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Flowering Phenology and Anthophilous Insect Community in a Grassland Ecosystem at Mt. Yufu, Western Japan

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ABSTRACT The hillsides of Mt. Yufu, located in Kyusyu, Japan, is a dormant volcano, are covered with natural and semi-natural grasslands; the latter of which are maintained by traditional mowing and burning. Both the natural and semi-natural grasslands are inhabited by many grassland-specific plant species, some of which are now endangered in Japan. To understand pollination mutualisms in the grassland ecosystem, we investigated the flowering phenology and anthophilous insect communities on 149 plant species from 49 different plant families, from April to October 2001. In total, 1192 individuals from 308 species, 83 families and 10 orders of Insecta were observed on flowers of 101 plant species. The most abundant insect order was Hymenoptera (37.8% of individuals), followed by Diptera (32.5%), Coleoptera (22.7%) and Lepidoptera (6.2%). The proportions of Coleoptera and Lepidoptera were respectively smaller and greater than in forested habitats, suggesting that many anthophilous beetles depend on woody plants during their larval stages and that anthophilous butterflies (especially Nymphalidae) are associated with grassland-specific perennials (especially *Viola* spp.) in their larval stages. The bee fauna consisted of 54 species, from 10 genera and 6 families; the bee community was characterized by an absence of cavity-nesting *Hylaeus* and *Xylocopa* and by the predominance of long-tongued *Tetralonia* in the early spring. The bumblebee community was characterized by the predominance of a short-haired *Bombus ignitus*, uncommon in forested habitats. The dominant pollination syndrome, among 70 plant species for which pollinators were inferred, was melittophily (82%), followed by myophily (14%), psychophily (1.4%), phalaenophily (1.4%) and anemophily (1.4%). Among the melittophilous species, small-bee-pollinated species (45%) dominated, followed by *Bombus*- (36%), *Apis*- (8.6%), *Tetralonia*- (6.9%), megachilid- (1.7%) and wasp- (1.7%) pollinated species. These data on community-level plant-pollinator interactions at Mt. Yufu will contribute to the conservation of endangered grassland ecosystems.

KEY WORDS flowering phenology / anthophilous insect community / bumblebee / grassland ecosystem / traditional grassland management

Introduction

Community-level plant-pollinator interactions are founded on mutualisms between plants and their pollinators, as well as on competition between plants for pollinators, and competition between pollinators for floral resources (Waser and Real, 1979; Kevan and Baker, 1983; Feinsinger, 1987). Thus, the study of both flowering phenology and the community structure of flower-visiting insects on individual flower species forms the foundation for studying mutual interactions and competition in terrestrial ecosystems (Sakagami and Fukuda, 1973).

Ecological studies of anthophilous bee communities have been conducted in various

vegetation types, at various localities, since the 1970s in Japan (Matsuura et al., 1972; Sakagami and Fukuda, 1973; Fukuda et al., 1973; Sakagami et al., 1974; Ikudome, 1978; Nakamura and Matsumura, 1985; Takahashi, 1990; Go'ukon, 1992; Yumoto, 1994; Negoro, 1999, 2000, 2001a. 2001b). In addition to studies of bee communities, ecological studies of entire anthophilous insect communities have been conducted at various localities since the 1980s (Kato et al., 1990; Inoue et al., 1990; Kakutani et al., 1990; Kato 1992; Kato et al. 1993; Kato and Miura, 1996; Suka, 1998; Kato, 2000).

These studies have demonstrated that, in Japan, anthophilous bee/insect assemblages vary greatly among plant species, and that anthophilous bee/insect communities vary among vegetation types. For example, it has been reported that bumblebees dominate the bee community in cool-temperate subalpine forests and meadows was dominated by bumblebees (Kato et al. 1993), while that in subtropical forests on Amami Islands were reported to be dominated by solitary bees (Kato, 2000). These studies on anthophilous insect communities have been conducted, primarily, in forest vegetation, with the exception of studies undertaken in cool-temperate meadows at Hamakoshimizu (Fukuda et al., 1973) and Mt. Kushigata (Kato et al. 1993), and the lowland marshes at Nakaikemi (Kato and Miura, 1996). Anthophilous insect communities in warm, temperate zone, grassland ecosystems have not yet been studied.

Most grasslands in Japan are intermediate successional stages, since both temperature and rainfall are favorable for climax forests. Accordingly, natural grasslands are rare; they are found only around active volcanoes, which cause grassland-maintaining. In addition to its natural grasslands, Japan also has semi-natural grasslands, which are maintained by traditional mowing methods, as a source of thatch and fodder (Kato, 2000). Both the grasslands are inhabited by many grassland-specific plant species that colonized Western Japan from the Asian continent during the last glacial epoch (Murata, 1977). Traditionally managed semi-natural grasslands have become less common over the last 40 years due to post industrial revolution innovations with respect to agriculture and economic systems.

The hillsides of Mt. Yufu, a dormant but geologically active, volcano located in Kyusyu, Japan, are covered with natural and semi-natural grasslands (Sumata, 1989). Both the grassland types are inhabited by many grassland-specific plant species, some of which are endangered in Japan (Environment agency of Japan, 2000). To conserve these endangered plant species, it is indispensable that we know the native pollinators and understand community-level plant-pollinator interactions in the grasslands.

This study describes flowering phenology and the composition of flower-visiting insect communities, especially the anthophilous bee community, as well as the phenology of these flower-visitors and the anthophilous insect assemblages of certain plant species in the grassland ecosystem. Secondly, pollination syndromes of certain plant species are inferred by examining their respective anthophilous insect communities and the contributions to pollination made by members of these communities. Finally, the anthophilous insect communities and pollination systems at Mt. Yufu are compared to those of other localities. Biodiversity conservation strategies and plant-pollinator interactions in the grassland ecosystem are discussed.

Study Site

Mt. Yufu, altitude 1583 m, is a dormant, but geologically active, volcano located in Oita Prefecture, Kyushu, Japan (33° 24' N, 131° 30' E, Fig. 1). The volcano was vigorously active 50,000 to 20,000 years ago (Yoshida and Moriyama, 1974).

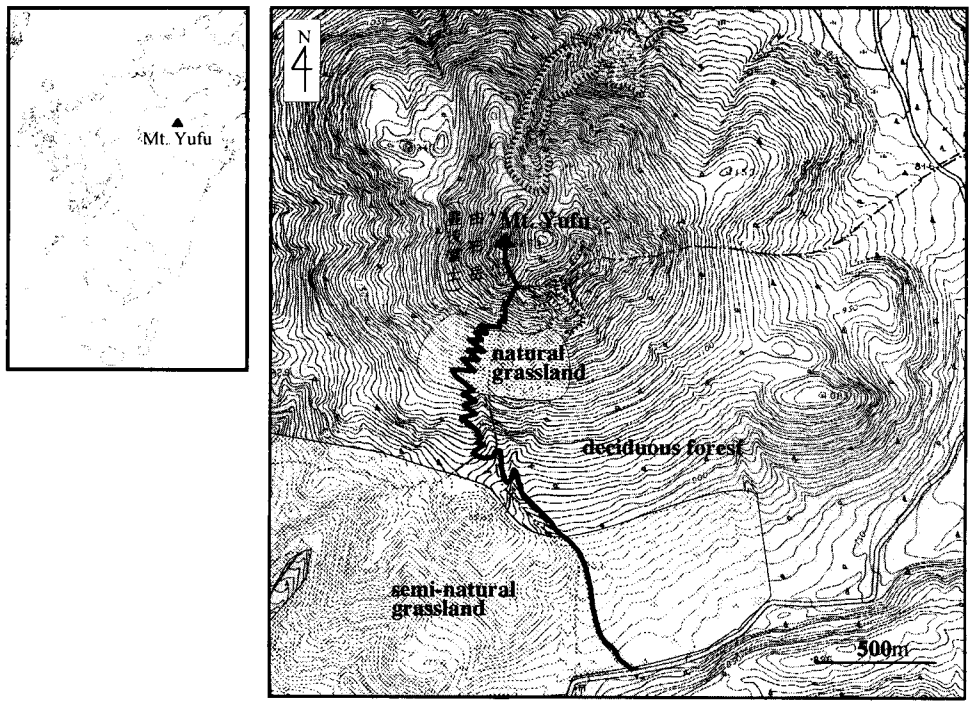

Fig. 1. The location of Mt. Yufu in Kyusyu district in Japan (left) and a topographical map of the study area (right). The sampling route is shown by a solid line. Grasslands are shown by pale areas.

The climate at Mt. Yufu is strongly affected by cold Siberian winds in the winter season. The mean temperature in 2001 at Yufuin (2 km southwest of Mt. Yufu, 435 m above sea level) was 13.4°C, the monthly minimum temperature was below 0°C from November to April, and total rainfall for the year was 1858 mm (Fig. 2). Rainfall is heavy in June and July. The peak of Mt. Yufu is often snow covered during the winter.

The vegetation of Mt. Yufu is typically semi-natural/natural volcanic grasslands (Plate 4A). The semi-natural grasslands, altitude 760–800 m, are maintained by traditional annual mowing and harvesting of grass (*Miscanthus sinensis*), and controlled burning. The natural grasslands are formed on upper mountain slopes (altitude 1,100–1,300 m) where the soil is thin (Plate 5A). Both grasslands contain various perennial plant species, e.g., *Miscanthus*

sinensis, *Arundinella hirta*, *Pleioblastus chino* var. *viridis*, *Themeda japonica*, *Calamagrostis arundinacea* var. *brachytricha*, and *Pennisetum alopecuroides* (Arakane et al., 1974). The grassland flora is also characterized by many herbaceous species which colonized to western Japan from the Asian continent during the last glacial epoch (Murata, 1977): *Iris rossi* (Plate 4D), *Allium thunbergii*, *Chionographis japonica*, *Aconitum japonicum* ssp. *Napifarm*, *Corydalis heterocarpa*, *Viola orientalis* (Plate 4E), *Echinops setifer* (Plate 5D), *Saussurea gracilis*, *Cephalanthera falcata*, *Angelica cartilagino-marginata* and *Atractylodes japonica* (Sumata, 1989). The grasslands are also inhabited by some plant species endemic in Kyushu district, e.g., *Salix sieboldiana*, and *Achillea alpina* var. *brevidens*. Other grassland-specific species, e.g., *Sophora flavescens* (Plate 5E), *Hemerocallis vespertina* (Plate 5B), *Dianthus superbus* var. *longicalycinus*, are also present.

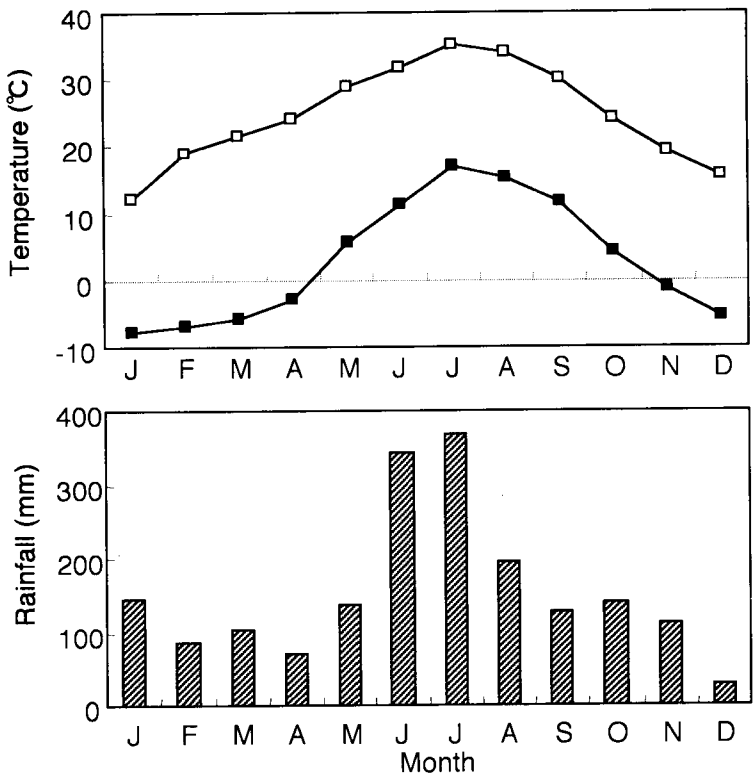

Fig. 2. Seasonal changes in the maximum (open rectangle) and the minimum (solid rectangle) temperature (upper) and monthly rainfall at Yufuin in 2001 (lower) (after Japan Meteorological Agency, 2002).

In some places, former grasslands now support pine forests, dominated by *Pinus densiflora* and *P. thunbergii,* and deciduous forests with *Weigela japonica* and *Hydrangea luteo-venosa.*

While the climate could otherwise support temperate forest growth at the top of the mountain, recent volcanic activity and the dominant northwest winter wind result in scrub vegetation dominated by *Rhododendron kiusuanum* (Sumata, 1989).

Methods

Surveys of flowering phenology and flower visitors were made at three-week intervals from mid April to mid October 2001. In total, 9 surveys were conducted, each lasting 2–3 days. Surveys were conducted from 0830 to 1600–1700, along a fixed route, which went upwards through semi-natural grasslands (alt. 760–800 m, Plate 4C), temperate deciduous forest (alt. 800–1,000 m), natural grasslands (alt. 1100–1300 m, Plate 4B) and the summit scrub (alt. 1300–1583 m).

Table 1. Observation dates and the numbers of flowering plant species and collected insects.

Code	Date	No. of flowering plant species	No. of collected insects
1	16-18 Apr. 2001	18	185
2	11-16 May 2001	25	205
3	26-29 May 2001	26	96
4	16-17 Jun. 2001	28	265
5	10-16 Jul. 2001	23	139
6	4- 5 Aug. 2001	25	47
7	24-26 Aug. 2001	26	104
8	17-22 Sep. 2001	25	142
9	14-16 Oct. 2001	11	9

When flowering plants were encountered, flower visitors were netted for about 8 minutes per site. The flowers were then swept with the net for 2 minutes to collect all visitors remaining on the flowers. If no visitors were collected during this 10-minute period, the observation time was prolonged.

All collected insect specimens were pinned and labeled by date, site, and flower species visited. The specimens were then sorted and identified to the species level, with some exceptions that were identified only to family or genus level. Thus, a data set of all insect visits to flowers was created. All specimens were put into storage at Kyoto University.

Using the data set, the faunal makeup of flower visitors, phenological patterns, and the

floral hosts for each insect group (order, family, genus, or species) were investigated. Principal component analysis and cluster analysis were performed on the data set to detect patterns of anthophilous insect communities on different plant species. In these analyses, plant species visited by fewer than 3 insects were excluded. For the 10 plant species visited by less than 4 visitors each (*Aconitum japonicum* ssp. *napiform, Corydalis lineariloba, Rubus phoenicolasius, Sanguisorba officinalis, Polygala japonica, Codonopsis lanceolata, Paederia scandens, Synurus excelsus, Aletris luteoviridis, Lilium leichtlinii* var. *maximowiczii*), additional records of flower-visits from subsequent observations were added. Thus, 70 plant species were included in the analysis. Anthophilous insects were grouped into 15 functional/taxonomical groups: *Bombus*, *Apis*, small bees, Megachilidae, *Tetralonia* (long-tongued anthophorine bees), wasps (Vespoidea, Pompiloidea, and Sphecoidea sensu stricto), Scoliidae, other Hymenoptera, Syrphidae, Calyptrata, other Diptera, butterflies, moths, Coleoptera, and other miscellaneous insects. Statistical analyses were made using SAS, in the Data Processing Center at Kyoto University.

Results

1. *Flora*

Flowering of 149 plant species, from 49 families, was observed, including 12 annuals, 101 perennials, 3 climbing perennials, 22 shrubs, 10 trees, and 1 liana (Table 2). Anthophilous insects were observed visiting 101 plant species.

Asteraceae was the most represented plant family (with 29 species), followed by Rosaceae (10 sp.), Liliaceae (8 sp.), Ranunculaceae (5 sp.), Caprifoliaceae (5 sp.), Violaceae (5 sp.), Saxifragaceae (5 sp.), and Gentianaceae (5 sp.). The only non- native plant species were *Lotus corniculatus* var. *corniculatua* and *Erigeron annuus*..

The flora included 9 species from the Red Data Book (Environment Agency of Japan, 2000): 2 endangered species [*Echinops setifer* (Plate 5D), *Dioscorea asclepiadea*] and 7 vulnerable species [*Viola orientalis* (Plate 4E–F), *Euphorbia adenochlora, Swertia pseudochinensis, Achillea alpina* var. *brevidens, Ligularia fisherii* var. *takeyuki* (Plate 5C), *Saussurea pulchella, Cephalanthera falcata*].

Table 2. A list of plants studied for phenology and flower-visitors, with blooming month (MB), growth habitat (GH), nativity (N), breeding system (BS), flower color (FC), flower symmetry (FS), flower morphology (FM), rank in Red Data Book(RD), the number of observed insects on flowers (NV), cluster dected by analysis on flower visitor spectra (CL), and pollination agent determinated (PA).

Subclass / Order / Family	Code	Species	Japanese name	MB[1]	GH[2]	N[3]	BS[4]	FC[5]	FS[6]	FM[7]	RD[8]	NV[9]	CL[10]	PA[11]
Magnoliidae														
Laurales														
Lauraceae	lau1	*Lindera sericea*	Kekuromoji	IV	s	n	d	g	a	o	-	27	C1	miscellaeous
Piperales														
Chloranthaceae		*Chloranthus japonicus*	Hitorishizuka	IV	p	n	h	w	a	b	-	-	-	?
Ranunculidae														
Ranunculales														
Ranunculaceae	ran3	*Aconitum japonicum* ssp. *napiform*	Tannatorikabuto	IV	p	n	h	v	z	sp	-	1	C12	*Bombus*
		Aquilegia adoxoides	Himeuzu	IV-V	p	n	h	w	a	o	-	-	-	?
		Aquilegia buergeriana var. *oxysepala*	Ooyamaodamaki	VII	p	n	h	c	a	t	-	-	-	?
	ran2	*Cimicifuga acerina*	Oobashouma	IV	p	n	h	w	a	b	-	3	-	?
	ran1	*Ranunculus japonicus*	Umanoashigata	V	p	n	h	y	a	o	-	20	C10	small bee
Berberridaceae	ber1	*Epimedium diphyllum*	Baikaikarisou	V	p	n	h	w	a	o	-	6	C1	small bee
Papaverales														
Papaveraceae		*Corydalis decumbens*	Jirobouengosaku	V	p	n	h	v	z	t	-	-	-	?
		Corydalis heterocarpa	Tsukushikikeman	IV	p	n	h	y	z	t	-	-	-	?
	pap1	*Corydalis lineariloba*	Yamaengosaku	IV	p	n	h	v	z	t	-	1	C6	*Tetralonia*
Hamamelidae														
Fagales														
Fagaceae	fag2	*Castanea crenata*	Kuri	VII	t	n	m	c	a	ct	-	5	-	Syrphidae
	fag1	*Quercus dentata*	Kashiwa	V	t	n	m	g	a	ct	-	27	-	wind
Betulaceae		*Alnus firma*	Yashabushi	V	t	n	m	y	a	ct	-	-	-	?
Caruophyllidae														
Caryophyllales														
Caryophyllaceae	car3	*Dianthus superbus* var. *longicalycinus*	Kawaranadeshiko	VII	p	n	h	p	a	t	-	6	C10	middle bee
	car2	*Moehringia lateriflora*	Ooyamafusuma	V	p	n	m	w	a	o	-	2	-	?
	car1	*Pseudostellaria heterantha*	Wachigaisou	V	p	n	h	w	a	o	-	3	-	?
Polygonales														
Polygonaceae		*Agrimonia pilosa*	Kinmizuhiki	VIII	p	n	h	y	a	o	-	-	-	?

	poly3	*Polygonum cuspidatum*	Itadori	VIII	p	n	d	p	a	o	-	35	C8	*Apis*
	poly2	*Polygonum filiforme*	Mizuhiki	VIII	p	n	h	p	a	o	-	3	-	?
Dilleniidae														
Theales														
Clusiaceae		*Hypericum erectum*	Otogirisou	VIII	p	n	h	y	a	o	-	-	-	?
	clu1	*Hypericum pseudopetiolatum*	Sawaotogiri	IX	p	n	h	y	a	o	-	2	-	?
Violales														
Violaceae		*Viola eizanensis*	Eizansumire	IV	p	n	h	p	z	sp	-	-	-	?
	vio2	*Viola grypoceras*	Tachitsubosumire	IV	p	n	h	v	z	sp	-	18	C2	*Tetralonia*
	vio3	*Viola hondoensis*	Aoisumire	IV	p	n	h	v	z	sp	-	1	-	?
		Viola japonica	Kosumire	IV	p	n	h	v	z	sp	-	-	-	?
	vio1	*Viola orientalis*	Kisumire	IV-V	p	n	h	y	z	sp	VU	14	C1	*Tetralonia*
Salicales														
Salicaceae	sal3	*Salix sieboldiana*	Yamayanagi	V	s	n	d	g	a	a	-	88	C2	small bee
	sal1	*Salix vulpina*	Kitsuneyanagi	IV	s	n	d	g	a	a	-	36	C8	Calyptrata
Capparales														
Brassicaceae	bra1	*Arabis glabra*	Hatazao	VI	a	n	h	y	a	o	-	1	-	?
Ericales														
Clethraceae	cle1	*Clethra barvinervis*	Ryoubu	VIII	t	n	h	w	a	o	-	7	C8	small bee
Ericaceae	eri6	*Lyonia ovalifolia* var. *elliptica*	Nejiki	VI	t	n	h	w	a	c	-	4	C2	*Bombus*
	eri1	*Pieris japonica*	Asebi	IV	s	n	h	w	a	c	-	70	C1	small bee
	eri4	*Rhododendron kiusuanum*	Miyamakirishima	V-VI	s	n	h	rv	a	f	-	20	C2	*Bombus*
	eri3	*Rhododendron reticulatum*	Kobanomitsubatsutsuji	V	s	n	h	rv	a	f	-	10	C2	small bee
Pyrolaceae		*Monotropa uniflora*	Ginryousoumodoki	IX	p	n	h	w	a	f	-	-	-	?
Diapesiales														
Diapensiaceae		*Schizocodon soldanelloides*	Iwakagami	V	p	n	h	p	a	f	-	-	-	?
Ebenales														
Styracaceae	sty1	*Styrax japonica*	Egonoki	VI	t	n	h	w	a	o	-	11	C12	*Bombus*
Primulales														
Primulaceae	pri1	*Lysimachia clethroides*	Okatoranoo	VII-VIII	p	n	h	w	a	o	-	22	C9	small bee
Rosales														
Hydrangeaceae	hyd1	*Hydrangea luteo-venosa*	Kogakuutsugi	V-VI	s	n	h	w	a	o	-	9	C2	small bee
	hyd3	*Hydrangea paniculata*	Noriutsugi	VII-VIII	s	n	h	w	a	o	-	8	C3	*Apis*
	hyd2	*Hydrangea serrata*	Yamaajisai	VII	s	n	h	w	a	o	-	6	C3	*Apis*
Crassulaceae		*Sedum kamtschaticum*	Kirinsou	IX	p	n	h	y	a	o	-	-	-	?
Saxifragaceae	sax5	*Astilbe thunbergii*	Akashouma	VII	p	n	h	w	a	o	-	19	C8	Syrphidae

	sax2	*Deutzia crenata*	Utsugi	VI	s	n	h	w	a	f	-	32	C10	*Bombus*
	sax6	*Deutzia crenata* var. *floribunda*	Koutsugi	VI-VII	s	n	h	w	a	f	-	33	C8	small bee
	sax8	*Parnassia palustris*	Umebachisou	X	p	n	h	w	a	o	-	3	-	?
	sax7	*Schizophragma hydrangeoides*	Iwagarami	VI	l	n	h	w	a	o	-	1	-	?
Rosaceae		*Potentilla fragarioides* var. *major*	Kijimushiro	V	p	n	h	y	a	o	-	-	-	?
	ros1	*Potentilla freyniana*	Mitsubatsuchiguri	IV-V	p	n	h	y	a	o	-	13	C10	small bee
	ros3	*Prunus jamasakura*	Yamazakura	V	t	n	h	p	a	o	-	26	C1	Syrphidae
		Prunus maximowiczii	Miyamazakura	V	t	n	h	w	a	o	-	-	-	?
		Rosa multiflora	Noibara	IV	s	n	h	w	a	o	-	-	-	?
	ros8	*Rubus parvifolius*	Nawashiroichigo	VI	s	n	h	p	a	o	-	6	C1	*Bombus*
	ros6	*Rubus phoenicolasius*	Urajiroichigo	V	s	n	h	w	a	o	-	1	C12	*Bombus*
	ros11	*Sanguisorba officinalis*	Waremokou	VIII-IX	p	n	h	br	a	a	-	1	C8	Calyptrata
	ros9	*Spiraea japonica*	Shimotsuke	VII-VIII	s	n	h	p	a	o	-	6	C4	*Bombus*
		Stephanandra incisa	Kogomeutsugi	VI	s	n	h	w	a	o	-	-	-	?
Fabales														
Fabaceae	fab3	*Lespedeza bicolor*	Marubahagi	VIII-IX	p	n	h	v	z	p	-	41	C3	*Bombus*
		Lotus corniculatus var. *corniculatus*	Seiyoumiyakogusa	VI-VIII	p	a	h	y	z	p	-	-	-	?
	fab1	*Sophora flavescens*	Kurara	VI-VII	p	n	h	c	z	p	-	18	C4	*Bombus*
	fab2	*Vicia unijuga*	Nantenhagi	VI	p	n	h	v	z	p	-	3	C4	*Bombus*
Haloragales														
Haloragaceae		*Haloragis micrantha*	Arinotougusa	VII	p	n	h	r	a	a	-	-	-	?
Cornales														
Cornaceae	cor2	*Benthamidia japonica*	Yamaboushi	VI	t	n	h	w	a	o	-	14	C8	*Bombus*
Celastrales														
Celastraceae		*Euonymus alatus* f. *stiatus*	Komayumi	V	t	n	h	g	a	o	-	-	-	?
Euphorbiales														
Euphorbiaceae		*Euphorbia adenochlora*	Nourushi	VI	p	n	h	y	a	o	VU	-	-	?
		Euphorbia pekinensis	Takatoudai	VII	p	n	h	g	a	o	-	-	-	?
Polygalales														
Polygalaceae	pol1	*Polygala japonica*	Himehagi	V	p	n	h	v	z	p	-	1	C11	small bee
Sapindales														
Staphyleaceae	sta1	*Staphylea bumalda*	Mitsubautsugi	V	s	n	h	w	a	t	-	1	-	?
Geraniales														
Geraniaceae	ger1	*Geranium shikokianum*	Iyofuuro	VIII-IX	p	n	h	p	a	o	-	28	C10	small bee
Balsaminaceae		*Impatiens noli-tangere*	Kitsurifune	VIII	a	n	h	y	z	sp	-	-	-	?
Apiales														

