Travis Marsh:- invertebrate inventory and analysis

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SUMMARY

- Renaming the enlarged wetland of Travis swamp to a marsh would improve the perception of its value, so we use marsh in our report. The biodiversity of endemic invertebrate (confined to New Zealand) species from this marsh compares favourably to other herb to shrub communities investigated in lowland New Zealand. There are 467 insect species recorded from Travis Marsh and 81 % of these species are endemic and only 3 % were clearly vagrants. Of these species 40-70 % of the species are likely to be characteristic of marshes and wet pastures. The great reduction in manuka and raupo and loss of toetoe has probably lead to a loss of at least 10 insect species with beetles being among the more prominent possible examples. A further 55 species of the other larger invertebrates (spiders, centipedes, millipedes, landhoppers, slaters, snails, slugs, earthworms, flatworms) were found at Travis Marsh.
- From four independent extrapolations there are probably 700 (650-800) resident insect species and 85-155 species of non microscopic other invertebrates at the marsh. Of these a provisional 22-25 species could well be at least regionally rare and 1.7 % were flightless. The Christchurch endemic crane fly *Gynoplistia pedestris* (flightless) is the best researched case. One undescribed *Oxyserphus* seems to be an uncommon endemic to Banks Peninsula. Any orchid flower thrip *Dicromothrips maori* present may be regionally rare. Other less mobile insect species with shortened wings include: - four parasitic wasps (a pteromalid, an encyrtid, an undescribed scelionid, the introduced eupelmid *Macroneura vesicularis*), a fungus gnat, and the common bagworm moth (female) *Liothula omnivora*. These seven species will have much more limited mobility than winged insects and so continuation of vegetative patches that provide their environment is more critical to them. An outline is presented on the variable ability of insect species to colonise new areas (possibly less than 0.2 km to 30 or more km) and their normal foraging range (less than 30 m to 1.5 km) to provide some insight into the need to avoid producing small isolated patches of the charateristic native wetland plant species in Travis swamp.
- An estimated 66-85 insect (14-19%), 8-9 spider (30-32%) and one land snail (25%) species collected at Travis Marsh are undescribed. Certain undescribed insect species include an uncommon but widespread *Elasmus* species and probably three *Oxyserphus* wasp species, the tussock sedge moth *Megacraspedus* and a mirid. There are six undescribed muscid fly species and apparently a single undescribed fly species in both *Caligeria* and *Neolimnia*. Other probable undescribed species include:- *Psychoda* - moth flies (2-3 species), 2-4 sciariid fly species, a '*Gaurax'* fly species, Ichneumonidae wasps (25-30 species), Braconidae wasps (2-6 species), Chalcoidea wasps (7-15 species) and 14 Diapriidae wasp species and perhaps a longhorn beetle. For marsh communities a revision of Scirtidae (marsh beetles) is needed to allow for repeatable species identification. Naming of species is impossible with the latest 110 year old, synonym plagued, and keyless last taxonomic study of this family. This may involve a more moderate number of species than the literature indicates based on the diversity at Travis Marsh and two North island wetland studies. Our survey provides a valued insight into which insect families need systematic work most for lowland marshes in New Zealand and opportunities for Canterbury research. When new species are described then Travis Marsh should be a favoured 'type locality' provided the essential wetland areas are retained in a protected reserve. The marsh would be well suited to this vital scientific and educational function, because of **1.** an extended ecosystem that buffers invertebrates from contamination from surrounding housing **2.** the few alternative and smaller safe sites **3.** the ready accessibility to a population centre with a range of researchers and schools. Hence any more specimens can readily be recollected and the natural history studied in situ. In a similar way the smaller Riccarton bush is already an important preserved type locality for lowland bush in New Zealand.
- Few losses of species were clearly demonstrated. There is a provisional indication that beetle species may be among the insect orders more severely affected. The reduction manuka to a minimum of a few plants has almost certainly lead to the loss of the small sap sucking Psyllidae *Ctenarytaina pollicaris* and the plant hoppers *Novothymbris notata*. Four wetland moth species, *Elachista pumila*, the geometrid *Asaphodes abrogata* and the leaf rollers *Parienia mochloporana* and *Protithona fugitivana* are apparent missing from this wetland, after being recorded previously in or near Christchurch. More thorough night light sampling including earlier and later in the season and collection and extraction of insects from the litter and moss is likely to see the moth and rove beetle species lists increase about two fold.

- The most acute threats of localized extinction of invertebrate species apply to those in raupo, orchid flowers, tussock sedge and perhaps native reed, spiked sedge, swamp willow weed, mosses, New Zealand milfoil and New Zealand cudweed. The diversity of native insect hosts that these native plant species support is mostly unkonown or at best poorly recorded in New Zealand. The single host specialised parasitic wasp species (about half the parasitic wasp species) and flightless larger predators (e.g ground beetles, spiders) with low reproductive capacity are likely to be more vulnerable than their herbivore hosts. Most carefully studied species from genera of herbivores or detrivores have several parasitic species of insects, because different parasites affect the various stages - eggs, larvae or pupae. For the marsh, with insects there was a ratio of 5.4 herbivore/detrivore/omnivore species to 2.5 parasite species to 1 predator species. Raupo, tussock sedge, native rushes and perhaps cogeneric sedges and rushes support at least 10 species of herbivorous invertebrates that rely on them. Any parasitoids from raupo could be vulnerable to localized extinction either with added drainage which could prevent flowering or if a proposed expressway largely obliterates or fragments the current bigger raupo patches. Other families of invertebrates that could have one or two regionally rare species include crane flies (Tipulidae), various spiders and the undescribed land snail species. The parasitoid wasps (Hymenoptera), which are poorly known taxonomically, and other rarer parasitoids and snails would needed more targeted collection to assess their distribution and abundance within the marsh. In the south west destruction of moss, swamp willow weed could well lead to local extinction for 5-10 species of moths, beetles, plant sucking bugs, spider parasites and perhaps spiders. The losses of two native rush, two low growing native sedge species, New Zealand milfoil and New Zealand cudweed could well lead to further local losses of moth and other insect species partly known from Otago/Southland studies of moths. Hence a reasonably broad eastern band of land that incorporates all the wetland and some seasonally wet area as a buffer and further plant reservoir is the most vital area for invertebrate conservation. Consequently plans for modification of adjacent wetland areas to the south and north of Travis swamp should recognise this potential loss and even check what insect species are associated with these plants to properly assess the risks involved. Such a modest extension to this initial survey should occur before any native planting redevelopment proceeds.
- For non-entomologists the more noticeable invertebrates are the larger and at least moderately common or showy species that include:- cave wetas, *Wiseana* moths (nocturnal), damselflies, *Degithina* ichneumonids, the larger nursery web *Dolomedes minor*, the four largest crane fly species and some ground beetles.
- From a scientific and educational perspective Travis Marsh currently has plenty of potential for biology and ecology studies with few complications. Basic biology studies could include the discovery of parasite hosts, description of invertebrate species or their immature stages and definition of the limits and peak of adult activity. We provide keys or identification guides to the ground beetles, lady birds, marsh beetles, 11 fly families and the Ichneumonidae to assist future studies and to provide broad justification for the size of some undescribed groups. Ecology studies might refine differences in species dominance related to vegetative types that were partially revealed in our survey. Other possible study aspects are included in the discussion and text. Wet boggy autumn to spring conditions and the need to protect less common plants restrict the number of concurrent studies possible on peat areas for school and undergraduate students. Studies should be encouraged to extend the frame our initial survey provides to an understanding of invertebrates species interactions and biology. Only then can any Christchurch citizen know our natural history heritage properly.
- Invertebrates from the peat area with its sequence of wooded, tall marsh and rush to grassland vegetation had to be examined properly, because of a near total lack of literature on invertebrate from marshes in New Zealand. The ungrazed parts of Travis Marsh provide quilt like patches of undisturbed native plants that can indicate favoured hosts. Plant and habitat preferences were apparent for the mirid bugs through to the predator complexes (spiders, long legged flies, ground beetles) and parasitoid wasps. Any pattern for decomposers of plant litter and cattle and even pukeko dung was less apparent and may only be revealed with more intensive research. Our survey provides an initial guidance on which invertebrate groups are more likely to be affected by future vegetation changes. The overall scale of vulnerable species can be derived from details of their habitat needs (Appendix 1, 2). Spiders provide one of the clearest and most extensive examples of how changes in the vegetation type within the marsh is mirrored by an equally large shift in the species composition and dominance within the invertebrate community. Our invertebrate community study demonstrates the need to be cautious in park development, before plant and invertebrate surveys provide guidance on the scientific, educational and conservation value of an area. Our survey shows how an invertebrate community study can amplify and refine the more readily obtained plant maps and lists.

