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Flowering Phenology and Anthophilous Insect Community in the Cool-Temperate Subalpine Forests and Meadows at Mt. Kushigata in the Central Part of Japan

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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. *grosseserrata*. 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 pyrricholophum, 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.

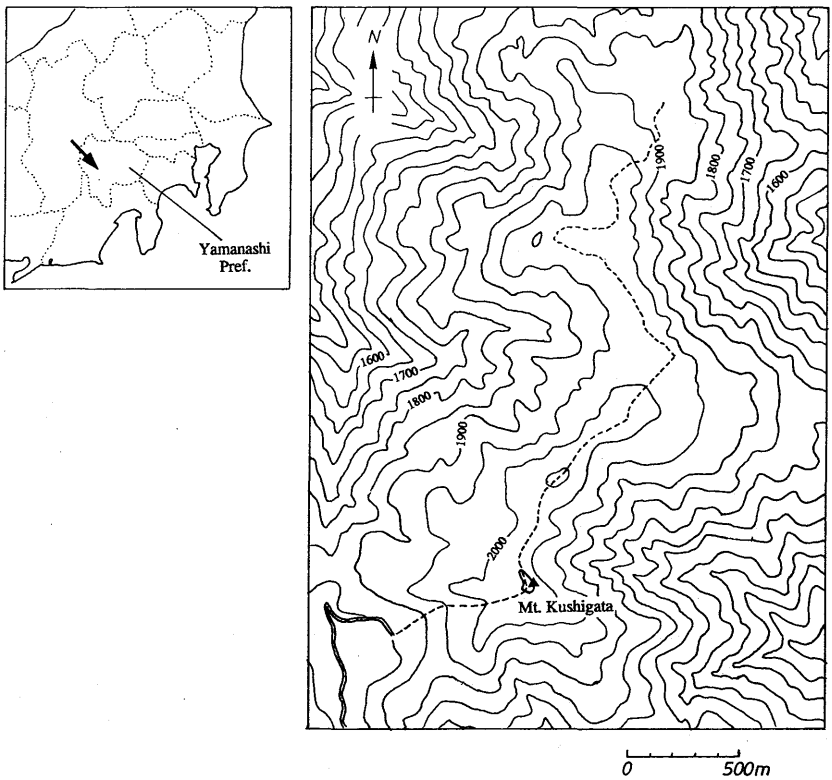

Fig. 1. The location of Mt. Kushigata in the central part of Japan (left) and a magnified map of the study area (right). The sampling route is shown as a broken line.

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-

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

Code	Date	Weather Condition	No. flower species
1	May 26, 1991	fine	5
2	May 27, 1990	fine	5
3	June 3, 1990	fine/cloudy	4
4	June 9, 1991	fine	8
5	June 9, 1991	fine	4
6	June 17, 1990	fine/cloudy	9
7	July 6, 1990	fine	14
8	July 7, 1991	fine	13
9	July 14, 1990	fine	18
10	July 25, 1991	fine	14
11	July 28, 1991	fine	13
12	July 29, 1990	fine/cloudy	11
13	August 17, 1991	fine	16
14	August 26, 1990	fine	17
15	September 1, 1991	fine	15
16	September 9, 1990	fine	11
17	September 22, 1991	fine/cloudy	5
18	September 23, 1990	fine	10

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

			M		J			J				A			S		
A	bra2	*Arabis lyrata kamtschatica*	+	+	+	+	+	+	+								
	ros3	*Fragaria nipponica*	+	+	+	+	+	+	+	+							
	ros7	*Potentilla freyniana*	+	+	+	+	+	+									
	oxa1	*Oxalis acetosella*	+	+	+												
	umb5	*Pternopetalum tanakae*	+	+	+	+	+	+									
	com24	*Taraxacum platycarpum*	+	+	+	+	+	+									
	lil5	*Iloydia triflora*	+	+	+	+											
	lil12	*Trillium tschonoskii*	+	+	+	+											
	car3	*Pseudostellaria heterantha*	+	+				+									
	fum1	*Corydalis lineariloba*	+	+													
	vio2	*Viola grypoceras*	+	+													
	ran6	*Coptis lidescens*	+														
	gen1	*Gentiana zollingeri*	+														
	pol1	*Bistorta suffulta*		+	+	+											
	lil1	*Clintonia udensis*		+	+	+	+										
	lil7	*Paris verticillata*		+	+	+	+	+	+								
	umb3	*Chamaele decumbens*		+													
	cyp1	*Carex spectabilis*		+													
	ran7	*Ranunculus japonicus*			+	+	+	+	+	+	+	+	+				
	bra1	*Arabis hirsuta*			+	+	+	+	+	+							
	sax7	*Tiarella polyphylla*			+	+	+	+			+						
	vio3	*Viola hirtipes*			+	+	+										
	ado1	*Adoxa moschatellina*			+	+											
	lil11	*Streptopus streptopoides var. japonicus*			+												
	orc1	*Coeloglossum viride var. bracteatum*			+	+	+				+						
	orc4	*Dactylostalix ringens*			+												
	vio1	*Viola acuminata*				+	+	+									
	lab2	*Meehania urticifolia*				+	+	+									
	lil2	*Convallaria keiskei*				+	+	+									
	lil6	*Maianthemum dilatatum*				+	+	+	+								
	sax3	*Mitella pauciflora*				+	+										
	ber1	*Caulophyllum robustum*				+											
	orc10	*Orchis cyclochila*				+											
	orc9	*Neottia asiatica*					+	+	+								
	ste1	*Croomia heterosepala*					+										
	ran8	*Thalictrum filamentosum tenerum*						+	+	+	+	+					
	ber2	*Diphylleia grayi*						+									
	ger1	*Geranium eriostemon var. reinii*						+	+	+	+	+	+	+		+	
	lil8	*Polygonatum lasianthum*						+	+	+	+						
	lil10	*Smilacina hondoensis*						+									
	orc2	*Cypripedium guttatum var. yatabeanum*						+									
	orc5	*Cypripedium macranthum*						+									
	orc6	*Gymnadenia conopsea*						+	+	+	+						
	orc7	*Listera cordata var. japonica*						+									
	ran4	*Aquilegia buergeriana*							+	+	+	+	+	+		+	+
	sax1	*Astilbe thunbergii*							+	+	+	+	+	+			
	sax6	*Rodgersia podophylla*							+	+	+						
	iri1	*Iris sanguinea*							+	+	+	+	+				
	pyr1	*Monotropastrum humile*							+								
	asc1	*Cynanchum ascyrifolium*							+								
	rub1	*Galium kamtschaticum var. acutifolium*							+								
	pla1	*Plantago asiatica*							+								
	com9	*Cacalia adenostyloides*							+					+		+	+ +
	com14	*Lactuca raddeana var. elata*							+			+					+
	gra1	*Agrostis clavata*							+								
	gra2	*Poa pratensis*							+								
	arc1	*Arisaema serratum*							+								
	ran9	*Trollius hondoensis*								+	+	+	+	+		+	
	pyr3	*Pyrola incarnata*								+	+						
	orc11	*Orchis joo-iokiana*								+	+						
	orc12	*Platanthera ophrydioides*								+	+						
	com13	*Ixeris dentata var. albiflora*								+							
	lil9	*Polygonatum macranthum*								+							
	car2	*Lychnis gracillima*									+	+	+	+			+
	pyr2	*Pyrola alpina*									+	+	+				
	pyr4	*Pyrola renifolia*									+						
	pim1	*Polemonium caeruleum yezoense*									+						
	scr3	*Veronicastrum sibiricum japonicum*									+	+	+	+		+	
	cam4	*Peracarpa carnosa var. circaeoides*									+						
	orc13	*Platanthera sachalinensis*									+						
	car1	*Dianthus superbus longicalycinus*										+	+	+		+	+ + +
	gut1	*Hypericum kamtschaticum*										+	+	+			
	cra2	*Sedum aizoon*										+	+	+		+	+
	ros2	*Filipendula multijuga*										+	+	+		+	+
	dip1	*Scabiosa japonica*										+	+	+		+	+ + + + +
	cam1	*Adenophora remotiflora*										+	+	+		+	+ +
	cam3	*Campanula punctata var hondoensis*										+	+	+			
	com15	*Ligularia dentata*										+	+	+		+	+ + +
	com17	*Picris hieracioides japonica*										+	+	+		+	+ + +
	lil3	*Hosta sieboldiana*										+	+	+		+	+
	lil4	*Lilium leichtlinii var. maximowiczii*										+	+	+		+	
	ros6	*Potentilla cryptotaeniae*										+	+			+	+
	ona1	*Chamaenerion angustifolium*										+	+				+
	com19	*Senecio flammeus glabrifolius*										+	+				+ +
	com12	*Eupatorium chinense sachalinense*										+		+			+ +
	pol2	*Reynoutria japonica*										+				+	+ + +
	gen2	*Halenia corniculata*										+					+ +
	val1	*Patrinia triloba palmata*											+	+			
	cam2	*Adenophora triphylla var. japonica*											+	+		+	+ + +
	lil13	*Veratrum album oxysepalum*											+	+		+	+
	lab1	*Clinopodium chinense grandiflorum*											+			+	+ +
	orc5	*Epipactis papillosa*											+				
	orc8	*Malaxis monophyllos*											+				
	cra1	*Hylotelephium verticillatum*												+			
	ros1	*Agrimonia pilosa*												+		+	+ +
	umb2	*Angelica pubescens*												+		+	+
	umb4	*Libanotis coreana*												+		+	+ +
	com3	*Anaphalis margaritacea*												+		+	+ + +
	ran3	*Aconitum senanense*														+	+ + + + +
	ran5	*Cimicifuga simplex*														+	+ + + + +
	scr2	*Pedicularis resupinata var. caespitosa*														+	+ +
	com11	*Cirsium effusum*														+	+ + + + +
	com20	*Senecio nemorensis*														+	+ + +
	com21	*Serratula coronata insularis*														+	+ + + +
	com22	*Solidago virgaurea asiatica*														+	+ + + + +
	lil14	*Veratrum maackii var. japonicum*														+	+
	com16	*Ligularia stenocephala*														+	+
	ros4	*Geum japonicum*														+	
	val2	*Patrinia villosa*														+	
	scr1	*Euphrasia maximowiczii*															+ +
	com2	*Ainslinea acerifolia var. subapola*															+ +
	com8	*Aster scaber*															+ + +
	com10	*Cacalia hastata farfaraefolia*															+ + +
	com18	*Senecio cannabifolius*															+ + +
	ran1	*Aconitum japonicum montanum*															+
	ona2	*Epilobium pyrricholophum*															+
	com1	*Achillea alpina var. discoidea*															+
	com7	*Aster glehni var. hondoensis*															+
	ran2	*Aconitum loczyanum*															+
	umb1	*Angelica polymorpha*															+
	com5	*Aster ageratoides leiophyllus*															+ + + +
	com23	*Synurus pungens*															+ + + +
	com4	*Artemisia princeps*															+
	com6	*Aster ageratoides ovatus*															+ + +
	gra3	*Miscanthus sinensis*															+
B	sax5	*Ribes maximowiczianum*	+	+	+	+											
	eri2	*Menziesia pentandra*	+	+	+												
	cap2	*Viburnum furcatum*	+	+	+												
	cap1	*Lonicera alpigena var. glehnii*				+	+		+								
	eri4	*Rhododendron wadanum*				+											
	ros12	*Rubus pungens var. oldhamii*					+		+								
	cap3	*Viburnum opulus var. calvescens*								+							
	ela1	*Elaeagnus montana*									+	+					
	ara1	*Oplopanax japonicus*									+						
	cap4	*Weigela decora*									+						
	sax4	*Philadelphus satsumi*										+	+				
	eri3	*Rhododendron degronianum*										+					
	ros10	*Rubus idaeus f. marmoratus*												+			
	ros14	*Spiraea japonica*												+			
	sax2	*Hydrangea paniculata*														+	
C	ros9	*Prunus nipponica*	+	+	+												
	ace1	*Acer japonicum*	+														
	cel1	*Euonymus macropterus*			+	+	+		+								
	ros8	*Prunus maximowiczii*				+	+		+								
	ace2	*Acer shirasawanum*				+											
	eri1	*Enkianthus campanulatus*				+	+			+	+						
	ros5	*Malus sieboldii*							+								
	ros13	*Sorbus commixta*								+							
	ace3	*Acer ukurunduense*									+						
	cel2	*Euonymus sieboldianus*										+					

Fig. 2. Flowering phenology of 151 plant species shown separately in trees, shrubs and herbs.
+ indicates flowering.

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.

Family	Code	Species	Japanese name	Life form[1]	Breeding System[2]	Flower Shape[3]	Flower Color[4]	Main Haditat[5]	No. of Insects collected	Flower Guilds[6] #1	#2
Polygonaceae	pol1	*Bistorta suffulta*	Kurinyukifude	h	h	o	w	s	0	-	-
	pol2	*Reynoutria japonica*	Itadori	h	d	o	w	m	112	1	-
Caryophyllaceae	car1	*Dianthus superbus longicalycinus*	Kawaranadeshiko	h	h	t2	p	m	5	5	-
	car2	*Lychnis gracillima*	Senjuganpi	h	h	t1	w	s	16	4	-
	car3	*Pseudostellaria heterantha*	Wachigaisou	h	h	o	w	d	1	5	-
Ranunculaceae	ran1	*Aconitum japonicum montanum*	Yamatorikabuto	h	h	t3	v	m	12	1	2
	ran2	*Aconitum loczyanum*	Reijinsou	h	h	t3	m	m	0	-	-
	ran3	*Aconitum senanense*	Hosobatorikabuto	h	h	t3	v	m	11	1	2
	ran4	*Aquilegia buergeriana*	Yamaodamaki	h	h	t3	yw	m	10	1	2
	ran5	*Cimicifuga simplex*	Sarashinashouma	h	h	a	w	m	49	5	1
	ran6	*Coptis lutescens*	Usugiouren	h	h	o	yw	c	0	-	-
	ran7	*Ranunculus japonicus*	Umanoashigata	h	h	o	y	m	30	5	-
	ran8	*Thalictrum filamentosum tenerum*	Miyamakaramatsu	h	h	a	w	m	2	5	-
	ran9	*Trollius hondoensis*	Kinbaisou	h	h	o	y	m	28	5	1
Berberidaceae	ber1	*Caulophyllum robustum*	Ruiyoubotan	h	h	o	yg	d	0	-	-
	ber2	*Diphylleia grayi*	Sankayou	h	h	o	w	d	0	-	-
Guttiferae	gut1	*Hypericum kamtschaticum senanense*	Miyamaotogiri	h	h	o	y	m	0	-	-
Fumariaceae	fum1	*Corydalis lineariloba*	Yamaengosaku	h	h	t3	v	m	0	-	-
Brasicaceae	bra1	*Arabis hirsuta*	Yamahatazao	h	h	t1	w	m	1	2	-
	bra2	*Arabis lyrata kamtschatica*	Miyamahatazao	h	h	t1	w	m	8	1	-
Crassulaceae	cra1	*Hylotelephium verticillatum*	Mitsubabenkeisou	h	h	t1	p	m	0	-	-
	cra2	*Sedum aizoon*	Kirinsou	h	h	t1	y	m	9	1	-
Saxifragaceae	sax1	*Astilbe thunbergii*	Akashouma	h	h	o	w	m	204	4	1
	sax2	*Hydrangea paniculata*	Noritsugi	s	h	o	w	s	21	1	-
	sax3	*Mitella pauciflora*	Kocharumerusou	h	h	o	yg	d	0	-	-
	sax4	*Philadelphus satsumi*	Baikautsugi	s	h	t1	w	s	17	4	4
	sax5	*Ribes maximowiczianum*	Zarikomi	s	h	o	w	c	2	3	-
	sax6	*Rodgersia podophylla*	Yagurumasou	h	h	o	w	d	93	4	1
	sax7	*Tiarella polyphylla*	Zudayakushu	h	h	t1	w	c	0	-	-
Rosaceae	ros1	*Agrimonia pilosa*	Kinmizuhiki	h	h	o	y	m	0	-	-
	ros2	*Filipendula multijuga*	Simotsukesou	h	h	o	p	m	79	1	3
	ros3	*Fragaria nipponica*	Shirobanashebiichigo	h	h	o	w	m	33	4	-
	ros4	*Geum japonicum*	Daikonsou	h	h	o	y	m	0	-	-
	ros5	*Malus sieboldii*	Zumi	t	h	o	w	s	12	5	-
	ros6	*Potentilla cryptotaeniae*	Mitsumotosou	h	h	o	y	m	0	-	-
	ros7	*Potentilla freyniana*	Mitsubatsuchiguri	h	h	o	y	m	21	5	-
	ros8	*Prunus maximowiczii*	Miyamazakura	t	h	o	w	d	12	5	-
	ros9	*Prunus nipponica*	Takanezakura	t	h	o	w	s	46	4	5
	ros10	*Rubus idaeus f. marmoratus*	Sinanokiichigo	h	h	o	w	s	2	1	3
	ros11	*Rubus microphyllus koehneanus*	Miyamanigaichigo	h	h	o	w	s	0	-	-
	ros12	*Rubus pungens var. oldhamii*	Sanagiichigo	h	h	o	w	c	22	1	3
	ros13	*Sorbus commixta*	Nanakamado	t	h	o	w	d	11	4	-
	ros14	*Spiraea japonica*	Shimotsuke	s	h	o	p	m	0	-	-
Oxalidaceae	oxa1	*Oxalis acetosella*	Komiyamakatabami	h	h	o	w	c	29	4	-
Geraniaceae	ger1	*Geranium eriostemon var. reinii*	Gunnaifuuro	h	h	o	m	m	87	5	3
Aceraceae	ace1	*Acer japonicum*	Hauchiwakaede	t	m	o	r	d	4	1	-
	ace2	*Acer shirasawanum*	Ooitayameigetsu	t	m	o	yw	d	15	3	5
	ace3	*Acer ukurunduense*	Ogarabana	t	m	o	yw	s	12	5	-
Celastraceae	cel1	*Euonymus macropterus*	Hirohatsuribana	t	h	o	yg	s	7	3	-
	cel2	*Euonymus sieboldianus*	Mayumi	t	h	o	yg	d	12	5	-
Elaeagnaceae	ela1	*Elaeagnus montana*	Mamegumi	s	h	t2	w	s	38	1	3
Violaceae	vio1	*Viola acuminata*	Ezotachitsubosumire	h	h	t2	m	m	0	-	-
	vio2	*Viola grypoceras*	Tachitsubosumire	h	h	t2	m	m	2	2	-
	vio3	*Viola hirtipes*	Sakurasumire	h	h	t2	v	m	0	-	-
Onagraceae	ona1	*Chamaenerion angustifolium*	Yanagiran	h	h	t2	m	m	15	1	3
	ona2	*Epilobium pyrricholophum*	Akabana	h	h	t1	p	m	0	-	-
Araliaceae	ara1	*Oplopanax japonicus*	Haribuki	s	h	o	yg	s	0	-	-
Umbelliferae	umb1	*Angelica polymorpha*	Shirancenkyuu	h	h	o	w	m	22	5	-
	umb2	*Angelica pubscens*	Shishiudo	h	h	o	w	m	50	5	-
	umb3	*Chamaele decumbens*	Sentousou	h	h	o	w	d	0	-	-
	umb4	*Libanotis coreana*	Ibukiboufuu	h	h	o	w	m	27	5	-
	umb5	*Ptemopetalum tanakae*	Iwasentousou	h	h	o	w	c	0	-	-
Pyrolaceae	pyr1	*Monotropastrum humile*	Ginryousou	h	h	t3	w	d	0	-	-
	pyr2	*Pyrola alpina*	Kobanoichiyakusou	h	h	o	w	c	20	4	1
	pyr3	*Pyrola incarnata*	Benibanaichiyakusou	h	h	o	p	c	7	1	4
	pyr4	*Pyrola renifolia*	Jinyouichiyakusou	h	h	o	w	c	0	-	-
Ericaceae	eri1	*Enkianthus campanulatus*	Sarasadoudan	s	h	t1	p	s	11	1	3
	eri2	*Menziesia pentandra*	Koyourakutsutsuji	s	h	t1	r	s	1	1	3
	eri3	*Rhododendron degronianum*	Shakunage	s	h	t1	p	d	1	5	-
	eri4	*Rhododendron wadanum*	Tougokumitsubatsutsuji	s	h	t1	m	d	6	1	3
Gentianaceae	gen1	*Gentiana zollingeri*	Fudetindou	h	h	t2	v	m	0	-	-
	gen2	*Halenia corniculata*	Hanaikari	h	h	t1	yw	m	0	-	-
Asclepiadaceae	asc1	*Cynanchum ascyrifolium*	Kusatachibana	h	h	c	w	m	14	3	5
Rubiaceae	rub1	*Galium kamtschaticum var. acutifolium*	Oobanoyotsubamugura	h	h	o	w	m	0	-	-
Polemoniaceae	plm1	*Polemonium caeruleum yezoense*	Miyamahanashinobu	h	h	o	m	m	10	5	4
Labiatae	lab1	*Clinopodium chinense grandiflorum*	Kurumabana	h	h	t1	w	m	3	1	3
	lab2	*Meehania urticifolia*	Rashoumonkazura	h	h	t3	v	d	3	1	1