Apiaceae	api3	*Angelica cartilagino-marginata*	Himenodake	VIII	p	n	h	w	a	o	-	1	-	?
	api2	*Angelica longeradiata*	Tsukushizeri	VIII	p	n	h	w	a	o	-	1	-	?
	api1	*Hydrocotyle ramiflora*	Oochidome	VI	p	n	h	g	a	o	-	4	C10	small bee
		Osmorhiza aristata	Yabuninjin	V	p	n	h	w	a	o	-	-	-	?
Asteridae														
Gentianales														
Gentianaceae		*Gentiana scabra* var. *buergeri*	Rindou	X	p	n	h	v	a	f	-	-	-	?
		Gentiana thunbergii	Harurindou	IV	a	n	h	v	a	f	-	-	-	?
	gen5	*Gentiana zollingeri*	Huderindou	IV	a	n	h	v	a	f	-	1	-	?
	gen4	*Swertia japonica*	Senburi	X	a	n	h	w	a	o	-	1	-	?
		Swertia pseudochinensis	Murasakisenburi	X	a	n	h	v	a	o	VU	-	-	?
Lamiales														
Lamiaceae	lam2	*Isodon inflexus*	Yamahakka	IX	p	n	h	v	z	t	-	1	-	?
		Isodon longitubus	Akichouji	IX	p	n	h	v	z	t	-	-	-	?
	lam1	*Prunella vulgaris* var. *lilacina*	Utsubogusa	VI-VIII	p	n	h	v	z	t	-	23	C9	small bee
		Isodon trichocarpa	Hikiokoshi	X	p	n	h	v	z	t	-	-	-	?
Scrophulariales														
Scrophulariaceae		*Melampyrum roseum* var. *japonicum*	Mamakona	VIII	a	n	h	rv	z	t	-	-	-	?
		Veronica arvensis	Tachiinunofuguri	V	a	a	h	b	z	o	-	-	-	?
	scr1	*Veronica rotunda* var. *petiolata*	Himetoranoo	VIII	p	n	h	v	z	o	-	6	C10	small bee
Orobanchaceae		*Aeginetia sinensis*	Oonanbangiseru	VIII	a	n	h	rv	a	f	-	-	-	?
Acanthaceae		*Phryma leptostachya* var. *asiatica*	Haedokusou	VII	p	n	h	w	z	o	-	-	-	?
Campanulales														
Campanulaceae	cam1	*Adenophora triphylla*	Saiyoushajin	VIII	p	n	h	v	a	c	-	4	C9	*Bombus*
	cam3	*Codonopsis lanceolata*	Tsuruninjin	IX	c	n	h	w/br	a	c	-	1	C5	wasp
		Campanula punctata	Hotarubukuro	VII-VIII	p	n	h	w	a	f	-	-	-	?
Rubiales														
Rubiaceae	rub1	*Galium japonicum*	Kurumamugura	V	p	n	h	w	a	o	-	1	-	?
	rub2	*Galium verum*	Kibanakawaramatsuba	VII-VIII	p	n	h	y	a	o	-	5	C10	small bee
	rub3	*Paederia scandens*	Hekusokazura	VIII	c	n	h	w	a	c	-	1	C11	small bee
		Pseudopyxis depressa	Inamorisou	VI	p	n	h	p	a	o	-	-	-	?
Dipsacales														
Caprifoliaceae	cap1	*Abelia serrata*	Kotsukubaneutsugi	V	s	n	h	w	a	f	-	18	C2	*Apis*
	cap5	*Viburnum dilatatum*	Gamazumi	VI	s	n	h	w	a	o	-	17	C1	small bee
	cap3	*Viburnum erosum* var. *punctatum*	Kobanogamazumi	V	s	n	h	w	a	o	-	4	C7	small bee
	cap6	*Weigela decora*	Nishikiutsugi	VI	s	n	h	w→p	a	f	-	20	C4	*Bombus*

	cap2	*Weigela japonica*	Tsukushiyabuutsugi	V	s	n	h	w→p	a	f	-	13	C4	*Bombus*
Valerianaceae	val3	*Patrinia scabiosaefolia*	Ominaeshi	IX	p	n	h	y	a	o	-	1	-	?
	val2	*Patrinia villosa*	Otokoeshi	VIII-IX	p	n	h	w	a	o	-	2	-	?
	val1	*Valeriana fauriei*	Kanokosou	V-VI	p	n	h	p	a	o	-	5	C7	Syrphidae
Asterales														
Asteraceae		*Achillea alpina* var. *brevidens*	Asonokogirisou	VII	p	n	h	w	a	h	VU	-	-	?
	ast13	*Anaphalis margaritacea* var. *angustifolia*	Hosobanoyamahahako	VIII	p	n	h	w/y	a	h	-	3	-	?
	ast21	*Aster ageratoides* ssp. *Leiophyllus*	Shiroyomena	IX	p	n	h	w/y	a	h	-	7	C11	small bee
		Aster fastigiatus	Himeshion	VIII	p	n	h	w/y	a	h	-	-	-	?
	ast19	*Aster scaber*	Shirayamagiku	VIII-IX	p	n	h	w	a	h	-	3	-	?
		Atractylodes japonica	Okera	IX	p	n	h	w	a	h	-	-	-	?
	ast3	*Cirsium japonicum*	Noazami	VI-VIII	p	n	h	v	a	h	-	97	C1	*Bombus*
		Cirsium lineare	Yanagiazami	X	p	n	h	v	a	h	-	-	-	?
	ast16	*Cirsium suffultum*	Tsukushiazami	VIII-X	p	n	h	v	a	h	-	55	C4	*Bombus*
	ast9	*Eupatorium chinense*	Hiyodoribana	VIII	p	n	h	p	a	h	-	2	-	?
	ast15	*Echinops setifer*	Higotai	VIII-IV	p	n	h	v	a	h	EN	16	C4	*Bombus*
	ast5	*Erigeron annuus*	Himejoon	VI-VII	a	a	h	w/y	a	h	-	15	C1	small bee
	ast4	*Erigeron philadelphicus*	Harujoon	VI	p	a	h	w/y	a	h	-	1	-	?
		Eupatorium lindleyanum	Sawahiyodori	IX	p	n	h	p	a	h	-	-	-	?
		Gnaphalium affine	Hahakogusa	VIII	p	n	h	y	a	h	-	-	-	?
	ast22	*Heteropappus hispidus*	Yamajinogiku	IX	a	n	h	v	a	h	-	8	C10	small bee
		Inula ciliaris	Mizugiku	VIII	p	n	h	y	a	h	-	-	-	?
	ast14	*Inula japonica*	Oguruma	VIII	p	n	h	y	a	h	-	2	-	?
	ast20	*Inula salicina* var. *asiatica*	Kasensou	IX	p	n	h	y	a	h	-	1	-	?
	ast1	*Ixeris dentata*	Nigana	V	p	n	h	y	a	h	-	18	C7	small bee
	ast8	*Ligularia fischerii* var. *takeyuki*	Asotakarakou	VII-VIII	p	n	h	y	a	h	VU	9	C9	Syrphidae
	ast6	*Ligularia japonica*	Hankaisou	VII-VIII	p	n	h	y	a	h	-	17	C9	*Bombus*
		Prenanthes acerifolia	Fukuousou	VIII	p	n	h	w	a	h	-	-	-	?
	ast12	*Saussurea gracilis*	Hokuchiazami	VIII-IX	p	n	h	p	a	h	-	4	C10	small bee
		Saussurea pulchella	Himehigotai	X	a	n	h	p	a	h	VU	-	-	?
	ast17	*Saussurea yanagisawae* var. *nivea*	Kirishimahigotai	IX	p	n	h	p	a	h	-	13	C3	*Apis*
	ast2	*Senecio pierotii*	Okaoguruma	V	p	n	h	y	a	h	-	1	-	?
	ast18	*Solidago virga-aurea* ssp. *Asiatica*	Akinokirinsou	IX	p	n	h	y	a	h	-	10	C1	small bee
	ast25	*Synurus excelsus*	Habayamabokuchi	X	p	n	h	br	a	h	-	3	C12	*Bombus*
Arecidae														
Arales														

Araceae	ara1	*Arisaema japonicum*	Mamushigusa	IV-VI	p	n	d	g	a	sx	-	17	C2	other Diptera
Commelinidae														
Juncales														
Juncaceae	jun1	*Luzula capitata*	Suzumenoyari	V	p	n	h	br	a	s	-	1	-	?
Cyperales														
Poaceae		*Cymbopogon tortilis* var. *goeringii*	Ogarukaya	X	p	n	h	br	a	s	-	-	-	?
Liliidae														
Liliales														
Liliaceae	lil9	*Aletris luteoviridis*	Nogiran	VII	p	n	h	w	a	o	-	1	C11	small bee
	lil13	*Allium thunbergii*	Yamarakkyou	IX-X	p	n	h	rv	a	o	-	6	C7	*Bombus*
	lil5	*Asparagus schoberioides*	Kijikakushi	V	p	n	d	g	a	o	-	1	-	?
	lil6	*Chionographis japonica*	Shiraitosou	V-VI	p	n	h	w	a	b	-	7	C7	Syrphidae
	lil8	*Hemerocallis vespertina*	Yuusuge	VII-VIII	p	n	h	y	a	f	-	8	C4	hawkmoth
		Hosta albo-marginata	Kobagiboushi	VIII	p	n	h	v	a	f	-	-	-	?
	lil12	*Lilium leichtlinii* var. *maximowiczii*	Kooniyuri	VIII	p	n	h	o	a	f	-	1	C9	butterfly
	lil10	*Veratrum maackii* var. *maackii*	Hosobashurosou	VIII	p	n	m	br	a	o	-	5	C8	Calyptrata
Iridaceae	iri1	*Iris rossii*	Ehimeayame	IV-VI	p	n	h	v	z	t	-	9	C6	*Tetralonia*
Dioscoreaceae	dio1	*Dioscorea asclepiadea*	Tsukushitachidokoro	V	c	n	d	g	a	o	EN	1	-	?
Orchidales														
Orchidaceae	orc1	*Cephalanthera falcata*	Kinran	V	p	n	h	y	z	c	VU	7	-	?
		Epipactis thunbergii	Kakiran	VII	p	n	h	o	z	o	-	-	-	?
		Platanthera japonica	Tsuresagisou	VI	p	n	h	w	z	sp	-	-	-	?

[1] MB, month when a plant blooming

[2] GH, growing habitat: a, annual; c, climbing perennial; p, perennial; l, liana; s, shrub; t, tree

[3] N, nativity: a, alien; c, cultivated; n, native

[4] BS, breeding system: d, dioecious; h, hermaphrodite; m, monoecious

[5] FC, flower color: b, blue; br, brown; c, cream; g, green; o, orange; p, pink; rv, reddish violet; v, violet; w, white; y, yellow; w/y, white and yellow; w→p, white turn pink

[6] FS, flower / inflorescence symmetry: a, actinomorphic; z, zygomorphic

[7] FM, flower morphology: a, apetalous; b, brush; c, cup/bell-shaped; ct, catkins; f, funnelform; h, head; o, open regular; p, papilionaceous; s, spikelet; sp, long-spurred; sx, spadix; t, tubular

[8] RD, IUCN Red Data Book Category: EN, Endangered; VU, Vulnerable (Environment agency of Japan, 2000)

[9] NV, number of flower visitors

[10] CL, cluster detected by an analysis of flower visitor spectra (see Fig. 10)

[11] PA, pollination agents

2. *Flowering phenology*

Flowering was observed from April to October. The number of plant species in flower remained between 23 and 28 from May to September, with no clear peak flowering period (Fig. 3). The number of flowering perennial species reained higher than 12, except for October, and was higher in the fall than in the spring. Flowering shrubs and trees began in the spring, peaked in June, and decreased suddenly in July. Spectacular mass-flowering was observed in*Viola orientalis* in April (Plate 4C), in *Hemerocallis vespertina* (Plate 5B) and *Echinops septifer* in August (Plate 5D).

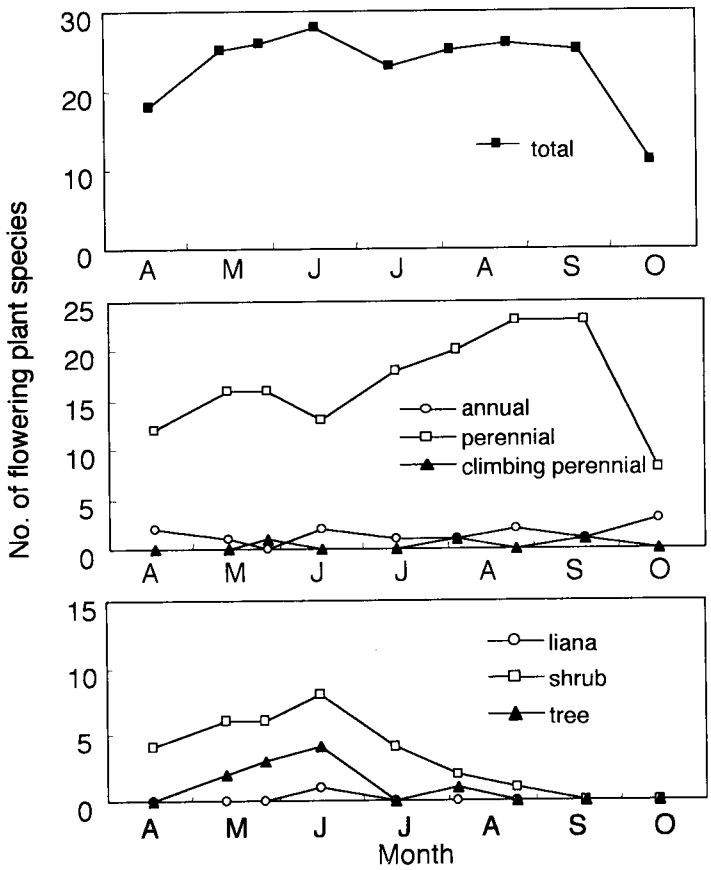

Fig. 3. Seasonal changes in the number of flowering plant species at each sampling date at Mt. Yufu. Plant species are sorted by their habits: annual, perennial, climbing perennial, liana, shrub and tree.

3. *The Flower-visiting insect community*

3.1 *Fauna*

A total of 1192 individuals from 308 species, 83 families, and 10 orders were observed on the flowers of 101 plant species (Table 3, Appendix 1). The most represented order (in numbers of individuals) was Hymenoptera (37.8% of individuals), followed by Diptera (32.5%), Coleoptera (22.7%), Lepidoptera (6.2%), and others (Fig. 4). The order represented by the greatest number of species was Diptera (40.3%), followed by Hymenoptera (31.8%), Coleoptera (16.2%), and Lepidoptera (8.4%).

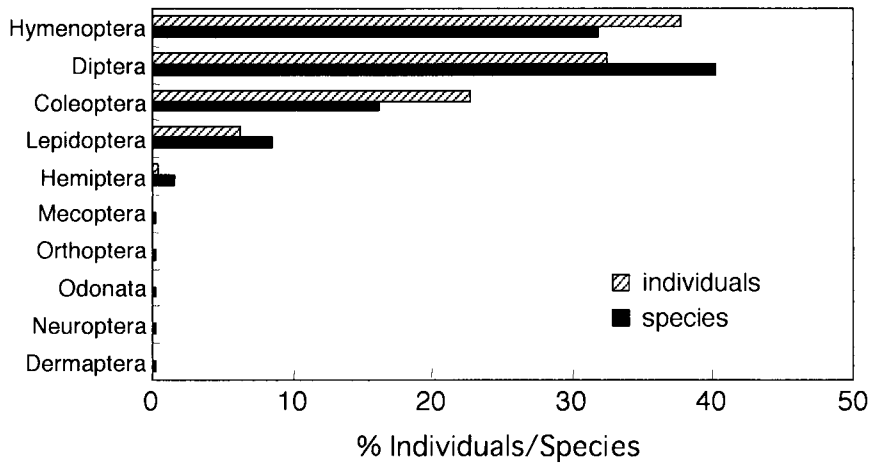

Fig. 4. The percentages of insect species and individuals in orders.

3.2 *Hymenoptera*

A total of 18 families, 98 species, and 450 individuals were recorded. The most abundant Hymenoptera superfamily was Apoidea sensu stricto (85.3%), followed by Vespoidea (7.1%), Ichneumonoidea (4.9%), Tenthredinoidea (1.3%), and Chalcidoidea (1.3%). In Apoidea, 7 families, 56 species, and 384 individuals were recorded.

The most abundant family in Apoidea was Apidae (40.8% of individuals), followed by Anthophoridae (22.1%), Andrenidae (18.9%), Halictidae (16.3%), Megachilidae (1.3%), and Colletidae (0.5%). The family with the greatest number of species was Halictidae (18 sp.), followed by Andrenidae (15 sp.), Anthophoridae (11 sp.), Apidae (5 sp.), Megachilidae (4 sp.), and Colletidae (1 sp.).

The most abundant genus of Apoidea was *Bombus* (30.7% of individuals), followed by *Andrena* (18.9%), *Lasioglossum* (16.3%), *Ceratina* (15.7%), *Apis* (10.1%), and *Tetralonia* (4.8%) (Table 4). Excluding cleptoparasitic species, 267 and 101 individual underground-nesting and cavity-nesting bees were found, belonging to 38 and 9 species, respectively.

Table 3. A list of insect families collected or observed on flowers at Mt. Yufu, with their larval/adult feeding habits, numbers and percentages of species and individuals.

Order	Insect family	Larval feeding habit*	Adult feeding habit*	Species		Individual	
				No.	%	No.	%
Odonata							
	Libellulidae	pr	pr	1	0.32	1	0.08
Orthoptera							
	Tettigoniidae	ph	ph	1	0.32	1	0.08
Dermaptera							
	Forficulidae	s	p	1	0.32	1	0.08
Hemiptera							
	Ricaniidae	ph	ph	1	0.32	1	0.08
	Deltocephalidae	ph	ph	2	0.65	2	0.17
	Tingidae	ph	ph	1	0.32	1	0.08
	Lygaeidae	ph	ph	1	0.32	1	0.08
Neuroptera							
	Chrysopidae	pr	pr	1	0.32	1	0.08
Coleoptera							
	Staphylinidae	ph,o	ph,o	1	0.32	43	3.61
	Scarabaeidae	ph	p,ph	8	2.60	38	3.19
	Buprestidae	x	p,ph	1	0.32	1	0.08
	Elateridae	x,ph	p	4	1.30	5	0.42
	Cantharidae	pr	pr	7	2.27	16	1.34
	Nitidulidae	ph	p	2	0.65	4	0.34
	Cryptophagidae	ph	p	1	0.32	1	0.08
	Byturidae	ph	p	2	0.65	3	0.25
	Coccinellidae	pr	p,pr	1	0.32	1	0.08
	Mordellidae	ph	p	2	0.65	8	0.67
	Oedemeridae	pr	p,pr	1	0.32	22	1.85
	Scraptiidae	ph	p	2	0.65	3	0.25
	Lagriidae	ph	p	1	0.32	1	0.08
	Alleculidae	ph	p	1	0.32	1	0.08
	Cerambycidae	x	p	3	0.97	4	0.34
	Chrysomelidae	ph	p,ph	8	2.60	61	5.12
	Attelabidae	x	ph	1	0.32	1	0.08
	Curculionidae	x,ph	p,ph	4	1.30	57	4.78
Hymenoptera							
	Tenthredinidae	ph	n,pr	6	1.95	6	0.50
	Braconidae	ps	n	10	3.25	11	0.92
	Ichneumonidae	ps	n	11	3.57	11	0.92
	Pteromalidae	ps	n	1	0.32	1	0.08
	Perilampidae	ps	n	1	0.32	1	0.08
	Eulophidae	ps	n	2	0.65	4	0.34
	Scoliidae	ps	n	3	0.97	16	1.34
	Formicidae	pr	n,pr	4	1.30	10	0.84
	Pompilidae	pr	pr	1	0.32	1	0.08
	Eumenidae	pr	n,pr	1	0.32	1	0.08
	Vespidae	pr	n,pr	2	0.65	4	0.34
	Sphecidae	pr	n,pr	2	0.65	9	0.76
	Colletidae	n,p	n,p	1	0.32	2	0.17

Halictidae	n,p	n,p	18	5.84	61	5.12
Andrenidae	n,p	n,p	15	4.87	71	5.96
Megachilidae	n,p	n,p	4	1.30	5	0.42
Anthophoridae	n,p	n,p	11	3.57	83	6.96
Apidae	n,p	n,p	5	1.62	153	12.84
Mecoptera						
Panorpidae	s	o	1	0.32	2	0.17
Diptera						
Tipulidae	s,aq	n	5	1.62	5	0.42
Culicidae	aq	n,b	1	0.32	1	0.08
Chironomidae	aq	n	1	0.32	1	0.08
Ceratopagonidae	aq	pr	4	1.30	6	0.50
Bibionidae	s	n	8	2.60	56	4.70
Cecidomyiidae	ph	m	1	0.32	1	0.08
Mycetophilidae	m	n	11	3.57	12	1.01
Sciaridae	s,m	n	7	2.27	7	0.59
Acroceridae	ps	n	1	0.32	18	1.51
Bombyliidae	ps	n	1	0.32	10	0.84
Asilidae	pr	n,pr	1	0.32	2	0.17
Empididae	pr	n,pr	11	3.57	15	1.26
Pipunculidae	ps	n	1	0.32	1	0.08
Syrphidae	s,pr	n,p	30	9.74	122	10.23
Conopidae	ps	n	1	0.32	1	0.08
Tephritidae	ph	n	2	0.65	3	0.25
Sepsidae	s	s,n	1	0.32	1	0.08
Lauxaniidae	s	n	2	0.65	3	0.25
Agromyzidae	ph	n	1	0.32	1	0.08
Chloropidae	ph	n	2	0.65	2	0.17
Drosophilidae	ph	n	2	0.65	2	0.17
Sphaeroceridae	s	n	1	0.32	1	0.08
Anthomyiidae	ph	n	8	2.60	46	3.86
Muscidae	s	n	1	0.32	1	0.08
Calliphoridae	s	n	6	1.95	38	3.19
Sarcophagidae	s	n	1	0.32	1	0.08
Tachinidae	ps	n	13	4.22	30	2.52
Lepidoptera						
Incurvariidae	ph	n	1	0.32	1	0.08
Tortricidae	ph	n	2	0.65	2	0.17
Zygaenidae	ph	n	1	0.32	1	0.08
Thyrididae	ph	n	1	0.32	1	0.08
Hesperiidae	ph	n	4	1.30	24	2.01
Papilionidae	ph	n	2	0.65	8	0.67
Pieridae	ph	n	1	0.32	4	0.34
Lycaenidae	ph	n	2	0.65	7	0.59
Nymphalidae	ph	n	7	2.27	21	1.76
Sphingidae	ph	n	4	1.30	4	0.34
Lymantriidae	o	-	1	0.32	1	0.08
Total			308	100.00	1192	100.00

* aq, aquatic scavebger/predator; b, blood-sucker; m, mycophagous; n, nectarivorous; o, omnivorous; p, pollenivorous; ph, phytophagous; pr, predatory; ps, parasitic; s, saprophagous; x, xylophagous

Table 4. A list of bee genera recorded at Mt. Yufu, with their size class, nest site and relative abundance.

