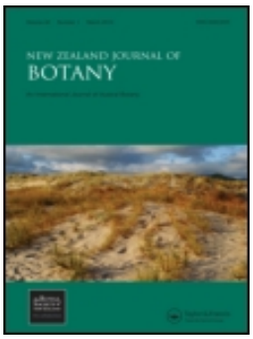

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Richard B. Primack

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Insect pollination in the New Zealand mountain flora

RICHARD B. PRIMACK
Biology Department, Boston University
Boston, Massachusetts, USA 02215

Abstract A wide variety of lepidopterans, bees, flies, and beetles visit the flowers of most species of New Zealand montane plants. Of the 82 plant species which were well-collected, 4 species (*Pterostylis* sp., *Pratia macrodon*, *Mazus radicans*, and *Dracophyllum acerosum*) exhibited specialised pollination relationships with an insect order; 3 species (*Cyathodes fraserii*, *Microtis unifolia*, and *Thelymitra venosa*) are not apparently visited by insects; and the remaining 75 species are visited by a variety of insects in 2 or more orders. Introduced plant species in the Composite family are visited predominantly by introduced bumblebees. Bees in the genera *Lasioglossum* and *Leioproctus* are abundant flower visitors. The most common lepidopteran flower visitors are in the families Noctuidae, Geometridae, and Pyralidae, and the genus *Lycaena*. Dipterans, in particular tachinids and syrphids, are numerically the most abundant flower visitors, and visit a wide range of species. The syrphid *Melangyna novaezelandiae* visits the flowers of more plant species than any other flower visitor. Beetles are typically not abundant, and do not move often between flowers. Species in the genus *Hebe* might be expected to have different insect pollinators from species in the Composite family, because of the quite different floral characteristics in these groups. However, there is no general difference in the insects visiting the flowers in the genus *Hebe*, the family Compositae, and the remaining species, indicating a lack of specialisation for particular pollinators. Individual flowers of most species last more than 4 days, so that several consecutive days of bad weather need not prevent a flower from being pollinated. There is no obvious relationship between the biogeographical origin of plant species and the types of insects visiting its flowers.

Keywords pollination; reproductive behaviour; New Zealand flora; mountain flora; insects; insect pollination

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INTRODUCTION

The pollination ecology of New Zealand plants is unusual because of the absence or rarity of native specialised pollinators such as butterflies, long-tongued social bees, bee flies, hawkmoths, and nectar-feeding birds, which are so important to other montane floras, such as those of the Andes of Chile (Arroyo et al. 1982) and those of the mountains of western North America (Moldenke 1979, Moldenke & Lincoln 1979). Only 3 surveys (Thomson 1881, 1927; Heine 1937) and one review (Godley 1979) have examined New Zealand pollination systems. Heine (1937) emphasised the importance of short-tongued bees and flies in the pollination of New Zealand plants. These studies did not focus on the mountain flora, and for the earlier studies identification of many insect groups was not possible. As a result our knowledge of the pollination ecology of montane species is quite limited. Consequently, a study was undertaken to give a more complete picture of pollination systems in the New Zealand montane flora. The goals of this project were to determine (1) whether plant species were specialised in their types of insect visitors and (2) conversely, whether insect species were specialists in the types of flowers they would visit and (3) if introduced honeybees and bumblebees were important pollinators of native plant species.

MATERIALS AND METHODS

Insects which were visiting flowers of 95 native species and 14 introduced species to collect pollen and nectar were captured by net or by hand. No attempt was made to determine if an insect was actually carrying pollen on its body. However, all of the insects collected contacted the anthers and the stigmas of the flowers being visited. Tiny insects, such as thrips, were not collected and their significance as pollinators is not known. Insects were captured as encountered, so that the abundance of insects in a sample of flower visitors gives an approximate idea of the abundance of a species as a flower visitor. In nature, the relative abundance of flower visitors may vary rapidly depending on environmental conditions (Primack 1978); this affects the relative importance of a species as a pollinator (Primack & Silander 1975). When particular insect species, such as native bees or March flies, were abundant locally, only a few specimens of a species were captured.

Insect specimens were pinned, labelled with the name of the plant species which the insect was visiting, and later identified as closely as possible. All insect specimens were deposited as vouchers at the University of Canterbury Zoology Department.

Four field sites in the South Island were studied:

1. Cass. Insects were collected from early December until the end of February during the summers of 1976–77 and 1977–78. Most collecting was done between 600 and 800 m elevation on the lower, western slopes of Cass Hill; some additional collecting was done along the edge of the river and on the terraces at the base of Mt Horrible. This montane area is grassland with scattered isolated shrubs and thickets (Burrows 1977). Sheep and cattle graze in this area.

2. Craigieburn Mountains (CR). Insects were collected approximately 2 days/week during the summer of 1976–77. The area is on the southern edge of the Waimakariri River Valley, Canterbury. Insects were collected in the subalpine grassland and rocky cliffs above the treeline on the southeastern slope of the range between 1600 and 1800 m elevation on land used by the Craigieburn Valley Ski Club.

3. Arthur's Pass National Park (AP). Insects were collected approximately 1 day/week in 1976–77 and 1 day every 2 weeks in 1977–78. Insects were collected in subalpine grassland and scrub approximately 1.5 km east of the Otira Gorge at an elevation of 900 m. This site is on the main divide, and is considerably wetter, and the vegetation more lush than the Craigieburn site.

4. Mount Cook National Park (MC). Flower visitors were collected on 2 sunny days, 22 and 23 February 1977, along the Ball Hut Road (elevation 1100 m) and along the path to the top of Mt Sealy. The area is subalpine grassland and scrub (Wilson 1976).

Data was also gathered on the longevity of individual blossoms. Flowers were tagged before opening and checked every day initially, and later once every 2 days, to determine how long a flower remains open before a corolla discolours or falls off. The mean flower longevity is reported for each species and the number (N) of flowers observed. Data were also gathered on the number of days an individual inflorescence, or head, continued to have open flowers in plants of the Composite family.

Species names for native species follow Mark & Adams (1973), Allan (1961), and Moore & Edgar (1970), and for introduced species follow *Flora Europa*. The abbreviated species names for many bees correspond to an unpublished manuscript by Barry Donovan.

RESULTS

The plants

A wide variety of lepidopterans, bees, flies, and beetles visit most species. The number of insect species listed as visiting the flowers of a plant species is usually related to the number of specimens caught. The flowers of certain shrubs, such as *Discaria toumatou*, *Leptospermum scoparium*, and *Hebe salicifolia*, and herbs, such as *Aciphylla scott-thomsoni* and *Wahlenbergia albomarginata*, attract many insects of numerous insect species. For example, at least 45 insect species were collected from the flowers of *Leptospermum scoparium*. Only a few insect species were collected from the flowers of 13 species, because these plants attracted fewer visitors and less time was spent collecting from them. If additional time was spent collecting on these plants, a similarly large number of insect species would probably be collected. No pollinators were observed at the flowers of *Cyathodes fraseri*, *Microtis unifolia*, and *Thelymitra venosa*, despite extensive observations.

Individual foraging insects were followed at the Craigieburn site. Individual bees, flies, and lepidopterans moved readily between the flowers of different species. Individual insects visited the flowers of up to 4 unrelated plant species in rapid succession. There was no evidence that any native insect species forages exclusively on one plant species.

Four plant species in this study seem to have only one class of flower visitors: *Pterostylis* sp. is visited by craneflies, *Mazus radicans* by small bees, *Pratia macrodon* by day-flying moths, and *Dracophyllum acerosum* by night-flying moths. *Dracophyllum acerosum* in particular was observed extensively over many days and nights and, except for a few craneflies, the hundreds of moths observed were the only flower visitors.

Altogether, of the 82 species of plants which were well-observed, 4 species exhibited specialised pollination relationships with an insect order. Three species apparently were not visited by insects and may be either automatically self-pollinated or have lost their pollinators as a result of human disturbance. The remaining 75 species were pollinated by a diversity of insects in 2 or more orders.

Introduced plants showed various patterns of flower visitation. Seven introduced plant species, 5 of which are in the Composite family, were visited predominantly or exclusively by native insects: *Achillea millefolium*, *Chrysanthemum leucanthemum*, *Hieracium pilosella*, *Hieracium praealtum*, *Hypochaeris radicata*, *Cytisis scoparius*, and *Rosa rubiginosa*. Six other introduced plant species, none

of which are in the Composite family, were visited predominantly by bumblebees: *Digitalis purpurea*, *Echium vulgare*, *Prunella vulgaris*, *Trifolium pratense*, and *Trifolium repens*. *Cirsium arvense* (Compositae) is visited actively by both bumblebees and native insects. Flower visitors were virtually absent from *Lupinus polyphyllus*.

The insects

This study did not show that flower-visiting insects are comparatively scarce in New Zealand, in contrast to the reports of Heine (1937). During windy, cold, and rainy periods in the mountains, insect visitors are not easily found. However, insects are often abundant, or even exceedingly abundant, during warm, still, sunny times. During fine weather, more than 100 insects representing many species could be observed visiting the flowers on a single shrub of species such as *Leptospermum scoparium*, *Discaria toumatou*, and *Hebe salicifolia*. In certain mountain areas of New Zealand, sunny, warm weather is not common, so that a brief visit to an area during a period of rain would lead to the false impression that insects are not abundant. As with insects generally, native bees were present as foragers primarily during sunny, warm periods. During such times, the density of bees on the flowers was often very high. Native bees are definitely common and important flower visitors. The abundance of native bees seems to be more affected by the weather than most other groups.

The 2 species of small bees in the genus *Lasioglossum* were collected on a wide range of plants. These bee species were often in great abundance on particular species, such as *Cytisus scoparius*, *Pimelea traversii*, and *Corokia cotoneaster*. Bees may forage in groups since many of bees will be visiting one shrub while, a few meters away, another comparable shrub of the same species is only rarely visited. The means by which this group foraging takes place is not known, and might also be related to variation among plants in food reward. There is no evidence that either bee species is specialised to visit the flowers of any group of plant species.

In the bee genus *Leioproctus*, 4 species, (*L.* "B" and *L. vestitus*, *L. boltonii*, and *L. imatatus*) were collected only on one plant species. *L. maritimus*, *L.* "C", *L.* "D", and *L.* "E" visit only a narrow range of plant species, with *L.* "D" visiting predominantly flowers of species in the Compositae. *Leioproctus* "A" visited a wide range of plant species. *L. monticola* visited the flowers of many species, but was concentrated on species of *Hebe*, and *L. fulvescens* also visited a wide range of species though was concentrated on Compositae species.

Hymenopterans in the genus *Hyleus* and *Pseudofoenus* were only rare flower visitors.

The introduced bumblebees and honeybees were not abundant at these field sites. These social bees visited primarily the flowers of introduced plants.

Only one species of ants, *Chelaner antarcticus*, was seen visiting flowers and it was never abundant.

The 2 butterfly species, *Lycaena salustius* and *L. boldenarum*, were both abundant and visited a wide range of plant species. *L. salustius* was somewhat more common than the other species.

Most species of moths in the families Noctuidae and Geometridae were collected exclusively on the flowers of shrubs, and were never collected on herbs. Although many of these shrubs have large flowers, other species, such as *Olearia virgata*, have small flowers. In contrast with other groups of flower visitors, these moths seem to depend on only a few sources of food. At Cass, noctuid and geometrid moths were abundant and active almost entirely at night. At the higher elevations of the Craigieburns, noctuids were rare and geometrids infrequent and both were active during the day. These alpine geometrids visited the flowers of herbs and prostrate shrubs as well as upright shrubs. *Dasyuris anceps* was the most common visitor to *Wahlenbergia albomarginata* and *Dracophyllum pronum* at the Craigieburns. At Cass, the abundance of moths on the flowers was highly variable. On most nights, moth activity was low. However, on occasional warm, still, misty nights the abundance of moths on the flowers could be extremely high.

