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<th>Flowering phenology and anthophilous insect community at a threatened natural lowland marsh at Nakaikemi in Tsuruga, Japan</th>
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<td>KATO, Makoto; MIURA, Reiichi</td>
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Kyoto University
Flowering phenology and anthophilous insect community
at a threatened natural lowland marsh at Nakaikemi in Tsuruga, Japan

Makoto Kato and Reiichi Miura

ABSTRACT Nakaikemi marsh, located in Fukui Prefecture, is one of only a few natural
lowland marshlands left in western Japan, and harbors many endangered marsh plants and animals.
Flowering phenology and anthophilous insect communities on 64 plant species of 35 families
were studied in the marsh in 1994-95. A total of 936 individuals of 215 species in eight orders
of Insecta were collected on flowers from mid April to mid October. The anthophilous insect
community was characterized by dominance of Diptera (58% of individuals) and relative paucity
of Hymenoptera (26%), Hemiptera (6%), Lepidoptera (5%), and Coleoptera (5%). Syrphidae
was the most abundant family and probably the most important pollination agents. Bee community
was characterized by dominance of an aboveground nesting bee genus, Hylaeus (Colletidae), the
most abundant species of which was a minute, rare little-recorded species. Cluster analysis on
flower-visiting insect spectra grouped 64 plant species into seven clusters, which were respectively
classified by dominance of small or large bees (18 spp.), syrphid flies (13 spp.), Calyptrate
and other flies (11 spp.), wasps and middle-sized bees (8 spp.), Lepidoptera (2 spp.), Coleoptera
(1 sp.) and a mixture of these various insects (11 spp.). These flower guilds largely coincided
with pollination guilds with some exceptions such as anemophilous grasses visited by specific
syrphid flies. The flower-insect relationship in the marsh was discriminated from that in woodlands
by rarity of specialized relationships and by prevalence of relationships between flowers and flies,
most larvae of which grow in waterlogged habitats. Nakaikemi marsh is regarded as a rare,
important wetland habitat not only harboring many endangered plant and anthophilous insect
species but also fostering unique insect-flower relationships. The presence of some plant species
originally pollinated by bumblebees nesting at forest floor suggests that the marshland should
be conserved as a whole ecosystem uniting the marshland and the neighboring woodlands.

KEY WORDS flowering phenology / pollination / wetland / marsh / bees / Syrphidae

Introduction

Lowland marshland is one of the most endangered ecosystems in Japan as well as in other
countries (Dugan, 1990; Williams, 1990; Richards, 1990). The marshland in Japan has been
reclaimed and utilized as rice field since more than 2000 years ago. These traditional rice fields
were habitats of various aquatic and subaquatic plants and animals which originally inhabited
in marshlands. Recent changes of cultivation system accompanied by overuse of insecticides and
herbicides has exterminated many of these aquatic organisms (Red Data Book Committee Japan,
1989; Kadono, 1994).

Recent decline of population size and species diversity of inhabitants in wetlands appears
to result in changes of interactions and partnerships between plants and animals. One example
is Primula sieboldii, a perennial which was widely distributed in swamps and marshlands along
rivers but now is endangered. In Kanto District, this species survives only at one isolated site
along Arakawa River, but its seed-set rates are very low due to extinction of its legal pollinators,
i.e., long-tongued bumblebees (Washitani et al., 1991; Washitani et al., 1995). It is urgently
necessary to understand original flower-insect relationships at lowland habitats since the condition
of almost all wetland habitats are rapidly degrading.

There are many studies on anthophilous bee fauna in Japan (Sakagami and Fukuda, 1973; Sakagami et al., 1974; Matsuura et al., 1974; Nakamura and Matsumura, 1985; Inoue et al., 1990; Kakutani et al., 1990; Kato et al., 1990; Ikudome, 1992; Go’ukon, 1993). Most of these studies, however, were conducted in woodlands. The only two studies at wetland are made at cool-temperate meadows (Fukuda et al., 1973; Kato et al., 1993). At natural lowland wetland habitats, anthophilous insect communities have not yet been studied.

In order to understand original flower-insect relationships at lowland wetlands and to propose ground plan to conserve wetland ecosystems, we studied flowering phenology and anthophilous insect community at Nakaikemi marsh in Hokuriku district, Japan. The marshland is one of only a few natural lowland wetlands barely left in Japan, and harbors various types of vegetations such as reed swamps, Typha and Zizania marshes, channels penetrating the marshland, traditionally cultivated rice fields and abandoned rice fields on a way of succession. The marsh is a habitat of many endangered aquatic and marsh plant species (Watanabe, 1989), most of which are extinct in most other localities.

In this paper, firstly, we describe flowering phenology, total anthophilous fauna and flower-visiting insect communities on respective plant species. Secondly, we examine the similarity of flower-visitor spectra among individual plant species. Thirdly, we compare flower-visiting patterns among dominant bee and syrphid fly species. Finally, we compare the anthophilous insect community with those at woodlands in various localities, and discuss characteristics of flower-insect relationships at wetlands.

**Study Site**

Nakaikemi marsh, sometimes called as Kashimagari swamp, is located at 1 km east of Tsuruga city, Fukui Prefecture, Japan (35°39'N, 136°05'E). The marsh is surrounded by low hills covered with natural deciduous forests and planted Cryptomeria forests (Fig. 1). The marsh area is ca. 25 ha, and the altitude ranges from 41 to 48 m.

The marsh is thought to have been originally a reed (Phragmites communis) swamp accompanied by deciduous trees such as alders. About 350 years ago, a part of the marsh was reclaimed and utilized as traditional rice fields. In recent ten years, some of these rice fields were abandoned and are now on a way to return to original vegetation. Thus, the marsh is a mosaic of various types of vegetation; reed swamps, Typha and Zizania marshes, traditionally cultivated rice fields and abandoned rice fields on a way of succession (Plate 1, A-D). Among these vegetation, there are channels in which various aquatic plant species grow. The marsh has been known as the habitat of many endangered aquatic and marsh plant species such as Marsilea quadrifolia (Marsileaceae), Salvinia natans (Salviniaceae), Nymphaea tetragona (Nymphaeaceae), Trapa incisa (Trapaceae), Menyanthes trifoliata (Menyanthaceae), Eusteralis yatabeana (Labiatae), Prenanthes tanakae (Asteraceae), Monochoria korsakowii (Pontederiaceae) and Iris laevigata (Iridaceae) (Watanabe, 1989). Since construction of a highway at west edge of the marsh in 1990’s, alien plant species started to invade some parts of the marsh. The marsh is now threatened by a plan of reclamation and construction of LNG storing plants.
Methods

Surveys on flowering phenology and insect visits to flowers were conducted roughly monthly from mid April to mid October in 1994-95. Sampling dates and weather conditions on the days are shown in Table 1 (Sampling dates are coded in seasonal sequence). We started sampling of flower visiting insects at 0600-0900 and finished at 1200-1400. The sampling method of Kato et al. (1989) was adopted here. We walked on the fixed route in the marsh. When we found flowering plants, we netted insect visitors for about 10 minutes per one location. In the first 8 minutes we caught only insects flying around and visiting to flowers, avoiding harmful effects on flowers. In the last two minutes, we completely swept insects on the flowers.

All insect specimens were pinned and labeled with the complete census data (date, locality and flower species visited). They are classified and identified at species level although some were unidentified. All the specimens are kept in Biological Laboratory, Yoshida College, Kyoto University. Statistical analyses were made by the SAS package in the Data Processing Center, Kyoto University.
Table 1. Sampling dates with weather, number of observed flower species and number of insects collected on flowers.

<table>
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<th>No. insects collected</th>
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Results

1. Studied plants

In Nakaikemi marsh, we studied flowering of 64 plant species (35 families, 55 genera); three shrubs, one climber, 17 annuals and 43 perennials (Table 2). These plant species consist of terrestrial (48.4% of species), marsh (37.5%), emerged (9.4%), floating-leaved (3.1%) and submerged plants (3.1%). All plant species except naturalized Bidens frondosa and cultivated Solanum melongena and Nymphaea marliacea were indigenous, probably including some 'prehistoric-naturalized plants' (Maekawa, 1943). Most species were hermaphrodites, and three were monoecious (Sagittaria trifolia, Hydrocharita dubia and Typha angustifolia). Lythrum anceps showed tristyly, and Monochoria korsakowii and M. vaginalis showed enantiostyly.

Flower shape was classified into six categories; open flowers with radiate dish-bowl corollas (43.8% of species), tubular (23.4%), head (20.3%), cup (6.3%), spikelet (6.3%) and apetalous flowers (1.6%). Tubular flowers were subdivided into short-, middle- and long-tubed ones by the length of corolla tube; 0-5, 5-10, ≥10 mm, respectively. Four long-tubed flowers were Prunella vulgaris, Weigela hortensis, Iris laevigata and Hosta albomarginata. As to flower symmetry, 77.6% were actinomorphic and 22.4% were zygomorphic. Among various flower colors, white was dominant (26.1%) and followed by purple (22.9%), yellow (20.3%), pink (11.4%), green (9.4%), blue (7.8%), cream (1.6%) and brown (1.6%).

2. Flowering phenology

Flowering was observed from mid April to mid October (Fig. 2). The first bloomer was Senecio pierotii (Plate 1, C) and the last was Prenanthes tanakae; both were conspicuous perennial composites in the marsh and had brilliant yellow flowers. Other conspicuous flowers in the marsh were Iris laevigata in May (Plate 1, B), Cardamine lyrata in early June, Hosta albomarginata in July, Persicaria spp., Lythrum anceps, Eusteralis yatabeana (Plate 1, E).
Fig. 2. Flowering phenology of 64 plant species at Nakaikemi marsh. + indicates flowering. Plant species codes are shown in Table 2.
### Table 2

A list of 64 studied plant species in a order of Cronquist (1981), with species code, Japanese name, life form, habit, nativity, breeding system, flower shape, flower symmetry, flower color, number of insects collected on flowers, flower guild expected by a cluster analysis, and pollination guild of each plant species.

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<th>Code</th>
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<th>Japanese name</th>
<th>Life form</th>
<th>Habit</th>
<th>Nativity</th>
<th>Breeding system</th>
<th>Flower shape</th>
<th>Flower symmetry</th>
<th>Flower color</th>
<th>No. of insects collected</th>
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Total 936

1 a, annual; c, climber; p, perennial; s, shrub.
2 e, emerged plants; f, floating-leaved plants; m, marsh plants; s, submerged plants; t, terrestrial plants.
3 c, cultivated; i, indigenous; n, naturalized.
4 e, eanantiostyle hermaphrodite; h, hermaphrodite; m, monoecious; t, tristylistyle hermaphrodite.
5 a, apetalous; c, cup-shaped; h, head; o, open (disk-like); s, spikelet; t, tubular (≤ 5 mm); t2, middle-tubed (5 ≤ tube < 10 mm); t3, long-tubed (≥ 10 mm)
6 a, actinomorphic; z, zygomorphic. Heads are treated as actinomorphic.
7 Color of petal, sepal or bract: bl, blue; br, brown; c, cream; g, green; pk, pink; pl, purple; w, white; y, yellow.
8 characterized by: A, syrphid flies; B, small or large bees; C1, a mixture of various groups of insects; C2, beetles; C3, lepidopterans; C4, wasps or middle-sized bees; C5, caryprate or other flies.
9 in addition to flower guild: W, anemophilous; L, pollinated by long-tongued bumblebees.
Seasonal change in the number of plant species blooming at each sampling date. The number above the column denote sampling codes shown in Table 1.

The number of insect species plotted in the Preston’s octave.

Eupatorium lindleyanum (Plate 1, F) and Monochoria korsakowii (Plate 1, H) in September. In channels, Sagittaria trifolia flowered from July to September and Hydrocharis dubia flowered from September to October (Plate 1, K). The number of aquatic and marsh plant species flowering at each sampling date increased from April to late September, and decreased in October (Fig. 3).

3. Flower-visiting insect community

3-1. Faunal makeup

A total of 936 individuals of 216 species in seven insect orders were collected (Table 3). In Fig. 4, the number of species is plotted in octave of abundance, which is the logarithm of the number of individuals to base 2 (Preston, 1962; May, 1975). The curve is regarded as the truncated log-normal distribution of species abundance. When the data is applied to Fisher's logarithmic series (Fisher et al., 1943), the Fisher’s index of diversity, α, was estimated to be 88.
The relative abundance of individuals was greatest in Diptera (57.2 %), followed by Hymenoptera (26.1 %), Hemiptera (6.1 %), Lepidoptera (5.1 %) and Coleoptera (4.9 %, Fig. 5). The relative number of species was also greatest in Diptera (44.0 %), followed by Hymenoptera (29.7 %), Hemiptera (10.0 %), Coleoptera (9.1 %) and Lepidoptera (5.7 %). The mean number of individuals per species was highest in Diptera (5.8), followed by Lepidoptera (4.0), Hymenoptera (3.9), Hemiptera (2.7) and Coleoptera (2.4). The ranking of individual number of each species is shown in Fig. 6. Five most abundant species were dipterans.
Table 3. A list of insect families collected on flowers at Nakai-kemi with numbers and percentages of species and individuals.

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Flower-Insect Relationship at Nakaikemi Marsh

Hymenoptera

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Total 215 936

1 n, nectarivorous; o, omnivorous; p, pollenivorous; ph, phytophagous; pr, predatory; ps, parasitic; r, reared with hunted prey; s, saprophagous.
2 a, aquatic or subaquatic; t, terrestrial.

3-2. Hemiptera

The most abundant family was Lygaeidae (33.3 %), followed by Cercopidae (15.8 %), Pentatomidae (12.8 %), Deltocephalidae (12.3 %) and Miridae (10.5 %). Two dominant lygaeid species were Nysius plebeius (21.0 %) and Tropidothorax cruciger (12.3 %), both of which were found sucking flowers of Asteriaceae and other plant families.