Family	Subfamily	Genus	Body Size*	Nest Site	No. of species	No. of individuals
Colletidae	Colletinae	*Colletes*	s	underground	1	2
Halictidae	Halictinae	*Lasioglossum*	s	underground	18	61
Andrenidae	Andreninae	*Andrena*	s	underground	15	71
Megachilidae	Megachilinae	*Coelioxys*	m	cleptoparasitic	1	1
		Megachile	m	in cavities	3	4
Anthophoridae	Nomadinae	*Nomada*	s	cleptoparasitic	6	6
	Anthophorinae	*Tetralonia*	m	underground	1	18
	Xylocopinae	*Ceratina*	s	in cavities	4	59
Apidae	Bombinae	*Bombus*	l	underground	3	115
	Apinae	*Apis*	m	in tree hollows	2	38
Total					54	375

*: l, large; m, middle-sized; s, small.

Nine eusocial bee species were found: *Lasioglossum apristum, L. sibiriacum, L. baleicum* (Halictidae), *Ceratina iwatai* (Anthophoridae), 3 species of *Bombus*, and 2 species of *Apis* (Apidae). Long-tongued bees were proportionally more abundant (64.3%) than short-tongued bees (35.7%). The bee fauna was characterized by the absence of wood-boring *Xylocopa*..

Four species of *Ceratina* were found. *Ceratina japonica* and *C. megastigmata* were common (45.8% and 37.3% of individuals, respectively), while *C. flavipes* and *C. iwatai* were uncommon (15.3% and 1.7%, respectively).

The most abundant *Bombus* species was *B. ignitus* (48.7% of individuals), followed by *B. diversus* (29.6%) and *B. ardens* (21.7%). No queens were collected from these three species. All *B. diversus* individuals were workers, but males of *B. ardens* (72%) and *B. ignitus* (37%) were found. During the field surveys, a living colony of *B. ignitus* was found at the forest edge, neighboring a grassland.

3.3 *Diptera*

A total of 387 individuals, of 124 species, and 27 families were recorded (Table 3). The most abundant group was syrphid flies (31.5% of all individuals), followed by Calyptrata flies (30.0%). Dominant families were Syrphidae (31.5%), Bibionidae (14.5%), Anthomyiidae (11.9%), Calliphoridae (9.8%), Tachinidae (7.8%), Acroceridae (4.7%), Empididae (3.9%), Mycetophilidae (3.1%), and Bombyliidae (2.6%).

The most species rich families were Syrphidae (24.2% of species), Tachinidae (10.5%), Empididae (8.9%), Mycetophilidae (8.9%), Anthomyiidae (6.5%), Bibionidae (6.5%), Sciaridae (5.6%), Calliphoridae (4.8%), and Tipulidae (4.0%).

3.4 *Coleoptera*

A total of 270 individuals from 18 families were recorded (Table 3). The most abundant family was Chrysomelidae (22.6% of individuals), followed by Curculionidae (21.1%), Staphylinidae (15.9%), Scarabaeidae (14.1%), Oedemeridae (8.1%), Cantharidae (5.9%), and Mordellidae (3.0%).

3.5 *Lepidoptera*

A total of 74 individuals from 11 families were recorded (Table 3). The most abundant family was Hesperiidae (32.4% of individuals), followed by Nymphalidae (28.4%), Papilionidae (10.8%), and Lycaenidae (9.5%). Butterflies accounted for 86.5% of all individuals. Sphingidae was the most abundant type of moth.

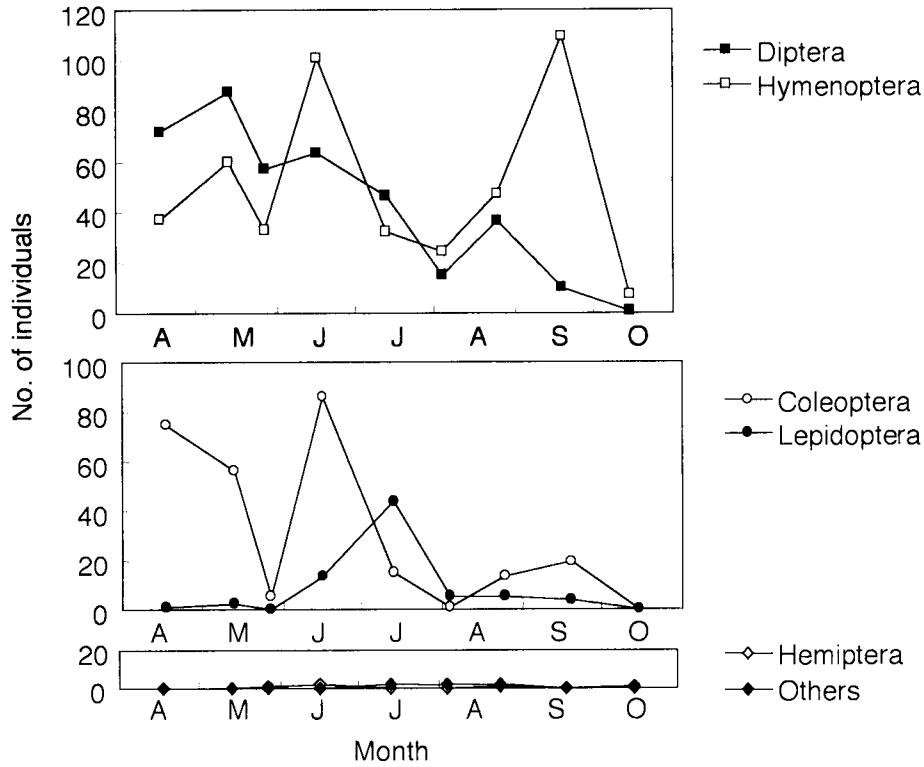

Fig. 5. Seasonal changes in the number of insects observed on flowers at each sampling data. Insects are sorted by order.

4. *Phenology of flower visitors*

4.1 *Order*

The number of Hymenoptera individuals peaked three times, in early May, mid June, and mid September. Numbers of Diptera peaked in May, and then decreased gradually, peaking again, weakly, in September (Fig. 5). The number of Coleoptera individuals peaked in the spring and in June, but the number was low in other months. Lepidoptera numbers showed a clear peak in July.

4.2 *Anthophilous bee genera*

The three bee genera, *Andrena, Nomada,* and *Tetralonia*, appeared almost exclusively from April to June. Other dominant bee genera, *Lasioglossum, Ceratina, Bombus,* and *Apis*, showed bimodal patterns, peaking in June/July and in September (Fig. 6). The three less abundant genera, *Megachile*, *Coelioxys*, and *Colletes*, peaked in June, July, and August, respectively.

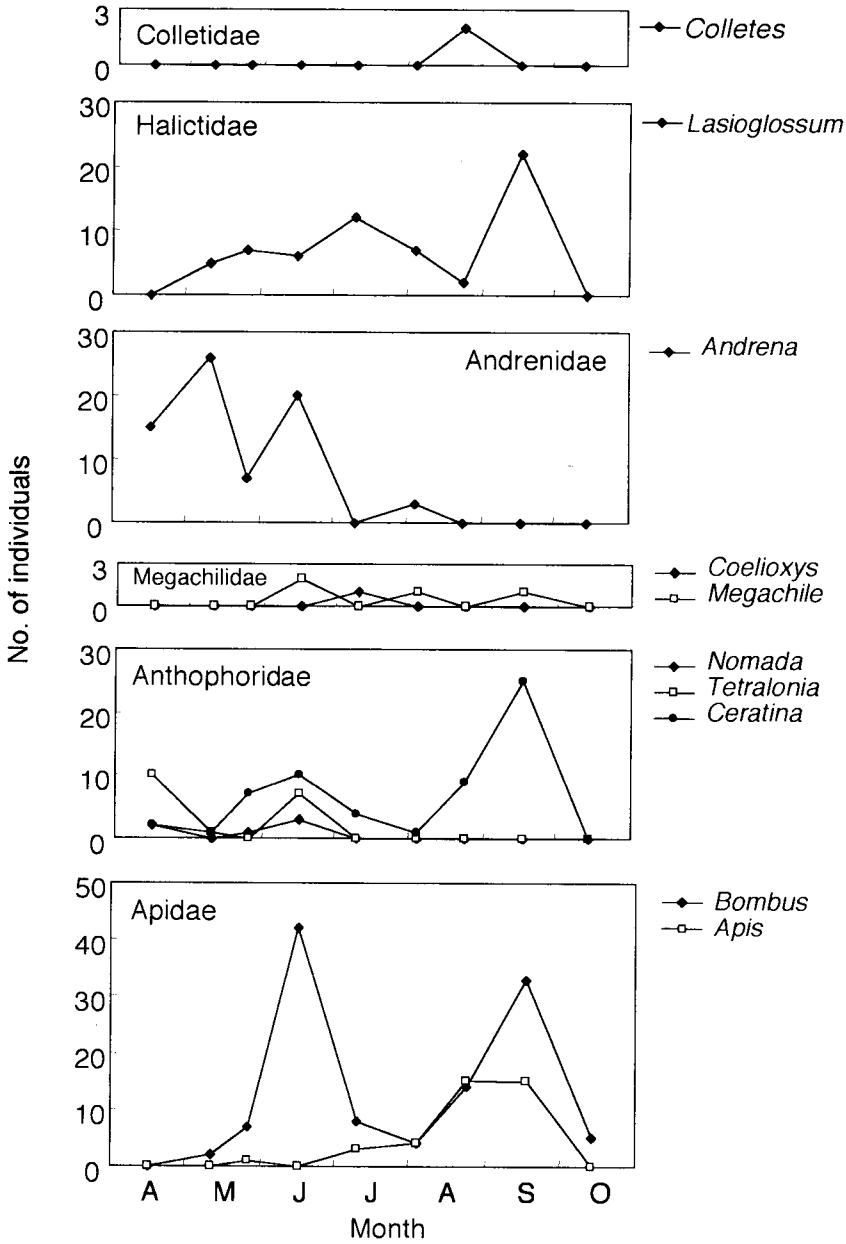

Fig. 6. Seasonal changes in the number of bee genera observed on flowers at each sampling data.

4.3 Bombus *species*

Bombus ardens appeared in May and disappeared before the summer (Fig. 7). *B. diversus* appeared in May and was active until October, peaking in June and September. *B. ignitus* appeared in June and was active until October, with worker peaks in June and August/September, and a male peak in September.

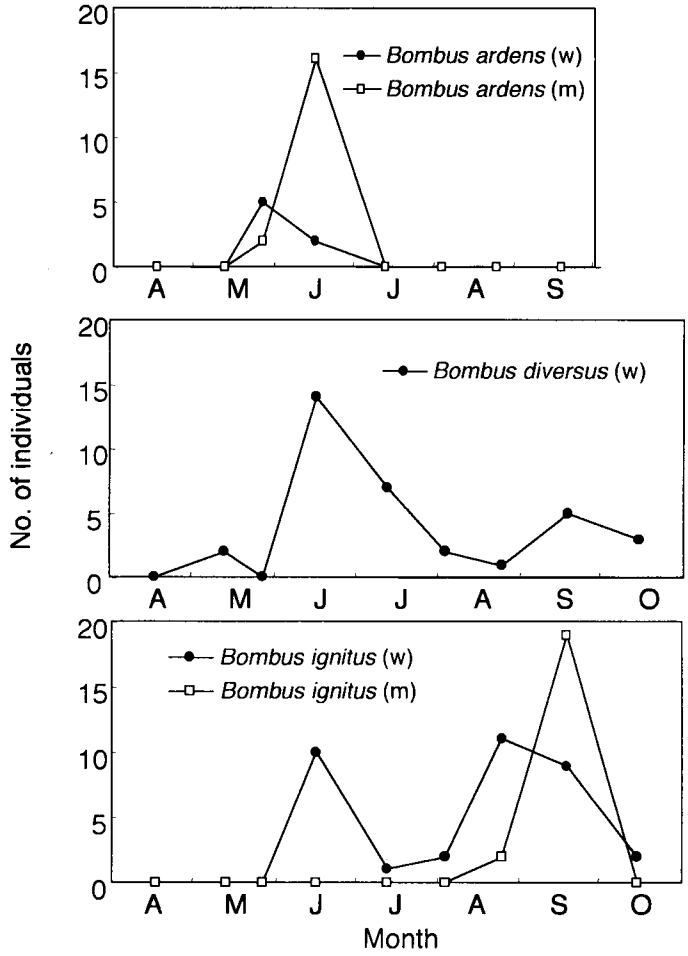

Fig. 7. Seasonal changes in the number of *Bombus* individuals observed on flowers at each sampling date. Solid and open circles denote worker and male, respectively

5. *Anthophilous insect communities on individual plant species*

5.1 *Principal component analysis*

The anthophilous insect community per plant species varied greatly. To explain this variance, a principal component analysis was conducted. Insects were classified into 15 groups: *Bombus*, *Apis*, small bees, Megachilidae, *Tetralonia*, wasps, Scoliidae, other

Hymenoptera, syrphid flies, Calyptrata flies, other Diptera, butterflies, moths, Coleoptera, and other miscellaneous insects. The percentages of these 15 groups found on each plant species were defined as the flower-visitor spectrum of each plant species.

The flower visitor spectra of 70 plant species were used in the principal component analysis. Eigenvectors of 1st, 2nd, and 3rd principal components for each insect group are shown in Fig. 8. The major trend involved alternation of dominant insect groups between [other Hymenoptera + Calyptrata fly + other Diptera] and [Megachilidae + *Bombus* + syrphid fly]. The variance of the first principal component, PC1, contributed to 11.2% of the total variance. The second factor corresponded to the dominance of [*Bombus* + butterfly + moth + others] over the small bee group (PC2, 10.5%). The third factor was primarily related to alternation between [syrphid fly + Calyptrata fly] and [*Bombus* + *Tetralonia* + Coleoptera] (PC3, 8.7%). The cumulative percentages of variance of the first three principal components were 30.4%, suggesting that additional factors also contributed to the total variance.

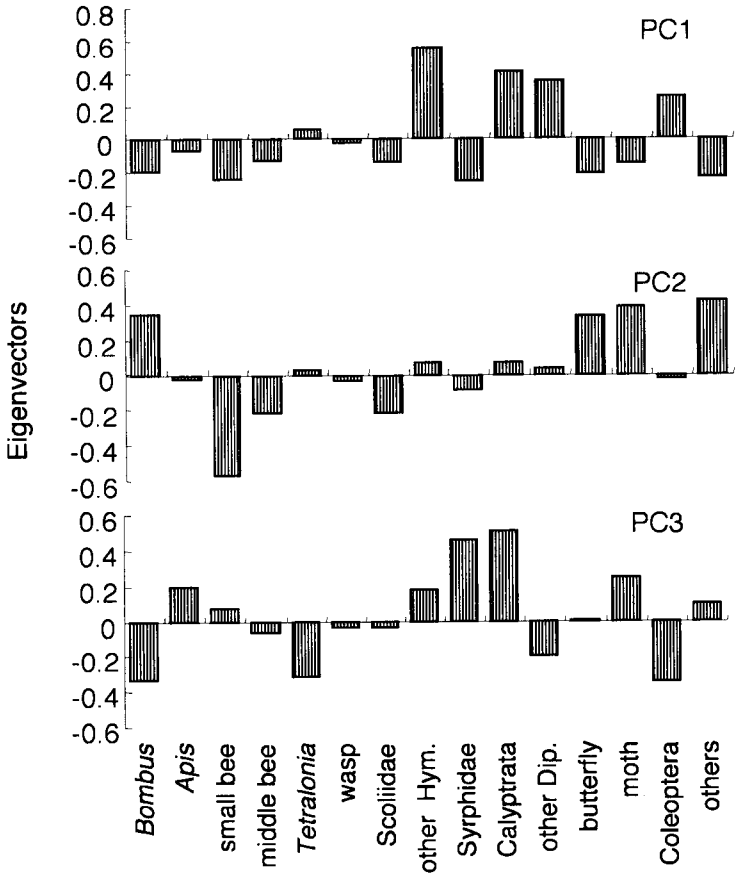

Fig. 8. A result of principal component analysis of flower-visitor spectra of 70 plant species. Eigenvectors of the first three principal components calculated for each visitor group are shown.

Scatter plots of loadings on PC1 and PC2 (Fig. 9) show that most apetalous flowers had positive loadings on PC1, whereas many head, and all papilionaceous, flowers had negative loadings on PC1. Loadings of funnel-form flowers were positive or close to zero on PC2. Loadings of tubular flowers were negative on PC3.

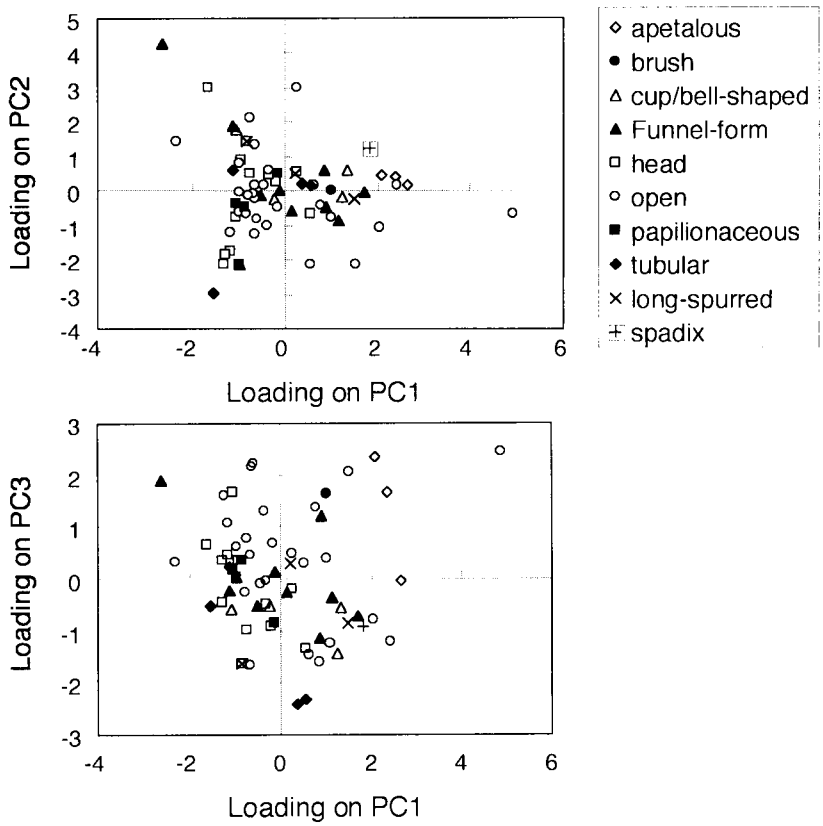

Fig. 9. Scattering graphs obtained by principal component analysis of flower-visitor spectra of 70 plant species. The loadings of the second and the third principal components (PC2 and PC3) are plotted against those of the first principal components (PC1). Plots refer to plant species discriminated by flower shape. Eigenvectors of the axes are shown in Fig. 8.

5.1 *Cluster analysis*

The flower-visitor spectra were also subjected to cluster analysis. The dendrogram derived from the cluster analysis using Ward's minimum variance method is shown in Fig. 10. At 20% of objective function, 70 plant species were divided into 12 clusters.

Cluster 1 (C1) was composed of 10 plant species, which were visited mainly by Coleoptera and, with two exceptions (*Lindera sericea* and *Prunus jamasakura*), also by small bees. Most plant species in C1 were visited by various groups of insects, and flower shapes were primarily open or head, with the exceptions of *Viola orientalis* and *Pieris japonica*.

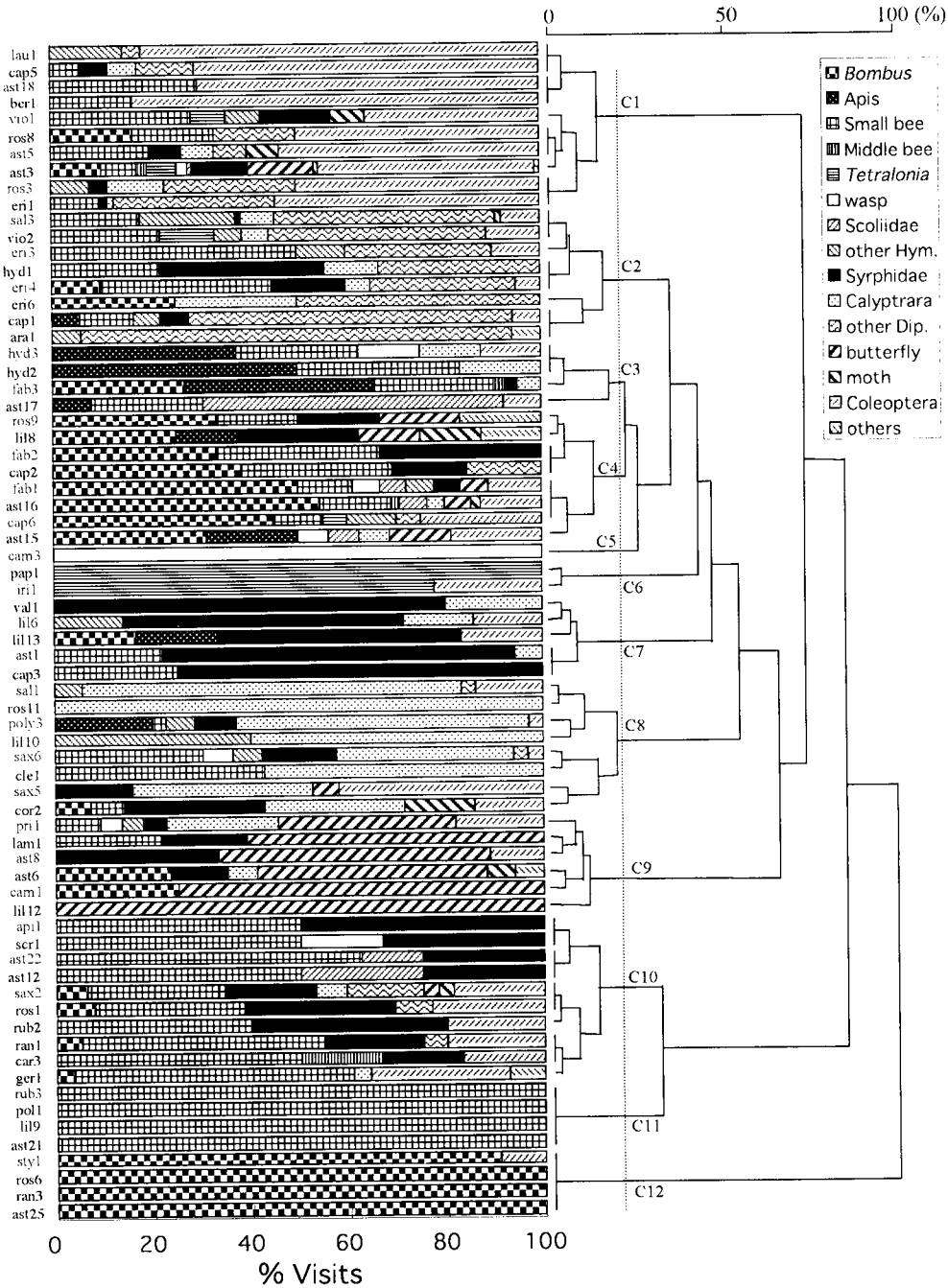

Fig. 10. Flower-visitor spectra (sorted by visitor group) of 70 plant species and dendrogram (right) derived from cluster analysis on the flower-visitor spectra. Plant species codes are shown in Table 2.

