insect species are abbreviated as insect family code + species code number.

### Polygonaceae

*Cix1 (Cix: He) 17-viii-91 (1); Psy1 (Psy: He) 17-vii-91 (1); Mir2 (Mir: He) 17-vii-91 (2); *Ectinohplia obducta* (Sea: Co) 26-viii-90 (2); *Ectinohplia obducta* (Sea: Co) 26-viii-90 (2); *Oedemeronia manicata* (Oed: Co) 17-vii-91 (1); *Anaspis funagata* (Str: Co) 1-ix-91 (1); *Anastrangalis acotodes* (Cer: Co) 17-vii-91 (1); *Anaspis funagata* (Str: Co) 1-ix-91 (1); *Anastrangalis acotodes* (Cer: Co) 17-vii-91 (1); *Bra2 (Bra: Hy) 17-viii-91 (1); *Ich4 (Ieh: Hy) 17-viii-91 (1); *Pro1 (Pro: Hy) 17-viii-91 (1); *Pte3 (Pte: Hy) 17-viii-91 (1); *Perl (Per: Hy) 17-viii-91 (1); *Eul3 (Eul: Hy) 17-viii-91 (1); *Eul4 (Eul: Hy) 17-viii-91 (1); *Eul5 (Eul: Hy) 17-viii-91 (1); *Eul6 (Eul: Hy) 17-viii-91 (1); *Dolichovespula adulterina montivaga* (Ves: Hy) 17-viii-91 (2); *Lasioglossum* (E.) *apristum* (Hal: Hy) 17-viii-91 (2); *Andrena (Eua.) togashii* (And: Hy) 17-viii-91 (1); *Tau1 (Tau: Di) 17-viii-91 (1); *Tab1 (Tab: Di) 17-viii-91 (1); *Bombylius* *major* (Born: Di) 17-viii-91 (1); *Cheilosia* *sp.3 (Syr: Di) 17-viii-91 (1); *Cheilosia* *sp.5 (Syr: Di) 17-viii-91 (1); *Cheilosia* *sp.6 (Syr: Di) 1-ix-91 (1), 17-viii-91 (4); *Cheilosia* *sp.8 (Syr: Di) 17-viii-91 (1); *Cheilosia* *sp.11 (Syr: Di) 17-viii-91 (2); *Eristalis tenax* (Syr: Di) 17-viii-91 (2), 26-viii-90 (2); *Dexopollenia flava* (Cal: Di) 1-ix-91 (2); *Cal7 (Cal: Di) 1-ix-91 (1); *Lucilia* *sp. (Cal: Di) 17-viii-91 (1); *Onesia* *sp. (Cal: Di) 1-ix-91 (1); *Tachina jakovlevi* (Tae: Di) 17-viii-91 (1); *Tae20 (Tae: Di) 26-viii-90 (1); *Ypo1 (Ypo: Le) 17-viii-91 (1); *Catoptia permiaca* (Pyr: Le) 17-viii-91 (1)

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**Caryophyllaceae**

*Maliscaeva cinctella* (Syr: Di) 1-ix-91 (1); *Eristalis tenax* (Syr: Di) 17-vii-91 (1); *Dasysyrphus bilineatus* (Syr: Di) 16-vii-90 (1)

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**Aquilegia buergeriana**

*Epuraea fergeri* (Nit: Co) 6-vii-90 (1); *Oedemeronia subrobusta* (Oed: Co) 14-vii-90 (1); *Bombus*
consobrinus (Api: Hy) 14-vii-90 (1), 6-vii-90 (1), 7-vii-90 (3), 9-ix-90 (1); Bombus diversus (Api: Hy) 25-vii-90 (1); Panorpoides paradoxa (Pan: Me) 6-vii-90 (1)

Cimicifuga simplex

Adelphocorbus rubripes (Mir: He) 1-ix-91 (1); Anaspis funagata (Str: Co) 17-vii-91 (1); Pidonia grallatrix (Cer: Co) 26-vii-90 (1); Pachydras cometes (Cer: Co) 17-vii-91 (1), 26-vii-90 (1); Vespa austriaca (Ves: Hy) 1-ix-91 (1); Dolichovespula norvegicoides (Ves: Hy) 1-ix-91 (1), 17-vii-91 (1), 26-vii-90 (2), 29-vii-90 (1); Andrena (Eua.) toshashi (And: Hy) 26-vii-90 (1); Bombus diversus (Api: Hy) 9-ix-90 (1); Bombus beaticolor (Api: Hy) 26-vii-90 (1); Bombus hypocrita (Api: Hy) 26-vii-90 (2); Meliscaeva cinctella (Sy: Di) 23-ix-90 (1), 26-vii-90 (2); Platycheirus scutatus (Sy: Di) 23-ix-90 (2), 9-ix-90 (2); Eristalis tenax (Sy: Di) 26-vii-90 (2); Syrphus ribessii (Sy: Di) 23-ix-90 (1); Syrphus vitripennis (Sy: Di) 1-ix-91 (1); Syrphus sp.1 (Sy: Di) 23-ix-90 (1); Sca1 (Sca: Di) 26-vii-90 (1); Ant1 (Ant: Di) 1-ix-91 (3), 26-vii-90 (3); Antt1 (Ant: Di) 23-ix-90 (1); Calliphora sp.1 (Cal: Di) 23-ix-90 (2); Cal9 (Cal: Di) 9-ix-90 (1); Xanthothyxus mongol (Cal: Di) 9-ix-90 (1); Tac6 (Tac: Di) 26-vii-90 (1); Tac7 (Tac: Di) 9-ix-90 (1); Tac15 (Tac: Di) 9-ix-90 (1); Tac22 (Tac: Di) 9-ix-90 (1); Parnara guttata guttata (Hes: Le) 26-vii-90 (1); Zophoessa callipogeris (Sat: Le) 26-vii-90 (1); Alcis angulifera (Geo: Le) 26-vii-90 (1); Geo5 (Geo: Le) 26-vii-90 (1); Cosmia variegata (Noc: Le) 26-vii-90 (1)

 Ranunculus japonicus

 Oedemeronia subrosbusta (Oed: Co) 6-vii-90 (1), 9-vi-91 (4); For2 (For: Hy) 17-vi-91 (1); Lasioglossum (E.) nipponense (Hal: Hy) 17-vi-91 (1), 7-vii-90 (1); Lasioglossum (E.) alibes (Hal: Hy) 17-vi-91 (4); Cheilosia sp.3 (Sy: Di) 6-vii-90 (2); Cheilosia sp.6 (Sy: Di) 17-vi-91 (1), 6-vii-90 (1); Chelisotia sp.18 (Sy: Di) 6-vii-90 (1); Sphaerophoria meuthastri (Sy: Di) 6-vii-90 (2); Platycheirus sp. (Sy: Di) 17-vi-91 (1); Platycheirus scutatus (Sy: Di) 7-vii-90 (1); Platycheirus ambiguus (Sy: Di) 6-vii-90 (1); Melanostoma transversum (Sy: Di) 6-vii-90 (1); Melanostoma scalare (Sy: Di) 17-vi-91 (1); Eristalis tenax (Sy: Di) 17-vi-91 (1); Metasyrphus luniger (Sy: Di) 7-vii-90 (1); Ant3 (Ant: Di) 7-vii-90 (3); Colias erate poliograhus (Pie: Le) 9-iv-91 (1)

 Thalictrum filamentosum tenerum

 Meliscaeva omoensis (Sy: Di) 14-vii-90 (1); Platycheirus scutatus (Sy: Di) 14-vii-90 (1)

 Trollius hondoensis

 Oedemeronia subrosbusta (Oed: Co) 14-vii-90 (2), 25-vii-90 (5); Pidonia grallatrix (Cer: Co) 25-vii-90 (1); Bombus hypocrita (Api: Hy) 25-vii-90 (1); Chelisotia sp.1 (Sy: Di) 28-vii-91 (1); Chelisota sp.5 (Sy: Di) 25-vii-90 (1); Cheilosia sp.9 (Sy: Di) 25-vii-90 (1); Meliscaeva cinctella (Sy: Di) 25-vii-90 (1); Platycheirus scutatus (Sy: Di) 14-vii-90 (3); Eristalis tenax (Sy: Di) 25-vii-90 (3); Syrphus vitripennis (Sy: Di) 28-vii-91 (1); Ant1 (Ant: Di) 28-vii-91 (1); Ant2 (Ant: Di) 25-vii-90 (1); Ant3 (Ant: Di) 25-vii-90 (5), 28-vii-91 (1)

 Brassicaceae

 Arabis hirsuta

 Colias erate poliograhus (Pie: Le) 9-iv-91 (1)

 Arabis lyrata kamtschatica

 Ten8 (Ten: Hy) 9-vi-91 (1); Cheilosia sp.3 (Sy: Di) 9-vi-91 (1); Cheilosia sp.4 (Sy: Di) 9-vi-91 (1); Eristalis tenax (Sy: Di) 9-vi-91 (1); Ant2 (Ant: Di) 9-vi-91 (1); Anthocharis cardamines hayashii (Pie: Le) 9-vi-91 (2); Pieris napi japonica (Pie: Le) 9-vi-91 (1)

 Crassulaceae

 Sedum aizoon

 Eum1 (Eum: Hy) 29-vii-90 (1); Lasioglossum (L.) harmandi (Hal: Hy) 29-vii-90 (1); Lasioglossum (E.) sp.4 (Hal: Hy) 25-vii-90 (1); Megachile sp. (Meg: Hy) 29-vii-90 (1); Chelisotia sp.1 (Sy: Di) 29-vii-90 (2); Cheilosia sp.14 (Sy: Di) 29-vii-90 (1); Phytomia zonata (Sy: Di) 29-vii-90 (1); Eristalis cerealis (Sy: Di) 29-vii-90 (1)

 Saxifragaceae

 Astilbe thunbergii

 Hoplia communis (Sca: Co) 14-vii-90 (1); Hoplia maorenis (Sca: Co) 28-vii-90 (1); Gnorimus subopacus (Sca: Co) 14-vii-90 (1); Popilla japonica (Sca: Co) 25-vii-90 (1); Lat1 (Lat: Co) 29-vii-90 (1); Chrysanthia viatica (Oed: Co) 25-vii-90 (7), 29-vii-90 (2); Anaspis funagata (Str: Co) 29-vii-90 (115); Pidonia testacea (Cer: Co) 29-vii-90 (8); Pidonia puziloi (Cer: Co) 29-vii-90 (1); Pseudalosterna misella (Cer: Co)
29-vii-90 (6); Corymbia variicorns (Cer: Co) 25-vii-90 (3), 28-vii-91 (1); Leptura arcuata (Cer: Co) 25-vii-90 (2); Pachytophes cometes (Cer: Co) 25-vii-90 (1), 29-vii-90 (1); Cryptopheus approximatus (Chr: Co) 25-vii-90 (1); Rhogogaster varipes (Ten: Hy) 14-vii-90 (1), 25-vii-90 (3), 28-vii-91 (1); Dolichovespula norvegicoides (Ves: Hy) 29-vii-90 (1); Lasiosglossum (E.) apristum (Hal: Hy) 25-vii-90 (3), 28-vii-91 (1); Lasiosglossum (D.) problematicum (Hal: Hy) 28-vii-91 (1); Bombus hypocrita (Api: Hy) 25-vii-90 (1), 28-vii-91 (2); Apis mellifera (Api: Hy) 14-vii-90 (1); Sim3 (Sim: Di) 14-vii-90 (1); Sr1 (Str: Di) 29-vii-90 (1); Cheliosia sp.11 (Syr: Di) 14-vii-90 (6); Cheliosia sp.12 (Syr: Di) 14-vii-90 (6), 25-vii-90 (1); Cheliosia sp.15 (Syr: Di) 25-vii-90 (1); Cheliosia motodomariensis (Syr: Di) 14-vii-90 (1), 28-vii-91 (2); Melanostoma transversum (Syr: Di) 29-vii-90 (1); Ant1 (Ant: Di) 14-vii-90 (1), 29-vii-90 (1); Ant4 (Ant: Di) 14-vii-90 (3), 25-vii-90 (2), 28-vii-91 (1); Ant5 (Ant: Di) 29-vii-90 (1), 28-vii-90 (1); Tachina jakovlevi (Tac: Di) 29-vii-90 (1), 29-vii-90 (1); Tac4 (Tac: Di) 25-vii-90 (1); Rapala erata (Lyc: Le) 25-vii-90 (1); Libythea celtis celtoides (Lyb: Le) 25-vii-90 (1)

Hydrangea paniculata

Corymbia variicorns (Cer: Co) 17-vii-91 (1); Pachytophes cometes (Cer: Co) 17-vii-91 (2); Leptura ochraceofasciata (Cer: Co) 17-vii-91 (1); Corennys sericata (Cer: Co) 17-vii-91 (2); Rhogogaster varipes (Ten: Hy) 17-vii-91 (1); Dolichovespula norvegicoides (Ves: Hy) 17-vii-91 (5); Dolichovespula adulterina montivaga (Ves: Hy) 17-vii-91 (2); Cossocerus sp. (Syr: Hy) 17-vii-91 (1); Lasiosglossum (E.) apristum (Hal: Hy) 17-vii-91 (1); Ant13 (Ant: Di) 17-vii-91 (1); Calliphora sp.2 (Cal: Di) 17-vii-91 (1); Tachina lutoeula (Tac: Di) 17-vii-91 (1); Tac10 (Tac: Di) 17-vii-91 (1); Tac14 (Tac: Di) 17-vii-91 (1)