- Travis Marsh provides a plant barrier for the spread and multiplication of garden pests of potatoes, cabbages and other crucifers, tomatoes, corn, and most fruit and berry pest subject to aphid, scale, caterpillar, mite and cherry slug attacks. Overall the marsh will act as a pest sink when these species disperse into the area and find no hosts and few flower food sources. Nesting prospects for the social wasps *Vespula germanica* (German wasp) and *V. vulgaris* (common wasp) are poor due to wetness and foraging due to very limited honeydew resources. *Vespula* predation will be greatest on Lepidoptera and crane flies that are most active in February and March, when wasps populations peak seasonally. Grassgub and porina from adjacent pasture will reinforce home lawn populations. Woody stems of gorse, broom and willows provide more limited areas for the lemon tree borer and the main polyphagous leafroller species. Tree lupin removal along the sandier margins of housing land would lower the risk of silver Y moth affecting tomatoes and vulnerable cultivated *Echium* shrubs.
- For pukeko the more immobile invertebrates (aphids, spiders, cutworm caterpillars) or cold insects (katydids, crickets *Conocephalus*) may enrich their spring and summer diet. These insect live among marsh foxtail, crested dogstail, yorkshire fog and tussock sedge. Pukeko faeces from one tussock sedge-grass territory confirmed that marsh foxtail seed heads and to a lesser extent oval sedge seeds were the main remnants in pukeko faeces in early summer. There was only a 12.5% incidence of <u>solitary</u> invertebrate remnants from beetle adults and larvae. The winter rise in the water table drowns worms, which could lead to an influx of water feeding birds. These worms could be important for nestling pukeko. Mobile ground invertebrates (e.g. spiders, flies, moths) form much of the diet of the native skink *Oligosoma* (=*Leiolopisma*) *zealandicus*. Hence invertebrate food resources in the ungrazed grass and sedge communities are likely to be most significant in retaining maximum populations of the skink. Fungus gnats, crane and other flies and litter breeding moths are likely to provide a substantial part of the diet of any bush birds and caterpillars for nestlings. Our survey provides an insight into the taxa most likely species that occupy areas dominated by trees.
- The grass and rush dominated southern pastures probably have fewer native invertebrate species, because it has less native plant species. Various small introduced Acalypterate flies, aphids and weevils will dominate the insect fauna numerically in the grazed pasture herb and seed zone, but some native soil insects e.g. grassgrub and porina may be prominent in the soil. Small black crickets *Pteronemobius* species and the larger green longhorn Tettigonidae *Conocephalus* were confined to the drier grassy area. Observations by Macfarlane on stilletto flies adjacent sandy areas to the north and west on *Anabarhynchus* and the chirping crickets *Pteronemobius* species show these species have higher populations in sandy areas than in the alluvial soils that characterise the southern part of Travis Marsh. This suggests that the moisture level in soil may be critical to the survival and hatching of the cricket eggs in the soil and availability of beetle prey to be important for *Anabarhynchus*. Introduced grassland species will lower the level of endemic species in the grazed pasture to a moderate degree. Grazing will reduce the litter and weed diversity, which will tend to reinforce lowered invertebrate diversity. This can be predicted with a fair degree of certainty given the considerable studies of pastoral invertebrates on the Canterbury plains and other lowland South island sites. Cattle dung supported dung, blow and other small flies and centipedes. Three introduced lumbricid species dominated earthworm populations in the drier loam soils, but within 50 m there were no worms in low moist peat in the Travis Marsh. The sandy element of Kaiapoi soils offer areas that will allow native bee, solitary wasp to nest successfully without the immature stages drowning or being affected by pathogenic fungi.
- Trees or more bulky marsh plants (e.g. flax, tussock sedge, rushes) accumulate the most litter and support a moderately diverse fly and beetle fauna. Conversely grazed areas have the least secure damp litter for decomposer invertebrates to act on. One native slug species and four snail species were concentrated in the heaviest and dampest litter (hard fern/grey willow, flax and raupo) during the driest part of the year. Occupation of a larger part of the marsh beyond these summer retreats is likely, but the extent of use of other areas is unknown. Grazed pastures will be among the least suitable habitat for native molluscs, but the litter supports a distinct set of fly, introduced slugs and other invertebrates.
- Flower sources for bees, flies and nectar feeding birds (bellbird, tui) on Travis Marsh are impoverished from autumn to mid spring. In early spring gorse and then broom provide limited mainly pollen sources. Manuka, flax, cabbage trees, hemlock, square stemmed St Johns wart, the buttercups, lotus, white clover, blackberry and mallows within or around the marsh perimeter provide nectar and pollen in summer, which scotch thistles and yarrow add to in late summer. For flies and nectar loving beetles:- manuka and cabbage trees were favoured late spring/summer sources and after that yarrow is likely to extend food sources for flies.

- The southern pastures with lighter, better drained soils offer the best potential for integrated restoration of a more aesthetic reserve. The full restoration of a range of native herbs, shrubs to large slow growing trees e.g. kahikatea will allow for diversification of the invertebrate fauna at Travis Marsh. Native trees could also aid reestablishment of some arboreal birds (e.g. bellbirds, pigeons). However, replanting poses a risk of contaminating the soils with some of the common and flightless introduced weevils that occur within Christchurch, so it will be desirable to use smaller nursery plants to minimize this risk. Some invertebrate species from native shrubs e.g. *Hebe* and cabbage trees cultivated in gardens will probably recolonize plants that are planted in suitable parts of Travis Marsh. However, deliberate introductions could be needed with some invertebrates (e.g. moths and their parasites from kahikatea or beetles on *Coprosma* and *Pseudopanax* species) to achieve the full natural history potential of this site. Restoration that duplicates patches e.g. of manuka where other invertebrates e.g. native *Leioproctus* bees and perhaps green manuka beetles can gain access to them from better drained loam soils could eventually reveal what are critical patch sizes for such prominent invertebrates. The small coastal sand dune area in the north and lighter dumped soils in the Travis Country Estate provide suitably drained soil for less common and localised insects such as the stiletto flies *Anabarhynchus*. Restoration planting should aim to improve the sequence of flowers for native bees, flies, parasitic wasps and moths as well as better nectar for some birds. Plants that provide nectar and pollen are the winter flowering and berry bearing five finger *Pseudopanax*, the spring flowering kowhais *Sophora microphylla*, *Pittosporum* spp, manuka and early summer flowering flax *Phormium tenax*. As the area is restored replacement of hemlock with some native Umbelliferae or Compositae flowers should be considered. Hemlock is currently a significant flower source for various parasites, flies, and a few beetle species. In the established adjacent parks on the western side and perhaps any eastern and northern areas with drier soils the planting of ornamental manuka, native brooms, hebes and a few strategic late summer or early spring flowering gum trees could help both bellbirds and perhaps tuis as well as the insects. Tagastaste (tree lucerne) helps supply nutritious spring food for pigeons and some pollinating insects and should be considered for inclusion in adjacent parks to Travis Marsh. These flowering plants could be vital in an integrated attempt to provide corridors and a touch of variety for the local residents on the modified filled soils.

INTRODUCTION

<u>The marsh</u>

Travis Marsh (next to New Brighton) being large (about 130 ha) and urban has much potential for recreation, education and research compared to the only other similarly diverse and large sites (L. Wairarapa, Taupo marsh, Sinclair wetlands) in eastern New Zealand (Meurk 1995, McMillan & Reynolds 1996). Travis Marsh has 62 indigenous (native to New Zealand) vascular plant species. This represents 79 % of the original wetland floral diversity of Christchurch and probably lowland Canterbury. The peaty northern half has a sequence of three main marsh vegetation types, which are mapped (Meurk 1988). The vegetation ranges from tall wooded plants to low grassland that was grazed at the start of the survey:

1. <u>Willow woodland or marsh shrubland</u> with scattered manuka *Leptospermum scoparium*, mikimiki *Coprosma propinqua* and native reed *Baumea rubiginosa.*

2. <u>Tall Marsh plants:</u> Raupo *Typha orientalis*, tussock sedge *Carex secta* or flax *Phormium tenax* (Fig. 2, p 6,11 & 13 McMillan & Reynolds 1996).

3. <u>Rush-sedge herbfield</u> with three increasingly drier phases **a.** spike rush *Eleocharis acuta* - jointed rush *Juncus articulatus* - glaucous sedge *Carex flacca*- the wettest peat **b.** *Baumea* reed - deep seasonally wet peat **c.** Soft/wiwi rush *Juncus* spp- grasses - wet pasture on peat or glayed silt loam.

The tall marsh and swamp area of Travis swamp is a unique lowland site for Canterbury. Only Maori lakes (623 m altitude) in the inland Ashburton river basin has a bog-swamp area (7.1 ha) with both raupo (Typhaceae) and tussock sedge (Cyperaceae) (Kelly 1972). Small marsh areas with both tussock sedge and New Zealand flax (Agavaceae) exist infrequently in Canterbury reserves at lowland (Dan rogers creek, Okuti valley; Banks Peninsula; Peel forest, South Canterbury) or with mountain flax *P. colensoi* at Lewis Pass, L. grasmere and Pareora River reserves. Riccarton bush retains both plants in non marsh sites. Only Lewis Pass has sundews *Drosera* species, while Okuti reserve (4.4 ha), near Little river has retained swamp willoweed *Polygonum salicifolium*. None of these marshes have New Zealand reed *Baumea rubiginosa* or spike sedge *Epicrauta acuta*, and New Zealand reed is rare in Cnaterbury and Marlborough (Moore & Edgar 1976).

Much of the southern half of the Travis wetland is grazed pasture with some rushes. Cattle help control weeds and provide revenue. Along the eastern part Travis "stream" is true wetland area with tall marsh plants screened along the east border with willow. In some places notably in the south west corner there are seasonal ponded areas with moss (Meurk 1995, McMillan & Reynolds 1996 p 7). The grazed southern block extends botanical diversity by over 10 % despite a rather degraded flora (Meurk 1995) and the soils change from wet Waimairi peats to Taitapu, mineral Taitapu and Kaiapoi loam.

For birds the grazed pasture supports up to 700 pukeko, which is a nationally significant concentration (Crossland 1995) that is near a city. Pukeko feed mainly on pasture and water plants based on Australian and two New Zealand gizzard studies (Marchant & Higgins 1993). Small animals (mainly flightless invertebrates from grass and water) supplement and probably enrich the diet with more digestible protein. Seeds from sedges in spring and then grasses could improve the energy source before and during the feeding of the chicks. The only detailed New Zealand study did not analyze seasonal diet trends. Nor were the invertebrates from the gizzards identified well enough to determine if ground or vegetation dwelling species were favoured. Spiders, worms and slaters seem to be the main invertebrates eaten in New Zealand, but faeces contents are unstudied in Australasia.

At Travis Marsh 29 out of 52 bird species seen were New Zealand species (Crossland 1995). The native skink *Oligosoma* sp. completes the known terrestrial vertebrate inhabitants (Meurk 1988). Bird foraging peaks in winter and spring before the soils begin to dry out. The conspicuous cattle egret is encouraged most by cattle, but other species benefit from the vegetation management too. Terrestrial native birds include the fantail, silver eye, grey warbler, and in winter bellbird and pipit. Restoration may allow for restablishment of wetland (bittern, fernbird, crake, banded rail) and bush (tomtit, rifleman, bellbird, brown creeper, tui) bird species.