C2 was composed of 8 plant species, which were visited by miscellaneous insects, including the other Diptera group. Except for *Arisaema japonicum*, which was visited mainly by other Diptera, the other plant species in C2 were also visited by a few groups of bee species and various other groups of insects. There were three species with funnel-form flowers, two of which, *Rhododendron kiusuanum* and *Rhododendron reticulatum*, were predominantly visited by bee groups. *Viola grypoceras* was visited by long-tongued solitary bees (*Tetralonia*) and had a long-spurred flower.

C3 was composed of 4 plant species, visited mainly by *Apis* and the small bee group. Only *Lespedeza bicolor*, with a papilionaceous flower shape, was visited by *Bombus*. The other plant species had open or head-shaped flowers.

C4 was composed of 8 plant species, characterized by a predominance of *Bombus*, *Apis* and small bee visitors. Five plant species were also visited by butterflies. *Weigela decora*, with a funnel-form flower shape, was visited by long-tongued solitary bees (*Tetralonia*).

C5 contained only *Codonopsis lanceolata*, visited only by vespid wasps.

C6 was composed of 2 species, *Corydalis lineariloba* and *Iris rossii*, characterized by the predominance of long-tongued solitary bee visitors (*Tetralonia*). These two plant species bloomed in early spring and had tubular flowers.

C7 was composed of 5 plant species and was characterized by the predominance of Syrphidae. Except for *Valeriana fauriei* and *Chionographis japonica*, the plant species were visited by all groups of bees.

C8 was composed of 8 plant species and was characterized by the predominance of Calyptrata flies. Four plant species had white flowers, 2 species had brown flowers, 1 species had green flowers, and 1 species had pink flowers. Half of the species were visited by bee group(s). *Salix vulpina* and *Chionographis japonica* had apetalous flowers and were visited mainly by Calyptrata.

C9 was composed of 6 species and was characterized by the predominance of butterflies. Some of the 6 plant species were also visited by bee groups.

C10 was composed of 10 plant species, which were mainly visited by small bees. Most were also visited by syrphid flies. Many had open or head-shaped flowers. The tubular flowers of *Dianthus superbus* var. *longicalycinus*, and the funnel-form flowers of *Deutzia crenata*, were also visited by long-tongued bees (Megachilidae and *Bombus*, respectively).

C11 was composed of 4 plant species, predominantly visited by small bees. Flower types were various, such as papilionaceous, cup/bell-shaped, head, and open. Flower colors were white (3 sp.) or violet (1 sp.).

C12 was composed of 4 plant species, which were almost exclusively visited by *Bombus*. The cluster included three flower types: pendent rotate flowers with abundant pollen and nectar (*Styrax japonica* and *Rubus phoenicolasius*), deep flowers with long spurs (*Aconitum japonicum* ssp. *napiform*), or deep flowers with floral tubes (*Synurus excelsus*).

5.2 Pollination guilds

The dominant flower visitor per plant species was not always the pollinator. Actual pollinators were inferred by examination of the flower-visitor communities, behavior of the flower visitors, pollen attachment on visitor's bodies, and floral morphology. Among the flower visitors, the following hierarchy in the contribution to pollination was hypothesized:

(*Tetralonia*, *Bombus*) > middle-sized bee > *Apis* > hawkmoth > small bee > butterfly > Syrphidae > Calyptrata fly > Coleoptera > other Hymenoptera > other groups

Thus, the insects of higher pollination status could be regarded as more effective pollinators than those of lower status, as long as the frequency of flower visitation by the pollination candidate was not too low. For several clusters (i.e., C4, C5, C6, C11, and C12), the dominant visitors were regarded as pollinators. For each plant species in other clusters, an effective pollinator group was determined from the visitor assemblage following the above hierarchy. Using this procedure, 71 plant species were classified into the following pollination guilds: *Bombus*-, *Apis*-, small bee (*Nomada, Ceratina, Colletes, Lasioglossum, Andrena)*-, megachilid-, *Tetralonia*-, wasp-, syrphid fly-, Calyptrata fly-, other Diptera-, butterfly-, hawkmoth-, and wind-pollinated guilds.

The dominant pollination syndrome was melittophily (i.e., bee-pollination, 57 species, 81%), followed by myophily (i.e., fly-pollination, 10 species, 14%), psychophily (i.e., butterfly-pollinated, 1 species, 1.4%), phalaenophily (i.e., moth-pollinated, 1 species, 1.4%), and anemophily (1 species, 1.4%). Of the melittophilous species, small-bee-pollinated species (45%) dominated, followed by *Bombus*- (36%), *Apis*- (8.6%), *Tetralonia*- (6.9%), Megachilid- (1.7%), and wasp- (1.7%) pollinated species.

6. *Floral hosts of anthophilous insects*

The plant species most frequently utilized by insects was *Cirsium japonicum* (8.1% of all visits), followed by *Salix sieboldiana* (7.4%), *Pieris japonica* (5,9%), *Cirsium suffultum* (4.6%), and *Lespedeza bicolor* (3.4%).

The plant family most frequently visited by bees was Asteraceae (29.6% of individuals), followed by Fabaceae (13.6%), Caprifoliaceae (6.9%), Ericaceae (5.9%), and Saxifragaceae (5.6%).

The host plant species varied greatly among insect families, genera, and species. The plant family most frequently visited by *Lasioglossum* bees was Asteraceae (36.1% of individuals), followed by Ranunculaceae (13.1%). The plant family most frequently visited by *Andrena* was Saxifragaceae (25.4%), followed by Ericaceae (19.7%), and Violaceae (8.5%). *Ceratina* preferred to visit Asteraceae (32.2%), Geraniaceae (22.0%), and Fabaceae (16.9%).

The plant family most frequented by *Bombus* was Asteraceae (45.2%), followed by Fabaceae (18.3%), Caprifoliaceae (12.2%), and Styracaceae (8.7%). *B. diversus* (a total of 34 individuals) visited 13 plant species, whereas *B. ardens* (25 individuals) and *B. ignitus* (56 individuals) visited 9 and 10 plant species, respectively. The number of individuals per floral host species was highest for *B. ignitus* (5.6%), followed by *B. ardens* (2.8%), and *B.*

diversus (2.6%). A floral host family common to three *Bombus* species was Rosaceae, whereas floral host families common only to *B. diversus* and *B. ignitus* were Fabaceae, Asteraceae, and Liliaceae. Flower colors of *Bombus*-visited plant species were violet (7 species), white (7 species), pink (5 species), yellow (4 species), red-violet (2 species), brown (1 species), and cream (1 species).

The plant family most frequently visited by *Apis* was Fabaceae (42.1%), followed by Polygonaceae (18.4%) and Hydrangeaceae (15.8%). *Apis cerana* (A total of 7 individuals) visited only 2 plant species, both of which were also visited by *Apis mellifera* (A total of 31 individuals).

Discussion

This is the first report on community-level plant-pollinator interactions in a grassland ecosystem in Japan. Characteristics of floral phenology, anthophilous insect community, and plant-pollinator interactions at Mt. Yufu were compared with those from various other climatic regions with different vegetation types.

1. *Flowering phenology*

At Mt. Yufu, the total number of flowering species did not show a clear decrease from May to September. This contrast with the forested habitats in temperate zones in Japan where the number of blooming plant species decrease during mid-summer (Inoue et al., 1990; Kato et al., 1990; Kato et al., 1993). Generally, the mid-summer decrease of flowers is mainly caused by early finishing of flowering by tree and shrub species. The lack of the mid-summer decrease of flowers at Mt. Yufu is probably due to the low species richness of trees and shrubs and to the high species richness of mid-summer flowering perennials at grassland habitats.

2. *Anthophilous insect community*

The dominance of Hymenoptera, in terms of the number of individuals, and the dominance of Diptera, in terms of the number of species, in anthophilous insect communities were also seen in forested habitats at Ashu (Kato et al., 1990), Kibune (Inoue et al., 1990), and Mt. Kushigata (Kato et al., 1993). However, in the grasslands, the proportions of Coleoptera were lower, and those of Lepidoptera were higher, than in these forested habitats. This pattern suggests that many anthophilous beetles depend on forests in their larval stages, and that anthophilous butterflies (especially Nymphalidae) are associated with grassland-specific perennials (especially *Viola* spp.) in their larval stages.

The bee fauna at Mt. Yufu was characterized by the absence of cavity-nesting *Hylaeus* and *Xylocopa*, probably due to a scarcity of nest sites and the effects of artificial fires. The bee community at Mt. Yufu was generally similar to that of temperate forests at Ashu, Kibune, Hanayama, and Rifu (Fig. 11). The predominance of *Tetralonia* in the spring was characteristic at Mt. Yufu, and corresponded to the abundance of plant species pollinated by

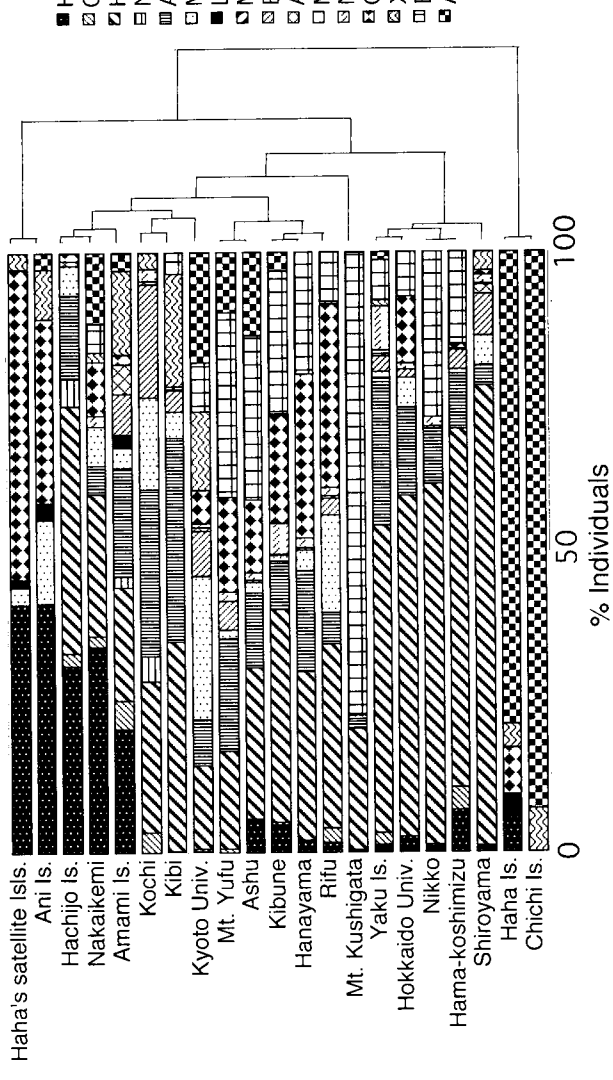

Fig. 11. A comparison of relative abundance of bee tribes among 21 localities in Japan. Data source are as follows: Hama-koshimizu (Fukuda et al., 1973), Botanical garden of Hokkaido University in Sapporo (Sakagami and Fukuda, 1973), Rifu and Hanayama in Miyagi Pref. (Go'ukon, 1992), Nikko in Gunma Pref. (Nakamura and Matsumura, 1985), Mt. Kushigata in Yamanashi Pref. (Kato et al., 1993), Ashu (Kato et al., 1990), Kibune (Inoue et al.,1990), Botanical garden of Kyoto University (Kakutani et al., 1990), in Kyoto Pref., Nakaikemi in Fukui Pref. (Kato and Miura, 1996), Kibi in Wakayama Pref. (Matsuura et al., 1972), Kochi (Ikudome, 1978), Shiroyama in Kagoshima Pref. (Ikudome, 1992), Yaku Is. (Yumoto, 1994), Amami Islands. (Kato, 2000), Hachijo Is. (Takahashi, 1990), Ani Is., Haha's satellite islands, Chichi Is. and Haha Is. (Kato, 1992). *Apis* was excluded from the analyses at Hamakoshimizu, Hokkaido Univ., Rifu, Hanayama, Nikko, Hachijo, Kibi, Kochi and Shiroyama.

Tetralonia bees.

The *Bombus* fauna at Mt. Yufu was characterized by the predominance of *B. ignitus*, rare in forested habitats, and by the absence of *B. hypocrita* and *B. honshuensis*, abundant in forested habitats (Fig. 12). *B. ignitus* has short, velvet-like hairs, and is probably adapted to flight in sunny habitats, such as grasslands. Since the proboscis length of *B. ignitus* is similar to that of *B. hypocrita*, but much shorter than *B. diversus* (Inoue and Kato, 1992), competition between the former two short-tongued bumblebee species would have resulted in the absence of *H. hypocrita* at Mt. Yufu.

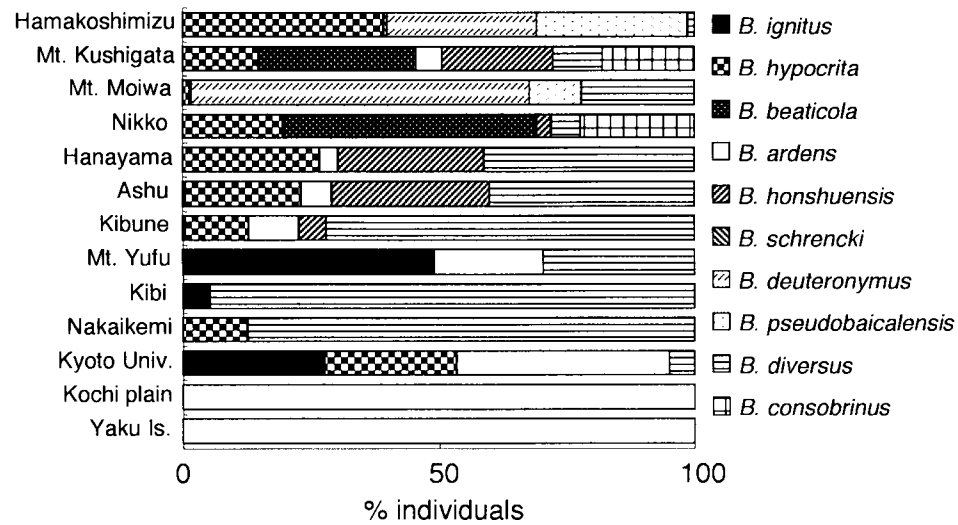

Fig. 12. A comparison of relative abundance of *Bombus* species among 13 localities in Japan. Localities are arranged according to a climatic cline. Data source are as follows: Hama-koshimizu (Fukuda et al., 1973), Mt. Moiwa (Sakagami et al., 1974), Hanayama (Go'ukon, 1992), Nikko (Nakamura and Matsumura, 1985), Mt. Kushigata (Kato et al., 1993), Ashu (Kato et al., 1990), Kibune (Inoue et al.,1990), Botanical garden of Kyoto University (Kakutani et al., 1990)., Nakaikemi (Kato and Miura, 1996), Kibi (Matsuura et al., 1972), Kochi (Ikudome, 1978) and Yaku Is. (Yumoto, 1994).

3. *Plant-pollinator interaction*

A cluster analysis on flower-visitor spectra of 70 plant species detected 12 clusters (Fig. 10). Two plant species, *Corydalis lineariloba* and *Iris rossii* (Plate 4D), were almost exclusively visited by long-tongued *Tetralonia* bees. These plants had long-spurred or deep tubular flowers and bloomed in early spring, before bumblebees became abundant. The flower of *Iris rossii* is much smaller than those of other Japanese *Iris* species, which are pollinated by long-tongued bumblebees (i.e., *B. diversus, B. consobrinus, B. ussurensis*, and *B. yezoensis*). Mt. Yufu has an abundance of nest sites for *Tetralonia* bees, as they nest in sand in sunny habitats, such as riverbanks, seashores, and grasslands.

Scoliid wasps were frequent visitors to flowers of some asteraceous, such as *Saussurea gracilis, Heteropappus hispidus and Echinops septifer* (Plate 5G). As their body is covered with long hairs, scoliid wasps are potential pollinators of these flowers. The larvae of scoliid wasps are parasitoids of scarabaeid larvae, which infest roots of perennials; thus, scoliid wasps are abundant at seashores and grasslands, where scarabaeid larvae are abundant.

The pollination system of *Codonopsis lanceolata* was unique; only vespid wasps visited flowers of this species.

Flowers of 6 plant species were predominantly visited by butterfly. The percentage of butterfly-visited plant species (8.6%) was higher at Mt. Yufu than in any forested habitat. The dominant anthophilous butterflies were species of *Fabriciana* (Plate 5C) and *Argyronome* (Nymphalidae), whose larval host plants are grassland-specific *Viola* spp.

4. *Conservation*

Large areas of the Mt. Yufu grasslands are maintained by controlled burning in March. In these semi-natural grasslands, early flowering species, such as *Viola orientalis* (Plate 4E–F) and *Iris rossii* (Plate 4D) can get a lot of sunlight because the fire burns back the tall grasses and bamboo. Burning is advantageous to grassland-specific perennials because it excludes the competitively superior bamboo, shrubs and trees, and it offers sunny nest sites for some grassland-specific pollinators such as *Tetralonia.*

In the grasslands, there are mowed areas of exceptionally rich flora. Prior to burning, in September, the local people mow grasses along the forest edge, to prevent the fire from burning the neighboring forests. The growth of grasses in the mowed area is more restrained than in the areas where only controlled burning occurs. The mowed, unburned, areas are refuges for fire-intolerant plants and herbivores. The unburned grass shoots could be refuges for cavity-nesting bees. Thus, the balance between burning and mowing, and the mosaic of burned and unburned areas, could be important factors affecting the diversity of grassland plants and pollinators.

The grassland ecosystem at Mt. Yufu is a sanctuary for grassland-specific plants and insects. In the current surveys, an endangered butterfly, *Fabriciana nerippe*, was observed on the flower of *Lysimachia clethroides.* The life of this butterfly is tightly connected to grasslands, because its larval host plants are grassland-specific *Viola* spp., and the adult butterfly sucks nectar from *Cirsium* flowers, and probably pollinates them. The community-level plant-pollinator interactions recorded at Mt. Yufu will contribute to the conservation of natural grassland ecosystems.

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Appendix 1.

A List of Insect Species Recorded on Flowers of 101 Plant Species at Mt. Yufu in 2001.

Insect-visit records for each plant species are listed as follows: insect species, (family code: order code), date, and (number of individuals collected or observed). Plant taxa and insect taxa are arranged following the natural systems of Cronquist (1981) and Hirashima (1989), respectively. Insect order and family codes are abreviated as two and three head characters of each order and family name, respectively.

Lauraceae

Lindera sericea

Eusphalerum parallelym (Sta: Co) 16-18 Apr. (11); *Anaspis* sp.1 (Scr: Co) 16-18 Apr. (2); *Manobidia nipponica* (Chr: Co) 16-18 Apr. (9); sp.1 (Eul: Hy) 16-18 Apr. (1); sp.2 (Eul: Hy) 16-18 Apr. (3); *Drosophila* sp.2 (Dro: Di) 16-18 Apr. (1)

Ranunculaceae

Aconitum japonicum ssp. *napiform*

Bombus diversus diversus (Api: Hy) 17-22 Sep. (1)

Cimicifuga acerina

Lasioglossum sp.3 (Hal: Hy) 17-22 Sep. (2); *Apis mellifera* (Api: Hy) 17-22 Sep. (1)

Ranunculus japonicus

Oedemeronia lucidicollis (Oed: Co) 11-16 May (3); *Zypangia lewisi* (Chr: Co) 11-16 May (1); *Lasioglossum occidens* (Hal: Hy) 26-29 May (1); *Lasioglossum* (carinaless *Evylaeus)* sp.2 (Hal: Hy) 11-16 May (3), 26-29 May (1); *Lasioglossum* (carinaless *Evylaeus)* sp.4 (Hal: Hy) 11-16 May (1); *Andrena komachi* (And: Hy) 11-16 May (1); *Andrena kaguya* (And: Hy) 11-16 May (1); *Ceratina japonica* (Ant: Hy) 11-16 May (1); *Ceratina flavipes* (Ant: Hy) 26-29 May (1); *Bombus diversus diversus* (Api: Hy) 11-16 May (1); *Euthyneura* sp.1 (Emp: Di) 11-16 May (1); *Eristalis tenax* (Syr: Di) 26-29 May (1); *Melanastoma scalare* (Syr: Di) 11-16 May (1); *Cheilosia* sp.1 (Syr: Di) 11-16 May (1); *Platycheirus urakawensis* (Syr: Di) 11-16 May (1)

Berberidaceae

Epimedium diphyllum

Oedemeronia lucidicollis (Oed: Co) 11-16 May (2), 26-29 May (1); *Zypangia lewisi* (Chr: Co) 11-16 May (2); *Lasioglossum* (carinaless *Evylaeus)* sp.4 (Hal: Hy) 26-29 May (1)

Papaveraceae

Corydalis lineariloba

Tetralonia nipponensis (Ant: Hy) 16-18 Apr. (1)

Fagaceae

Castanea crenata

sp.1 (Del: He) 16-17 Jun. (1); *Cteniopinus hypocrita* (All: Co) 16-17 Jun. (1); *Hesperomorpha hirsuta* (Chr: Co) 16-17 Jun. (1); *Eristalis cerealis* (Syr: Di) 16-17 Jun. (1); *Siphona* sp.1 (Tac: Di) 16-17 Jun. (1)

Quercus dentata

Oxycetonia jucunda (Sca: Co) 11-16 May (1); *Eucetonia pilifera* (Sca: Co) 11-16 May (3); *Hoplia moerens* (Sca: Co) 11-16 May (14); *Camponotus japonicus* (For: Hy) 11-16 May (1); *Crossocerus* sp.1 (Sph: Hy) 11-16 May (4); *Syrphus torvus* (Syr: Di) 11-16 May (2); sp.2 (Cal: Di) 11-16 May (1); *Neope niphonica niphonica* (Nym: Le) 11-16 May (1)

Caryophyllaceae

Dianthus superbus var. *longicalyc*

Mordellistena sp.1 (Mor: Co) 10-16 Jul. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.5 (Hal: Hy) 10-16 Jul. (2); *Lasioglossum* (carinaless *Evylaeus)* sp.8 (Hal: Hy) 10-16 Jul. (1); *Coelioxys* sp.1 (Meg: Hy) 10-16 Jul. (1); *Sphaerophoria macrogaster* (Syr: Di) 10-16 Jul. (1)

Moehringia lateriflora

Melanastoma scalare (Syr: Di) 26-29 May (2)

Pseudostellaria heterantha

Oedemeronia lucidicollis (Oed: Co) 11-16 May (2); *Sphaerophoria philanthus* (Syr: Di) 11-16 May (1)

Polygonaceae

Polygonum cuspidatum

Oxycetonia jucunda (Sca: Co) 24-26 Aug. (1); *Camponotus japonicus* (For: Hy) 24-26 Aug. (2); *Lasioglossum sibiriacum* (Hal: Hy) 24-26 Aug. (1); *Apis cerana* (Api: Hy) 24-26 Aug. (4); *Apis mellifera* (Api: Hy) 24-26 Aug. (3); sp.1 (Cul: Di) 24-26 Aug. (1); sp.1 (Cec: Di) 24-26 Aug. (1); *Eristalis tenax* (Syr: Di) 24-26 Aug. (1); *Eristalis cerealis* (Syr: Di) 24-26 Aug. (1); *Sphaerophoria philanthus* (Syr: Di) 24-26 Aug. (1); *Drosophila* sp.1 (Dro: Di) 24-26 Aug. (1); *Stomorhina obsoleta* (Cal: Di) 24-26 Aug. (18); sp.2 (Cal: Di) 24-26 Aug. (3)