Philadelphus satsumi

Adelphocoris rubipes (Mir: He) 25-vii-90 (1); Meligethes morosus (Nit: Co) 25-vii-90 (2); Anaspis funagata (Str: Co) 25-vii-90 (8); Bombus honshuensis (Api: Hy) 14-vii-90 (2); Emp1 (Emp: Di) 14-vii-90 (2); Erístalis tenax (Syr: Di) 14-vii-91 (1); Syrphus vitripennis (Syr: Di) 14-vii-91 (1)

Ribes maximowiczianum

Eusphalerum parallelum (Sta: Co) 3-vi-90 (1); Emp8 (Emp: Di) 3-vi-90 (1)

Rodgersia podophylla

Aph (Aph: He) 6-vii-90 (1); Eusphalerum parallelum (Sta: Co) 6-vii-90 (2); Hoplia communis (Sca: Co) 7-vii-90 (2); Meligethes morosus (Nit: Co) 6-vii-90 (29); Anaspis funagata (Str: Co) 6-vii-90 (26); Pidonia insuturata (Cer: Co) 6-vii-90 (15); Pidonia ayzame (Cer: Co) 6-vii-90 (6); Pidonia testacea (Cer: Co) 6-vii-90 (3); Chr1 (Chr: Co) 7-vii-90 (1); Lupesos moorii (Chr: Co) 7-vii-90 (1); Lasiosglossum (L.) laeviventre (Hal: Hy) 7-vii-90 (1); Bombus hypocrita (Apy: Hy) 7-vii-90 (2); Emp9 (Emp: Di) 6-vii-90 (1); Ant1 (Ant: Di) 7-vii-90 (2); Tachina politula (Tac: Di) 7-vii-90 (1)

Rosaceae

Filipendula multiflora

Meligethes morosus (Nit: Co) 28-vii-91 (3); Antheraphagus nigricornis (Cry: Co) 28-vii-91 (1); Pidonia grallatrix (Cer: Co) 29-vii-90 (1); Pidonia aequora (Cer: Co) 25-vii-90 (1), 28-vii-91 (1); Pidonia insuturata (Cer: Co) 25-vii-90 (1); Anastrangalis acotodes (Cer: Co) 28-vii-90 (1), 29-vii-90 (1); Aphanoperomorpha excavata (Cer: Co) 25-vii-90 (1); Leptura arcuata (Cer: Co) 25-vii-90 (2), 28-vii-91 (1); Nakanea vicaria (Cer: Co) 25-vii-90 (1), 29-vii-90 (2); Cossocerus sp. (Syr: Hy) 25-vii-90 (1); Lasiosglossum (L.) laeviventre (Hal: Hy) 25-vii-90 (1), 28-vii-91 (1); Lasiosglossum (E.) apristum (Hal: Hy) 17-vii-91 (4), 25-vii-90 (6), 28-vii-91 (1); Lasiosglossum (D.) problematicum (Hal: Hy) 25-vii-90 (2); Bombus honshuensis (Apy: Hy) 17-vii-91 (2); Bombus beatitocala (Apy: Hy) 17-vii-91 (1), 25-vii-90 (4), 29-vii-90 (2); Bombus hypocrita (Apy: Hy) 25-vii-90 (1); Panoropades paradoxa (Pan: Me) 25-vii-90 (2); Empis flavofasalis (Emp: Di) 28-vii-91 (1); Cheliosia sp.6 (Syr: Di) 28-vii-91 (1), 29-vii-90 (1); Cheliosia sp.15 (Syr: Di) 25-vii-90 (3); Phytomyza zonata (Syr: Di) 29-vii-90 (1); Meliscaeva cinctella (Syr: Di) 28-vii-91 (1), 29-vii-90 (1); Erístalis tenax (Syr: Di) 25-vii-90 (5), 29-vii-90 (2); Syrphus vitripennis (Syr: Di) 17-vii-91 (2); Ant1 (Ant: Di) 17-vii-91 (2), 28-vii-90 (1); Ant4 (Ant: Di) 25-vii-90 (2), 28-vii-91 (2); Tac14 (Tac: Di) 25-vii-90 (1)

Fragaria nipponica

Meligethes morosus (Nit: Co) 26-v-90 (14); Byturus sp. (Byt: Co) 6-vii-90 (1); Byturus atricolis (Byt: Co) 6-vii-90 (1); Oedemeronia subrobusta (Oed: Co) 17-vii-91 (1), 6-vii-90 (1); Lasiosglossum (L.) laeviventre (Hal: Hy) 26-v-90 (1); Emp1 (Emp: Di) 17-vii-91 (1); Emp3 (Emp: Di) 6-vii-90 (2); Emp6 (Emp: Di) 6-vii-90 (1); Sim2 (Sim: Di) 3-vi-90 (1); Cheliosia sp.3 (Syr: Di) 17-vii-91 (1); Cheliosia sp.6 (Syr: Di) 17-vii-91 (1); Cheliosia sp.14 (Syr: Di) 3-vi-90 (1); Meliscaeva omogensis (Syr: Di) 6-vii-90 (1);
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**Melanostoma transversum** (Syr: Di) 6-vii-90 (1); Agr2 (Agr: Di) 17-vi-91 (1); Sph3 (Sph: Di) 6-vii-90 (1); Ant10 (Ant: Di) 3-vi-91 (1); *Glyphterix nigromarginata* (Cho: Le) 17-vi-91 (1)

*Malus sieboldii*

*Andrena (Sim.) yamato* (And: Hy) 17-vi-91 (1); *Andrena (A.) brehinhirscoopa* (And: Hy) 17-vi-91 (1); *Paparordes paradoxa* (Pan: Me) 17-vi-91 (1); Emp1 (Emp: Di) 17-vi-91 (1); Sim1 (Sim: Di) 17-vi-91 (1); *Cheilosis motodomariensis* (Syr: Di) 17-vi-91 (1); *Platycheirus sp.* (Syr: Di) 17-vi-91 (1); *Eristalis tenax* (Syr: Di) 17-vi-91 (2); *Syrius vitripennis* (Syr: Di) 17-vi-91 (1); *Metasyrphus luniger* (Syr: Di) 17-vi-91 (1); *Onesia sp.* (Cal: Di) 17-vi-91 (1)

*Potentilla freyniana*

*Anthaxia reticulata* (Bup: Co) 26-v-90 (1); *Oedemeronia subrobusata* (Oed: Co) 3-vi-90 (3); *Lasioglossum (L.) laeviceinentre* (Hal: Hy) 26-v-90 (1); *Lasioglossum (E.) apristum* (Hal: Hy) 26-v-90 (1); *Lasioglossum (D.) problematicum* (Hal: Hy) 3-vi-90 (1); *Cheilosis sp.2* (Syr: Di) 26-v-90 (1); *Cheilosis sp.3* (Syr: Di) 26-v-90 (1); *Cheilosis sp.13* (Syr: Di) 27-v-90 (3); *Sphaerophoria meuthastri* (Syr: Di) 26-v-90 (1), 3-vi-90 (1); *Didea fasciata* (Syr: Di) 26-v-90 (1); *Dro3 (Dro: Di) 26-v-90 (1); *Sph1 (Sph: Di) 26-v-90 (2); Ant15 (Ant: Di) 27-v-90 (2); Ant18 (Ant: Di) 27-v-90 (1)

*Prunus maximowiczii*

*Emp1 (Emp: Di) 17-vi-91 (4); Emp7 (Emp: Di) 17-vi-91 (3); Emp8 (Emp: Di) 17-vi-91 (2); *Empis flavofasalis* (Emp: Di) 17-vi-91 (3)

*Prunus nipponica*

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*Rubus idaeus f. marmoratus*

*Bombus beaticola* (Api: Hy) 17-vi-91 (2)

*Rubus pungens var. oldhamii*

*Byturis ohtai* (Byt: Co) 17-vi-91 (3); *Bombus honshuensis* (Apri: Hy) 9-vi-91 (2); *Bombus ardens* (Api: Hy) 9-vi-91 (3); *Bombus beaticola* (Api: Hy) 17-vi-91 (3), 9-vi-91 (7); *Aca1 (Aca: Di) 17-vi-91 (1); *Platycheirus sp.* (Syr: Di) 17-vi-91 (1); *Melanostoma scalare* (Syr: Di) 17-vi-91 (2)

*Sorbus commixta*

*Eusphalerum parallelum* (Sta: Co) 6-vii-90 (3); *Meligethes morosus* (Nit: Co) 6-vii-90 (1); *Biphyllis thurosideoides* (Bip: Co) 6-vii-90 (1); *Pidonias oyamae* (Cer: Co) 6-vii-90 (2); *Pidonias testacea* (Cer: Co) 6-vii-90 (3); *Chysoscharis sp.* (Eul: Hy) 6-vii-90 (1)

*Oxalidaceae*

*Oxalis acetosella*

*Eusphalerum parallelum* (Sta: Co) 26-v-90 (23); *Nomada sp.* (Ant: Hy) 27-v-90 (1); *Cheilosis sp.6* (Syr: Di) 27-v-90 (2); *Cheilosis sp.13* (Syr: Di) 27-v-90 (2); *Platycheirus sp.* (Syr: Di) 27-v-90 (1)

*Geraniaceae*

*Geranium eriostemon var. reini*

*Oedemeronia subrobusata* (Oed: Co) 14-vii-90 (2), 29-vii-90 (3); *Bombus consobrinus* (Api: Hy) 25-vii-90 (4), 28-vii-90 (1); *Bombus diversus* (Api: Hy) 7-vii-90 (1); *Bombus honshuensis* (Api: Hy) 14-vii-90 (2), 7-vii-90 (1); *Bombus ardens* (Api: Hy) 25-vii-90 (1), 6-vii-90 (1); *Bombus beaticola* (Api: Hy) 14-vii-90 (24), 25-vii-90 (4), 28-vii-90 (3), 29-vii-90 (2), 6-vii-90 (15), 7-vii-90 (6); *Empis flavofasalis* (Emp: Di) 6-vii-90 (1); *Cheilosis sp.1* (Syr: Di) 25-vii-90 (5), 28-vii-90 (2); *Cheilosis sp.4* (Syr: Di) 25-vii-90 (1); *Cheilosis sp.9* (Syr: Di) 14-vii-90 (1), 28-vii-90 (1); *Melanostoma transversum* (Syr: Di) 14-vii-90 (1); *Melanostoma scalare* (Syr: Di) 14-vii-90 (1); *Didea fasciata* (Syr: Di) 7-vii-90 (2); *Anaria funebris assimilis* (Pyr: Le) 6-vii-90 (1); *Pieris napi japonica* (Pie: Le) 6-vii-90 (1)

*Acer japonicum*

*Vespula schrenckii* (Ves: Hy) 26-v-90 (2); *Criorhina apicalis* (Syr: Di) 26-v-90 (1); *Platycheirus ambiguus* (Syr: Di) 26-v-90 (1)

*Acer shirasawanum*
Penl (Pen: He) 9-vi-91 (1); Mir5 (Mir: He) 9-vi-91 (1); Eusphalerum parallelum (Sta: Co) 9-vi-91 (2); Micadoantharis japonicus (Can: Co) 9-vi-91 (1); Byturus affinis (Byt: Co) 9-vi-91 (1); Phyllobius picepes (Cur: Co) 9-vi-91 (1); Ich5 (Ich: Hy) 9-vi-91 (1); Eu9 (Eu: Hy) 9-vi-91 (1); Bombus ardens (Api: Hy) 9-vi-91 (1); HelI (Hel: Di) 9-vi-91 (1); Ant15 (Ant: Di) 9-vi-91 (2); Tac22 (Tac: Di) 9-vi-91 (1); Geo3 (Geo: Le) 9-vi-91 (1)

Acer ukurunduense
Mir3 (Mir: He) 7-vii-90 (1); Mir5 (Mir: He) 7-vii-90 (1); Lupesus moorii (Chr: Co) 7-vii-90 (1); Emp4 (Emp: Di) 7-vii-90 (1); Emp5 (Emp: Di) 7-vii-90 (8)

Celastraceae

Euonymus macropterus
ThrI (Thr: Th) 17-vi-91 (1); Eusphalerum parallelum (Sta: Co) 17-vi-91 (2); Podabrus malthinoides (Can: Co) 17-vi-91 (1); Emp2 (Emp: Di) 17-vi-91 (2); Emp8 (Emp: Di) 17-vi-91 (1)

Euonymus sieboldianus
Ligus honshuensis (Mir: He) 14-vii-90 (1); Andrena (A.) aburana (And: Hy) 14-vii-90 (1); Scil (Sci: Di) 14-vii-90 (4); Cheilosia sp.10 (Syr: Di) 14-vii-90 (1); Cheilosia sp.12 (Syr: Di) 14-vii-90 (1); Ant15 (Ant: Di) 14-vii-90 (1); Ant22 (Ant: Di) 14-vii-90 (2); Tac21 (Tac: Di) 14-vii-90 (1)

Elaeagnaceae

Elaeagnus montana
Micadoantharis japonicus (Can: Co) 14-vii-90 (1); Bombus honshuensis (Api: Hy) 14-vii-90 (3), 7-vii-90 (3); Bombus ardens (Api: Hy) 7-vii-90 (6); Bombus beatitola (Api: Hy) 14-vii-90 (5), 7-vii-90 (9); Meliscaeva cinctella (Syr: Di) 14-vii-90 (5); Lau1 (Lau: Di) 14-vii-90 (1); Lau2 (Lau: Di) 14-vii-90 (1); Dro1 (Dro: Di) 14-vii-90 (1); Dro2 (Dro: Di) 14-vii-90 (1); Dro4 (Dro: Di) 14-vii-90 (1); Ant14 (Ant: Di) 7-vii-90 (1)