Pyralid moths are found primarily on the flowers of shrubs at night. Two species, *Scoparia submarginalis* and *Eudonia sabulosella*, visited the flowers of many plant species with *S. submarginalis* being at times very abundant on the flowers of *Leptospermum scoparium*.

Hemipterans are uncommon flower visitors, as is true in other floras.

Dipterans are numerically the most abundant flower visitors, based on the number of individuals collected foraging. Dipterans comprise 50–80% of the total flower visitors (Table 1). There are many flower-visiting fly species, in contrast with the hymenopterans. The most important family is the Tachnidae, with the following genera containing at least 3 species in the sample: *Pales*, *Avibrissina*, *Heteria*, *Proscissio*, *Zealandotachina*, and *Protohystricia*. At Cass, the most common tachinid flies are *Proscissio cana*, *"Peremptor" modica*, and *Protohystricia orientalis*. At higher elevations, *Veluta albicincta* and *Avibrissina isolata* become more common. Individual species of tachinids visit many unrelated species of diverse growth habits. There is no evidence of any tachinid species visiting exclusively one plant species or groups of related

Table 1 The percentage of numbers of insects of each group of flower visitors, based on samples collected at Mount Cook and the Craigieburn mountains. See the text for dates and methods of collection. The category "Other flies" is composed mainly of tachinid and muscid flies.

Site	Plant group	Sample size	Native bees	Wasps	Bumble bees	Syrphid flies	Other flies	Beetles	Day-flying lepidopterans
Mount Cook:	*Hebe*	67	22	4	0	21	45	3	4
	Compositae	81	17	0	0	27	46	1	9
	Remaining species	95	15	0	4	14	36	19	13
Craigieburn mountains:	*Hebe*	56	0	4	0	30	50	9	7
	Compositae	181	10	0	0	25	46	15	4
	Remaining species	173	11	0	0	31	50	4	3

plant species. Tachinids may be particularly important as pollinators since they are hairy and they often forage on cold, rainy days when other insects are not present (Primack 1978).

Syrphids are the second most abundant group of dipteran flower visitors, comprising approximately one-quarter of the number of individual dipteran flower visitors (Table 1). Syrphids are easy to recognise because of their shiny, dark, hairless bodies and hovering flight. Individuals of the genus *Melangyna* are the most common syrphids, but difficulties of species identification prevent a detailed discussion of species preferences. *Melangyna ortas, M. novaezelandiae*, and the unidentified *Melangyna* specimens were all collected on many plant species of all growth habits. From all of these observations, it is clear that syrphids do not specialise on the flowers of any plant species. *Melangyna novaezelandiae* visits the flowers of more plant species than any other insect species, and occurs commonly at all 4 sites.

Flies in the family Muscidae are abundant visitors to many plant species. Unfortunately, identifications could not be obtained even to the genus for any of the specimens I collected.

Dipteran flower visitors in the families Calliphoridae, Tabanidae, Asilidae, Bibionidae, Empidae, Stratiomyiidae, Dolichopodidae, and Cyrtidae are also present at low numbers. *Calliphora quadrimaculata* visits the flowers of many plants with conspicuous floral displays. Males of *Philia nigrostigma* are occasionally extremely abundant on particular flowering shrubs; this may be part of a mating display.

Beetles are not important as pollinators at these sites for several reasons: their density on the flowers is low, their bodies are not hairy enough to carry much pollen, and they move between flowers infrequently. The most common beetle species, *Adoxia obscura*, is apparently specialised as a visitor to flowers in the Composite family.

Comparisons of insects collected at Mount Cook and at the Craigieburns

Specialisation for pollinators might be evident if particular groups of plants showed different proportions of insect types on their flowers. To examine this question, the insects collected at the Mount Cook site and the Craigieburn site were identified as being either 1) native bees, 2) muscid or tachinid flies, 3) syrphid flies, 4) beetles, 5) day-flying Lepidopterans, 6) wasps, or 7) bumblebees. Flower visitors to species of the genus *Hebe* (Scrophulariaceae) and to species of the Composite family were separated out from the other plant species (Table 1). The plant species in this comparison are given in the lists of plant species and the localities observed. Different species in these 2 groups were observed at the 2 localities. The species in each of these 2 groups of plants have differing floral characteristics: *Hebe* flowers are usually moderate in size, bilaterally symmetrical, blue or purple in colour, and oriented horizontally; the flowers in Composite heads are usually small, composed mainly of radially symmetrical flowers in New Zealand species, white or yellow in colour, and oriented upwards. Consequently, major differences might be expected between each of these species groups and the remaining species.

On both sites, the patterns of insect distribution do not differ among the 3 groups of plant species (Table 1). The distributions among the sites are similar, except that Mount Cook has proportionately more individual bees and fewer individual beetles than the Craigieburns. The differences between the 3 groups of plant species are not

Table 2 Mean flower longevities for species growing at Cass and the Craigieburns. The longevity of flowering for heads is reported separately for the Compositae family.

	Mean of means	S D	Number of species	Range of species means
Cass				
Flowers	5 6	4.1	18	1 0–19.2
Compositae	9 2	4.3	3	4.6–13.0
Craigieburns				
Flowers	8.5	3.8	18	3.1–15.0
Compositae	12 9	2.0	10	10.0–15.0

consistent between the 2 sites, indicating that the differences observed are not really general. However, roughly 12% of the individual flower visitors are native bees, 25% are syrphid flies, 46% are muscid and tachinid flies, 8% are beetles, and 7% are day-flying lepidopterans.

At Mount Cook, the distribution of insects on *Hebe* flowers is similar to the distribution on Composite flowers, with bees slightly more common on *Hebe* flowers than on Composite flowers (Table 1). In contrast, at the Craigieburns, no bees were collected on *Hebe* flowers, but bees comprised 10% of the individual visitors to Composite flowers. Bees and flies were less abundant, and bees and lepidopterans were more abundant on the remaining species than on the *Hebe* and Composite flowers at the Mount Cook site. In contrast, at the Craigieburn site, proportionately *fewer* beetles were collected from the remaining species than either *Hebe* species or Composite species.

Flower longevity

The flowers of most species examined in this study remain open for at least 3 days and many stay open for much longer (Table 2). For 18 species examined at the Craigieburns, there was an average flower longevity of 8.5 days, with individual species varying between 3 and 15 days in flower longevity. For 18 species examined at Cass, there was an average flower longevity of only 4.1 days, with species varying between 1 and 19 days. At both of these field sites, most species have flowers which typically last more than 3 days. Since a single flower is apparently viable for such a long period, several consecutive days of rainy weather in which pollinator activity is low need not prevent a flower from being successfully pollinated by insects. The flower may be able to persist until weather conditions allow greater pollinator activity. Of course, self-pollination of the flowers in self-compatible species may be occurring during this period of bad weather. The generally cool and humid weather conditions at these 2 sites may contribute to the flower longevity of several days by lowering the respiration rate and transpiration rate of the flower. However, it is not known whether the flower longevities at these sites are different from other areas as there is no comparative data from other environments.

For the 10 species in the Compositae at the Craigieburn site, individual flower heads had an average longevity of 12.9 days, with species averages varying between 10 days and 15 days. For the 3 species at Cass, individual flower heads had an average longevity of 9.2 days, with species varying between 4.6 days and 13.0 days. Individual flowers were not tagged, but they probably only last 1 or 2 days. The average floral longevity of a Composite head is greater than the longevity of individual flowers of other species in the same habitat.

DISCUSSION

The subalpine areas of the Craigieburn Range and Arthur's Pass present a major contrast to the montane Cass area in the timing of flower visitor activity. At Cass, moths and craneflies are active almost exclusively at night. In the subalpine areas, craneflies are not common as flower visitors and the moths appear to be exclusively active during the day. Flower-visiting insects may forage only during the day in the subalpine areas because temperatures drop rapidly following sunset.

At Cass, flowering times for the majority of species are spread out over a 20-week period from late October to early March. There is a progression of flowering with individual species coming into flower successively over this time period (Primack 1980). At the Craigieburn site, flowering is spread over only 15 weeks. In the subalpine areas, changes in direction of slope, angle of slope, or elevational differences over a short distance can have major influences on the micro-climate of the plants, with consequent effects on the flowering time of the plants (Scott 1960, Clark 1968, Wardle 1978a). In particular, plants covered by an accumulation of snow until late in the growing season may not flower until many weeks after neighbouring plants of the same species have flowered. As a result, individual species often have a broad flowering period, and there seems to be more overlap in flowering time among species than at lower elevations.

Differences in flowering time between closely related species can be an important isolating mechanism preventing hybridisation, yet this mechanism does not seem to be operating in this alpine area. As an example, 2–6 species of *Celmisia* may grow in intermixed populations at the field sites. These species flower at approximately the same time and have similar floral displays, and their

flowers are visited by the same species of insects. Yet, hybrids between species are not common.

A possible isolating mechanism which may be important in the subalpine areas is the periodic flowering of many of the species. A low percentage of the individuals of a species may flower for several years, followed by one year in which a far higher percentage of the individuals flower. Good flowering years seem to be triggered by environmental conditions (Mark 1965, 1970). Consequently, the local density of flowering plants of a species may be very high when the species does flower, and other closely related species may not be flowering as well that year.

New Zealand lacks native bumblebees. However, several mountain species in this study possess flowers which show certain features resembling the typical adaptations for bumblebee pollination in other regions, such as complex zygomorphy (*Mazus radicans, Ourisia macrocarpa, Euphrasia revoluta*), large, cup-shaped flowers (*Gentiana montana, G. corymbifera, Wahlenbergia albomarginata*), large urceolate flowers (*Gaultheria crassa*), and blue and purple colouration (*Mazus radicans, Wahlenbergia albomarginata*). The flowers of these species are visited by native insects. The quality of the pollinator service which these insects are performing is not known. However, it is clear that plant species with flowers apparently adapted for bumblebee pollination can live and reproduce in areas without bumblebees. Interestingly, the introduced bumblebees do not visit the flowers of these species, suggesting that either these plant species are not at present adapted for bumblebee pollination or that bumblebees are more attracted to the introduced species. A discussion of the origin and evolution of the mountain flora and pollinator fauna is beyond the scope of this paper. Biogeographical treatments of this subject may be found elsewhere (Wardle 1978b, Raven 1972). As a general statement, there appears to have been rapid speciation associated with Pleistocene glaciation over the last few million years (Raven 1972). The flora seem to be a mixture of ancient species, rapidly evolving genera of uncertain origin, and close relatives of cosmopolitan species groups. Many of the insects which visit flowers, such as the bees, tachinid flies and geometrid moths, belong to groups more or less related to Australian or South American groups, perhaps being a remnant of an ancient Gondwanaland fauna (J. Dugdale & B. Donovan, pers. comm.). Other important flower visitors, such as the pyralid moths, *Melangyna* syrphid flies, and *Lycaena* butterflies have unknown, though possibly northern hemisphere, affinities. It is particularly surprising that New Zealand has so few butterflies, since Australian species are constantly being blown across the Tasman Sea to New Zealand (Dugdale 1975, Fox 1976). Since the flowers of most New Zealand mountain plant species are visited by a wide range of insects, there is no obvious relationship between the biogeographical origin of a plant species and the types of insects visiting its flowers. The recent evolution of new plant species, the great variability of the weather, the absence and rarity of groups of advanced pollinating animals, and the presence in New Zealand of opportunistic insects such as pyralid moths and tachinid and syrphid flies are all significant factors in the pollination ecology of New Zealand montane species. In contrast with earlier studies commenting on the "comparative scarcity of insects in New Zealand" (Heine 1937), it is found that flower-visiting insects generally, and bees in particular, are not scarce during periods of sunny weather. The flowers of New Zealand plant species can last many days until such favourable conditions occur and the generalist insects arrive to visit the flowers.

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APPENDIX 1

Plant species

An asterisk is used to indicate that a species is introduced. Abbreviations are used to indicate localities where pollinators were caught: Cass (CASS), Mount Cook (MC), Arthur's Pass (AP), Craigieburns (CR). The number of individuals caught of each species is given after the species name.