Clusiaceae

Hypericum pseudopetiolatum

Oxycetonia jucunda (Sca: Co) 17-22 Sep. (1); sp.1 (Cal: Di) 17-22 Sep. (1)

Violaceae

Viola grypoceras

Eusphalerum parallelym (Sta: Co) 16-18 Apr. (2); sp.2 (Ten: Hy) 16-18 Apr. (1); *Andrena watasei* (And: Hy) 16-18 Apr. (2); *Ceratina japonica* (Ant: Hy) 16-18 Apr. (1); *Nomada mutsuensis* (Ant: Hy) 16-18 Apr. (1); *Tetralonia nipponensis* (Ant: Hy) 16-18 Apr. (2); sp.1 (Chi: Di) 16-18 Apr. (1); *Bibio* sp.1 (Bib: Di) 16-18 Apr. (1); *Bibio gracilipalpus* (Bib: Di) 16-18 Apr. (1); *Bombylus major* (Bom: Di) 16-18 Apr. (4); sp.3 (Emp: Di) 16-18 Apr. (1); *Tachina* sp.1 (Tac: Di) 16-18 Apr. (1)

Viola hondoensis

Bombylus major (Bom: Di) 16-18 Apr. (1)

Viola orientalis

Oedemeronia lucidicollis (Oed: Co) 16-18 Apr. (4); *Chrysomela vigintipunctata* (Chr: Co) 16-18 Apr. (1); sp.3 (Ten: Hy) 16-18 Apr. (1); *Andrena watasei* (And: Hy) 16-18 Apr. (2); *Andrena kaguya* (And: Hy) 16-18 Apr. (1); *Andrena minutula* (And: Hy) 16-18 Apr. (1); *Tetralonia nipponensis* (Ant: Hy) 16-18 Apr. (1); *Cheilosia* sp.4 (Syr: Di) 11-16 May (1); *Platycheirus urakawensis* (Syr: Di) 16-18 Apr. (1); *Scirpophaga* sp.1 (Thy: Le) 16-18 Apr. (1)

Salicaceae

Salix sieboldiana

Athousius sp.1 (Ela: Co) 11-16 May (1); *Themus midas* (Can: Co) 11-16 May (1); *Mikadocantharis japonica* (Can: Co) 11-16 May (1); *Anthemus magnius* (Can: Co) 11-16 May (1); *Podabrus malthinoides* (Can: Co) 11-16 May (1); *Oedemeronia lucidicollis* (Oed: Co) 11-16 May (1); *Dinoptera minuta* (Cer: Co) 11-16 May (1); *Tenthredo fukaii* (Ten: Hy) 11-16 May (1); *Rhogogaster varipes* (Ten: Hy) 11-16 May (1); sp.1 (Ten: Hy) 11-16 May (1); sp.1 (Bra: Hy) 11-16 May (1); sp.2 (Bra: Hy) 11-16 May (1);

sp.4 (Bra: Hy) 11-16 May (1); sp.5 (Bra: Hy) 11-16 May (1); sp.6 (Bra: Hy) 11-16 May (1); sp.9 (Bra: Hy) 11-16 May (2); sp.10 (Bra: Hy) 11-16 May (1); *Ichneumon* sp.2 (Ich: Hy) 11-16 May (1); sp.3 (Ich: Hy) 11-16 May (1); sp.4 (Ich: Hy) 11-16 May (1); sp.6 (Ich: Hy) 11-16 May (1); sp.1 (Pte: Hy) 11-16 May (1); sp.1 (Per: Hy) 11-16 May (1); *Andrena mikado* (And: Hy) 11-16 May (2); *Andrena longitibialis* (And: Hy) 11-16 May (11); *Andrena benefica* (And: Hy) 11-16 May (3); sp.2 (Tip: Di) 11-16 May (1); sp.5 (Tip: Di) 11-16 May (1); sp.2 (Cer: Di) 11-16 May (1); *Bibio* sp.1 (Bib: Di) 11-16 May (3); *Bibio simulans* (Bib: Di) 11-16 May (1); *Bibio* sp.4 (Bib: Di) 11-16 May (1); *Bibio gracilipalpus* (Bib: Di) 11-16 May (28); sp.2 (Myc: Di) 11-16 May (1); sp.5 (Myc: Di) 11-16 May (1); sp.8 (Emp: Di) 11-16 May (1); *Syrphus vitripernis* (Syr: Di) 11-16 May (1); *Homoneura* sp.1 (Lau: Di) 11-16 May (2); sp.1 (Chl: Di) 11-16 May (1); *Hylmyia* sp.1 (Ant: Di) 11-16 May (2); *Delia* sp.1 (Ant: Di) 11-16 May (1); *Delia* sp.2 (Ant: Di) 11-16 May (1); sp.1 (Tor: Le) 11-16 May (1)

Salix vulpina

Eusphalerum parallelym (Sta: Co) 16-18 Apr. (1); *Manobidia nipponica* (Chr: Co) 16-18 Apr. (4); sp.7 (Bra: Hy) 16-18 Apr. (1); sp.8 (Bra: Hy) 16-18 Apr. (1); *Bibio gracilipalpus* (Bib: Di) 16-18 Apr. (1); *Lasiomma* sp.1 (Ant: Di) 16-18 Apr. (23); *Hydrophoria* sp.1 (Ant: Di) 16-18 Apr. (5)

Brassicaceae

Arabis glabra

Sphaerophoria philanthus (Syr: Di) 16-17 Jun. (1)

Clethraceae

Clethra barvinervis

Lasioglossum apristum (Hal: Hy) 4-5 Aug. (1); *Andrena dentata* (And: Hy) 4-5 Aug. (2); *Stomorhina obsoleta* (Cal: Di) 4-5 Aug. (3); *Meigenia* sp.2 (Tac: Di) 4-5 Aug. (1)

Ericaceae

Lyonia ovalifolia var. *elliptica*

Bombus ardens ardens (Api: Hy) 16-17 Jun. (1); *Bibio* sp.2 (Bib: Di) 16-17 Jun. (2); *Liriomyza* sp.1 (Agr: Di) 16-17 Jun. (1)

Ericaceae

Pieris japonica

Eusphalerum parallelym (Sta: Co) 16-18 Apr. (27); *Eucetonia pilifera* (Sca: Co) 16-18 Apr. (1); *Podabrus malthinoides* (Can: Co) 16-18 Apr. (1); *Meligethes* sp.1 (Nit: Co) 16-18 Apr. (2); sp.1 (Cry: Co) 16-18 Apr. (1); *Byturus* sp.1 (Byt: Co) 16-18 Apr. (1); *Vibidia duodecimguttata* (Coc: Co) 16-18 Apr. (1); *Nonarthra cyanea* (Chr: Co) 16-18 Apr. (3); *Himatium* sp.1 (Cur: Co) 16-18 Apr. (1); *Audrena okabei sapporensis* (And: Hy) 16-18 Apr. (1); *Andrena dentata* (And: Hy) 16-18 Apr. (1); *Andrena mikado* (And: Hy) 16-18 Apr. (1); *Andrena watasei* (And: Hy) 16-18 Apr. (1); *Andrena komachi* (And: Hy) 16-18 Apr. (1); *Ceratina japonica* (Ant: Hy) 16-18 Apr. (1); *Nomada diervillae* (Ant: Hy) 16-18 Apr. (1); sp.4 (Cer: Di) 16-18 Apr. (3); *Bibio* sp.1 (Bib: Di) 16-18 Apr. (3); *Bibio* sp.3 (Bib: Di) 16-18 Apr. (1); *Bibio gracilipalpus* (Bib: Di) 16-18 Apr. (2); *Bibio aneuretus* (Bib: Di) 16-18 Apr. (11); sp.3 (Sci: Di) 16-18 Apr. (1); sp.5 (Sci: Di) 16-18 Apr. (1); *Helophilus virgatus* (Syr: Di) 16-18 Apr. (1); *Copromyza* sp.1 (Sph: Di) 16-18 Apr. (1); *Delia* sp.3 (Ant: Di) 16-18 Apr. (1)

Rhododendron kiusuanum

Pidonia piziloi (Cer: Co) 26-29 May (1); *Andrena mikado* (And: Hy) 26-29 May (2); *Andrena longitibialis* (And: Hy) 26-29 May (2); *Ceratina japonica* (Ant: Hy) 26-29 May (2); *Nomada asozuana* (Ant: Hy) 26-29 May (1); *Bombus ardens ardens* (Api: Hy) 16-17 Jun. (1), 26-29 May (1); *Philopota nigroaenea* (Acr: Di) 26-29 May (4); *Bombylus major* (Bom: Di) 26-29 May (2); *Eristalis tenax* (Syr: Di) 26-29 May (1); *Sphaerophoria philanthus* (Syr: Di) 26-29 May (1); *Platycheirus clypeatus* (Syr: Di) 26-29 May (1); *Delia* sp.5 (Ant: Di) 16-17 Jun. (1)

Rhododendron reticulatum

Pidonia piziloi (Cer: Co) 11-16 May (1); sp.1 (Ich: Hy) 11-16 May (1); *Andrena mikado* (And: Hy) 11-

16 May (4); *Andrena longitibialis* (And: Hy) 11-16 May (1); *Bombylus major* (Bom: Di) 11-16 May (3)

Styracaceae

Styrax japonica

Pidonia hylophila hylophila (Cer: Co) 16-17 Jun. (1); *Bombus ardens ardens* (Api: Hy) 16-17 Jun. (1)

Primulaceae

Lysimachia clethroides

Popillia japonica (Sca: Co) 10-16 Jul. (1); *Mordellistena* sp.1 (Mor: Co) 10-16 Jul. (2); *Hippuriphila* sp.1 (Chr: Co) 10-16 Jul. (1); sp.5 (Ich: Hy) 10-16 Jul. (1); *Stenodynerus tokyanus tokyanus* (Eum: Hy) 10-16 Jul. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.5 (Hal: Hy) 10-16 Jul. (2); *Sphaerophoria philanthus* (Syr: Di) 10-16 Jul. (1); *Campiglossa hirayamae* (Tep: Di) 10-16 Jul. (1); *Peribaea* sp.1 (Tac: Di) 10-16 Jul. (1); *Siphona* sp.1 (Tac: Di) 10-16 Jul. (3); *Polytremis pellucida pellucida* (Hes: Le) 10-16 Jul. (1); *Lycaena phlaeas daimio* (Lyc: Le) 10-16 Jul. (4); *Fabriciana adippe pallescens* (Nym: Le) 10-16 Jul. (2); *Fabriciana nerippe* (Nym: Le) 10-16 Jul. (1)

Hydrangeaceae

Hydrangea luteo-venosa

Andrena longitibialis (And: Hy) 26-29 May (1); *Ceratina japonica* (Ant: Hy) 26-29 May (1); *Philopota nigroaenea* (Acr: Di) 26-29 May (1); *Neaitamus angusticornis* (Asi: Di) 26-29 May (2); *Melanastoma scalare* (Syr: Di) 26-29 May (1); *Sphaerophoria philanthus* (Syr: Di) 26-29 May (1); *Eumerus* sp.1 (Syr: Di) 26-29 May (1); sp.3 (Cal: Di) 26-29 May (1)

Hydrangea paniculata

Baris dispilota (Cur: Co) 24-26 Aug. (1); *Priocnemis cyphonota* (Pom: Hy) 4-5 Aug. (1); *Lasioglossum apristum* (Hal: Hy) 4-5 Aug. (1); *Andrena dentata* (And: Hy) 4-5 Aug. (1); *Apis mellifera* (Api: Hy) 4-5 Aug. (3); *Stomorhina obsoleta* (Cal: Di) 4-5 Aug. (1)

Hydrangea serrata

Lasioglossum sibiriacum (Hal: Hy) 10-16 Jul. (1); *Lasioglossum baleicum* (Hal: Hy) 10-16 Jul. (1); *Apis mellifera* (Api: Hy) 10-16 Jul. (3); *Delia* sp.1 (Ant: Di) 10-16 Jul. (1)

Saxifragaceae

Astilbe thunbergii

Baris dispilota (Cur: Co) 10-16 Jul. (8); *Baccha maculata* (Syr: Di) 10-16 Jul. (1); *Cheilosia* sp.3 (Syr: Di) 10-16 Jul. (1); *Sphaerophoria philanthus* (Syr: Di) 10-16 Jul. (1); *Stomorhina obsoleta* (Cal: Di) 10-16 Jul. (2); *Peribaea* sp.1 (Tac: Di) 10-16 Jul. (2); *Siphona* sp.1 (Tac: Di) 10-16 Jul. (2); *Fischeria* sp.1 (Tac: Di) 10-16 Jul. (1); *Ochlodes ochraceus* (Hes: Le) 10-16 Jul. (1)

Deutzia crenata

Hoplia moerens (Sca: Co) 16-17 Jun. (2); *Trachys saundersi* (Bup: Co) 16-17 Jun. (1); *Mordellina* sp.1 (Mor: Co) 16-17 Jun. (1); *Anaspis* sp.2 (Scr: Co) 16-17 Jun. (1); *Exosoma flaviventre* (Chr: Co) 16-17 Jun. (1); *Andrena knuthi* (And: Hy) 16-17 Jun. (4); *Andrena taraxaci chikuzenensis* (And: Hy) 16-17 Jun. (1); *Andrena prostomias* (And: Hy) 16-17 Jun. (3); *Andrena hikosana* (And: Hy) 16-17 Jun. (1); *Bombus ardens ardens* (Api: Hy) 16-17 Jun. (2); *Philopota nigroaenea* (Acr: Di) 16-17 Jun. (2); sp.1 (Emp: Di) 16-17 Jun. (2); *Helophilus virgatus* (Syr: Di) 16-17 Jun. (1); *Betasyrphus serarius* (Syr: Di) 16-17 Jun. (1); *Cheilosia* sp.2 (Syr: Di) 16-17 Jun. (1); *Cheilosia* sp.3 (Syr: Di) 16-17 Jun. (1); *Sphaerophoria philanthus* (Syr: Di) 16-17 Jun. (1); *Allobaccha* sp.1 (Syr: Di) 16-17 Jun. (1); *Zodion* sp.1 (Con: Di) 16-17 Jun. (1); *Stomorhina obsoleta* (Cal: Di) 16-17 Jun. (1); *Peribaea* sp.1 (Tac: Di) 16-17 Jun. (1); *Nemophora umbripennis* (Inc: Le) 16-17 Jun. (1); *Pieris melete melete* (Pie: Le) 16-17 Jun. (1)

Deutzia crenata var. *floribunda*

Exosoma flaviventre (Chr: Co) 16-17 Jun. (1); *Protichneumon* sp.1 (Ich: Hy) 10-16 Jul. (1); *Hoplismenus* sp.1 (Ich: Hy) 10-16 Jul. (1); *Ammophila sabulosa nipponica* (Sph: Hy) 16-17 Jun. (2); *Lasioglossum* sp.1 (Hal: Hy) 16-17 Jun. (1); *Andrena knuthi* (And: Hy) 16-17 Jun. (1); *Andrena prostomias* (And: Hy) 16-17 Jun. (8); *Philopota nigroaenea* (Acr: Di) 16-17 Jun. (1); *Eristalis cerealis* (Syr: Di) 10-16 Jul. (3);

Helophilus virgatus (Syr: Di) 10-16 Jul. (1); *Paragus jozanus* (Syr: Di) 10-16 Jul. (1); *Delia* sp.1 (Ant: Di) 10-16 Jul. (8); *Stomorhina obsoleta* (Cal: Di) 10-16 Jul. (3); *Sisyropa* sp.1 (Tac: Di) 10-16 Jul. (1)

Parnassia palustris
Pachygrontha sp.1 (Lyg: He) 14-16 Oct. (1); *Formica japonica* (For: Hy) 14-16 Oct. (1); *Paragus jozanus* (Syr: Di) 14-16 Oct. (1)

Schizophragma hydrangeoides
sp.1 (Emp: Di) 16-17 Jun. (1)

Rosaceae

Potentilla freyniana
Oedemeronia lucidicollis (Oed: Co) 16-18 Apr. (3); *Andrena komachi* (And: Hy) 11-16 May (1); *Andrena minutula* (And: Hy) 16-18 Apr. (3); *Bombus diversus diversus* (Api: Hy) 11-16 May (1); sp.2 (Emp: Di) 11-16 May (1); *Cheilosia* sp.5 (Syr: Di) 16-18 Apr. (1); *Melangyna* sp.1 (Syr: Di) 16-18 Apr. (1); *Cheilosia* sp.1 (Syr: Di) 11-16 May (1); *Platycheirus urakawensis* (Syr: Di) 11-16 May (1)

Prunus jamasakura
Eusphalerum parallelym (Sta: Co) 11-16 May (2); *Dalopius tamui* (Ela: Co) 11-16 May (1); *Mikadocantharis japonica* (Can: Co) 11-16 May (3); *Anthemus magnius* (Can: Co) 11-16 May (1); *Meligethes* sp.1 (Nit: Co) 11-16 May (1); *Epuraea bergeri* (Nit: Co) 11-16 May (1); *Byturus* sp.2 (Byt: Co) 11-16 May (1); *Manobidia nipponica* (Chr: Co) 11-16 May (3); *Pachyprotasis* sp.1 (Ten: Hy) 11-16 May (1); sp.2 (Ich: Hy) 11-16 May (1); sp.1 (Tip: Di) 11-16 May (1); sp.3 (Cer: Di) 11-16 May (1); *Bibio* sp.5 (Bib: Di) 11-16 May (1); sp.4 (Myc: Di) 11-16 May (1); sp.6 (Myc: Di) 11-16 May (1); sp.5 (Emp: Di) 11-16 May (1); *Euthyneura* sp.1 (Emp: Di) 11-16 May (1); *Melanastoma scalare* (Syr: Di) 11-16 May (1); sp.2 (Chl: Di) 11-16 May (1); *Hylmyia* sp.1 (Ant: Di) 11-16 May (2)

Rubus parvifolius
Byturus sp.1 (Byt: Co) 16-17 Jun. (1); *Baris dispilota* (Cur: Co) 16-17 Jun. (1); *Phytobius* sp.1 (Cur: Co) 16-17 Jun. (1); *Ceratina japonica* (Ant: Hy) 16-17 Jun. (1); *Bombus ardens ardens* (Api: Hy) 16-17 Jun. (1); *Sepsis* sp.1 (Sep: Di) 16-17 Jun. (1)

Rubus phoenicolasius
Bombus ardens ardens (Api: Hy) 26-29 May (1)

Sanguisorba officinalis
Eurychaeta sp.1 (Cal: Di) 17-22 Sep. (1)

Spiraea japonica
Anechura japonica (For: De) 10-16 Jul. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.1 (Hal: Hy) 10-16 Jul. (1); *Bombus diversus diversus* (Api: Hy) 4-5 Aug. (1); *Bombus ignitus* (Api: Hy) 4-5 Aug. (1); *Eristalis tenax* (Syr: Di) 4-5 Aug. (1); *Fabriciana adippe pallescens* (Nym: Le) 10-16 Jul. (1)

Fabaceae

Lespedeza bicolor
Colletes perforator (Col: Hy) 24-26 Aug. (2); *Megachile remota sakagamii* (Meg: Hy) 4-5 Aug. (1); *Ceratina japonica* (Ant: Hy) 24-26 Aug. (5); *Ceratina flavipes* (Ant: Hy) 24-26 Aug. (2); *Ceratina megastigmata* (Ant: Hy) 24-26 Aug. (1); *Bombus diversus diversus* (Api: Hy) 17-22 Sep. (1), 24-26 Aug. (1); *Bombus ignitus* (Api: Hy) 17-22 Sep. (1), 24-26 Aug. (8); *Apis cerana* (Api: Hy) 17-22 Sep. (2), 24-26 Aug. (1); *Apis mellifera* (Api: Hy) 17-22 Sep. (9), 24-26 Aug. (4); *Scaeva komabensis* (Syr: Di) 24-26 Aug. (1); *Prosena* sp.1 (Tac: Di) 24-26 Aug. (2)

Sophora flavescens
Trypherus niponicus (Can: Co) 16-17 Jun. (2); *Campsomeris prismatica* (Sco: Hy) 16-17 Jun. (1); *Camponotus japonicus* (For: Hy) 16-17 Jun. (1); *Ammophila sabulosa nipponica* (Sph: Hy) 16-17 Jun.

(1); *Ceratina japonica* (Ant: Hy) 16-17 Jun. (2); *Bombus diversus diversus* (Api: Hy) 10-16 Jul. (1), 16-17 Jun. (7); *Bombus ignitus* (Api: Hy) 16-17 Jun. (1); *Sphaerophoria philanthus* (Syr: Di) 16-17 Jun. (1); *Neptis sappho intermedia* (Nym: Le) 16-17 Jun. (1)

Vicia unijuga

Lasioglossum (carinaless *Evylaeus)* sp.4 (Hal: Hy) 16-17 Jun. (1); *Bombus diversus diversus* (Api: Hy) 16-17 Jun. (1); *Sphaerophoria philanthus* (Syr: Di) 16-17 Jun. (1)

Cornaceae

Benthamidia japonica

Themus midas (Can: Co) 16-17 Jun. (1); *Prothemus ciusianus* (Can: Co) 16-17 Jun. (1); *Andrena taraxaci chikuzenensis* (And: Hy) 16-17 Jun. (1); *Bombus ardens ardens* (Api: Hy) 16-17 Jun. (1); *Eristalis tenax* (Syr: Di) 16-17 Jun. (1); *Epistrophe aino* (Syr: Di) 16-17 Jun. (2); *Eristalis cerealis* (Syr: Di) 16-17 Jun. (1); *Aldrichina grahami* (Cal: Di) 16-17 Jun. (2); *Ravinia* sp.1 (Sar: Di) 16-17 Jun. (1); *Phebellia* sp.1 (Tac: Di) 16-17 Jun. (1); sp.2 (Tor: Le) 16-17 Jun. (1); *Ivela auripes* (Lym: Le) 16-17 Jun. (1)

Polygalaceae

Polygala japonica

Lasioglossum (carinaless *Evylaeus)* sp.4 (Hal: Hy) 11-16 May (1)

Staphyleaceae

Staphylea bumalda

Pipunculus sp.1 (Pip: Di) 11-16 May (1)

Geraniaceae

Geranium shikokianum

sp.1 (Ric: He) 24-26 Aug. (1); *Nonarthra cyanea* (Chr: Co) 24-26 Aug. (7); *Rhinoncomimus* sp.1 (Cur: Co) 24-26 Aug. (1); *Lasioglossum* sp.3 (Hal: Hy) 17-22 Sep. (2); *Lasioglossum* (carinaless *Evylaeus)* sp.3 (Hal: Hy) 4-5 Aug. (1); *Ceratina japonica* (Ant: Hy) 17-22 Sep. (3); *Ceratina flavipes* (Ant: Hy) 4-5 Aug. (1); *Ceratina megastigmata* (Ant: Hy) 17-22 Sep. (9); *Bombus diversus diversus* (Api: Hy) 17-22 Sep. (1); *Panorpa trizonata* (Pan: Me) 4-5 Aug. (1); *Prosena siberita* (Tac: Di) 24-26 Aug. (1)

Apiaceae

Angelica cartilagino-marginata

Sphaerophoria philanthus (Syr: Di) 24-26 Aug. (1)

Angelica longeradiata

Panorpa trizonata (Pan: Me) 24-26 Aug. (1)

Hydrocotyle ramiflora

Lasioglossum (carinaless *Evylaeus)* sp.4 (Hal: Hy) 16-17 Jun. (2); *Paragus quadrifasciatus* (Syr: Di) 16-17 Jun. (1); *Paragus jozanus* (Syr: Di) 16-17 Jun. (1)

Gentianaceae

Gentiana zollingeri

Andrena sp.1 (And: Hy) 16-18 Apr. (1)

Swertia japonica

Formica japonica (For: Hy) 14-16 Oct. (1)

Lamiaceae

Isodon inflexus

Apis mellifera (Api: Hy) 17-22 Sep. (1)

Prunella vulgaris var. *lilacina*

Ceratina japonica (Ant: Hy) 10-16 Jul. (2), 16-17 Jun. (1); *Ceratina flavipes* (Ant: Hy) 10-16 Jul. (1); *Ceratina iwatai* (Ant: Hy) 10-16 Jul. (1); *Betasyrphus serarius* (Syr: Di) 10-16 Jul. (3); *Melanastoma scalare* (Syr: Di) 10-16 Jul. (1); *Ochlodes ochraceus* (Hes: Le) 10-16 Jul. (13); *Fabriciana adippe pallescens* (Nym: Le) 10-16 Jul. (1)