<u>Lowland invertebrate communities</u>

At Lake Ellesmere, 16 land invertebrate and 29 fresh water taxa were recorded (Hughes *et al*. 1974). The land invertebrates included three smaller butterfly species, the cricket *Teleogryllus commodus* (southern record), New Zealand grassgrub *Costelytra zealandica*, cicadas, and from sand the large sand scarab *Pericoptus truncatus* and the katipo spider *Latrodectus katipo*. New Zealand (Table 1) and Canterbury (Knox 1969) studies of the invertebrate communities in the lowlands have concentrated on grasslands and moths and butterflies. Initially these studies did little more than list 200-300 species present and for some rank their relative abundance. Only the 3 year Nelson study of pastures deals with spiders, mites, worms and insects. No general study extends to deal with flatworms and leeches. From about 1990 studies began to rear the invertebrates from hosts and so associate their food sources more precisely. There are no community studies of a <u>wetland terrestrial invertebrate</u> fauna.

About 97 % of an estimated 18,000-24,000 insect species in New Zealand are terrestrial. When smaller mainly non-native groups (lice, fleas, aphids, lacewings) are excluded about 75% of the insect species are endemic (only found in New Zealand). Currently 326 invertebrate species in New Zealand (about 3% of the described species) are definitely or seem to be endangered or regionally rare (Tisdal 1994) and about 300 more species were suggested for inclusion (Millar pers comm.). About 12,500 insect species are known from New Zealand insect collection and about 55-60% of the insect species in New Zealand are described (Emberson 1997). Other larger invertebrates (spiders, harvestmen, mites, pseudoscorpions, slaters, landhoppers, centipedes, millipedes, snails, slugs, flatworms and leeches) have at least 3,000 species, and as few as 15 % of these species are described i.e. flatworms. For every New Zealand vascular native plant species there are 5-10 insect species (2.0-4.0 beetle spp.,1.0-2.0 fly spp., 0.7-1.3 moth spp., 0.4-0.8 bug spp.), 0.5-1 spider species, 0.5-1.0 mite species, 0.1-0.2 snail, slug species, 0.05 to 0.1 millipede and centipede and 0.08 to 0.1 earthworm species.

An appreciation of the possible biodiversity in the Travis Marsh can be gauged from previous grassland to marsh studies (Table 1). At a single site in ungrazed lowlands selected insect groups there are often 2.5-20 % of all the New Zealand fauna, if sampling extends to several methods or seasons. Lowlands from Manawatu to Southland have been light trapped for moths, butterflies and sometimes caddisflies. These sites had at least 5 to 15 % of New Zealand's Lepidoptera fauna. The floristically richer Southland coast (Patrick 1994b) and the smaller Riccarton bush (Molloy 1995) had larger Lepidoptera faunas than Kaitorete Spit (Patrick 1994a) and coastal Otago salt marsh (Patrick 1995). The fungus gnats (mainly decomposers) are exceptional with 47 % of New Zealand species being found at the edge of lowland broadleaf forest in Hawkes Bay (Davies 1988).

Table 1 Biodiversity and habitat surveys of New Zealand grasslands to marshes (arranged by geographic and habitat proximity to Travis Marsh)

Location & reference **no**		Habitat	Sampling methods	Main taxa studied	Species found	found as % of NZ fauna
Riccarton Bush	**18**	Bush,soil	Lt Se	Moths,scales	263	14.8
Banks Peninsula	**7**	Bush, tussocks	Se Gt Sw	Most invertebrates	1416	9.5
Christchurch airport	**5**	Grass, lucerne	Sw Li Lt	Insect,spider, worm	94	-
Dunedin harbour	**16**	Saltmarsh	Lt Se	Moths	87	4.9
Kaitorete Spit	**15**	Low ungrazed flora	Lt Se Re	Moths	130	7.4
Invercargill coast	**17**	Swamp, bush, dunes	Lt Se Re	Moths	268	15.2
Manawatu plain	**1**	Flax marsh	Lt	Main insect orders	233	2.7
Nelson to Otago	**3**	Lucerne & weeds	Sw Li So	Insect, some others	275	2.5
Nelson, nr Waimea	**7**	Pasture, dung	Sw Gt So	Insects, most others	435	2.9
Manawatu hills	**11**	Grass, rushes	Lt	Most insects	201	1.1
North Island	**2**	Pastures	Sw Li So	Insects	276	1.5
Wellington Harbor Is	**12**	Shrub/grass margins	Mt Gt Lt	Insect, snails	500	2.7
Hawkes Bay	**15**	Bush, shrubland	Gt Li Se	Some insects, snails	90	
Upper Waimakariri	**14**	Tussocks,shrubs	Lt Se Re	Moths	202	11.4
Cass	**6**	Tussocks, forest	Lt Se Re	Other insects	940	8.8
Cass	**6**	Tussocks, forest	Lt Se Re	Spiders,molluscs**	149	
Central Otago	**10**	Tussock,shrubs,bog	Gt Lt	Most insects	464	2.6
Hawkes Bay coast	**4,9**	Coastal sites	Lt Se Re	Moths	452	25.6
Hawkes Bay coast	**9**	Bush,pasture mainly	Lt Se	Arthropods	1237	
Hawkes Bay	**9**	Bush	Mt	Some flies	134	67
Chatham Islands	**20**	Pasture to bush	Most	Most invertebrates	933	5.2
Auckland,Lynfield	**13**	Bush to pasture	Most	Beetles	982	20

Reference no 1 Cumber 1950, 1951 1952 Cumber & Harrison 1959 **2**. Cumber 1958, 1959 1960 **3** Macfarlane 1970 **4** Davies 1973 **5** Moeed 1976 **6** Burrows 1977 **7** Martin 1983 **8** Johns 1986 **9** Davies 1986 1988 **10** Barratt & Patrick 1987 **11** McGregor *et al* 1987 **12** Grehan 1990 **13** Kuschel 1990 **14** White 1991 **15** Moeed & Meads 1992 **16,17, 18** Patrick 1994 a,b 1995 **19** Molloy 1995 **20** Macfarlane *et al.* unpublished
****** excludes mites, nematodes, etc. not sampled in Travis Swamp survey.

Sampling method code: Gt = ground trap - pitfall, water **Lt** = Light trap **Mt =** Malaise trap **Re** = Rearing **Se** = Searching, sight, pooting **So/Li =** Soil or litter sampling **Sw** = Sweep, vacuum

South Island lucerne fields had at least 352 species, when contamination (from grasses, weeds) or vagrants (e.g. gorse seed weevil) were included (Macfarlane 1970). A parallel situation could occur at Travis Marsh with weeds and adjacent garden vagrants. At Nelson in heavily grazed sheep pasture, there were 283 species of the winged insect orders, 19 of the primitively wingless orders (springtails to Protura) and four millipede and centipede species (Martin 1983). On Somes Island, 500 invertebrate species were found (Grehan 1990), 1416 species in 44 Banks Peninsula reserves (Johns 1986) and an estimated 800-1200 land invertebrates on the Chatham Islands (Macfarlane *et al.* unpublished).

For web building spiders grazed pasture is a challenging and unstable environment. Even an often bare and seasonally dry pasture had 46 species with a few species abundant in summer (Martin 1983). At Lincoln, 18 times more spiders and 2.6 times more species (18 species) were found in shelter belts than grazed pastures (McLachlan 1996, unpublished). Ungrazed trees and tall swamp plants provide more secure shelter and opportunities to maintain spider webs (Forster 1956, Forster & Blest 1979, Molloy 1995), 87 species from the Banks Peninsula reserves (Johns 1986), 60 species from Wellington bush (Fitzgerald 1993) and 36 species from Chatham Islands (Macfarlane *et al.* unpublished). Bush contains an appreciable fauna of harvestmen with 26 species identified from Hawkes Bay (Davies 1986) and 12 species from Banks Peninsula (Johns 1986). Up to 10 % of the listed mite species in New Zealand occur in pasture soils ranging from 54-55 species in peat (Luxton 1982 1983) and 48-81 species in pasture (McMillan 1969, Adams 1971, Martin 1983). Spider and mite faunas have a broadly similar size from these studies of lowland sites and the currently described New Zealand species.

For land snails and slugs in central New Zealand, 15-25 small species of almost exclusively litter dwellers can be expected from bush (Climo 1975, Grehan 1990, Moeed & Meads 1992) with a sharp decline to 0-3 native snail species in pasture grassland (Martin 1983, Moeed & Meads 1992). Larger areas have from 33 species (Stewart Island, Dell 1954) to 47 species (Chatham Islands, Macfarlane *et al*. unpublished). High levels of endemism indicate snails are worth investigating for regional species conservation. Snails were among the early invertebrate species listed as threatened to possibly threatened in New Zealand (Tisdal 1994).

Earthworms are a major component of the soil fauna, which can keep up with dung removal (Martin 1983) until dryness in late spring-early summer leads to a population decline and forces the remaining worms to go deeper into the soil (Yeates 1979, Springett 1992) and become inactive. Earthworm populations in uncultivated pastures and under pine trees change two to five fold from the late summer/autumn trough 80-500 per m^2 to the late winter spring peak of 900-1,800 per m^2 (Yeates 1976, Martin 1978 1983, McMillan 1981, Fraser *et al* 1995). Soil type did not have much influence on populations in pastures (Fraser *et al.* 1995) except for peat which had a mean of 0.08-0.2 m^2 of earthworms (Luxton 1982, 1983). Waikato peat has appreciable autumn and winter populations of enchytraeid annelids. In pastures, there are usually one very predominant species *Aporrectodea* (= *Allolobophora*) *caliginosa* (Yeates 1986, Martin 1978 1983, McMillan 1981, Springett 1992, Fraser *et al.* 1995) with four more introduced species making up the remaining fauna. At Riccarton bush four of the seven earthworm species were natives (Molloy 1995). Losses of most native species, which nearly all inhabited bush and scrub, occurs within 1-3 years of clearance and conversion to grazed pasture (Lee 1961). Only subsoil native species survive in the longer term.