BORAGINACEAE

**Echium vulgare* (CASS). *Hym.*: **Bombus terrestris*, 1. **Bombus ruderatus*, 1. **Apis mellifera*, 2.

This introduced roadside weed is visited by introduced bees.

CAMPANULACEAE

Wahlenbergia albomarginata (CASS, AP, CR) *Hym.*: *Leioproctus* "A", 3. *Emp.* sp., 1. *Strat: Eulalia* sp., 1. *Col.*: *Mordella detracta*, 2. *Leioproctus fulvescens*. *Leioproctus* "D", 1. *Lasioglossum* "A", 3. *Lep.*: Unidentified day-flying butterflies and moths. *Tach*: *Avibrissina isolata*, 1. *Syrph.*: *Melangyna novaezelandiae*, 1. *Melangyna* sp., 1.

The flowers of this species close in the late afternoon and during cloudy weather, unlike most other species in this area. Each clone closes at a distinct time, with all the flowers of a clone closing at the same time.

These flowers were actively visited by a diversity of insects in warm sunny weather.

Flowers last 7.2 days (N = 3, CASS).

COMPOSITAE

**Achillea millefolium* (CASS). *Tach.*: *Proscissio cana*, 9. *Proscissio* n. sp. (*lucida*), 1. *Zealandotachina varipes*, 3. *Protohystricia alcis*, 1. *Protohystricia orientalis*, 1. *Syrph.*: *Melangyna ortas*, 1. *Melangyna novaezelandiae*, 2. *Melangyna* sp., 4. *Tab.*: *Scaptia adrel*, 1. *Cal.*: *Calliphora quadrimaculata*, 1. *Calliphora icela*, 1. *Musc.* sp.: 21.

Native flower visitors are abundant on this introduced herb.

Brachycome sinclairii (CASS, CR, MC). *Hym.*: *Lasioglossum sordidum*, 2. *Lasioglossum* "A", 2. *Pseudofoenus pedunculatus*, 1. *Lep.*: *Orocrambus crenaeus*, 1. *Syrph.*: *Melangyna* sp., 3.

Individual heads last an average of 14.5 days (N = 2, CR), and over 13.0 days (N = 3, CASS).

Cassinia fulvida (CASS). *Hym.*: *Leioproctus fulvescens*, 4. *Leioproctus monticola*, 1. *Leioproctus* "D", 8. *Leioproctus* "E", 2. *Lep.*: *Lycaena salustius*, 5. *Argyrophenga antipodum*, 1. *Orocrambus flexuosellus*, 1. *Tach.*: *Proscissio cana*, 1. *"Peremptor" modica*, 1. *Syrph.*: *Helophilus hochstetteri*, 1. *Melangyna ortas*, 4. *Melangyna novaezelandiae*, 2, *Melangyna* sp., 3. *Asil.*: *Saropogon proximus*, 1. *Cal.*: *Calliphora quadrimaculata*, 1. *Musc.*: sp., 2.

Flower visitors are often very abundant on this species.

Cassinia vauvilliersii (AP, MC, CR). *Hym.*: *Leioproctus maritimus*, 1. *Leioproctus* "D", 1. *Lep.*: Lycaena salustius, 2. *Tach.*: *Erythronychia aliena*, 1. *"Occisor" versutus*, 1. *"Peremptor" modica*, 12. *Zealandotachina nigrifemorata*, 4. *Zealandotachina varipes*, 1. *Syrph.*: *Helophilus hochstetteri*, 1. *Lepidomyia decessum*, 2. *Melangyna novaezelandiae*, 8. *Melangyna* sp., 1. *Col.*: Unidentified species.

Celmisia armstrongii (AP). *Lep.*: *Argyrophenga*, n. sp., 1. *Tach.*: *Veluta albicincta*, 1. *Syrph.*: *Pilinasica cingulata*, 1. *Xylota montana*, 4. *Cheilosia fulvipes*. *Cheilosia* sp. *Cyrt.*: *Apsona muscaria*, 1. *Col.*: Unidentified species.

This species was flowering at the same time as *Celmisia coriacea* in the Arthur's Pass area in January 1977. Pollinators moved readily between the inflorescences of the 2 species.

Celmisia coriacea (AP). *Hym.*: *Leioproctus fulvescens*, 1. *Lep.*: *Argyrophenga janitae*. *Tach.*: *Veluta albicincta*, 1. *Syrph.*: *Pilinasica cingulata*, 1. *Xylota montana*, 4. *Cheilosia fulvipes*, 3. *Cheilosia* sp., 1. *Cyrt.*: *Apsona muscaria*, 1. *Musc.* sp., 1. *col.*: Unidentified species.

Heine (1937) reports a variety of flower visitors.

Celmisia discolor (CR). *Hym.*: *Lasioglossum* "A", 1. *Hylaeus* sp. *Lep.*: *Pasiphilus nereis*, 1. *Tach.*: *Veluta albicincta*, 1. *Syrph.*: *Melangyna* sp., 1. *Eristalis tenax*. *Emp.*: Unidentified species, 4. *Strat.*: *Eulalia* sp. *Cyrt.*: *Helle longirostris*, 1. *Musc.* sp., 7. Unidentified acrocerid fly. *Col.*: *Adoxia obscura*, 3. *"Cyphon"* sp. (aff. *fuscifrons*), 1.

Individual heads last an average of 12.0 days (N = 5).

Celmisia gracilenta (CASS, CR). *Hym.*: *Lasioglossum sordidum*, 3. *Leioproctus* "D", 1. *Lasioglossum* "A", 1. *Lep.*: *Lycaena boldenarum*, 3. *Pasiphila nereis*, 1. *Pieris raphae*. *Syr.*: Unidentified species. *Tach.*: *Protohystricia huttoni*, 1. *Col.*: *Zorion minutum*, 1.

Individual heads last an average of 10.0 days (N = 2, CASS).

Celmisia laricifolia, (CR). *Lep.*: *Asaphodes clarata*, 1. *Syrph.*: *Melangyna novaezelandiae*, 1. *Melangyna* sp., 1. *Col.*: *Adoxia obscura*, 1.

Celmisia lyallii, (CR). *Tach.*: *Avibrissina isolata*, 1. Syrphids. *Col.*: *Adoxia obscura*, 1.

Celmisia petiolata, (MC, CR). *Hym.*: *Lasioglossum* "A", 1. *Tach.*: *Avibrissina isolata*, 4. *Avibrissina brevipalpis*, 1. *Proscissio* n. sp., 1. *Veluta albicincta*, 1. *Syrph.*: *Melangyna* sp., 4. *Emp.* sp., 4. *Musc.* sp., 7. *Col.*: *Adoxia cheesemani*, 1. *Adoxia obscura*, 4.

Individual heads last an average of 12.5 days (N = 2, CR).

Celmisia sessiliflora (CR) *Musc.* sp., 1. *Col.*: New genus (*Erirhininae*), 1.

Individual heads flower over 12 days (N = 3).

Celmisia spectabilis (CASS, CR). *Hym.*: *Leioproctus fulvescens*, 2. *Chelaner antarcticus*, 1. *Leioproctus* "A", 3. *Lasioglossum* "A", 1. *Tach.*: *Avibrissina isolata*, 4. *Avibrissina brevipalpis*, 1. *Syrph.*: *Xylota montana*, 2. *Melangyna novaezelandiae*, 1. *Melangyna* sp., 5. *Emp.* sp., 4. *Cyrt.*: *Helle longirostris*, 1. *Musc.* sp., 10. Tabanids. *Col.*: *Adoxia obscura*, 3. *Dasytes subcyaneus*, 2.

Numerous crab spiders were observed catching flower visitors on the heads of this species and *Celmisia petiolata*.

**Chrysanthemum leucanthemum* (CR, AP, MC). *Hym.*: *Leioproctus* "A", 1. *Leioproctus fulvescens*, *Lasioglossum* "A", 1. *Lep.*: Small butterflies. *Tach.*: *Neotachina* n. sp., 1. *"Peremptor" modica*, 1. *Proscissio lateralis*, 1. *Syrph.*: *Melangyna* sp., 3.

This introduced herb is actively visited by native insects.

**Cirsium arvense* (CASS, MC). *Hym.*: **Bombus terrestris*, 1. **Bombus hortorum*, 1. *Lep.*: *Lycaena salustius*, 2. *Tach.*: *Pales efferata*. *Bothrophora lupina*, 1. *"Occisor" versutus*, 1. *Proscissio cana*, 1. *Proscissio valida*, 1. *Protohystricia alcis*, 1. *Protohystricia huttoni*. *Protohystricia orientalis*, 4. *Hybopygia varia*, 1. *Syrph.*: *Eristalis tenax*, 1. *Melangyna novaezelandia*, 1. *Tab.*: *Scaptia adrel*, 1. *Musc.* sp., 4.

This introduced herb is visited actively by many native species, but mainly by bumblebees.

Cotula pyrethrifolia (CR). *Tach.*: *Avibrissina isolata*, 1. *Syr.*: Unidentified species. *Dol.* sp., 1. *Musc.* sp., 4. *Col.*: *Peristoreus* sp., 1.

Flower visitors are not abundant on this species. Individual heads last an average of 9.8 days (N = 4).

Craspedia uniflora (AP, MC, CR). *Leioproctus fulvescens*, 1. *Leioproctus* "A", 2. *Lep.*: *Lycaena salustius*, 1. *Argyrophenga*. *Tach.*: *Avibrissina isolata*, 1. *Syrph.*: *Cheilosia* sp., 1. *Melangyna* sp., 3.

Individual heads last more than 15 days (N = 4, CR).

Helichrysum bellidioides (CR, AP). *Lep.*: Unidentified species. *Tach.*: *Mallochomacquartia setiventris*, 1. *Veluta albicincta*, 1. *Syrph.*: *Melangyna* sp., 9. *Emp*: sp., 1. *Dol.* sp., 1. *Musc.* sp., 4. *Col.*: *Adoxia obscura*, 1. *Asilis pilicornis*, 1.

The inflorescences close before sunset and during cloudy weather. Individual heads last an average of 12.4 days (N = 5, CR).

Helichrysum selago (CASS, CR). *Lep.*: *Pareromene pyrsophanes*, 1. *Scoparia submarginalis*, 1. *Scoparia cataxesta*, 1. *Scoparia rotuella*, 1. *Eudonia sabulosella*, 2. *Gelechia lithodes*, 1. *Pasiphila nereis*, 1. *Tach.*: *Avibrissina brevipalpis*, 1. *Syrph.*: *Lepidomyia decessum*, 1. *Melangyna novaezelandiae*, 1. *Melangyna* sp., 4. *Musc*: sp., 2. *Col.*: *"Cyphon"* sp., 1. Many small black beetles.

The sweet scented flowers are visited at night by many moths. Spiders are abundant on the flowers, apparently trying to catch flower visitors. No flower visitors observed during the day.

**Hieracium pilosella* (CR). *Hym.*: *Leioproctus fulvescens*, 4. *Leioproctus* "C", 1. *Syrph.*: *Melangyna novaezelandiae*, 2.

**Hieracium praealtum* (MC, CR). *Hym.*: *Leioproctus fulvescens*, 3. *Lep.*: *Lycaena salustius*, 1. *Tach.*: *Avibrissina brevipalpis*, 1. *Syrph.*: *Cheilosia* sp., 1. *Melangyna novaezelandiae*, 1. *Melangyna* sp., 1. *Eristalis tenax*.

**Hypochaeris radicata* (CR). *Hym.*: *Leioproctus fulvescens*, 1. *Lep.*: *Lycaena boldenarum*, 1. *Argyrophenga* sp. *Syrph.*: *Melangyna* sp., 2.

Leucogenes grandiceps (CR). *Hym.*: Unidentified bees. *Lep.*: Unidentified day-flying moths. *Tach.*: *Mallomacquartia setiventris*, 1. *Veluta albicincta*, 2. *Syrph.*: *Melangyna novaezelandiae*, 1. *Melangyna* sp., 3. *Musc.* sp., 10. *Col.*: *Adoxia obscura*, 7.