Table 2. (continued)

Family	Code	Species	Japanese name	Life form[1]	Breeding System[2]	Flower Shape[3]	Flower Color[4]	Main Haditat[5]	No. of Insects collected	Flower Guilds[6] #1	#2
Scrophulariaceae	scr1	*Euphrasia maximowiczii*	Tachikogomegusa	h	h	t1	w	m	1	5	-
	scr2	*Pedicularis resupinata var. caespitosa*	Tomoeshiogama	h	h	t2	p	m	7	1	4
	scr3	*Veronicastrum sibiricum japonicum*	Kugaisou	h	h	t1	m	m	96	1	3
Plantaginaceae	pla1	*Plantago asiatica*	Oobako	h	h	a	yg	m	0	-	-
Caprifoliaceae	cap1	*Lonicera alpigena var. glehnii*	Surugahyoutanboku	s	h	t2	r	s	55	1	3
	cap2	*Viburnum furcatum*	Mushikari	s	h	c	w	s	65	4	-
	cap3	*Viburnum opulus var. calvescens*	Kanboku	s	h	c	w	d	9	3	-
	cap4	*Weigela decora*	Nishikiutsugi	s	h	t3	p	s	18	1	2
Adoxaceae	ado1	*Adoxa moschatellina*	Renpukusou	h	h	o	yg	m	0	-	-
Valerianaceae	val1	*Patrinia triloba palmata*	Kinreika	h	h	c	y	d	2	1	3
	val2	*Patrinia villosa*	Otokoeshi	h	h	c	w	m	15	1	-
Dipsacaceae	dip1	*Scabiosa japonica*	Matsumushisou	h	h	h	v	m	99	1	1
Campanulaceae	cam1	*Adenophora remotiflora*	Sobana	h	h	c	v	m	0	-	-
	cam2	*Adenophora triphylla var. japonica*	Tsuriganeninjin	h	h	c	v	m	2	3	-
	cam3	*Campanula punctata var. hondoensis*	Yamahotarubukuro	h	h	c	p	m	3	1	2
	cam4	*Peracarpa carnosa var. circaeoides*	Tanigikyou	h	h	o	w	d	0	-	-
Compositae	com1	*Achillea alpina var. discoidea*	Yamanokogirisou	h	h	h	w	m	1	5	-
	com2	*Ainsliaea acerifolia var. subapoda*	Okumomijihaguma	h	h	h	w	c	0	-	-
	com3	*Anaphalis margaritacea*	Yamahahako	h	h	h	yw	m	21	5	-
	com4	*Artemisia princeps*	Yomogi	h	h	h	yg	m	0	-	-
	com5	*Aster ageratoides leiophyllus*	Shiroyomena	h	h	h	w	m	5	3	-
	com6	*Aster ageratoides ovatus*	Nokongiku	h	h	h	v	m	10	1	-
	com7	*Aster glehni var. hondoensis*	Gomana	h	h	h	w	m	5	3	-
	com8	*Aster scaber*	Shirayamagiku	h	h	h	w	m	0	-	-
	com9	*Cacalia adenostyloides*	Kanikoumori	h	h	h	w	c	15	1	4
	com10	*Cacalia hastata farfaraefolia*	Koumorisou	h	h	h	w	c	4	1	1
	com11	*Cirsium effusum*	Hosocazami	h	h	h	v	m	66	1	4
	com12	*Eupatorium chinense sachalinense*	Yotsubahiyodori	h	h	h	p	m	16	5	-
	com13	*Ixeris dentata var. albiflora*	Shirobananigana	h	h	h	w	m	4	5	-
	com14	*Lactuca raddeana var. elata*	Yamanigana	h	h	h	y	m	0	-	-
	com15	*Ligularia dentata*	Marubadakebuki	h	h	h	y	m	22	5	3
	com16	*Ligularia stenocephala*	Metakarakou	h	h	h	y	m	0	-	-
	com17	*Picris hieracioides japonica*	Kouzorina	h	h	h	y	m	3	4	-
	com18	*Senecio cannabifolius*	Hangonsou	h	h	h	y	m	13	5	-
	com19	*Senecio flammeus glabrifolius*	Kourinka	h	h	h	r	m	0	-	-
	com20	*Senecio nemorensis*	Kion	h	h	h	y	m	7	5	-
	com21	*Serratula coronata insularis*	Tamurasou	h	h	h	v	m	100	1	4
	com22	*Solidago virgaurea asiatica*	Akinokirinsou	h	h	h	y	m	23	5	-
	com23	*Synurus pungens*	Oyamabokuchi	h	h	h	v	d	6	1	2
	com24	*Taraxacum hondoense*	Ezotanpopo	h	h	h	y	m	17	4	-
Liliaceae	lil1	*Clintonia udensis*	Tsubameomoto	h	h	o	w	c	0	-	-
	lil2	*Convallaria keiskei*	Suzuran	h	h	c	w	m	0	-	-
	lil3	*Hosta sieboldiana*	Oobagiboushi	h	h	t3	m	m	37	1	2
	lil4	*Lilium leichtlinii var. maximowiczii*	Kooniyuri	h	h	c	r	m	0	-	-
	lil5	*Lloydia triflora*	Hosobasmana	h	h	o	w	m	0	-	-
	lil6	*Maianthemum dilatatum*	Maizurusou	h	h	o	w	c	0	-	-
	lil7	*Paris verticillata*	Kurumabatsukubane	h	h	o	yg	d	0	-	-
	lil8	*Polygonatum lasianthum*	Miyamanarukoyuri	h	h	t3	w	d	11	1	3
	lil9	*Polygonatum macranthum*	Oonarukoyuri	h	h	t3	w	m	1	1	2
	lil10	*Smilacina hondoensis*	Yamatoyukizasa	h	h	o	yg	d	0	-	-
	lil11	*Streptopus streptopoides var. japonicus*	Takeshimaran	h	h	o	b	m	0	-	-
	lil12	*Trillium tschonoskii*	Shirobanenreisou	h	h	o	w	m	0	-	-
	lil13	*Veratrum album oxysepalum*	Baikeisou	h	h	o	w	s	23	4	-
	lil14	*Veratrum maackii var. japonicum*	Shurosou	h	h	o	g	m	2	5	-
Stemonaceae	ste1	*Croomia heterosepala*	Nabewari	h	h	o	yg	s	0	-	-
Iridaceae	iri1	*Iris sanguinea*	Ayame	h	h	t3	v	m	63	1	4
Graminae	gra1	*Agrostis clavata*	Yamanukabo	h	h	s	g	m	8	5	-
	gra2	*Poa pratensis*	Nagahagusa	h	h	s	g	m	2	5	-
	gra3	*Miscanthus sinensis*	Susuki	h	h	s	g	m	0	-	-
Araceae	arc1	*Arisaema serratum*	Hosobatennanahou	h	d	a	g	d	0	-	-
Cyperaceae	cyp1	*Carex spectabilis*	Miyamakurosuge	h	m	a	b	m	0	-	-
Orchidaceae	orc1	*Coeloglossum viride var. bracteatum*	Aochidori	h	h	t1	yg	m	0	-	-
	orc2	*Cypripedium guttatum var. yatabeanum*	Kibananoatsumorisou	h	h	c	yg	m	4	3	-
	orc3	*Cypripedium macranthum*	Atsumorisou	h	h	c	v	m	0	-	-
	orc4	*Dactylostalix ringens*	Ichiyouran	h	h	o	yg	c	0	-	-
	orc5	*Epipactis papillosa*	Ezosuzuran	h	h	c	yg	m	0	-	-
	orc6	*Gymnandenia conopsea*	Tegatachidori	h	h	t3	m	m	1	4	-
	orc7	*Listera cordata var. japonica*	Futabaran	h	h	o	yg	c	0	-	-
	orc8	*Malaxis monophyllos*	Hozakiichiyouran	h	h	o	yg	c	0	-	-
	orc9	*Neottia asiatica*	Himemuyouran	h	h	t1	yb	c	0	-	-
	orc10	*Orchis cyclochila*	Kamomeran	h	h	t2	m	s	0	-	-
	orc11	*Orchis joo-iokiana*	Nyohouchidori	h	h	t3	m	m	0	-	-
	orc12	*Platanthera ophrydioides*	Kisochidori	h	h	t2	yg	d	0	-	-
	orc13	*Platanthera sachalinensis*	Ooyamasagisou	h	h	t3	w	m	0	-	-
Total									2127		

1 h, herb; s, shrub; t, tree.

2 d, dioecious; h, hermaphrodite; m, monoecious.

3 a, apetalous; c, cup-shaped; h, head; o, open; s, spikelet; t1, short-tubed (< 5 mm); t2, middle-tubed (5 ≤ tube < 10 mm); t3 long-tubed (≥ 10 mm).

4 b, brown; g, green; m, mauve; p, pink; r, red; v, violet; w, white; y, yellow; yb, yellow brown; yg, yellow-green; yw, yellow-white.

5 d, deciduous oak forest; c, coniferous forests; m, meadows; s, shrubby thickets;

6 Flower guild #1, derived from cluster analysis on flower-visitor spectra sorted by insect orders (see Fig. 13).
#2, derived from cluster analysis on flower-visiting bumblebee spectra (see Fig. 16).

(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*

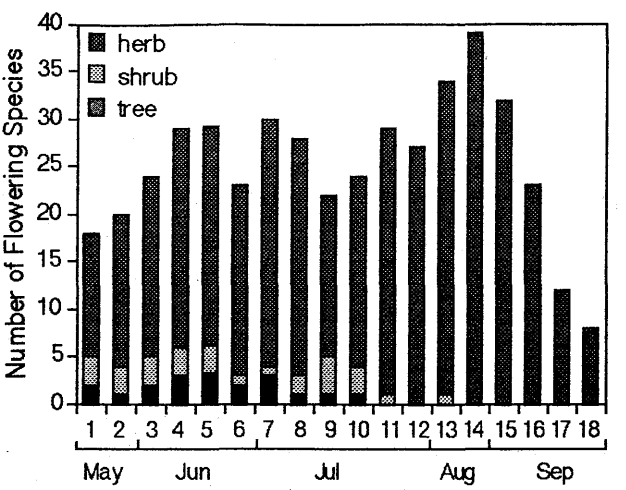

Fig. 3. Seasonal change in the number of plant species blooming at each sampling date.

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	%
Dermaptera	Forficulidae	For	1	0.27	1	0.05
Thysanoptera	Thripidae	Thr	1	0.27	2	0.09
Hemiptera	Cixiidae	Cix	1	0.27	1	0.05
	Aphrophoridae	Aph	1	0.27	1	0.05
	Penthimiidae	Pen	1	0.27	1	0.05
	Psyllidae	Psy	2	0.54	2	0.09
	Miridae	Mir	6	1.62	16	0.75
Coleoptera	Staphylinidae	Sta	1	0.27	71	3.34
	Scarabaeidae	Sca	5	1.35	9	0.42
	Buprestidae	Bup	1	0.27	1	0.05
	Elateridae	Ela	1	0.27	1	0.05
	Cantharidae	Can	2	0.54	3	0.14
	Melyridae	Mel	1	0.27	1	0.05
	Nitidulidae	Nit	3	0.81	75	3.53
	Cryptophagidae	Cry	1	0.27	1	0.05
	Byturidae	Byt	4	1.08	52	2.45
	Biphyllidae	Bip	11	2.97	1	0.05
	Coccinellidae	Coc	1	0.27	1	0.05
	Lathridiidae	Lat	1	0.27	1	0.05
	Mordellidae	Mor	2	0.54	3	0.14
	Oedemeridae	Oed	3	0.81	64	3.01
	Scraptiidae	Str	1	0.27	163	7.67
	Cerambycidae	Cer	23	6.22	124	5.84
	Chrysomelidae	Chr	5	1.35	7	0.33
	Attelabidae	Att	1	0.27	1	0.05
	Curculionidae	Cur	2	0.54	5	0.24
	Scolytidae	Sco	1	0.27	1	0.05
Hymenoptera	Tenthredinidae	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
	Pteromalidae	Pte	3	0.81	3	0.14
	Perilampidae	Per	1	0.27	2	0.09
	Eulophidae	Eul	12	3.24	13	0.61
	Cynipidae	Cyn	1	0.27	2	0.09
	Formicidae	For	3	0.81	6	0.28
	Pompilidae	Pom	1	0.27	1	0.05
	Eumenidae	Eum	3	0.81	3	0.14
	Vespidae	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	498	23.45
Mecoptera	Panorpidae	Pan	1	0.27	4	0.19
Diptera	Empididae	Emp	12	3.24	48	2.26
	Pipunculidae	Pip	1	0.27	1	0.05
	Taumaleidae	Tau	1	0.27	1	0.05
	Simuliidae	Sim	3	0.81	3	0.14
	Acatopsidae	Aca	1	0.27	1	0.05
	Sciaridae	Sci	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
	Acroceridae	Acr	1	0.27	4	0.19
	Bombyliidae	Bom	1	0.27	1	0.05
	Asilidae	Asi	1	0.27	1	0.05
	Syrphidae	Syr	54	14.59	406	19.11
	Conopidae	Con	4	1.08	6	0.28
	Tephritidae	Tep	1	0.27	1	0.05
	Lauxaniidae	Lau	2	0.54	5	0.24
	Agromyziidae	Agr	2	0.54	2	0.09
	Chloropidae	Chl	2	0.54	2	0.09
	Drosophilidae	Dro	4	1.08	4	0.19
	Heleomyzidae	Hel	2	0.54	2	0.09
	Sphaeroceridae	Sph	4	1.08	6	0.28
	Scathophagidae	Sca	2	0.54	2	0.09
	Anthomyiidae	Ant	29	7.84	113	5.32
	Muscidae	Mus	1	0.27	2	0.09
	Calliphoridae	Cal	16	4.32	29	1.37
	Tachinidae	Tac	22	5.95	45	2.12
Lepidoptera	Incurvariidae	Inc	1	0.27	1	0.05
	Yponomeutidae	Ypo	1	0.27	1	0.05
	Choreutidae	Cho	1	0.27	1	0.05
	Zygaenidae	Zyg	1	0.27	2	0.09
	Pyralidae	Pyr	2	0.54	2	0.09
	Pterophoridae	Pte	1	0.27	1	0.05
	Hesperiidae	Hes	1	0.27	20	0.94
	Papilionidae	Pap	3	0.81	5	0.24
	Pieridae	Pie	4	1.08	11	0.52
	Lycaenidae	Lyc	1	0.27	1	0.05
	Lybytheidae	Lyb	1	0.27	1	0.05
	Nymphalidae	Nym	5	1.35	10	0.47
	Satyridae	Sat	1	0.27	6	0.28
	Geometridae	Geo	5	1.35	7	0.33
	Callidulidae	Cal	1	0.27	1	0.05
	Sphingidae	Sph	1	0.27	1	0.05
	Noctuidae	Noc	2	0.541	4	0.19
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

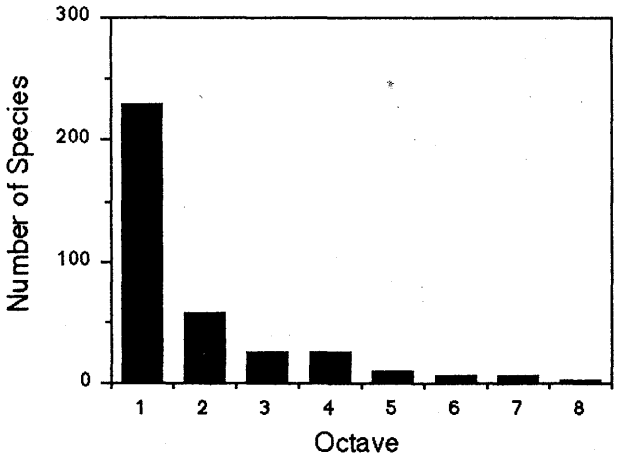

Fig. 4. The number of insect species plotted in the Preston's octave.