For 44 Banks Peninsula reserves estimates of endemic species (at least 2.2 %) were derived (Johns 1986). On the dry gravel at Kaitorete spit 4.6 % of the Lepidoptera were endemic to the 171 ha reserve (Patrick 1994).

Previous studies of grasslands share some plant species with Travis Marsh and so will to an ill defined extent have some similar herbivores. In the Manawatu, there were rushes *Juncus* and low fertility grasses (McGregor *et al.* 1987), Convolvulaceae at Kaitorete spit (Patrick 1994), sedges at the Aramoana salt flats and mainly grasses at Somes Island (Grehan 1990) and South Island lucerne fields (Macfarlane 1970) and manuka (Moeed & Meads 1992). The only New Zealand faunal study adjacent to a city (Auckland) dealt with 982 beetle species from bush, gardens, pasture and the seashore (Kuschel 1990). This six plus years investigation estimated about 3,000 insect species probably lived in the 2-3 km^2 study area with 212 native vascular plant species (14 insects per plant species).

The potential at Travis Marsh apparently existed for over 97 beetle and 147 other insect species to be associated with sedges (mainly in bush), manuka, cabbage tree, willow and other trees based on studies elsewhere in New Zealand. These studies include taxonomic revisions of certain groups, an Auckland beetle survey (Kuschel 1990), a survey of Chatham Island invertebrates (Macfarlane *et al.* unpublished) and a national plant host record review (Dale & Maddison 1982). This literature does not always designate either the geographic or habitat range of these species. Hence this provisional list only provides an initial guidance on further species that could be at Travis Marsh. A compilation of insect species from plants in New Zealand (Dale & Maddison 1982) list 41 beetle, moth, bug, thrip and katydid species from manuka, 31 moth, bug and fly species associated with flax, 10 bug and moth species from *Carex* sedges, and seven moth and bug species from three rush species, six moth and bug species associated with cabbage trees, four moth and four bug species from *Coprosma robusta* but none from *C. propinqua*, and four moths species from raupo. There was no information on the invertebrates from orchids, sundews, swamp willow weed and buttercups in this summary.

Terrestrial invertebrate survey objectives

Christchurch city council parks managers have proposed the Travis wetland as a nature heritage park (McMillan & Reynolds 1996). They needed:

- an invertebrate inventory that measures and estimates species diversity and distinguishes endemic from native and introduced species.
- to determine which invertebrates are typical of the marsh and relate them to wetland plants.
- to evaluate and rank different areas of the marsh for invertebrate biodiversity to include any areas of marginal value for invertebrates. To define the more critical areas for conserving native insects that represent lowland Canterbury wetlands. To comment on:- any rare, uncommon species. To highlight the most generally or educationally interesting species.
- for restoration and planning an assessment of current deficiencies in the wetland invertebrates at Travis Marsh and how restoration may affect the potential deficiencies revealed. A summary of the restoration potential of Travis Marsh for terrestrial invertebrates. Comments on where new roading, housing or restoration will have the least impact on the less common native species that represent wetlands and invertebrate biodiversity.
- comments on the relative importance and distribution of invertebrates that could be used as a food source for wetland birds.
- an initial overall assessment of the invertebrate value of the Travis Marsh compared to other New Zealand wetland sites.

For entomological science in New Zealand the authors wished to:-

- determine in a non tidal wetland community the percentage of undescribed invertebrate species and what families require taxonomic imput more acutely. Evaluate how wetlands and further representative communities should allow for more rational assessments of national taxonomic needs in the future.
- assess a realistic but minimal cost required to characterize a terrestrial invertebrate community. The labour cost of invertebrate community studies is often underestimated mainly because most New Zealanders have no appreciation of their size and complexity. Over use or near repetitions of community studies can compete with the need for taxonomic revisions to describe 8,000-14,000 more insect species in New Zealand (Emberson 1996). Hence the scarce New Zealand pool of capable invertebrate scientists should largely focus on taxonomic revisions and species descriptions. These revisions will speed up community and other studies and improve the accuracy of identifications.
- provide some guidance on the suitability of various sampling methods for collecting selected invertebrate groups. The limited number of published invertebrate terrestrial community studies and the cost of making them make it important to use effective sampling methods.

METHODS

Sampling procedure and site features

The survey of the northern wetland was made from 29 November 1995 to 17 February 1996, because many but not all invertebrates are much more active in summer (Cumber 1951 1952, Cumber & Harrison 1959a, Martin 1983, McGregor *et al.* 1987, Moeed & Meads 1992). The southern pasture area was sampled from May 2. Further samples were taken in the spring from sites B and H between September 16 and 24. Simple and inexpensive sampling methods were used, partly to illustrate what school or university students, teachers or naturalists could find most readily.

Initial day time collection concentrated on sweeping and beating from the largest and most discrete patches of the main plant species. Native plant species checked were:- the cabbage tree *Cordyline australis*, manuka, mikimiki (trees - shrubs), swamp kiokio (hard fern) *Blechnum minus*, tussock sedge, raupo (bullrush), flax, wiwi rush *Juncus gregiflorus*, and wahu (tall upright sundew) *Drosera binata.* The introduced plants checked were:- broom *Cytisus scoparius*, grey willow *Salix cinerea,* tree lupin *Lupinus arboreus*, oval sedge *C. ovalis*, glacous sedge *C. flacca*, soft rush *J. effusus,* jointed rush *J. articulatus*, twitch or couch grass *Agropyron repens,* Yorkshire fog *Holcus lanatus*, creeping bent *Agrostis stolonifera*, creeping buttercup *Ranunculus repens,* celery-leaved buttercup *R. sceleratus*, hemlock *Conium maculatum*, broad leaved dock *Rumex obtusifolius*, bog stichwort *Stellaria alsine*, lotus *Lotus pedunculatus* and Californian thistle *Cirsium arvense*. The bog stichwort is a new plant record for Travis Marsh.

Foliage of onion and spider orchids *Microtus unifolia, Corybus* species, and wahu were checked for chewing and leaf mining damage. Insect prey caught on the leaves of three wahu plants were gathered with a paint brush on two days. Insects were taken from vegetation, litter, and the soil mainly during the day, but night sampling was used (Table 2). Butterflies, apid bees, blow flies and damselflies were recorded directly on flowers, dung or over water where possible. No cricket or cicada sounds were heard in the marsh.

Most of the study centred on three representative vegetative areas owned by the council (Fig. 1) that were fenced off from Travis country estate property at the start of the study. For nocturnal insects flourescent lights placed at ground level were used at sites (A to C) on two night and site D on one night (Appendix 3). Sites G and F were on Travis country estate land.

Site A: Ungrazed soft rush- introduced sedge, grass site interspersed with wooded shrubs and very little native plants: Here creeping buttercup was locally common, intermixed with two hemlock patches, gorse, regenerating willow, some tree lupin, a little Scotch broom, square stemmed St Johns wort *Hypericum tetrapterum* with twitch and Yorkshire fog as the main grasses. There were a few native herbs of *Senecio glomeratus* and the onion leaved orchid. The sample site was close to a slow running ditch and the fill from housing development. Site B was 320-400 m to the north. Insects were extracted with a berlese funnel from four samples of grss litter in September 1997.

Site B: Grey willow- manuka - mikimiki and native reed area. At the willow margin and among scattered marsh shrubland with understory hard fern and glacous sedge were investigated. So too was the adjacent native reed and glacous sedge area. The malaise trap was between hard fern and manuka with glacous sedge as the main ground cover under it. This trap was run from 13 -24 January. Two impact raps were run between September 16 and 23. Within 20 m of the traps were clumps or several shrubs of *Coprosma robusta*, blackberry *Rubus fructicosus* agg. and gorse. Cabbage trees were regenerating within the grey willow patch, but were not tall enough to flower or have much dry leaves to shelter invertebrates.

Site C: Tall marsh plants. This area was 800 m E of Site B and only 90 m from Beach Road on a long island bordered by deep ditches. It was named Long Island. Here there was the best quality raupo, tussock sedge, the best native silverweed patch *Potentilla anserinoides* on the marsh and ungrazed creeping bent (Fig. 2). Other large plants included a few flax bushes, three crack willows *S. fragilis*, blackberry, with patches of celery buttercup, wiwi rush *J. gregiflorus*, some strawberry clover *Trifolium fragiferum*, jointed rush and damp dark bare areas and mud. These bare areas between the celery leaved dock and the raupo and tussock sedge (Fig 2) became overgrown with jointed rush, grass and silverweed, when the area was protected from grazing and so this habitat was lost for its few specialist insect species. The malaise trap was within 6-15m of ditches and damp wet spots to the east and west and had raupo on its southern wall and tussock sedge on the NE corner. Creeping bent was the main ground cover with some jointed rush, *Glyceria* under this trap. There was flax, *J. gregiflorus* and willow with 9m of the trap. Here the malaise trap was operated from 1-12 January. Twelve seed heads and stalks of raupo from Long island were collected and all the larvae and pupae reared within a canister.

Site D had two sample points **1. -** A mature cabbage tree along the west drainage ditch. **2.** A night light sample point near the spiked sedge *Eleocharis acuta* and tussock sedge on the western margin of the marsh.

Figure 1 Travis Marsh with location of survey sites

Site E had five sample points from sweeping of wiwi and jointed rush in the marsh and lotus and yarrow on the sandy upland margin. The raupo was inspected for leaf damage, but it had no seed heads.
Site F Grazed pasture (marsh foxtail the dominant grass) subject to winter ponding (McMillan & Reynolds 1996 p 5). Initially this grassland was still moist and pugged from cattle grazing. The February soil samples were hard and dry unlike the moist peat on Long island. Hemlock flowers by the ditch and the gate and the stock pool were monitored for flower visiting insects.
Site G Grazed pasture wet after autumn rain and with a high autumn to spring water table. Soil, cattle dung and invertebrates under sticks, logs and boards were sampled and a garage wall was checked for invertebrates.
Site H Willow, flax, tussock sedge, raupo area examined. Insects in rotting willow and under foam rubber mat examined. Spiders checked from grassland, raupo/blackberry patch and flax and under willow logs. An impact trap was operated from September 16 to 23 1996 during mainly fine weather.