3-3. Coleoptera

Four dominant families were Chrysomelidae (41.3 %), Scarabaeidae (13.0 %), Curculionidae (10.8 %) and Helodidae (8.7 %). Abundant coleopterous species were Calomicrus sp. (Chrysomelidae, 9) and Oxycetonia jucunda (Scarabaeidae, 6) (Plate 1, F). Cryptophilus sp. (Languriidae) was only visitors to flowers of Typha angustifolia (Typhaceae), and was also reared up from its sampled female spikes.

3-4. Diptera

The most abundant groups were hoverflies (42.8 % in Diptera) and Calyptrate flies (39.3 %). In Syrphidae, 22 species of 17 genera, eight tribes and three subfamilies were recorded (Table 4). Larval feeding types of the hoverflies could be grouped following Ferrar (1987), Owen and Gilbert (1989) and Rotheray (1993): predators (9 genera, 12 species, 90 individuals, 38.8 % in Syrphidae), aquatic or subaquatic saprophages (6 gen., 7 spp., 136 individuals, 58.6 %), herbivores
Table 4. A list of syrphid fly species collected on flowers, with their larval feeding habits, numbers of individuals collected in each month, and sex ratios.

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<th>Jul</th>
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1 a, ant nest inquiline; h, herbivore; p, predator of aphids and other invertebrates; s, aquatic or subaquatic saprophage.
Flower-Insect Relationship at Nakaikemi Marsh

(1 gen., 2 spp., 4 individuals, 1.7 %) and ant nest inquiline (1 gen., 1 sp., 1 individual, 0.5 %).

In Calyptrata, Calliphoridae was most abundant (22.2 %), followed by Muscidae (12.3 %), Tachinidae (2.2 %), Sarcophagidae (1.9 %). Dominant muscid genera, Helina, Limnophora (Plate 1, J) and Lispe, are saprophages in mesic, subaquatic or aquatic habitats (Ferrar, 1987). The calliphorid fly, Stomorhina obsoleta, was the most abundant species in Diptera, and the muscid fly, Helina sp. 1, was the second (Fig. 6). Abundant families other than Calyptrata were Dolichopodidae (4.5 % in Diptera), Ephydridae (3.4 %) and Lauxaniidae (2.4 %); larvae of the former two families are aquatic (Table 3).

3.5. Lepidoptera

The most abundant family was Hesperiidae (58.3 %), followed by Pyralidae (20.8 %), Papilionidae (6.3 %) and Nymphalidae (6.3 %). A grass-feeding skipper, Parnara guttata guttata, was the most abundant species (45.8 %), and a polyphagous pyralid, Hymenura recurvalis, was the second (16.7 %).

3.6. Hymenoptera

The most abundant superfamily of Hymenoptera was Apoidea (69.3 %), followed by Ichneumonoidea (14.3 %) and Vespoida (7.0 %). Rarity of Sphecoidea nesting under ground was characteristic. In Apoidea, 28 species and 169 individuals were collected, and Colletidae was most abundant (36.1 %), followed by Halictidae (23.7 %), Apidae (16.5 %), Anthophoridae (12.4 %), Megachilidae (6.5 %) and Andrenidae (4.7 %) (Table 5). The most abundant bee species was Hylaeus macilentus, followed by H. noomen, Apis cerana and Lasioglossum sibiriacum (Fig. 6). Hylaeus macilentus (Plate 1, I) is a minute rare species which has been

Table 5. A list of bee genera at Nakaikemi marsh, with size class, nest site and relative abundance of them.

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<td>Megachile</td>
<td>m</td>
<td>s</td>
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<tr>
<td></td>
<td></td>
<td>Osmia</td>
<td>m</td>
<td>s</td>
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<td>1</td>
</tr>
<tr>
<td>Anthophoridae</td>
<td>Nomadinae</td>
<td>Nomada</td>
<td>s</td>
<td>p</td>
<td>2</td>
<td>3</td>
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<tr>
<td></td>
<td>Xylocopoidea</td>
<td>Ceratina</td>
<td>s</td>
<td>s</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Xylocopa</td>
<td>l</td>
<td>w</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Apidae</td>
<td>Bombinae</td>
<td>Bombus</td>
<td>g</td>
<td>h</td>
<td>2</td>
<td>8</td>
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<tr>
<td></td>
<td>Apinae</td>
<td>Apis</td>
<td>m</td>
<td>h</td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

Total: 28 169

¹ l, large; m, middle-sized; s, small.
² g, underground; h, tree hollows; p, cleptoparasitic; s, preexisting cavities such as stem hollows or beetle burrows; w, tree burrows bored by itself.
Fig. 7. Seasonal change in the number of insects collected on flowers at each sampling date. Insects are sorted by orders.

Fig. 8. Seasonal change in the proportion of six bee families collected on flowers at Nakaikami marsh.

recorded from only three localities in Hokkaido and Honshu (Ikudome, 1989). *Bombus* was uncommon in the marsh (4.7% of bees). All collected bumblebees except one male of *B. hypocrita* were workers of long-tongued *B. diversus*. In the genus *Apis*, only *A. cerana* was recorded mainly in autumn. A large proportion of bees were aboveground nest makers (65.1%), and 34.9% were underground nest makers.

4. Phenology of flower visitors

The number of collected insects per census had two peaks in early June and late September (Fig. 7). The samples except in May and late July were dominated by dipterans. Dominant hoverfly species were active throughout the flowering season (Table 4). In contrast, the most dominant calliphorid fly, *Stomorhina obsoleta*, was abundant only in autumn. Anthophilous fauna of Hymenoptera was dominated by Colletidae, Halictidae or Apidae except in April and May when Andrenidae was abundant (Fig. 8).
5. Anthophilous insect communities on individual plant species

5.1. Principal component analysis

Anthophilous insect community on each plant species varied greatly among plant species (Appendix 1). In order to search for trends explaining the variance in flower-visiting insect communities, a principal component analysis was made. In this analysis, insects were classified into eleven taxonomic groups; coleopterans, hemipterans, syrphid flies, calypterate flies, other dipterans, lepidopterans, wasps, small bees, middle-sized bees, large bees (bees are categorized as shown in Table 4) and other orders. The percentages of these eleven groups in individual number were defined as a flower-visitor spectrum of each plant species.

The flower visitor spectra of 64 plant species were used as statistics of the principal component analysis. Loadings of 1st and 2nd principal components are shown in Fig. 9. The
major trend involved alternation of dominant insect groups between large bees and calyptrate flies (the first principal component, PC1, being 15.6% of the total variance). The second factor corresponds to dominance of wasps and middle-sized bees over syrphid flies (PC2, 14.4%). It is interesting that wasps and middle-sized bees had similar loading patterns. The third factor was mainly related to alternation of dominant insect groups between calyptrate flies and syrphid flies (PC3, 13.3%). The cumulative percentages of eigenvalues of the first three principal components were 43.3%, suggesting that there are additional factors contributing to the total variance. Scattering plots in Fig. 10 show that there is no clear trend unique to flower shape with the exception of the larger PC1 of long-tubed flowers and the larger PC2 of middle-tubed flowers. In other words, long-tubed and middle-tubed flowers had tendency to be visited by large and middle-sized bees, respectively.

5.2. Cluster analysis

The flower-visitor spectra were also applied for cluster analysis; statistics were the percentages of individuals in respective insect groups. A dendrogram derived from the cluster analysis is shown in Fig. 11. At semi-partial $r^2 = 0.2$, 64 plant species were divided into three clusters. Cluster A was separated from others by predominance of syrphid flies, and was composed of 13 species of Saururaceae (1 sp.), Papaveraceae (1 sp.), Guttiferae (1 sp.), Onagraceae (1 sp.), Plantaginaceae (1 sp.), Scrophulariaceae (2 spp.), Asteraceae (1 sp.), Commelinaceae (2 spp.) and Graminae (3 spp.). A submerged aquatic perennial, *Limnophila sessiliflora*, flowered after water level went down in September, and was visited exclusively by a small syrphid fly, *Sphaerophoria macrogaster* (Plate 1, J).

Cluster B was separated from others by predominance of small or large bees, and was composed of 18 plant species of Nymphaeaceae (1 sp.), Ranunculaceae (1 sp.), Caryophyllaceae (1 sp.), Rosaceae (1 sp.), Leguminosae (1 sp.), Oxalidaceae (1 sp.), Solanaceae (1 sp.), Labiatae (1 sp.), Acanthaceae (1 sp.), Asteraceae (4 spp.), Pontederiaceae (2 spp.), Iridaceae (1 sp.) and Liliaceae (2 spp.). For example, *Iris laevigata* was frequently visited by colletid small bees (Plate 1, I).

The last cluster C was sub-divided into five clusters (Cluster C1-C5) at semi-partial $r^2 = 0.03$. Cluster C1 was characterized by a mixture of various insect groups, and was composed of 11 species of Polygonaceae (1 sp.), Brassicaceae (1 sp.), Lythraceae (1 sp.), Umbelliferae (1 sp.), Labiatae (3 spp.), Campanulaceae (1 sp.), Asteraceae (1 sp.) and Alismataceae (2 spp.). Cluster C2 composed of only *Typha angustifolia* (Typhaceae) and was characterized by dominance of Coleoptera. Cluster C3 was composed of *Clerodendrum trichotomum* (Verbenaceae) and *Weigela hortensis* (Caprifoliaceae), and was characterized by dominance of Lepidoptera. Cluster C4 was separated by dominance of wasps and middle-sized bees, and was composed of 8 plant species of Polygonaceae (1 sp.), Leguminosae (1 sp.), Primulaceae (1 sp.), Vitaceae (1 sp.), Labiatae (1 sp.), Asteraceae (3 spp.). For example, *Ampelopsis brevipedunculata* (Vitaceae) and *Lycopus ramosissimus* were uniquely visited by *Eumenes* spp. (*Eumenidae*) and *Polistes chinensis* (Vespidae), respectively. Naturalized *Bidens frondosa* was visited only by *Apis cerana*. Cluster C5 was characterized by high proportions of calyptrate flies and other dipterans, and was composed of 11 species of Polygonaceae (3 spp.), Rosaceae (1 sp.), Rubiaceae (1 sp.), Asteraceae
Flower-Insect Relationship at Nakaikemi Marsh

Fig. 11. Flower-visitor spectra (sorted by visitor group) of 64 plant species and dendrogram (right) derived from cluster analysis on the flower spectra. Plant species codes are shown in Table 2. Three clusters (A, B and C) were detected at semi-partial $r^2 = 0.2$. The cluster C was subdivided into five clusters at semi-partial $r^2 = 0.03$. 
Fig. 12. Seasonal changes in the number of plant species blooming at each sampling date for each flower guild detected by a cluster analysis in Fig. 11.

(4 spp.), Hydrocharitaceae (1 sp.) and Gramineae (1 sp.). A floating leaved aquatic plant, Hydrocharis dubia, had flowers just above the water surface, and was frequently visited by muscid flies (Plate 1, K), larvae of which are aquatic or subaquatic saprophages. These seven clusters can be regarded as flower guilds based on flower-visits by insect groups.

Flowering phenology was compared among these flower guilds (Fig. 12). Flowers in three guilds (A, B, C1) bloomed sequentially from mid April to mid October. Wasp/middle-sized bee flowers (C4) were summer and autumn bloomers, and calyptrate fly flowers (C5) were autumn bloomers.

5.3. Flower guilds and pollination guilds

In order to detect the factors determining flower guilds, effects of flower shape and flower color on flower guilds were examined. We compared the frequencies of plant species in each flower guild among flower shape, and examined homogeneity of these frequencies by chi-square tests (Table 6). There was no significant correlation between flower shape and flower guilds. Long-tubed flowers were likely to be bee flowers whereas this correlation was not significant ($\chi^2 = 0.29$, $P > 0.05$). As for flower symmetry, zygomorphic flowers had tendency to be bee flowers (8 spp. of 14 zygomorphic species and 18 spp. of 50 actinomorphic ones were bee flowers), whereas this correlation was not significant ($\chi^2 = 2.03$, $P > 0.05$).

Table 7 shows the relationship between flower colors and flower guilds. Significant correlations were detected between blue color and bee flowers ($\chi^2 = 7.22$, $P < 0.01$).
Table 6. Numbers of plant species sorted by flower guild and flower shape.

<table>
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<th>Flower guild</th>
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<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
<th>Total</th>
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<td>0</td>
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<tr>
<td><strong>Total</strong></td>
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<td>13</td>
<td>18</td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>11</td>
<td>64</td>
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</table>

Table 7. Numbers of plant species sorted by flower guild and flower color.

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<th>Flower guild</th>
<th>A</th>
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<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
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<td>0</td>
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<td>13</td>
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<tr>
<td><strong>Total</strong></td>
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<td>18</td>
<td>11</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>11</td>
<td>64</td>
</tr>
</tbody>
</table>

As for breeding systems, monoecious entomophilous species, *Sagittaria trifolia* and *Hydrocharis dubia*, were C1 and C5, respectively. A tristyyle perennial, *Lythrum anceps* and an enantiostyle annual, *Monochoria korsakowii*, were C1 and B, respectively.