Scrophulariaceae

Veronica rotunda var. *petiolata*

Ammophila sabulosa nipponica (Sph: Hy) 4-5 Aug. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.1 (Hal: Hy) 4-5 Aug. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.4 (Hal: Hy) 4-5 Aug. (2); *Sphaerophoria macrogaster* (Syr: Di) 4-5 Aug. (1); *Sphaerophoria philanthus* (Syr: Di) 4-5 Aug. (1)

Campanulaceae

Adenophora triphylla

Bombus ignitus (Api: Hy) 4-5 Aug. (1); *Maculinea teleius kazamoto* (Lyc: Le) 4-5 Aug. (2); *Minois dryas bipunctata* (Nym: Le) 4-5 Aug. (1)

Codonopsis lanceolata

Vespa simillima xanthoptera (Ves: Hy) 17-22 Sep. (1)

Rubiaceae

Galium japonicum

Meliscaeva cinctella (Syr: Di) 11-16 May (1)

Galium verum

Mordellistena sp.1 (Mor: Co) 10-16 Jul. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.5 (Hal: Hy) 10-16 Jul. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.6 (Hal: Hy) 10-16 Jul. (1); *Paragus quadrifasciatus* (Syr: Di) 10-16 Jul. (2)

Paederia scandens

Lasioglossum (carinaless *Evylaeus)* sp.4 (Hal: Hy) 4-5 Aug. (1)

Caprifoliaceae

Abelia serrata

Macrolagria robusticeps (Lag: Co) 26-29 May (1); *Myrmica* sp.1 (For: Hy) 26-29 May (1); *Lasioglossum* (carinate *Evylaeus)* sp.3 (Hal: Hy) 26-29 May (1); *Ceratina japonica* (Ant: Hy) 26-29 May (1); *Apis mellifera* (Api: Hy) 26-29 May (1); sp.3 (Tip: Di) 11-16 May (1); *Philopota nigroaenea* (Acr: Di) 11-16 May (1), 26-29 May (7); sp.9 (Emp: Di) 11-16 May (1); *Euthyneura* sp.1 (Emp: Di) 11-16 May (1); sp.10 (Emp: Di) 11-16 May (1); *Helophilus virgatus* (Syr: Di) 26-29 May (1)

Viburnum dilatatum

Ectinohoplia obducta (Sca: Co) 16-17 Jun. (7); *Vuilletus viridis* (Ela: Co) 16-17 Jun. (1); *Oedemeronia lucidicollis* (Oed: Co) 16-17 Jun. (4); *Andrena knuthi* (And: Hy) 16-17 Jun. (1); sp.4 (Emp: Di) 16-17 Jun. (1); sp.6 (Emp: Di) 16-17 Jun. (1); *Eristalis tenax* (Syr: Di) 16-17 Jun. (1); *Peribaea* sp.1 (Tac: Di) 16-17 Jun. (1)

Viburnum erosum var. *punctatum*

Lasioglossum (carinate *Evylaeus)* sp.2 (Hal: Hy) 26-29 May (1); *Eristalis tenax* (Syr: Di) 26-29 May (1); *Helophilus virgatus* (Syr: Di) 26-29 May (1); *Betasyrphus serarius* (Syr: Di) 26-29 May (1)

Weigela decora

Paraserica gricea (Sca: Co) 16-17 Jun. (1); *Dalopius tamui* (Ela: Co) 16-17 Jun. (1); *Anthemus maculielytris* (Can: Co) 16-17 Jun. (1); *Prothemus ciusianus* (Can: Co) 16-17 Jun. (2); sp.3 (Bra: Hy) 16-17 Jun. (1); *Myrmica* sp.1 (For: Hy) 16-17 Jun. (1); *Lasioglossum* sp.2 (Hal: Hy) 16-17 Jun. (1); *Ceratina flavipes* (Ant: Hy) 16-17 Jun. (1); *Tetralonia nipponensis* (Ant: Hy) 16-17 Jun. (1); *Bombus ardens ardens* (Api: Hy) 16-17 Jun. (2); *Bombus ignitus* (Api: Hy) 16-17 Jun. (7); *Homoneura* sp.2 (Lau: Di)

16-17 Jun. (1)

Weigela japonica

Andrena watasei (And: Hy) 26-29 May (1); *Andrena halictoides* (And: Hy) 26-29 May (1); *Ceratina japonica* (Ant: Hy) 26-29 May (1); *Ceratina megastigmata* (Ant: Hy) 26-29 May (1); *Bombus ardens ardens* (Api: Hy) 26-29 May (5); *Philopota nigroaenea* (Acr: Di) 26-29 May (2); *Dideaides coquilletti* (Syr: Di) 26-29 May (1); *Allobaccha apicalis* (Syr: Di) 26-29 May (1)

Valerianaceae

Patrinia scabiosaefolia

Stomorhina obsoleta (Cal: Di) 17-22 Sep. (1)

Patrinia villosa

Chrysopa sp.1 (Chr: Ne) 24-26 Aug. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.3 (Hal: Hy) 24-26 Aug. (1)

Valeriana fauriei

Eristalis tenax (Syr: Di) 16-17 Jun. (2), 26-29 May (2); *Peribaea* sp.1 (Tac: Di) 16-17 Jun. (1)

Asteraceae

Anaphalis margaritacea var. *angus*

Baris dispilota (Cur: Co) 24-26 Aug. (1); *Eristalis tenax* (Syr: Di) 24-26 Aug. (1); sp.1 (Mus: Di) 24-26 Aug. (1)

Aster ageratoides ssp. *leiophyllus*

Lasioglossum sp.3 (Hal: Hy) 17-22 Sep. (2); *Lasioglossum* (carinaless *Evylaeus)* sp.3 (Hal: Hy) 17-22 Sep. (1); *Ceratina japonica* (Ant: Hy) 17-22 Sep. (1); *Ceratina megastigmata* (Ant: Hy) 17-22 Sep. (3)

Aster scaber

Aulacophora nigripennis (Chr: Co) 17-22 Sep. (1); *Lasioglossum* sp.3 (Hal: Hy) 17-22 Sep. (1); *Ceratina megastigmata* (Ant: Hy) 17-22 Sep. (1)

Cirsium japonicum

sp.2 (Del: He) 16-17 Jun. (1); *Mordellistena* sp.1 (Mor: Co) 16-17 Jun. (3); *Nonarthra cyanea* (Chr: Co) 16-17 Jun. (2); *Zypangia lewisi* (Chr: Co) 16-17 Jun. (5); *Baris dispilota* (Cur: Co) 16-17 Jun. (33); *Megacampsomeris grossa matsumurai* (Sco: Hy) 16-17 Jun. (1); *Vespa simillima xanthoptera* (Ves: Hy) 16-17 Jun. (1); *Vespa tropica pulchra* (Ves: Hy) 16-17 Jun. (1); *Lasioglossum* (carinaless *Evylaeus)* sp.5 (Hal: Hy) 16-17 Jun. (1); *Megachile tsurugensis* (Meg: Hy) 16-17 Jun. (1); *Megachile japonica* (Meg: Hy) 16-17 Jun. (1); *Ceratina japonica* (Ant: Hy) 16-17 Jun. (3); *Ceratina flavipes* (Ant: Hy) 16-17 Jun. (2); *Nomada japonica* (Ant: Hy) 16-17 Jun. (1); *Tetralonia nipponensis* (Ant: Hy) 16-17 Jun. (6); *Bombus diversus diversus* (Api: Hy) 10-16 Jul. (2), 16-17 Jun. (6); *Bombus ignitus* (Api: Hy) 16-17 Jun. (2); *Eristalis tenax* (Syr: Di) 16-17 Jun. (5); *Volucella jeddona* (Syr: Di) 16-17 Jun. (1); *Eristalis cerealis* (Syr: Di) 16-17 Jun. (1); *Betasyrphus serarius* (Syr: Di) 16-17 Jun. (1); *Sphaerophoria philanthus* (Syr: Di) 16-17 Jun. (3); *Thoressa varia* (Hes: Le) 16-17 Jun. (1); *Parnara guttata guttata* (Hes: Le) 10-16 Jul. (2); *Ochlodes ochraceus* (Hes: Le) 10-16 Jul. (1); *Pieris melete melete* (Pie: Le) 10-16 Jul. (1), 16-17 Jun. (2); *Fabriciana adippe pallescens* (Nym: Le) 10-16 Jul. (3), 16-17 Jun. (3); *Macroglossum stellatarum* (Sph: Le) 16-17 Jun. (1)

Cirsium suffultum

Oxycetonia jucunda (Sca: Co) 17-22 Sep. (1); *Nonarthra cyanea* (Chr: Co) 17-22 Sep. (6); *Campsomeris prismatica* (Sco: Hy) 17-22 Sep. (2); *Megacampsomeris grossa matsumurai* (Sco: Hy) 17-22 Sep. (1); *Lasioglossum* (carinate *Evylaeus)* sp.2 (Hal: Hy) 17-22 Sep. (1); *Megachile tsurugensis* (Meg: Hy) 17-22 Sep. (1); *Ceratina japonica* (Ant: Hy) 17-22 Sep. (1); *Ceratina megastigmata* (Ant: Hy) 17-22 Sep. (6); *Bombus diversus diversus* (Api: Hy) 17-22 Sep. (2); *Bombus ignitus* (Api: Hy) 14-16 Oct. (2), 17-22 Sep. (26); *Prosena* sp.1 (Tac: Di) 17-22 Sep. (2); *Parnara guttata guttata* (Hes: Le) 17-22 Sep. (1); *Papilio machaon hippocrates* (Pap: Le) 17-22 Sep. (1); *Vanessa indica* (Nym: Le) 17-22 Sep. (1); *Macroglossum*

sp.1 (Sph: Le) 17-22 Sep. (1)

Echinops setifer
Oxycetonia jucunda (Sca: Co) 17-22 Sep. (1), 24-26 Aug. (2); *Campsomeriella annulata annulata* (Sco: Hy) 24-26 Aug. (1); *Vespa simillima xanthoptera* (Ves: Hy) 24-26 Aug. (1); *Bombus ignitus* (Api: Hy) 24-26 Aug. (5); *Apis mellifera* (Api: Hy) 24-26 Aug. (3); *Prosena* sp.1 (Tac: Di) 24-26 Aug. (1); *Parnara guttata guttata* (Hes: Le) 24-26 Aug. (1); *Papilio machaon hippocrates* (Pap: Le) 24-26 Aug. (1)

Erigeron annuus
Baris dispilota (Cur: Co) 16-17 Jun. (8); *Lasioglossum* (carinaless *Evylaeus)* sp.7 (Hal: Hy) 10-16 Jul. (1); *Nomada muinensis* (Ant: Hy) 16-17 Jun. (1); *Nomada* sp.1 (Ant: Hy) 16-17 Jun. (1); *Sphaerophoria philanthus* (Syr: Di) 16-17 Jun. (1); *Urophora sachalinensis* (Tep: Di) 16-17 Jun. (1); *Peribaea* sp.1 (Tac: Di) 16-17 Jun. (1); *Balataea gracilis* (Zyg: Le) 16-17 Jun. (1)

Erigeron philadelphicus
Urophora sachalinensis (Tep: Di) 16-17 Jun. (1)

Eupatorium chinense
Baris dispilota (Cur: Co) 4-5 Aug. (1); *Betasyrphus serarius* (Syr: Di) 4-5 Aug. (1)

Heteropappus hispidus
Campsomeris prismatica (Sco: Hy) 17-22 Sep. (1); *Lasioglossum* sp.3 (Hal: Hy) 17-22 Sep. (5); *Eristalis cerealis* (Syr: Di) 17-22 Sep. (1); *Paragus haemorrhous* (Syr: Di) 17-22 Sep. (1)

Inula japonica
Ceratina flavipes (Ant: Hy) 24-26 Aug. (1); *Papilio machaon hippocrates* (Pap: Le) 24-26 Aug. (1)

Inula salicina var. *asiatica*
Ceratina megastigmata (Ant: Hy) 17-22 Sep. (1)

Ixeris dentata
Lasioglossum (carinaless *Evylaeus)* sp.2 (Hal: Hy) 26-29 May (1); *Lasioglossum* (carinaless *Evylaeus)* sp.4 (Hal: Hy) 26-29 May (1); *Andrena knuthi* (And: Hy) 11-16 May (2); *Eristalis tenax* (Syr: Di) 26-29 May (1); *Sphaerophoria macrogaster* (Syr: Di) 11-16 May (3), 26-29 May (2); *Melanastoma scalare* (Syr: Di) 26-29 May (1); *Sphaerophoria philanthus* (Syr: Di) 11-16 May (1), 26-29 May (4); *Platycheirus clypeatus* (Syr: Di) 26-29 May (1); *Peribaea* sp.1 (Tac: Di) 11-16 May (1)

Ligularia fischerii var. *takeyuki*
Baris dispilota (Cur: Co) 10-16 Jul. (1); *Eristalis tenax* (Syr: Di) 10-16 Jul. (2), 4-5 Aug. (1); *Fabriciana adippe pallescens* (Nym: Le) 10-16 Jul. (5)

Ligularia japonica
Sympetrum frequens (Lib: Od) 10-16 Jul. (1); *Bombus diversus diversus* (Api: Hy) 10-16 Jul. (3); *Bombus ignitus* (Api: Hy) 10-16 Jul. (1); *Eristalis tenax* (Syr: Di) 10-16 Jul. (2); *Peribaea* sp.1 (Tac: Di) 10-16 Jul. (1); *Polytremis pellucida pellucida* (Hes: Le) 10-16 Jul. (1); *Parnara guttata guttata* (Hes: Le) 24-26 Aug. (1); *Papilio bianor dehaanii* (Pap: Le) 10-16 Jul. (4); *Lycaena phlaeas daimio* (Lyc: Le) 10-16 Jul. (1); *Argyronome ruslana lysippe* (Nym: Le) 10-16 Jul. (1); *Macroglossum bombylaus* (Sph: Le) 10-16 Jul. (1)

Saussurea gracilis
Campsomeris prismatica (Sco: Hy) 24-26 Aug. (1); *Lasioglossum* sp.3 (Hal: Hy) 17-22 Sep. (2); *Eristalis tenax* (Syr: Di) 24-26 Aug. (1)

Saussurea yanagisawae var. *nivea*

Nonarthra cyanea (Chr: Co) 17-22 Sep. (1); *Campsomeris prismatica* (Sco: Hy) 17-22 Sep. (8); *Lasioglossum* sp.3 (Hal: Hy) 17-22 Sep. (3); *Apis mellifera* (Api: Hy) 17-22 Sep. (1)

Senecio pierotii
Sphaerophoria philanthus (Syr: Di) 26-29 May (1)

Solidago virga-aurea ssp. *Asiatic*
Nonarthra cyanea (Chr: Co) 17-22 Sep. (3); *Aulacophora nigripennis* (Chr: Co) 17-22 Sep. (4); *Lasioglossum* sp.3 (Hal: Hy) 17-22 Sep. (3)

Synurus excelsus
Bombus diversus diversus (Api: Hy) 14-16 Oct. (3)

Araceae

Arisaema japonicum
sp.1 (Tin: He) 26-29 May (1); *Tapinoma* sp.1 (For: Hy) 26-29 May (1); sp.4 (Tip: Di) 26-29 May (1); sp.1 (Myc: Di) 26-29 May (2); sp.3 (Myc: Di) 26-29 May (1); sp.7 (Myc: Di) 26-29 May (1); sp.8 (Myc: Di) 16-17 Jun. (1); sp.9 (Myc: Di) 26-29 May (1); sp.10 (Myc: Di) 16-18 Apr. (1); sp.11 (Myc: Di) 26-29 May (1); sp.1 (Sci: Di) 26-29 May (1); sp.2 (Sci: Di) 16-18 Apr. (1); sp.4 (Sci: Di) 16-18 Apr. (1); sp.6 (Sci: Di) 16-18 Apr. (1); sp.7 (Sci: Di) 26-29 May (1); sp.7 (Emp: Di) 26-29 May (1)

Juncaceae

Luzula capitata
Phyllopertha diversa (Sca: Co) 26-29 May (1)

Liliaceae

Aletris luteoviridis
Lasioglossum (carinate *Evylaeus)* sp.1 (Hal: Hy) 10-16 Jul. (1)

Allium thunbergii
Nonarthra cyanea (Chr: Co) 17-22 Sep. (1); *Bombus ignitus* (Api: Hy) 17-22 Sep. (1); *Apis mellifera* (Api: Hy) 17-22 Sep. (1); *Epioyrphus balteatus* (Syr: Di) 17-22 Sep. (2); *Scaeva komabensis* (Syr: Di) 17-22 Sep. (1)

Asparagus schoberioides
Ammophila sabulosa nipponica (Sph: Hy) 26-29 May (1)

Chionographis japonica
Gambrinus sp.1 (Ela: Co) 16-17 Jun. (1); *Camponotus japonicus* (For: Hy) 16-17 Jun. (1); *Sphaerophoria macrogaster* (Syr: Di) 16-17 Jun. (3), 26-29 May (1); *Linnaenya* sp.1 (Tac: Di) 16-17 Jun. (1)

Hemerocallis vespertina
Metrioptera hime (Tet: Or) 4-5 Aug. (1); *Bombus diversus diversus* (Api: Hy) 10-16 Jul. (1), 4-5 Aug. (1); *Apis mellifera* (Api: Hy) 4-5 Aug. (1); *Eristalis tenax* (Syr: Di) 4-5 Aug. (2); *Parnara guttata guttata* (Hes: Le) 4-5 Aug. (1); *Ampelophaga rubiginosa* (Sph: Le) 4-5 Aug. (1)

Lilium leichtlinii var. *maximowic*
Papilio machaon hippocrates (Pap: Le) 24-26 Aug. (1)

Veratrum maackii var. *maackii*
Ichneumon sp.1 (Ich: Hy) 4-5 Aug. (1); *Ichneumon* sp.3 (Ich: Hy) 4-5 Aug. (1); *Meigenia* sp.1 (Tac: Di) 4-5 Aug. (1); *Eumea* sp.1 (Tac: Di) 4-5 Aug. (1); *Eumea* sp.2 (Tac: Di) 4-5 Aug. (1)

Iridaceae

Iris rossii

Oedemeronia lucidicollis (Oed: Co) 11-16 May (2); *Tetralonia nipponensis* (Ant: Hy) 11-16 May (1), 16-18 Apr. (6)

Dioscoreaceae

Dioscorea asclepiadea
Anomala octiescoctata (Sca: Co) 26-29 May (1)

Orchidaceae

Cephalanthera falcata
Zypangia lewisi (Chr: Co) 11-16 May (4); *Apoderus erythrogaster* (Att: Co) 11-16 May (1); sp.1 (Cer: Di) 11-16 May (1); *Delia* sp.4 (Ant: Di) 11-16 May (1)

Appendix 2

A List of Floral Host Species for Each Anthophilous Insect Species Recorded at Mt. Yufu in 2001

Flower-visit records of each insect species are arranged in the following sequence: plant species, (plant species code), date and (number of individuals collected or observed). Insect taxa and plant taxa are arranged following the natural systems of Hirashima (1989) and Cronquist (1981).

ORTHOPTERA

Libellulidae

Sympetrum frequens
Ligularia japonica (ast6) 10-16 Jul. (1)

Tettigoniidae

Metrioptera hime
Hemerocallis vespertina (lil8) 4-5 Aug. (1)

DERMAPTERA

Forficulidae

Anechura japonica
Spiraea japonica (ros9) 10-16 Jul. (1)

HEMIPTERA

Ricaniidae

sp.1
Geranium shikokianum (ger1) 24-26 Aug. (1)

Deltocephalidae

sp.1
Castanea crenata (fag2) 16-17 Jun. (1)

sp.2
Cirsium japonicum (ast3) 16-17 Jun. (1)

Tingidae

sp.1
Arisaema japonicum (ara1) 26-29 May (1)

Lygaeidae

Pachygrontha
sp.1 *Parnassia palustris* (sax8) 14-16 Oct. (1)

Chrysopidae

Chrysopa sp.1
Patrinia villosa (val2) 24-26 Aug. (1)

COLEOPTERA

Staphylinidae

Eusphalerum parallelym
Lindera sericea (lau1) 16-18 Apr. (11); *Viola grypoceras* (vio2) 16-18 Apr. (2); *Salix vulpina* (sal1) 16-18 Apr. (1); *Pieris japonica* (eri1) 16-18 Apr. (27); *Prunus jamasakura* (ros3) 11-16 May (2)

Scarabaeidae

Anomala octiescoctata
Dioscorea asclepiadea (dio1) 26-29 May (1) *Popillia japonica Lysimachia clethroides* (pri1) 10-16 Jul. (1)

Phyllopertha diversa
Luzula capitata (jun1) 26-29 May (1)

Paraserica gricea
Weigela decora (cap6) 16-17 Jun. (1)

Oxycetonia jucunda
Quercus dentata (fag1) 11-16 May (1); *Polygonum cuspidatum* (pol3) 24-26 Aug. (1); *Hypericum pseudopetiolatum* (clu1) 17-22 Sep. (1); *Cirsium suffultum* (ast16) 17-22 Sep. (1); *Echinops setifer* (ast15) 17-22 Sep. (1), 24-26 Aug. (2)

Eucetonia pilifera
Quercus dentata (fag1) 11-16 May (3); *Pieris japonica* (eri1) 16-18 Apr. (1)

Ectinohoplia obducta
Viburnum dilatatum (cap5) 16-17 Jun. (7)

Hoplia moerens
Quercus dentata (fag1) 11-16 May (14); *Deutzia crenata* (sax2) 16-17 Jun. (2)

Buprestidae

Trachys saundersi
Deutzia crenata (sax2) 16-17 Jun. (1)

Elateridae

Gambrinus sp.1
Chionographis japonica (lil6) 16-17 Jun. (1)

Athousius sp.1
Salix sieboldiana (sal3) 11-16 May (1)

Dalopius tamui
Prunus jamasakura (ros3) 11-16 May (1); *Weigela decora* (cap6) 16-17 Jun. (1)

Vuilletus viridis
Viburnum dilatatum (cap5) 16-17 Jun. (1)

Cantharidae

Themus midas
Salix sieboldiana (sal3) 11-16 May (1); *Benthamidia japonica* (cor2) 16-17 Jun. (1)

Mikadocantharis japonica
Salix sieboldiana (sal3) 11-16 May (1); *Prunus jamasakura* (ros3) 11-16 May (3)

Anthemus magnius
Salix sieboldiana (sal3) 11-16 May (1); *Prunus jamasakura* (ros3) 11-16 May (1)

Anthemus maculielytris
Weigela decora (cap6) 16-17 Jun. (1)

Prothemus ciusianus
Benthamidia japonica (cor2) 16-17 Jun. (1); *Weigela decora* (cap6) 16-17 Jun. (2)

Trypherus niponicus
Sophora flavescens (fab1) 16-17 Jun. (2)

Podabrus malthinoides
Salix sieboldiana (sal3) 11-16 May (1); *Pieris japonica* (eri1) 16-18 Apr. (1)

Nitidulidae

Meligethes sp.1
Pieris japonica (eri1) 16-18 Apr. (2); *Prunus jamasakura* (ros3) 11-16 May (1)

Epuraea bergeri
Prunus jamasakura (ros3) 11-16 May (1)

Cryptophagidae

sp.1
Pieris japonica (eri1) 16-18 Apr. (1)

Byturidae

Byturus sp.1
Pieris japonica (eri1) 16-18 Apr. (1); *Rubus parvifolius* (ros8) 16-17 Jun. (1)

Byturus sp.2
Prunus jamasakura (ros3) 11-16 May (1)

Coccinellidae

Vibidia duodecimguttata
Pieris japonica (eri1) 16-18 Apr. (1)

Mordellidae

Mordellistena sp.1
Dianthus superbus var. *longicalyc* (car3) 10-16 Jul. (1); *Lysimachia clethroides* (pri1) 10-16 Jul. (2); *Galium verum* (rub2) 10-16 Jul. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (3)

Mordellina sp.1
Deutzia crenata (sax2) 16-17 Jun. (1)