Figure 2 Vegetation and east ditch boundary of the Long I. raupo-tussock sedge community

Ground and litter dwelling invertebrates were gathered from 6 pitfall traps and 6 water traps laid among the rush/sedge grass area from 4-10 December, the margin of the willows and manuka/*Coprosma* species area from 10-20 December and from 4 pitfall and 7 water traps at Long island from 20-30 December. A cursory examination was made of invertebrates amongst dense sedge and rush litter at each of the three main sites. Observations were made on insects associated with fresh cow dung and pukekos. The soil was sampled from the peat at Long island and the adjacent seasonally wet pasture on February 11 th after a drier than average January and February. Four spade squares per ground type were used to sample the larger soil invertebrates and earthworms. The spade squares were dug to half the spade depth, which was often enough to just reach the B horizon in the soil and cover 0.12 m^2 (i.e. detect populations down to 8 per m^2). The February samples from site F were in an area subject to winter flooding by the rushes (see McMillan & Reynolds 1996, p5).

Initial habitat and ecology priorities were to assess what insect species the sedges, rushes and other marsh plants supported, and what was amongst the less disturbed litter. Abundance was recorded in the categouries: abundant, common, uncommon. We assume sampling was not extensive enough from any habitat to detect the rare or very localized invertebrate species.

Table 2 Invertebrate collection:- duration, composition and habitats sampled

Collection methods	Type of site sampled	Number of Nov.- Dec.	sampling days January- Feb.	Duration
Sweep, beat	Vegetation	11	1	29 Nov. -31 Dec.
Hand, sight	Flower to litter	8	3	29 Nov. - 12 Jan.
Malaise trap	Mobile invertebrates	0	24	1-24 January
Ground traps water, pitfall	Ground level	23	0	4-27 December
Light trap	Nocturnal species	1	1	21 Dec., 12 Feb.

Fauna investigated and identification

No attempt was made to investigate biodiversity of some of the smaller invertebrates (mites, nematodes, fleas, lice, scale insects, thrips, protura) that have overall higher levels of non endemic species. Canterbury Museum, Canterbury and Lincoln Universities kindly supplemented resources with the loan of gear and staff help with identification and some sampling (see Acknowledgements). Voucher specimens were mainly lodged in the Canterbury museum except for the spiders and most beetles at Lincoln University. Some duplicates were lodged with Ministry of Agriculture (Lincoln), Lincoln University, the New Zealand Arthropod Collection (Landcare, Auckland) and Auckland Museum. Chalcoidea, Braconidae duplicates and uncommon Diapriidae were sent to specialists in Auckland.

Accurate identification is an important limitation with the diverse invertebrate fauna in a community study. Appendix 4 contains justification for some new species status, partial clarification for some tentative identifications and extra guidance for some unidentified species. The often sketchy older taxonomic keys for New Zealand species have few if any illustrations. This challenge was met by the use of CSIRO (1991) for much of insect family identification and some guidance with subfamilies. Sources for insect and other invertebrate identification are designated, to aid newer students or school teachers, who eventually may extend this initial study. For Diptera (flies), nomenclature follows Evenhius (1989). Figures from the North American genera by McAlpine *et al.* (1981) or British studies (Collin 1961, Freeman 1983) were used to update keys and supplement illustrations of New Zealand studies on Acalypterate families (Harrison 1959), Anisopodidae (Fuller 1933), Calliphoridae (Dear 1986), Dolichopodidae (Parent 1933, Bickel 1991), Empididae (Miller 1923, Collin 1928), Helosciomyzidae (Barnes 1981), Keratoplatidae, Mycetophilidae, Sciariidae (Tonnoir & Edwards 1927), Phoridae (Schmitz 1939), Psychodidae (Satchell 1950 1954), Sciomyzidae (Barnes 1979a), Tachinidae (Dugdale 1969, Malloch 1930, 1938) and Tipulidae (Edwards 1923). Hymenoptera nomenclature follows Valentine & Walker (1991). Illustrated keys to subfamilies, genera and some species were constructed for New Zealand Braconidae from a range of sources including world Hymenoptera (Goulet & Huber 1993) family revisions (Shaw & Huddleston 1991) and New Zealand sources (Valentine and Walker 1991), because Ichneumonoidea families have never been reviewed in New Zealand. These families account for about a third of the estimated Hymenoptera species in New Zealand (Valentine 1970, Valentine & Walker 1991). Literature consulted included keys and illustrations of Chalcoidea (Boucek 1988, Noyes & Valentine 1989b), Pompilidae (Harris 1987), Proctotrupidae (Townes & Townes 1981), Sphecidae (Harris 1994), Formicidae (Brown 1958, Miller 1984) and some Scelionidae (Austin 1988). Information on the hosts of parasites is derived from

Valentine (1967) for non Hymenoptera and Valentine & Walker (1991) for Hymenoptera. Nomenclature for moths and butterflies follows Dugdale (1988). Hudson (1928), Gaskin (1966), Dugdale (1988) and White (1991) provide moth illustrations and either keys or summaries of the feeding habits of moths. Hudson (1934) last catalogued beetle species and Crosby & Larochelle (1994) the genera. The well illustrated summary with keys to New Zealand families and the more important subfamilies (Klimaszewski & Watt 1997) appeared at the end of this project. Hudson (1934) and Kuschel (1990) provide the best overall species accounts of beetle habits in New Zealand, while Klimaszewski *et al* (1996) and Klimaszewski and Watt (1997) summarize known family or subfamily biology. Studies on Anthribiidae (Holloway 1982), Carabidae (Britton 1940 1941, Pilgrim 1967, Lindroth 1976, Noonan 1976), Cerambycidae (Breuning 1962), Lucanidae (Holloway 1961) and Scarabaeidae (Given 1952) have keys for genera and species recognition. For Hemiptera (Deitz 1979) and minor orders catalogue (Wise 1977) provides sources for identification and much of the information on the size of these insect orders in New Zealand. Revisions or keys for Cicadellidae (Dumbleton 1964, Knight 1973-1976), Fulgoroidea (Deitz & Helmore 1979), Delphacidae (Fennah 1965), Lygaeidae (Eyles 1990), Miridae (Eyles 1975 a b, Eyles & Coravillo 1988a b 1991), Acanthosomatidae/ Pentatomidae (Lariviere 1995) and booklice (Smithers 1969 1990, Thornton *et al.* 1977) were used to assist with the identifications and provide information on host associations (Appendix 1,2).

For the other invertebrates sources of illustrations, identification, distribution and family classification used were:- Spiders (Best & Taylor 1995), Forster (1956, 1967), Forster & Blest (1979), Forster & Forster (1973), Forster *et al.* (1988), Forster & Platnick (1985), Forster & Wilton (1973), Hann (1994), Platnick & Forster (1989), Roberts (1985); harvestmen (Forster 1954 1962, 1963), snails (Suter 1913 Climo 1970 1975, Powell 1979), slugs (Burton 1963, Barker 1979), millipedes (Johns 1962 1964, 1966 Blower 1985) centipedes (Archey 1936/1937), woodlice (Hurley 1950, Oliver & Mechan 1993) and landhoppers (Duncan 1974).

RESULTS AND DISCUSSION

Invertebrate diversity and mobility

At least 467 species of insects and 55 species of other invertebrates were recorded from Travis Marsh (Appendix 1). A further 249 species may feed on the plants from Travis Marsh or parasitise their herbivores based on studies from other parts of New Zealand. Fully 81% of these insect species are only found in New Zealand and 40-70% are likely to be characteristic of marshes and wet pasture. Only 3% of the species are clear vagrants from the surrounding higher and lighter soils and housing. Many of these insect and other invertebrate species are not apparent, because they are small or tiny or they are solely or mainly active at night. Other species e.g. grass grubs, some weevils, some click and rove beetles live in the peat or soil for most of their lives and so are seldom visible.

Considerably more species can be recorded from Travis Marsh, because the last field sampling was still adding new insect records at 1.5 per hour down from the initial average of 10 per hour. Spring sampling with a group of students in a new site H in 1996. With minimal extraction of insects from litter added 36 species (mainly beetles) to the total recorded. Kuschel (1990) estimated there were still 15 % more beetles species to collect from a mixed area in Auckland after 6 years of intensive collection, when the rate of recovery of new beetle species had declined to one species per fortnight.

The ability of insects to remain in an area will depend on their normal host foraging range and host patch size. Their ability to consistently colonize new host patches each year will be affected by their foraging range and dispersal ability. Research on releases of parasitic and predatory biocontrol agents in New Zealand (Cameron *et al.* 1989, Moller *et al.* 1991), pests e.g. yellow jacket wasps *Vespula* species (Thomas 1960, Moller 1991), blow flies and beneficial bee pollinators (Macfarlane & Gurr 1995, Macfarlane unpublished) provide some insight into the average dispersal rates of these insects. However, the review of the biocontrol agents focuses on establishment and the levels of parasitism with no emphasis on the sporadic dispersal information recorded in especially in the more modern research. These studies and others overseas indicate average dispersal rates of 3-35 km per year for larger social insects like bumble bees, honey bees and yellow jacket wasps. Thus their average dispersal ability is about 10-20 times their energetically comfortable foraging range of 400-1,500m (Edwards 1980, Crane 1990, Macfarlane *et al.* 1995). For bumble bees the limits of colonization seem to be 15-30 km, perhaps 2-3 times their average dispersal ability, even although queens can fly at least 30 km out to sea (Macfarlane & Gurr 1995). These distances are much less than exceptional colonization of some moth species (Fox 1973, 1978) and aphids across over 2,000 km from Australia to New Zealand with persistent strong westerly winds. These examples tend to represent the upper range of insect dispersal, compared to the smaller solitary insect parasites and beetles. For the parasites information on dispersal even overseas is very limited and is concentrated on the relatively fecund egg (Keller *et al* 1986) and aphid parasites (Dingle 1978, Gupta 1988).