Individual heads last more than 15 days (N = 4).

Olearia moschata (MC). *Hym.*: *Leioproctus fulvescens*, 2. *Leioproctus* "D", 3. *Lep.*: *Lycaena salustius*, 1. *Tach.*:

Proscissio kumarensis, 1. *Syrph.*: *Melangyna novaezelandiae*, 2. *Melangyna* sp., 1 *Musc.* sp., 2. *Col.*: Unidentified species.

Olearia virgata (CASS). *Hym.*: *Lasioglossum sordidum*, 7. *Lep.*: *Rictonis comma*, 1. *Epiphryne xanthaspis*, 1. *Helastia semistignata*. *Homodotis megaspilata*, 1. *Pasiphila sandycias*, 6. *Orocrambus flexuosellus*, 2. *Orocrambus lectus*, 2. *Scoparia submarginalis*, 4. *Scoparia philerga*, 1. *Eudonia sabulosella*, 2. *Mecyna flavidalis*, 1. *Cremnogenes* sp. indet., 1. *Pasiphila bilineolata*, 2. *Bib.*: *Philia nigrostigma*, 1. Misc. fl.: Tipulids. Culicidae. *Col.*: *Arthacanthus obscuricollis*, 1. *Oreocalus hebe*, 1.

A tremendous number of small moths and flies visit the flowers at night. The moths foraged much more actively than the flies. On successive nights, the absolute abundance of insects and the relative abundance of moths and flies varied greatly. Bees may be abundant on the flowers during the day.

Raoulia grandiflora (CR, MC). *Hym.*: Unidentified small bees. *Lep.*: Unidentified species. *Percnodaimon pluto*. *Syrph.*: *Melangyna novaezelandiae*, 2. *Melangyna* sp., 1. *Musc.* sp., 1. *Col.*: Unidentified species.

Individual heads last an average of 15 days (N = 5, CR).

Raoulia hookerii (CASS). Unidentified flies.

Individual heads last an average of 4.6 days (N = 7).

Raoulia lutescens (CASS). *Hym.*: *Leioproctus fulvescens*, 1. *Leioproctus maritimus*, 8. *Lep.*: *Lycaena boldenarum*, 4. *Tach.*: *Proscissio albiceps*, 3.

Pollen-collecting bees are the most common visitors.

Raoulia mammilaris (CASS). *Musc.* sp., 1.

Raoulia subsericea (CASS, CR, MC). *Hym.*: *Leioproctus* "A", 1. *Leioproctus* "D", 3. *Lep.*: *Lycaena salustius*, 2. *Lycaena boldenarum*, 1. *Notoreas catapyrrha*, 4. *Tach.*: *Heteria appendiculata*, 8. *Heteria plebeia*, 3. *Proscissio albiceps*, 1. *Proscissio cana*, 1. *Zealandotachina nigrifemorata*, 1. *Musc.* sp., 4.

Flower visitors are common during the day to these fragrant flowers. However, at night, pyralid moths are seen only infrequently on the flowers.

Senecio bellidioides (AP). *Hym.*: *Lasioglossum* "A", 2. *Leioproctus fulvescens*. *Lep.*: Unidentified small butterflies. *Tach.*: *Avibrissina isolata*, 1. *Medinella flavofemorata*, 1. *Syrph. Cheilosia* sp., 1.

Senecio bidwillii (MC, AP). *Hym.*: Unidentified small bees. *Syrph.*: *Melangyna* sp., 4. *Dol.* sp., 1. *Cal.*: *Calliphora quadrimaculata*, 1. *Musc.* sp., 4.

Senecio lyallii (AP, CR). Acrocerid fly. Stratiomyid fly.

Senecio scorzoneroides (AP, CR). *Hym.*: Unidentified small bees. Unidentified flies. Syrphids. *Lep.*: *Pasiphila inductata*, 1.

Individual heads last an average of 10.0 days (N = 2, CR).

Senecio scorzoneroides × *lyallii* (CR). Tach.: *Avibrissina isolata*, 2.

Individual heads last an average of 13.0 days (N = 2).

CORNACEAE

Corokia cotoneaster (CASS). *Hym.*: *Lasioglossum sordidum*, 3. *Lep.*: *Eudonia subulosella*, 1. *Tach.*: *Pales efferata*, 1. *Pales nyctemeriana*, 1. *Campylia nudarum*, 1. *"Peremptor" modica*, 1. *Protohystricia alcis*, 1. *Protohystricia orientalis*, 1. *"Occissor"* n. sp. *Syrph.*: *Helophilus hochstetteri*, 1. *Melangyna ortas*, 1. *Melangyna novaezelandiae*, 3. *Melangyna* sp., 2. *Cal.*: *Calliphora vicina*, 1. *Musc.* sp., 5. *Col.*: *Arthracanthus obscuricollis*, 1.

21% of a sample of 190 flowers went on to become fruit. Flower visitors may be abundant at times.

Flowers last an average of 2.6 days (N = 16).

CRUCIFERAE

Cardamine bilobata (CR). Syrphids. Unidentified flies.

Flowers last an averge of 7.1 days (N = 7).

Notothlaspi rosulatum (CR). *Hym.*: Unidentified small bees.

The high level of fruit set (greater than 90%) on 165 plants on Mt Misery suggests that these plants are self-pollinating.

DONATIACEAE

Donatia novae-zelandiae (CR). *Tach.*: *Neotachina* n. sp. (*acuta*), 1. *Neotachina obtusa*, 1. *Proscissio lateralis*, 2. *"Peremptor" modica*, 1. *Musc.* sp., 1.

Flies are the only pollinators observed.

EPACRIDACEAE

Cyathodes fraseri (CASS).

This species was observed extensively over a period of months during both day and night, but no flower visitors were observed. Flowers last an average of 3.9 days (N = 7).

Dracophyllum acerosum and *D. uniflorum* (CASS). *Lep.*: *"Leucania" toroneura*, 1. *Graphania sequens*, 2. *Graphania disjungens*, 1. *Rictonis comma*, 6. *Declana junctilinea*, 1. *"Eucymatoge" gobiata*, 1. *"Hydriomena" deltoidata*, 1. *"Hydriomena" rixata*, 1. *Pasiphila bilineolata*, 1. *Pasiphila* sp. near *dryas*, 1. *Scoparia submarginalis*, 4. *Eudonia sabulosella*, 1. *Orocrambus flexuosellus*, 1.

The fragrant flowers of this species were not visited during the day during c. 50 h of observation. On certain still, humid nights the density of moths visiting the flowers is extremely high. These moths actively move between plants. Occasional craneflies also visit the flowers.

The flowers last an average of 5.2 days (N = 16).

See Primack (1978) for additional details.

Dracophyllum pronum (CR). *Hym.*: Unidentified bees. *Lep.*: *Dasyuris anceps*, 3. *Notoreas anthracias*, 2. *Tach.*: *Avibrissina isolata*, 1. *Neotachina* n. sp., 1. *Veluta albicincta*, 8. *Plagiomya turbidum*. *Syr.*: Unidentified species. *Dol.* sp., 1.

This species has a shorter corolla than the other *Dracophyllum* species in the area. This is probably related to a pollination syndrome associated with butterflies and flies rather than nocturnal moths.

Flowers last an average of 7.2 days (N = 9).

ERICACEAE

Gaultheria crassa (CASS). *Hym.*: Unidentified small bees. **Bombus* sp. *Tach.*: Unidentified species. Other unidentified flies.

In a survey of 45 plants on Cass Hill, 20 plants had only pistillate flowers, 24 plants had perfect flowers, and 1 plant seemed intermediate between the other 2 forms.

GENTIANACEAE

Gentiana corymbifera (MC, AP). *Hym.*: *Leioproctus fulvescens*, 2. *Leioproctus* "A", 6. *Lep.*: *Lycaena salustius*, 1. *Tach.*: *Avibrissina isolata*, 1. *Avibrissina* n. sp., 1. *Proscissio* n. sp. nr. *kumarensis* (*rufa*), 2. *Zealandotachina nigrifemorata*, 1. *Syrph.*: *Melangyna*, 1. *Col.*: *Adoxia cheesemani*, 1. "*Cyphon*" sp., 1.

Small bees were the most common visitors at Ball Hut, whereas flies were the most common visitors at the Sealy Lake area. See discussion of *Hebe macrantha*.

Gentiana montana (CR). *Hym.*: *Leioproctus monticola*, 1.

HECTORELLACEAE

Hectorella caespitosa (MC). *Lep.*: *Percnodaimon pluto*. *Syr.*: Unidentified species. *Musc.* sp., 2. *Col.*: *Adoxia cheesemani*, 2.

Flies are the most common visitors.

LABIATAE

**Marrubium vulgare* (CASS). *Hym.*: **Apis mellifera*. **Bombus* sp.

Introduced bees visit the flowers of this introduced herb. Flowers last an average of 3.6 days (N = 10).

**Prunella vulgaris* (MC). *Hym.*: **Bombus* sp.

LEGUMINOSAE

Carmichaelia angusta (CASS). *Hym.*: *Leioproctus* (*vestitus*), 1. *Leioproctus* "A", 2. *Leioproctus* "C", 4. *Syr.*: Unidentified species. *Tab.*: Unidentified species. *Col.*: *Hoplocneme* sp., 1.

Flowers fragrant. Small bees collect pollen from this species.

Carmichaelia grandiflora (MC). Unidentified large flies.

**Cytisus scoparius* (CASS). *Hym.*: *Lasioglossum sordidum*, 3.

The density of bees is often high.

**Lupinus polyphyllus* (CASS). *Hym.*: *Lasioglossum* "A", 2. **Bombus* sp.

Few flower visitors were seen despite the showy floral display.

**Trifolium pratense* (CASS). *Hym.*: **Bombus hortorum*, 2. *Syrph.*: *Melangyna novaezelandiae*, 1.

**Trifolium repens* (CASS, MC). *Hym.*: **Bombus terrestris*, 2. *Lep.*: *Lycaena salustius*, 1. *Argyrophenga* sp.

LILIACEAE

Bulbinella augustifolia (Porter's Pass). Mainly unidentified flies. Also unidentified syrphids, small butterflies, and hymenopterans.

Flower visitors were abundant.

LINACEAE

**Linum catharticum* (CASS). *Hym.*: Unidentified small bees. *Syrph.*: *Melangyna novaezelandiae*, 1.

Flowers last 1.0 days (N = 5).

LOBELIACEAE

Isotoma fluviatilis (CASS). *Hym.*: Unidentified species. *Lep.*: *Lycaena boldenarum*, 3. *Tach.*: *Heteria appendiculata*, 3. "*Occisor*" n. sp., 3. *Protohystricia huttoni*, 3. *Syrph.*: *Melangyna novaezelandiae*, 3. *Musc.* sp., 3. *Col.*: Unidentified species.

Pratia angulata (CASS, AP, CR). *Hym.*: Unidentified small bees. *Lep.*: *Eudonia sabulosella*, 2. *Argyrophenga* sp. Unidentified small day-flying butterflies and moths. *Tach.*: *Gracilicera setosa*, 1. *Heteria plebeia*, 1. New genus near *Avibrissina*, 1. "*Occisor*" n. sp., 1. *Proscissio cana*, 9. *Protohystricia huttoni*, 2. *Protohystricia orientalis*, 1. *Syrph.*: *Melangyna novaezelandiae*, 4. *Cal.*: Unidentified species, 4. *Musc.* sp., 4.

At the Kettlehole Tarn outside Cass is a population with flowers of 2 types: perfect flowers and pistillate flowers with short corollas. In a random sample of 184 flowers, 27 flowers were pistillate flowers. It is not known whether the plants in this population are gynodioecious or sequentially monoecious. However, since pistillate flowers are found in patches, gynodioecy seems most likely. There was no fruit set in an isolated, 1 m^2 patch of pistillate flowers separated by 30 m from the nearest perfect flowers. In contrast, fruit set appears to be high in pistillate flowers produced near perfect flowers. In populations examined elsewhere, only perfect flowers were found. Flower visitor activity on the flowers was high. Heine (1937) observed flies, bugs, beetles, and moths on the flowers.