Oedemeridae

Oedemeronia lucidicollis
Ranunculus japonicus (ran1) 11-16 May (3); *Epimedium diphyllum* (ber1) 11-16 May (2), 26-29 May (1); *Pseudostellaria heterantha* (car1) 11-16 May (2); *Viola orientalis* (vio1) 16-18 Apr. (4); *Salix sieboldiana* (sal3) 11-16 May (1); *Potentilla freyniana* (ros1) 16-18 Apr. (3); *Viburnum dilatatum* (cap5) 16-17 Jun. (4); *Iris rossii* (iri1) 11-16 May (2)

Scraptiidae

Anaspis sp.1
Lindera sericea (lau1) 16-18 Apr. (2)

Anaspis sp.2
Deutzia crenata (sax2) 16-17 Jun. (1)

Lagriidae

Macrolagria robusticeps

Abelia serrata (cap1) 26-29 May (1)

Alleculidae

Cteniopinus hypocrita
Castanea crenata (fag2) 16-17 Jun. (1)

Cerambycidae

Dinoptera minuta
Salix sieboldiana (sal3) 11-16 May (1)

Pidonia hylophila hylophila
Styrax japonica (sty1) 16-17 Jun. (1)

Pidonia piziloi
Rhododendron kiusuanum (eri4) 26-29 May (1); *Rhododendron reticulatum* (eri3) 11-16 May (1)

Chrysomelidae

Nonarthra cyanea
Pieris japonica (eri1) 16-18 Apr. (3); *Geranium shikokianum* (ger1) 24-26 Aug. (7); *Cirsium japonicum* (ast3) 16-17 Jun. (2); *Cirsium suffultum* (ast16) 17-22 Sep. (6); *Saussurea yanagisawae* var. *nivea* (ast17) 17-22 Sep. (1); *Solidago virga-aurea* ssp. *Asiatic* (ast18) 17-22 Sep. (3); *Allium thunbergii* (lil13) 17-22 Sep. (1)

Aulacophora nigripennis
Aster scaber (ast19) 17-22 Sep. (1); *Solidago virga-aurea* ssp. *Asiatic* (ast18) 17-22 Sep. (4)

Exosoma flaviventre
Deutzia crenata (sax2) 16-17 Jun. (1); *Deutzia crenata* var. *floribunda* (sax6) 16-17 Jun. (1)

Zypangia lewisi
Ranunculus japonicus (ran1) 11-16 May (1); *Epimedium diphyllum* (ber1) 11-16 May (2); *Cirsium japonicum* (ast3) 16-17 Jun. (5); *Cephalanthera falcata* (orc1) 11-16 May (4)

Hippuriphila sp.1
Lysimachia clethroides (pri1) 10-16 Jul. (1)

Hesperomorpha hirsuta
Castanea crenata (fag2) 16-17 Jun. (1)

Chrysomela vigintipunctata
Viola orientalis (vio1) 16-18 Apr. (1)

Manobidia nipponica
Lindera sericea (lau1) 16-18 Apr. (9); *Salix vulpina* (sal1) 16-18 Apr. (4); *Prunus jamasakura* (ros3) 11-16 May (3)

Attelabidae

Apoderus erythrogaster
Cephalanthera falcata (orc1) 11-16 May (1)

Curculionidae

Baris dispilota
Hydrangea paniculata (hyd3) 24-26 Aug. (1); *Astilbe thunbergii* (sax5) 10-16 Jul. (8); *Rubus parvifolius* (ros8) 16-17 Jun. (1); *Anaphalis margaritacea* var. *angus* (ast13) 24-26 Aug. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (33); *Eupatorium chinense* (ast9) 4-5 Aug. (1); *Erigeron annuus* (ast5) 16-17 Jun. (8); *Ligularia fischerii* var. *takeyuki* (ast8) 10-16 Jul. (1)

Himatium sp.1
Pieris japonica (eri1) 16-18 Apr. (1)

Rhinoncomimus sp.1
Geranium shikokianum (ger1) 24-26 Aug. (1)

Phytobius sp.1
Rubus parvifolius (ros8) 16-17 Jun. (1)

HYMENOPTERA
Tenthredinidae

Tenthredo fukaii
Salix sieboldiana (sal3) 11-16 May (1)

Rhogogaster varipes
Salix sieboldiana (sal3) 11-16 May (1)

Pachyprotasis sp.1
Prunus jamasakura (ros3) 11-16 May (1)

sp.1
Salix sieboldiana (sal3) 11-16 May (1)

sp.2
Viola grypoceras (vio2) 16-18 Apr. (1)

sp.3
Viola orientalis (vio1) 16-18 Apr. (1)

Braconidae

sp.1
Salix sieboldiana (sal3) 11-16 May (1)

sp.2
Salix sieboldiana (sal3) 11-16 May (1)

sp.3
Weigela decora (cap6) 16-17 Jun. (1)

sp.4
Salix sieboldiana (sal3) 11-16 May (1)

sp.5
Salix sieboldiana (sal3) 11-16 May (1)

sp.6
Salix sieboldiana (sal3) 11-16 May (1)

sp.7
Salix vulpina (sal1) 16-18 Apr. (1)

sp.8
Salix vulpina (sal1) 16-18 Apr. (1)

sp.9
Salix sieboldiana (sal3) 11-16 May (2)

sp.10
Salix sieboldiana (sal3) 11-16 May (1)

Ichneumonidae

Protichneumon sp.1
Deutzia crenata var. *floribunda* (sax6) 10-16 Jul. (1)

Hoplismenus sp.1
Deutzia crenata var. *floribunda* (sax6) 10-16 Jul. (1)

Ichneumon sp.1
Veratrum maackii var. *maackii* (lil10) 4-5 Aug. (1)

Ichneumon sp.2
Salix sieboldiana (sal3) 11-16 May (1)

Ichneumon sp.3
Veratrum maackii var. *maackii* (lil10) 4-5 Aug. (1)

sp.1
Rhododendron reticulatum (eri3) 11-16 May (1)

sp.2
Prunus jamasakura (ros3) 11-16 May (1)

sp.3
Salix sieboldiana (sal3) 11-16 May (1)

sp.4
Salix sieboldiana (sal3) 11-16 May (1)

sp.5
Lysimachia clethroides (pri1) 10-16 Jul. (1)

sp.6
Salix sieboldiana (sal3) 11-16 May (1)

Pteromalidae

sp.1
Salix sieboldiana (sal3) 11-16 May (1)

Perilampidae

sp.1
Salix sieboldiana (sal3) 11-16 May (1)

Eulophidae

sp.1
Lindera sericea (lau1) 16-18 Apr. (1)

sp.2
Lindera sericea (lau1) 16-18 Apr. (3)

Scoliidae

Campsomeris prismatica
Sophora flavescens (fab1) 16-17 Jun. (1); *Cirsium suffultum* (ast16) 17-22 Sep. (2); *Heteropappus hispidus* (ast22) 17-22 Sep. (1); *Saussurea gracilis* (ast12) 24-26 Aug. (1); *Saussurea yanagisawae* var. *nivea* (ast17) 17-22 Sep. (8)

Campsomeriella annulata annulata
Echinops setifer (ast15) 24-26 Aug. (1)

Megacampsomeris grossa matsumurai
Cirsium japonicum (ast3) 16-17 Jun. (1); *Cirsium suffultum* (ast16) 17-22 Sep. (1)

Formicidae

Camponotus japonicus
Quercus dentata (fag1) 11-16 May (1); *Polygonum cuspidatum* (pol3) 24-26 Aug. (2); *Sophora flavescens* (fab1) 16-17 Jun. (1); *Chionographis japonica* (lil6) 16-17 Jun. (1)

Formica japonica
Parnassia palustris (sax8) 14-16 Oct. (1); *Swertia japonica* (gen4) 14-16 Oct. (1)

Tapinoma sp.1
Arisaema japonicum (ara1) 26-29 May (1)

Myrmica sp.1
Abelia serrata (cap1) 26-29 May (1); *Weigela decora* (cap6) 16-17 Jun. (1)

Pompilidae

Priocnemis cyphonota
Hydrangea paniculata (hyd3) 4-5 Aug. (1)

Eumenidae

Stenodynerus tokyanus tokyanus
Lysimachia clethroides (pri1) 10-16 Jul. (1)

Vespidae

Vespa simillima xanthoptera
Codonopsis lanceolata (cam3) 17-22 Sep. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (1); *Echinops setifer* (ast15) 24-26 Aug. (1)

Vespa tropica pulchra
Cirsium japonicum (ast3) 16-17 Jun. (1)

Sphecidae

Crossocerus sp.1
Quercus dentata (fag1) 11-16 May (4)

Ammophila sabulosa nipponica
Deutzia crenata var. *floribunda* (sax6) 16-17 Jun. (2); *Sophora flavescens* (fab1) 16-17 Jun. (1); *Veronica rotunda* var. *petiolata* (scr1) 4-5 Aug. (1); *Asparagus schoberioides* (lil5) 26-29 May (1)

Colletidae

Colletes perforator
Lespedeza bicolor (fab3) 24-26 Aug. (2)

Halictidae

Lasioglossum (Lasioglossum) sp.1

Deutzia crenata var. *floribunda* (sax6) 16-17 Jun. (1)

Lasioglossum (Lasioglossum) sp.2
Weigela decora (cap6) 16-17 Jun. (1)

Lasioglossum occidens
Ranunculus japonicus (ran1) 26-29 May (1)

Lasioglossum (Lasioglossum) sp.3
Cimicifuga acerina (ran2) 17-22 Sep. (2); *Geranium shikokianum* (ger1) 17-22 Sep. (2); *Aster ageratoides* ssp. *leiophyllus* (ast21) 17-22 Sep. (2); *Aster scaber* (ast19) 17-22 Sep. (1); *Heteropappus hispidus* (ast22) 17-22 Sep. (5); *Saussurea gracilis* (ast12) 17-22 Sep. (2); *Saussurea yanagisawae* var. *nivea* (ast17) 17-22 Sep. (3); *Solidago virga-aurea* ssp. *Asiatic* (ast18) 17-22 Sep. (3)

Lasioglossum sibiriacum
Polygonum cuspidatum (pol3) 24-26 Aug. (1); *Hydrangea serrata* (hyd2) 10-16 Jul. (1)

Lasioglossum baleicum
Hydrangea serrata (hyd2) 10-16 Jul. (1)

Lasioglossum (carinate *Evylaeus)* sp.1
Aletris luteoviridis (lil9) 10-16 Jul. (1)

Lasioglossum (carinate *Evylaeus)* sp.2
Viburnum erosum var. *punctatum* (cap3) 26-29 May (1); *Cirsium suffultum* (ast16) 17-22 Sep. (1)

Lasioglossum (carinate *Evylaeus)* sp.3
Abelia serrata (cap1) 26-29 May (1)

Lasioglossum apristum
Clethra barvinervis (cle1) 4-5 Aug. (1); *Hydrangea paniculata* (hyd3) 4-5 Aug. (1)

Lasioglossum (carinaless *Evylaeus)* sp.1
Spiraea japonica (ros9) 10-16 Jul. (1); *Veronica rotunda* var. *petiolata* (scr1) 4-5 Aug. (1)

Lasioglossum (carinaless *Evylaeus)* sp.2
Ranunculus japonicus (ran1) 11-16 May (3), 26-29 May (1); *Ixeris dentata* (ast1) 26-29 May (1)

Lasioglossum (carinaless *Evylaeus)* sp.3
Geranium shikokianum (ger1) 4-5 Aug. (1); *Patrinia villosa* (val2) 24-26 Aug. (1); *Aster ageratoides* ssp. *leiophyllus* (ast21) 17-22 Sep. (1)

Lasioglossum (carinaless *Evylaeus)* sp.4
Ranunculus japonicus (ran1) 11-16 May (1); *Epimedium diphyllum* (ber1) 26-29 May (1); *Vicia unijuga* (fab2) 16-17 Jun. (1); *Polygala japonica* (pol1) 11-16 May (1); *Hydrocotyle ramiflora* (api1) 16-17 Jun. (2); *Veronica rotunda* var. *petiolata* (scr1) 4-5 Aug. (2); *Paederia scandens* (rub3) 4-5 Aug. (1); *Ixeris dentata* (ast1) 26-29 May (1)

Lasioglossum (carinaless *Evylaeus)* sp.5
Dianthus superbus var. *longicalyc* (car3) 10-16 Jul. (2); *Lysimachia clethroides* (pri1) 10-16 Jul. (2); *Galium verum* (rub2) 10-16 Jul. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (1)

Lasioglossum (carinaless *Evylaeus)* sp.6
Galium verum (rub2) 10-16 Jul. (1)

Lasioglossum (carinaless *Evylaeus)* sp.7

Erigeron annuus (ast5) 10-16 Jul. (1)

Lasioglossum (carinaless *Evylaeus)* sp.8
Dianthus superbus var. *longicalyc* (car3) 10-16 Jul. (1)

Andrenidae

Audrena okabei sapporensis
Pieris japonica (eri1) 16-18 Apr. (1)

Andrena knuthi
Deutzia crenata (sax2) 16-17 Jun. (4); *Deutzia crenata* var. *floribunda* (sax6) 16-17 Jun. (1); *Viburnum dilatatum* (cap5) 16-17 Jun. (1); *Ixeris dentata* (ast1) 11-16 May (2)

Andrena taraxaci chikuzenensis
Deutzia crenata (sax2) 16-17 Jun. (1); *Benthamidia japonica* (cor2) 16-17 Jun. (1)

Andrena dentata
Clethra barvinervis (cle1) 4-5 Aug. (2); *Pieris japonica* (eri1) 16-18 Apr. (1); *Hydrangea paniculata* (hyd3) 4-5 Aug. (1)

Andrena prostomias
Deutzia crenata (sax2) 16-17 Jun. (3); *Deutzia crenata* var. *floribunda* (sax6) 16-17 Jun. (8)

Andrena mikado
Salix sieboldiana (sal3) 11-16 May (2); *Pieris japonica* (eri1) 16-18 Apr. (1); *Rhododendron kiusuanum* (eri4) 26-29 May (2); *Rhododendron reticulatum* (eri3) 11-16 May (4)

Andrena longitibialis
Salix sieboldiana (sal3) 11-16 May (11); *Rhododendron kiusuanum* (eri4) 26-29 May (2); *Rhododendron reticulatum* (eri3) 11-16 May (1); *Hydrangea luteo-venosa* (hyd1) 26-29 May (1)

Andrena watasei
Viola grypoceras (vio2) 16-18 Apr. (2); *Viola orientalis* (vio1) 16-18 Apr. (2); *Pieris japonica* (eri1) 16-18 Apr. (1); *Weigela japonica* (cap2) 26-29 May (1)

Andrena halictoides
Weigela japonica (cap2) 26-29 May (1)

Andrena benefica
Salix sieboldiana (sal3) 11-16 May (3)

Andrena hikosana
Deutzia crenata (sax2) 16-17 Jun. (1)

Andrena komachi
Ranunculus japonicus (ran1) 11-16 May (1); *Pieris japonica* (eri1) 16-18 Apr. (1); *Potentilla freyniana* (ros1) 11-16 May (1)

Andrena kaguya
Ranunculus japonicus (ran1) 11-16 May (1); *Viola orientalis* (vio1) 16-18 Apr. (1)

Andrena minutula
Viola orientalis (vio1) 16-18 Apr. (1); *Potentilla freyniana* (ros1) 16-18 Apr. (3)

Andrena sp.1

Gentiana zollingeri (gen5) 16-18 Apr. (1)

Megachilidae

Coelioxys sp.1
Dianthus superbus var. *longicalyc* (car3) 10-16 Jul. (1)

Megachile tsurugensis
Cirsium japonicum (ast3) 16-17 Jun. (1); *Cirsium suffultum* (ast16) 17-22 Sep. (1)

Megachile japonica
Cirsium japonicum (ast3) 16-17 Jun. (1)

Megachile remota sakagamii
Lespedeza bicolor (fab3) 4-5 Aug. (1)

Anthophoridae

Ceratina japonica
Ranunculus japonicus (ran1) 11-16 May (1); *Viola grypoceras* (vio2) 16-18 Apr. (1); *Pieris japonica* (eri1) 16-18 Apr. (1); *Rhododendron kiusuanum* (eri4) 26-29 May (2); *Hydrangea luteo-venosa* (hyd1) 26-29 May (1); *Rubus parvifolius* (ros8) 16-17 Jun. (1); *Lespedeza bicolor* (fab3) 24-26 Aug. (5); *Sophora flavescens* (fab1) 16-17 Jun. (2); *Geranium shikokianum* (ger1) 17-22 Sep. (3); *Prunella vulgaris* var. *lilacina* (lam1) 10-16 Jul. (2), 16-17 Jun. (1); *Abelia serrata* (cap1) 26-29 May (1); *Weigela japonica* (cap2) 26-29 May (1); *Aster ageratoides* ssp. *leiophyllus* (ast21) 17-22 Sep. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (3); *Cirsium suffultum* (ast16) 17-22 Sep. (1)

Ceratina flavipes
Ranunculus japonicus (ran1) 26-29 May (1); *Lespedeza bicolor* (fab3) 24-26 Aug. (2); *Geranium shikokianum* (ger1) 4-5 Aug. (1); *Prunella vulgaris* var. *lilacina* (lam1) 10-16 Jul. (1); *Weigela decora* (cap6) 16-17 Jun. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (2); *Inula japonica* (ast14) 24-26 Aug. (1)

Ceratina megastigmata
Lespedeza bicolor (fab3) 24-26 Aug. (1); *Geranium shikokianum* (ger1) 17-22 Sep. (9); *Weigela japonica* (cap2) 26-29 May (1); *Aster ageratoides* ssp. *leiophyllus* (ast21) 17-22 Sep. (3); *Aster scaber* (ast19) 17-22 Sep. (1); *Cirsium suffultum* (ast16) 17-22 Sep. (6); *Inula salicina* var. *asiatica* (ast20) 17-22 Sep. (1)

Ceratina iwatai
Prunella vulgaris var. *lilacina* (lam1) 10-16 Jul. (1)

Nomada diervillae
Pieris japonica (eri1) 16-18 Apr. (1)

Nomada japonica
Cirsium japonicum (ast3) 16-17 Jun. (1)

Nomada asozuana
Rhododendron kiusuanum (eri4) 26-29 May (1)

Nomada mutsuensis
Viola grypoceras (vio2) 16-18 Apr. (1)

Nomada muinensis
Erigeron annuus (ast5) 16-17 Jun. (1)

Nomada sp.1
Erigeron annuus (ast5) 16-17 Jun. (1)

Tetralonia nipponensis

Corydalis lineariloba (pap1) 16-18 Apr. (1); *Viola grypoceras* (vio2) 16-18 Apr. (2); *Viola orientalis* (vio1) 16-18 Apr. (1); *Weigela decora* (cap6) 16-17 Jun. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (6); *Iris rossii* (iri1) 11-16 May (1), 16-18 Apr. (6)

Apidae

Bombus diversus diversus

Aconitum japonicum ssp. *napiform* (ran3) 17-22 Sep. (1); *Ranunculus japonicus* (ran1) 11-16 May (1); *Potentilla freyniana* (ros1) 11-16 May (1); *Spiraea japonica* (ros9) 4-5 Aug. (1); *Lespedeza bicolor* (fab3) 17-22 Sep. (1), 24-26 Aug. (1); *Sophora flavescens* (fab1) 10-16 Jul. (1), 16-17 Jun. (7); *Vicia unijuga* (fab2) 16-17 Jun. (1); *Geranium shikokianum* (ger1) 17-22 Sep. (1); *Cirsium japonicum* (ast3) 10-16 Jul. (2), 16-17 Jun. (6); *Cirsium suffultum* (ast16) 17-22 Sep. (2); *Ligularia japonica* (ast6) 10-16 Jul. (3); *Synurus excelsus* (ast25) 14-16 Oct. (3); *Hemerocallis vespertina* (lil8) 10-16 Jul. (1), 4-5 Aug. (1)

Bombus ardens ardens

Lyonia ovalifolia var. *elliptica* (eri6) 16-17 Jun. (1); *Rhododendron kiusuanum* (eri4) 16-17 Jun. (1), 26-29 May (1); *Styrax japonica* (sty1) 16-17 Jun. (10); *Deutzia crenata* (sax2) 16-17 Jun. (2); *Rubus parvifolius* (ros8) 16-17 Jun. (1); *Rubus phoenicolasius* (ros6) 26-29 May (1); *Benthamidia japonica* (cor2) 16-17 Jun. (1); *Weigela decora* (cap6) 16-17 Jun. (2); *Weigela japonica* (cap2) 26-29 May (5)

Bombus ignitus

Spiraea japonica (ros9) 4-5 Aug. (1); *Lespedeza bicolor* (fab3) 17-22 Sep. (1), 24-26 Aug. (8); *Sophora flavescens* (fab1) 16-17 Jun. (1); *Adenophora triphylla* (cam1) 4-5 Aug. (1); *Weigela decora* (cap6) 16-17 Jun. (7); *Cirsium japonicum* (ast3) 16-17 Jun. (2); *Cirsium suffultum* (ast16) 14-16 Oct. (2), 17-22 Sep. (26); *Echinops setifer* (ast15) 24-26 Aug. (5); *Ligularia japonica* (ast6) 10-16 Jul. (1); *Allium thunbergii* (lil13) 17-22 Sep. (1)

Apis cerana

Polygonum cuspidatum (pol3) 24-26 Aug. (4); *Lespedeza bicolor* (fab3) 17-22 Sep. (2), 24-26 Aug. (1)

Apis mellifera

Cimicifuga acerina (ran2) 17-22 Sep. (1); *Polygonum cuspidatum* (pol3) 24-26 Aug. (3); *Hydrangea paniculata* (hyd3) 4-5 Aug. (3); *Hydrangea serrata* (hyd2) 10-16 Jul. (3); *Lespedeza bicolor* (fab3) 17-22 Sep. (9), 24-26 Aug. (4); *Isodon inflexus* (lam2) 17-22 Sep. (1); *Abelia serrata* (cap1) 26-29 May (1); *Echinops setifer* (ast15) 24-26 Aug. (3); *Saussurea yanagisawae* var. *nivea* (ast17) 17-22 Sep. (1); *Allium thunbergii* (lil13) 17-22 Sep. (1); *Hemerocallis vespertina* (lil8) 4-5 Aug. (1)

MECOPTERA

Panorpidae

Panorpa trizonata

Geranium shikokianum (ger1) 4-5 Aug. (1); *Angelica longeradiata* (api2) 24-26 Aug. (1)

DIPTERA

Tipulidae

sp.1

Prunus jamasakura (ros3) 11-16 May (1)

sp.2

Salix sieboldiana (sal3) 11-16 May (1)

sp.3

Abelia serrata (cap1) 11-16 May (1)

sp.4

Arisaema japonicum (ara1) 26-29 May (1)

sp.5
Salix sieboldiana (sal3) 11-16 May (1)

Culicidae

sp.1
Polygonum filiforme (pol2) 24-26 Aug. (1)

Chironomidae

sp.1
Viola grypoceras (vio2) 16-18 Apr. (1)

Ceratopagonidae

sp.1
Cephalanthera falcata (orc1) 11-16 May (1)

sp.2
Salix sieboldiana (sal3) 11-16 May (1)

sp.3
Prunus jamasakura (ros3) 11-16 May (1)

sp.4
Pieris japonica (eri1) 16-18 Apr. (3)

Bibionidae

Bibio sp.1
Viola grypoceras (vio2) 16-18 Apr. (1); *Salix sieboldiana* (sal3) 11-16 May (3); *Pieris japonica* (eri1) 16-18 Apr. (3)

Bibio sp.2
Lyonia ovalifolia var. *elliptica* (eri6) 16-17 Jun. (2)

Bibio simulans
Salix sieboldiana (sal3) 11-16 May (1)

Bibio sp.3
Pieris japonica (eri1) 16-18 Apr. (1)

Bibio sp.4
Salix sieboldiana (sal3) 11-16 May (1)

Bibio gracilipalpus
Viola grypoceras (vio2) 16-18 Apr. (1); *Salix sieboldiana* (sal3) 11-16 May (28); *Salix vulpina* (sal1) 16-18 Apr. (1); *Pieris japonica* (eri1) 16-18 Apr. (2)

Bibio aneuretus
Pieris japonica (eri1) 16-18 Apr. (11)

Bibio sp.5
Prunus jamasakura (ros3) 11-16 May (1)

Cecidomyiidae

sp.1
Polygonum filiforme (pol2) 24-26 Aug. (1)