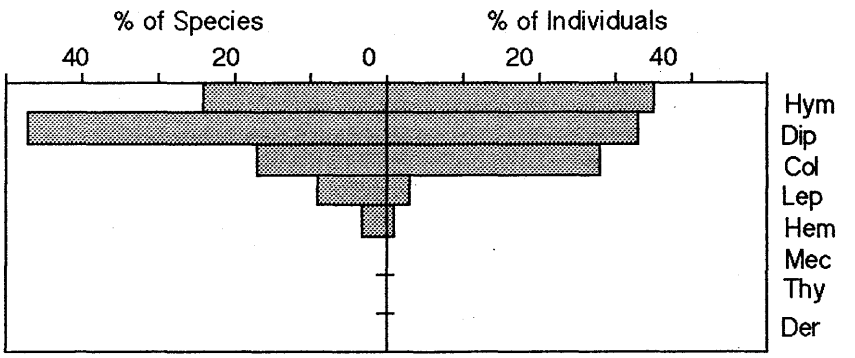

Fig. 5. The percentages of numbers of insect species (left) and individuals (right) in orders: Hym, Hymenoptera; Dip, Diptera; Col, Coleoptera; Lep, Lepidoptera; Hem, Hemiptera; Mec, Mecoptera; Thy, Thysanaoptera; Der, Dermaptera.

Hemiptera (1.9).

3-2. *Coleoptera*

Dominant families were Scraptiidae (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* (Scraptiidae, 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%), Hylaeninae (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

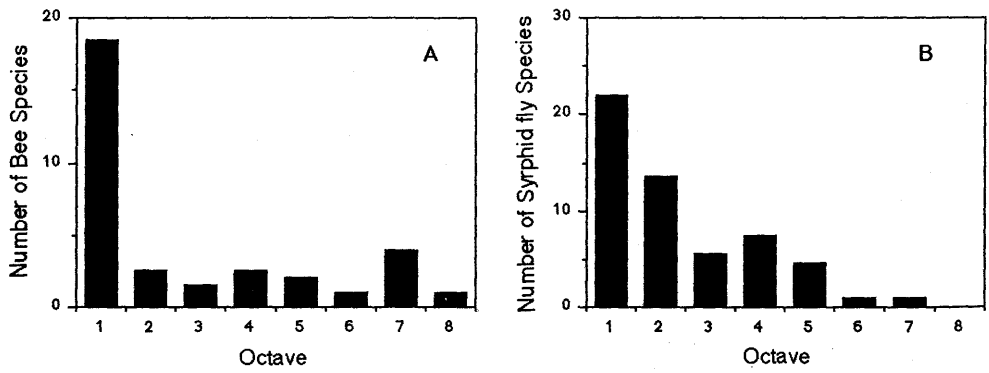

Fig. 6. The number of bee species (A) and hoverfly species (B) plotted in the Preston's octave.

Table 4. Relative abundance of bee genera at Mt. Kushigata.

Family	Subfamily	Genus	No. of Species	No. of Individuals
Colletidae	Hylaeninae	*Hylaeus*	2	2
Halictidae	Halictinae	*Lasioglossum*	11	131
		Sphecodes	1	1
Andrenidae	Andreninae	*Andrena*	7	10
Megachilidae	Megachilinae	*Megachile*	3	3
Anthophoridae	Nomadinae	*Nomada*	2	2
Apidae	Bombinae	*Bombus*	6	496
		Psythirus	1	1
	Apinae	*Apis*	1	1
Total			34	647

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 decreased (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 Cerambycidae 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 Vespoidea was observed in August. Most andrenid species were active only from June to mid July, excluding alpine species, *Andrena (Euandrena) 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 after August. An eusocial halictid bee, *Lasioglossum (Evylaeus) apristum* appeared in late May, and most abundant in August. Most hylaeine and Megachilid bees appeared in August.

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

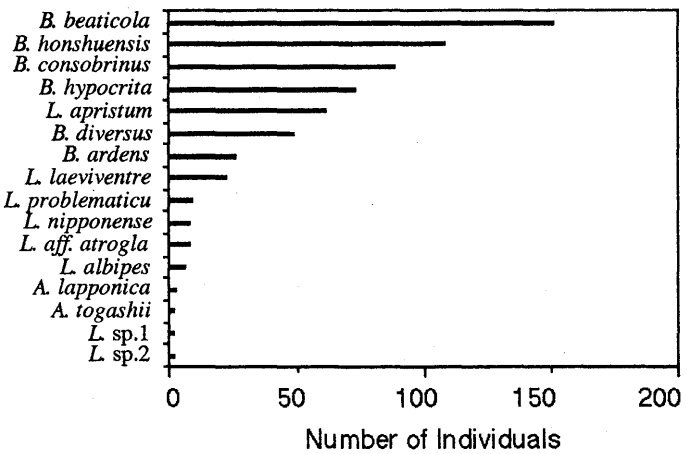

Fig. 7. Abundance ranking of bee species at Mt. Kushigata. Only bee species with ≥ 2 individuals are shown.

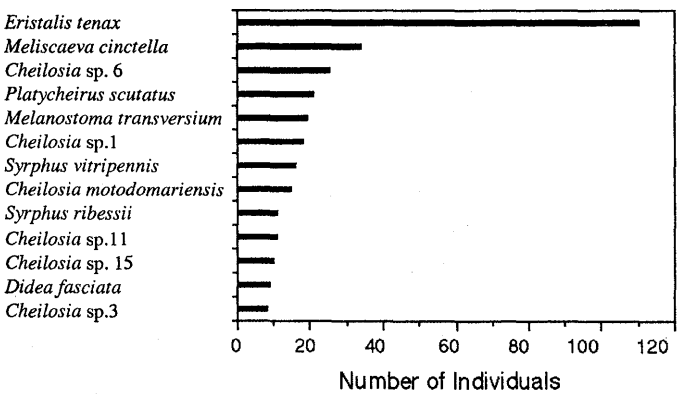

Fig. 8. Abundance ranking of hoverfly species at Mt. Kushigata. Only species with ≥ 8 individuals are shown.

periods of some *Cheilosia* species were confined in spring. In Calyptrata, 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

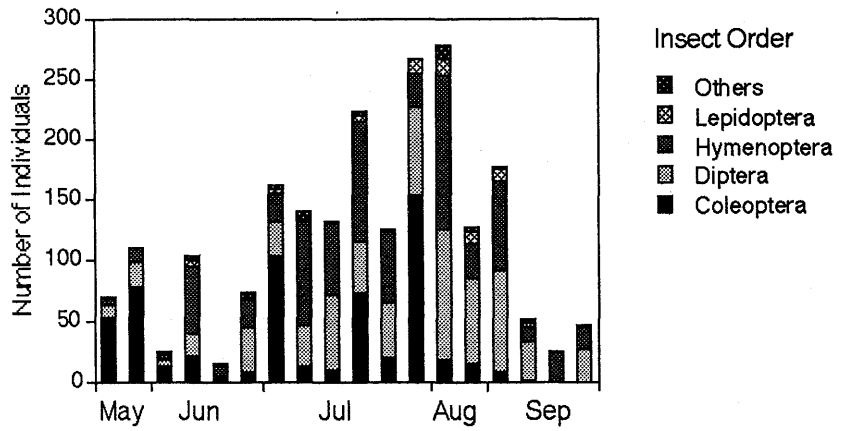

Fig. 9. Seasonal change in the number of insects collected on flowers at each sampling date. Insects are sorted by orders.

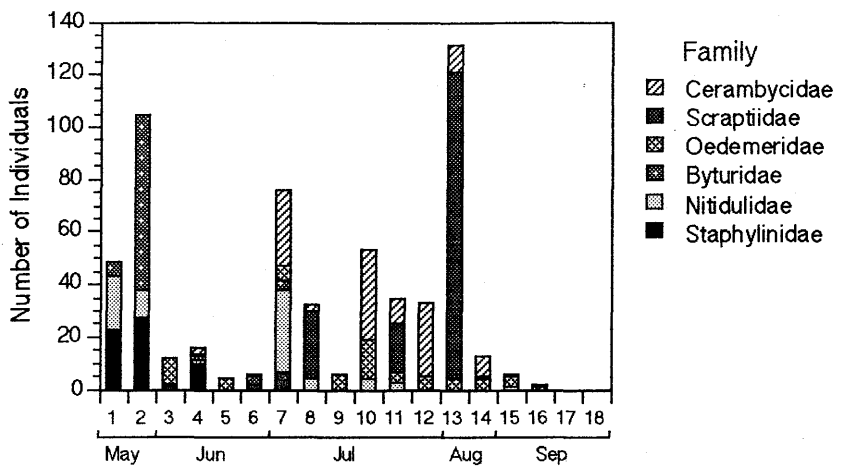

Fig. 10. Seasonal change in the number of coleopterous insects of six dominant families collected on flowers at Mt. Kushigata.

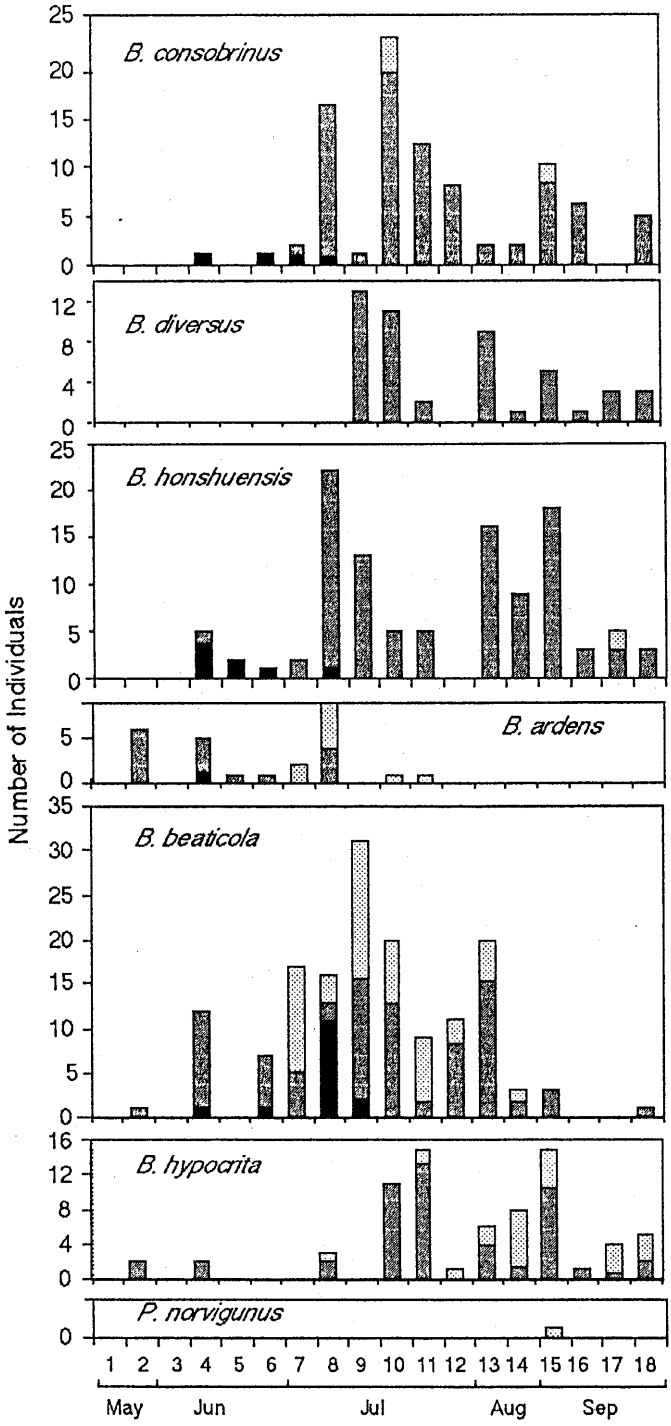

Fig. 11. Seasonal change in the number of bumblebees collected at Mt. Kushigata. Solid, shaded and dotted columns denote queens, workers and males, respectively.

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 Asclepidaceae, 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 degronianum, Euphrasia maximowiczii, Achillea alpina, Cirsium 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 Anthophoridae, Caryophyllaceae and Brassicaceae 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 ($\geq$ 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*

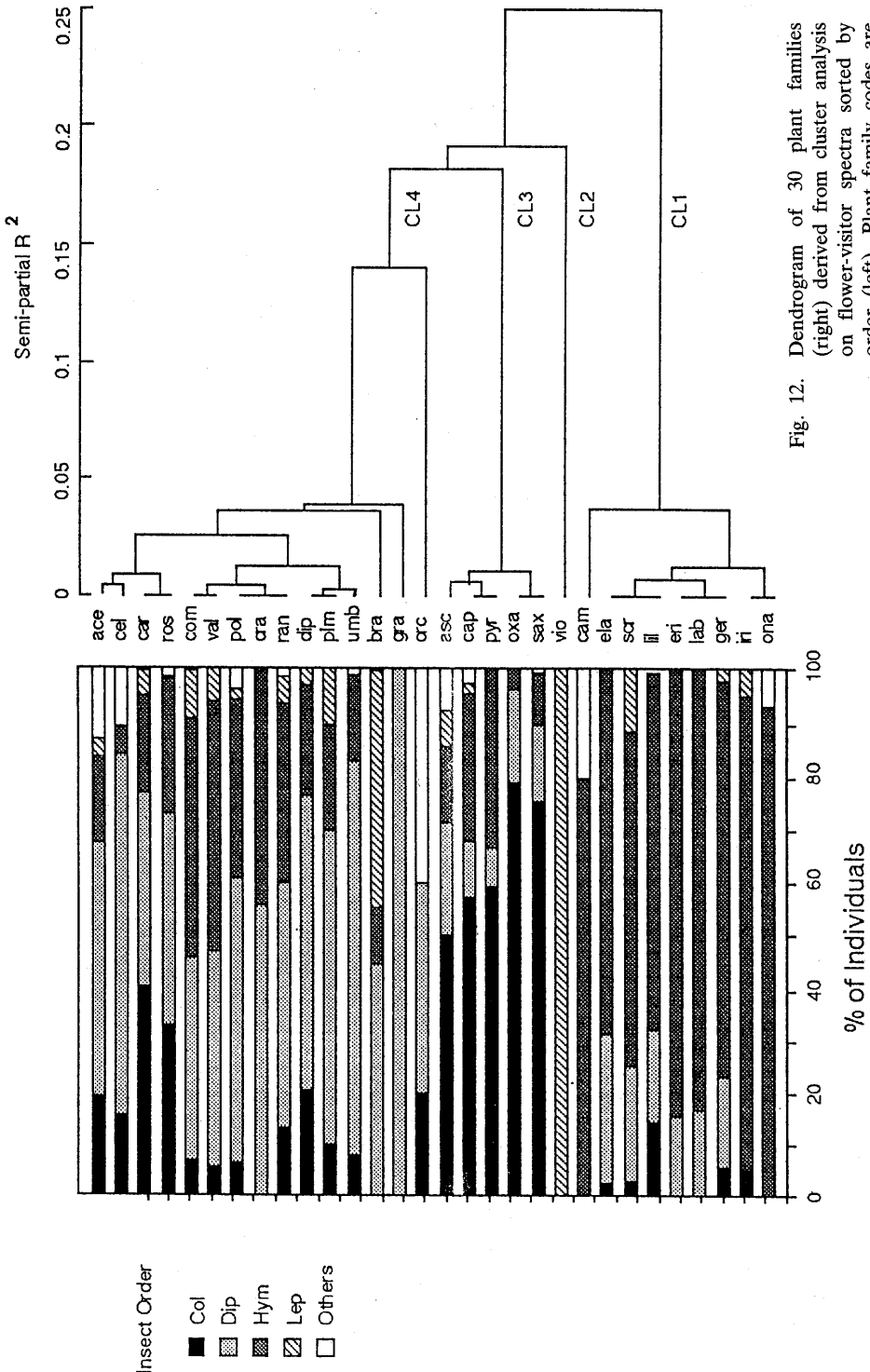

Fig. 12. Dendrogram of 30 plant families (right) derived from cluster analysis on flower-visitor spectra sorted by order (left). Plant family codes are shown in Table 2.