Violaceae

Viola grypoceras
Anthocharis cardamines hayashii (Pic: Le) 26-v-90 (2)

Onagraceae

Chamaenerion angustifolium
Mir2 (Mir: He) 28-viii-91 (1); Dolichovespula norvegicoides (Ves: Hy) 28-viii-91 (2); Lasio glossum (D.) problematicum (Hal: Hy) 25-vii-90 (1); Lasio glossum (E.) apristum (Hal: Hy) 25-vii-90 (2); Bombus honshuensis (Api: Hy) 25-vii-90 (2), 28-vii-90 (5); Bombus beatitola (Api: Hy) 28-vii-91 (1); Bombus hypocrita (Api: Hy) 28-vii-91 (1)

Umbelliferae

Angelica polymorpha
Mir5 (Mir: He) 1-ix-91 (1); Epuraea fegerri (Nit: Co) 1-ix-91 (1); Bra1 (Bra: Hy) 1-ix-91 (1); Ich7 (Ich: Hy) 1-ix-91 (1); EuI0 (Eu: Hy) 1-ix-91 (1); Cyn1 (Cyn: Hy) 1-ix-91 (1); Cheilosia sp.6 (Syr: Di) 1-ix-91 (2); Cheilosia sp.15 (Syr: Di) 1-ix-91 (1); Cheilosia sp.17 (Syr: Di) 1-ix-91 (1); Meliscaeva cinctella (Syr: Di) 1-ix-91 (1); Melanostoma scalare (Syr: Di) 1-ix-91 (1); Sypnus ribessii (Syr: Di) 1-ix-91 (1); Sphl (Sph: Di) 1-ix-91 (1); Ant1 (Ant: Di) 1-ix-91 (2); Ant15 (Ant: Di) 1-ix-91 (3); Ant20 (Ant: Di) 1-ix-91 (1); Ant27 (Ant: Di) 1-ix-91 (1); Dapsopoda flavia (Cal: Di) 1-ix-91 (1); Angelica pubescens

Hoplia moerens (Sca: Co) 29-vii-90 (1); Pidonia grallatrix (Cer: Co) 26-viii-90 (1); Corymbia succedanea (Cer: Co) 17-viii-91 (1), 26-viii-90 (1); Pachytodes cometes (Cer: Co) 26-viii-90 (2); Per1 (Per: Hy) 26-viii-90 (1); Dolichovespula norvegicoides (Ves: Hy) 17-viii-91 (5); Dolichovespula adulterina montivaga (Ves: Hy) 17-viii-91 (3); Hylaeus thoracius (Col: Hy) 17-viii-91 (1); Lasio glossum (E.) apristum (Hal: Hy) 17-viii-91 (1); Lasio glossum (E.) aff. atroglaicum (Hal: Hy) 17-viii-91 (1); Cheilosia sp.2 (Syr: Di) 17-viii-91 (1); Cheilosia sp.11 (Syr: Di) 17-viii-91 (1); Cheilosia motodomiariensis (Syr: Di) 26-viii-90 (2), 29-vii-90 (4); Ichyrosyrphus glaucius (Syr: Di) 26-viii-90 (1); Didea fasciata (Syr: Di) 17-viii-91 (1); Lau1 (Lau: Di) 26-viii-90 (1); Agr1 (Agr: Di) 26-viii-90 (1); Ant1 (Ant: Di) 17-viii-91 (1), 29-vii-90 (1); Ant3 (Ant: Di) 29-vii-90 (1); Ant13 (Ant: Di) 26-viii-90 (1); Ant14 (Ant: Di) 26-viii-90 (1); Ant21 (Ant: Di) 29-vii-90 (1); Cal5 (Cal: Di) 29-vii-90 (1); Cal7 (Cal: Di) 26-viii-90 (1); Xanthothymes mongol (Cal: Di)
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<tbody>
<tr>
<td>26-vii-90 (1); Onesia sp. (Cal: Di) 26-vii-90 (2); Tachina jakovlevi (Tac: Di) 17-vii-91 (4), 26-vii-90 (1); Tac9 (Tac: Di) 29-vii-90 (1); Tac12 (Tac: Di) 29-vii-90 (1); Tac16 (Tac: Di) 26-vii-90 (1); Tac18 (Tac: Di) 29-vii-90 (1)</td>
</tr>
<tr>
<td><strong>Libanotis coreana</strong></td>
</tr>
<tr>
<td>Oedemeronia subrobusta (Oed: Co) 26-vii-90 (1); Cheilosia sp.5 (Syr: Di) 29-vii-90 (1); Cheilosia motodomariensis (Syr: Di) 29-vii-90 (5); Eristalis tenax (Syr: Di) 26-vii-90 (11); Syrphus vitripennis (Syr: Di) 29-vii-90 (2); Calliphora sp.1 (Cal: Di) 26-vii-90 (1); Cal16 (Cal: Di) 26-vii-90 (1)</td>
</tr>
<tr>
<td><strong>Pyrolaceae</strong></td>
</tr>
<tr>
<td>Pyrola incarnata</td>
</tr>
<tr>
<td>Meligethes morosus (Nit: Co) 25-vii-90 (2); Anaspis funagata (Str: Co) 25-vii-90 (1); Pidonia grallatix (Cer: Co) 25-vii-90 (3); Pidonia signifera (Cer: Co) 25-vii-90 (1); Pidonia yokoyamai (Cer: Co) 25-vii-90 (1); Pidonia masakii (Cer: Co) 25-vii-90 (2); Pidonia oyamae (Cer: Co) 25-vii-90 (3); Pidonia semiobscura (Cer: Co) 25-vii-90 (1); Bombus hypocrita (Api: Hy) 25-vii-90 (4)</td>
</tr>
<tr>
<td>Pyrola alpina</td>
</tr>
<tr>
<td>Menziesia pentandra</td>
</tr>
<tr>
<td><strong>Ericaceae</strong></td>
</tr>
<tr>
<td>Enkianthus campanulatus</td>
</tr>
<tr>
<td>Vespa simillima xanthoptera (Ves: Hy) 9-vi-91 (1); Dolichovespula norvegicoides (Ves: Hy) 9-vi-91 (2); Lasioglossum (L.) laeviventre (Hal: Hy) 9-vi-91 (1); Andreana (Gyma.) parathoracina (And: Hy) 7-vii-90 (1); Bombus diversus (Api: Hy) 7-vii-90 (1); Bombus honshuensis (Api: Hy) 7-vii-90 (1); Bombus ardens (Api: Hy) 7-vii-90 (1); Platyceras scutatus (Syr: Di) 14-vii-90 (1); Syrphus vitripennis (Syr: Di) 7-vii-90 (1)</td>
</tr>
<tr>
<td><strong>Asclepiadaceae</strong></td>
</tr>
<tr>
<td>Cynanchum ascrifolium</td>
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<tr>
<td>Polemonium caeruleum yezoense</td>
</tr>
<tr>
<td><strong>Polemoniaceae</strong></td>
</tr>
<tr>
<td>Polemonium caeruleum yezoense</td>
</tr>
<tr>
<td><strong>Labiateae</strong></td>
</tr>
<tr>
<td>Clinopodium chinense grandiflorum</td>
</tr>
<tr>
<td><strong>Meehania urticifolia</strong></td>
</tr>
</tbody>
</table>
Euphrasia maximowiczii
Meliscaeva cinctella (Syr: Di) 26-viii-90 (1)

Scrophulariaceae

Bombus consobrinus (Api: Hy) 9-vi-91 (1); Bombus hypocrita (Api: Hy) 9-vi-91 (2)

Phus vitripennis (27-v-90 (1); 28-vii-91 (1); 91 (1);
28-vii-91 (2); Bombus beaticola (Api: Hy) 17-viii-91 (1); Bombus hypocrita (Api: Hy) 17-viii-91 (2), 26-viii-90 (1)
Veronicastrum sibiricum japonicum

Mordellistena sp.1 (Mor: Co) 28-vii-90 (1); Anoplolemera sp. excavata (Cer: Co) 25-vii-90 (1);
Nakanea vicaria (Cer: Co) 28-vii-91 (1); Ten2 (Ten: Hy) 29-vii-91 (1); Sigmus sp. (Sph: Hy) 28-vii-91 (1);
Lasioglossum (L.) proximatum (Hal: Hy) 28-vii-91 (1); Lasioglossum (D.) problematicum (Hal: Hy) 25-vii-90 (1);
Lasioglossum (E.) sp. K2 (Hal: Hy) 25-vii-90 (2); Lasioglossum (E.) apristum (Hal: Hy) 25-vii-90 (1);
Mallota dimorpha (Sy: Di) 29-vii-90 (1); Voltucella pellucens (Sy: Di) 25-vii-90 (1), 28-vii-90 (1);
Voltucella jeddarina (Sy: Di) 28-vii-90 (1), 29-vii-90 (1); Meliscaeva cinctella (Sy: Di) 29-vii-90 (5);
Syrphus vitripennis (Sy: Di) 29-vii-90 (1); Con4 (Con: Di) 25-vii-90 (1), Ant1 (Ant: Di) 28-vii-90 (1),
Ant4 (Ant: Di) 25-vii-90 (1); Ant14 (Ant: Di) 29-vii-90 (1); Balatala gracilis (Zyg: Le) 29-vii-90 (1);
Platyptilia sachalinensis (Pte: Le) 29-vii-90 (1); Melitaea niphora (Nym: Le) 28-vii-90 (1); Inachis io geisha (Nym: Le) 29-vii-90 (1); Sypeperia aglaja fortuna (Nym: Le) 25-vii-90 (1),
Zophaessa callipleris (Sat: Le) 29-vii-90 (2); Ourapteryx persica (Geo: Le) 29-vii-90 (1); Psychostrophia melanorgia (Cal: Le) 29-vii-90 (1);
Symgrapha ain (Noc: Le) 29-vii-90 (3)

Caprifoliaceae

Lonicera alpigena var. glehni

Euphalarum parallelum (Sta: Co) 9-vi-91 (8); Meligethes morosus (Nit: Co) 9-vi-91 (1); Byturus sp. (Byt: Co) 9-vi-91 (1), Pseudolosterna misella (Cer: Co) 9-vi-91 (1); Asemum amurense (Cer: Co) 9-vi-91 (1);
Chirs (Chr: Co) 9-vi-91 (1); Att1 (Att: Co) 9-vi-91 (1); Scoll (Scoll: Co) 9-vi-91 (1); Tentredo bajionana (Ten: Hy) 9-vi-91 (1); Ten5 (Ten: Hy) 9-vi-91 (1); Allophrombocerus komowi (Ten: Hy) 9-vi-91 (1); Strongylolaster sp. (Ten: Hy) 9-vi-91 (1); Br3 (Bra: Hy) 9-vi-91 (1); Ich1 (Ich: Hy) 9-vi-91 (1),
Ich2 (Ich: Hy) 9-vi-91 (1); Ich3 (Ich: Hy) 9-vi-91 (4); Ich6 (Ich: Hy) 9-vi-91 (1); Pte1 (Pte: Hy) 9-vi-91 (1), Pte2 (Pte: Hy) 9-vi-91 (1); Eu18 (Eu1: Hy) 9-vi-91 (1); Pom1 (Pom: Hy) 9-vi-91 (1); Dolichevespula norvegicoides (ves: Hy) 9-vi-91 (2); Lasioglossum (L.) laeviventre (Hal: Hy) 9-vi-91 (2); Lasioglossum (E.) apristum (Hal: Hy) 9-vi-91 (1); Lasioglossum (L.) laeviventre (Hal: Hy) 9-vi-91 (1);
Andrena (A.) lapponica sumizome (And: Hy) 9-vi-91 (1); Bombus honshuensis (Api: Hy) 9-vi-91 (1); Bombus beaticola (Api: Hy) 9-vi-91 (5), Emp3 (Emp: Di) 9-vi-91 (1); Emp10 (Emp: Di) 9-vi-91 (1); Pip1 (Pip: Di) 9-vi-91 (1);
Sphegina sp. (Spr: Di) 9-vi-91 (1); Lau2 (Lau: Di) 9-vi-91 (1); Chl2 (Chl: Di) 9-vi-91 (1); Hel2 (Hel: Di) 9-vi-91 (1); Calliphora sp.1 (Cal: Di) 9-vi-91 (1); Tac18 (Tac: Di) 9-vi-91 (1); Pieris napi japonica (Pie: Le) 9-vi-91 (1);
Geo4 (Geo: Le) 9-vi-91 (1)

Viburnum furcatum

Euphalarum paralleleum (Sta: Co) 27-v-90 (1); Dasyes vulgaris (Mel: Co) 27-v-90 (1); Euphraea sp.1 (Nit: Co) 26-v-90 (5), 27-v-90 (1); Meligethes morosus (Nit: Co) 26-v-90 (1); Euphalarum fergeri (Nit: Co) 27-v-90 (9); Byturus sp. (Byt: Co) 26-v-90 (1); Byturus ohtai (Byt: Co) 26-v-90 (1); Byturus affinis (Byt: Co) 26-v-90 (4), 27-v-90 (37); Curculio convexus (Cur: Co) 26-v-90 (3), 27-v-90 (1)