The Ichneumonidae wasp parasite *Spechophaga vesparum* has a proven average dispersal capacity of 2.37 km per year (Moller *et al.* 1991) and it is a medium sized insect species. The 11 species of winged weevils and long horn beetles there was no colonization of trees (cabbage trees, fivefinger, lancewood, *Pittosporum, Coprosma*) or flax only 225m from native broadleaf forest (Kuschel 1990). Smaller and flightless insect species can be expected to regularly colonize even smaller distances than the above cases of large to medium sized insects. Information on the dispersal ability of insects shows major differences between species, so this basic situation must be born in mind, when considering distances of over 200 m between patches of native wetland plants at Travis Marsh.

Food patch size is likely to be vital for key predatory and parasitic species. For predatory ground beetles in Europe it has been calculated that species may need up to 70 ha for long term survival (Lovei & Sutherland 1996). New Zealand ground beetles are clearly vulnerable because nearly 10 % of New Zealand described species are on the proven or suspected endangered species list (Klimaszewski & Watt 1997). Small patch size (under 50 m^2) favoured unspecialised multiple parasites per host species (idiobionts) in the parasite complex affecting case bearing moths in rushes in Europe (Gupta 1988). Parasitism of dung inhabiting maggots placed at various distances from releases of two Pteromalidae species (medium sized parasites) proved the parasites forage freely up to 30 m (Gupta 1988). Lincoln University studies (Wratten *et al* unpublished) on foraging of hover flies indicate that adult flies mainly forage within 30-70 m and ground beetles often forage within 20-50 m of their shelter (Thiele 1977). Radioactive marking of ground beetles overseas indicates similar average foraging distances with ranges up to 200m (Lovei & Sunderland 1996). For an insect community the size of the insect varies well over 500 fold from the largest bumble bee queens, white butterflies and *Wiseana* moths to tiny parasitic wasps about the size of a pin head. At the marsh 1.7% of the insects (eight species) are flightless. Hence the dispersal ability of the insects varies greatly. Bumble bees mainly fly within 600-800 m of their colonies, and in cold weather honey bees also remain within 200-400 m of the colony for preference, but honey bees forage freely to 2 km when temperature exceed 20-25°C. German and common yellow jacket wasps *Vespula* mainly forage within 200-400 m of their colonies (Edwards 1980). In terms of comparative body length the 400 m foraging range of the large bumble bee queens would represent a foraging distance of 27.5 km for a male human of average height. A few moths of various species travel 400-1,500 m from their nearest host plant to a trap set up well above ground level (White 1991), but smaller moths do not fly so readily in cold temperatures especially but also windy conditions (White 1991, Zoology 205 student 1997 projects). These estimates of the upper host seeking range for moth species do not account for the possibility that the moths may have already drifted 30-50 m from their host plants before they reacted to the light trap. Light traps set only 2.5 cm above the ground like those used in this survey apparently attract few moths beyond 40-60 m (Macfarlane *et al.* 1997, 2 Zoology 205 student 1997 projects). According to Walker & Galbreath 1979 with light traps many species only come from within 3 m so a 30 m space between traps was considered enough to avoid disturbance between them, but this is probably a too conservative estimate of the distance that moths readily travel to light traps (Bowden 1982).

For the wingless spiders, slugs, native snails, worms, centipedes, millipedes and flatworms the daily mobility and seasonal dispersal is likely to be lower than for similar sized insects. However, spiders disperse as immatures by ballooning so moderate seasonal dispersal is possible.

Habitat and ecological relationships

Within Travis Marsh the species composition of the invertebrates changes (Appendix 1) and there are differences in the population densities too that reflect the plant succession from the simplified willow/manuka woodland to the grazed grassland (Table 3). Near the raupo there were noticeably more acalypterate flies (mainly *Cerodontha australis* but also *Hydriellia tritici*, *Scatella* and *Ephydrella aquaria*), *Neolimnia sigma*, *Lonchoptera dubia*, midges, *Caligeria* near *varius*, *Tetrachaetus bipunctatus*, the spotted moth, *Rhopalimorpha obscura* and aphid predators based on the rate they were caught per day than by the manuka. These differences were primarily due to more grass surrounding the raupo Site C (acalypterates, aphid predators) and the closeness to bare spots, mud ooze and the ditch. These wet and bare areas supported midges, *Limnohelina* muscid flies, *Scatella*, *E. aquaria*, *N. sigma* and *Erioptera*. Conversely food for other invertebrates near the manuka came from fungi (Anthribidae) dead twigs, rotting wood (longhorn beetles, fungus gnats, booklice) probably rotting sedge and their roots (large crane flies) and scales on the manuka (*Rhyzobius forestieri*). These resources favoured these groups at the woodland margin. The damp floored woodland with more small soft bodied, gall midges, moth flies, book lice and some small crane flies seemed to favour the other Dolichopodidae *Sympycnus distinctus*, *Parentia mobile*, but *Parentia* species are also abundant in other bush sites in Christchurch.

Table 3. Comparison of relative abundance of insect groups from a malaise trap at shrub/tree and the tall marsh plant sites

Invertebrate groups and food source (function)	Collection rate per day Site B (Willow/Manuka area)	Collection rate per day: Long I (Long I., Raupo/tussock sedge)
Herbivores		
Spotted moth	0	8.8
Rhopalimorpha obscura	0.13	1.3
Zygina zealandica	3.4	0.7
Ribautiana tenerrima	0	0.3
Other plant hoppers	7.25	0.1
Nysius huttoni (vagrant)	0.25	0.25
Lonchoptera dubia	0.75	More
Cecidomyiidae Gall midges	16.5	5.6 (4.8 of ?*Contarinia* spp)
Philaenus spumarius spittle bug	0.4	Similar
Mirid bugs	0.13	More
Herbivore-decomposers		
Acalypterate flies	18.75	Much more
Sciariidae Root gnat flies	5.5	Similar
Monomorium antarticus Ant	0.6	0
Pollinators		
Bumble bees (2 spp)	0.6	0
Honey bee	0	0.1
Hyleaus capitosus	0.1	0.1
Dasytes beetles	0.5	0.8
Xenocalliphora hortona		1.2
Calliphora vicina	0.25	0.1
Hybopygia varia	0	0.4
Aquatic as larvae		
Chironomidae -midges	8 (large spp 0.1)	More (1.5 large spp)
Ceratopogonidae biting midges	3	More of large species
Scirtidae-marsh beetles (6 spp)	88.75	Similar
Small tipulids *Erioptera* (main spp)	2.3	
Fungi mainly		
Mycetophilidae	30.4	
Phoridae -Humpbacked flies	5.75	Similar
Lathridiidae-Mildew beetles	3.25	Similar
Anthribidae beetles (2 species)	0.5	0
Litter decomposers- wood feeders		
Psychodidae- Moth flies (5 spp)	29.25	Rather less
Tipulidae - *Leptotarsus huttoni*	9.4 (Main large species)	0.2
Psocoptera-Book lice (8 spp)	7 (more species)	0.2
Cerambycidae - longhorn beetles	3.25 (2 species)	0.1 (1 species)

Invertebrate groups and food source (function)	Collection rate per day Site B (Willow/Manuka area)	Collection rate per day: Long I (Long I., Raupo/tussock sedge)
Parasites		
Ichneumonidae wasps (34 spp)	10.75	19.2
Braconidae *Apanteles* (3 species)	0.28	4
Braconidae *Choreas helespas*	0.1	1.4
Braconidae wasps	6.45	8.6
Anacharis zealandica	1	5.8
Diapriidae wasps (14 spp)	2.2	4.8
Chalcoidea wasps	6.4	10.3
Proctotrupidae wasps (3 spp)	0.1	0.6
Bethylids, charipids (3 spp)	0.75	0.1
Megaspilidae (2 spp)	0.1	0.3
Baeinine wasp species	0.3	0.1
Platygaster	0.1	0
Caligeria near *varius*	0.25	25.5
Heteria ?plebia & other tachinids	1	1
Huttonobesseria verecunda	0	0.6
Predators		
Aerial		
Micromus tasmaniae	1.5	5.5
Coccinella unidecimpunctata	0	0.3
C. leonina	0	0.1
Rhyzobius forestieri	0.5	0
Syrphidae -aphid predatory spp	0.3	1.4
Sympycnus distinctus	23.75	6.8
Parentia mobile	14.5	3.5
Tetrachaetus bipunctatus	0.1	2.5
Neolimnia signata	0	0.5
Empididae (2-3 spp)	2.8	2.8
Vespula vulgaris	0.25	0
Ground		
Carabidae ground beetles	0.25	0.8
Staphylinidae -rove beetles	0.25	0.1

Foliage and seed herbivores and their parasites

Nearly all adults of the light green shield bug *Rhopalimorpha obscura* were on tussock sedge *Carex secta* at Travis Marsh, but two adults were swept from glacous sedge in the soft rush area. Within a month from the end of November its orangy nymphs (camouflaged with seed) progressed from the first two instars to fully grown nymphs on *C. secta* alone, so *R. obscura* is virtually monophagous at Travis Marsh. No *R. obscura* were found from elsewhere on rushes, other sedges or herbs or from malaise trap by the manuka. *R. obscura* nymph mobility was limited, because few were taken in a malaise trap (raupo area) even when a *C. secta* plant was at one corner of this trap. *R.. obscura* is found throughout the main islands, which coincides with all but the southern range of its host sedges (native *Carex secta*, *C. virgata*, *C. trifida*, *Cyperus* (= *Mariscus*) *ustalatus*: introduced *Carex divulsa*, *C. longebrachiata*) (Pendergrast 1952, Knox 1969, Lariviere 1995). Our survey extends evidence that *R. obscura* does not breed on other marsh plants despite adults being associated with marsh and some crop plants (Lariviere 1995). In winter adults shelter at the base among rushes and nymphs are present from October to December (Lariviere 1995). The undescribed seed feeding moth *Megacraspedus* was collected in the malaise trap at Long Island, and at Aramoana and the Southland coast it breeds on a different sedge (Patrick 1994b,1995). *Chinamiris aurantiacus* was collected in small numbers from tussock sedge, so *C. aurantiatus* could well have other hosts than the only proven host ngaio (Eyles & Caravillo 1991). The largish crane fly *Gynoplistria pedestris* with its very reduced wings was commonest around the manuka, but was also collected at site D (by night light). This endemic Christchurch species has been found at five or six of the wetter sites in Christchurch from Halswell, the Styx through to the sewerage works. Travis Marsh appears to provide one of the few large undisturbed sites for *G. pedestris*.