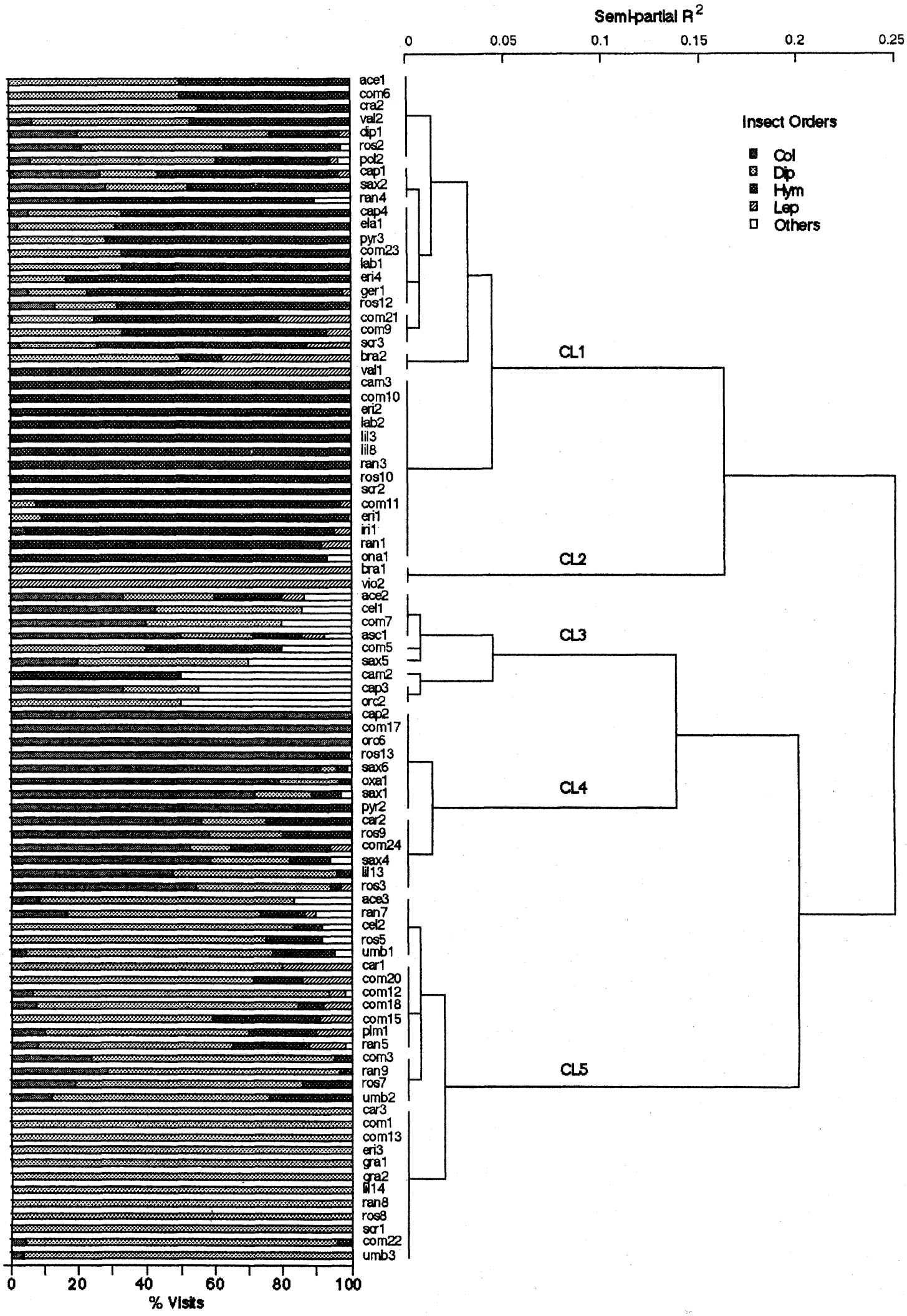

Fig. 13. Dendrogram of 90 plant species (above) derived from cluster analysis on flower-visitor spectra sorted by order (below).

leiophyllus, 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.*

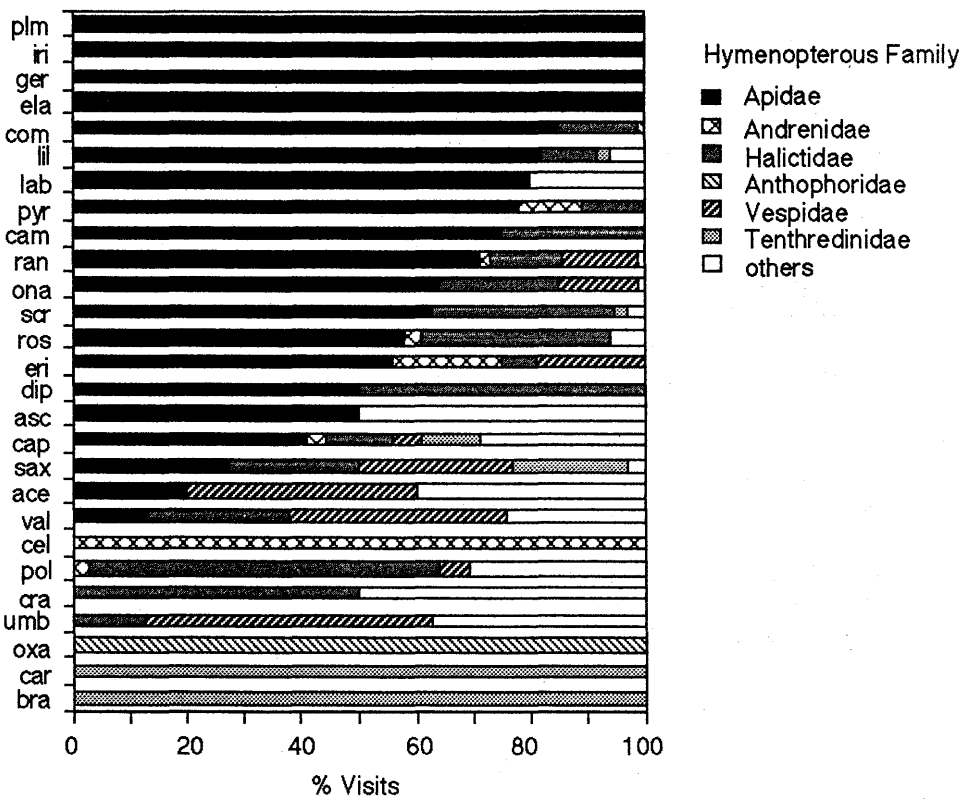

Fig. 14. Flower-visitor spectra (sorted by hymenopterous family) of 27 plant families which were visited by at least an individual of Hymenoptera.

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 pentandra, 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*

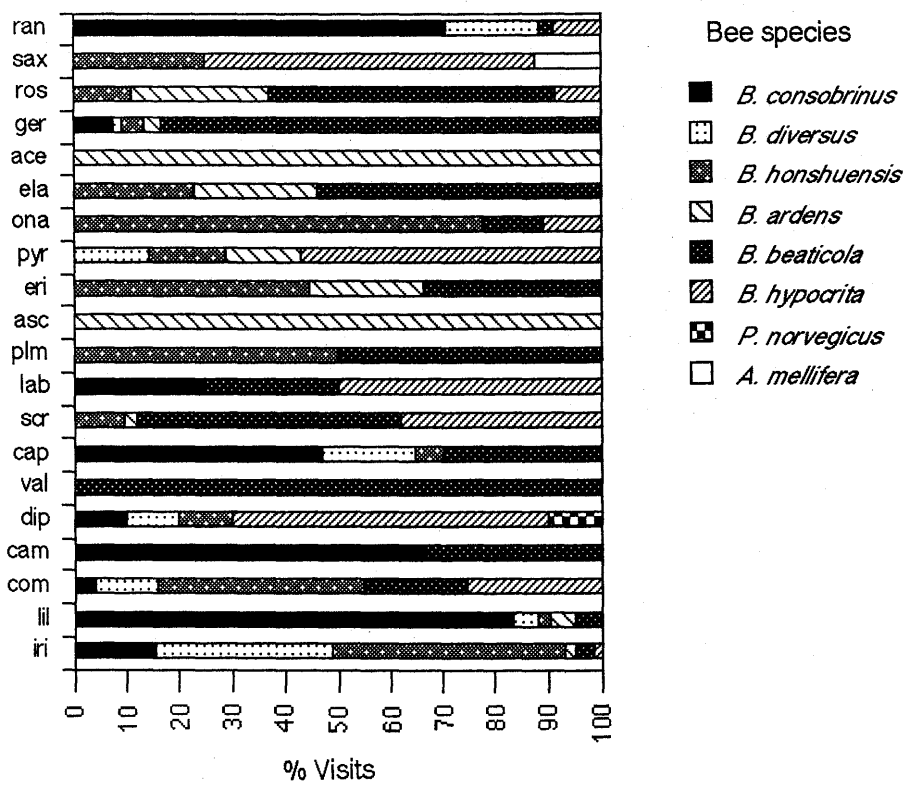

Fig. 15. Flower-visitor spectra (sorted by apid bee species) of plant families. Plant families are arranged as in Table 2.

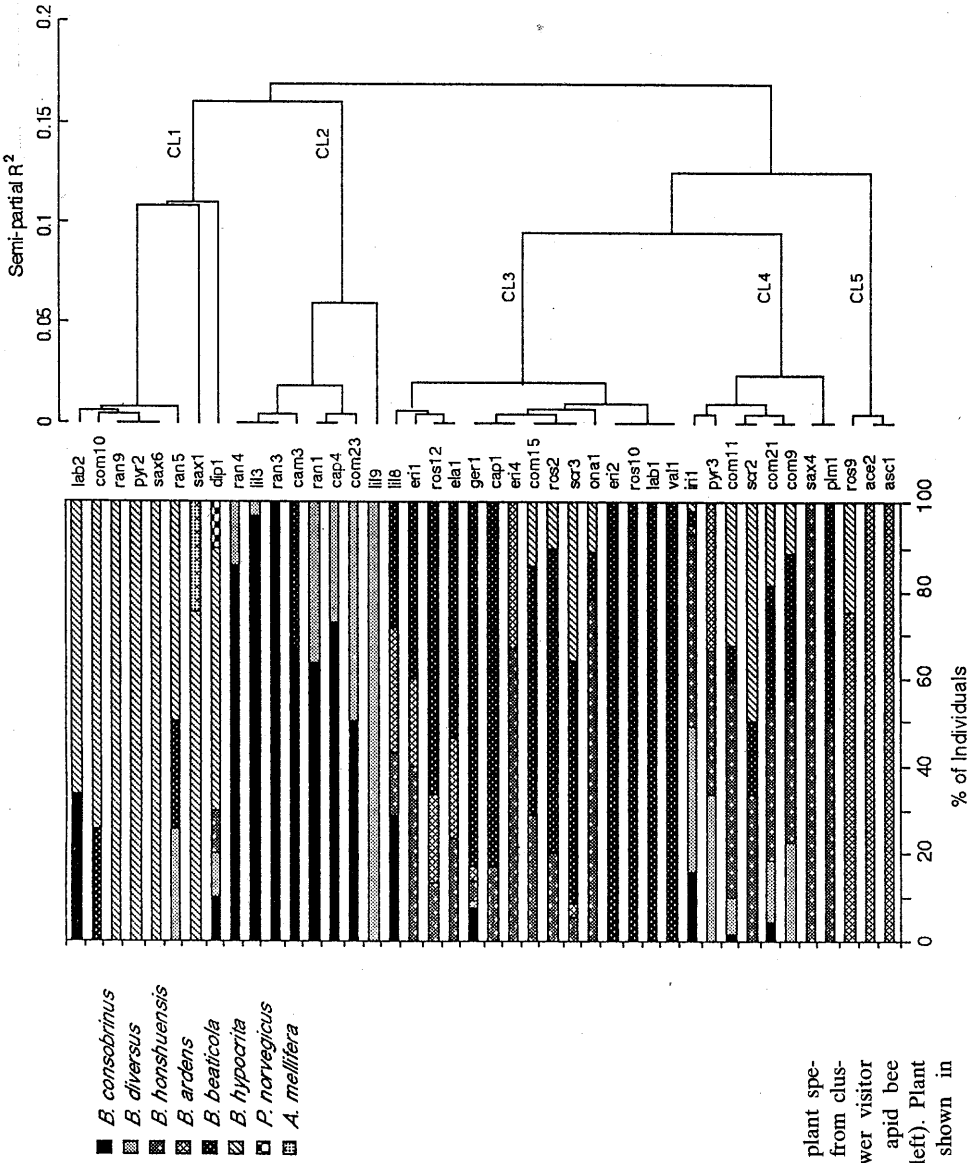

Fig. 16. Dendrogram of 42 plant species (right) derived from cluster analysis on flower visitor spectra (sorted by apid bee species) of plants (left). Plant family codes are shown in Table 2.

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: ***, $p < 0.001$.

	Flower guilds #1					Total	χ^2	Flower guilds #2					Total	χ^2
Life form	1	2	3	4	5			1	2	3	4	5		
herb	28	2	5	10	26	71	1.1	8	7	10	7	1	33	1.7
shrub	7	0	2	2	0	11	6.3	0	1	5	1	0	7	4.5
tree	1	0	2	2	4	9	4.1	0	0	0	0	2	2	26.0***
Total	36	2	9	14	30	91		8	8	15	8	3	42	

#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.

In order to detect the factors determinating 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 correlationship 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 hymeopterous 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 ($\chi^2 = 16.7$, $p < 0.01$). 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 ($\chi^2 = 15.5$, $p < 0.01$). *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

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: *, $p < 0.05$; **, $p < 0.01$.

	Flower guilds #1					Total	χ^2	Flower guilds #2					Total	χ^2
Flower shape	1	2	3	4	5			1	2	3	4	5		
apetalous	0	0	0	0	2	2	4.3	1	0	0	0	0	1	4.3
cup	4	0	4	1	0	9	14.2**	0	1	1	0	1	3	4.4
head	7	0	2	2	8	19	1.4	2	1	1	3	0	7	3.9
open	6	0	3	8	14	31	7.9	4	0	4	2	2	12	5.2
spikelet	0	0	0	0	2	2	5.1	0	0	0	0	0	0	-
short-tubed	7	1	0	2	2	12	5.1	0	0	5	1	0	6	6.5
middle-tubed	5	1	0	1	1	8	6.7	0	0	3	1	0	4	3.6
long-tubed	8	0	0	0	0	8	11.8*	1	6	1	1	0	9	13.4**
Total	37	2	9	14	29	91		8	8	15	8	3	42	

#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: *, $p < 0.05$.

	Flower guilds #1					Total	χ^2	Flower guilds #2					Total	χ^2
Flower color	1	2	3	4	5			1	2	3	4	5		
green	0	0	0	0	3	3	6.5	0	0	0	0	0	0	-
mauve	4	1	0	1	2	8	5.0	1	1	4	1	0	7	1.7
pink	6	0	0	0	3	9	4.0	0	2	2	2	0	6	2.9
red	3	0	0	0	0	3	4.4	0	0	2	0	0	2	3.6
violet	10	0	1	0	0	11	12.4*	2	3	0	3	0	8	6.4
white	11	1	5	11	11	39	6.3	4	1	5	2	2	14	2.9
yellow	2	0	0	2	7	11	6.3	1	0	2	0	0	3	-
yellow-green	0	0	2	0	1	3	11.7*	0	0	0	0	0	0	2.5
yellow-white	1	0	1	0	2	4	2.4	0	1	0	0	1	2	7.6
Total	37	2	9	14	29	91		8	8	15	8	3	42	

#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. Staphylinidae 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%), Scraptiidae 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*.

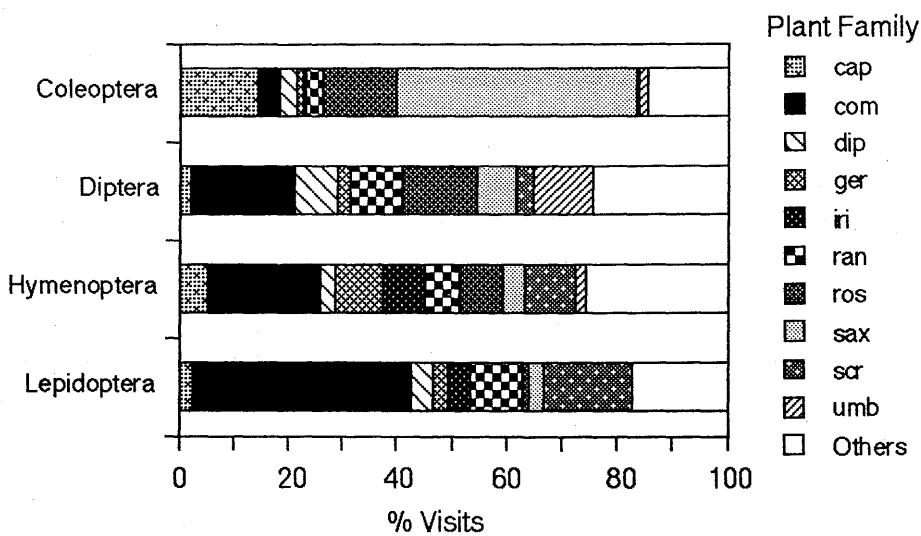

Fig. 17. Flower spectra (sorted by family) of the four dominant insect orders. Plant family codes are shown in Table 2.

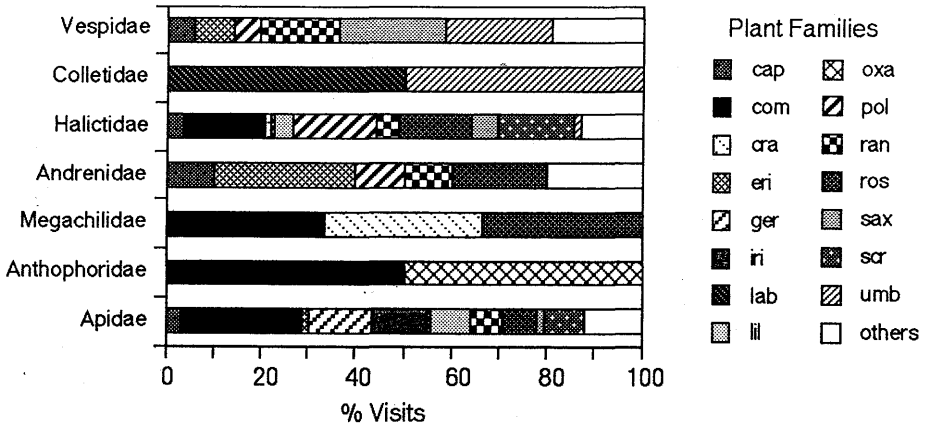

Fig. 18. Flower spectra (sorted by families) of seven hymenopterous families (one in Vespoidea and six in Apoidea). Plant family codes are shown in Table 2.

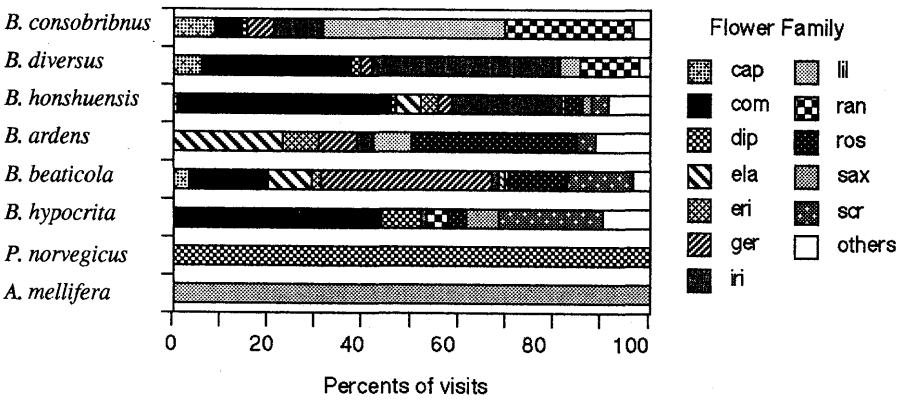

Fig. 19. Flower spectra (sorted by family) of eight apid bee species. Plant family codes are shown in Table 2.

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.

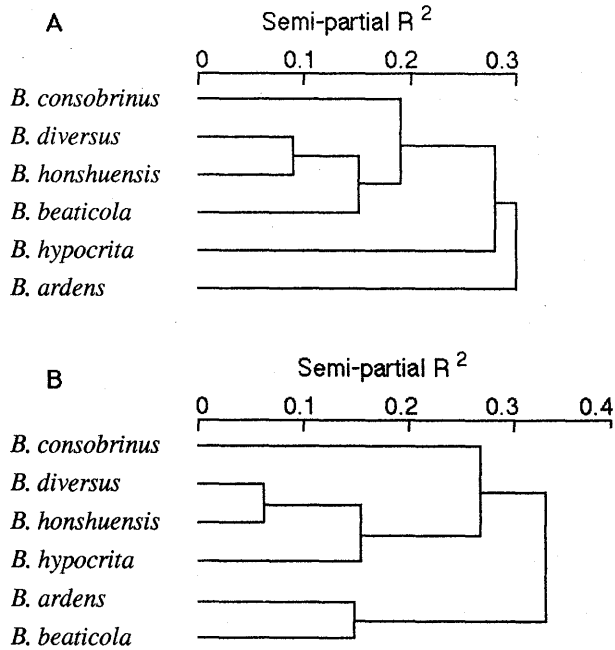

Fig. 20. Dendrograms of bumblebee species, derived from cluster analyses on the flower spectra sorted by plant family (A) and plant species (B).