By examining flower-visitor communities, floral morphology, visitor behavior and pollen attachment on visitor’s body, we inferred pollination guilds (Table 2). Flower guild expected from cluster analysis largely coincided with pollination guild. There were three kinds of exceptions: (1) four anemophilous plant species, i.e., *Isachne globosa*, *Leesia japonica*, *Phragmites communis* (Gramineae) and *Scirpus triqueter* (Cyperaceae), visited by hoverflies of the tribe Melanostomatini (Plate 1, L) and other flies, (2) one anemophilous plant species, i.e., *Typha angustifolia* (Typhaceae), visited by ovule-parasitic langurid beetles, and (3) long-tubed flower species, *Weigela hortensis* (Caprifoliaceae), *Cirsium sieboldii* (Asteraceae) and *Iris laevigata* (Iridaceae), which were mainly visited by butterflies or small bees (Plate 1, I) but are thought to be originally visited and pollinated by the long-tongued bumblebee, *Bombus diversus*. Enantiosyle flowers of *Monochoria korsakowii* were visited by small bees and syrphid flies (Plate 1, G), whereas they are reported to be visited by larger bees such as *Bombus*, *Xylocopa* and *Apis* in a natural localities (Wang et al., 1995).
6. Floral hosts of anthophilous insects

6.1. General Pattern

Floral host species varied greatly among insect families and species (Appendix 2). The plant families which were most frequently utilized by insects was Asteraceae (25.4% of total visits), followed by Polygonaceae (18.5%), Labiatae (13.7%), Gramineae (4.2%), Iridaceae (4.2%), Rubiaceae (4.2%), Alismataceae (4.1%), Pontederiaceae (3.8%), Lythraceae (2.8%), and Brassicaceae (2.8%). Figure 13 shows a comparison of flower visiting patterns among five dominant insect orders. The orders except Lepidoptera had similar patterns, whereas Hymenoptera did not visit Gramineae. The floral host spectrum of Lepidoptera was characterized by preference to Lythraceae and ignorance of Iridaceae and Pontederiaceae.

6.2. Floral hosts of Diptera

Floral host spectra greatly varied among dominant syrphid fly species (≥7 individuals collected). Cluster analysis of the floral host spectra (using Ward’s method) grouped syrphid species into four clusters at semi-partial $r^2 = 0.18$ (Fig. 14). Two species of tribe Melanostomatini, *Platychirus pennipes* and *Melanostoma mellinum*, were separated by others by exclusive relationships with anemophilous flowers of Cyperaceae and Gramineae, respectively. *Platychirus pennipes* visited *Scirpus triqueter* in the morning on July 30, and collected pollen and licking droplet on stigma. *Melanostoma mellinum* visited *Leesia japonica* flowers in early morning just after sunrise on August 5, and collected pollen. Both male and female of these species visited them (Table 4). Two species of the tribe Syrphini and two species of the tribe Eristalini shared the same cluster, and visited various families of flowers. *Mesembrius flaviceps* had strong preference to *Iris*. Four species of the tribe Eristalini were grouped in the same cluster, and were characterized by preference to Asteraceae and Polygonaceae.
Flower-Insect Relationship at Nakaikemi Marsh

Fig. 14. Flower spectra (sorted by families) of ten dominant syrphid fly species (left) and dendrogram (right) derived from cluster analysis on the flower spectra.

Fig. 15. Flower spectra (sorted by families) of ten dominant bee species.

6.3 Floral hosts of Hymenoptera

Floral host spectra of dominant bee species (≥ 7 individuals collected) varied greatly among bee species (Fig 15). Even in the same genus, Hylaeus, the spectra varied. Hylaeus macilentus frequently visited Iris laevigata in mid May (Plate 1, I), Prunella vulgaris in late June, both of which are thought to be pollinated by a long-tongued bumblebee, Bombus diversus. Only pollen but not nectar was harvested by H. macilentus. Hylaeus noomen, frequently visited Rosa multiflora in late June and Monochoria korsakowii flowers in late September and harvested pollen. No bee species were confirmed to be oligolectic. Floral host species of Bombus diversus in the marsh were Solanum melongena (Solanaceae), Prunella vulgaris (Labiatae), Justicia procumbens (Acanthaceae), Adenophora triphylla (Campanulaceae) and Hosta albomarginata (Liliaceae).
Makoto Kato and Reiichi Miura

Discussion

Among several studies on anthophilous insect communities conducted in Japan, this study is unique in that studied habitat is a wetland in warm temperate region. We discuss some characteristics of flower-insect relationships in the marsh by comparing them with those studied in a cool temperate coastal meadow at Hama-Koshimizu in east Hokkaido (Fukuda et al., 1973), in subalpine coniferous forests and meadows at Mt. Kushigata in Yamanashi Pref. (Kato et al., 1993), in temperate deciduous forests at Mt. Moiwa in Sapporo (Sakagami et al., 1974), Rifu and Hanayama in Miyagi Pref. (Go’ukon, 1992), Ashu (Kato et al., 1990), Kibune (Inoue et al., 1990) in Kyoto Pref., at botanical gardens of Hokkaido University (Sakagami and Fukuda, 1973) and Kyoto University (Kakutani et al., 1990), and in warm temperate forests at Wakayama (Matsuura et al., 1972), Kochi (Ikudome, 1978) and Kagoshima (Ikudome, 1992).

Flowering phenology at Nakaikemi marshland was discriminated from those at woodlands by rarity of early bloomers. The only early bloomer was an asteraceous marsh perennial, Senecio pierotii. The rarity of early bloomers is thought to be due to scarcity of active insects in marshes in early spring. Since specific heat of water is greater than that of soil, the increase of temperature at waterlogged land is behind that at terrestrial, and emergence of insects is also behind time. The rarity of early bloomers may be also related with the rarity of andrenid bees most of which are active only in spring.

Anthophilous fauna at the marsh was characterized by dominance of Diptera over Hymenoptera; the percentage of collected individuals of Diptera was 58 % in this marsh, which is much higher than that of Ashu (35 %), Kibune (30 %), Kyoto (16 %) and Mt. Kushigata (33 %). The dominance of Diptera in the marsh results from the fact that permanently waterlogged land is favorable habitats for larvae of many dipterans but not for bees and wasps. Especially, dominant dipterans such as tribe Eristalini of Syrphidae and genera Limnophora and Lispe of Muscidae were aquatic or subaquatic saprophages.

The relative inferiority of bees in the marsh is thought to come from lack of dry nest site for underground nest makers. In fact, the proportion of underground nesting bees was lowest at the campus of Kyoto University in Kyoto (34.5%) and second lowest at Nakaikemi marsh (34.9%) among various habitats (Hama-Koshimizu, 88.6%; Sapporo, 80.3%; Moiwa, 61.8%; Rifu, 49.9%; Hanayama, 66.4%; Mt. Kushigata, 98.8%; Ashu, 65.4%; Kibune, 68.1%; Wakayama, 76.2%; Kochi, 75.6%; Kagoshima, 88.6%) (Fig. 16).

Bee community at Nakaikemi marsh was unique also in that Hylaeinae was the most abundant subfamily (Fig. 16). Hylaeine bees nest in pre-existing cavities especially dead shoot of reed. Although wetlands are relatively unimportant habitats for bees, a few specialist species utilize plant material for nesting sites (Falk, 1991). An extreme specialist bee in Europe, H. pectoralis, nests exclusively in old galles induced in the flower heads of the reed Phragmites communis, by larvae of the chloropid fly, Lipara luscens (O'Toole and Raw, 1991). The most abundant bee in Nakaikemi marsh, Hylaeus macilentus, may also be another example, whereas its nest has not yet been found. This minute bee species has been recorded only at three localities (probably wetlands) in Honshu and Hokkaido (Ikudome, 1989).

Hoverfly community at Nakaikemi marsh was next compared with those at woodlands at Ashu and Kibune, botanical garden of Kyoto University, and subalpine coniferous forests and
Flower-Insect Relationship at Nakaikemi Marsh

A comparison of relative abundance of bee subfamilies among 14 localities in Japan. Data sources are as follows: Hama-Koshimizu (Fukuda et al., 1973), Botanical garden of Hokkaido University in Sapporo (Sakagami and Fukuda, 1973), Mt. Moiwa (Sakagami et al., 1974) in Hokkaido, 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), Nakaikemi (this data), Ashu (Kato et al., 1990), Kibune (Inoue et al., 1990), Botanical garden of Kyoto University (Kakutani et al., 1990) in Kyoto Pref., Wakayama (Matsuura et al., 1972), Kochi (Ikudome, 1978) and Kagoshima (Ikudome, 1992).

meadows at Mt. Kushigata (Fig. 17), and characterized by relative abundance of saprophagous tribe Milesini (Genus *Rhinotropidia*) (Fig. 17). Percentage of saprophages in collected hoverflies was highest at Nakaikemi (61%), followed by Ashu (44.9%), Kyoto (37.3%), Mt. Kushigata (30.7%) and Kibune (29.2%). This suggests that syrphid fauna in the marsh is dominated by saprophagous groups most of which are aquatic or subaquatic. In turn, phytophagous groups (i.e., tribe Cheilosini) were rarer in the marsh and the botanical garden in Kyoto than at woodland habitats. Aphidophagous groups (i.e., tribe Syrphini) constituted more than 20% at every habitat, and the percentage of them was highest in the urban habitat of the botanical garden in Kyoto.

A cluster analysis of flower-visitor spectra of 64 plant species distinguished seven flower guilds (Fig. 10). Among them, 24 species were fly flowers (A + C5), 26 spp. were bee flowers (B + C4), and 11 spp. were general flowers (C1). Irrespective of dominance of Diptera in the anthophilous community, 40.6% of plant species were bee flowers, suggesting that the dominant *Hylaeus* bees are uniquely important pollinators. Thus, Nakaikemi marsh is regarded as a rare, important wetland habitat not only harboring many endangered plant and anthophilous insect species but also fostering characteristic insect-flower relationships.

Studied flowers included some weed species in traditional rice fields such as *Eusteralis*
Fig. 17. A comparison of relative abundance of syrphid tribes among five localities in Japan. Data sources are as follows: Botanical garden of Kyoto University (Kakutani et al., 1989), Kibune (Inoue et al., 1989), Ashu (Kato et al., 1989), Mt. Kushigata (Kato et al., 1993) and Nakaikemi (this data).

Finally, we discuss a ground plan to conserve the ecosystem of the marshland. Since a large part of the anthophilous fauna were inhabitants of various microhabitats of the marshlands, various types of habitats including reed swamps, Zizania marshes, channels and even traditionally cultivated rice fields should be conserved. Another standpoint for conservation is a continuum between wetlands and neighboring woodlands. Although there is no nest site of bumblebees in the marsh, there were four long-tubed flower species which are thought to have originally been pollinated by long-tongued bumblebees (Inoue and Kato, 1992). Probably due to reduction of population size and isolation from woodlands, some of these long-tubed flowers were not visited by bumblebees. An enantiostyle Monochoria korsakowii is also thought to have adapted to large or middle-sized bees’ visits (Wang et al., 1995), but they were visited only by small bees and syrphid flies in this marsh. The presence of these plant species pollinated by bumblebees suggests that the marshland should be conserved as a whole ecosystem by uniting the wetland and the surrounding woodlands.
Acknowledgments

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Appendix 1

A List of Insect Species Recorded on Flowers of 64 Plant Species at Nakaikemi Marsh in 1994-95

Insect-visit records for each plant species are listed as follows: insect species, (family code: order code), date, and (number of individuals collected). Plant taxa and insect taxa are arranged in the orders of Tables 2 and 3, respectively. Insect order code is abbreviated as two head characters of each order name. Insect family codes are shown in Table 3.

Saururaceae

*Houttuynia cordata*
   Episyrphus balteatus (Syr: Di) 22-vi-94 (1)

Nymphaeaceae

*Nymphaea marliacea*
   Lasioglossum percassicipes (Hal: Hy) 30-vi-95 (1)

Ranunculaceae

*Ranunculus japonicus*
   Athemus lineatipennis (Can: Co) 14-v-94 (1); Cheilosia sp.1 (Syr: Di) 14-v-94 (3); Sphaerophoria macrogaster (Syr: Di) 14-v-94 (1); Lasioglossum sibiriacum (Hal: Hy) 14-v-94 (2); Lasioglossum jaonicum (Hal: Hy) 14-v-94 (1); Lasioglossum alloidum (Hal: Hy) 14-v-94 (1); Andrena knuthi (And: Hy) 14-v-94 (2); Andrena munututa (And: Hy) 14-v-94 (1); Ceratina japonica (Ant: Hy) 14-v-94 (3)

Papaveraceae

*Chelidonium majus var. asiaticum*
   Episyrphus balteatus (Syr: Di) 5-viii-95 (1)

Caryophyllaceae

*Stellaria media*
   Hylaeus macilentus (Col: Hy) 22-vi-94 (1)

Polygonaceae

*Persicaria comspicua*
   Limnophora sp.2 (Mus: Di) 9-x-94 (1); sp. (Ich: Hy) 9-x-94 (1)

*Persicaria nipponensis*
   Sphaerophoria macrogaster (Syr: Di) 28-ix-95 (1); Helina sp.1 (Mus: Di) 28-ix-95 (1); Stomorhina obsoleta (Cal: Di) 28-ix-95 (3); Apis mellifera (Api: Hy) 28-ix-95 (1)

*Persicaria sieboldi*
   Propylea japonica (Coc: Co) 28-ix-95 (1); Chaetocnema bicolorata (Chr: Co) 28-ix-95 (6); Coptosoma parvipictum (Pla: He) 28-ix-95 (1); Petaphora maritima (Cer: He) 28-ix-95 (1); Eristalis cerealis (Syr: Di) 28-ix-95 (1); Eristalis kyokoaense (Syr: Di) 2-x-94 (1), 28-ix-95 (3); Rhinotropidia rostrata (Syr: Di) 28-ix-95 (3); Brontaea sp. (Mus: Di) 28-ix-95 (1); Graphomyia rufitibia (Mus: Di) 28-ix-95 (2); Helina sp.3 (Mus: Di) 28-ix-95 (1); Limnophora sp.1 (Mus: Di) 28-ix-95 (2); Limnophora sp.4 (Mus: Di) 28-ix-95 (1); sp. (Mus: Di) 28-ix-95 (1); Ravenia striata (Sar: Di) 28-ix-95 (1); Chrysomya pinguis (Cal: Di) 28-ix-95 (2); Lucilia caesar (Cal: Di) 28-ix-95 (1); Lucilia papuensis (Cal: Di) 9-x-94 (1); Stomorhina obsoleta (Cal: Di) 28-ix-95 (12); Agathis sp. (Bra: Hy) 28-ix-95 (9); Colletes palellatus (Col: Hy) 28-ix-95 (1); Apis cerana (Api: Hy) 28-ix-95 (4)