Pistillate flowers last an average of 7.4 days (N = 30, CASS): perfect flowers last an average of 6.2 days (N = 14, CASS).

Pratia macrodon (CR). *Lep.*: *Dasyuris anceps*.

This one lepidopteran was a common flower visitor during many hours of observation. No other flower visitors were observed.

Flowers last an average of 10.9 days (N = 8).

MALVACEAE

Hoheria glabrata (AP). *Tach.*: *Neotachina obtusa*, 1. *Proscissio kumarensis*, 5. *Proscissio* n. sp (*rufa*). *Syrph.*: *Melangyna* sp., 6. Misc. flies: Tipulids. *Col.*: *Zorion minutum*, 1. *Mordella detracta*, 7. *Hoplocneme* sp., 1.

Hoheria lyallii (MC). *Hym.*: *Leioproctus* "B", 1. **Bombus terrestris*, 1. *Lep.*: *Lycaena salustius*, 1. *Agrotis ipsilon anietuma*, 1. *Tmetolophota propria*, 1. *Declana feredayi*, 1. *Declana niveata*, 1. *Pseudocoremia scariphota*, 1. *Epiphryne undosata*, 1. *Helastia semistignata*. *Helastia cineraria*. *Orocrambus flexuosellus*, 1. *Tach.*: *Neotachina* n. sp., 1. *Proscissio* n. sp. near *kumarensis*, 1. *Zealandotachina nigrifemorata*, 1. *Proscissio albiceps*, 1. *Proscissio lateralis*, 1. *Syrph.*: *Helophilus antipodus*, 1. *Lepidomyia decessum*, 1. *Melangyna ortas*, 1. *Melangyna* sp., 1. *Strat.*: *Eulalia* sp., 1. *Cal.*: *Calliphora quadrimaculata*, 1. Mycetophilid flies. *Col.*: *Tysius* sp., 1.

A great variety of insects visit the flowers during the day, with moths and craneflies visiting the flowers at night.

MYRTACEAE

Leptospermum scoparium (CASS, CR) *Hym.*: *Leioproctus boltonii*, 17. *Leioproctus imitatus*, 7. *Leioproctus* "E", 7. *Hylaeus relegatus*, 1. **Apis mellifera*, 1. **Bombus terrestris*, 1. *Lep.*: *Lycaena salustius*, "*Leucania*" *semivittata*, 1. *Graphania omoplaca*, 2. *Rictonis comma*, 1. *Declana junctilinea*, 1. *Sestra flexata*, 1. *Austrocidaria similata*, 2. *Helastia cineraria*. *Homodotis megaspilata*, 6. "*Hydriomena*" *deltoidata*, 2. *Pasiphila inductata*, 1. *Pasiphila* sp. (grey). *Pasiphila sandycias*, 1. *Pareromene pyrsophanes*, 1. *Scoparia minisculalis*, 1. *Scoparia submarginalis*, 48. *Scoparia philerga*, 1. *Tach.*: *Neotachina* n. sp. (*acuta*), 1. *Perissina brunniceps*, 1. *Proscissio cana*, 9. *Zealandotachina nigrifemorata*, 2. *Zealandotachina quadrivittata*, 1. *Zealandotachina subtilis*, 9. *Tach.*: *Protohystricia orientalis*, 5. "*Peremptor*" *modica*, 6. *Syrph.*: *Melangyna ortas*, 2. *Melangyna novaezelandiae*, 14. *Melangyna* sp., 2. *Bib.*: *Philia*

nigrostigma, 14. *Strat.*: *Eulalia*, 1. *Tab.*: *Scaptia adrel*, 3. *Scaptia brevipalpis*, 3. *Cal.*: *Calliphora quadrimaculata*, 5. *Calliphora stygia*, 1. *Calliphora icela*, 1. *Musc.* sp., 6. *Col.*: *Mordella detracta*, 3.

See Primack & Lloyd (1980) for additional data on this species. Heine (1937) also reports a large diversity of flower visitors.

Flowers last an average of 19.2 days (N = 16, CASS).

ONAGRACEAE

Epilobium sp. (CASS, CR). *Hym.*: *Leioproctus* "A", 1. *Hylaeus* sp., 1. *Syrph.*: Unidentified species. *Tach.*: *Avibrissina isolata*, 2. *Bib.*: *Philia nigrostigma*, 1. *Dol.* sp., 1.

The flowers close at night and during cloudy weather. Flower visitors are not common. See Raven & Raven (1976).

Flowers last an average of 3.7 days (N = 6, CR).

ORCHIDACEAE

Microtus unifolia (CASS). No pollinators observed. The high level of fruit set suggests that this species is self-pollinating.

Thomson (1927) suggests that this species is predominantly self-pollinating.

Flowers last an average of 8.2 days (N = 17, CASS).

Prasophyllum sp. (MC). Miscellaneous tiny flies on the flowers. Thomson (1927) reports similar observations.

Pterostylis sp. (terrace bogs; CASS). Misc. flies: craneflies.

Seven fruits were produced from 11 flowers under observation on Cass Hill. Eighteen fruits were produced from 24 flowers under observation at the Terrace Bog at the base of Mt Misery. Thomson (1927) describes the variety of floral morphologies found in the genus.

A cranefly was observed emerging from a flower with pollinia attached to its head. The cranefly was caught after it had taken flight.

Thelymitra venosa (CASS). No pollinators were observed in several hours of observation over 1 week. Fruit set seems very high, so automatic self-pollination is likely.

Thomson (1927) believes that many species in this genus are self-pollinating.

Flowers last an average of 6.0 days (N = 4).

POLYGONACEAE

Muehlenbeckia axillaris (CASS, MC, CR) *Hym.*: *Chelaner antarcticus*, 3. Unidentified small bees. *Lep.*: *Lycaena boldenarum*, 1. *Tach.*: *Pales tecta*, 3. *Heteria appendiculata*, 2. *Plagiomyia turbidum*, 1. *Syrph.*: Unidentified species. *Dol.* sp., 1. *Musc.* sp., 1.

Thomson (1881, 1927) says that species in this genus may be wind-pollinated or visited by beetles. In fact, insects are often abundant on the flowers of this species, collecting pollen and nectar from the staminate flowers and nectar from the pistillate flowers. This species has an attractive yellow floral display when in full flower.

Pistillate flowers last an average of 7.1 days (N = 29, CASS); staminate flowers last an average of 2.1 days (N = 40, CASS).

Muehlenbeckia complexa (CASS) *Tach.*: *Proscissio cana*, 2.

Heine (1937) observed flies and butterflies on the flowers.

RANUNCULACEAE

Ranunculus enysii (CR). *Syrph.*: *Melangyna* sp., 7. *Dol.* sp., 1. *Musc.* sp., 2.

Flowers last an average of 9.8 days (N = 4).

Ranunculus lyallii (AP, MC). *Hym.*: Unidentified small bees. *Syrph.*: Unidentified species. *Musc.* sp., 2. *Col.*: *Adoxia cheesemanii*, 10.

The species of *Ranunculus* which I have studied were visited by many insects, yet Thomson (1927) did not observe any flower visitors. Heine (1937) observed flies, weevils, and thrips visiting the flowers.

Ranunculus sarcofulus (MC). *Syrph.*: Unidentified species. Unidentified flies.

RHAMNACEAE

Discaria toumatou (CASS). *Hym.*: *Lasioglossum sordidum*, 8. *Lep.*: *Lycaena boldenarum*, 1. *Tach.*: *Pales aurea*, 1. *Pales nyctemeriana*, 6. *Pales tecta*, 1. *Pales usitata*, 1. *Evibrissa huttoni*, 1. *Gracilicera setosa*, 1. *"Occisor"* n. sp., 4. *"Peremptor" modica*, 10. *Proscissio cana*, 16. *Zealandotachina nigrifemorata*. *Protohystricia alcis*, 1. *Protohystricia orientalis*, 5. *Calcager apertum*, 1. *Syrph.*: *Helophilus hochstetteri*, 1. *Lepidomyia decessum*, 1. *Platycheirus* sp., 4. *Melangyna novaezelandiae*, 5. *Melangyna* sp., 1. *Strat.*: *Eulalia* sp., 1. *Cal.*: *Lucilia sericata*, 1. *Calliphora quadrimaculata*, 3. *Musc.* sp., 12. *Col.*: *Zorion minutum*, 1.

See Primack (1979) for additional data.

The flowers last an average of 6.1 days (N = 16).

ROSACEAE

Geum uniflorum (CR). *Hym.*: *Leioproctus* "A", 2. *Syrph.*: *Melangyna novaezelandiae*, 1. *Melangyna* sp., 5. *Emp.* sp., 1. *Musc.* sp., 3.

Flowers last more than 15 days (N = 8). Flowers of *Geum* parviflorum last an average of 4.6 days (N = 7, CR).

Potentilla anserina (CASS). *Hym.*: *Lasioglossum sordidum*, 1. *Tach.*: *Heteria appendiculata*, 1. *Heteria plebeia*, 4. *Hybopygia varia*, 1. *Col.*: *Cyphon* sp. (aff. *suturalis*), 2. *"Cyphon"* sp., 1.

**Rosa rubiginosa* (CASS). *Hym.*: *Lasioglossum sordidum*, 2. *Lasioglossum* "A", 1. **Apis mellifera*, 1. *Tach.*: *Heteria appendiculata*, 1. *Proscissio cana*, 1. *Syrph.*: *Eristalis tenax*, 1. *Melangyna ortas*, 2. *Melangyna* sp., 1.

Flowers last an average of 1.3 days (N = 6).

RUBIACIAE

Galium perpusillum (CR). *Tach.*: *Veluta albicincta*, 1. *Dol.* sp., 1. *Musc.* sp., 3.

Galium propinquum (CASS, CR, AP). *Hym.*: Unidentified small bees. *Lep.*: Unidentified butterflies. *Tach.*: *Heteria appendiculata*, 1. *Heteria plebeia*, 1. *"Occisor"* n. sp., 3. *"Peremptor" modica*, 1. *Proscissio cana*, 2. *Cal.*: Unidentified species. *Bib.*: *Philia nigrostigma*. *Dol.* sp., 1. *Musc.* sp., 11. *Hem.*: Unidentified species.

Flowers are sweet-scented. Flowers last an average of 7.2 days (N = 9, CR), and 8.0 days (N = 7, CASS).

SCROPHULARIACEAE

**Digitalis purpurea* (CASS, MC). *Hym.*: **Bombus hortorum*, 3.

Bumblebee activity is moderately high on the flowers of this introduced herb. Flowers last an average of 5.2 days (N = 31, CASS).

Euphrasia cockayniana (AP). *Syrph.*: Unidentified species.

Euphrasia revoluta (CR, MC). *Hym.*: *Leioproctus* "A", 1. *Lep.*: *Percnodaimon pluto*. *Tach.*: *Avibrissina isolata*, 1. *Syrph.*: *Cheilosia captalis*, 1. *Melangyna novaezelandiae*, 1. *Melangyna* sp., 13. *Musc.* sp., 1.

Flowers last an average of 6.5 days (N = 8, CR).

Euphrasia zelandica (MC, CR). *Hym.*: *Leioproctus fulvescens*, 1. *Lep.*: Unidentified butterflies. *Tach.*: *Erythronychia aliena*, 1.

Flowers last an average of 5.4 days (N = 5, CR).

Hebe brachysiphon (CASS). *Hym.*: *Leioproctus monticola*, 2. *Leioproctus* "E", 6. *Lep.*: *Lycaena salustius*, 2. *Tach.*: *"Peremptor" modica*, 1. *Syrph.*: *Melangyna* sp., 5. *Bib.*: *Philia segnis*, 3. *Tab.*: *Scaptia adrel*, 1.

Bees occasionally reach high densities on the flowers.