Viburnum opulus var. calvecens

Mir1 (Mir: He) 7-vi-90 (2); Adolphoriscus rubripes (Mir: He) 7-vi-90 (2); Ela1 (Ela: Co) 7-vi-90 (1);
Mordellistena sp.1 (Mor: Co) 7-vi-90 (1); Pidonia grallatrix (Cer: Co) 7-vi-90 (1); Xyl2 (Xyl: Di) 7-vi-90 (1), Ant14 (Ant: Di) 7-vi-90 (1)

Weigela decora

Pidonia signifera (Cer: Co) 7-vi-90 (1); Lasioglossum (E.) nipponense (Hal: Hy) 7-vi-90 (1); Bombus consobrinus (Api: Hy) 7-vi-90 (8); Bombus diversus (Api: Hy) 7-vi-90 (3); Oligoneura itoi (Acr: Di) 7-vi-90 (1); Sphaerophoria javana (Syr: Di) 7-vi-90 (1); Meliscaeva cinctella (Syr: Di) 7-vi-90 (2);
Syrphus ribessii (Syr: Di) 7-vi-90 (1)
Flowering Phenology and Anthophilous Insect Community

Valerianaceae

*Patrinia triloba palmata*  
*Bombus beaticolus* (Api: Hy) 28-vii-91 (1); *Balatala gracilis* (Zyg: Le) 28-vii-91 (1)

*Patrinia villosa*

*Corymbia succedanea* (Cer: Co) 1-ix-91 (1); Eum2 (Eum: Hy) 1-ix-91 (1); Eum3 (Eum: Hy) 1-ix-91 (1); *Dolichovespula norvegicoides* (Ves: Hy) 1-ix-91 (2), 17-viii-91 (1); *Lasiosglossum (L.) laeviventre* (Hal: Hy) 1-ix-91 (1); *Melanostoma mellinum* (Syr: Di) 1-ix-91 (1); *Conops flavipes* (Con: Di) 1-ix-91 (1); Cal8 (Cal: Di) 1-ix-91 (1); Tac16 (Tac: Di) 1-ix-91 (1); Tac18 (Tac: Di) 1-ix-91 (1); Tac22 (Tac: Di) 17-vii-91 (2)

Dipsacaceae


Dipsacaceae

*Corymbia succedanea* (Cer: Co) 1-ix-91 (1); Eum2 (Eum: Hy) 1-ix-91 (1); Eum3 (Eum: Hy) 1-ix-91 (1); *Dolichovespula norvegicoides* (Ves: Hy) 1-ix-91 (2), 17-viii-91 (1); *Lasiosglossum (L.) laeviventre* (Hal: Hy) 1-ix-91 (1); *Melanostoma mellinum* (Syr: Di) 1-ix-91 (1); *Conops flavipes* (Con: Di) 1-ix-91 (1); Cal8 (Cal: Di) 1-ix-91 (1); Tac16 (Tac: Di) 1-ix-91 (1); Tac18 (Tac: Di) 1-ix-91 (1); Tac22 (Tac: Di) 17-vii-91 (2)

Scabiosa japonica


Campanulaceae

*Adenophora triphylla var. japonica*

*Forficula mikado* (For: De) 26-viii-90 (1); *Lasiosglossum (E.) albipes* (Hal: Hy) 1-ix-91 (1); *Bombus diversus* (Api: Hy) 1-ix-91 (1); *Bombus honshuensis* (Api: Hy) 1-ix-91 (1); *Bombus hypocrita* (Api: Hy) 1-ix-91 (2), 28-vii-91 (4); *Psithyrus norvegicus nipponicus* (Api: Hy) 1-ix-91 (1); *Cheilosia sp.* (Syr: Di) 17-vii-91 (1); *Meliscaeva cinctella* (Syr: Di) 26-viii-90 (1); *Eristalis tenax* (Syr: Di) 26-viii-90 (5); *Eristalis cerealis* (Syr: Di) 26-viii-90 (5);

*Campanula punctata var. hondoensis*

*Bombus consobrinus* (Api: Hy) 28-vii-91 (1); *Bombus diversus* (Api: Hy) 1-ix-91 (1); *Bombus honshuensis* (Api: Hy) 1-ix-91 (1); *Bombus hypocrita* (Api: Hy) 1-ix-91 (2), 28-vii-91 (4); *Psithyrus norvegicus nipponicus* (Api: Hy) 1-ix-91 (1); *Cheilosia sp.* (Syr: Di) 17-vii-91 (1); *Meliscaeva cinctella* (Syr: Di) 26-viii-90 (1); *Eristalis tenax* (Syr: Di) 26-viii-90 (5); *Eristalis cerealis* (Syr: Di) 26-viii-90 (5); *Tachina politula* (Tac: Di) 23-ix-90 (1)

Compositae

*Achillea alpina var. discoida*

*Meliscaeva cinctella* (Syr: Di) 17-vii-91 (1)

Anaphalis margaritacea

*Oedemeronia subrobusta* (Oed: Co) 26-viii-90 (2); *Chrysarthia viatica* (Oed: Co) 1-ix-91 (2), 26-vii-90 (1); *Lasiosglossum (D.) problematicum* (Hal: Hy) 26-viii-90 (1); *Cheilosia sp.* (Syr: Di) 1-ix-91 (1); *Melanostoma transversum* (Syr: Di) 9-ix-90 (1); *Eristalis tenax* (Syr: Di) 26-viii-90 (5); *Eristalis cerealis* (Syr: Di) 26-viii-90 (5); *Tachina politula* (Tac: Di) 23-ix-90 (1)

*Aster ageratoides amplexifolius*

*Lasiosglossum (E.) aff. atroglaucum* (Hal: Hy) 23-ix-90 (1); *Lasiosglossum (E.) sp.* K1 (Hal: Hy) 23-ix-90 (1); *Helophilus virgatus* (Syr: Di) 23-ix-90 (1); *Eristalis tenax* (Syr: Di) 23-ix-90 (1); *Tachina politula* (Tac: Di) 23-ix-90 (1)

*Aster ageratoides oevatus*

*Lasiosglossum (L.) laeviventre* (Hal: Hy) 22-ix-91 (1); *Lasiosglossum (E.) aff. atroglaucum* (Hal: Hy) 22-ix-91 (4); *Eristalis tenax* (Syr: Di) 23-ix-90 (5)

*Aster glehni var. hondoensis*

*Mir5* (Mir: He) 26-viii-90 (1); *Psithyrus norvegicus nipponicus* (Api: Hy) 26-viii-90 (1); *Parastrangalis nymphula* (Cer: Co) 26-viii-90 (1); *Meliscaeva cinctella* (Syr: Di) 26-viii-90 (1); *Melanostoma transversum* (Syr: Di) 26-viii-90 (1)

*Cacalia adenostyloides*
Bombus diversus (Api: Hy) 17-viii-91 (2); Bombus honshuensis (Api: Hy) 17-viii-91 (3); Bombus beatitica (Api: Hy) 17-viii-91 (3); Bombus hypocrita (Api: Hy) 17-viii-91 (1); Emp11 (Emp: Di) 17-viii-91 (1); Cheilosia sp.6 (Syr: Di) 17-viii-91 (1); Melissaeva cinctella (Syr: Di) 17-viii-91 (3); Alcis angulifera (Geo: Le) 17-viii-91 (1)

Cacalia hastata farfaraefolia

Bombus beatitica (Api: Hy) 26-viii-90 (1); Bombus hypocrita (Api: Hy) 26-viii-90 (3)

Cirsium effusum

Bombus consobrinus (Api: Hy) 9-ix-90 (1); Bombus diversus (Api: Hy) 1-ix-91 (4), 26-viii-90 (1); Bombus honshuensis (Api: Hy) 1-ix-91 (17), 22-ix-91 (5), 23-ix-90 (3), 26-viii-90 (3), 9-ix-90 (1); Bombus beatitica (Api: Hy) 1-ix-91 (3), 23-ix-90 (1), 26-viii-90 (1); Bombus hypocrita (Api: Hy) 1-ix-91 (13), 23-ix-90 (5), 26-viii-90 (1); Platychéirius scutatus (Syr: Di) 23-ix-90 (1); Erístalis tenax (Syr: Di) 23-ix-90 (2); Didéa alneti (Syr: Di) 23-ix-90 (1); Syrphus ribésii (Syr: Di) 9-ix-90 (1); Parnara guttata guttata (Hes: Le) 23-ix-90 (1), 26-viii-90 (1)

Eupatorium chinense sachalinense

Cryptoscelus approximatus (Chr: Co) 17-viii-91 (1); Erístalis tenax (Syr: Di) 1-ix-91 (2), 17-viii-91 (1); Anth (Ant: Di) 1-ix-91 (3); Anth3 (Ant: Di) 17-viii-91 (1); Dexopollénia flava (Cal: Di) 1-ix-91 (1); Cal4 (Cal: Di) 1-ix-91 (1); Tac5 (Tac: Di) 1-ix-91 (1); Tac8 (Tac: Di) 17-viii-91 (1); Tac13 (Tac: Di) 1-ix-91 (1); Tacc22 (Tacc: Di) 1-ix-91 (1), 17-viii-91 (1); Zophoessa callipeteris (Sat: Le) 17-viii-91 (1)

Ixeris dentata var. albiflora

Cheilosia sp.15 (Syr: Di) 14-ix-90 (1); Platychéirius scutatus (Syr: Di) 14-ix-90 (1); Melanostoma transversum (Syr: Di) 14-ix-90 (1)

Ligularia dentata

Bombus honshuensis (Api: Hy) 17-viii-91 (2); Bombus beatitica (Api: Hy) 17-viii-91 (2), 29-vii-90 (2); Bombus hypocrita (Api: Hy) 17-viii-91 (1); Cheilosia sp.1 (Syr: Di) 28-vii-91 (4), 29-vii-90 (3); Cheilosia sp.10 (Syr: Di) 28-vii-91 (2); Rhingia laevigata (Syr: Di) 28-vii-91 (1); Melanostoma mellinum (Syr: Di) 28-vii-91 (1); Syrphus ribésii (Syr: Di) 28-vii-91 (1); Ant7 (Ant: Di) 29-vii-90 (1); Parnara guttata guttata (Hes: Le) 17-viii-91 (1); Zophoessa callipeteris (Sat: Le) 29-vii-90 (1)

Picris hieracioides japonica

Oedemeronia subrubusta (Oed: Co) 28-vii-91 (3)

Senecio cannabifolius

Oedemeronia subrubusta (Oed: Co) 1-ix-91 (1); Lasïoglóssum (L.) laeviventre (Hal: Hy) 1-ix-91 (1); Cheilosia sp.3 (Syr: Di) 1-ix-91 (1); Cheilosia sp.10 (Syr: Di) 9-ix-90 (1); Helophílus virgatus (Syr: Di) 9-ix-90 (1); Erístalis tenax (Syr: Di) 1-ix-91 (1); 9-ix-90 (2); Syrphus ribésii (Syr: Di) 9-ix-90 (1); Anth6 (Ant: Di) 1-ix-91 (1); Anth8 (Ant: Di) 9-ix-90 (1); Cali11 (Cal: Di) 9-ix-90 (1); Parnara guttata guttata (Hes: Le) 9-ix-90 (1)

Senecio nemorensis

Lasïoglóssum (L.) laeviventre (Hal: Hy) 1-ix-91 (1); Cheilosia sp.11 (Syr: Di) 1-ix-91 (1); Melanostoma transversum (Syr: Di) 1-ix-91 (1); Erístalis tenax (Syr: Di) 26-vii-90 (3); Alcis angulifera (Geo: Le) 26-vii-90 (1)

Serratula coronata insularis

Oedemeronia subrubusta (Oed: Co) 9-ix-90 (1); Lasïoglóssum (L.) laeviventre (Hal: Hy) 1-ix-91 (2); Lasïoglóssum (L.) laeviventre (Hal: Hy) 1-ix-91 (3); Lasïoglóssum (E.) nipponense (Hal: Hy) 22-ix-91 (1); Megáchile tsurugensis (Meg: Hy) 17-viii-91 (1); Nomada issikii (Ant: Hy) 1-ix-91 (1); Bombus consobrinus (Api: Hy) 17-viii-91 (1), 9-ix-90 (1); Bombus diversus (Api: Hy) 17-viii-91 (6); Bombus honshuensis (Api: Hy) 17-viii-91 (9), 25-viii-90 (6); Bombus beatitica (Api: Hy) 17-viii-91 (12); Bombus hypocrita (Api: Hy) 17-viii-91 (2), 22-ix-91 (4), 26-vii-90 (1), 9-ix-90 (1); Cheilosia sp.7 (Syr: Di) 26-viii-90 (1); Leucózona lucorum (Syr: Di) 1-ix-91 (1); Melissaeva cinctella (Syr: Di) 1-ix-91 (1); Erístalis tenax (Syr: Di) 1-ix-91 (7), 17-viii-91 (2), 26-vii-90 (1), 9-ix-90 (1); Dideá fasciáta (Syr: Di) 17-viii-91 (2), 9-ix-90 (1); Dasyysyrphus bilíneatus (Syr: Di) 26-vii-90 (1); Syrphus ribésii (Syr: Di) 17-viii-91 (1), 26-vii-90 (1); Metasuysyrphus farquenu (Syr: Di) 1-ix-91 (2), 17-viii-91 (1); Dasyysyrphus trincíctus (Syr: Di) 1-ix-91 (1); Con1 (Con: Di) 17-vii-91 (1); Parnara guttata guttata (Hes: Le) 1-ix-91 (4), 17-viii-91 (2), 26-vii-90 (2), 9-ix-90 (5); Papilio machoán hippocrates (Pap: Le) 17-viii-91 (1); Gonepterex aspásia niphónica (Pie: Le) 17-viii-91 (1); Argynnis paphia tushishiana (Nym: Le) 1-ix-91 (1); Ináchis io geisha (Nym: Le) 1-ix-91 (1), 17-viii-91 (1); Speyera aglaia forúnta (Nym: Le) 17-viii-91 (1); Vanessa indica (Nym: Le) 1-ix-91 (1); Macroglóssum fringilla (Sph: Le) 1-ix-91 (1)
Chrysanthisa viatica (Oed: Co) 1-ix-91 (1); Lasioglossum (L.) laeviventre (Hal: Hy) 1-ix-91 (1); Cheilosis sp.3 (Syr: Di) 1-ix-91 (1); Cheilosis sp.6 (Syr: Di) 1-ix-91 (1), 9-ix-90 (1); Platycheirus scutatus (Syr: Di) 9-ix-90 (6); Melanostoma transversum (Syr: Di) 1-ix-91 (3); Eristalis tenax (Syr: Di) 23-ix-90 (1); Sca2 (Sca: Di) 23-ix-90 (1); Ant17 (Ant: Di) 1-ix-91 (1); Cal15 (Cal: Di) 9-ix-90 (1); Tac7 (Tac: Di) 9-ix-90 (1); Tac17 (Tac: Di) 1-ix-91 (1); Tac22 (Tac: Di) 1-ix-91 (3)