Raupo seed heads and stems contained the small plain light brown moth *Scieropepla typhicola.* It was reared from raupo seed heads, while stems yielded *L. phragmitella*. Forty seven moths emerged over a month after collection on 16 December. The seed heads yielded 3.9 *S. typhicola* moths per seed head and the stems 2.8 moths. The 34 moths from the stem emerged later mainly between 16-28 January, so *S typhicola* must have been in the last larval instar and pupae, when they were collected. At 6.7 moths per seedhead and stem combined there could be around 3350-6000 moths in the 300 m^2 patch of raupo in 1996. In the past *S. typhicola* was collected at Lake Ellesmere and Horseshoe Lake (Canterbury Museum), but the Canterbury collections lacked any recent specimens. In Otago, Patrick has only reared *S. typhicola* from raupo seedheads. Raupo seedheads can harbour three species of moths and previously only *L. phragmitella* had been reared from the stems, and no caterpillars were recorded from the foliage (Hudson 1928). *L. phragmitella* and *S. typhicola* almost certainly have quite localized populations, because neither species was found in the extensive Manawatu (Cumber 1951, Gaskin 1970, McGregor 1987), Hawkes Bay (Davies 1986) Canterbury (White 1991, Patrick 1994a, Molloy 1995) and Otago/Southland studies (Patrick 1994b, 1995). The lack of recent records of the native moth *Stathmopoda phylegyra* from raupo could indicate either its populations have declined since the introduction of the other two species or raupo is not a favoured host. It was uncommon among the light trap next to a Manawatu flax (another host) marshes too (Cumber 1951) at Riccarton bush (Molloy 1995) and absent from Southland wetlands (Patrick 1994b), but was common in Hawkes Bay (Davies 1986). *S. phylegryra* seems at least to be a more localized species in raupo than the other two species. Raupo seedheads had a pale yellow mite among the frass of the caterpillars. The margins of some raupo leaves were chewed and two large plain green caterpillars were collected, but not reared.

Five reasons could account for the lack of parasites from the caterpillars and pupae in raupo in our study and in the literature from *S. typhicola, L. phragmitella,* and *S. phylegyra* (Valentine & Walker 1991). This small isolated patch may have lost the parasite species, because the raupo patches were 330, 210 and 860 m apart in the Travis Marsh. Such large distances for a tiny wasp of a few mm length could be beyond their flight range. Another possibility is any original parasitic species had low or sporadic levels of parasitism and so became extinct during a low period in a population fluctuation cycle. Alternatively summer may be the low point in parasite populations before more are produced when new hosts become available in fresh raupo seedheads. A fourth possibility is that the seed head moths species that were accidentally introduced to New Zealand lost their parasites when only a few hosts originally arrived in New Zealand. The rearing of these moths done in New Zealand to date suggests any parasitism levels are rather low. Studies on raupo at Cockayne reserve or Wilsons swamp around Christchurch or Lake Waihola-Sinclair wetlands will eventually resolve which of these possibilities applies to parasites of the moths.

Flax leaves had chewed central strips and marginal notches. Flax notcher *Tmetolophota steropastis* and white flax moth *Orthoclydon praefectata* caterpillars cause these discrete types of damage (Cumber 1954). Many recent flax plantings at other Christchurch reserves had no chewed flax leaves. Hence these moths seem to take a few years to find the more isolated new patches of flax. A few flax notcher moths were expected even although the main flax areas at Travis Marsh were 250m to 1km from the light traps at sites B, C and D. Flax notcher moths came in limited numbers from over 300m from flax (White 1991) and were consistently trapped at Manawatu (Cumber 1951, Gaskin 1970, McGregor *et al.* 1987), Hawkes Bay (Davies 1986), Riccarton bush (Molloy 1995) and Southland (Patrick 1994b). Failure to catch white flax moth in the light traps is understandable, because most adults fly in April and May (Cumber 1951) and none were recorded from Hawkes Bay (Davies 1986), Riccarton Bush (Molloy 1995) or Southland wetlands (Patrick 1994b).

The wiwi rush *J. gregiflorus* and soft rush supported the black pointed winged moth *Batrachedra tristictica*, which feeds on the seedheads. The small pointed and speckled winged (beige) moth was common only on Long Island so potential hosts include jointed and wiwi rush and raupo or tussock sedge, which were not present near the malaise trap at Site A or B. This species and *Glyphipterix iocheaera* was not among the moths recorded in the Manawatu (Cumber 1951, Gaskin 1970, McGregor *et al.* 1987) Riccarton Bush, Kaitorere spit (Patrick 1994b, Molloy 1995) near Greymouth (Lyford 1994) and were nearly absent in inland Canterbury (White 1991) studies. These species were at the saltmarsh north of Dunedin (Patrick 1995) but *G. iocheaera* was scarce near bush and gardens in Hawkes Bay (Davies 1986). This suggests these small rush moths are not very pervasive beyond the rushes among pastures and perhaps in some marshes. More rush stems within 5 m of the malaise trap with the *Glyphipterix iocheaera* and probably grass and herbs for cutworm larvae probably accounted for the predominance of the parasitic Braconidae wasps *Choreas helespas* and *Apanteles* (broad sense) respectively at the raupo-rush site C. The other alternative host *Protosynaema* speculated for *C. helespas* (Walker 1996) was not recorded from Travis Marsh (Appendix 1).

The speckled browny rush mirid *Chinamiris laticinctus* may feed on rush pollen and green rush seeds, because it was swept from rush flowerheads. The rush mirid was more common than the generalist potato mirid and *Sidnia kinbergi* on rushes. *C. laticicinctus* is associated with rushes, sedges, grasses and some shrubs, but its hosts remain unkown (Eyles & Caravallo 1991). Rushes do not appear to favour potato mirids and *S. kinbergi*. For lotus, lucerne and white clover seed growers rush control near to the crop would be less important than the control of dock and buttercups. In the litter the pale torpedo shaped plant hopper *Paradocyclium* sp and among the foliage a few dark brown speckled deltocephalinid hoppers.

On Long Island, celery-leaved buttercup and elsewhere creeping buttercup was a favoured host for the potato mirid with fewer *S. kinbergi* using them as well.

The ungrazed community of soft rush, sedges (oval, glaucous) - grass - creeping buttercup and other plants at Site A supported the polyphagous orange moth *Mnesictena flavidalis*. During the day this moth was most closely associated with grass. This species could prefer damper pastures and marshes, because it was relatively prominent in the marsh light trapping (Cumber 1951) but was localized in Southland wetlands (Patrick 1994b) rare at Riccarton Bush (Molloy 1995) and absent from bush to pastures in Hawkes Bay (Davies 1986). The introduced spittle bug *Philaneus spumarius* was commonest on lotus and introduced weeds e.g. Californian thistle, blackberry. In November most mirids were nymphs, which will hinder identification except to an expert. The potato mirid *Calocoris norvegicus*, favoured the buttercups, lotus and dock and the Australian crop mirid *Sidnia kinbergi* was mainly on hemlock and to a lesser extent on dock. Hemlock had plenty of *Agonopterix alstromeriana* caterpillars. The few aphids on hemlock were mainly winged (alates), although it has the specialized aphid *Hyadaphis foeniculi* on it (Cottier 1953). Twitch grass supported many stem boring *Tetramesa*. There were a few long horn katydid nymphs *Conocephalus bilineatus* more among the drier grass and a few of the small grey anthribid *Eucoides suturalis* with its long antennae (Holloway 1985) among the grass. Yorkshire fog supported both the pale slender grass mirid *Megaloceroea recticornis* and then the darker green mirid *Stenotus binotatus* with the potato mirid ranking third on grass. Perhaps the potato mirid was dispersing from adjacent lotus and does not prefer grass.

The willow, and remnant manuka, *Coprosma* and *Blechnum* fern community supported a different range of herbivores and their associated beetle and spider predators. Most manuka stems were black with fungus that grows from honey dew secreted by the scale. The dark grey lady bird larvae *Rhyzobius forestieri* crawled along manuka stems where they and the uniformly blackish adult beetles presumably feed on these scales and perhaps the first instar nymphs of a manuka mirid *Lygus* sp. The other possibility is that they feed on freshly forming manuka seed heads, while they are softest and in this case they could contribute to the delay in seed formation and prolonged flowering in manuka. Several of the large bag worm moth cases was seen on the manuka, but no stick insects were beaten from it even although this is reputed to be a favoured host for these insects (Salmon 1991) nor were there any shiny green *Pyronota* beetles, which are characteristic of drier sites. Thrips were quite common from flowering manuka. The honey dew on the trunks attracted foraging southern ants *Monomorium antarcticus*, the metallic green *Parentia mobile* and the undescribed greyish '*Limnohelina*' auct muscid fly species. The common *M. antarcticum* is a flexible native ant species that extends into wet and peaty lowland to upland sites throughout New Zealand (Moore 1940, Miller 1984,Valentine & Walker 1991).