Mycetophilidae

sp.1
Arisaema japonicum (ara1) 26-29 May (2)

sp.2
Salix sieboldiana (sal3) 11-16 May (1)

sp.3
Arisaema japonicum (ara1) 26-29 May (1)

sp.4
Prunus jamasakura (ros3) 11-16 May (1)

sp.5
Salix sieboldiana (sal3) 11-16 May (1)

sp.6
Prunus jamasakura (ros3) 11-16 May (1)

sp.7
Arisaema japonicum (ara1) 26-29 May (1)

sp.8
Arisaema japonicum (ara1) 16-17 Jun. (1)

sp.9
Arisaema japonicum (ara1) 26-29 May (1)

sp.10
Arisaema japonicum (ara1) 16-18 Apr. (1)

sp.11
Arisaema japonicum (ara1) 26-29 May (1)

Sciaridae

sp.1
Arisaema japonicum (ara1) 26-29 May (1)

sp.2
Arisaema japonicum (ara1) 16-18 Apr. (1)

sp.3
Pieris japonica (eri1) 16-18 Apr. (1)

sp.4
Arisaema japonicum (ara1) 16-18 Apr. (1)

sp.5
Pieris japonica (eri1) 16-18 Apr. (1)

sp.6
Arisaema japonicum (ara1) 16-18 Apr. (1)

sp.7

Arisaema japonicum (aral) 26-29 May (1)

Acroceridae

Philopota nigroaenea

Rhododendron kiusuanum (eri4) 26-29 May (4); *Hydrangea luteo-venosa* (hyd1) 26-29 May (1); *Deutzia crenata* (sax2) 16-17 Jun. (2); *Deutzia crenata* var. *floribunda* (sax6) 16-17 Jun. (1); *Abelia serrata* (cap1) 11-16 May (1), 26-29 May (7); *Weigela japonica* (cap2) 26-29 May (2)

Bombyliidae

Bombylus major

Viola grypoceras (vio2) 16-18 Apr. (4); *Viola hondoensis* (vio3) 16-18 Apr. (1); *Rhododendron kiusuanum* (eri4) 26-29 May (2); *Rhododendron reticulatum* (eri3) 11-16 May (3)

Asilidae

Neaitamus angusticornis

Hydrangea luteo-venosa (hyd1) 26-29 May (2)

Empididae

sp.1

Deutzia crenata (sax2) 16-17 Jun. (2); *Schizophragma hydrangeoides* (sax7) 16-17 Jun. (1)

sp.2

Potentilla freyniana (ros1) 11-16 May (1)

sp.3

Viola grypoceras (vio2) 16-18 Apr. (1)

sp.4

Viburnum dilatatum (cap5) 16-17 Jun. (1)

sp.5

Prunus jamasakura (ros3) 11-16 May (1)

sp.6

Viburnum dilatatum (cap5) 16-17 Jun. (1)

sp.7

Arisaema japonicum (aral) 26-29 May (1)

sp.8

Salix sieboldiana (sal3) 11-16 May (1)

sp.9

Abelia serrata (cap1) 11-16 May (1)

Euthyneura sp.1

Ranunculus japonicus (ran1) 11-16 May (1); *Prunus jamasakura* (ros3) 11-16 May (1); *Abelia serrata* (cap1) 11-16 May (1)

sp.10

Abelia serrata (cap1) 11-16 May (1)

Pipunculidae

Pipunculus sp.1

Staphylea bumalda (sta1) 11-16 May (1)

Syrphidae

Eristalis tenax
Ranunculus japonicus (ran1) 26-29 May (1); *Polygonum cuspidatum* (pol3) 24-26 Aug. (1); *Rhododendron kiusuanum* (eri4) 26-29 May (1); *Spiraea japonica* (ros9) 4-5 Aug. (1); *Benthamidia japonica* (cor2) 16-17 Jun. (1); *Viburnum dilatatum* (cap5) 16-17 Jun. (1); *Viburnum erosum* var. *punctatum* (cap3) 26-29 May (1); *Valeriana fauriei* (val1) 16-17 Jun. (2), 26-29 May (2); *Anaphalis margaritacea* var. *angus* (ast13) 24-26 Aug. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (5); *Ixeris dentata* (ast1) 26-29 May (1); *Ligularia fischerii* var. *takeyuki* (ast8) 10-16 Jul. (2), 4-5 Aug. (1); *Ligularia japonica* (ast6) 10-16 Jul. (2); *Saussurea gracilis* (ast12) 24-26 Aug. (1); *Hemerocallis vespertina* (lil8) 4-5 Aug. (2)

Dideaides coquilletti
Weigela japonica (cap2) 26-29 May (1)

Volucella jeddona
Cirsium japonicum (ast3) 16-17 Jun. (1)

Syrphus torvus
Quercus dentata (fag1) 11-16 May (2)

Epistrophe aino
Benthamidia japonica (cor2) 16-17 Jun. (2)

Syrphus vitripernis
Salix sieboldiana (sal3) 11-16 May (1)

Eristalis cerealis
Castanea crenata (fag2) 16-17 Jun. (1); *Polygonum cuspidatum* (pol3) 24-26 Aug. (1); *Deutzia crenata* var. *floribunda* (sax6) 10-16 Jul. (3); *Benthamidia japonica* (cor2) 16-17 Jun. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (1); *Heteropappus hispidus* (ast22) 17-22 Sep. (1)

Helophilus virgatus
Pieris japonica (eri1) 16-18 Apr. (1); *Deutzia crenata* (sax2) 16-17 Jun. (1); *Deutzia crenata* var. *floribunda* (sax6) 10-16 Jul. (1); *Abelia serrata* (cap1) 26-29 May (1); *Viburnum erosum* var. *punctatum* (cap3) 26-29 May (1)

Epioyrphus balteatus
Allium thunbergii (lil13) 17-22 Sep. (2)

Baccha maculata
Astilbe thunbergii (sax5) 10-16 Jul. (1)

Allobaccha apicalis
Weigela japonica (cap2) 26-29 May (1)

Betasyrphus serarius
Deutzia crenata (sax2) 16-17 Jun. (1); *Prunella vulgaris* var. *lilacina* (lam1) 10-16 Jul. (3); *Viburnum erosum* var. *punctatum* (cap3) 26-29 May (1); *Cirsium japonicum* (ast3) 16-17 Jun. (1); *Eupatorium chinense* (ast9) 4-5 Aug. (1)

Scaeva komabensis
Lespedeza bicolor (fab3) 24-26 Aug. (1); *Allium thunbergii* (lil13) 17-22 Sep. (1)

Cheilosia sp.5
Potentilla freyniana (ros1) 16-18 Apr. (1)

Melangyna sp.1
Potentilla freyniana (ros1) 16-18 Apr. (1)

Meliscaeva cinctella
Galium japonicum (rub1) 11-16 May (1)

Sphaerophoria macrogaster
Dianthus superbus var. *longicalyc* (car3) 10-16 Jul. (1); *Veronica rotunda* var. *petiolata* (scr1) 4-5 Aug. (1); *Ixeris dentata* (ast1) 11-16 May (3), 26-29 May (2); *Chionographis japonica* (lil6) 16-17 Jun. (3), 26-29 May (1)

Paragus quadrifasciatus
Hydrocotyle ramiflora (api1) 16-17 Jun. (1); *Galium verum* (rub2) 10-16 Jul. (2)

Melanastoma scalare
Ranunculus japonicus (ran1) 11-16 May (1); *Moehringia lateriflora* (car2) 26-29 May (2); *Hydrangea luteo-venosa* (hyd1) 26-29 May (1); *Prunus jamasakura* (ros3) 11-16 May (1); *Prunella vulgaris* var. *lilacina* (lam1) 10-16 Jul. (1); *Ixeris dentata* (ast1) 26-29 May (1)

Paragus jozanus
Deutzia crenata var. *floribunda* (sax6) 10-16 Jul. (1); *Parnassia palustris* (sax8) 14-16 Oct. (1); *Hydrocotyle ramiflora* (api1) 16-17 Jun. (1)

Cheilosia sp.1
Ranunculus japonicus (ran1) 11-16 May (1); *Potentilla freyniana* (ros1) 11-16 May (1)

Cheilosia sp.2
Deutzia crenata (sax2) 16-17 Jun. (1)

Cheilosia sp.3
Astilbe thunbergii (sax5) 10-16 Jul. (1); *Deutzia crenata* (sax2) 16-17 Jun. (1)

Sphaerophoria philanthus
Pseudostellaria heterantha (car1) 11-16 May (1); *Polygonum cuspidatum* (pol3) 24-26 Aug. (1); *Arabis glabra* (bra1) 16-17 Jun. (1); *Rhododendron kiusuanum* (eri4) 26-29 May (1); *Lysimachia clethroides* (pri1) 10-16 Jul. (1); *Hydrangea luteo-venosa* (hyd1) 26-29 May (1); *Astilbe thunbergii* (sax5) 10-16 Jul. (1); *Deutzia crenata* (sax2) 16-17 Jun. (1); *Sophora flavescens* (fab1) 16-17 Jun. (1); *Vicia unijuga* (fab2) 16-17 Jun. (1); *Angelica cartilagino-marginata* (api3) 24-26 Aug. (1); *Veronica rotunda* var. *petiolata* (scr1) 4-5 Aug. (1); *Cirsium japonicum* (ast3) 16-17 Jun. (3); *Erigeron annuus* (ast5) 16-17 Jun. (1); *Ixeris dentata* (ast1) 11-16 May (1), 26-29 May (4); *Senecio pierotii* (ast2) 26-29 May (1)

Paragus haemorrhous
Heteropappus hispidus (ast22) 17-22 Sep. (1)

Platycheirus clypeatus
Rhododendron kiusuanum (eri4) 26-29 May (1); *Ixeris dentata* (ast1) 26-29 May (1)

Eumerus sp.1
Hydrangea luteo-venosa (hyd1) 26-29 May (1)

Allobaccha sp.1
Deutzia crenata (sax2) 16-17 Jun. (1)

Cheilosia sp.4
Viola orientalis (vio1) 11-16 May (1)

Platycheirus urakawensis
Ranunculus japonicus (ran1) 11-16 May (1); *Viola orientalis* (vio1) 16-18 Apr. (1); *Potentilla freyniana* (ros1) 11-16 May (1)

Conopidae

Zodion sp.1
Deutzia crenata (sax2) 16-17 Jun. (1)

Tephritidae

Urophora sachalinensis
Erigeron annuus (ast5) 16-17 Jun. (1); *Erigeron philadelphicus* (ast4) 16-17 Jun. (1)

Campiglossa hirayamae
Lysimachia clethroides (pri1) 10-16 Jul. (1)

Sepsidae

Sepsis sp.1
Rubus parvifolius (ros8) 16-17 Jun. (1)

Lauxaniidae

Homoneura sp.1
Salix sieboldiana (sal3) 11-16 May (2)

Homoneura sp.2
Weigela decora (cap6) 16-17 Jun. (1)

Agromyzidae

Liriomyza sp.1
Lyonia ovalifolia var. *elliptica* (eri6) 16-17 Jun. (1)

Chloropidae

sp.1
Salix sieboldiana (sal3) 11-16 May (1)

sp.2
Prunus jamasakura (ros3) 11-16 May (1)

Drosophilidae

Drosophila sp.1
Polygonum filiforme (pol2) 24-26 Aug. (1)

Drosophila sp.2
Lindera sericea (lau1) 16-18 Apr. (1)

Sphaeroceridae

Copromyza sp.1
Pieris japonica (eri1) 16-18 Apr. (1)

Anthomyiidae

Lasiomma sp.1
Salix vulpina (sal1) 16-18 Apr. (23)

Hydrophoria sp.1
Salix vulpina (sal1) 16-18 Apr. (5)

Hylmyia sp.1
Salix sieboldiana (sal3) 11-16 May (2); *Prunus jamasakura* (ros3) 11-16 May (2)

Delia sp.1
Salix sieboldiana (sal3) 11-16 May (1); *Hydrangea serrata* (hyd2) 10-16 Jul. (1); *Deutzia crenata* var. *floribunda* (sax6) 10-16 Jul. (8)

Delia sp.2
Salix sieboldiana (sal3) 11-16 May (1)

Delia sp.3
Pieris japonica (eri1) 16-18 Apr. (1)

Delia sp.4
Cephalanthera falcata (orc1) 11-16 May (1)

Delia sp.5
Rhododendron kiusuanum (eri4) 16-17 Jun. (1)

Muscidae

sp.1
Anaphalis margaritacea var. *angus* (ast13) 24-26 Aug. (1)

Calliphoridae

Stomorhina obsoleta
Polygonum cuspidatum (pol3) 24-26 Aug. (18); *Clethra barvinervis* (cle1) 4-5 Aug. (3); *Hydrangea paniculata* (hyd3) 4-5 Aug. (1); *Astilbe thunbergii* (sax5) 10-16 Jul. (2); *Deutzia crenata* (sax2) 16-17 Jun. (1); *Deutzia crenata* var. *floribunda* (sax6) 10-16 Jul. (3); *Patrinia scabiosaefolia* (val3) 17-22 Sep. (1)

sp.1
Hypericum pseudopetiolatum (clu1) 17-22 Sep. (1)

sp.2
Quercus dentata (fag1) 11-16 May (1); *Polygonum cuspidatum* (pol3) 24-26 Aug. (3)

Aldrichina grahami
Benthamidia japonica (cor2) 16-17 Jun. (2)

Eurychaeta sp.1
Sanguisorba officinalis (ros11) 17-22 Sep. (1)

sp.3
Hydrangea luteo-venosa (hyd1) 26-29 May (1)

Sarcophagidae

Ravinia sp.1
Benthamidia japonica (cor2) 16-17 Jun. (1)

Tachinidae

Linnaenya sp.1
Chionographis japonica (lil6) 16-17 Jun. (1)

Tachina sp.1
Viola grypoceras (vio2) 16-18 Apr. (1)

Sisyropa sp.1
Deutzia crenata var. *floribunda* (sax6) 10-16 Jul. (1)

Meigenia sp.1
Veratrum maackii var. *maackii* (lil10) 4-5 Aug. (1)

Meigenia sp.2
Clethra barvinervis (cle1) 4-5 Aug. (1)

Phebellia sp.1
Benthamidia japonica (cor2) 16-17 Jun. (1)

Eumea sp.1
Veratrum maackii var. *maackii* (lil10) 4-5 Aug. (1)

Eumea sp.2
Veratrum maackii var. *maackii* (lil10) 4-5 Aug. (1)

Prosena siberita
Geranium shikokianum (ger1) 24-26 Aug. (1)

Prosena sp.1
Lespedeza bicolor (fab3) 24-26 Aug. (2); *Cirsium suffultum* (ast16) 17-22 Sep. (2); *Echinops setifer* (ast15) 24-26 Aug. (1)

Peribaea sp.1
Lysimachia clethroides (pri1) 10-16 Jul. (1); *Astilbe thunbergii* (sax5) 10-16 Jul. (2); *Deutzia crenata* (sax2) 16-17 Jun. (1); *Viburnum dilatatum* (cap5) 16-17 Jun. (1); *Valeriana fauriei* (val1) 16-17 Jun. (1); *Erigeron annuus* (ast5) 16-17 Jun. (1); *Ixeris dentata* (ast1) 11-16 May (1); *Ligularia japonica* (ast6) 10-16 Jul. (1)

Siphona sp.1
Castanea crenata (fag2) 16-17 Jun. (1); *Lysimachia clethroides* (pri1) 10-16 Jul. (3); *Astilbe thunbergii* (sax5) 10-16 Jul. (2)

Fischeria sp.1
Astilbe thunbergii (sax5) 10-16 Jul. (1)

LEPIDOPTERA

Incurvariidae

Nemophora umbripennis
Deutzia crenata (sax2) 16-17 Jun. (1)

Tortricidae

sp.1
Salix sieboldiana (sal3) 11-16 May (1)

sp.2
Benthamidia japonica (cor2) 16-17 Jun. (1)

Zygaenidae

Balataea gracilis
Erigeron annuus (ast5) 16-17 Jun. (1)

Thyrididae

Scirpophaga sp.1
Viola orientalis (viol) 16-18 Apr. (1)

Hesperiidae

Thoressa varia
Cirsium japonicum (ast3) 16-17 Jun. (1)

Polytremis pellucida pellucida
Lysimachia clethroides (pri1) 10-16 Jul. (1); *Ligularia japonica* (ast6) 10-16 Jul. (1)

Parnara guttata guttata
Cirsium japonicum (ast3) 10-16 Jul. (2); *Cirsium suffultum* (ast16) 17-22 Sep. (1); *Echinops setifer* (ast15) 24-26 Aug. (1); *Ligularia japonica* (ast6) 24-26 Aug. (1); *Hemerocallis vespertina* (lil8) 4-5 Aug. (1)

Ochlodes ochraceus
Astilbe thunbergii (sax5) 10-16 Jul. (1); *Prunella vulgaris* var. *lilacina* (lam1) 10-16 Jul. (13); *Cirsium japonicum* (ast3) 10-16 Jul. (1)

Papilionidae

Papilio machaon hippocrates
Cirsium suffultum (ast16) 17-22 Sep. (1); *Echinops setifer* (ast15) 24-26 Aug. (1); *Inula japonica* (ast14) 24-26 Aug. (1); *Lilium leichtlinii* var. *maximowic* (lil12) 24-26 Aug. (1)

Papilio bianor dehaanii
Ligularia japonica (ast6) 10-16 Jul. (4)

Pieridae

Pieris melete melete
Deutzia crenata (sax2) 16-17 Jun. (1); *Cirsium japonicum* (ast3) 10-16 Jul. (1), 16-17 Jun. (2)

Lycaenidae

Maculinea teleius kazamoto
Adenophora triphylla (cam1) 4-5 Aug. (2)

Lycaena phlaeas daimio
Lysimachia clethroides (pri1) 10-16 Jul. (4); *Ligularia japonica* (ast6) 10-16 Jul. (1)

Nymphalidae

Fabriciana adippe pallescens
Lysimachia clethroides (pri1) 10-16 Jul. (2); *Spiraea japonica* (ros9) 10-16 Jul. (1); *Prunella vulgaris* var. *lilacina* (lam1) 10-16 Jul. (1); *Cirsium japonicum* (ast3) 10-16 Jul. (3), 16-17 Jun. (3); *Ligularia fischerii* var. *takeyuki* (ast8) 10-16 Jul. (5)

Fabriciana nerippe
Lysimachia clethroides (pri1) 10-16 Jul. (1)

Vanessa indica
Cirsium suffultum (ast16) 17-22 Sep. (1)

Neptis sappho intermedia
Sophora flavescens (fab1) 16-17 Jun. (1)

Argyronome ruslana lysippe
Ligularia japonica (ast6) 10-16 Jul. (1)

Neope niphonica niphonica
Quercus dentata (fagl) 11-16 May (1)

Minois dryas bipunctata
Adenophora triphylla (caml) 4-5 Aug. (1)

Sphingidae

Ampelophaga rubiginosa
Hemerocallis vespertina (lil8) 4-5 Aug. (1)

Macroglossum bombylaus
Ligularia japonica (ast6) 10-16 Jul. (1)

Macroglossum stellatarum
Cirsium japonicum (ast3) 16-17 Jun. (1)

Macroglossum sp.1
Cirsium suffultum (ast16) 17-22 Sep. (1)

Lymantriidae

Ivela auripes
Benthamidia japonica (cor2) 16-17 Jun. (1)

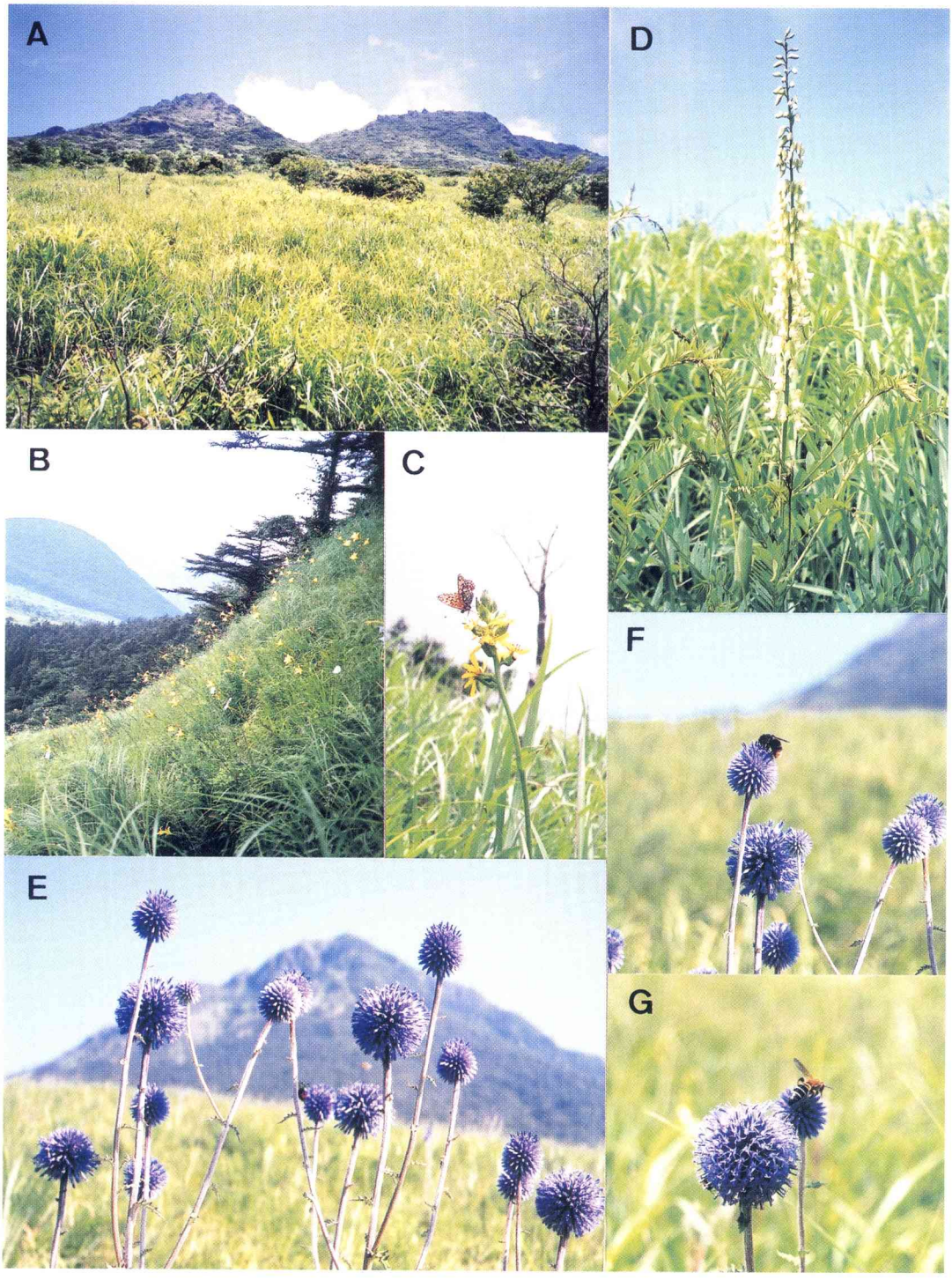
Plate 4. Landscapes and flowers in April at Mt. Yufu

A, Mt Yufu viewed from the base, showing an extensive semi-natural grassland at the foot and a hilside natural grassland halfway up the mountain (left side); **B**, field survey at the natural grassland; **C**, a traditionally managed grassland after burning in March, with many *Viola orientalis* flowers blooming; **D**, an *Iris rossii* flower; **E**, *Viola orientalis* flowers visited by oedemerid beetles; **F**, a *Viola orientalis* flower visited by a syrphid fly.

Plate 5. Grasslands and flowers in August at Mt Yufu

A, a hillside grassland dominated by *Miscanthus sinensis*; **B**, a semi-natural grassland blooming with *Hemerocallis vespertina*; **C**, *Ligularia fischerii* var. *takeuki* flowers visited by a nymphalid butterfly, *Fabriciana adippe pallescens*; **D**, a *Sophora flavescens* plant in a semi-natural grassland; **E**, *Echinops septifer* stands against the background of Mt. Yufu; **F**, **G**, *Echinops septifer* flowers respectively visited by a *Bombus ignitus* worker and a scoliid wasp, *Campsomeriella annulata annulata*.


A
B
C
D
E
F


A
D
B
C
F
E
G