**Synurus pungens**

*Bombus consobrinus* (Api: Hy) 1-ix-91 (1), 9-ix-90 (1); *Bombus diversus* (Api: Hy) 23-ix-90 (2); *Didea alneti* (Syr: Di) 23-ix-90 (1); *Syphrus vitripennis* (Syr: Di) 23-ix-90 (1)

**Taraxacum hondoense**

*Meligethes morosus* (Nit: Co) 3-vi-90 (1); *Oedemeronia subrobus* (Oed: Co) 3-vi-90 (7), 9-vi-91 (1); *Diglyphus mino* (Eul: Hy) 3-vi-90 (2); *Eul7* (Eul: Hy) 3-vi-90 (1); *Lasioglossum (L.) laeviventre* (Hal: Hy) 9-vi-91 (1); *Lasioglossum (E.) albies* (Hal: Hy) 3-vi-90 (1); *Cheilosis sp.3* (Syr: Di) 9-vi-91 (1); *Melanostoma scalare* (Syr: Di) 3-vi-90 (1); *Colias erate poligratus* (Pie: Le) 3-vi-90 (1)

**Liliaceae**

*Hosta sieboldiana*


**Polygonatum laiantham**

For1 (For: Hy) 17-vi-91 (1); For2 (For: Hy) 17-vi-91 (2); *Lasioglossum (D.) problematicum* (Hal: Hy) 17-vi-91 (1); *Bombus consobrinus* (Api: Hy) 17-vi-91 (1), 6-vii-90 (1); *Bombus honshuensis* (Api: Hy) 17-vi-91 (1); *Bombus ardens* (Api: Hy) 17-vi-91 (1), 9-vi-91 (1); *Bombus beaticola* (Api: Hy) 17-vi-91 (2)

**Polygonatum macrantham**

*Bombus diversus* (Api: Hy) 14-vii-90 (1)

**Veratrum album oxysepalum**

*Harmonia axyridis* (Coc: Co) 29-vii-90 (1); *Anaspis funagata* (Str: Co) 29-vii-90 (2); *Pdionia grallatix* (Cer: Co) 29-vii-90 (1); *Pdionia oyamae* (Cer: Co) 29-vii-90 (1); *Pdionia puziolo* (Cer: Co) 29-vii-90 (1); *Pseudalosterna misella* (Cer: Co) 29-vii-90 (3); *Leptura arcauta* (Cer: Co) 29-vii-90 (1); *Nakanea vicaria* (Cer: Co) 29-vii-90 (1); *Rhogogaster variop* (Ten: Hy) 29-vii-90 (1); *Empis flavofasalis* (Emp: Di) 29-vii-90 (2); *Cheilosis sp.6* (Syr: Di) 26-vii-90 (1), 29-vii-90 (2); *Cheilosis sp.15* (Syr: Di) 29-vii-90 (2); *Episyrphus balleatus* (Syr: Di) 29-vii-90 (1); *Meliscaeva cinctella* (Syr: Di) 29-vii-90 (1); *Ant9* (Ant: Di) 29-vii-90 (1); *Cal6* (Cal: Di) 29-vii-90 (1)

Veratrum maackii var. japonicum

*Didea alneti* (Syr: Di) 17-vii-91 (1); *Sitareia vibrissata* (Tep: Di) 17-vii-91 (1)

**Iridaceae**

*Iris sanguinea*


**Gramineae**

*Melliscaeva cinctella* (Syr: Di) 6-vii-90 (3); *Melanostoma mellinum* (Syr: Di) 6-vii-90 (1); *Melanostoma transversum* (Syr: Di) 6-vii-90 (3); *Melanostoma scalare* (Syr: Di) 6-vii-90 (1)

**Pod pratensis**

*Melanostoma transversum* (Syr: Di) 6-vii-90 (1); *Melanostoma scalare* (Syr: Di) 6-vii-90 (1)

**Orchidaceae**

*Cypripedium guttatum var. yatabeanum*

Thr1 (Thr: Th) 17-vi-91 (1); Psy2 (Psy: He) 17-vi-91 (1); *Platycheirus scutatus* (Syr: Di) 17-vi-91 (1); *Melanostoma transversum* (Syr: Di) 17-vi-91 (1)
APPENDIX 2

A List of Floral Host Species of Anthophilous Insect Species Recorded in 1990-91 at Mt. Kushigata

Each record is arranged in the following order: plant species, (plant species code), date and (number of individuals). Insect taxa and plant taxa are arranged in the order in Tables 3 and 2, respectively.

COLEOPTERA

Staphylinidae

_Eusphalerum parallelum_
- _Ribes maximowiczianum_ (sax5) 3-vi-90 (1);
- _Rodgersia podophylla_ (sax6) 6-vii-90 (2);
- _Prunus nipponica_ (ros9) 27-v-90 (27);
- _Sorbus commixta_ (ros13) 6-vii-90 (3);
- _Oxalis acetosella_ (oxa1) 26-v-91 (23);
- _Acer shirasawanum_ (ace2) 9-vi-91 (2);
- _Euonymus macropterus_ (cell) 17-vi-91 (2);
- _Cynanchum ascyrifolium_ (asc1) 6-vii-90 (2);
- _Lonicera alpigena var. glehni_ (cap1) 9-vi-91 (8);
- _Viburnum furcatum_ (cap2) 27-v-90 (1)

_Ectinohoplia obducta_
- _Reynoutria japonica_ (pol2) 26-viii-90 (2)

_Ectinohoplia obducta_
- _Reynoutria japonica_ (pol2) 26-viii-90 (2)

_Hoplia communis_
- _Astilbe thunbergii_ (sax1) 14-vii-90 (1);
- _Rodgersia podophylla_ (sax6) 7-vii-90 (2)

_Hoplia moerens_
- _Astilbe thunbergii_ (sax1) 28-vii-91 (1);
- _Angelica pubescens_ (umb2) 29-vii-90 (1)

_Gnorimus subopacus_
- _Astilbe thunbergii_ (sax1) 14-vii-90 (1)

_Popilla japonica_
- _Astilbe thunbergii_ (sax1) 25-vii-90 (1)

Scarabaeidae

_Micadocantharis japonicus_
- _Acer shirasawanum_ (ace2) 9-vi-91 (1);
- _Elaeagnus montana_ (ela1) 14-vii-90 (1)

_Podabrus malthinoides_
- _Euonymus macropterus_ (cell) 17-vi-91 (1)

Cantharidae

_Melyridae_

_Dasytes vulgaris_
- _Viburnum furcatum_ (cap2) 27-v-90 (1)

Nitidulidae

_Epuraea sp.1_
- _Viburnum furcatum_ (cap2) 26-v-91 (5), 27-v-90 (1)

_Meligethes morosus_
- _Philadelphus satsumi_ (sax4) 25-vii-90 (2);
- _Rodgersia podophylla_ (sax6) 6-vii-90 (29);
- _Filipendula multiflora_ (ros2) 28-vii-91 (3);
- _Fragaria nipponica_ (ros3) 26-v-91 (14);
- _Sorbus commixta_ (ros13) 6-vii-90 (1);
- _Pyrola alpina_ (pyr2) 25-vii-90 (2);
- _Cynanchum ascyrifolium_ (asc1) 7-vii-90 (4);
- _Lonicera alpigena var. glehni_ (cap1) 9-vi-91 (1);
- _Viburnum furcatum_ (cap2) 26-v-91 (1);
- _Taraxacum hondoense_ (com24) 3-vi-90 (1)
Euphrasia fergeri
Aquilegia buergeriana (ran4) 6-vii-90 (1); Angelica polymorpha (umb1) 1-ix-91 (1); Viburnum furcatum (cap2) 27-v-90(9)

Cryptophagidae

Antherophagus nigricornis
Filipendula multiijuga (ros2) 28-vii-91 (1)

Byturidae

Byturus sp.
Fragaria nipponica (ros3) 6-vii-90 (1); Cynanchum ascrifolium (asc1) 6-vii-90 (1); Lonicera alpigena var. glehni (cap1) 9-vi-91 (1); Viburnum furcatum (cap2) 26-v-91 (1); Gymnadenia conopsea (orc6) 6-vii-90 (1)

Byturus ohtai
Rubus pungens var oldhamii (ros12) 17-vi-91 (3); Viburnum furcatum (cap2) 26-v-91 (1)

Byturus affinis

Byturus atricollis
Fragaria nipponica (ros3) 6-vii-90 (1)

Biphyllidae

Biphyllus throscoide
Sorbus commixta (ros13) 6-vii-90 (1)

Coccinellidae

Harmonia axyridis
Veratrum album oxysepalum (til13) 29-vii-90 (1)

Mordellidae

Hoshihannomia perlata
Reynoutria japonica (pol2) 17-viii-91 (1)

Mordellistena sp.1
Veronicastrum sibiricum juponinicum (scr3) 28-vii-91 (1); Viburnum opulus var. calvescens (cap3) 7-vii-90 (1)

Oedemeridae

Oedemeronia manicata
Reynoutria japonica (pol2) 17-viii-91 (1)

Oedemeronia subrobusta
Trollius hondoensis (ran9) 14-vii-90 (2), 25-vii-90 (5); Aquilegia buergeriana (ran4) 14-vii-90 (1); Ranunculus japonicus (ran7) 6-vii-90 (1), 9-vi-91 (4); Fragaria nipponica (ros3) 17-vi-91 (1), 6-vii-90 (1); Potentilla freyniana (ros7) 3-vi-90 (3); Geranium eriostemon var. reinii (ger1) 14-vii-90 (2), 29-vii-90 (3); Libanotis coreana (umb4) 26-viii-90 (1); Polemonium caeruleum yezoense (plm1) 14-vii-90 (1); Scabiosa japonica (dip1) 17-viii-91 (3), 25-vii-90 (3), 28-vii-91 (1); Anaphalis margaritacea (com3) 26-vii-90 (2); Picris hieracioides japonica (com17) 28-vii-91 (3); Senecio cannabifolius (com18) 1-ix-91 (1); Serratula coronata insularis (com21) 9-ix-90 (1); Taraxacum hondoense (com24) 3-vi-90 (7), 9-vi-91 (1); Iris sanguinea (iri1) 6-vii-90 (3)

Chrysanthia viatica
Astilbe thunbergii (sax1) 25-vii-90 (7), 29-vii-90 (2); Anaphalis margaritacea (com3) 1-ix-91 (2), 26-vii-90 (1); Solidago virgaurea asiatica (com22) 1-ix-91 (1)

Scaptiidae

Anaspis funagata
Reynoutria japonica (pol2) 1-ix-91 (1); Lychnis gracillima (car2) 25-vii-90 (9); Cimicifuga simplex (ran5) 17-viii-91 (1); Astilbe thunbergii (sax1) 29-vii-90 (115); Philadelphus satsumi (sax4) 25-vii-90 (8); Rodgersia podophylla (sax6) 6-vii-90 (26); Pyrola alpina (pyr2) 25-vii-90 (1); Veratrum album oxysepa-
Cerambycidae

Asemum amurense

Lonicera alpigena var. glehni (cap1) 9-vi-91 (1)

Anastrangalia scotodes

Reynoutria japonica (pol2) 17-vii-91 (2); Filipendula multiijuga (ros2) 28-vii-91 (1), 29-vii-90 (1)

Anoploderomorpha excavata

Filipendula multiijuga (ros2) 25-vii-90 (1); Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (1)

Corenyns seriata

Hydrangea paniculata (sax2) 17-vii-91 (2)

Corymbia succedanea

Angelica pubescens (umb2) 17-viii-91 (1), 26-viii-90 (1); Patrinia villosa (val2) 1-ix-91 (1)

Corymbia varicorns

Aster thunbergii (sax1) 25-vii-90 (1), 28-vii-91 (1); Hydrangea paniculata (sax2) 17-vii-91 (1)

Leptura arcuata

Aster thunbergii (sax1) 25-vii-90 (2); Filipendula multiijuga (ros2) 25-vii-90 (2), 28-vii-91 (1); Scabiosa japonica (dip1) 25-vii-90 (1); Veratrum album oxysepalum (lil13) 29-vii-90 (1)