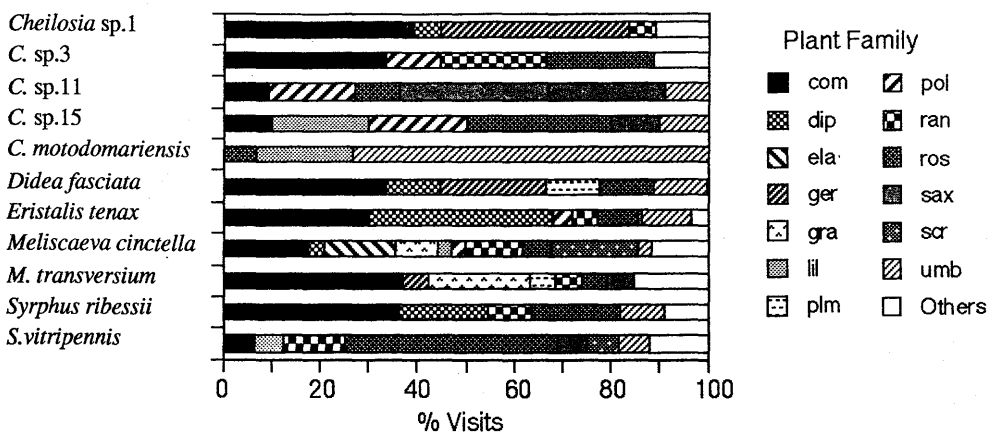

Fig. 21. Flower spectra (sorted by plant family) of hoverfly species with ≥ 28 individuals collected. Plant family codes are shown in Table 2.

Discussion

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

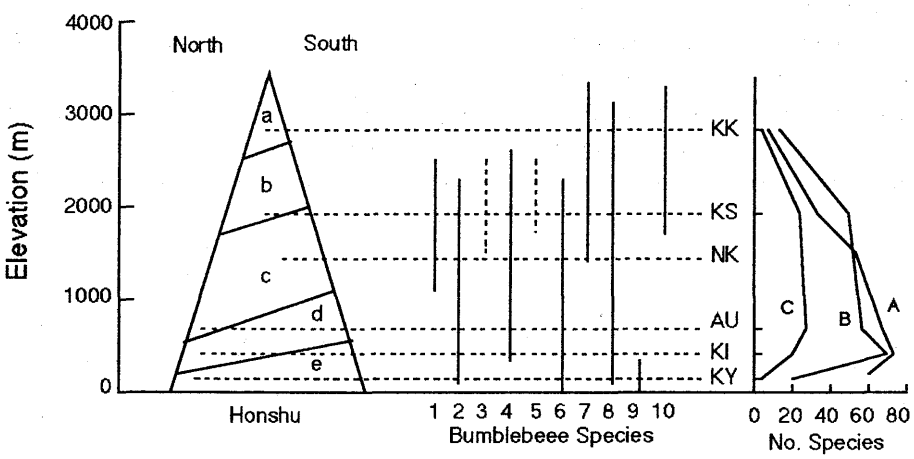

Fig. 22. Altitudinal distribution of ten bumblebee species in Honshu (vertical lines) and numbers of bee (A), hoverfly (B) and cerambycid beetle (C) species recorded at six locations: KK, Mt. Kiso-komagatake (Yumoto, 1986); KS, Mt. Kushigata (this study); NK, Nikko (Nakamura & Matsumura, 1985); AU, Ashu (Kato et al., 1990); KI, Kibune (Inoue et al., 1990); KY, Kyoto (Kakutani et al., 1990). Bumblebee species: 1, *Bombus consobrinus*; 2, *B. diversus*; 3, *B. ussurensis*; 4, *B. honshuensis*; 5, *B. deuteronymus*; 6, *B. ardens*; 7, *B. beaticola*; 8, *B. hypocrita*; 9, *B. ignitus*; 10, *Psithyrus norvegicus*. Vertical broken line refers to localized distribution. Five vegetation zones are distinguished : a, alpine zone over tree line; b, subalpine coniferous forest zone; c, beech forest zone; d, deciduous oak forest zone; e, evergreen oak forest zone.

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

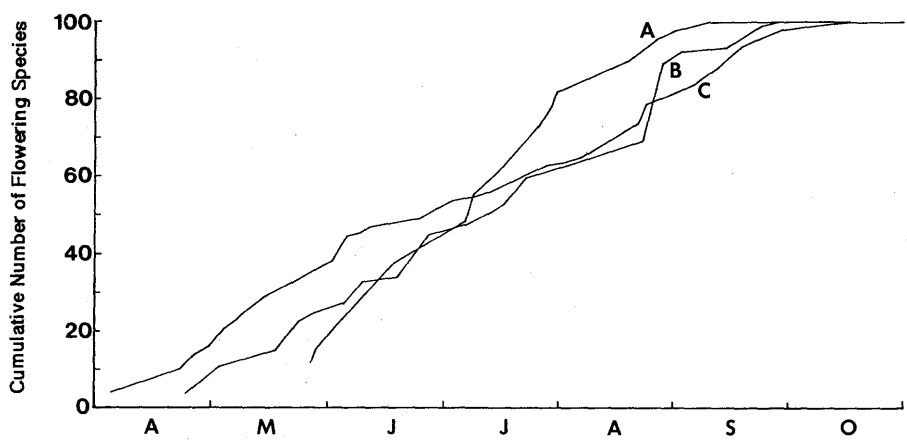

Fig. 23. Seasonal changes in cumulative numbers of flowering plant species at Mt. Kushigata (A), Ashu (B) and Kibune (C).

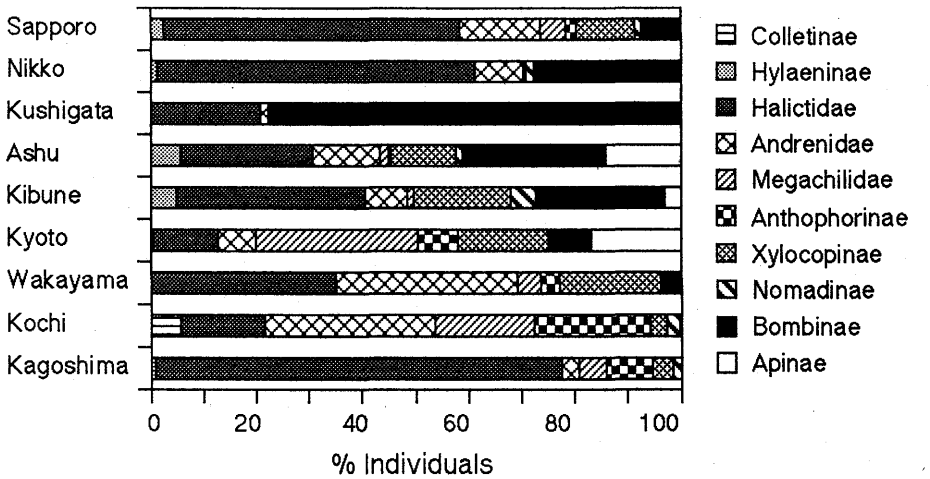

Fig. 24. A comparison of relative abundance of bee subfamilies among nine localities in Japan. Data sources are as follows: Sapporo, Sakagami & Fukuda (1973); Nikko, Nakamura & Matsumura (1985); Mt. Kushigata, this study; Ashu, Kato et al. (1990); Kibune, Inoue et al. (1990); Kyoto, Kakutani et al. (1990); Wakayama, Matsuura 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

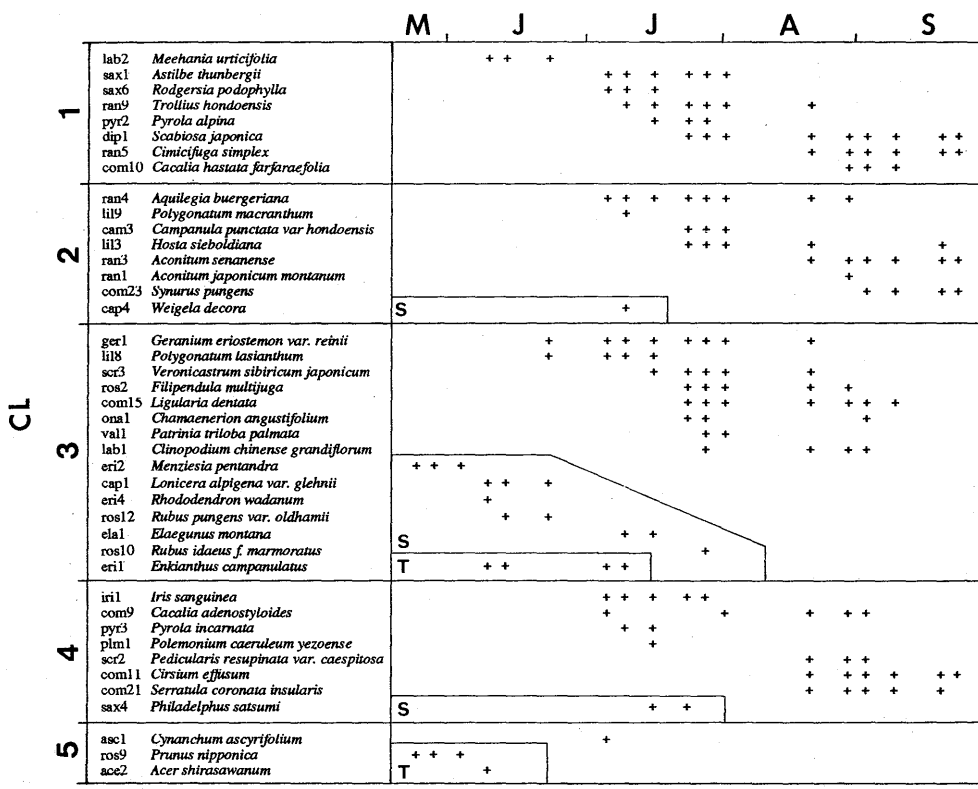

Fig. 25. Flowering phenology of bumblebee flowers at Mt. Kushigata, sorted by the clusters in Fig. 16. Flower species are also sorted by life form; S, shrub; T, tree; others without any letters, herb.

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.

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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. Order code is two head characters of each order name. Family codes are shown in Table 3. Unidentified insect species are abbreviated as insect family code + species code number.

Polygonaceae

Reynoutria japonica

Cix1 (Cix: He) 17-viii-91 (1); Psy1 (Psy: He) 17-viii-91 (1); Mir2 (Mir: He) 17-viii-91 (2); Ectinohoplia obducta (Sca: Co) 26-viii-90 (2); *Ectinohoplia obducta* (Sca: Co) 26-viii-90 (2); *Hoshihananomia perlata* (Mor: Co) 17-viii-91 (1); *Oedemeronia manicata* (Oed: Co) 17-viii-91 (1); *Anaspis funagata* (Str: Co) 1-ix-91 (1); *Anastrangalis acotodes* (Cer: Co) 17-viii-91 (2); Bra2 (Bra: Hy) 17-viii-91 (1); Ich4 (Ich: Hy) 17-viii-91 (1); Pro1 (Pro: Hy) 17-viii-91 (1); Pte3 (Pte: Hy) 17-viii-91 (1); Per1 (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); Eul11 (Eul: Hy) 17-viii-91 (1); Eul12 (Eul: Hy) 17-viii-91 (1); Cyn1 (Cyn: Hy) 1-ix-91 (1); *Dolichovespula adulterina montivaga* (Ves: Hy) 17-viii-91 (2); *Lasioglossum* (E.) *apristum* (Hal: Hy) 17-viii-91 (23); *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* (Bom: 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); *Cheilosia* sp.15 (Syr: Di) 17-viii-91 (2); *Ischyrosyrphus laternarius* (Syr: Di) 17-viii-91 (1); *Meliscaeva cinctella* (Syr: Di) 1-ix-91 (1); *Eristalis tenax* (Syr: Di) 17-viii-91 (2), 26-viii-90 (2); *Didea nikkoensis* (Syr: Di) 17-viii-91 (1); *Syrphus vitripennis* (Syr: Di) 17-viii-91 (1); *Metasyrphus* sp.1 (Syr: Di) 17-viii-91 (1); Con2 (Con: Di) 17-viii-91 (1); Lau1 (Lau: Di) 17-viii-91 (1); Sph2 (Sph: Di) 17-viii-91 (1); Sph4 (Sph: Di) 17-viii-91 (1); Ant1 (Ant: Di) 1-ix-91 (5), 17-viii-91 (4); Ant4 (Ant: Di) 17-viii-91 (2); Ant12 (Ant: Di) 17-viii-91 (1); Ant15 (Ant: Di) 17-viii-91 (2); Ant16 (Ant: Di) 17-viii-91 (1), 26-viii-90 (1); Ant19 (Ant: Di) 17-viii-91 (1); Ant24 (Ant: Di) 17-viii-91 (1); Ant25 (Ant: Di) 17-viii-91 (1); Ant26 (Ant: Di) 1-ix-91 (1); *Mesembrina resplendens* (Mus: Di) 17-viii-91 (2); *Dexopollenia flava* (Cal: Di) 1-ix-91 (2); Cal7 (Cal: Di) 1-ix-91 (1); Cal10 (Cal: Di) 1-ix-91 (1); *Lucilia* sp. (Cal: Di) 17-viii-91 (1); *Xanthothyxus mongol* (Cal: Di) 26-viii-90 (1); *Onesia* sp. (Cal: Di) 1-ix-91 (1); *Tachina jakovlevi* (Tac: Di) 17-viii-91 (1); Tac11 (Tac: Di) 1-ix-91 (1); Tac20 (Tac: Di) 1-ix-91 (1); Tac22 (Tac: Di) 26-viii-90 (1); Ypo1 (Ypo: Le) 17-viii-91 (1); *Catoptria permiaca* (Pyr: Le) 17-viii-91 (1)

Caryophyllaceae

Dianthus superbus longicalycinus

Meliscaeva cinctella (Syr: Di) 29-vii-90 (2); *Eristalis tenax* (Syr: Di) 28-vii-91 (2); *Parnara guttata guttata* (Hes: Le) 29-vii-90 (1)

Lychnis gracillima

Anaspis funagata (Str: Co) 25-vii-90 (9); *Rhogogaster varipes* (Ten: Hy) 25-vii-90 (3); *Tenthredo japonica* (Ten: Hy) 25-vii-90 (1); Emp1 (Emp: Di) 14-vii-90 (1); *Eristalis tenax* (Syr: Di) 25-vii-90 (1); *Dasysyrphus bilineatus* (Syr: Di) 14-vii-90 (1)

Pseudostellaria heterantha

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

Ranunculaceae

Aconitum japonicum montanum

Bombus consobrinus (Api: Hy) 1-ix-91 (3), 23-ix-90 (2), 9-ix-90 (2); *Bombus diversus* (Api: Hy) 22-ix-91 (3), 23-ix-90 (1); *Parnara guttata guttata* (Hes: Le) 9-ix-90 (1)

Aconitum senanense

Bombus consobrinus (Api: Hy) 1-ix-91 (6), 23-ix-90 (3), 26-viii-90 (2)

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); *Panorpodes paradoxa* (Pan: Me) 6-vii-90 (1)

Cimicifuga simplex

Adelphocoris rubripes (Mir: He) 1-ix-91 (1); *Anaspis funagata* (Str: Co) 17-viii-91 (1); *Pidonia grallatrix* (Cer: Co) 26-viii-90 (1); *Pachytodes cometes* (Cer: Co) 17-viii-91 (1), 26-viii-90 (1); *Vespula austriaca* (Ves: Hy) 1-ix-91 (1); *Dolichovespula norvegicoides* (Ves: Hy) 1-ix-91 (1), 17-viii-91 (1), 26-viii-90 (2), 29-vii-90 (1); *Andrena (Eua.) togashii* (And: Hy) 26-viii-90 (1); *Bombus diversus* (Api: Hy) 9-ix-90 (1); *Bombus beaticola* (Api: Hy) 26-viii-90 (1); *Bombus hypocrita* (Api: Hy) 26-viii-90 (2); *Meliscaeva cinctella* (Syr: Di) 23-ix-90 (1), 26-viii-90 (2); *Platycheirus scutatus* (Syr: Di) 23-ix-90 (2), 9-ix-90 (2); *Eristalis tenax* (Syr: Di) 26-viii-90 (2); *Syrphus ribessii* (Syr: Di) 23-ix-90 (1); *Syrphus vitripennis* (Syr: Di) 1-ix-91 (1); *Syrphus* sp.1 (Syr: Di) 23-ix-90 (1); Sca1 (Sca: Di) 26-viii-90 (1); Ant1 (Ant: Di) 1-ix-91 (3), 26-viii-90 (3); Ant11 (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-viii-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-viii-90 (1); *Zophoessa callipteris* (Sat: Le) 26-viii-90 (1); *Alcis angulifera* (Geo: Le) 26-viii-90 (1); Geo5 (Geo: Le) 26-viii-90 (1); *Cosmia variegata* (Noc: Le) 26-viii-90 (1)

Ranunculus japonicus

Oedemeronia subrobusta (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.) albipes* (Hal: Hy) 17-vi-91 (4); *Cheilosia* sp.3 (Syr: Di) 6-vii-90 (2); *Cheilosia* sp.6 (Syr: Di) 17-vi-91 (1), 6-vii-90 (1); *Cheilosia* sp.18 (Syr: Di) 6-vii-90 (1); *Sphaerophoria meuthastri* (Syr: Di) 6-vii-90 (2); *Platycheirus* sp. (Syr: Di) 17-vi-91 (1); *Platycheirus scutatus* (Syr: Di) 7-vii-90 (1); *Platycheirus ambiguus* (Syr: Di) 6-vii-90 (1); *Melanostoma transversum* (Syr: Di) 6-vii-90 (1); *Melanostoma scalare* (Syr: Di) 17-vi-91 (1); *Eristalis tenax* (Syr: Di) 17-vi-91 (1); *Metasyrphus luniger* (Syr: Di) 7-vii-90 (1); Ant3 (Ant: Di) 7-vii-90 (3); *Colias erate poliograhus* (Pie: Le) 9-vi-91 (1)

Thalictrum filamentosum tenerum

Meliscaeva omogensis (Syr: Di) 14-vii-90 (1); *Platycheirus scutatus* (Syr: Di) 14-vii-90 (1)