*Persicaria thunbergii*
   Monolepta fulvicollis (Chr: Co) 28-ix-95 (1); Involvutus ilosus (Att: Co) 9-x-94 (1); Phytobius sp.
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(Cur: Co) 9-x-94 (1); Eurydema rugosum (Pen: He) 9-x-94 (1); Tropidothorax cruciger (Lyg: He) 2-x-94 (1); Petaphora maritima (Cer: He) 28-ix-95 (3); sp. (Del: He) 28-ix-95 (1); Pipiza lugubrius (Syr: Di) 9-x-94 (1); Eristalis viridis (Syr: Di) 28-ix-95 (1); Eristalis cerealis (Syr: Di) 28-ix-95 (1), 9-x-94 (1); Eristalis kyokoea (Syr: Di) 2-x-94 (4), 28-ix-95 (5), 9-x-94 (12); Helophilus virgatus (Syr: Di) 2-x-94 (2), 9-x-94 (1); Rhinotropidia rostrata (Syr: Di) 28-ix-95 (2); Melanostoma scalare (Syr: Di) 28-ix-95 (1); Phytomia zonata (Syr: Di) 28-ix-95 (8); Sphaerophoria macrogaster (Syr: Di) 28-ix-95 (1); Dolichopus nitidus (Dol: Di) 28-ix-95 (4), 9-x-94 (2); Homoneura sp.1 (Lau: Di) 9-x-94 (1); Dasyphora sp. (Mus: Di) 9-x-94 (1); Graphomyia rautiliba (Mus: Di) 28-ix-95 (1); Limnophora sp.6 (Mus: Di) 28-ix-95 (1); Aldrichina grahami (Cal: Di) 9-x-94 (2); Lucilia caesar (Cal: Di) 28-ix-95 (1), 9-x-94 (1); Lucilia papuensis (Cal: Di) 28-ix-95 (1), 9-x-94 (1); Stomorhina obsoleta (Cal: Di) 2-x-94 (1), 28-ix-95 (3), 9-x-94 (3); Echinomyia mikado (Tac: Di) 9-x-94 (1); Thelairea nigripes (Tac: Di) 2-x-94 (1); Parnara guttata guttata (Hes: Le) 2-x-94 (2), 28-ix-95 (1); Pelopidas mathias oebertuiri (Hes: Le) 28-ix-95 (1); sp. (Ich: Hy) 9-x-94 (1); sp. (Ic: Hy) 9-x-94 (1); Agathis sp. (Bra: Hy) 28-ix-95 (7); Odontobracon sp. (Bra: Hy) 9-x-94 (1); Chelenus sp. (Bra: Hy) 28-ix-95 (1); sp. (Eul: Hy) 28-ix-95 (1); sp. (Cha: Hy) 28-ix-95 (1); Vespa similimata xantheoptera (Ves: Hy) 9-x-94 (1); Polistes chinensis antennalis (Ves: Hy) 2-x-94 (1); Hylaeus floralis (Col: Hy) 28-ix-95 (1); Hylaeus noomen (Col: Hy) 28-ix-95 (1); Apis cerana (Api: Hy) 2-x-94 (1), 28-ix-95 (4), 9-x-94 (2)

Persicaria yokusaiana
Stomorhina obsoleta (Cal: Di) 9-x-94 (3)

Guttiferae
Hypericum erectum
Rhinotropidia rostrata (Syr: Di) 16-viii-94 (1)

Brassicaceae
Cardamine lyrata
Eurydema rugosum (Pen: He) 1-vi-95 (3); Hydrometra procera (Hyd: He) 1-vi-95 (1); Tipula patagiata (Tip: Di) 1-vi-95 (1); sp. (Sci: Di) 1-vi-95 (1); Rhinotropidia rostrata (Syr: Di) 1-vi-95 (6); Melanostoma scalare (Syr: Di) 1-vi-95 (2); Limnia sp. (Scm: Di) 1-1vi-95 (1); Dolichopus nitidus (Dol: Di) 1-1vi-95 (1); Helina sp.1 (Mus: Di) 1-1vi-95 (7); Arge nipponensis (Arg: Hy) 1-1vi-95 (1); Hylaeus macilentus (Col: Hy) 1-1vi-95 (1); Lasiosglossum sibiriacum (Hal: Hy) 1-1vi-95 (1)

Primulaceae
Lysimachia fortunei
Polytrems pellucida pellucida (Hes: Le) 16-viii-94 (1); Megachile nipponica (Meg: Hy) 16-viii-94 (1)

Rosaceae
Potentilla egedei var. grandis
sp. (Tip: Di) 1-1vi-95 (1); sp. (Sci: Di) 1-1vi-95 (1); Sphaerophoria macrogaster (Syr: Di) 1-1vi-95 (1); Dolichopus nitidus (Dol: Di) 1-1vi-95 (1); sp. (Eph: Di) 1-1vi-95 (1); sp. (Sph: Di) 1-1vi-95 (2); sp. (Cac: Di) 1-1vi-95 (2); Helina sp.1 (Mus: Di) 1-1vi-95 (7); Lasiosglossum sibiriacum (Hal: Hy) 1-1vi-95 (1)

Rosa multiflora
Hylaeus noomen (Col: Hy) 30-iv-95 (4)

Leguminosae
Aeschynomene indica
Ceratina japonica (Ant: Hy) 28-ix-95 (1)

Lespedeza bicolor
Eumenes samurai (Eum: Hy) 28-ix-95 (1); Megachile tsurugensis (Meg: Hy) 28-ix-95 (1)
Flower-Insect Relationship at Nakaikemi Marsh

Lythraceae

*Lythrum anceps* (Chr: Co) 17-ix-94 (1); *Rhinotropidia rostrata* (Syr: Di) 17-ix-94 (7); *Parnara guttata guttata* (Hes: Le) 16-viii-94 (4), 17-ix-94 (5), 28-ix-95 (2); sp. (Bra: Hy) 17-ix-94 (1); sp. (Enc: Hy) 17-ix-94 (3); *Hylaeus macilentus* (Col: Hy) 17-ix-94 (1); *Hylaeus noomen* (Col: Hy) 17-ix-94 (1)

Onagraceae

*Ludwigia epilobioides*

*Rhinotropidia rostrata* (Syr: Di) 16-viii-94 (3)

Vitaceae

*Ampelopsis brevipedunculata var. heterophylla*

*Eumenes micado* (Eum: Hy) 16-viii-94 (1); *Eumenes samurai* (Eum: Hy) 16-viii-94 (3); *Megachile tsurugensis* (Meg: Hy) 16-viii-94 (1); *Megachile nipponica* (Meg: Hy) 16-viii-94 (1)

Oxalidaceae

*Oxalis corniculata*

*Paragus jozanus* (Syr: Di) 28-ix-95 (1); *Paragus kaemorrhous* (Syr: Di) 28-ix-95 (1), 5-viii-95 (2); sp. (Eph: Di) 28-ix-95 (1); *Helina sp.3* (Mus: Di) 28-ix-95 (1); *Hylaeus macilentus* (Col: Hy) 30-vi-95 (2); *Hylaeus florialis* (Col: Hy) 28-ix-95 (1); *Hylaeus noomen* (Col: Hy) 28-ix-95 (3)

Umbelliferae

*Oenanthe javanica*

*Solanum melongena*

*Lasiosglossum sibiriacum* (Hal: Hy) 5-viii-95 (1); *Bombus diversus* (Api: Hy) 5-viii-95 (1)

Verbenaceae

*Papilio helenus nicconicotens* (Pap: Le) 16-viii-94 (1)

Labiatae

*Euasteris yatabeana*

*Conocephalus japonicus* (Tet: Or) 17-ix-94 (1); *Adomerus biguttulus* (Cyd: He) 28-ix-95 (1); *Petaphora maritima* (Cer: He) 17-ix-94 (3); *Eristalis cerealis* (Syr: Di) 28-ix-95 (1); *Eristalis kyokoeae* (Syr: Di) 28-ix-95 (2); *Rhinotropidia rostrata* (Syr: Di) 16-viii-94 (2), 17-ix-94 (8); *Phytomia zonata* (Syr: Di) 28-ix-95 (2); *Limnia sp.* (Smp: Smp) 17-ix-94 (1); *Dolichopus nitidus* (Dol: Di) 17-ix-94 (4); sp. (Eph: Di) 17-ix-94 (1); *Ravinia striata* (Sar: Di) 17-ix-94 (5), 28-ix-95 (1); *Lucilia papuensis* (Cal: Di) 28-ix-95 (1); *Stomorhina obsoleta* (Cal: Di) 17-ix-94 (3), 28-ix-95 (2); *Masica sp.* (Tac: Di) 17-ix-94 (2); *Hymenri recurvalis* (Pyr: Le) 17-ix-94 (4), 28-ix-95 (2); *Parnara guttata guttata* (Hes: Le) 16-viii-94 (3), 17-ix-94 (1); sp. (Bra: Hy) 17-ix-94 (1); *Campomeris grossa* (Sco: Hy) 28-ix-95 (1); *Oreumenes decoratus* (Eum: Hy) 28-ix-95 (1); *Hylaeus macilentus* (Col: Hy) 17-ix-94 (1); *Lycopterus ramosissimus var. japonicus*

*Sphaerophoria macrogaster* (Syr: Di) 28-ix-95 (1); *Ravinia striata* (Sar: Di) 28-ix-95 (1); *Servillia jokovlewii* (Tac: Di) 28-ix-95 (1); *Polistes chinensis antennalis* (Ves: Hy) 28-ix-95 (4); *Cyphononyx dorsalis* (Pom: Hy) 28-ix-95 (1); *Hylaeus florialis* (Col: Hy) 28-ix-95 (2); *Lasiosglossum japonicum* (Hal: Hy) 28-ix-95 (1)
Mosla dianthera

Conecephalus japonicus (Tet: Or) 9-x-94 (1); Calomicrus sp. (Chr: Co) 9-x-94 (7); Dolycoris bacculum (Pen: He) 9-x-94 (1); Nysius plebeius (Lyg: He) 9-x-94 (3); Epyrisphus balteatus (Syr: Di) 28-ix-95 (1); Rhinotropidia rostrata (Syr: Di) 9-x-94 (2); Paragus kaemorrhous (Syr: Di) 9-x-94 (1); Sphaerophoria macrogaster (Syr: Di) 28-ix-95 (6); Eudorilas cruciator (Pip: Di) 28-ix-95 (1); Phaonia sp.3 (Mus: Di) 9-x-94 (1); Lucilia papuensis (Cal: Di) 9-x-94 (1); sp. (Ten: Hy) 28-ix-95 (1); Larra sp. (Sph: Hy) 28-ix-95 (1); Hylaecus florais (Col: Hy) 28-ix-95 (1), 9-x-94 (1); Hylaecus noomen (Col: Hy) 28-ix-95 (1); Lasioglossum sibiriacum (Hal: Hy) 9-x-94 (1); Lasioglossum japonicum (Hal: Hy) 28-ix-95 (1); Lasioglossum exiliceps (Hal: Hy) 28-ix-95 (1); Apis cerana (Api: Hy) 2-x-94 (1)

Prunella vulgaris ssp. asiatica

Cyphon sp. (Hel: Co) 30-vi-95 (1); Scotinophara lurida (Pen: He) 30-vi-95 (1); Petaphora maritima (Cer: He) 30-vi-95 (2); sp. (Cer: Di) 30-vi-95 (1); sp. (Eph: Di) 30-vi-95 (1); Hylaecus maclentus (Col: Hy) 30-vi-95 (9); Hylaecus florais (Col: Hy) 30-vi-95 (1); Megachile nippinon (Meg: Hy) 17-ix-94 (1), 30-vi-95 (1); Ceratina esakii (Ant: Hy) 30-vi-95 (1); Ceratina flavipes (Ant: Hy) 30-vi-95 (1); Xylocopa appendiculata (Ant: Hy) 22-ii-94 (1); Bombus diversus (Api: Hy) 22-vi-94 (1)

Salvia japonica

Paragus jozanus (Syr: Di) 9-x-94 (1); Thelaira nigripes (Tac: Di) 9-x-94 (1); Hymenopter recurrealis (Pyr: Le) 9-x-94 (2); Apis cerana (Api: Hy) 9-x-94 (1)

Plantaginaceae

Sphaerophoria macrogaster (Syr: Di) 30-vi-95 (1)

Scrophulariaceae

Limophila sessiliflora

Rhinotropidia rostrata (Syr: Di) 28-ix-95 (1); Sphaerophoria macrogaster (Syr: Di) 28-ix-95 (4); Homoneura sp.2 (Lau: Di) 28-ix-95 (1); sp. (Eph: Di) 28-ix-95 (1)

Lindernia procumbens

Rhinotropidia rostrata (Syr: Di) 28-ix-95 (1)

Acanthaceae

Justicia procumbens

Paragus quadrifasciatus (Syr: Di) 17-ix-94 (1); Lasioglossum sibiriacum (Hal: Hy) 28-ix-95 (1); Lasioglossum gorkiense (Hal: Hy) 28-ix-95 (1); Ceratina japonica (Ant: Hy) 28-ix-95 (3); Apis mellifera (Api: Hy) 28-ix-95 (1); Bombus diversus (Api: Hy) 28-ix-95 (1); Bombus hypocrita (Api: Hy) 28-ix-95 (1)

Campanulaceae

Adenophora triphylla var. japonica

Epyrisphus balteatus (Syr: Di) 9-x-94 (2); Helophilus virgatus (Syr: Di) 9-x-94 (1); Eurema hecabe (Pie: Le) 16-viii-94 (1); Lasioglossum mutilum (Hal: Hy) 16-viii-94 (1); Bombus diversus (Api: Hy) 28-ix-95 (1)