Hebe epacridea (CR). *Hym.*: *Leioproctus* "A", 1. *Lep.*: *Dasyuris callicrena*, 1. *Tach.*: *Neotachina* n. sp. (*acuta*), 1. *Neotachina obtusa*, 4. *Syrph.*: *Melangyna* sp., 9. *Musc.* sp., 1. *Col.*: Unidentified species.

Flowers last an average of 3.5 days (N = 33).

Hebe macrantha (MC). *Hym.*: *Leioproctus monticola*, 4. *Leioproctus* "A". *Hylaeus relegatus*, 1. *Tach.*: *Avibrissina isolata*, 2. *Syrph.*: *Melangyna novaezelandiae*, 2. *Col.*: *Adoxia obscura*, 1.

My limited observations suggest that this species has evolved as a mimic of *Gentiana corymbifera*. Both species occur in the same habitat and have: 1. a large flower size, 2. yellow tinting in the inside of the corolla, 3. an incised corolla with pointed petals, and 4. few flowers per inflorescence. Although these characters are not unusual for New Zealand gentians, these characters separate *Hebe macrantha* from the other New Zealand species of *Hebe*.

Some of the same species of insect visit the flowers of *Hebe macrantha* and *Gentiana corymbifera*, and insects were observed moving repeatedly between the flowers of the 2 species.

Hebe odora (AP, CR). *Lep.*: Unidentified small butterflies *Tach.*: *Erythronychia aliena*, 1. *Proscissio kumarensis*, 2. *Proscissio lateralis*, 1. *Syrph.*: *Cheilosia fulvipes*. *Musc.* sp., 1. *Col.*: *Rhopalomerus* sp., 1.

Hebe pinguifolia (CR). *Lep.*: *Gelophaula aenea*, 1. *Dasyuris anceps*, 1. *Asaphodes clarata*, 1. *Tach.*: *Erythronychia aliena*, 2. *Mallochomacquartia setiventris*, 1. *Neotachina* n. sp. (*acuta*), 1. *"Peremptor" modica*, 1. *Veluta albicincta*, 1. *Syrph*: *Melangyna* sp., 3. *Musc.* sp., 4.

Flowers last an average of 3.2 days (N = 7).

Hebe salicifolia (CASS, MC). *Hym.*: *Leioproctus monticola*, 8. *Leioproctus* "E", 8. *Hylaeus agilis*, 1. *Lep.*: *Lycaena salustius*, 2. *Agrotis ipsilon anietuma*, 1. *Declana niveata*, 1. *Pseudocoremia monacha*, 1. *Pseudocoremia leucelaea*, 2. *Pseudocoremia productata*, 4. *Ischalis fortinata*, 1. *Helastia semisignata*, *Helastia cineraria* complex. *Pasiphila bilineolata*, 4. *Scoparia rotuella*, 1. *"Eucymatoge" gobiata*, 1. *Epiphryne undosata*, 2, *Tach.*: *"Occisor" versutus*, 1. *Peremptor modica*, 1. *Proscissio lateralis*, 2. *Proscissio valida*, 1. *Zealandotachina nigrifemorata*, 3. *Protohystricia orientalis*, 1. *Syrph.*: *Helophilus antipodus*, 1. *Helophilus hochstetteri*, 1. *Eristalis tenax*, 1. *Melangyna ortas*, 1. *Melangyna novaezelandiae*, 2. *Melangyna* sp., 2. *Tab.*: *Scaptia adrel*, 2. *Cal.*: *Calliphora quadrimaculata*, 5. *Calliphora vicina*, 3. Misc. flies: Tipulids. *Col.*: *Pyronota laeta*, 1.

The density of small bees of the flowers at Cass may be very high at times. Ten bees can be captured just by passing a collecting net several times over a flowering shrub. At Mount Cook, flies were the most common flower visitors. At night, moths and craneflies were abundant on the flowers. Thomson (1927) and Heine (1937) observed many insects on the flowers.

Hebe subalpina (MC, CR). *Hym.*: *Leioproctus fulvescens*, 1. *Leioproctus* "A". *Lep.*: 1. *Lycaena salustius*, 1. *Argyrophenga* sp. *Tach.*: *Avibrissina isolata*, 2. *Medinella flavotemorata*, 4. *Neotachina* n. sp., 3. *Neotachina obtusa*, 1. *"Peremptor"* n. sp., 1. *Proscissio kumarensis*, 1. *Veluta albicincta*, 1. *Xenorhynchia peelii*, 1. *Zealandotachina nigrifemorata*, 4. *Protohystricia orientalis*, 1. *Calcager nudum*, 1. *Avibrissina brevipalpis*, 1. *Syrph.*: *Lepidomyia decessum*, 2. *Melangyna* sp., 2. *Bib.*: *Philia nigrostigma*, 1. *Musc.* sp., 1. *Cal.*: *Calliphora quadrimaculata*, 1. *Col.*: *Rygmodus cyaneus*, 2.

Heine (1937) observed flies and a butterfly on the flowers.

Mazus radicans (CASS). *Hym.*: Small bees.

Bees enter flowers without visibly disturbing the flower parts.

The flowers of this species last an average of 2.6 days (N = 16).

Seed production from 10 tagged flowers open in fine weather (7–10 December 1976) was expected to be higher than seed production from 10 tagged flowers open in bad weather (3–6 December 1976). In fact, there was little difference in the average number of seeds per capsule in the flowers opening on 3 December (mean = 27, s.d. = 25) and 7 December (mean = 23, s.d. = 25).

Ourisia caespitosa (CR). *Hym.*: *Lasioglossum* "A", 1. *Syrph.*: *Melangyna* sp., 1.

The flowers are protogynous.

Flowers last an average of 10.6 days. (N = 6).

Ourisia macrocarpa (AP). *Hym.*: Small unidentified bees. *Syrph.*: *Cheilosia fulvipes*, 1.

Parahebe decora (CASS, CR, MC). *Hym.*: *Leioproctus* "A", 3. *Lep.*: *Lycaena salustius*, 1. *Tach.*: *Avibrissina brevipalpis*, 1. *Syrph.*: *Melangyna* sp., 3. *Dol.* sp., 1 *Strat.*: *Eulalia* sp., 1.

In this species and *P. lyallii*, insects visit the flowers in moderate abundance to collect pollen.

Parahebe lyallii (CASS, AP). *Hym.*: *Lasioglossum* "A", 2. *Syrph.*: *Melangyna ortas*, 1. *Melangyna* sp., 4.

Syrphids are the most common visitors.

Flowers last an average of 2.0 days (N = 6, CASS).

**Verbascum thapsus* (CASS). *Hym.*: *Hylaeus agilis*. *Musc.* sp., 1.

Flower visitor activity is low.

STYLIDIACEAE

Forstera tenella (CR). *Syrph.*: Unidentified species.

Flowers last an average of 11 days (N = 7, CR).

Phyllachne colensoi (CR, MC). *Lep.*: Unidentified

Phyllachne colensoi (CR, MC). *Lep.*: Unidentified butterflies. *Percnodaimon pluto*. *Tach.*: *Heteria atripes*, 1.

Veluta albicincta, 9. *Syrph.*: *Melangyna novaezelandiae*, 5. *Melangyna* sp., 1. *Emp.* sp., 1. *Musc.* sp., 2.

A population in the Craigieburn Mountains was surveyed for the frequency of staminate plants and pistillate plants. No plants with perfect flowers were seen. In about 1 out of every 7 plant clumps examined, a neighbouring staminate plant and pistillate plant seem to have grown next to each other, forming a single clump. In these mixed clumps, the boundary between the 2 flower types is very sharp, and often highlighted by a change in leaf morphology, suggesting that 2 genetically distinct plants form a single clump. Of 53 distinct clumps, 26 were staminate, 24 were pistillate, and 8 were composed of the 2 sexes. Hence, there appears to be an equal number of staminate plants and pistillate plants in this population. In the mixed clumps, there seemed to be a tendency for the staminate part to be downslope of the pistillate part.

Insect activity on the flowers was high, with insects moving readily between clumps and between sexes.

Flowers last an average of 7.8 days (N = 64, CR).

THYMELEACEAE

Drapetes densa (MC). *Lep.*: *Percnodaimon pluto.*

Drapetes dieffenbachii (CR). *Lep.*: *Notoreas mechanitis*, 1. *Tach.*: *Veluta albicincta*. *Syrph.*: *Melangyna novaezelandiae*, 3. *Melangyna* sp., 1. *Musc.* sp., 6.

Thomson (1880) reports this species as probably being visited by small Lepidopterans, whereas most observations here are of flies. Flowers last an average of 13.2 days (N = 14).

Drapetes lyallii (MC). *Lep.*: *Percnodaimon pluto*. *Musc.* sp., 3.

Pimelea sericeo-villosa (CASS). *Hym.*: *Chelaner antarcticus*, 2. *Lep.*: *Lycaena boldenarum*, 1. *Eudonia sabulosella*, 1. *Pieris rapae*. *Tach.*: *Pygocalager minor*, 1. *Hybopygia varia*, 1.

See Burrows (1961). Insect activity is moderate.

Pistillate flowers last an average of 6.3 days (N = 6); staminate flowers last an average of 8.3 days (N = 10).

Pimelea traversii (CASS, CR). *Hym.*: *Leioproctus monticola*, 3. *Leioproctus* "D", 1. *Lasioglossum sordidum*, 1. *Lasioglossum* "A", 8. *Lep.*: *Lycaena salustius*, 1. *Lycaena boldenarum*, 1. *Tach.*: *Proscissio cana*, 1. "*Occisor*" n. sp. (*oxcani*), 1. *Cal.*: Unidentified species.

Flower visitors may often be abundant.

UMBELLIFERAE

Aciphylla divisa (MC). *Tach.*: *Avibrissina*, n. sp., 1. *Syrph.*: *Melangyna novaezelandiae*, 4. *Cal.*: *Calliphora quadrimaculata*, 2. *Musc.* sp., 9. *Col.*: *Adoxia cheesemani*, 1.

Many individual flies were visiting staminate inflorescences, but no visitors were observed on pistillate inflorescences. This may be because the pistillate inflorescences had finished flowering, whereas the staminate plants were still flowering.

Aciphylla scott-thomsonii (CR). *Syrph.*: *Melangyna* sp., 8. *Musc.* sp., 12. *Col.*: *Rygmodus cyaneus*, 4. *Dasytes subcyaneus*, 1.

As many as 200 individual insects will forage on a single inflorescence. On staminate inflorescences, insects gather pollen and nectar. On pistillate inflorescences, insects gather nectar from both the normal flowers and small sterile flowers at the center of the umbel. The flowers on a staminate inflorescence seem to open over a longer time period than the flowers on a pistillate inflorescence.

Aciphylla subflabellata (CASS). *Hym.*: *Lasioglossum sordidum*, 22. *Tach.*: *Pales efferata*, 2. *Pales nyctemeriana*, 1. *Pales tecta*, 2. *Gracilicera setosa*, 1. "*Occisor*" *versutus*, 1. '*Occisor*" n. sp., 7. "*Peremptor*" *modica*, 1. *Proscissio cana*, 24. *Protohystricia orientalis*, 3. *Hybopygia varia*, 2. *Cal.*: *Calliphora quadrimaculata*, 1. *Calliphora vicina*, 1. *Musc.* sp., 5. *Col.*: *Selenopalus aciphyllae*, 1. *Dasytes subcyaneus*, 1.

Insect activity is often very high on flowering plants.

Anisotome aromatica (CR). *Tach.*: *Mallochomaquarna setiventris*, 1. *Syrph.*: *Cheilosia* sp., 1. *Melangyna novaezelandiae*, 1. *Strat.*: *Eulalia* sp., 1.

Anistome flexuosus (CR, MC). *Syrph.*: *Melangyna novaezelandiae*, 6. Unidentified flies.

Gingidia montana (AP). *Hym.*: Unidentified small bees. *Syrph.*: Unidentified species. *Cal.*: Unidentified species. Assorted other unidentified flies.

Heine (1937) observed flies, moths, beetles, and thrips as visitors.