Trollius hondoensis

Oedemeronia subrobusta (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); *Cheilosia* sp.1 (Syr: Di) 28-vii-91 (1); *Cheilosia* sp.5 (Syr: Di) 25-vii-90 (1); *Cheilosia* sp.9 (Syr: Di) 25-vii-90 (1); *Meliscaeva cinctella* (Syr: Di) 25-vii-90 (1); *Platycheirus scutatus* (Syr: Di) 14-vii-90 (3); *Eristalis tenax* (Syr: Di) 25-vii-90 (3); *Syrphus vitripennis* (Syr: 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-vi-91 (1)

Arabis lyrata kamtschatica

Ten8 (Ten: Hy) 9-vi-91 (1); *Cheilosia* sp.3 (Syr: Di) 9-vi-91 (1); *Cheilosia* sp.4 (Syr: Di) 9-vi-91 (1); *Eristalis tenax* (Syr: Di) 9-vi-91 (1); Ant26 (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); *Cheilosia* sp.1 (Syr: Di) 29-vii-90 (2); *Cheilosia* sp.14 (Syr: Di) 29-vii-90 (1); *Phytomia zonata* (Syr: Di) 29-vii-90 (1); *Eristalis cerealis* (Syr: Di) 29-vii-90 (1)

Saxifragaceae

Astilbe thunbergii

Hoplia communis (Sca: Co) 14-vii-90 (1); *Hoplia moerens* (Sca: Co) 28-vii-91 (1); *Gnorimus subopacus* (Sca: Co) 14-vii-90 (1); *Popilla japonica* (Sca: Co) 25-vii-90 (1); Lat1 (Lat: Co) 29-vii-90 (1); *Chrysarthia 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 variicornis* (Cer: Co) 25-vii-90 (3), 28-vii-91 (1); *Leptura arcuata* (Cer: Co) 25-vii-90 (2); *Pachytodes cometes* (Cer: Co) 25-vii-90 (1), 29-vii-90 (1); *Cryptocephalus 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); *Lasioglossum (E.) apristum* (Hal: Hy) 25-vii-90 (3), 28-vii-91 (1); *Lasioglossum (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); Str1 (Str: Di) 29-vii-90 (1); *Cheilosia* sp.11 (Syr: Di) 14-vii-90 (6); *Cheilosia* sp.12 (Syr: Di) 14-vii-90 (6), 25-vii-90 (1); *Cheilosia* sp.15 (Syr: Di) 25-vii-90 (1); *Cheilosia 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); Ant22 (Ant: Di) 28-vii-91 (1), 29-vii-90 (1); *Tachina jakovlevi* (Tac: Di) 14-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 variicornis (Cer: Co) 17-viii-91 (1); *Pachytodes cometes* (Cer: Co) 17-viii-91 (2); *Leptura ochraceofasciata* (Cer: Co) 17-viii-91 (1); *Corennys sericata* (Cer: Co) 17-viii-91 (2); *Rhogogaster varipes* (Ten: Hy) 17-viii-91 (1); *Dolichovespula norvegicoides* (Ves: Hy) 17-viii-91 (5); *Dolichovespula adulterina montivaga* (Ves: Hy) 17-viii-91 (2); *Crossocerus* sp. (Sph: Hy) 17-viii-91 (1); *Lasioglossum (E.) apristum* (Hal: Hy) 17-viii-91 (1); Ant13 (Ant: Di) 17-viii-91 (1); *Calliphora* sp.2 (Cal: Di) 17-viii-91 (1); *Tachina luteola* (Tac: Di) 17-viii-91 (1); Tac10 (Tac: Di) 17-viii-91 (1); Tac14 (Tac: Di) 17-viii-91 (1)

Philadelphus satsumi

Adelphocoris rubripes (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); *Eristalis tenax* (Syr: Di) 14-vii-90 (1); *Syrphus vitripennis* (Syr: Di) 14-vii-90 (1)

Ribes maximowiczianum

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

Rodgersia podophylla

Aph1 (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 oyamae* (Cer: Co) 6-vii-90 (6); *Pidonia testacea* (Cer: Co) 6-vii-90 (3); Chr1 (Chr: Co) 7-vii-90 (1); *Lupesus moorii* (Chr: Co) 7-vii-90 (1); *Lasioglossum (L.) laeviventre* (Hal: Hy) 7-vii-90 (1); *Bombus hypocrita* (Api: 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 multifuga

Meligethes morosus (Nit: Co) 28-vii-91 (3); *Antherophagus nigricornis* (Cry: Co) 28-vii-91 (1); *Pidonia grallatrix* (Cer: Co) 29-vii-90 (1); *Pidonia aegrota* (Cer: Co) 25-vii-90 (1), 28-vii-91 (1); *Pidonia insuturata* (Cer: Co) 28-vii-91 (1); *Anastrangalis acotodes* (Cer: Co) 28-vii-91 (1), 29-vii-90 (1); *Anoploderomorpha 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); *Crossocerus* sp. (Sph: Hy) 28-vii-91 (1); *Lasioglossum (L.) laeviventre* (Hal: Hy) 25-vii-90 (1), 28-vii-91 (1); *Lasioglossum (E.) apristum* (Hal: Hy) 17-viii-91 (4), 25-vii-90 (6), 28-vii-91 (1); *Lasioglossum (D.) problematicum* (Hal: Hy) 25-vii-90 (2), 28-vii-91 (1); *Bombus honshuensis* (Api: Hy) 17-viii-91 (2); *Bombus beaticola* (Api: Hy) 17-viii-91 (1), 25-vii-90 (4), 29-vii-90 (2); *Bombus hypocrita* (Api: Hy) 25-vii-90 (1); *Panorpodes paradoxa* (Pan: Me) 25-vii-90 (2); *Empis flavofasalis* (Emp: Di) 28-vii-91 (1); *Cheilosia* sp.6 (Syr: Di) 28-vii-91 (1), 29-vii-90 (1); *Cheilosia* sp.15 (Syr: Di) 25-vii-90 (3); *Phytomia zonata* (Syr: Di) 29-vii-90 (1); *Meliscaeva cinctella* (Syr: Di) 28-vii-91 (1), 29-vii-90 (1); *Eristalis tenax* (Syr: Di) 25-vii-90 (5), 29-vii-90 (2); *Syrphus vitripennis* (Syr: Di) 17-viii-91 (2), 28-vii-91 (2), 29-vii-90 (2); *Metasyrphus ferquens* (Syr: Di) 17-viii-91 (1); Ant1 (Ant: Di) 17-viii-91 (2), 28-vii-91 (2), 29-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 atricollis* (Byt: Co) 6-vii-90 (1); *Oedemeronia subrobusta* (Oed: Co) 17-vi-91 (1), 6-vii-90 (1); *Lasioglossum (L.) laeviventre* (Hal: Hy) 26-v-90 (1); Emp1 (Emp: Di) 17-vi-91 (1); Emp3 (Emp: Di) 6-vii-90 (2); Emp6 (Emp: Di) 6-vii-90 (1); Sim2 (Sim: Di) 3-vi-90 (1); *Cheilosia* sp.3 (Syr: Di) 17-vi-91 (1); *Cheilosia* sp.6 (Syr: Di) 17-vi-91 (1); *Cheilosia* sp.14 (Syr: Di) 3-vi-90 (1); *Meliscaeva omogensis* (Syr: Di) 6-vii-90 (1);

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-90 (1); *Glyphipterix nigromarginata* (Cho: Le) 17-vi-91 (1)

Malus sieboldii

Andrena (Sima.) yamato (And: Hy) 17-vi-91 (1); *Andrena (A.) brenihirtiscopa* (And: Hy) 17-vi-91 (1); *Panorpodes paradoxa* (Pan: Me) 17-vi-91 (1); Emp1 (Emp: Di) 17-vi-91 (1); Sim1 (Sim: Di) 17-vi-91 (1); *Cheilosia motodomariensis* (Syr: Di) 17-vi-91 (1); *Platycheirus* sp. (Syr: Di) 17-vi-91 (1); *Eristalis tenax* (Syr: Di) 17-vi-91 (2); *Syrphus 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 subrobusta* (Oed: Co) 3-vi-90 (3); *Lasioglossum (L.) laeviventre* (Hal: Hy) 26-v-90 (1); *Lasioglossum (E.) apristum* (Hal: Hy) 26-v-90 (1); *Lasioglossum (D.) problematicum* (Hal: Hy) 3-vi-90 (1); *Cheilosia* sp.2 (Syr: Di) 26-v-90 (1); *Cheilosia* sp.3 (Syr: Di) 26-v-90 (1); *Cheilosia* 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

Eusphalerum parallelum (Sta: Co) 27-v-90 (27); For1 (For: Hy) 27-v-90 (1); *Bombus ardens* (Api: Hy) 27-v-90 (6); *Bombus hypocrita* (Api: Hy) 27-v-90 (2); *Oligoneura itoi* (Acr: Di) 27-v-90 (1); *Cheilosia* sp.6 (Syr: Di) 27-v-90 (1); *Cheilosia* sp.11 (Syr: Di) 27-v-90 (1); *Cheilosia* sp.16 (Syr: Di) 27-v-90 (1); *Helophilus virgatus* (Syr: Di) 27-v-90 (1); *Platycheirus scutatus* (Syr: Di) 27-v-90 (1); *Syrphus ribessii* (Syr: Di) 27-v-90 (2); *Metasyrphus luniger* (Syr: Di) 27-v-90 (1); Ant15 (Ant: Di) 27-v-90 (1)

Rubus idaeus f. marmoratus

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

Rubus pungens var. oldhamii

Byturus ohtai (Byt: Co) 17-vi-91 (3); *Bombus honshuensis* (Api: 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 throscoides* (Bip: Co) 6-vii-90 (1); *Pidonia oyamae* (Cer: Co) 6-vii-90 (2); *Pidonia testacea* (Cer: Co) 6-vii-90 (3); *Chrysocharis* 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); *Cheilosia* sp.6 (Syr: Di) 27-v-90 (2); *Cheilosia* sp.13 (Syr: Di) 27-v-90 (2); *Platycheirus* sp. (Syr: Di) 27-v-90 (1)

Geraniaceae

Geranium eriostemon var. reinii

Oedemeronia subrobusta (Oed: Co) 14-vii-90 (2), 29-vii-90 (3); *Bombus consobrinus* (Api: Hy) 25-vii-90 (4), 28-vii-91 (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-91 (3), 29-vii-90 (2), 6-vii-90 (15), 7-vii-90 (6); *Empis flavofasalis* (Emp: Di) 6-vii-90 (1); *Cheilosia* sp.1 (Syr: Di) 25-vii-90 (5), 28-vii-91 (2); *Cheilosia* sp.4 (Syr: Di) 25-vii-90 (1); *Cheilosia* sp.9 (Syr: Di) 14-vii-90 (1), 28-vii-91 (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)

Aceraceae

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

Pen1 (Pen: He) 9-vi-91 (1); Mir5 (Mir: He) 9-vi-91 (1); *Eusphalerum parallelum* (Sta: Co) 9-vi-91 (2); *Micadocantharis 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); Eul9 (Eul: Hy) 9-vi-91 (1); *Bombus ardens* (Api: Hy) 9-vi-91 (1); Hel1 (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

Thr1 (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); Sci1 (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

Micadocantharis 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 beaticola* (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 (Pie: Le) 26-v-90 (2)

Onagraceae

Chamaenerion angustifolium

Mir2 (Mir: He) 28-vii-91 (1); *Dolichovespula norvegicoides* (Ves: Hy) 28-vii-91 (2); *Lasioglossum (D.) problematicum* (Hal: Hy) 25-vii-90 (1); *Lasioglossum (E.) apristum* (Hal: Hy) 25-vii-90 (2); *Bombus honshuensis* (Api: Hy) 25-vii-90 (2), 28-vii-91 (5); *Bombus beaticola* (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 fergeri* (Nit: Co) 1-ix-91 (1); Bra1 (Bra: Hy) 1-ix-91 (1); Ich7 (Ich: Hy) 1-ix-91 (1); Eul10 (Eul: 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); *Syrphus ribessii* (Syr: Di) 1-ix-91 (1); Sph1 (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); *Dexopollenia flava* (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); *Lasioglossum (E.) apristum* (Hal: Hy) 17-viii-91 (1); *Lasioglossum (E.)* aff. *atroglaucum* (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 motodomariensis* (Syr: Di) 26-viii-90 (2), 29-vii-90 (4); *Ischyrosyrphus 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); *Xanthothyxus mongol* (Cal: Di)

26-viii-90 (1); *Onesia* sp. (Cal: Di) 26-viii-90 (2); *Tachina jakovlevi* (Tac: Di) 17-viii-91 (4), 26-viii-90 (1); Tac9 (Tac: Di) 29-vii-90 (1); Tac12 (Tac: Di) 29-vii-90 (1); Tac16 (Tac: Di) 26-viii-90 (1); Tac18 (Tac: Di) 29-vii-90 (1)

Libanotis coreana

Oedemeronia subrobusta (Oed: Co) 26-viii-90 (1); *Cheilosia* sp.5 (Syr: Di) 29-vii-90 (1); *Cheilosia* sp.6 (Syr: Di) 29-vii-90 (3); *Cheilosia motodomariensis* (Syr: Di) 29-vii-90 (5); *Eristalis tenax* (Syr: Di) 26-viii-90 (11); *Syrphus vitripennis* (Syr: Di) 26-viii-90 (1); Ant3 (Ant: Di) 29-vii-90 (1); Ant22 (Ant: Di) 29-vii-90 (2); *Calliphora* sp.1 (Cal: Di) 26-viii-90 (1); Cal16 (Cal: Di) 26-viii-90 (1)

Pyrolaceae

Pyrola alpina

Meligethes morosus (Nit: Co) 25-vii-90 (2); *Anaspis funagata* (Str: Co) 25-vii-90 (1); *Pidonia grallatrix* (Cer: Co) 25-vii-90 (3); *Pidonia signifera* (Cer: Co) 25-vii-90 (1); *Pidonia yokoyamai* (Cer: Co) 25-vii-90 (1); *Pidonia signata* (Cer: Co) 25-vii-90 (2); *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)

Pyrola incarnata

Lasioglossum (L.) laeviventre (Hal: Hy) 7-vii-90 (1); *Andrena (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); *Platycheirus scutatus* (Syr: Di) 14-vii-90 (1); *Syrphus vitripennis* (Syr: Di) 7-vii-90 (1)

Ericaceae

Enkianthus campanulatus

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); *Andrena (A.) lapponica sumizome* (And: Hy) 9-vi-91 (1); *Bombus honshuensis* (Api: Hy) 9-vi-91 (2); *Bombus ardens* (Api: Hy) 7-vii-90 (1); *Bombus beaticola* (Api: Hy) 6-vii-90 (2); *Melanostoma transversum* (Syr: Di) 9-vi-91 (1)

Menziesia pentandra

Bombus beaticola (Api: Hy) 27-v-90 (1)

Rhodoendron degronianum

Cheilosia sp.10 (Syr: Di) 14-vii-90 (1)

Rhododendron wadanum

Andrena (A.) longitibialis (And: Hy) 9-vi-91 (1); *Andrena (A.) lapponica sumizome* (And: Hy) 9-vi-91 (1); *Bombus honshuensis* (Api: Hy) 9-vi-91 (2); *Bombus ardens* (Api: Hy) 9-vi-91 (1); *Empis flavofasalis* (Emp: Di) 9-vi-91 (1)

Asclepiadaceae

Cynanchum ascyrifolium

Mir3 (Mir: He) 6-vii-90 (1); *Eusphalerum parallelum* (Sta: Co) 6-vii-90 (2); *Meligethes morosus* (Nit: Co) 7-vii-90 (4); *Byturus* sp. (Byt: Co) 6-vii-90 (1); For3 (For: Hy) 7-vii-90 (1); *Bombus ardens* (Api: Hy) 6-vii-90 (1); Emp7 (Emp: Di) 6-vii-90 (1); Xyl1 (Xyl: Di) 7-vii-90 (1); *Oligoneura itoi* (Acr: Di) 7-vii-90 (1); *Nemophora amurensis* (Inc: Le) 6-vii-90 (1)

Polemoniaceae

Polemonium caeruleum yezoense

Oedemeronia subrobusta (Oed: Co) 14-vii-90 (1); *Bombus honshuensis* (Api: Hy) 7-vii-90 (1); *Bombus beaticola* (Api: Hy) 14-vii-90 (1); Emp7 (Emp: Di) 14-vii-90 (1); *Oligoneura itoi* (Acr: Di) 7-vii-90 (1); *Platycheirus scutatus* (Syr: Di) 14-vii-90 (1); *Melanostoma transversum* (Syr: Di) 14-vii-90 (1); *Didea fasciata* (Syr: Di) 7-vii-90 (1); Ant3 (Ant: Di) 7-vii-90 (1); *Parnassius gracialis* (Pap: Le) 7-vii-90 (1)

Labiatae

Clinopodium chinense grandiflorum

Hylaeus paradifformis (Col: Hy) 17-viii-91 (1); *Bombus beaticola* (Api: Hy) 17-viii-91 (1); *Syrphus vitripennis* (Syr: Di) 17-viii-91 (1)

Meehania urticifolia

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

Scrophulariaceae

Euphrasia maximowiczii

Meliscaeva cinctella (Syr: Di) 26-viii-90 (1)

Pedicularis resupinata var. caespitosa

Megachile sumizome (Meg: Hy) 17-viii-91 (1); *Bombus honshuensis* (Api: Hy) 9-ix-90 (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-91 (1); *Anoploderomorpha excavata* (Cer: Co) 25-vii-90 (1); *Nakanea vicaria* (Cer: Co) 28-vii-91 (1); Ten2 (Ten: Hy) 29-vii-90 (1); *Stigmus* 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); *Lasioglossum (E.) apristum* (Hal: Hy) 25-vii-90 (10), 28-vii-91 (5), 29-vii-90 (1); *Bombus honshuensis* (Api: Hy) 25-vii-90 (2); *Bombus ardens* (Api: Hy) 28-vii-91 (1); *Bombus beaticola* (Api: Hy) 25-vii-90 (12), 28-vii-91 (4), 29-vii-90 (4); *Bombus hypocrita* (Api: Hy) 25-vii-90 (4), 28-vii-91 (8), 29-vii-90 (1); *Empis flavofasalis* (Emp: Di) 28-vii-91 (1), 29-vii-90 (3); *Dioctria nakanensis* (Asi: Di) 29-vii-90 (1); *Mallota dimorpha* (Syr: Di) 29-vii-90 (1); *Vollucella pellucens* (Syr: Di) 25-vii-90 (1), 28-vii-91 (1); *Vollucella jeddona* (Syr: Di) 28-vii-91 (1), 29-vii-90 (1); *Meliscaeva cinctella* (Syr: Di) 29-vii-90 (5); *Syrphus vitripennis* (Syr: Di) 29-vii-90 (1); Con4 (Con: Di) 25-vii-90 (1); Ant1 (Ant: Di) 28-vii-91 (1); Ant4(Ant: Di) 25-vii-90 (1); Ant14 (Ant: Di) 29-vii-90 (1); Ant22 (Ant: Di) 29-vii-90 (2); *Balatala gracilis* (Zyg: Le) 29-vii-90 (1); *Platyptilia sachalinensis* (Pte: Le) 29-vii-90 (1); *Melitaea niphora* (Nym: Le) 28-vii-91 (1); *Inachis io geisha* (Nym: Le) 29-vii-90 (1); *Speyeria aglaja fortuna* (Nym: Le) 25-vii-90 (1); *Zophoessa callipteris* (Sat: Le) 29-vii-90 (2); *Ourapterix persica* (Geo: Le) 29-vii-90 (1); *Psychostrophia melanorgia* (Cal: Le) 29-vii-90 (1); *Syngrapha ain* (Noc: Le) 29-vii-90 (3)