Rubiaceae

Galium trifidum var. brevipedunculatum

Ischnura asiatica (Agr: Od) 30-vi-95 (1); Polymerus pekinensis (Mir: He) 30-vi-95 (2); Rhopalus maculatus (Rho: He) 30-vi-95 (1); sp. (Del: He) 30-vi-95 (5); sp. (Chi: Di) 30-vi-95 (2); sp. (Chi: Di) 30-vi-95 (1); sp. (Chi: Di) 30-vi-95 (3); Sphaerophoria macrogaster (Syr: Di) 30-vi-95 (7); Limnia sp. (Scm: Di) 30-vi-95 (1); Helina sp.1 (Mus: Di) 30-vi-95 (15); Gymnosoma sp. (Tac: Di) 30-vi-95 (1)
Flower-Insect Relationship at Nakaikemi Marsh

Caprifoliaceae

*Weigela hortensis*
*Papilio helenus nicconicolens* (Pap: Le) 14-v-94 (2); *Xylocopa appendiculata* (Ant: Hy) 14-v-94 (1)

Asteraceae

*Bidens frondosa*
*Apis mellifera* (Api: Hy) 2-x-94 (1), 28-ix-95 (1)

*Cirsium japonicum*
sp. (Eph: Di) 17-v-94 (2); *Polytremis pellucida pellucida* (Hes: Le) 16-viii-94 (1); *Lasioglossum sibiriacum* (Hal: Hy) 22-vi-94 (1); *Lasioglossum scitutum* (Hal: Hy) 22-vi-94 (1)

*Cirsium sieboldii*
*Homoneura extera* (Lau: Di) 28-ix-95 (6); *Xylocopa appendiculata* (Ant: Hy) 28-ix-95 (1)

Eupatorium chinense
*Oxycetonia jucunda* (Sca: Co) 16-viii-94 (2); *Yphima argus* (Sat: Le) 16-viii-94 (1); sp. (Cha: Hy) 16-viii-94 (1); *Megachile nipponica* (Meg: Hy) 16-viii-94 (1)

Eupatorium lindleyanum
*Pteronemobius csikii* (Gry: Or) 28-ix-95 (1); *Oxycetonia jucunda* (Sca: Co) 17-ix-94 (1), 28-ix-95 (3); *Oulema erichsoni* (Chr: Co) 9-x-94 (1); *Tropidothorax cruciger* (Lyg: He) 28-ix-95 (1); *Nystius plebeius* (Lyg: He) 9-x-94 (3); *Piocoris varius* (Lyg: He) 28-ix-95 (1); *Lygcoris pallens* (Mir: He) 9-x-94 (4); sp. (Del: He) 17-ix-94 (1); *Eristalis cerealis* (Syr: Di) 17-ix-94 (1), 28-ix-95 (5); *Allograpta javana* (Syr: Di) 28-ix-95 (1); *Phytomia zonata* (Syr: Di) 28-ix-95 (3); sp. (Eph: Di) 28-ix-95 (1); *Drosophilus sp.* (Dro: Di) 9-x-94 (1); *Limnophora sp.* (Mus: Di) 28-ix-95 (1); *Chrysomya pinguis* (Cal: Di) 28-ix-95 (1); *Phaenicia seriata* (Cal: Di) 9-x-94 (1); *Stomorhina obsoleta* (Cal: Di) 17-ix-94 (1), 28-ix-95 (33), 9-x-94 (1); sp. (Cal: Di) 28-ix-95 (1); *Masicera sp.* (Tac: Di) 9-x-94 (1); sp. (Taci: Di) 28-ix-95 (1); *Vespula liewissii* (Ves: Hy) 28-ix-95 (1); *Hylaeus noomen* (Col: Hy) 28-ix-95 (1); *Lasioglossum exiliceps* (Hal: Hy) 17-ix-94 (2)

Ixeris debilis
*Sphaerophoria macrogaster* (Syr: Di) 30-vi-95 (1); *Hylaeus macilentus* (Col: Hy) 30-vi-95 (2)

Ixeris dentata
*Tropidothorax cruciger* (Lyg: He) 14-v-94 (1); *Nomada nipponica* (Ant: Hy) 1-vi-95 (1); *Ceratina flavipes* (Ant: Hy) 14-v-94 (2)

Kalimeris pinnatifida
*Allograpta javana* (Syr: Di) 28-ix-95 (1); *Homoneura extera* (Lau: Di) 28-ix-95 (2); sp. (Eph: Di) 28-ix-95 (1); sp. (Ant: Di) 28-ix-95 (1); *Stomorhina obsoleta* (Cal: Di) 28-ix-95 (16); *Lycaena phlaeas daimio* (Lyc: Le) 28-ix-95 (1); *Agathis sp.* (Bra: Hy) 28-ix-95 (1); sp. (Bra: Hy) 28-ix-95 (1); *Colletes palrellatus* (Col: Hy) 28-ix-95 (2); *Megachile tsurugensis* (Meg: Hy) 28-ix-95 (1)

Kalimeris yomena
*Rhinotropidia rostrata* (Syr: Di) 16-viii-94 (1); *Agathis sp.* (Bra: Hy) 2-x-94 (1); *Stenodynerus sp.* (Eum: Hy) 5-vii-95 (1); *Eumenes samurai* (Eum: Hy) 2-x-94 (1); *Hylaeus floralis* (Col: Hy) 2-x-94 (1); *Apis cerana* (Api: Hy) 9-x-94 (1)

Lactuca indica
*Pipiza lugubrius* (Syr: Di) 9-x-94 (1); *Epistrophe sp.* (Syr: Di) 9-x-94 (1)

Prenanthes tanakae
*Tropidothorax belogolowi* (Lyg: He) 9-x-94 (1); *Helophilus virgatus* (Syr: Di) 9-x-94 (2); *Melanostoma scalarum* (Syr: Di) 9-x-94 (1); *Phytomia zonata* (Syr: Di) 9-x-94 (4); *Homoneura extera* (Lau: Di) 9-x-94 (1); sp. (Eph: Di) 9-x-94 (1); *Stomorhina obsoleta* (Cal: Di) 9-x-94 (23); *Parnara
guttata guttata (Hes: Le) 9-x-94 (3); Pelopidas mathias oberthueri (Hes: Le) 9-x-94 (1); Argynnis paphia tsushimana (Nym: Le) 9-x-94 (1); Vespula vulgaris (Ves: Hy) 9-x-94 (1); Megachile tsurugensis (Meg: Hy) 9-x-94 (1)

Senecio pietrotii

Athemus lineatipennis (Can: Co) 14-v-94 (1); Sceymnus jamato (Coc: Co) 14-v-94 (1); Malachius prolongatus (Mel: Co) 14-v-94 (1); Nysius plebeius (Lgy: He) 14-v-94 (5), 17-v-94 (1); Phynocoris ornatrus (Red: He) 17-v-94 (1); sp. (Tip: Di) 17-v-94 (1); sp. (Sci: Di) 14-v-94 (1); Cheilosia sp.2 (Syr: Di) 17-v-94 (1); Eristalis cerealis (Syr: Di) 17-v-94 (3); Eristalis kyokoe (Syr: Di) 17-v-94 (1); Helophilus virgatus (Syr: Di) 17-v-94 (3); Rhinotropidia rostrata (Syr: Di) 14-v-94 (2); Melanostoma scalare (Syr: Di) 17-v-94 (1); Rhamphomyia latistriata (Emp: Di) 17-v-94 (3); Phaonia sp.3 (Mus: Di) 17-v-94 (1) sp. (Mus: Di) 17-v-94 (1); Echinomyia mihado (Tac: Di) 14-v-94 (1); Thelaira sp. (Tac: Di) 14-v-94 (1); Thoreyssya varia (Hes: Le) 14-v-94 (1); sp. (Ten: Hy) 17-v-94 (1); sp. (For: Hy) 14-v-94 (6); Andrena knuthi (And: Hy) 17-v-94 (2); Osmia taurus (Meg: Hy) 17-v-94 (1); Ceratina japonica (Ant: Hy) 14-v-94 (4)

Taraxacum japonicum

Athemus lineatipennis (Can: Co) 14-v-94 (1); Sceymnus jamato (Coc: Co) 14-v-94 (1), 28-ix-95 (1); Argynnis paphia tsushimana (Nym: Le) 28-ix-95 (2); sp. (Ich: Hy) 28-ix-95 (1); Lasioiglossum siberiaticum (Hal: Hy) 17-v-94 (1); Andrena knuthi (And: Hy) 14-v-94 (2); Andrena japonicum (And: Hy) 17-v-94 (1); Nomada fukuiana (Ant: Hy) 14-v-94 (1); Nomada nipponica (Ant: Hy) 1-vi-95 (1), 17-v-94 (1); Apis cerana (Api: Hy) 14-v-94 (2)

Alismataceae

Alisma canaliculatum

Stratiomys sp. (Syr: Di) 17-vii-94 (1); Rhinotropidia rostrata (Syr: Di) 28-vii-94 (1); Mesembrius flaviceps (Syr: Di) 17-vii-94 (1); Sphaerophoria macrogaster (Syr: Di) 17-vii-94 (1); Helina sp. (Mus: Di) 17-vii-94 (3); Everes argiades helliotia (Lyc: Le) 28-vii-94 (1)

Sagittaria trifolia

Bagous sp.2 (Cur: Co) 28-vii-94 (3); Tropidothorax cruciger (Lgy: He) 17-ix-94 (1); Episyrphus balteatus (Syr: Di) 28-ix-95 (1); Rhinotropidia rostrata (Syr: Di) 16-ix-94 (3), 17-ix-94 (5); Mesembrius flaviceps (Syr: Di) 17-ix-94 (1); Sphaerophoria macrogaster (Syr: Di) 5-viii-95 (1); sp. (Pho: Di) 28-vii-94 (1); Dolichopus nitidus (Dol: Di) 17-ix-94 (1), 28-ix-95 (1); sp. (Eph: Di) 28-ix-95 (3); Ochtera manitis (Eph: Di) 17-ix-94 (1); Limnophora promineus (Mus: Di) 28-ix-95 (5); Limnophora sp.6 (Mus: Di) 28-ix-95 (1); Diasemia litterata (Pyr: Le) 17-ix-94 (2); sp. (Bra: Hy) 17-ix-94 (1); Hylaeus macilentus (Col: Hy) 5-viii-95 (1); Lasioiglossum siberiaticum (Hal: Hy) 16-viii-94 (1); Lasioiglossum percassiceps (Hal: Hy) 16-viii-94 (1), 28-vii-94 (1); Lasioiglossum affine (Hal: Hy) 16-viii-94 (1); Megachile tursugensis (Meg: Hy) 16-viii-94 (1)

Hydrochariaceae

Hydrocharis dubia

Scymnus hoffmanni (Coc: Co) 28-ix-95 (1); sp. (Cer: Di) 28-ix-95 (1); Dolichopus nitidus (Dol: Di) 28-ix-95 (4); Dolichopus sp. (Dol: Di) 28-ix-95 (3); Homoneura extera (Lau: Di) 28-ix-95 (2); sp. (Eph: Di) 28-ix-95 (1); Drosophila sp.1 (Dro: Di) 28-ix-95 (1); Limnophora promineus (Mus: Di) 28-ix-95 (4); Limnophora sp.3 (Mus: Di) 28-ix-95 (1); Limnophora sp.5 (Mus: Di) 28-ix-95 (1); Limnophora sp.6 (Mus: Di) 28-ix-95 (1); Lispe sp. (Mus: Di) 28-ix-95 (1)

Commelinaceae

Commelina communis

Episyrphus balteatus (Syr: Di) 28-ix-95 (1)

Murdannia keisak

Paragus kaemorhous (Syr: Di) 28-ix-95 (1); Sphaerophoria macrogaster (Syr: Di) 28-ix-95 (1)
Flower-Insect Relationship at Nakaikemi Marsh

**Gramineae**

*Isachne globosa*

*Melanostoma mellinum* (Syr: Di) 28-vii-94 (1), 5-viii-95 (7); *Limnina* sp. (Scm: Di) 5-viii-95 (1); sp.2 (Ant: Di) 5-viii-95 (1)

*Leesia japonica*

*Episyrphus balteatus* (Syr: Di) 5-viii-95 (2); *Melanostoma mellinum* (Syr: Di) 5-viii-95 (14); sp.2 (Ant: Di) 5-viii-95 (1); *Ravinia striata* (Dor: Di) 5-viii-95 (1)

**Phragmites communis**

*Dienerella* sp.2 (Lat: Co) 28-ix-95 (1); *Orthopagus lunulifer* (Dic: He) 28-ix-95 (1); sp. (Sci: Di) 28-ix-95 (1); sp. (Chi: Di) 28-ix-95 (2); sp. (Chi: Di) 28-ix-95 (1); sp. (Pho: Di) 28-ix-95 (1); *Drosophila* sp.1 (Dro: Di) 28-ix-95 (1); *Limmophora* sp.1 (Mus: Di) 28-ix-95 (1); *Phaonia* sp.1 (Mus: Di) 28-ix-95 (1); *Phaonia* sp.2 (Mus: Di) 28-ix-95 (1)

**Cyperaceae**

*Scirpus triqueter*

*Scotinophara lurida* (Pen: He) 30-vi-95 (1); *Platycheirus pennipes* (Syr: Di) 30-vi-95 (8); *Sphaerophoria macrogaster* (Syr: Di) 28-vii-94 (1)

**Typhaceae**

*Typha angustifolia*

*Cryptophilus* sp. (Lan: Co) 28-vii-94 (2)