Leptura ochraceofasciata

Hydrangea paniculata (sax2) 17-vii-91 (1)

Nakanea varicia

Filipendula multiijuga (ros2) 25-vii-90 (1), 29-vii-90 (2); Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1); Veratrum album oxysepalum (lil13) 29-vii-90 (1)

Pachytodes cometes

Cimicifuga simplex (ran5) 17-vii-91 (1), 26-vii-90 (1); Asterol thunbergii (sax1) 25-vii-90 (1), 29-vii-90 (1); Hydrangea paniculata (sax2) 17-vii-91 (2); Angelica pubescens (umb2) 26-vii-90 (2); Asterol glehni var. hondoensis (com7) 26-vii-90 (1)

Parastrangalis nymphula

Scabiosa japonica (dip1) 25-vii-90 (1); Asterol glehni var. hondoensis (com7) 26-vii-90 (1)

Pidonía grallatix

Trollius hondoensis (ran9) 25-vii-90 (1); Cimicifuga simplex (ran5) 26-vii-90 (1); Filipendula multiijuga (ros2) 29-vii-90 (1); Angelica pubescens (umb2) 26-vii-90 (1); Pyrola alpina (pyr2) 25-vii-90 (3); Viburnum opulus var. calvenses (cap3) 7-vii-90 (1); Scabiosa japonica (dip1) 25-vii-90 (6), 28-vii-91 (4); Veratrum album oxysepalum (lil13) 29-vii-90 (1)

Pidonía aegrota

Filipendula multiijuga (ros2) 25-vii-90 (1), 28-vii-90 (1)

Pidonía insuturata

Rodgersia podophylla (sax6) 6-vii-90 (15); Filipendula multiijuga (ros2) 28-vii-91 (1)

Pidonía signifera

Pyrola alpina (pyr2) 25-vii-90 (1); Weigela decora (cap4) 7-vii-90 (1)

Pidonía yokoyamai

Pyrola alpina (pyr2) 25-vii-90 (1)

Pidonía signata

Pyrola alpina (pyr2) 25-vii-90 (2)

Pidonía masakii

Pyrola alpina (pyr2) 25-vii-90 (2)

Pidonía oyamae

Rodgersia podophylla (sax6) 6-vii-90 (6); Sorbus commixta (ros13) 6-vii-90 (2); Pyrola alpina (pyr2) 25-vii-90 (3); Veratrum album oxysepalum (lil13) 29-vii-90 (1)

Pidonía semiobscura

Pyrola alpina (pyr2) 25-vii-90 (1)

Pidonía testacea

Aster thunbergii (sax1) 29-vii-90 (8); Rodgersia podophylla (sax6) 6-vii-90 (3); Sorbus commixta (ros13) 6-vii-90 (3)

Pidonía puziloi

Aster thunbergii (sax1) 29-vii-90 (1); Veratrum album oxysepalum (lil13) 29-vii-90 (1)
Flowering Phenology and Anthophilous Insect Community

Pseudalosterna misella
  Astilbe thunbergii (sax1) 29-vii-90 (6); Lonicera alpigena var. glehni (cap1) 9-vi-91 (1); Veronicastrum oxysepalum (lil13) 29-vii-90 (3)

Chrysomelidae

Cryptocephalus approximatus
  Astilbe thunbergii (sax1) 25-vii-90 (1); Eupatorium chinense sachalinense (com12) 17-viii-91 (1)

Lutesus moorii
  Rodgersia podophylla (sax6) 7-vii-90 (1); Acer ukurunduense (ace3) 7-vii-90 (1)

Pyrrhata annulicornis
  Scabiosa japonica (dip1) 17-viii-91 (1)

Curculionidae

Curculio convexus
  Viburnum furcatum (cap2) 26-v-91 (3), 27-v-90 (1)

Phyllobius picepes
  Acer shirasawanum (ace2) 9-vi-91 (1)

Hymenoptera

Tenthredinidae

Alphostrombocerus komowi
  Lonicera alpigena var. glehni (cap1) 9-vi-91 (1)

Rhogogaster variipes
  Lychnis gracillima (car2) 25-vii-90 (3); Astilbe thunbergii (sax1) 14-vii-90 (1), 25-vii-90 (3), 28-vii-91 (1); Hydrangea paniculata (sax2) 17-vii-91 (1); Veronicastrum oxysepalum (lil13) 29-vii-90 (1)

Strongylogaster sp.
  Lonicera alpigena var. glehni (cap1) 9-vi-91 (1)

Tenthredo japonica

Tenthredo basizonata
  Lonicera alpigena var. glehni (cap1) 9-vi-91 (1)

Vespidae

Vespa simillima xanthoptera
  Enkianthus campanulatus (eri1) 9-vi-91 (1)

Vespa schrenckii
  Acer japonicum (ace1) 26-v-91 (2)

Vespa austriaca
  Cimicifuga simplex (ran5) 1-ix-91 (1)

Dolichovespula norvegicoides
  Cimicifuga simplex (ran5) 1-ix-91 (1), 17-vii-91 (1), 26-viii-90 (2), 29-vii-90 (1); Astilbe thunbergii (sax1) 29-vii-90 (1); Hydrangea paniculata (sax2) 17-vii-91 (5); Chamaenerion angustifolium (ona1) 28-vii-91 (2); Angelica pubescens (umb2) 17-vii-91 (5); Enkianthus campanulatus (eri1) 9-vi-91 (2); Lonicera alpigena var. glehni (cap1) 9-vi-91 (2); Patrinia villosa (val2) 1-ix-91 (2), 17-vii-91 (1)

Dolichovespula adulterina montivaga
  Reynoutria japonica (pol2) 17-vii-91 (2); Hydrangea paniculata (sax2) 17-vii-91 (2); Angelica pubescens (umb2) 17-vii-91 (3)

Sphecidae

Stigmus sp.
  Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1)

Crossocerus sp.
  Hydrangea paniculata (sax2) 17-vii-91 (1); Filipendula multifluga (ros2) 28-vii-91 (1)

Colletidae
Hylaeus thoracius
   Angelica pubescens (umb2) 17-vii-91 (1)
Hylaeus paradifformis
   Clinopodium chinense grandiflorum (lab1) 17-vii-91 (1)

Halictidae

Lasioglossum (Lasioglossum) harmandi
   Sedum aizoon (cra2) 29-vii-90 (1)
Lasioglossum (L.) proximatum
   Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1)
Lasioglossum (L.) laeviventre
   Rodgersia podophylla (sax6) 7-vii-90 (1); Filipendula multijuga (ros2) 25-vii-90 (1), 28-vii-91 (1); Potentilla freyniana (ros7) 26-v-91 (1); Pyrola incarnata (pyr3) 7-vii-90 (1); Enkianthus campanulatus (eril) 9-vi-91 (1); Lonicera alpigena var. glehnii (cap1) 9-vi-91 (2); Scabiosa japonica (dip1) 22-ix-91 (1); Patrinia villosa (val2) 1-ix-91 (1); Aster ageratoides ovatus (com6) 22-ix-91 (1); Senecio cannabifolius (com18) 1-ix-91 (2); Serratula coronata insularis (com21) 1-ix-91 (5); Solidago virgaurea asiatica (com22) 1-ix-91 (1); Taraxacum hondoense (com24) 9-vi-91 (1)
Lasioglossum (Evylaeus) nipponense
   Ranunculus japonicus (ran7) 17-vi-91 (1), 7-vii-90 (1); Weigela decora (cap4) 7-vii-90 (1); Scabiosa japonica (dip1) 1-ix-91 (1), 22-ix-91 (3); Serratula coronata insularis (com21) 22-ix-91 (1); Hosta sieboldiana (lii3) 17-viii-91 (2)
Lasioglossum (E.) alipes
   Ranunculus japonicus (ran7) 17-vi-91 (4); Adenophora triphylla var. japonica (cam2) 26-viii-90 (1)
   Taraxacum hondoense (com24) 3-vi-90 (1)
Lasioglossum (E.) apristum
   Reynoutria japonica (pol2) 17-vii-91 (23); Astilbe thunbergii (sax1) 25-vii-90 (3), 28-vii-91 (1); Hydrangea paniculata (sax2) 17-vii-91 (1); Fragaria nipponica (ros3) 26-v-91 (1); Filipendula multijuga (ros2) 17-vii-91 (4), 25-vii-90 (6), 28-vii-91 (1); Potentilla freyniana (ros7) 26-v-91 (1); Chamaenerion angustifolium (ona1) 25-vii-90 (2); Angelica pubescens (umb2) 17-vii-91 (1); Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (11), 28-vii-91 (5), 29-vi-90 (1); Scabiosa japonica (dip1) 17-vii-91 (2); Lonicera alpigena var. glehnii (cap1) 9-vi-91 (2); Serratula coronata insularis (com21) 17-vii-91 (3); Hosta sieboldiana (lii3) 17-vii-91 (1), 25-vii-90 (1)
Lasioglossum (E.) sp.K1
   Scabiosa japonica (dip1) 9-ix-90 (1); Aster ageratoides amplexifolius (com5) 23-ix-90 (1)
Lasioglossum (E.) sp.K2
   Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (2)
Lasioglossum (E.) sp.4
   Sedum aizoon (cra2) 25-vii-90 (1)
Lasioglossum (E.) aff. atroglaucaum
   Angelica pubescens (umb2) 17-vii-91 (1); Scabiosa japonica (dip1) 22-ix-91 (2); Aster ageratoides ovatus (com6) 22-ix-91 (4); Aster ageratoides amplexifolius (com5) 23-ix-90 (1)
Lasioglossum (Dialictus) problematicum
   Astilbe thunbergii (sax1) 28-vii-91 (1); Filipendula multijuga (ros2) 25-vii-90 (2), 28-vii-91 (1); Potentilla freyniana (ros7) 3-vi-90 (1); Chamaenerion angustifolium (ona1) 25-vii-90 (1); Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (1); Patrinia villosa (val2) 17-vii-91 (1); Anaphalis margaritacea (com3) 26-vii-90 (1); Polygonatum lasianthum (lii8) 17-vi-91 (1)

Andrenidae

Andrena (Andrena) aburana
   Euonymus sieboldianus (cel2) 14-vii-90 (1)
Andrena (A.) brenhirtisca
   Malus sieboldii (ros5) 17-vi-91 (1)
Andrena (A.) lapponica sumizome
   Enkianthus campanulatus (eril) 9-vi-91 (1); Rhododendron wadanum (eri4) 9-vi-91 (1); Lonicera alpigena var. glehnii (cap1) 9-vi-91 (1)
Andrena (A.) longitibialis
**Flowering Phenology and Anthophilous Insect Community**

Rhododendron wadanum (eri4) 9-vi-91 (1)
Andrena (Euandrena) togashi
Reynoutria japonica (pol2) 17-viii-91 (1); Cimicifuga simplex (ran5) 26-viii-90 (1)
Andrena (Gymandrena) parathoracina
Pyrola incarnata (pyr3) 7-vii-90 (1)
Andrena (Simandrena) yamato
Malus sieboldii (ros5) 17-vi-91 (1)

**Megachilidae**

Megachile tsurugensis
Serratula coronata insularis (com21) 17-viii-91 (1)
Megachile sp.
Sedum aizoon (cra2) 29-vii-90 (1)
Megachile sumizome
Pedicularis resupinata var. caespitosa (scr2) 17-viii-91 (1)

**Anthophoridae**

Nomada sp.
Oxalis acetosella (oxa1) 27-v-90 (1)
Nomada issitii
Serratula coronata insularis (com21) 1-ix-91 (1)

**Apidae**

Bombus consobrinus
Aconitum japonicum montanum (ran1) 1-ix-91 (3), 23-ix-90 (2), 9-ix-90 (2); Aconitum senanense (ran3) 1-ix-91 (6), 23-ix-90 (3), 26-vii-90 (2); Aquilegia baergeriana (ran4) 14-vii-90 (1), 6-vii-90 (1), 7-vii-90 (3), 9-ix-90 (1); Geranium eriostemon var. reiiii (ger1) 25-ix-90 (4), 28-vii-91 (1); Meehania urticifolia (lab2) 9-vi-91 (1); Weigela decora (cap4) 7-vii-90 (8); Scabiosa japonica (dip1) 28-vii-91 (1); Campylnula punctata var. hondoensis (carn3) 28-vii-91 (1), 29-vii-90 (1); Cirsim effusum (com11) 9-ix-90 (1); Serratula coronata insularis (com21) 17-viii-91 (1), 9-ix-90 (1); Synurus pungens (com23) 1-ix-91 (1), 9-ix-90 (1); Hosta sieboldiana (lil3) 17-viii-91 (1), 25-vii-90 (15), 28-vii-91 (9), 29-vii-90 (7); Polygonatum lasianthum (lil8) 17-vi-91 (1), 6-vii-90 (1); Iris sanguinea (iri1) 25-vii-90 (4), 7-vii-90 (5)

Bombus diversus
Aconitum japonicum montanum (ran1) 22-ix-91 (3), 23-ix-90 (1); Aquilegia baergeriana (ran4) 25-vii-90 (1); Cimicifuga simplex (ran5) 9-ix-90 (1); Geranium eriostemon var. reiiii (ger1) 7-vii-90 (1); Pyrola incanata (pyr3) 7-vii-90 (1); Weigela decora (cap4) 7-vii-90 (3); Scabiosa japonica (dip1) 1-ix-91 (1); Calacia adenosylloides (com9) 17-vii-91 (2); Cirsim effusum (com11) 1-ix-91 (4), 26-vii-90 (1); Serratula coronata insularis (com21) 1-ix-91 (3); Synurus pungens (com23) 23-ix-90 (2); Hosta sieboldiana (lil3) 17-viii-91 (1); Polygonatum macranthum (lil9) 14-vii-90 (1); Iris sanguinea (iri1) 14-vii-90 (10), 25-vii-90 (1), 7-vii-90 (8)