VIOLACEAE

Viola cunninghamii (CR). *Syrph.*: Unidentified species. *Tach.*: *Avibrissina isolata*, 1. *Erythronychia aliena*, 1. *Veluta albicincta*, 2. *Hem.*: Unidentified bugs.

Flower visitors are not abundant, but not as rare as suggested by Thomson (1881).

Flowers last an average of 10.9 days (N = 7).

APPENDIX 2

Insects

LEPIDOPTERA

Lycaenidae

Lycaena salustius (Fabricius): *Raoulia subsericea*, *Trifolium repens*, *Hebe brachysiphon*, *H. salicifolia*, *H. subalpina*, *Craspedia uniflora*, *Parahebe decora*, *Hieracium praealtum*, *Olearia moschata*, *Gentiana corymbifera*, *Cirsium arvense*, *Pimelea traversii*, *Leptospermum scoparium*

Lycaena boldenarum White: *Hypochaeris radicata*, *Raoulia subsericea*, *R. lutescens*, *Muehlenbeckia axillaris*, *Discaria toumatou*, *Isotoma fluviatilis*, *Pimelea sericeo-villosa*, *P. traversii*, *Celmisia gracilenta*

Nymphalidae

Argyrophenga antipodum Doubleday: *Cassinia fulvida*

Argyrophenga janitae Craw: *Celmisia coriacea*, *C. armstrongii*

Noctuidae

Agrotis ipsilon anietuma (Walker): *Hebe salicifolia*, *Hoheria lyallii*

Tmetolophota propria (Walker): *Hoheria lyallii*

"*Leucania*" *toroneura* Meyrick: *Dracophyllum acerosum*

Graphania omoplaca (Meyrick): *Leptospermum scoparium*

Graphania sequens (Howes): *Dracophyllum acerosum*

Graphania disjungens (Walker): *Dracophyllum acerosum*

Rictonis comma (Walker): *Leptospermum scoparium*, *Dracophyllum acerosum*, *Olearia virgata*

Geometridae: Ennominae

Declana feredayi Butler: *Hoheria lyallii*

Declana junctilinea (Walker): *Dracophyllum acerosum, Leptospermum scoparium*

Declana niveata (Butler): *Hebe salicifolia, Hoheria lyallii*

Sestra flexata (Walker): *Leptospermum scoparium*

Pseudocoremia monacha (Hudson): *Hebe salicifolia*

Pseudocoremia productata (Walker): *Hebe salicifolia*

Pseudocoremia scariphota (Meyrick): *Hoheria lyallii*

Ischalis fortinata (Guenee): *Hebe salicifolia*

Geometridae: Larentiinae

Asaphodes clarata (Walker): *Celmisia laricifolia, Hebe pinguifolia*

Austrocidaria similata (Walker): *Leptospermum scoparium*

Dasyuris anceps (Butler): *Dracophyllum pronum, Hebe pinguifolia, Pratia macrodon*

Ephiphryne undosata (Felder): *Dracophyllum acerosum, Hebe salicifolia*

Epiphryne xanthaspis (Meyrick): *Olearia virgata*

"Eucymatoge" gobiata (Felder): *Dracophyllum acerosum, Hebe salicifolia*

Helastia semisignata complex: *Hebe salicifolia, Hoheria laylii, Olearia virgata*

Helastia cineraria complex: *Hebe salicifolia, Hoheria lyallii, Leptospermum scoparium*

Homodotis megaspilata (Walker): *Leptospermum scoparium, Olearia virgata*

"Hydriomena" deltoidata (Walker): *Dracophyllum acerosum, Leptospermum scoparium*

"Hydriomena" rixata (Felder): *Dracophyllum acerosum*

Notoreas anthracias (Meyrick): *Dracophyllum pronum*

Notoreas mechanitis (Meyrick): *Drapetes dieffenbachii*

Notoreas cataphyrrha (Butler) (CASS): *Raoulia subsericea*

Pasiphila bilineolata (Walker): *Leptospermum scoparium, Hebe salicifolia, Olearia virgata, Dracophyllum acerosum*

Pasiphila sp., near *humilis* (Philpott): *Leptospermum scoparium*

Pasiphila sp., (grey): *Leptospermum scoparium*

Pasiphila sandycias (Meyrick): *Leptospermum scoparium, Olearia virgata*

Pasiphila nereis (Meyrick): *Celmisia discolor, C. gracilenta, Helichrysum selago*

**Pasiphila* sp., near *"dryas"*: *Dracophyllum acerosum*

Pyralidae: Crambinae

Orocrambus flexuosellus (Doubleday): *Cassinia fulvida, Dracophyllum acerosum, Hoheria lyallii, Olearia virgata*

Orocrambus crenaeus (Meyrick): *Brachycome sinclairii*

Orocrambus lectus (Philpott): *Olearia virgata*

Pareromene pyrsophanes (Meyrick): *Leptospermum scoparium, Helichrysum selago*

Pyralidae: Scopariinae

Scoparia submarginalis (Walker): *Olearia virgata, Leptospermum scoparium, Helichrysum selago, Dracophyllum acerosum*

Scoparia minisculalis Walker: *Leptospermum scoparium*

Scoparia philerga group: *Leptospermum scoparium, Olearia virgata*

Scoparia cataxesta Meyrick: *Helichrysum selago*

Scoparia rotuella (Felder): *Helichrysum selago, Hebe salicifolia*

Eudonia sabulosella (Walker): *Helichrysum selago, Pratia angulata, Olearia virgata, Corokia cotoneaster, Dracophyllum acerosum, Pimelea sericeo-villosa*

Pyralidae: Pyraustinae

Mecyna flavidalis (Doubleday): *Olearia virgata*

Tortricidae

Gelophaula aenea (Butler): *Hebe pinguifolia*

Gelechiidae

Gelechia lithodes Meyrick: *Helichrysum selago*

Oecophoridae

Tingena sp. indet.: *Olearia virgata*

HEMIPTERA

Calocoris norvegicus (Gmelin): *Ranunculus lyallii*

Rhypodes chinai Usinger: *Raoulia lutescens*

DIPTERA

Tachinidae

Goniinae

Pales aurea (Hutton): *Discaria toumatou*

Pales efferata (Hutton): *Aciphylla subflabellata, *Cirsium arvense, Corokia cotoneaster*

Pales nyctemeriana (Hudson) complex: *Aciphylla subflabellata, Corokia cotoneaster, Discaria toumatou*

Pales tecta (Hutton): *Aciphylla subflabellata, Discaria toumatou, Muehlenbeckia axillaris*

Pales usitata (Hutton): *Discaria toumatou*

Phasiinae

Evibrissa huttoni Malloch: *Discaria toumatou*

Tachininae: Occisorini

Avibrissina isolata (Malloch): *Celmisia spectabilis, C. lyallii, C. petiolata, Senecio bellidioides, Hebe subalpina, H. macrantha, Wahlenbergia albomarginata, Epilobium* sp., *Craspedia uniflora, Dracophyllum pronum, Gentiana corymbifera, Viola cunninghamii, Cotula pyrethrifolia, Euphrasia revoluta*

Avibrissina brevipalpis Malloch: **Hieracium praealtum, Celmisia spectabilis, C. petiolata, Parahebe decora, Hebe subalpina, Helichrysum selago*

Avibrissina n. sp.: *Aciphylla divisa, Gentiana corymbifera*

New genus and species near *Avibrissina*: *Pratia angulata*

Bothrophora lupina (Svederus): **Cirsium arvense*

Campylia nudarum Malloch: *Corokia cotoneaster*

Erythronychia aliena Malloch: *Euphrasia zelandica, Hebe odora, H. pinguifolia, Cassinia vauvilliersii, Viola cunninghamii*

Gracilicera setosa (Malloch): *Pratia angulata, Discaria toumatou, Aciphylla subflabellata*

Heteria appendiculata Malloch: *Muehlenbeckia axillaris, Raoulia subsericea, Isotoma fluviatilis, Rosa rubiginosa, Galium propinquum, Potentilla anserina*

Heteria atripes Malloch: *Phyllachne colensoi*

Heteria plebeia Malloch: *Raoulia subsericea, Galium propinquum, Potentilla anserina, Pratia angulata*

Mallochomacquartia setiventris (Malloch): *Hebe pinguifolia, Anisotome aromatica, Leucogenes grandiceps, Helichrysum bellidioides*

Neotachina n. sp.: *Donatia novae-zelandiae, *Chrysanthemum leucanthemum, Leptospermum scoparium, Dracophyllum pronum, Hebe epacridea, H. subalpina, H. odora*

Neotachina obtusa Malloch: *Hebe epacridea, H. subalpina, Donatia novae-zelandiae, Hoheria glabrata*

"Occisor" versutus Hutton: *Hebe salicifolia, *Cirsium arvense, Aciphylla subflabellata, Cassinia vauvilliersii*

"Occisor" n. sp.: *Aciphylla subflabellata, Discaria toumatou, Pimelea traversii, Galium propinquum, Corokia cotoneaster, Isotoma fluviatilis, Pratia angulata*

"Peremptor" modica (Hutton): *Leptospermum scoparium, Galium propinquum, Corokia cotoneaster, *Chrysanthemum leucanthemum, Cassinia vauvilliersii, C. fulvida, Discaria toumatou, Aciphylla subflabellata, Hebe brachysiphon, H. pinguifolia, H. salicifolia, Donatia novae-zelandiae*

"Peremptor" n. sp.: *Hebe subalpina*

Perrissina brunniceps Malloch: *Leptospermum scoparium*

Proscissio albiceps Malloch: *Raoulia lutescens, R. subsericea, Isotoma fluviatilis, Hoheria lyallii*

Proscissio cana Hutton: *Pratia angulata, Discaria toumatou, Leptospermum scoparium, Raoulia subsericea, Aciphylla subflabellata, Rosa rubiginosa, Galium propinquum, Pimelea traversii, Cassinia fulvida, Muehlenbeckia complexa, Isotoma fluviatilis, *Achillea millefolium*

Proscissio kumarensis (Miller): *Hoheria glabrata, Hebe odora, H. subalpina, Olearia moschata*

Proscissio lateralis Malloch: *Donatia novae-zelandiae, Hebe odora, H. salicifolia, Hoheria lyallii, Chrysanthemum leucanthemum*

Proscissio n. sp.: *Achillea millefolium*

Proscissio n. sp. near *kumarensis*: *Hoheria lyallii, H. glabrata, Celmisia petiolata, Gentiana corymbifera*

Proscissio valida Hutton: *Hebe salicifolia, *Cirsium arvense*

Veluta albicincta Malloch: *Dracophyllum pronum, Hebe pinguifolia, H. subalpina, Phyllacne colensoi, Viola cunninghamii, Helichrysum bellidioides, Leucogenes grandiceps, Drapetes dieffenbachii, Celmisia armstrongii, C. coriacea, C. discolor, C. petiolata, Galium perpusillum*

Xenorhynchia peeli Malloch: *Hebe subalpina*

Zealandotachina nigrifemorata Malloch: *Leptospermum scoparium, Cassinia vauvilliersii, Hoheria lyallii, Raoulia subsericea, Hebe salicifolia, H. subalpina, Discaria toumatou, Gentiana corymbifera*

Zealandotachina quadrivittata Malloch: *Leptospermum scoparium*

Zealandotachina subtilis Hutton: *Leptospermum scoparium*

Zealandotachina varipes Malloch: *Achillea millefolium, Cassinia vauvilliersii*

Tachininae: Protohystricini

Protohystricia alcis (Walker): *Achillea millefolium, Corokia cotoneaster, Discaria toumatou, *Cirsium arvense*

Protohystricia huttoni (Malloch): *Isotoma fluviatilis, Pratia angulata, Celmisia gracilenta, *Cirsium arvense*

Protohystricia orientalis (Schiner): *Leptospermum scoparium, *Cirsium arvense, Aciphylla subflabellata, *Achillea millefolium, Hebe salicifolia, H. subalpina, Discaria toumatou, Pratia angulata, Corokia cotoneaster*