**Pontederiaceae**

*Monochoria korsakowii*

*Dienerella* sp.1 (Lat: Co) 28-vii-94 (1); *Bagoi* sp.1 (Cur: Co) 28-vii-94 (1); *Eristalinus viridis* (Syr: Di) 2-x-94 (1), 28-ix-95 (2); *Rhinotropidia rostrata* (Syr: Di) 2-x-94 (1), 28-ix-95 (3); *Mesembrius flaviceps* (Syr: Di) 28-ix-95 (1); *Sphaerophoria macrogaster* (Syr: Di) 28-ix-95 (1); *Dolichopus nitidus* (Dol: Di) 28-ix-95 (2); sp. (Dol: Di) 28-ix-95 (1); sp. (Eph: Di) 2-x-94 (1); *Limmophora* sp.2 (Mus: Di) 28-ix-95 (1); sp. (Ich: Hy) 28-ix-95 (1); *Hylaeus macilentus* (Col: Hy) 2-x-94 (1); *Hylaeus floralis* (Col: Hy) 28-ix-95 (1); *Hylaeus noomen* (Col: Hy) 2-x-94 (2), 28-ix-95 (8); *Lasioglossum sibiriacum* (Hal: Hy) 16-viii-94 (1); *Lasioglossum percassiceps* (Hal: Hy) 28-ix-95 (1), 28-vii-94 (3)

*Monochoria vaginalis*

*Hylaeus noomen* (Col: Hy) 28-ix-95 (1)

**Iridaceae**

*Iris laevigata*

*Cyphon* sp. (Hel: Co) 1-vi-95 (3); *Calicmonic* sp. (Chr: Co) 1-vi-95 (1); *Donacia provostii* (Chr: Co) 1-vi-95 (2); *Tropidothorax cruciger* (Lyg: He) 1-vi-95 (1); sp. (Nab: He) 1-vi-95 (1); *Rhinotropidia rostrata* (Syr: Di) 1-vi-95 (3); *Mesembrius flaviceps* (Syr: Di) 1-vi-95 (4); *Microdon japonicus* (Syr: Di) 1-vi-95 (1); sp. (Eph: Di) 1-vi-95 (1); *Helina* sp.2 (Mus: Di) 1-vi-95 (1); *Lagidina platyeerus* (Ten: Hy) 1-vi-95 (2); sp. (Ich: Hy) 1-vi-95 (2); *Hylaeus macilentus* (Col: Hy) 1-vi-95 (8); *Hylaeus floralis* (Col: Hy) 1-vi-95 (1); *Lasioglossum sibiriacum* (Hal: Hy) 1-vi-95 (7); *Lasioglossum affine* (Hal: Hy) 1-vi-95 (1)

**Liliaceae**

*Alium grayi*

*Lasioglossum mutilum* (Hal: Hy) 22-vi-94 (1)

*Hosta albomarginata*

*Haplothrips* sp. (Phil: Th) 28-vii-94 (2); *Episyrphus balteatus* (Syr: Di) 5-viii-95 (1); *Bombus diversus* (Api: Hy) 16-viii-94 (1), 28-vii-94 (1), 5-viii-95 (1)
APPENDIX 2

A List of Floral Host Species for Each Anthophilous Insect Species Recorded at Nakaikemi Marsh in 1994-95

Flower-visit records of each insect species are arranged in the following order: plant species, (plant species code), date and (number of individuals). Insect taxa and plant taxa are arranged in the order in Table 3 and 2, respectively.

**ODONATA**

*Agrionidae*

*Ischnura asiatica*

*Galium trifidum var. brevipedunculatum* (rub1) 30-vi-95 (1)

**ORTHOPTERA**

*Tettigoniidae*

*Conocephalus japonicus*

*Eusteralis yatabeana* (lab1) 17-ix-94 (1); *Mosla dianthera* (lab3) 9-x-94 (1)

*Gryllidae*

*Pteronomobius csikii*

*Eupatorium lindleyanum* (ast5) 28-ix-95 (1)

**THYSANOPTERA**

*Phlaeothripidae*

*Haplothrips* sp.

*Hosta albo-marginata* (li12) 28-vii-94 (2)

**HEMIPTERA**

*Pentatomidae*

*Dolycoris bacculum*

*Mosla dianthera* (lab3) 9-x-94 (1)

*Eurydema rugosum*

*Persicaria thunbergii* (pol4) 9-x-94 (1); *Cardamine lyrata* (bra1) 1-vi-95 (3)

*Scotinophara lurida*

*Prunella vulgaris* ssp. *asiatica* (lab4) 30-vi-95 (1); *Scirpus triqueter* (cypl) 30-vi-95 (1)

**Cynidae**

*Adomerus biguttulus*

*Eusteralis yatabeana* (lab1) 28-ix-95 (1)

**Platispidae**

*Coptosoma parvipictum*

*Persicaria sieboldi* (pol3) 28-ix-95 (1)

**Lygaeidae**

*Tropidothorax belogolowi*

*Prenanthes tanakae* (ast11) 9-x-94 (1)
Tropidothorax cruciger
Persicaria thunbergii (pol4) 2-x-94 (1); Eupatorium lindleyanum (ast5) 28-ix-95 (1); Ixeris dentata (ast7) 14-v-94 (1); Sagittaria trifolia (ali2) 17-ix-94 (1); Iris laevigata (iri1) 1-vi-95 (1)

Nysius plebeius
Mosla dianthera (lab3) 9-x-94 (3); Eupatorium lindleyanum (ast5) 9-x-94 (3); Senecio pierotii (ast12) 14-v-94 (5), 17-iv-94 (1)

Piocoris varius
Eupatorium lindleyanum (ast5) 28-ix-95 (1)

Miridae

Lygocoris pallens
Eupatorium lindleyanum (ast5) 9-x-94 (4)

Polymerus pekinensis
Galium trifidum var. brevipedunculatum (rub1) 30-vi-95 (2)

Rhopalidae

Rhopalus maculatus
Galium trifidum var. brevipedunculatum (rub1) 30-vi-95 (1)

Reduviidae

Phynocoris ornatus
Senecio pierotii (ast12) 17-iv-94 (1)

sp. 1
Iris laevigata (iri1) 1-vi-95 (1)

Nabidae

Hydrometridae
Cardamine lyrata (bra1) 1-vi-95 (1)

Cercopidae

Petaphora maritima
Persicaria sieboldi (pol3) 28-ix-95 (1); Persicaria thunbergii (pol4) 28-ix-95 (3); Eusterialis yatabeana (lab1) 17-ix-94 (3); Prunella vulgaris ssp. asiatica (lab4) 30-vi-95 (2)

Deltocephalidae

sp. 1
Persicaria thunbergii (pol4) 28-ix-95 (1)

sp. 2
Galium trifidum var. brevipedunculatum (rub1) 30-vi-95 (5)

sp. 3
Eupatorium lindleyanum (ast5) 17-ix-94 (1)

Dictyophraridae

Orthopagus lunulifer
Phragmites communis (gra3) 28-ix-95 (1)
COLEOPTERA

Scarabaeidae

*Oxycetonia jucunda*
*Eupatorium chinense* (ast4) 16-viii-94 (2); *Eupatorium lindleyanum* (ast5) 17-ix-94 (1), 28-ix-95 (3)

Helodidae

*Cyphon sp.*
*Prunella vulgaris* ssp. *asiatica* (lab4) 30-vi-95 (1); *Iris laevigata* (iri1) 1-vi-95 (3)

Cantharidae

*Athemus lineatipennis*
*Ranunculus japonicus* (ran1) 14-v-94 (1); *Senecio pierotii* (ast12) 14-v-94 (1); *Taraxacum japonicum* (ast13) 14-v-94 (1)

Coccinellidae

*Propylea japonica*
*Persicaria sieboldi* (pol3) 28-ix-95 (1)

*Scymnus jamato*
*Senecio pierotii* (ast12) 14-v-94 (1)

*Scymnus hoffmanni*
*Hydrocharis dubia* (hyd1) 28-ix-95 (1)

Melyridae

*Malachius prolongatus*
*Senecio pierotii* (ast12) 14-v-94 (1)

Lathridiidae

*Dienerella sp. 1*
*Monochoria korsakowii* (pon1) 28-vii-94 (1)

*Dienerella sp. 2*
*Phragmites communis* (gra3) 28-ix-95 (1)

Languriidae

*Cryptophilus sp.*
*Typha angustifolia* (typ1) 28-vii-94 (2)

Chrysomelidae

*Calomicrus sp.*
*Lythrum anceps* (lyt1) 17-ix-94 (1); *Mosla dianthera* (lab3) 9-x-94 (7); *Iris laevigata* (iri1) 1-vi-95 (1)

*Monolepta fulvicollis*
*Persicaria thunbergii* (pol4) 28-ix-95 (1)

*Oulema erichsonii*
*Eupatorium lindleyanum* (ast5) 9-x-94 (1)

*Chaetocnema bicolorata*
*Persicaria sieboldi* (pol3) 28-ix-95 (6)

*Donacia provostii*
*Iris laevigata* (iri1) 1-vi-95 (2)
Flower-Insect Relationship at Nakaikemi Marsh

**Attelabidae**

*Involvatus ilosus*

*Persicaria thunbergii* (pol4) 9-x-94 (1)

**Curculionidae**

*Phytobius* sp.

*Persicaria thunbergii* (pol4) 9-x-94 (1)

**Bagous** sp. 1

*Monochoria korsakowii* (pon1) 28-vii-94 (1)

**Bagous** sp. 2

*Sagittaria trifolia* (ali2) 28-vii-94 (3)

**DIPTERA**

**Tipulidae**

*Tipula patagiata*

*Cardamine lyrata* (bral) 1-vi-95 (1)

sp. 1

*Potentilla egedei* var. *grandis* (ros1) 1-vi-95 (1)

sp. 2

*Senecio pierotii* (ast12) 17-iv-94 (1)

**Sciaridae**

sp. 1

*Cardamine lyrata* (bral) 1-vi-95 (1); *Potentilla egedei* var. *grandis* (ros1) 1-vi-95 (1); *Senecio pierotii* (ast12) 14-v-94 (1)

sp. 2

*Phragmites communis* (gra3) 28-ix-95 (1)

**Chironomidae**

sp. 1

*Phragmites communis* (gra3) 28-ix-95 (2)

sp. 2

*Galium trifidum* var. *brevipedunculatum* (rub1) 30-vi-95 (2); *Phragmites communis* (gra3) 28-ix-95 (1)

sp. 3

*Galium trifidum* var. *brevipedunculatum* (rub1) 30-vi-95 (1)

sp. 4

*Galium trifidum* var. *brevipedunculatum* (rub1) 30-vi-95 (3)

**Ceratopogonidae**

sp. 1

*Prunella vulgaris* ssp. *asiatica* (lab4) 30-vi-95 (1); *Hydrocharis dubia* (hyd1) 28-ix-95 (1)

**Empididae**

*Rhamphomyia latistriata*

*Senecio pierotii* (ast12) 17-iv-94 (3)
Stratiomyidae

Stratiomys sp.
Alisma canaliculatum (ali1) 17-vi-94 (1)

Syrphidae

Allograpta javana
Kalimeris pinnatifida (ast8) 28-ix-95 (1); Eupatorium lindleyanum (ast5) 28-ix-95 (1)

Cheilosia sp. 1
Ranunculus japonicus (ran1) 14-v-94 (3)

Cheilosia sp. 2
Senecio pierotii (ast12) 17-iv-94 (1)

Episyrphus balteatus
Houttuynia cordata (saul) 22-vi-94 (1); Chelidonium majus var. asiaticum (pap1) 5-viii-95 (1); Mosla dianthera (lab3) 28-ix-95 (1); Adenophora triphylla var. japonica (cam1) 9-x-94 (2); Sagittaria trifolia (ali2) 28-ix-95 (1); Commelina communis (com1) 28-ix-95 (1); Leesia japonica (gra2) 5-viii-95 (2); Hosta albo-marginata (li12) 5-viii-95 (1)

Eristalinus viridis
Persicaria thunbergii (pol4) 28-ix-95 (1); Monochoria korsakowii (pon1) 2-x-94 (1), 28-ix-95 (2)

Eristalis cerealis
Persicaria sieboldi (pol3) 28-ix-95 (1); Persicaria thunbergii (pol4) 28-ix-95 (1), 9-x-94 (1); Eusteralis yatabeana (lab1) 28-ix-95 (1); Eupatorium lindleyanum (ast5) 17-ix-94 (1), 28-ix-95 (5); Senecio pierotii (ast12) 17-iv-94 (3)

Eristalis kyokoae
Persicaria sieboldi (pol3) 2-x-94 (1), 28-ix-95 (3); Persicaria thunbergii (pol4) 2-x-94 (4), 28-ix-95 (5), 9-x-94 (12); Eusteralis yatabeana (lab1) 28-ix-95 (2); Senecio pierotii (ast12) 17-iv-94 (1)

Eristrophe sp.
Lactuca indica (ast10) 9-x-94 (1)

Helophilus virgatus
Persicaria thunbergii (pol4) 2-x-94 (2), 9-x-94 (1); Adenophora triphylla var. japonica (cam1) 9-x-94 (1); Prenanthes tanakae (ast11) 9-x-94 (2); Senecio pierotii (ast12) 17-iv-94 (3)

Melanostoma mellinum
Isachne globosa (gra1) 28-vii-94 (1), 5-viii-95 (7); Leesia japonica (gra2) 5-viii-95 (14)

Melanostoma scalare
Persicaria thunbergii (pol4) 28-ix-95 (1); Cardamine lyrata (bra1) 1-vi-95 (2); Prenanthes tanakae (ast11) 9-x-94 (1); Senecio pierotii (ast12) 17-iv-94 (1)

Mesembrinus flaviceps
Alisma canaliculatum (ali1) 17-vii-94 (1); Sagittaria trifolia (ali2) 17-ix-94 (1); Monochoria korsakowii (pon1) 28-ix-95 (1); Iris laevigata (iri1) 1-vi-95 (4)