Bombus honshuensis
Philadelphus satsumi (sax4) 14-vii-90 (2); Filipendula multijuga (ros2) 17-vii-91 (2); Rubus pungens var oldhamii (ros12) 9-vi-91 (2); Geranium eriostemon var. reiiii (ger1) 14-vii-90 (2), 7-vii-90 (1); Elaeagnus montana (ela1) 14-vii-90 (3), 7-vii-90 (3); Chamaenerion angustifolium (ona1) 25-vii-90 (2), 28-vii-91 (5); Pyrola incanata (pyr3) 7-vii-90 (1); Enkianthus campanulatus (eri1) 9-iv-91 (2); Rhododendron wadanum (eri4) 9-vi-91 (2); Polemonium caeruleum yezoense (plm1) 7-vii-90 (1); Pedicularis resupinata var. caespitosa (scr2) 9-ix-90 (2); Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (2); Lonicer aalpigena var. glehni (cap1) 9-vi-91 (1); Scabiosa japonica (dip1) 1-ix-91 (1); Calacia adenosylloides (com9) 17-vii-91 (3); Cirsim effusum (com11) 1-ix-91 (17), 22-ix-91 (5), 23-ix-90 (3), 26-vii-90 (3), 9-ix-90 (1); Ligularia dentata (com15) 17-vii-91 (2); Serratula coronata insularis (com21) 17-vii-91 (9), 26-vii-90 (6); Polygonatum lasianthum (lil8) 17-vi-91 (1); Iris sanguinea (iri1) 14-vii-90 (6), 25-vii-90 (1), 6-vii-90 (2), 7-vii-90 (16)

Bombus ardens
Prunus nipponica (ros9) 27-v-90 (6); Rubus pungens var oldhamii (ros12) 9-vi-91 (3); Geranium eriostemon var. reiiii (ger1) 25-vii-90 (1), 6-vii-90 (1); Acer shirasawanum (ace2) 9-vi-90 (1); Elaeagnus montana (ela1) 7-vii-90 (6); Pyrola incanata (pyr3) 7-vii-90 (1); Enkianthus campanulatus (eri1) 7-vi-90 (1);
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(1); Rhododendron wadanum (eri4) 9-vi-91 (1); Cynanchum ascyrifolium (asc1) 6-vii-90 (1); Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1); Polygonatum lasianthum (lil8) 17-vi-91 (1), 9-vi-91 (1); Iris sanguinea (iri1) 7-vii-90 (1)

Bombus beaticola

Cimicifuga simplex (ran5) 26-viii-90 (1); Filipendula multiijuga (ros2) 17-vii-91 (1), 25-vii-90 (4), 29-vii-90 (2); Rubus idaeus f. marmoratus (ros10) 17-vi-91 (2); Rubus pungens var. oldhamii (ros12) 17-vi-91 (3), 9-vi-91 (7); Geranium reinitii (ger1) 14-vii-90 (24), 25-vii-90 (4), 28-vii-91 (3), 29-vii-90 (2), 6-vii-90 (15), 7-vii-90 (6); Chamaenerion angustifolium (ona1) 28-vii-91 (1); Menziesia campanulata (eri1) 6-vii-90 (2); Pyrola alpina (pyr2) 25-vii-90 (4); Cimicifuga simplex (ran5) 26-viii-90 (2); Pedicularis resupinata var. caespitosa (scr2) 17-viii-91 (1); Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (12), 28-vii-91 (4), 29-vii-90 (4); Lonicera alpigena var. gilehni (cap1) 30-vi-91 (5); Patrinia triloba palmata (val1) 28-vii-91 (1); Campanula punctata var. hondoensis (cam3) 29-vii-90 (1); Cacalia adenosystoides (com9) 17-vii-91 (3); Cacalia hastata farfaraefolia (com10) 26-viii-90 (1); Cirsium effusum (com11) 1-ix-91 (3), 23-ix-90 (1), 26-viii-90 (1); Ligularia dentata (com15) 17-vii-91 (2), 29-vii-90 (2); Serratula coronata insularis (com21) 17-vii-91 (12); Polygonatum lasianthum (lil8) 17-vii-91 (2); Iris sanguinea (iri1) 14-vii-90 (1), 7-vii-90 (1)

Bombus hypocrita

Trollius hondoensis (ran9) 25-vii-90 (1); Cimicifuga simplex (ran5) 26-viii-90 (2); Asitlbe thunbergii (sax1) 25-vii-90 (1), 28-vii-90 (2); Rodgersia podophylla (sax5) 7-vii-90 (2); Filipendula multiijuga (ros2) 25-vii-90 (1); Prunus nipponica (ros9) 27-v-90 (2); Chamaenerion angustifolium (ona1) 28-vii-90 (1); Pyrola alpina (pyr2) 25-vii-90 (4); Meehania arcticifolia (lab2) 9-vi-90 (1); Pedicularis resupinata var. caespitosa (scr2) 17-vii-91 (2), 26-vii-90 (1); Veronicastrum sibiricum japonicum (sc3) 25-vii-90 (4), 28-vii-90 (8), 29-vii-90 (1); Scabiosa japonica (dip1) 1-ix-91 (2), 28-vii-91 (4); Cacalia adenosystoides (com9) 17-vii-91 (1); Cacalia hastata farfaraefolia (com10) 26-viii-90 (3); Cirsium effusum (com11) 1-ix-91 (13), 23-ix-90 (5), 26-vii-90 (1); Ligularia dentata (com15) 17-vii-91 (2), 22-ix-91 (4), 26-viii-90 (1), 9-ix-90 (1); Iris sanguinea (iri1) 7-vii-90 (1)

Psithyrus norvegicus nipponicus

Scabiosa japonica (dip1) 1-ix-91 (1)

Apis mellifera

Asitlbe thunbergii (sax1) 14-vii-90 (1)

DIPTERA

Bombylliidae

Bombyllus major

Reynoutria japonica (pol2) 17-vii-91 (1)

Asilidae

Dioctria nakanensis

Veronicastrum sibiricum japonicum (scr3) 29-vii-90 (1)

Syrphidae

Cheilosia sp.1

Trollius hondoensis (ran9) 28-vii-91 (1); Sedum aizoon (crap2) 29-vii-90 (2); Geranium eriostemon var. reinitii (ger1) 25-vii-90 (5), 28-vii-91 (2); Scabiosa japonica (dip1) 17-vii-91 (1); Ligularia dentata (com15) 28-vii-91 (4), 29-vii-90 (3)

Cheilosia sp.2

Potentilla freyniana (ros7) 26-v-91 (1); Angelica pubescens (umb2) 17-vii-91 (1)

Cheilosia sp.3

Reynoutria japonica (pol2) 17-vii-91 (1); Ranunculus japonicus (ran7) 6-vii-90 (2); Arabis lyrata kamtschatica (bra2) 9-vi-91 (1); Fragraaria nipponica (ros3) 17-vii-91 (1); Potentilla freyniana (ros7) 26-v-91 (1); Senecio canabifolius (com18) 1-ix-91 (1); Solidago virgaeura asiatica (com22) 1-ix-91 (1); Taraxacum hondoense (com24) 9-vi-91 (1)

Cheilosia sp.4

Arabys lyrata kamtschatica (bra2) 9-vi-91 (1); Geranium eriostemon var. reinitii (ger1) 25-vii-90 (1)
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Cheilosia sp.5
Trollius hondoensis (ran9) 25-vii-90 (1); Reynoutria japonica (pol2) 17-viii-91 (1); Libanotis coreana (umb4) 29-vii-90 (1)

Cheilosia sp.6
Reynoutria japonica (pol2) 1-ix-91 (1), 17-viii-91 (4); Filipendula multiijuga (ros2) 28-vii-91 (1), 29-vii-90 (1); Fragaria nipponica (ros3) 17-vi-91 (1); Prunus nipponica (ros9) 27-v-90 (1); Oxalis aceroseella (oxa1) 27-v-90 (2); Angelica polymorpha (umb1) 1-ix-91 (2); Libanotis coreana (umb4) 29-vii-90 (3); Anaphalis margaritacea (com3) 1-ix-91 (1); Cacalia adnexitoides (com9) 17-vii-91 (1); Solidago virgaurea asiatica (com22) 1-ix-91 (1), 9-ix-90 (1); Veratrum album oxyselatum (li13) 26-viii-90 (1), 29-vii-90 (2)

Cheilosia sp.7

Cheilosia sp.8
Reynoutria japonica (pol2) 17-viii-91 (1)

Cheilosia sp.9
Trollius hondoensis (ran9) 25-vii-90 (1); Geranium eriostemon var. reinii (ger1) 14-vii-90 (1), 28-vii-91 (1)

Cheilosia sp.10
Euonymus sieboldianus (cel2) 14-vii-90 (1); Rhododendron degronianum (eri3) 14-vii-90 (1); Ligularia dentata (com15) 28-vii-91 (2); Senecio canebifolis (com18) 9-ix-90 (1)

Cheilosia sp.11
Reynoutria japonica (pol2) 17-viii-91 (2); Astilbe thunbergii (sax1) 14-vii-90 (6); Prunus nipponica (ros9) 27-v-90 (1); Angelica pubescens (umb2) 17-viii-91 (1); Senecio nemoresis (com20) 1-ix-91 (1)

Cheilosia sp.12
Astilbe thunbergii (sax1) 14-vii-90 (6), 25-vii-90 (1); Euonymus sieboldianus (cel2) 14-vii-90 (1)

Cheilosia sp.13
Potentilla freyniana (ros7) 27-v-90 (3); Oxalis aceroseella (oxa1) 27-v-90 (2)

Cheilosia sp.14
Sedum aizoon (era2) 29-vii-90 (1); Fragaria nipponica (ros3) 3-vi-90 (1); Anaphalis margaritacea (com3) 9-ix-90 (1)

Cheilosia sp.15
Reynoutria japonica (pol2) 17-viii-91 (2); Astilbe thunbergii (sax1) 25-vii-90 (1); Filipendula multiijuga (ros2) 25-vii-90 (3); Angelica polymorpha (umb1) 1-ix-91 (1); Ixeris dentata var. albiflora (com13) 14-vii-90 (1); Veratrum album oxyselatum (li13) 29-vii-90 (2)

Cheilosia sp.16
Prunus nipponica (ros9) 27-v-90 (1)

Cheilosia sp.17
Angelica polymorpha (umb1) 1-ix-91 (1)

Cheilosia sp.18
Ranunculus japonicus (ran7) 6-vii-90 (1)

Cheilosia motodomariensis
Astilbe thunbergii (sax1) 14-vii-90 (1), 28-vii-90 (1); Malus sieboldii (ros5) 17-vi-91 (1); Angelica pubescens (umb2) 26-vii-90 (2), 29-vii-90 (4); Libanotis coreana (umb4) 29-vii-90 (5)

Criorhina apicalis
Acer japonicum (ace1) 26-v-91 (1)

Dasysyrphus bilineatus
Lychnis gracillima (car2) 14-vii-90 (1); Serratula coronata insularis (com21) 26-viii-90 (1)

Dasysyrphus tricinctus
Serratula coronata insularis (com21) 1-ix-91 (1)

Didea alneti
Cirsium effusum (com11) 23-ix-90 (1); Synurus pungens (com23) 23-ix-90 (1); Veratrum maackii var. japonicum (li14) 17-viii-91 (1)