Voriinae

Calcager apertum Hutton: *Discria toumatou*

Calcager nudum (Malloch): *Hebe subalpina*

Plagiomyia turbidum (Hutton): *Dracophyllum pronum, Muehlenbeckia axillaris*

Sarcophagidae

Hybopygia varia (Walker): *Potentilla anserina, Aciphylla subflabellata, *Cirsium arvense, Pimelea sericeo-villosa*

Syrphidae

Helophilus antipodus Schiner: *Hebe salicifolia, Hoheria lyallii*

Helophilus hochstetteri Nowicki: *Cassinia vauvilliersii, C. fulvida, Discaria toumatou, Hebe salicifolia, Corokia cotoneaster*

Eristalis tenax (Linnaeus): *Rosa rubiginosa, Hebe salicifolia, *Cirsium arvense*

Pilinasica cingulata (Fabricius): *Celmisia coriacea, C. armstrongii*

Xylota montana (Miller): *Celmisia armstrongii C. coriacea, C. spectabilis,*

Lepidomyia decessum (Hutton): *Hebe subalpina, Hoheria lyallii, Cassinia vauvilliersii, Helichrysum selago, Discaria toumatou*

Cheilosia captalis (Miller): *Euphrasia revoluta*

Cheilosia fulvipes (Miller): *Ourisia macrocarpa, Hebe odora, Celmisia armstrongii, C. coriacea*

Cheilosia sp.: *Celmisia armstrongii, C. coriacea, Senecio bellidiodes, Anisotome aromatica, Craspedia uniflora, *Hieracium praealtum*

Platycheirus sp.: *Discaria toumatou*

Melangyna ortas (Walker): *Corokia cotoneaster, Hebe salicifolia, Hoheria lyallii, Parahebe lyallii, Leptospermum scoparium, *Achillea millefolium, *Rosa rubiginosa, Cassinia fulvida*

Melangyna novaezelandiae (Macquart): *Anisotome aromatica, A. flexuosa, Phyllachne colensoi, Corokia cotoneaster, Pratia angulata, *Trifolium pratense, *Linum catharticum, Isotoma fluviatilis, Wahlenbergia albomarginata, Drapetes dieffenbachii, Geum uniflorum, Euphrasia revoluta, *Hieracium pilosella, *H. praealtum, Celmisia laricifolia, C. spectabilis, Leucogenes grandiceps, Raoulia grandiflora, Helichrysum selago, *Cirsium arvense, *Achillea millefolium, Aciphylla divisa, Discaria toumatou, Hebe macrantha, H. salicifolia, Leptospermum scoparium, Cassinia fulvida, C. vauvilliersii, Olearia moschata*

Melangyna sp.: *Ourisia caespitosa, O. macrocarpa, Helichrysum bellidioides, H. selago, Hoheria glabrata, H. lyallii, *Achillea millefolium, Wahlenbergia albomarginata, *Hypochaeris radicata, Brachycome sinclairii, Euphrasia revoluta, Hebe brachysiphon, H. epacridea, H. pinguifolia, H. salicifolia, H. subalpina, Aciphylla scott-thomsonii, Geum uniflorum, Cassinia*

*fulvida, C. vauvilliersii, Leucogenes grandiceps, Corokia cotoneaster, *Rosa rubiginosa, Parahebe decora, P. lyallii, Senecio bidwillii, Discaria toumatou, *Chrysanthemum leucanthemum, *Hieracium praealtum, Ranunculus enysii, Epilobium* sp., *Craspedia uniflora, Celmisia discolor, C. laricifolia, C. petiolata, C. spectabilis, Olearia moschata, Raoulia grandiflora, Phyllachne colensoi, Leptospermum scoparium, Gentiana corymbifera, Drapetes dieffenbachii*

Asilidae

Saropogon proximus complex: *Cassinia fulvida*

Bibionidae

Philia segnis? (Hutton): *Hebe brachysiphon*

Philia nigrostigma (Walker): *Leptospermum scoparium, Galium propinquum, Hebe subalpina, Olearia virgata, Epilobium* sp.

Empididae

Unidentified species: *Celmisia discolor, C. petiolata, C. spectabilis, Phyllachne colensoi, Geum uniflorum, Helichrysum bellidioides, Wahlenbergia albomarginata*

Stratiomyiidae

Eulalia sp.: *Discaria toumatou, Leptospermum scoparium, Anisotome aromatica, Wahlenbergia albomarginata, Celmisia discolor, Hoheria lyallii, Parahebe decora*

Dolichopodidae

Unidentified species: *Muehlenbeckia axillaris, Epilobium* sp., *Galium perpusillum, G. propinquum, Dracophyllum pronum, Helichrysum bellidioides, Senecio bidwillii, Cotula pyrethrifolia, Ranunculus enysii*

Cyrtidae

Apsona muscaria (Westwood): *Celmisia armstrongii, C. coriacea*

Helle longirostris (Hudson): *Celmisia discolor, C. spectabilis*

Calliphoridae

Calliphora icela (Walker): *Achillea millefolium, Leptospermum scoparium*

Calliphora quadrimaculata (Svederus): *Leptospermum scoparium, Discaria toumatou, Aciphylla divisa, A. subflabellata, Cassinia fulvida, *Achillea millefolium, Hebe subalpina, H. salicifolia, Hoheria lyallii, Senecio bidwillii*

Calliphora stygia auct.: *Leptospermum scoparium*

Calliphora vicina Robineau-Desvoidy: *Corokia cotoneaster, Aciphylla subflabellata, Hebe salicifolia*

**Lucilia sericata* Meigen: *Discaria toumatou*

Tabanidae

Scaptia (Pseudoscione) adrel (Walker): *Leptospermum scoparium, Hebe brachysiphon, H. salicifolia, *Cirsium arvense, *Achillea millefolium*

Scaptia (Pseudoscione) brevipalpis Kröeber: *Leptospermum scoparium*

Muscidae

Unidentified species *Celmisia coriacea, C. discolor, C. petiolata, C. sessilifora, C. spectabilis, *Cirsium arvense, Senecio bidwillii, Drapetes dieffenbachii, D. lyallii, Aciphylla divisa, A. scott-thomsonii, A. subflabellata, Corokia cotoneaster, Discaria toumatou, Raoulia grandiflora, R. mammillaris, R. subsericea, Ranunculus enysii, R. lyallii, Hebe epacridea, H. odora, H. pinguifolia, H. subalpina, Cotula pyrethrefolia, Donatia novae-zelandiae, Leucogenes grandiceps, Anisotome aromatica, Olearia moschata, Phyllachne colensoi, Hectorella caespitosa, Cassinia fulvida, Hoheria lyallii, *Verbascum thapsus, Pratia angulata, Galium perpusillum, G. propinquum, Isotoma fluviatilis, Leptospermum scoparium, Geum uniflorum, Helichrysum bellidioides, H. selago, Euphrasia revoluta, Muehlenbeckia axillaris, *Achillea millefolium*

No species identifications, even to genus, were possible for any specimens of Muscidae collected in this study.

HYMENOPTERA

**Apis mellifera*: **Rosa rubiginosa*, **Echium vulgare, Leptospermum scoparium*

Honeybees were rare at these sites.

**Bombus hortorum*: **Trifolium pratense*, **Cirsium arvense*, **Digitalis purpurea*

**Bombus ruderatus*: **Echium vulgare*

**Bombus terrestris*: *Leptospermum scoparium, Hoheria lyallii, *Cirsium arvense, *Echium vulgare, *Trifolium repens, *Lupinus polyphyllous*

Leioproctus boltonii: *Leptospermum scoparium*

Leioproctus fulvescens: **Hypochaeris radicata*, **Hieracium pilosella, H. praealtum, Celmisia coriacea, C. spectabilis, Gentiana corymbifera, Craspedia uniflora, Olearia moschata, Euphrasia zelandica, Hebe subalpina, Cassinia fulvida, Raoulia lutescens*

Leioproctus imitatus: *Leptospermum scoparium*

Leioproctus maritimus: *Cassinia vauvilliersii, Raoulia lutescens*

Leioproctus monticola: *Pimelea traversii, Cassinia fulvida, Hebe brachysiphon, H. macrantha, H. salicifolia, Gentiana montana*

Leioproctus (*vesticus*): *Carmichaelia angusta*

Leioproctus "A": *Euphrasia revoluta, Hebe epacridea, H. macrantha, H. subalpina, Geum uniflorum, Wahlenbergia albomarginata, Parahebe decora, *Chrysanthemum leucanthemum, Craspedia uniflora, Celmisia spectabilis, Epilobium* sp., *Raoulia subsericea, Gentiana corymbifera, Carmichaelia angusta*

Leioproctus "B": *Hoheria lyallii*

Leioproctus "C": *Carmichaelia angusta, *Hieracium pilosella*

Leioproctus "D": *Celmisia gracilenta, Cassinia fulvida, C. vauvilliersii, Wahlenbergia albomarginata, Raoulia subsericea, Olearia moschata, Pimelea traversii*

Leioproctus "E": *Cassinia fulvida, Hebe brachysiphon, H. salicifolia, Leptospermum scoparium*

Hylaeus sp.: *Epilobium* sp.

Hylaeus agilis: *Hebe salicifolia, *Verbascum thapsus*

Hylaeus relegatus: *Leptospermum scoparium, Hebe macrantha*

Pseudofoenus pedunculatus: *Brachycome sinclairii*

Lasioglossum sordidum: *Corokia cotoneaster, Aciphylla subflabellata, *Cytisus scoparius, *Rosa rubiginosa, Potentilla anserina, Olearia virgata, Brachycome sinclairii, Celmisia gracilenta, Discaria toumatou, Pimelea traversii*

Lasioglossum "A": **Chrysanthemum leucanthemum, Wahlenbergia albomarginata, Brachycome sinclairii, Ourisia caespitosa, Celmisia discolor, C. gracilenta, C.*

*petiolata, C. spectabilis, Parahebe lyallii, Senecio bellidioides, *Rosa rubiginosa, Pimelea traversii*

Formicidae

Chelaner antarcticus (White): *Muehlenbeckia axillaris, Pimelea sericeo-villosa*

COLEOPTERA

Cantharidae

Asilis pilicornis Broun: *Helichrysum bellidioides*

Chrysomelidae

Adoxia cheesemani (Broun): *Ranunculus lyallii, Hectorella caespitosa, Celmisia petiolata, Gentiana corymbifera, Aciphylla divisa*

Adoxia obscura (Broun): *Celmisia discolor, C. laricifolia, C. lyallii, C. petiolata, C. spectabilis, Leucogenes grandiceps, Helichrysum bellidioides*

Cerambycidae

Zorion minutum (Fabricius): *Hoheria glabrata, Discaria toumatou, Celmisia gracilenta*

Curculionidae

Hoplocneme sp.: *Carmichaelia angusta*

Hoplocneme sp.: *Hoheria glabrata*

New genus (Erirhininae) and sp.: *Celmisia sessiflora*

Oreocalus hebe (Marshall): *Olearia virgata*

Rhopalomerus sp.: *Hebe odora*

Tysius sp.: *Hoheria lyallii*

Peristoreus sp. : *Cotula pyrethrifolia*

Scirtidae (= Helodidae)

Cyphon sp. (aff. *suturalis*): *Potentilla anserina*

"Cyphon" sp. (aff. *fuscifrons*): *Celmisia discolor*

"Cyphon" sp.: *Helichrysum selago, Gentiana corymbifera*

Hydrophilidae

Rygmodus cyaneus Broun: *Aciphylla scott-thomsonii, Hebe subalpina*

Melyridae

Arthracanthus obscuricollis (Broun): *Corokia cotoneaster, Olearia virgata*

Dasytes subcyaneus Broun: *Celmisia spectabilis, Aciphylla scott-thomsonii, A. subflabellata*

Mordellidae

Mordella detracta Pascoe: *Hoheria glabrata, Leptospermum scoparium, Wahlenbergia albomarginata*

Oedemeridae

Selenopalpus aciphyllae Broun: *Aciphylla subflabellata*

Scarabaeidae

Pyronota laeta (Fabr.): *Hebe salicifolia*