Microdon japonicus
Iris laevigata (iri1) 1-vi-95 (1)

Paragus quadrifasciatus
Justicia procumbens (aca1) 17-ix-94 (1)
Flower-Insect Relationship at Nakaikemi Marsh

Paragus jozanus

*Oxalis corniculata* (oxal) 28-ix-95 (1); *Salvia japonica* (lab5) 9-x-94 (1)

Paragus kaemorrhous

*Oxalis corniculata* (oxal) 28-ix-95 (1), 5-viii-95 (2); *Mosla dianthera* (lab3) 9-x-94 (1); *Murdannia keisak* (com2) 28-ix-95 (1)

Phytoma zonata

*Persicaria thunbergii* (pol4) 28-ix-95 (8); *Eusteralis yatabeana* (lab1) 28-ix-95 (2); *Eupatorium lindleyanum* (ast5) 28-ix-95 (3); *Prenanthes tanakae* (ast11) 9-x-94 (4)

Pipiza lugubrius

*Persicaria thunbergii* (pol4) 9-x-94 (1); *Lactuca indica* (ast10) 9-x-94 (1)

Platycheirus pennipes

*Scirpus triqueter* (cyp1) 30-vi-95 (8)

Rhinotropidia rostrata

*Persicaria sieboldi* (pol3) 28-ix-95 (3); *Persicaria thunbergii* (pol4) 28-ix-95 (2); *Hypericum erectum* (gut1) 16-viii-94 (1); *Cardamine lyrata* (bral) 1-vi-95 (6); *Lythrum anceps* (lyt1) 17-ix-94 (7); *Ludwigia epilobioides* (onal) 16-viii-94 (3); *Oenanthe javanica* (umb1) 16-viii-94 (3); *Euerleris yatabeana* (lab1) 16-viii-94 (2), 17-ix-94 (8); *Mosla dianthera* (lab3) 9-x-94 (2); *Limophila sessiliflora* (scr1) 28-ix-95 (1); *Lindernia procumbens* (scr2) 16-viii-94 (1); *Kalimeris yomena* (ast9) 16-viii-94 (1); *Senecio pieroti* (ast12) 14-v-94 (2); *Alisma canaliculatum* (ali1) 17-vii-94 (1); 28-vii-94 (1); *Sagittaria trifolia* (ali2) 16-viii-94 (3), 17-ix-94 (5); *Monochoria korsakowii* (pon1) 2-x-94 (1), 28-ix-95 (3); *Iris laevigata* (iri1) 1-vi-95 (3)

Sphaerophoria macrogaster

*Ranunculus japonicus* (ran1) 14-v-94 (1); *Persicaria nipponensis* (pol2) 28-ix-95 (1); *Persicaria thunbergii* (pol4) 28-ix-95 (1); *Potentilla egedei* var. *grandis* (ros1) 1-vi-95 (1); *Lycopus ramosissimus* var. *japonicus* (lab2) 28-ix-95 (1); *Mosla dianthera* (lab3) 28-ix-95 (6); *Plantago asiatica* (plal) 30-vi-95 (1); *Limophila sessiliflora* (scr1) 28-ix-95 (4); *Galium trifidum* var. *brevipedunculatum* (rub1) 30-vi-95 (7); *Ixeris debilis* (ast6) 30-vi-95 (1); *Taraxacum japonicum* (ast13) 14-v-94 (1), 28-ix-95 (1); *Sagittaria trifolia* (ali2) 5-viii-95 (1); *Murdannia keisak* (com2) 28-ix-95 (1); *Alisma canaliculatum* (ali1) 17-vii-94 (1); *Scirpus triqueter* (cyp1) 28-vii-94 (1); *Monochoria korsakowii* (pon1) 28-ix-95 (1)

**Pipunculidae**

*Eudorilas cruciator*

*Mosla dianthera* (lab3) 28-ix-95 (1), 9-x-94 (1)

**Phoridae**

sp. 1

*Sagittaria trifolia* (ali2) 28-vii-94 (1)

sp. 2

*Phragmites communis* (gra3) 28-ix-95 (1)

**Sciomyzidae**

*Limnia sp.*

*Cardamine lyrata* (bral) 1-vi-95 (1); *Euerleris yatabeana* (lab1) 17-ix-94 (1); *Galium trifidum* var. *brevipedunculatum* (rub1) 30-vi-95 (1); *Isachne globosa* (gra1) 5-viii-95 (1)

*Sepedon aenescens*

*Persicaria comspicua* (pol1) 28-ix-95 (1)
Dolichopodidae

*Dolichopus nitidus*
- *Persicaria thunbergii* (pol4) 28-ix-95 (4), 9-x-94 (2); *Cardamine lyrata* (bra1) 1-vi-95 (1); *Potentilla egedei* var. *grandis* (ros1) 1-vi-95 (1); *Eusteralis yatabeana* (lab1) 17-ix-94 (4); *Sagittaria trifolia* (ali2) 17-ix-94 (1), 28-ix-95 (1); *Hydrocharis dubia* (hyd1) 28-ix-95 (4); *Monochoria korsakowii* (pon1) 28-ix-95 (2)

*Dolichopus sp.*
- *Hydrocharis dubia* (hyd1) 28-ix-95 (3)

sp. 1
- *Monochoria korsakowii* (pon1) 28-ix-95 (1)

Lauxaniidae

*Homoneura extera*
- *Cirsium sieboldii* (ast3) 28-ix-95 (6); *Kalimeris pinnatifida* (ast8) 28-ix-95 (2); *Prenanthes tanakae* (ast11) 9-x-94 (1); *Hydrocharis dubia* (hyd1) 28-ix-95 (2)

*Homoneura sp.1*
- *Persicaria thunbergii* (pol4) 9-x-94 (1)

*Homoneura sp.2*
- *Limophila sessiliflora* (scr1) 28-ix-95 (1)

Ephydridae

sp. 1
- *Oxalis corniculata* (oxa1) 28-ix-95 (1); *Eusteralis yatabeana* (lab1) 17-ix-94 (1); *Prunella vulgaris* ssp. *asiatica* (lab4) 30-vi-95 (1); *Limophila sessiliflora* (scr1) 28-ix-95 (1); *Eupatorium lindleyanum* (ast5) 28-ix-95 (1); *Sagittaria trifolia* (ali2) 28-ix-95 (3); *Hydrocharis dubia* (hyd1) 28-ix-95 (1)

sp. 2
- *Monochoria korsakowii* (pon1) 2-x-94 (1)

sp. 3
- *Prenanthes tanakae* (ast11) 9-x-94 (1)

sp. 4
- *Kalimeris pinnatifida* (ast8) 28-ix-95 (1)

sp. 5
- *Prunella vulgaris* ssp. *asiatica* (lab4) 30-vi-95 (1); *Iris laevigata* (iri1) 1-vi-95 (1)

sp. 6
- *Potentilla egedei* var. *grandis* (ros1) 1-vi-95 (1)

sp. 7
- *Cirsium japonicum* (ast2) 17-iv-94 (2)

Ochtera mantis
- *Sagittaria trifolia* (ali2) 17-ix-94 (1)

Sphaeroceridae

sp. 1
- *Potentilla egedei* var. *grandis* (ros1) 1-vi-95 (2)
Flower-Insect Relationship at Nakaikemi Marsh

Canaceidae

Potentilla egedei var. grandis (ros1) 1-vi-95 (2)

Drosophilidae

Drosophila sp. 1
Hydrocharis dubia (hyd1) 28-ix-95 (1); Phragmites communis (gra3) 28-ix-95 (1)

Drosophila sp. 2
Eupatorium lindleyanum (ast5) 9-x-94 (1)

Anthomyiidae

sp. 1
Kalimeris pinnatifida (ast8) 28-ix-95 (1)

sp. 2
Isachne globosa (gra1) 5-viii-95 (1); Leesia japonica (gra2) 5-viii-95 (1)

Muscidae

Brontaea sp.
Persicaria sieboldi (pol3) 28-ix-95 (1)

Dasyphora sp.
Persicaria thunbergii (pol4) 9-x-94 (1)

Graphomyia rufitibia
Persicaria sieboldi (pol3) 28-ix-95 (2); Persicaria thunbergii (pol4) 28-ix-95 (1)

Helina sp. 1
Persicaria nipponensis (pol2) 28-ix-95 (1); Cardamine lyrata (bra1) 1-vi-95 (7); Potentilla egedei var. grandis (ros1) 1-vi-95 (7); Galium tridifum var. brevipedunculatum (rub1) 30-vi-95 (15); Alisma canaliculatum (ali1) 17-vii-94 (3)

Helina sp. 2
Iris laevigata (iri1) 1-vi-95 (1)

Helina sp. 3
Persicaria sieboldi (pol3) 28-ix-95 (1); Oxalis corniculata (oxa1) 28-ix-95 (1)

Limnophora promineus
Sagittaria trifolia (ali2) 28-ix-95 (5); Hydrocharis dubia (hyd1) 28-ix-95 (4)

Limnophora sp. 1
Persicaria sieboldi (pol3) 28-ix-95 (2); Eupatorium lindleyanum (ast5) 28-ix-95 (1); Phragmites communis (gra3) 28-ix-95 (1)

Limnophora sp. 2
Persicaria conspicua (pol1) 9-x-94 (1); Monochoria korsakowii (pon1) 28-ix-95 (1)

Limnophora sp. 3
Hydrocharis dubia (hyd1) 28-ix-95 (1)

Limnophora sp. 4
Persicaria sieboldi (pol3) 28-ix-95 (1)

Limnophora sp. 5
Hydrocharis dubia (hyd1) 28-ix-95 (1)
Limnophora sp.6
Persicaria thunbergii (pol4) 28-ix-95 (1); Sagittaria trifolia (ali2) 28-ix-95 (1); Hydrocharis dubia (hyd1) 28-ix-95 (1)

Lispe sp.
Hydrocharis dubia (hyd1) 28-ix-95 (1)

Phaonia sp. 1
Phragmites communis (gra3) 28-ix-95 (1)

Phaonia sp. 2
Phragmites communis (gra3) 28-ix-95 (1)

Phaonia sp. 3
Mosla dianthera (lab3) 9-x-94 (1); Senecio pierotii (ast12) 17-iv-94 (1)

sp. 1
Senecio pierotii (ast12) 17-iv-94 (1)

sp. 2
Persicaria sieboldi (pol3) 28-ix-95 (1)

Sarcophagidae

Ravinia striata
Persicaria sieboldi (pol3) 28-ix-95 (1); Oenanthe javanica (umb1) 28-ix-95 (1); Eusteralis yatabeana (lab1) 17-ix-94 (5), 28-ix-95 (1); Lycopus ramosissimus var. japonicus (lab2) 28-ix-95 (1); Leesia japonica (gra2) 5-viii-95 (1)

Calliphoridae

Aldrichina grahami
Persicaria thunbergii (pol4) 9-x-94 (2)

Chrysomya pinguis
Persicaria sieboldi (pol3) 28-ix-95 (2); Eupatorium lindleyanum (ast5) 28-ix-95 (1)

Lucilia caesar
Persicaria sieboldi (pol3) 28-ix-95 (1); Persicaria thunbergii (pol4) 28-ix-95 (1), 9-x-94 (1)

Lucilia papuensis
Persicaria sieboldi (pol3) 9-x-94 (1); Persicaria thunbergii (pol4) 28-ix-95 (1), 9-x-94 (1); Eusteralis yatabeana (lab1) 28-ix-95 (1); Mosla dianthera (lab3) 9-x-94 (1)

Phaenicia sericata
Eupatorium lindleyanum (ast5) 9-x-94 (1)

Stomorhina obsoleta
Persicaria nipponensis (pol2) 28-ix-95 (3); Persicaria sieboldi (pol3) 28-ix-95 (12); Persicaria thunbergii (pol4) 2-x-94 (1), 28-ix-95 (3), 9-x-94 (3); Persicaria yokusaiana (pol5) 9-x-94 (3); Eusteralis yatabeana (lab1) 17-ix-94 (3), 28-ix-95 (2); Eupatorium lindleyanum (ast5) 17-ix-94 (1), 28-ix-95 (33), 9-x-94 (1); Kalimeris pinnatifida (ast8) 28-ix-95 (16); Prenanthes tanakae (ast11) 9-x-94 (23)

sp. 1
Eupatorium lindleyanum (ast5) 28-ix-95 (1)
Tachinidae

Echinomyia mikado
  Persicaria thunbergii (pol4) 9-x-94 (1); Senecio pierotii (ast12) 14-v-94 (1)

Eutachina sp.
  Oenanthe javanica (umb1) 16-viii-94 (1)

Gynnosoma sp.
  Galium trifidum var. bревipedunculatum (rub1) 30-vi-95 (1)

Masicera sp.
  Eusteralis yatabeana (lab1) 17-ix-94 (2); Eupatorium lindleyanum (ast5) 9-x-94 (1)

Servilla jokovlewii
  Lycopus ramosissimus var. japonicus (lab2) 28-ix-95 (1)

Thelaira nigripes
  Persicaria thunbergii (pol4) 2-x-94 (1); Salvia japonica (lab5) 9-x-94 (1)

Thelaira sp.
  Senecio pierotii (ast12) 14-v-94 (1)

sp. 1
  Eupatorium lindleyanum (ast5) 28-ix-95 (1)

LEPIDOPTERA

Pyralidae

Hymerria recurvalis
  Eusteralis yatabeana (lab1) 17-ix-94 (4), 28-ix-95 (2); Salvia japonica (lab5) 9-x-94 (2)

Diasemia litterata
  Sagittaria trifolia (ali2) 17-ix-94 (2)

Hesperiidae

Parnara guttata guttata
  Persicaria thunbergii (pol4) 2-x-94 (2), 28-ix-95 (1); Lythrum aniceps (lyt1) 16-viii-94 (4), 17-ix-94 (5), 28-ix-95 (2); Oenanthe javanica (umb1) 16-viii-94 (1); Eusteralis yatabeana (lab1) 16-viii-94 (3), 17-ix-94 (1); Prenanthes tanakae (ast11) 9-9-x-94 (3)