Caprifoliaceae

Lonicera alpigena var. glehnii

Eusphalerum parallelum (Sta: Co) 9-vi-91 (8); *Meligethes morosus* (Nit: Co) 9-vi-91 (1); *Byturus* sp. (Byt: Co) 9-vi-91 (1); *Pseudalosterna misella* (Cer: Co) 9-vi-91 (1); *Asemum amurense* (Cer: Co) 9-vi-91 (1); Chr3 (Chr: Co) 9-vi-91 (1); Att1 (Att: Co) 9-vi-91 (1); Sco1 (Sco: Co) 9-vi-91 (1); *Tenthredo basizonata* (Ten: Hy) 9-vi-91 (1); Ten5 (Ten: Hy) 9-vi-91 (1); *Alphostrombocerus komowi* (Ten: Hy) 9-vi-91 (1); *Strongylogaster* sp. (Ten: Hy) 9-vi-91 (1); Bra3 (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); Eul8 (Eul: Hy) 9-vi-91 (1); Pom1 (Pom: Hy) 9-vi-91 (1); *Dolichovespula 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); Emp8 (Emp: Di) 9-vi-91 (1); Emp10 (Emp: Di) 9-vi-91 (1); Pip1 (Pip: Di) 9-vi-91 (1); *Sphegina* sp. (Syr: 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

Eusphalerum parallelum (Sta: Co) 27-v-90 (1); *Dasytes vulgaris* (Mel: Co) 27-v-90 (1); *Epuraea* sp.1 (Nit: Co) 26-v-90 (5), 27-v-90 (1); *Meligethes morosus* (Nit: Co) 26-v-90 (1); *Epuraea 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. calvescens

Mir1 (Mir: He) 7-vii-90 (2); *Adelphocoris rubripes* (Mir: He) 7-vii-90 (2); Ela1 (Ela: Co) 7-vii-90 (1); *Mordellistena* sp.1 (Mor: Co) 7-vii-90 (1); *Pidonia grallatrix* (Cer: Co) 7-vii-90 (1); Xyl1 (Xyl: Di) 7-vii-90 (1); Ant14 (Ant: Di) 7-vii-90 (1)

Weigela decora

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

Valerianaceae

Patrinia triloba palmata

Bombus beaticola (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); *Lasioglossum (L.) laeviventre* (Hal: Hy) 1-ix-91 (1); *Lasioglossum (D.) problematicum* (Hal: Hy) 17-viii-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-viii-91 (2)

Dipsacaceae

Scabiosa japonica

Oedemeronia subrobusta (Oed: Co) 17-viii-91 (3), 25-vii-90 (3), 28-vii-91 (1); *Pidonia grallatrix* (Cer: Co) 25-vii-90 (6), 28-vii-91 (4); *Leptura arcuata* (Cer: Co) 25-vii-90 (1); *Parastrangalis nymphula* (Cer: Co) 25-vii-90 (1); *Pyrrhata annulicornis* (Chr: Co) 17-viii-91 (1); *Lasioglossum (E.) nipponense* (Hal: Hy) 1-ix-91 (1); *Lasioglossum (E.) apristum* (Hal: Hy) 17-viii-91 (1); *Lasioglossum (E.)* sp.K1 (Hal: Hy) 9-ix-90 (1); *Lasioglossum (L.) laeviventre* (Hal: Hy) 17-viii-91 (1); *Lasioglossum (E.) nipponense* (Hal: Hy) 22-ix-91 (3); *Lasioglossum (L.) laeviventre* (Hal: Hy) 22-ix-91 (1); *Lasioglossum (E.)* aff. *atroglaucum* (Hal: Hy) 22-ix-91 (2); *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.1 (Syr: Di) 17-viii-91 (1); *Meliscaeva cinctella* (Syr: Di) 9-ix-90 (1); *Eristalis tenax* (Syr: Di) 1-ix-91 (1), 17-viii-91 (17), 23-ix-90 (2), 25-vii-90 (4), 26-viii-90 (9), 28-vii-91 (6), 9-ix-90 (3); *Didea fasciata* (Syr: Di) 17-viii-91 (1); *Syrphus ribessii* (Syr: Di) 1-ix-91 (1), 28-vii-91 (1); *Metasyrphus ferquens* (Syr: Di) 17-viii-91 (1); *Conops flavipes* (Con: Di) 17-viii-91 (2); Ant1 (Ant: Di) 1-ix-91 (1); Ant3 (Ant: Di) 28-vii-91 (2); Ant14 (Ant: Di) 1-ix-91 (1); Ant29 (Ant: Di) 1-ix-91 (1); Cal7 (Cal: Di) 1-ix-91 (1); *Inachis io geisha* (Nym: Le) 17-viii-91 (1); *Speyeria aglaja fortuna* (Nym: Le) 1-ix-91 (1); *Zophoessa callipteris* (Sat: Le) 17-viii-91 (1)

Campanulaceae

Adenophora triphylla var. japonica

Forficula mikado (For: De) 26-viii-90 (1); *Lasioglossum (E.) albipes* (Hal: Hy) 26-viii-90 (1)

Campanula punctata var. hondoensis

Bombus consobrinus (Api: Hy) 28-vii-91 (1), 29-vii-90 (1); *Bombus beaticola* (Api: Hy) 29-vii-90 (1)

Compositae

Achillea alpina var. discoidea

Meliscaeva cinctella (Syr: Di) 17-viii-91 (1)

Anaphalis margaritacea

Oedemeronia subrobusta (Oed: Co) 26-viii-90 (2); *Chrysarthia viatica* (Oed: Co) 1-ix-91 (2), 26-viii-90 (1); *Lasioglossum (D.) problematicum* (Hal: Hy) 26-viii-90 (1); *Cheilosia* sp.6 (Syr: Di) 1-ix-91 (1); *Cheilosia* sp.14 (Syr: Di) 9-ix-90 (1); *Melanostoma transversum* (Syr: Di) 9-ix-90 (1); *Eristalis tenax* (Syr: Di) 26-viii-90 (5); *Eristalis cerealis* (Syr: Di) 26-viii-90 (1); Chl1 (Chl: Di) 26-viii-90 (1); Ant1 (Ant: Di) 26-viii-90 (1); Ant23 (Ant: Di) 26-viii-90 (1); Ant28 (Ant: Di) 1-ix-91 (1); Tac19 (Tac: Di) 1-ix-91 (1); Tac22 (Tac: Di) 1-ix-91 (1)

Aster ageratoides amplexifolius

Lasioglossum (E.) aff. atroglaucum (Hal: Hy) 23-ix-90 (1); *Lasioglossum (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 ovatus

Lasioglossum (L.) laeviventre (Hal: Hy) 22-ix-91 (1); *Lasioglossum (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); *Pachytodes cometes* (Cer: Co) 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 beaticola* (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); *Meliscaeva cinctella* (Syr: Di) 17-viii-91 (3); *Alcis angulifera* (Geo: Le) 17-viii-91 (1)

Cacalia hastata farfaraefolia

Bombus beaticola (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 beaticola* (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); *Platycheirus scutatus* (Syr: Di) 23-ix-90 (1); *Eristalis tenax* (Syr: Di) 23-ix-90 (2); *Didea alneti* (Syr: Di) 23-ix-90 (1); *Syrphus ribessii* (Syr: Di) 9-ix-90 (1); *Parnara guttata guttata* (Hes: Le) 23-ix-90 (1), 26-viii-90 (1)

Eupatorium chinense sachalinense

Cryptocephalus approximatus (Chr: Co) 17-viii-91 (1); *Eristalis tenax* (Syr: Di) 1-ix-91 (2), 17-viii-91 (1); Ant1 (Ant: Di) 17-viii-91 (3); Ant3 (Ant: Di) 17-viii-91 (1); *Dexopollenia 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); Tac22 (Tac: Di) 1-ix-91 (1), 17-viii-91 (1); *Zophoessa callipteris* (Sat: Le) 17-viii-91 (1)

Ixeris dentata var. albiflora

Cheilosia sp.15 (Syr: Di) 14-vii-90 (1); *Platycheirus* sp. (Syr: Di) 14-vii-90 (1); *Platycheirus scutatus* (Syr: Di) 14-vii-90 (1); *Melanostoma transversum* (Syr: Di) 14-vii-90 (1)

Ligularia dentata

Bombus honshuensis (Api: Hy) 17-viii-91 (2); *Bombus beaticola* (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* sp.1 (Syr: Di) 28-vii-91 (1); Ant7 (Ant: Di) 29-vii-90 (1); *Parnara guttata guttata* (Hes: Le) 17-viii-91 (1); *Zophoessa callipteris* (Sat: Le) 29-vii-90 (1)

Picris hieracioides japonica

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

Senecio cannabifolius

Oedemeronia subrobusta (Oed: Co) 1-ix-91 (1); *Lasioglossum (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); *Helophilus virgatus* (Syr: Di) 9-ix-90 (1); *Eristalis tenax* (Syr: Di) 1-ix-91 (1), 9-ix-90 (2); *Syrphus ribessii* (Syr: Di) 9-ix-90 (1); Ant6 (Ant: Di) 1-ix-91 (1); Ant8 (Ant: Di) 9-ix-90 (1); Cal11 (Cal: Di) 9-ix-90 (1); *Parnara guttata guttata* (Hes: Le) 9-ix-90 (1)

Senecio nemorensis

Lasioglossum (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); *Eristalis tenax* (Syr: Di) 26-viii-90 (3); *Alcis angulifera* (Geo: Le) 26-viii-90 (1)

Serratula coronata insularis

Oedemeronia subrobusta (Oed: Co) 9-ix-90 (1); *Lasioglossum (L.) laeviventre* (Hal: Hy) 1-ix-91 (2); *Lasioglossum (L.) laeviventre* (Hal: Hy) 1-ix-91 (3); *Lasioglossum (E.) apristum* (Hal: Hy) 17-viii-91 (3); *Lasioglossum (E.) nipponense* (Hal: Hy) 22-ix-91 (1); *Megachile 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), 26-viii-90 (6); *Bombus beaticola* (Api: Hy) 17-viii-91 (12); *Bombus hypocrita* (Api: Hy) 17-viii-91 (2), 22-ix-91 (4), 26-viii-90 (1), 9-ix-90 (1); *Cheilosia* sp.7 (Syr: Di) 26-viii-90 (1); *Leucozona lucorum* (Syr: Di) 1-ix-91 (1); *Meliscaeva cinctella* (Syr: Di) 1-ix-91 (1); *Eristalis tenax* (Syr: Di) 1-ix-91 (7), 17-viii-91 (2), 26-viii-90 (1); *Didea fasciata* (Syr: Di) 17-viii-91 (2), 9-ix-90 (1); *Dasysyrphus bilineatus* (Syr: Di) 26-viii-90 (1); *Syrphus ribessii* (Syr: Di) 17-viii-91 (1), 26-viii-90 (1); *Metasyrphus ferquens* (Syr: Di) 1-ix-91 (2), 17-viii-91 (1); *Dasysyrphus tricinctus* (Syr: Di) 1-ix-91 (1); Con1 (Con: Di) 17-viii-91 (1); *Parnara guttata guttata* (Hes: Le) 1-ix-91 (4), 17-viii-91 (2), 26-viii-90 (2), 9-ix-90 (5); *Papilio machaon hippocrates* (Pap: Le) 17-viii-91 (1); *Gonepteryx aspasia niphonica* (Pie: Le) 17-viii-91 (1); *Argynnis paphia tsushimana* (Nym: Le) 1-ix-91 (1); *Inachis io geisha* (Nym: Le) 1-ix-91 (1), 17-viii-91 (1); *Speyeria aglaja fortuna* (Nym: Le) 17-viii-91 (1); *Vanessa indica* (Nym: Le) 1-ix-91 (1); *Macroglossum fringilla* (Sph: Le) 1-ix-91 (1)

Solidago virgaurea asiatica

Chrysarthia viatica (Oed: Co) 1-ix-91 (1); *Lasioglossum (L.) laeviventre* (Hal: Hy) 1-ix-91 (1); *Cheilosia* sp.3 (Syr: Di) 1-ix-91 (1); *Cheilosia* 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); *Syrphus vitripennis* (Syr: Di) 23-ix-90 (1)

Taraxacum hondoense

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

Liliaceae

Hosta sieboldiana

Lasioglossum (E.) nipponense (Hal: Hy) 17-viii-91 (2); *Lasioglossum (E.) apristum* (Hal: Hy) 17-viii-91 (1), 25-vii-90 (1); *Bombus consobrinus* (Api: Hy) 17-viii-91 (1), 25-vii-90 (15), 28-vii-91 (9), 29-vii-90 (7); *Bombus diversus* (Api: Hy) 17-viii-91 (1)

Polygonatum lasianthum

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 macranthum

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); *Pidonia grallatrix* (Cer: Co) 29-vii-90 (1); *Pidonia oyamae* (Cer: Co) 29-vii-90 (1); *Pidonia puziloi* (Cer: Co) 29-vii-90 (1); *Pseudalosterna misella* (Cer: Co) 29-vii-90 (3); *Leptura arcuata* (Cer: Co) 29-vii-90 (1); *Nakanea vicaria* (Cer: Co) 29-vii-90 (1); *Rhogogaster varipes* (Ten: Hy) 29-vii-90 (1); *Empis flavofasalis* (Emp: Di) 29-vii-90 (2); *Cheilosia* sp.6 (Syr: Di) 26-viii-90 (1), 29-vii-90 (2); *Cheilosia* sp.15 (Syr: Di) 29-vii-90 (2); *Episyrphus balteatus* (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-viii-91 (1); Sitarea vibrissata (Tep: Di) 17-viii-91 (1)

Iridaceae

Iris sanguinea

Oedemeronia subrobusta (Oed: Co) 6-vii-90 (3); *Bombus consobrinus* (Api: Hy) 25-vii-90 (4), 7-vii-90 (5); *Bombus diversus* (Api: Hy) 14-vii-90 (10), 25-vii-90 (1), 7-vii-90 (8); *Bombus honshuensis* (Api: Hy) 14-vii-90 (6), 25-vii-90 (1), 6-vii-90 (2), 7-vii-90 (16); *Bombus ardens* (Api: Hy) 7-vii-90 (1); *Bombus beaticola* (Api: Hy) 14-vii-90 (1), 7-vii-90 (1); *Bombus hypocrita* (Api: Hy) 7-vii-90 (1); *Papilio machaon hippocrates* (Pap: Le) 25-vii-90 (2); *Papilio xuthus* (Pap: Le) 7-vii-90 (1)

Gramineae

Agrostis clavata

Meliscaeva 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)

Poa 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)

Gymnadenia conopsea
Byturus sp. (Byt: Co) 6-vii-90 (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* (cel1) 17-vi-91 (2); *Cynanchum ascyrifolium* (asc1) 6-vii-90 (2); *Lonicera alpigena* var. *glehnii* (cap1) 9-vi-91 (8); *Viburnum furcatum* (cap2) 27-v-90 (1)

Scarabaeidae

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)

Cantharidae

Micadocantharis japonicus
Acer shirasawanum (ace2) 9-vi-91 (1); *Elaeagnus montana* (ela1) 14-vii-90 (1)
Podabrus malthinoides
Euonymus macropterus (cel1) 17-vi-91 (1)

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 multijuga* (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. *glehnii* (cap1) 9-vi-91 (1); *Viburnum furcatum* (cap2) 26-v-91 (1); *Taraxacum hondoense* (com24) 3-vi-90 (1)

Epuraea 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 multijuga (ros2) 28-vii-91 (1)

Byturidae

Byturus sp.
Fragaria nipponica (ros3) 6-vii-90 (1); *Cynanchum ascyrifolium* (asc1) 6-vii-90 (1); *Lonicera alpigena* var. *glehnii* (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
Acer shirasawanum (ace2) 9-vi-91 (1); *Viburnum furcatum* (cap2) 26-v-91 (4), 27-v-90 (37)
Byturus atricollis
Fragaria nipponica (ros3) 6-vii-90 (1)

Biphyllidae

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

Coccinellidae

Harmonia axyridis
Veratrum album oxysepalum (lil13) 29-vii-90 (1)

Mordellidae

Hoshihananomia perlata
Reynoutria japonica (pol2) 17-viii-91 (1)
Mordellistena sp.1
Veronicastrum sibiricum japonicum (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-viii-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)
Chrysarthia viatica
Astilbe thunbergii (sax1) 25-vii-90 (7), 29-vii-90 (2); *Anaphalis margaritacea* (com3) 1-ix-91 (2), 26-viii-90 (1); *Solidago virgaurea asiatica* (com22) 1-ix-91 (1)

Scraptiidae

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-*

lum (lil13) 29-vii-90 (2)