Didea fasciata
Potentilla freyniana (ros7) 26-v-91 (1); Geranium eriostemon var. reinii (ger1) 7-vii-90 (2); Angelica pubescens (umb2) 17-viii-91 (1); Polemonium caeruleum yezoense (plm1) 7-vii-90 (1); Scabiosa japonica (dip1) 17-viii-91 (1); Serratula coronata insularis (com21) 17-viii-91 (1), 9-ix-90 (1)
Didea nikkoensis
  Reynoutria japonica (pol2) 17-vii-91 (1)
Episyrphus balteatus
  Veratrum album oxysepalum (lil13) 29-vii-90 (1)
Eristalis cerealis
  Sedum at zones (cra2) 29-vii-90 (1); Anaphalis margaritacea (com3) 26-viii-90 (1)
Eristalis tenax
  Trollius hondoensis (ran9) 25-vii-90 (3); Reynoutria japonica (pol2) 17-vii-91 (2), 26-vii-90 (2); Dianthus superbus longicalycinus (car1) 28-vii-91 (2); Lechnis gracillima (car2) 25-vii-90 (1); Cimicifuga simplex (ran5) 26-vii-90 (2); Ranunculus japonicus (ran7) 17-vi-91 (1); Arabis lyrata kamtschatica (bra2) 9-vi-91 (1); Philadelphus satsumi (sax4) 14-vii-90 (1); Filipendula multi jug. (ros2) 25-vii-90 (5), 29-vii-90 (2); Malus sieboldii (ros5) 17-vi-91 (2); Libanotis coreana (umb4) 26-vii-90 (11); Scabiosa japonica (dip1) 1-ix-91 (1), 17-vii-91 (17), 23-ix-90 (2), 25-vii-90 (4), 26-vii-90 (9), 28-vii-91 (6), 9-ix-90 (3); Anaphalis margaritacea (com3) 26-vii-90 (5); Aster ageratoides amplexifolius (com5) 23-ix-90 (1); Aster ageratoides ovatus (com6) 23-ix-90 (5); Cirsium effusum (com11) 23-ix-90 (2); Eupatorium chinense saschanlenense (com12) 1-ix-91 (2), 17-vii-91 (1); Senecio cannabifolius (com18) 1-ix-91 (1), 9-ix-90 (2); Senecio nemorensis (com20) 26-vii-90 (3); Serratula coronata insularis (com21) 1-ix-91 (7), 17-vii-91 (2), 26-vii-90 (1); Solidago virginAEA asiatica (com22) 23-ix-90 (1)
Helophilus virgatus
  Prunus nipponica (ros9) 27-v-90 (1); Aster ageratoides amplexifolius (com5) 23-ix-90 (1); Senecio cannabifolius (com18) 9-ix-90 (1)
Ichysrysyphus glaucius
  Angelica pubescens (umb2) 26-vii-90 (1)
Ichysrysyphus laternarius
  Reynoutria japonica (pol2) 17-vi-91 (1)
Leucozoa lucorum
  Serratula coronata insularis (com21) 1-ix-91 (1)
Mallota dimorpha
  Veronicastrum sibiricum japonicum (scr3) 29-vii-90 (1)
Melanostoma mellinum
  Patrinia villosa (val2) 1-ix-91 (1); Ligularia dentata (com15) 28-vii-91 (1); Agrostis clavata (gra1) 6-vii-90 (1)
Melanostoma scalare
  Ranunculus japonicus (ran7) 17-vi-91 (1); Rubus pungens var oldhamii (ros12) 17-vi-91 (2); Geranium eriostemon var. reini (ger1) 14-vii-90 (1); Angelica polymorpha (umb1) 1-ix-91 (1); Taraxacum hondoensis (com24) 3-ix-90 (1); Agrostis clavata (gra1) 6-vii-90 (1)
Melanostoma transversum
  Pseudostellaria heterantha (car3) 6-vii-90 (1); Ranunculus japonicus (ran7) 6-vii-90 (1); Astilbe thunbergii (sax1) 29-vii-90 (1); Fragaria nipponica (ros3) 6-vii-90 (1); Geranium eriostemon var. reini (ger1) 14-vii-90 (1); Enkianthus campanulatus (cri1) 9-vi-91 (1); Polemionca caeruleum yezoense (plm1) 14-vii-90 (1); Anaphalis margaritacea (com3) 9-ix-90 (1); Aster glehni var. hondoensis (com7) 26-vii-90 (1); Ixeris dentata var. albiflora (com13) 14-vii-90 (1); Senecio nemoensis (com20) 1-ix-91 (1); Solidago virgaurea asiatica (com22) 1-ix-91 (3); Agrostis clavata (gra1) 6-vii-90 (3); Poa pratensis (gra2) 6-vii-90 (1)
Meliscaeva cinctella
  Trollius hondoensis (ran9) 25-vii-90 (1); Reynoutria japonica (pol2) 1-ix-91 (1); Dianthus superbus longicalcinus (car1) 29-vii-90(2); Cimicifuga simplex (ran5) 23-ix-90 (1), 26-vii-90 (2); Filipendula multi jug. (ros2) 28-vii-91 (1), 29-vii-90 (1); Euelaagnus montana (ela1) 14-vii-90 (5); Angelica polymorpha (umb1) 1-ix-91 (1); Euphrasia maximoviczii (scr1) 26-vii-90 (1); Veronicastrum sibiricum japonicum (scr3) 29-vii-90 (5); Weigela decor (cap4) 7-ix-90 (2); Scabiosa japonica (dip1) 9-ix-90 (1); Achillea alpina var. discoidea (com1) 17-vii-91 (1); Aster glehni var. hondoensis (com7) 26-vii-90 (1); Cacalia adenostyloides (com9) 17-vii-91 (3); Serratula coronata insularis (com21) 1-ix-91 (1); Veratrum album oxysepalum (lil13) 29-vii-90 (1); Agrostis clavata (gra1) 6-vii-90 (3)
Meliscaeva omogensis
  Thalictrum filamentosum (ran8) 14-vii-90 (1); Fragaria nipponica (ros3) 6-vii-90 (1)
Metasyrphus luniger
Flowering Phenology and Anthophilous Insect Community

Ranunculus japonicus (ran7) 7-vii-90 (1); Malus sieboldii (ros5) 17-vi-91 (1); Prunus nipponica (ros9) 27-v-90 (1)

Metasyrphus ferquensis
Filipendula multijuga (ros2) 17-vii-91 (1); Scabiosa japonica (dip1) 17-vii-91 (1); Serratula coronata insularis (com21) 1-ix-91 (2), 17-viii-91 (1)

Metasyrphus sp.1
Reynoutria japonica (pol2) 17-vii-91 (1)

Phytomia zonata
Sedum aizoon (cra2) 29-vii-90 (1); Filipendula multijuga (ros2) 29-vii-90 (1)

Platycheirus ambiguus
Ranunculus japonicus (ran7) 7-vii-90 (1); Acer japonicum (ace1) 25-v-91 (1)

Platycheirus scutatus
Trollius hondoensis (ran9) 14-vii-90 (3); Cimicifuga simplex (ran5) 23-ix-90 (2), 9-vi-90 (2); Ranunculus japonicus (ran7) 7-vii-90 (1); Thalictrum filamentosum (ran8) 14-vii-90 (1); Prunus nipponica (ros9) 27-v-90 (1); Pyrola incarnata (pyr3) 17-vii-90 (1); Polemonium caeruleum yezoense (pln1) 14-vii-90 (1); Cirsium effusum (com11) 23-ix-90 (1); Ixeris dentata var. albiflora (com13) 17-vii-90 (1); Solidago virgaurea asiatica (com22) 9-ix-90 (6); Cyripedium guttatum var. yatabeanum (orc2) 17-vi-91 (1)

Platycheirus sp.
Ranunculus japonicus (ran7) 17-vi-91 (1); Malus sieboldii (ros5) 17-vi-91 (1); Rubus pungens var oldhamii (ros12) 17-vi-91 (1); Oxalis acetosella (oxa1) 27-v-90 (1); Ixeris dentata var. albiflora (com13) 14-vii-90 (1)

Rhingia laevigata
Ligularia dentata (com15) 28-vii-91 (1)

Sphaerophoria meuthastri
Ranunculus japonicus (ran7) 6-vii-90 (2); Potentilla freyniana (ros7) 26-v-91 (1), 3-vi-90 (1)

Sphaerophoria javana
Weigela decora (cap4) 7-vii-90 (1)

Sphegina sp.
Lonicer a alpigena var. glehni (cap1) 9-vi-91 (1)

Syrphus ribessii
Cimicifuga simplex (ran5) 23-ix-90 (1); Prunus nipponica (ros9) 27-v-90 (2); Angelica polymorpha (umb1) 1-ix-91 (1); Weigela decora (cap4) 7-vii-90 (1); Scabiosa japonica (dip1) 1-ix-91 (1), 28-vi-91 (1); Cirsium effusum (com11) 9-vi-90 (1); Senecio cannabifolius (com18) 9-ix-90 (1); Serratula coronata insularis (com21) 17-viii-91 (1), 26-vii-91 (1)

Syrphus vitripennis
Trollius hondoensis (ran9) 28-vii-91 (1); Reynoutria japonica (pol2) 17-vii-91 (1); Cimicifuga simplex (ran5) 1-ix-91 (1); Philadelphus satsumi (sax4) 14-vii-90 (1); Filipendula multijuga (ros2) 17-vii-91 (2), 28-vii-90 (2), 29-vii-90 (2); Malus sieboldii (ros5) 17-vi-91 (1); Libanothys coreana (umb4) 26-vii-90 (1); Pyrola incarnata (pyr3) 7-vii-90 (1); Clinopodium chinense grandiflorum (lab1) 17-vii-91 (1); Veronicastrum sibiricum japonicum (scr3) 29-vii-90 (1); Synurus pungens (com23) 23-ix-90 (1)

Syrphus sp.1
Cimicifuga simplex (ran5) 23-ix-90 (1); Ligularia dentata (com15) 28-vii-91 (1)

Vollucella pellucens
Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (1), 28-vi-91 (1)

Vollucella jeddona
Veronicastrum sibiricum japonicum (scr3) 28-vii-90 (1), 29-vii-90 (1)

LEPIDOPTERA

Zygaenidae
Baltata gracilis
Veronicastrum sibiricum japonicum (scr3) 29-vii-90 (1); Patrinia triloba palmata (val1) 28-vii-91 (1)

Pyralidae
Anaria funebris assimilis
Geranium eriostemon var. reinii (ger1) 6-vii-90 (1)
Catoptria permica  
Reynoutria japonica (pol2) 17-viii-91 (1)

**Pterophoridae**

**Platyptilia sachalinensis**  
Veronicastrum sibiricum japonicum (scr3) 29-vii-90 (1)

**Hesperiidae**

Parnara guttata guttata  
Dianthus superbus longicalycinus (car1) 29-vii-90 (1); Aconitum japonicum montanum (ran1) 9-ix-90 (1); Cimicifuga simplex (ran5) 26-viii-90 (1); Cirsium effusum (com11) 23-ix-90 (1), 26-viii-90 (1); Ligularia dentata (com15) 17-viii-91 (1); Senecio cannabifolius (com18) 9-ix-90 (1); Serratula coronata insularis (com21) 1-ix-91 (4), 17-viii-91 (2), 26-viii-90 (2), 9-ix-90 (5)

**Papilionidae**

Papilio machaon hippocrates  
Serratula coronata insularis (com21) 17-viii-91 (1); Iris sanguinea (iril) 25-vii-90 (2)

Papilio xuthus  
Iris sanguinea (iril) 7-vii-90 (1)

Parnassius gracialis  
Poilemonium caeruleum yezoense (plml) 7-vii-90 (1)

**Pieridae**

Anthocharis cardamines hayashii  
Arabis lyrata kamtschatica (bra2) 9-vi-91 (2); Viola grypoceras (vio2) 26-v-91 (2)

Colias erate poliogratus  
Ranunculus japonicus (ran7) 9-vi-91 (1); Arabis hirsuta (bra1) 9-vi-91 (1); Taraxacum hondoense (com24) 3-vi-90 (1)

Gonepteryx aspasia niphonica  
Serratula coronata insularis (com21) 17-vii-91 (1)

Pieris napi japonica  
Arabis lyrata kamtschatica (bra2) 9-vi-91 (1); Geranium eriostemon var. reinii (ger1) 6-vii-90 (1); Lonicera alpigena var. glehnnii (cap1) 9-vi-91 (1)

**Lycaenidae**

Rapala erata  
Astilbe thunbergii (sax1) 25-vii-90 (1)

**Lybytheidae**

Libythea celtis celtoides  
Astilbe thunbergii (sax1) 25-vii-90 (1)

**Nymphalidae**

Argynnis paphia tsuchimana  
Serratula coronata insularis (com21) 1-ix-91 (1)

Melitaea niphora  
Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1)

Inachi io geisha  
Veronicastrum sibiricum japonicum (scr3) 29-vii-90 (1); Scabiosa japonica (dip1) 17-viii-91 (1); Serratula coronata insularis (com21) 1-ix-91 (1), 17-viii-91 (1)

Speyeria aglaja fortuna  
Veronicastrum sibiricum japonicum (scr3) 25-vii-90 (1); Scabiosa japonica (dip1) 1-ix-91 (1); Serratula coronata insularis (com21) 17-viii-91 (1)

Vanessa indica  
Serratula coronata insularis (com21) 1-ix-91 (1)
Flowering Phenology and Anthophilous Insect Community

**Satyridae**

*Zophoessa callipteris*
- *Cimicifuga simplex* (ran5) 26-viii-90 (1);
- *Veronicastrum sibiricum japonicum* (scr3) 29-vii-90 (2);
- *Scabiosa japonica* (dip1) 17-viii-91 (1);
- *Eupatorium chinense sachalinense* (com12) 17-viii-91 (1);
- *Ligularia dentata* (com15) 29-vii-90(1)

**Geometridae**

*Ourapterix persica*
- *Veronicastrum sibiricum japonicum* (scr3) 29-vii-90 (1)

*Alcis angulifera*
- *Cimicifuga simplex* (ran5) 26-viii-90 (1);
- *Cacalia adenostyloides* (com9) 17-viii-91 (1);
- *Senecio nemorensis* (com20) 26-viii-90 (1)

**Callidulidae**

*Psychostrophia melanorgia*
- *Veronicastrum sibiricum japonicum* (scr3) 29-vii-90 (1)

**Sphingidae**

*Macroglossum fringilla*
- *Serratula coronata insularis* (com21) 1-ix-91 (1)

**Noctuidae**

*Syngrapha ain*
- *Veronicastrum sibiricum japonicum* (scr3) 29-vii-90 (3)

*Cosmia variegata*
- *Cimicifuga simplex* (ran5) 26-viii-90 (1)
EXPLANATION OF PLATE 52

Views of the study site at Mt. Kushigata. A, Typical vegetation comprising mosaic of forests and meadows, where *Prunus nipponica* is blooming in early June. Akaishi Mountain Range covered with snow can be seen far ahead. B, A *Tsuga*-dominated coniferous forest. C, An *Iris*-dominated meadow accompanied by a birch tree.