Pelopidas mathias oberthueri
  Persicaria thunbergii (pol4) 28-ix-95 (1); Oenanthe javanica (umb1) 28-ix-94 (1); Prenanthes tanakae (ast11) 9-x-94 (1)

Polytremis pellucida pellucida
  Lysimachia fortunei (pri1) 16-viii-94 (1); Cirsium japonicum (ast2) 16-viii-94 (1)

Thoressa varia
  Senecio pierotii (ast12) 14-v-94 (1)

Papilionidae

Papilio helenus nicconicolens
  Clerodendrum trichotomum (ver1) 16-viii-94 (1); Weigela hortensis (cap1) 14-v-94 (2)

Pieridae

Eurema hecabe
  Adenophora triphylla var. japonica (cam1) 16-viii-94 (1)
Lycaenidae

*Everes argiades hellotia*
*Alisma canaliculatum* (ali1) 28-vii-94 (1)

*Lycaena phlaeas daimio*
*Kalimeris pinnatifida* (ast8) 28-ix-95 (1)

Nymphalidae

*Argynnis paphia tsushimana*
*Prenanthes tanakae* (ast11) 9-x-94 (1); *Taraxacum japonicum* (ast13) 28-ix-95 (2)

Satyridae

*Ypthima argus*
*Eupatorium chinense* (ast4) 16-viii-94 (1)

HYMENOPTERA

Tenthredidae

*Lagidina platyeerus*
*Iris laevigata* (iri1) 1-vi-95 (2)

sp. 1
*Senecio pierotii* (ast12) 17-iv-94 (1)

sp. 2
*Mosla dianthera* (lab3) 28-ix-95 (1)

Argidae

*Arge nipponensis*
*Cardamine lyrata* (bral) 1-vi-95 (1)

Ichneumonidae

sp. 1
*Persicaria thunbergii* (pol4) 9-x-94 (1)

sp. 2
*Persicaria thunbergii* (pol4) 9-x-94 (1)

sp. 3
*Monochoria korsakowii* (pon1) 28-ix-95 (1)

sp. 4
*Persicaria conspicua* (pol1) 9-x-94 (1)

sp. 5
*Iris laevigata* (iri1) 1-vi-95 (2)

sp. 6
*Taraxacum japonicum* (ast13) 28-ix-95 (1)

Braconidae

*Agathis sp.*
*Persicaria sieboldii* (pol3) 28-ix-95 (9); *Persicaria thunbergii* (pol4) 28-ix-95 (7); *Kalimeris pinnatifida* (ast8) 28-ix-95 (1); *Kalimeris yomena* (ast9) 2-x-94 (1)

*Chelonus sp.*
*Persicaria thunbergii* (pol4) 28-ix-95 (1)
Flower-Insect Relationship at Nakaikemi Marsh

*Odontobracon* sp.

*Persicaria thunbergii* (pol4) 9-x-94 (1)

sp. 1

*Kalimeris pinnatifida* (ast8) 28-ix-95 (3)

sp. 2

*Kalimeris pinnatifida* (ast8) 28-ix-95 (1)

sp. 3

*Eusteralis yatabeana* (lab1) 17-ix-94 (1)

sp. 4

*Sagittaria trifolia* (ali2) 17-ix-94 (1)

sp. 5

*Lythrum anceps* (lyt1) 17-ix-94 (1)

sp. 6

*Lythrum anceps* (lyt1) 17-ix-94 (1)

**Eulophidae**

sp. 1

*Persicaria thunbergii* (pol4) 28-ix-95 (1)

**Chalcididae**

sp. 1

*Persicaria thunbergii* (pol4) 28-ix-95 (1); *Eupatorium chinense* (ast4) 16-viii-94 (1)

**Encyrtidae**

sp. 1

*Lythrum anceps* (lyt1) 17-ix-94 (3)

**Scolitidae**

*Campsomeris grossa*

*Eusteralis yatabeana* (lab1) 28-ix-95 (1)

**Formicidae**

sp. 1

*Senecio pierotii* (ast12) 14-v-94 (6)

**Eumenidae**

*Stenodynerus* sp.

*Kalimeris yomena* (ast9) 5-viii-95 (1)

*Eumenes micado*

*Ampelopsis brevipedunculata var. heterophylla* (vitl) 16-viii-94 (1)

*Oreumenes decoratus*

*Eusteralis yatabeana* (lab1) 28-ix-95 (1)

*Eumenes samurai*

*Lespedeza bicolor* (leg2) 28-ix-95 (1); *Ampelopsis brevipedunculata var. heterophylla* (vitl) 16-viii-94 (3); *Kalimeris yomena* (ast9) 2-x-94 (1)
46  Makoto Kato and Reiichi Miura

Vespidae

*Vespa simillima xanthoptera*

_Persicaria thunbergii_ (pol4) 9-x-94 (1)

_Polistes chinensis antennalis_

_Persicaria thunbergii_ (pol4) 2-x-94 (1); _Oenanthe javanica_ (umbl) 16-viii-94 (1); _Lycopus ramosissimus_ var. _japonicus_ (lab2) 28-ix-95 (4)

_Vespa lewisi_

_Eupatorium lindleyanum_ (ast5) 28-ix-95 (1)

_Vespa vulgaris_

_Prenanthes tanakae_ (ast11) 9-x-94 (1)

Pompilidae

_Cyphononyx dorsalis_

_Lycopus ramosissimus_ var. _japonicus_ (lab2) 28-ix-95 (1)

_Anoplus eous_

_Oenanthe javanica_ (umbl) 16-viii-94 (1)

Sphecidae

_Larra_ sp.

_Mosla dianthera_ (lab3) 28-ix-95 (1)

_Psen_ sp.

_Oenanthe javanica_ (umbl) 28-ix-95 (1)

Colletidae

_Hylaeus macilentus_

_Stellaria media_ (car1) 22-vi-94 (1); _Cardamine lyrata_ (bral) 1-vi-95 (1); _Lythrum anceps_ (lyt1) 17-ix-94 (1); _Oxalis corniculata_ (oxa1) 30-vi-95 (2); _Eusteralis yatabeana_ (lab1) 17-ix-94 (1); _Prunella vulgaris_ ssp. _asiatica_ (lab4) 30-vi-95 (9); _Ixeris debilis_ (ast6) 30-vi-95 (2); _Sagittaria trifolia_ (ali2) 5-vii-95 (1); _Monochoria korsakowii_ (pon1) 2-x-94 (1); _Iris laevigata_ (iri1) 1-vi-95 (8)

_Hylaeus floralis_

_Persicaria thunbergii_ (pol4) 28-ix-95 (1); _Oxalis corniculata_ (oxa1) 28-ix-95 (1); _Lycopus ramosissimus_ var. _japonicus_ (lab2) 28-ix-95 (2); _Mosla dianthera_ (lab3) 28-ix-95 (1), 9-x-94 (1); _Prunella vulgaris_ ssp. _asiatica_ (lab4) 30-vi-95 (1); _Kalimeris yomena_ (ast9) 2-x-94 (1); _Monochoria korsakowii_ (pon1) 28-ix-95 (1); _Iris laevigata_ (iri1) 1-vi-95 (1)

_Hylaeus noomen_

_Persicaria thunbergii_ (pol4) 28-ix-95 (1); _Rosa multiflora_ (ros2) 30-vi-95 (4); _Lythrum anceps_ (lyt1) 17-ix-94 (1); _Oxalis corniculata_ (oxa1) 28-ix-95 (3); _Mosla dianthera_ (lab3) 28-ix-95 (1); _Eupatorium lindleyanum_ (ast5) 28-ix-95 (1); _Monochoria korsakowii_ (pon1) 2-x-94 (2), 28-ix-95 (8); _Monochoria vaginalis_ (pon2) 28-ix-95 (8)

_Colletes palellatus_

_Persicaria sieboldi_ (pol3) 28-ix-95 (1); _Kalimeris pinnatifida_ (ast8) 28-ix-95 (2)

Halictidae

*Lasioglossum affine*

_Sagittaria trifolia_ (ali2) 16-viii-94 (1); _Iris laevigata_ (iri1) 1-vi-95 (1)

*Lasioglossum allobalum*

_Ranunculus japonicus_ (ran1) 14-v-94 (1); _Monochoria korsakowii_ (pon1) 28-ix-95 (1)
Lasioglossum exiliceps  
Mosla dianthera (lab3) 9-x-94 (1); Eupatorium lindleyanum (ast5) 17-x-94 (2)

Lasioglossum gorkiense  
Justicia procumbens (aca1) 28-ix-95 (1)

Lasioglossum japonicum  
Ranunculus japonicus (ran1) 14-v-94 (2); Lycopus ramosissimus var. japonicus (lab2) 28-ix-95 (1);  
Mosla dianthera (lab3) 28-ix-95 (1)

Lasioglossum mutilum  
Adenophora triphylla var. japonica (cam1) 16-viii-94 (1); Allium grayi (lil1) 22-vi-94 (1)

Lasioglossum percassicepes  
Nympheaea marlitta (nym1) 30-vi-95 (1); Sagittaria trifolia (ali2) 16-viii-94 (1), 28-vii-94 (1);  
Monochoria korsakowii (pon1) 28-ix-95 (1), 28-vii-94 (3)

Lasioglossum scitutum  
Cirsium japonicum (ast2) 22-vi-94 (1)

Lasioglossum sibiriacum  
Ranunculus japonicus (ran1) 14-v-94 (2); Cardamine lyrata (bra1) 1-vi-95 (1); Potentilla egedei var.  
grandis (ros1) 1-vi-95 (1); Oenanthe javanica (umbl) 16-viii-94 (1); Solanum melongena (soll) 5- 
vii-95 (1); Mosla dianthera (lab3) 9-x-94 (1); Justicia procumbens (aca1) 28-ix-95 (1);  
Cirsium japonicum (ast2) 22-vi-94 (1); Taraxacum japonicum (ast13) 17-iv-94 (1); Sagittaria trifolia (ali2)  
16-viii-94 (1); Monochoria korsakowii (pon1) 16-viii-94 (1); Iris laevigata (iril) 1-vi-95 (7)

Andrenidae

Andrena knuthi  
Ranunculus japonicus (ran1) 14-v-94 (2); Senecio pierotii (ast12) 17-iv-94 (2); Taraxacum japonicum  
(ast13) 14-v-94 (2)

Andrena kaguya  
Taraxacum japonicum (ast13) 17-iv-94 (1)

Andrena minutula  
Ranunculus japonicus (ran1) 14-v-94 (1)

Megachilidae

Megachile tsurugensis  
Lespedeza bicolor (leg2) 28-ix-95 (1); Ampelopsis brevipedunculata var. heterophylla (vit1) 16-viii- 
94 (1); Kalimeris pinnatifida (ast8) 28-ix-95 (1); Prenanthes tanakae (ast11) 9-x-94 (1); Sagittaria  
trifolia (ali2) 16-viii-94 (1)

Megachile nipponica  
Lysimachia fortunei (prel) 16-viii-94 (1); Ampelopsis brevipedunculata var. heterophylla (vit1) 16- 
vii-94 (1); Prunella vulgaris ssp. asiatica (lab4) 17-ix-94 (1), 30-vi-95 (1); Eupatorium chinense  
(ast4) 16-viii-94 (1)

Osmia taurus  
Senecio pierotii (ast12) 17-iv-94 (1)

Anthophoridae

Nomada fukuiana  
Taraxacum japonicum (ast13) 14-v-94 (1)
Nomada nipponica
Ixeris dentata (ast7) 1-vi-95 (1); Taraxacum japonicum (ast13) 1-vi-95 (1), 17-iv-94 (1)

Ceratina esakii
Prunella vulgaris ssp. asiatica (lab4) 30-vi-95 (1)

Ceratina flavipes
Prunella vulgaris ssp. asiatica (lab4) 30-vi-95 (1); Ixeris dentata (ast7) 14-v-94 (2)

Ceratina japonica
Ranunculus japonicus (ran1) 14-v-94 (3); Aeschynomene indica (leg1) 28-ix-95 (1); Justicia procumbens (acal) 28-ix-95 (3); Senecio pierotii (ast12) 14-v-94 (4)

Xylocopa appendiculata
Prunella vulgaris ssp. asiatica (lab4) 22-vi-94 (1); Weigela hortensis (cap1) 14-v-94 (1); Cirsium sieboldii (ast3) 28-ix-95 (1)

Apidae
Apis cerana
Persicaria nipponensis (pol2) 28-ix-95 (1); Persicaria sieboldi (pol3) 28-ix-95 (4); Persicaria thunbergii (pol4) 2-x-94 (1), 28-ix-95 (4), 9-x-94 (2); Mosla dianthera (lab3) 2-x-94 (1); Salvia japonica (lab5) 9-x-94 (1); Justicia procumbens (acal) 28-ix-95 (1); Bidens frondosa (ast1) 2-x-94 (1), 28-ix-95 (1); Kalimeris yomena (ast9) 9-x-94 (1); Taraxacum japonicum (ast13) 14-v-94 (2)

Bombus diversus
Solanum melongena (soll) 5-viii-95 (1); Prunella vulgaris ssp. asiatica (lab4) 22-vi-94 (1); Justicia procumbens (acal) 28-ix-95 (1); Adenophora triphylla var. japonica (cam1) 28-ix-95 (1); Hosta albomarginata (li12) 16-viii-94 (1), 28-vii-94 (1), 5-viii-95 (1)

Bombus hypocrita
Justicia procumbens (acal) 28-ix-95 (1)

EXPLANATION OF PLATE 1
M. KATO and R. MIURA: Flowering phenology and anthophilous insect community at a threatened natural lowland marsh at Nakaikei in Tsuruga, Japan