Cerambycidae

Asemum amurense
Lonicera alpigena var. *glehnii* (cap1) 9-vi-91 (1)
Anastrangalia scotodes
Reynoutria japonica (pol2) 17-viii-91 (2); *Filipendula multijuga* (ros2) 28-vii-91 (1), 29-vii-90 (1)
Anoploderomorpha excavata
Filipendula multijuga (ros2) 25-vii-90 (1); *Veronicastrum sibiricum japonicum* (scr3) 25-vii-90 (1)
Corennys sericata
Hydrangea paniculata (sax2) 17-viii-91 (2)
Corymbia succedanea
Angelica pubescens (umb2) 17-viii-91 (1), 26-viii-90 (1); *Patrinia villosa* (val2) 1-ix-91 (1)
Corymbia variicornis
Astilbe thunbergii (sax1) 25-vii-90 (3), 28-vii-91 (1); *Hydrangea paniculata* (sax2) 17-viii-91 (1)
Leptura arcuata
Astilbe thunbergii (sax1) 25-vii-90 (2); *Filipendula multijuga* (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-viii-91 (1)
Nakanea vicaria
Filipendula multijuga (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-viii-91 (1), 26-viii-90 (1); *Astilbe thunbergii* (sax1) 25-vii-90 (1), 29-vii-90 (1); *Hydrangea paniculata* (sax2) 17-viii-91 (2); *Angelica pubescens* (umb2) 26-viii-90 (2); *Aster glehni* var. *hondoensis* (com7) 26-viii-90 (1)
Parastrangalis nymphula
Scabiosa japonica (dip1) 25-vii-90 (1); *Aster glehni* var. *hondoensis* (com7) 26-viii-90 (1)
Pidonia grallatrix
Trollius hondoensis (ran9) 25-vii-90 (1); *Cimicifuga simplex* (ran5) 26-viii-90 (1); *Filipendula multijuga* (ros2) 29-vii-90 (1); *Angelica pubescens* (umb2) 26-viii-90 (1); *Pyrola alpina* (pyr2) 25-vii-90 (3); *Viburnum opulus* var. *calvescens* (cap3) 7-vii-90 (1); *Scabiosa japonica* (dip1) 25-vii-90 (6), 28-vii-91 (4); *Veratrum album oxysepalum* (lil13) 29-vii-90 (1)
Pidonia aegrota
Filipendula multijuga (ros2) 25-vii-90 (1), 28-vii-91 (1)
Pidonia insuturata
Rodgersia podophylla (sax6) 6-vii-90 (15); *Filipendula multijuga* (ros2) 28-vii-91 (1)
Pidonia signifera
Pyrola alpina (pyr2) 25-vii-90 (1); *Weigela decora* (cap4) 7-vii-90 (1)
Pidonia yokoyamai
Pyrola alpina (pyr2) 25-vii-90 (1)
Pidonia signata
Pyrola alpina (pyr2) 25-vii-90 (2)
Pidonia masakii
Pyrola alpina (pyr2) 25-vii-90 (2)
Pidonia 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)
Pidonia semiobscura
Pyrola alpina (pyr2) 25-vii-90 (1)
Pidonia testacea
Astilbe thunbergii (sax1) 29-vii-90 (8); *Rodgersia podophylla* (sax6) 6-vii-90 (3); *Sorbus commixta* (ros13) 6-vii-90(3)
Pidonia puziloi
Astilbe thunbergii (sax1) 29-vii-90 (1); *Veratrum album oxysepalum* (lil13) 29-vii-90 (1)

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

Chrysomelidae

Cryptocephalus approximatus
Astilbe thunbergii (sax1) 25-vii-90 (1); *Eupatorium chinense sachalinense* (com12) 17-viii-91 (1)
Lupesus 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. *glehnii* (cap1) 9-vi-91 (1)
Rhogogaster varipes
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-viii-91 (1); *Veratrum album oxysepalum* (lil13) 29-vii-90 (1)
Strongylogaster sp.
Lonicera alpigena var. *glehnii* (cap1) 9-vi-91 (1)
Tenthredo japonica
Lychnis gracillima (car2) 25-vii-90 (1)
Tenthredo basizonata
Lonicera alpigena var. *glehnii* (cap1) 9-vi-91 (1)

Vespidae

Vespa simillima xanthoptera
Enkianthus campanulatus (eri1) 9-vi-91 (1)
Vespula schrenckii
Acer japonicum (ace1) 26-v-91 (2)
Vespula austriaca
Cimicifuga simplex (ran5) 1-ix-91 (1)
Dolichovespula norvegicoides
Cimicifuga simplex (ran5) 1-ix-91 (1), 17-viii-91 (1), 26-viii-90 (2), 29-vii-90 (1); *Astilbe thunbergii* (sax1) 29-vii-90 (1); *Hydrangea paniculata* (sax2) 17-viii-91 (5); *Chamaenerion angustifolium* (ona1) 28-vii-91 (2); *Angelica pubescens* (umb2) 17-viii-91 (5); *Enkianthus campanulatus* (eri1) 9-vi-91 (2); *Lonicera alpigena* var. *glehnii* (cap1) 9-vi-91 (2); *Patrinia villosa* (val2) 1-ix-91 (2), 17-viii-91 (1)
Dolichovespula adulterina montivaga
Reynoutria japonica (pol2) 17-viii-91 (2); *Hydrangea paniculata* (sax2) 17-viii-91 (2); *Angelica pubescens* (umb2) 17-viii-91 (3)

Sphecidae

Stigmus sp.
Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1)
Crossocerus sp.
Hydrangea paniculata (sax2) 17-viii-91 (1); *Filipendula multijuga* (ros2) 28-vii-91 (1)

Colletidae

Hylaeus thoracius
Angelica pubescens (umb2) 17-viii-91 (1)
Hylaeus paradifformis
Clinopodium chinense grandiflorum (lab1) 17-viii-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* (eri1) 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* (lil3) 17-viii-91 (2)
Lasioglossum (E.) albipes
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-viii-91 (23); *Astilbe thunbergii* (sax1) 25-vii-90 (3), 28-vii-91 (1); *Hydrangea paniculata* (sax2) 17-viii-91 (1); *Fragaria nipponica* (ros3) 26-v-91 (1); *Filipendula multijuga* (ros2) 17-viii-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-viii-91 (1); *Veronicastrum sibiricum japonicum* (scr3) 25-vii-90 (11), 28-vii-91 (5), 29-vii-90 (1); *Scabiosa japonica* (dip1) 17-viii-91 (2); *Lonicera alpigena* var. *glehnii* (cap1) 9-vi-91 (2); *Serratula coronata insularis* (com21) 17-viii-91 (3); *Hosta sieboldiana* (lil3) 17-viii-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. *atroglaucum*
Angelica pubescens (umb2) 17-viii-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-viii-91 (1); *Anaphalis margaritacea* (com3) 26-viii-90 (1); *Polygonatum lasianthum* (lil8) 17-vi-91 (1)

Andrenidae

Andrena (Andrena) aburana
Euonymus sieboldianus (cel2) 14-vii-90 (1)
Andrena (A.) brenihirtiscopa
Malus sieboldii (ros5) 17-vi-91 (1)
Andrena (A.) lapponica sumizome
Enkianthus campanulatus (eri1) 9-vi-91 (1); *Rhododendron wadanum* (eri4) 9-vi-91 (1); *Lonicera alpigena* var. *glehnii* (cap1) 9-vi-91 (1)
Andrena (A.) longitibialis

Rhododendron wadanum (eri4) 9-vi-91 (1)
Andrena (Euandrena) togashii
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 issikii
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-viii-90 (2); *Aquilegia buergeriana* (ran4) 14-vii-90 (1), 6-vii-90 (1), 7-vii-90 (3), 9-ix-90 (1); *Geranium eriostemon* var. *reinii* (ger1) 25-vii-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); *Campanula punctata* var *hondoensis* (cam3) 28-vii-91 (1), 29-vii-90 (1); *Cirsium 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 buergeriana* (ran4) 25-vii-90 (1); *Cimicifuga simplex* (ran5) 9-ix-90 (1); *Geranium eriostemon* var. *reinii* (ger1) 7-vii-90 (1); *Pyrola incarnata* (pyr3) 7-vii-90 (1); *Weigela decora* (cap4) 7-vii-90 (3); *Scabiosa japonica* (dip1) 1-ix-91 (1); *Cacalia adenostyloides* (com9) 17-viii-91 (2); *Cirsium effusum* (com11) 1-ix-91 (4), 26-viii-90 (1); *Serratula coronata insularis* (com21) 17-viii-91 (6); *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-viii-91 (2); *Rubus pungens* var *oldhamii* (ros12) 9-vi-91 (2); *Geranium eriostemon* var. *reinii* (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 incarnata* (pyr3) 7-vii-90 (1); *Enkianthus campanulatus* (eri1) 9-vi-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); *Lonicera alpigena* var. *glehnii* (cap1) 9-vi-91 (1); *Scabiosa japonica* (dip1) 1-ix-91 (1); *Cacalia adenostyloides* (com9) 17-viii-91 (3); *Cirsium effusum* (com11) 1-ix-91 (17), 22-ix-91 (5), 23-ix-90 (3), 26-viii-90 (3), 9-ix-90 (1); *Ligularia dentata* (com15) 17-viii-91(2); *Serratula coronata insularis* (com21) 17-viii-91 (9), 26-viii-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. *reinii*(ger1) 25-vii-90 (1), 6-vii-90 (1); *Acer shirasawanum* (ace2) 9-vi-91 (1); *Elaeagnus montana* (ela1) 7-vii-90 (6); *Pyrola incarnata* (pyr3) 7-vii-90 (1); *Enkianthus campanulatus* (eri1) 7-vii-90

(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 multijuga* (ros2) 17-viii-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 eriostemon* var. *reinii* (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); *Elaeagnus montana* (ela1) 14-vii-90 (5), 7-vii-90 (9); *Chamaenerion angustifolium* (ona1) 28-vii-91 (1); *Enkianthus campanulatus* (eri1) 6-vii-90 (2); *Menziesia pentandra* (eri2) 27-v-90 (1); *Polemonium caeruleum yezoense* (plm1) 14-vii-90 (1); *Clinopodium chinense grandiflorum* (lab1) 17-viii-91 (1); *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. *glehnii* (cap1) 9-vi-91 (5); *Patrinia triloba palmata* (val1) 28-vii-91 (1); *Campanula punctata var hondoensis* (cam3) 29-vii-90 (1); *Cacalia adenostyloides* (com9) 17-viii-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-viii-91 (2), 29-vii-90 (2); *Serratula coronata insularis* (com21) 17-viii-91 (12); *Polygonatum lasianthum* (lil8) 17-vi-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); *Astilbe thunbergii* (sax1) 25-vii-90 (1), 28-vii-91 (2); *Rodgersia podophylla* (sax6) 7-vii-90 (2); *Filipendula multijuga* (ros2) 25-vii-90 (1); *Prunus nipponica* (ros9) 27-v-90 (2); *Chamaenerion angustifolium* (ona1) 28-vii-91 (1); *Pyrola alpina* (pyr2) 25-vii-90 (4); *Meehania urticifolia* (lab2) 9-vi-91 (2); *Pedicularis resupinata* var. *caespitosa* (scr2) 17-viii-91 (2), 26-viii-90 (1); *Veronicastrum sibiricum japonicum* (scr3) 25-vii-90 (4), 28-vii-91 (8), 29-vii-90 (1); *Scabiosa japonica* (dip1) 1-ix-91 (2), 28-vii-91 (4); *Cacalia adenostyloides* (com9) 17-viii-91 (1); *Cacalia hastata farfaraefolia* (com10) 26-viii-90 (3); *Cirsium effusum* (com11) 1-ix-91 (13), 23-ix-90 (5), 26-viii-90 (1); *Ligularia dentata* (com15) 17-viii-91 (1); *Serratula coronata insularis* (com21) 17-viii-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

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

DIPTERA

Bombyliidae

Bombylius major

Reynoutria japonica (pol2) 17-viii-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* (cra2) 29-vii-90 (2); *Geranium eriostemon* var. *reinii* (ger1) 25-vii-90 (5), 28-vii-91 (2); *Scabiosa japonica* (dip1) 17-viii-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-viii-91 (1)

Cheilosia sp.3

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

Cheilosia sp.4

Arabis lyrata kamtschatica (bra2) 9-vi-91 (1); *Geranium eriostemon* var. *reinii* (ger1) 25-vii-90 (1)

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); *Ranunculus japonicus* (ran7) 17-vi-91 (1), 6-vii-90 (1); *Filipendula multijuga* (ros2) 28-vii-91 (1), 29-vii-90 (1); *Fragaria nipponica* (ros3) 17-vi-91 (1); *Prunus nipponica* (ros9) 27-v-90 (1); *Oxalis acetosella* (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 adenostyloides* (com9) 17-viii-91 (1); *Solidago virgaurea asiatica* (com22) 1-ix-91 (1), 9-ix-90 (1); *Veratrum album oxysepalum* (lil13) 26-viii-90 (1), 29-vii-90 (2)

Cheilosia sp.7

Serratula coronata insularis (com21) 26-viii-90 (1)

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 cannabifolius* (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 nemorensis* (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 acetosella* (oxa1) 27-v-90 (2)

Cheilosia sp.14

Sedum aizoon (cra2) 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 multijuga* (ros2) 25-vii-90 (3); *Angelica polymorpha* (umb1) 1-ix-91 (1); *Ixeris dentata* var. *albiflora* (com13) 14-vii-90 (1); *Veratrum album oxysepalum* (lil13) 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-91 (2); *Malus sieboldii* (ros5) 17-vi-91 (1); *Angelica pubescens* (umb2) 26-viii-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* (lil14) 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 (2), 9-ix-90 (1)

Didea nikkoensis
Reynoutria japonica (pol2) 17-viii-91 (1)
Episyrphus balteatus
Veratrum album oxysepalum (lil13) 29-vii-90 (1)
Eristalis cerealis
Sedum aizoon (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-viii-91 (2), 26-viii-90 (2); *Dianthus superbus longicalycinus* (car1) 28-vii-91 (2); *Lychnis gracillima* (car2) 25-vii-90 (1); *Cimicifuga simplex* (ran5) 26-viii-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 multijuga* (ros2) 25-vii-90 (5), 29-vii-90 (2); *Malus sieboldii* (ros5) 17-vi-91 (2); *Libanotis coreana* (umb4) 26-viii-90 (11); *Scabiosa japonica* (dip1) 1-ix-91 (1), 17-viii-91 (17), 23-ix-90 (2), 25-vii-90 (4), 26-viii-90 (9), 28-vii-91 (6), 9-ix-90 (3); *Anaphalis margaritacea* (com3) 26-viii-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 sachalinense* (com12) 1-ix-91 (2), 17-viii-91 (1); *Senecio cannabifolius* (com18) 1-ix-91 (1), 9-ix-90 (2); *Senecio nemorensis* (com20) 26-viii-90 (3); *Serratula coronata insularis* (com21) 1-ix-91 (7), 17-viii-91 (2), 26-viii-90 (1); *Solidago virgaurea 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)
Ischyrosyrphus glaucius
Angelica pubescens (umb2) 26-viii-90 (1)
Ischyrosyrphus laternarius
Reynoutria japonica (pol2) 17-viii-91 (1)
Leucozona 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. *reinii* (ger1) 14-vii-90 (1); *Angelica polymorpha* (umb1) 1-ix-91 (1); *Taraxacum hondoense* (com24) 3-vi-90 (1); *Agrostis clavata* (gra1) 6-vii-90 (1); *Poa pratensis* (gra2) 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. *reinii* (ger1) 14-vii-90 (1); *Enkianthus campanulatus* (eri1) 9-vi-91 (1); *Polemonium caeruleum yezoense* (plm1) 14-vii-90 (1); *Anaphalis margaritacea* (com3) 9-ix-90 (1); *Aster glehni* var. *hondoensis* (com7) 26-viii-90 (1); *Ixeris dentata* var. *albiflora* (com13) 14-vii-90 (1); *Senecio nemorensis* (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); *Cypripedium guttatum* var. *yatabeanum* (orc2) 17-vi-91 (1)
Meliscaeva cinctella
Trollius hondoensis (ran9) 25-vii-90 (1); *Reynoutria japonica* (pol2) 1-ix-91 (1); *Dianthus superbus longicalycinus* (car1) 29-vii-90(2); *Cimicifuga simplex* (ran5) 23-ix-90 (1), 26-viii-90 (2); *Filipendula multijuga* (ros2) 28-vii-91 (1), 29-vii-90 (1); *Elaeagnus montana* (ela1) 14-vii-90 (5); *Angelica polymorpha* (umb1) 1-ix-91 (1); *Euphrasia maximowiczii* (scr1) 26-viii-90 (1); *Veronicastrum sibiricum japonicum* (scr3) 29-vii-90 (5); *Weigela decora* (cap4) 7-vii-90 (2); *Scabiosa japonica* (dip1) 9-ix-90 (1); *Achillea alpina* var. *discoidea* (com1) 17-viii-91 (1); *Aster glehni* var. *hondoensis* (com7) 26-viii-90 (1); *Cacalia adenostyloides* (com9) 17-viii-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

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

Metasyrphus ferquens

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

Metasyrphus sp.1

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

Phytomia zonata

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

Platycheirus ambiguus

Ranunculus japonicus (ran7) 6-vii-90 (1); *Acer japonicum* (ace1) 26-v-91 (1)

Platycheirus scutatus

Trollius hondoensis (ran9) 14-vii-90 (3); *Cimicifuga simplex* (ran5) 23-ix-90 (2), 9-ix-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) 14-vii-90 (1); *Polemonium caeruleum yezoense* (plm1) 14-vii-90 (1); *Cirsium effusum* (com11) 23-ix-90 (1); *Ixeris dentata* var. *albiflora* (com13) 14-vii-90 (1); *Solidago virgaurea asiatica* (com22) 9-ix-90 (6); *Cypripedium 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.

Lonicera alpigena var. *glehnii* (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-vii-91 (1); *Cirsium effusum* (com11) 9-ix-90 (1); *Senecio cannabifolius* (com18) 9-ix-90 (1); *Serratula coronata insularis* (com21) 17-viii-91 (1), 26-viii-90 (1)

Syrphus vitripennis

Trollius hondoensis (ran9) 28-vii-91 (1); *Reynoutria japonica* (pol2) 17-viii-91 (1); *Cimicifuga simplex* (ran5) 1-ix-91 (1); *Philadelphus satsumi* (sax4) 14-vii-90 (1); *Filipendula multijuga* (ros2) 17-viii-91 (2), 28-vii-91 (2), 29-vii-90 (2); *Malus sieboldii* (ros5) 17-vi-91 (1); *Libanotis coreana* (umb4) 26-viii-90 (1); *Pyrola incarnata* (pyr3) 7-vii-90 (1); *Clinopodium chinense grandiflorum* (lab1) 17-viii-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-vii-91 (1)

Vollucella jeddona

Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1), 29-vii-90 (1)

LEPIDOPTERA

Zygaenidae

Balatala 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 permiaca
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* (iri1) 25-vii-90 (2)
Papilio xuthus
Iris sanguinea (iri1) 7-vii-90 (1)
Parnassius gracialis
Polemonium caeruleum yezoense (plm1) 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 poliograhus
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-viii-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. *glehnii* (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 tsushimana
Serratula coronata insularis (com21) 1-ix-91 (1)
Melitaea niphora
Veronicastrum sibiricum japonicum (scr3) 28-vii-91 (1)
Inachis 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)

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.

A

B

C

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