An unidentified insect or snail (caterpillar unlikely - they often chew on leaf margins) chewed small central holes in the leaves of spider orchids leaves in one of three patches. In the manuka and especially in the soft rush area onion, orchid leaves were chewed completely through from the margin. Presumably a caterpillar or the katydid *Conocephalus* ate these leaves, because there are so few phytophagous beetles in the marsh. The orchid flowers may well support the relatively uncommon and understudied thrip *Dicromothrips maori* (Mound & Walker 1982).

Sundew *Drosera binata* and *Celmisia gracilentia* foliage were free of damage by insects. The most common prey trapped on sundew were the smaller crane fly species *Molophus quadrifidus*, tiny moth flies Psychodidae and the smaller marsh beetle species. A considerable range of small species were used (10 other flies-fungus gnat, sciarid, dolichopodid, tachinid, parasitic wasp - 3 braconids, beetles 2 small species, one moth). The illustration of a crane fly as prey of a sundew (Miller & Walker 1984) is clearly inncorrect in attributing this to be a large crane fly species. The tachinid *Caligeria* near *varius* was the bulkiest prey.

The commonest parasitic tachinid fly species, the black *Caligeria* near *varius*, seems to be rather localized being commoner at the Long I. site. Other species of this genus are parasites of Geometridae moths (Valentine 1967), but the host for *C.* near *varius* is unknown. *Pales ?nyctemeriana* was relatively common at sites A and C, and its hosts (sodwebworm moths) were readily seen in this grass habitat. Host of the smaller slender *Huttonobesseria verecunda* (orange abdomen) of the tribe Cylindromyiini may be distinct, because it has been reared from a bug (Harris pers comm.), while other species in the tribe affect moths. *H. verecunda* was commonest where there were rushes and grass and it will probably need a largish host so perhaps its host is the sedge shield bug. It was described from Christchurch and Wellington (Hutton 1901) and has been collected from the central plateau, up to Arthurs pass national park, Otira to Franz Josef on the west coast through to Stewart Island (Insect collections of Otago, Canterbury Museum, Canterbury & Lincoln University, Patrick) with a few habitat records hinting at wetter collecting sites. It was not found in upland Canterbury in the Mt Cook National park (Sweeney 1980) or Cass (Burrows 1977). Thus it seems to prefer lowland and non bush or tussuck sites as none were recorded in the survey of Banks Peninsula reserves (Johns 1986), from Riccarton or Dry bush in Christchurch, or from low dry grassland at McLeans Island (Macfarlane *et al* unpublished). The two Cylindromyiini genera are found in swamp, forest and alpine habitats (Dugdale 1969). *H. verecunda* seems to prefer lowland marshes and rather open grassed areas. *Heteria ?plebia* could be an undescribed species (Appendix 4). *H. plebia* was described from several South Island sites including Horseshoe Lake, Christchurch (Malloch 1930). The largest tachinid *Hexamera alcis* was uncommon during the period of the survey, but this is one of the best known tachinid flies in New Zealand, because it parasitises porina moths *Wiseana* species (Miller 1984, Scott 1984).

Thrip species (not formally identified) were quite common among lupin, buttercup and hemlock flowers and were collected among grass too. No predatory *Aeolothrips* with their broader and black and white banded wings were collected. The lack of aphid nymphs on marsh plants, dock, trees and shrubs was a noticeable sampling outcome, and not even lotus yielded more than a nymph from about 6 sweeps. Of the eight species recorded from the marsh *Acyrthosipon kondoi* and *A pisum* were commonest among the grassy areas, while *Cavariella aegopodii* and *Hyadaphis foeniculi* were associated with hemlock. There was a full array of aphid predators at sites C/F, so grasses probably feed many more aphids at other times in the year.

<u>Insects on invasive weeds of Travis Marsh</u>

Grey willow had a small amount of chewing damage to the centre of leaves, not overly reminiscent of most caterpillar feeding and from casual observation leafroller caterpillars were seen to be active among their leaves. What leafroller species prefer willows has yet to be recorded (Scott 1984, Cameron *et al.* 1989) in the literature although several species may use this tree (Dale & Maddison 1982). This would be useful to know given the importance of some of the introduced and native species as horticultural pests in New Zealand.

Broom and gorse foliage attracted few insects at the marsh. A similar situation applied to broom studied mainly at Hoon Hay valley (Syrett 1993) and gorse with the exception of the seed weevil (Cameron *et al.* 1989). Our survey extended the known species associated with broom slightly, because the insect visitors to its flowers were investigated. These shrubs when mature could offer harbour the general garden pest of shrubs the lemon tree borer, which adds another reason to control these weeds.

Ribautiana tenerrima (a pale yellow plant hopper with black wing marks) often sucked blackberry leaves, which at the marsh often have many tiny white flecks on them. Neither plant hopper species that feed on blackberry are ranked as pests (Scott 1984, Cameron *et al.* 1989). Few of these plant hoppers moved the few metres from blackberries to the nearby malaise traps at sites B and C. This indicates that in summer at least there is little movement between the semisolated plants at these sites. By the end of Beach Road a few shoots of blackberry were affected by the introduced spittle bug *Philaneus spumarius*.

Californian thistle had no foliage herbivores, despite small shoot die back on one plant. This situation may change when current introductions of several species via the Lincoln weed biocontrol group spread. The flowers at the marsh support the bright small long horn beetles *Zorion guttiferum*, pollinating bees, and the potato mirid. Elsewhere the potato mirid is among a small complex of fly and mirid flower visitors to scotch thistles that were in the marsh. Thistle species support a few moth species notably the small black *Tebenna micalis* and the larger *Asterivora edpota* among the stems (Macfarlane *et al.* unpublished), but otherwise not much else on the foliage (Dale & Maddison 1982, Cameron *et al.* 1989, Michaux 1989). Thistles could provide the resource for a study of the spread and distribution of some of the natural enemies that are being currently established in New Zealand if a deliberate introduction is made and followed.

With other weeds no foliage damage or shiny green beetles were seen on the square stemmed St Johns wart. The weeds on the marsh including the near invertebrate-sterile bracken fern (Winterbourn 1987) could provide senoir school of university classes with a resource to see the action or otherwise of insects on the various weeds for a biological control topic.

Parasites and their distribution within the marsh

A significant proportion of the parasite species were not identified readily beyond their family, because of the paucity of keys for New Zealand genera and species, reliably named specimens in Canterbury insect collections apart from the appreciable number of undescribed species and genera. Despite this limitation differences in the composition of the species between sites were of revealed between the manuka and raupo areas. With Ichneumonidae, 13 of the 37 species were shared by these sites. At the manuka there were 27 species and there were 21 species taken from the raupo area. There were less smaller black ichneumonids at the manuka area, and more species and individuals with longer stings at the manuka. The longer stings are probably needed to reach the larvae of prey within wood or twigs, while the blackness will allow the insects to gain heat in the wetter environment of the raupo area. Major differences occurred in the abundance or presence of a few ichneumonid species (undetermined species 1, 18, 21, 23) presumably because of the differences in caterpillar or beetle larval host between the manuka/willows and raupo/tussock sedge/rush environment. This provides some circumstantial evidence to expect these species to be reared from characteristic hosts of such plants, where the host is unknown (Valentine & Walker 1991).

Four Ichneumonidae and 18 Braconidae species (Valentine & Walker 1990, Berry 1990, Walker 1996) have been described since Valentine (1970) estimated 33 and 55 % respectively of the species in the New Zealand Arthropod collection were undescribed. Since then even more species will have been collected in malaise traps, which had hardly been used up until 1980. All or most of the undetermined Ichneumonidae are undescribed (Appendix 4), but only two of the Braconidae species were clearly undescribed species. For the large chalcoid families (Pteromalidae, Eulophidae, Aphelinidae) the estimated levels of undescribed species are at least 83, 88 and 70 % (Noyes & Valentine 1989, Berry 1995). These values for the % of undescribed species were applied to unidentified Ichneumonidae and Chalcoidea species in this survey. This results in an estimated 26-40 undescribed species from these four families. The higher than average level of undescribed Hymenoptera, contributes to the relatively high 12.1 % of species from the marsh compared to the species currently recorded from New Zealand.

There were 18 species of Diapriidae wasps at the marsh, and most in the raupo area. Bethylinae species are only known to parasitise fungus and root gnats (Goulet & Huber 1993). Four species were found throughout the marsh or at sites B and C. There were 15 species of the generally smaller Diapriinae. *Hemilexomyia* ? *spinosa* could well parasitise the muscid larvae of L*imnohelina* from the wet bare spots that there were in the raupo patch. Possible hosts for the other Diapriinae species would be expected from among the Syrphidae, Stratiomyiidae, Muscidae, Tachinidae or Calliphoridae based on world studies of these parasites. Sixteen of the species were undescribed (Early pers. comm.).

More of the tiny parasitic wasps (chalcoid, Megaspilidae, Scelionidae, Platygasteridae) were trapped at the raupo area mainly because of one common eulophid species. This included the distinctive brown wingless Beinini wasp (Austin 1988, Grehan 1990, CSIRO 1991), which parasites spider eggs (Valentine & Walker 1991). This Australian spider parasite adapts to grazed pasture too, where it can be abundant during January and February (Martin 1983).

The ratio of insect species on Travis Marsh that were herbivores was 5.4 to 2.5 parasites to 1 predatory species. How this compares with other plant communities in New Zealand has yet to be compiled, and the study of a few representative communities could provide an alternative estimate on the amount of scientific endeavour needed to remedy the taxonomic deficiency in Hymenoptera, which is the most acute lack in New Zealand entomological literature closely followed by that for beetles.

Flower visitors

Buttercups were the most prominent flowers throughout Travis Marsh in December. Bumble bees *Bombus terrestris* and honey bees *Apis mellifera* visited buttercup flowers sporadically. The bumble bees seemed to prefer lupin, which was used mainly for pollen. There were many small grey shore flies of *Phytomyza* with its yellow band on the legs and yellow forecoxa. The lupin, manuka and hemlock supported good numbers of the sluggish bibionid native *Doliphus nigrostigma*. This was the main flower visitor to manuka. This native species with reddish females and black males with the dark spot on the leading edge of the wing is a characteristic fly in wet areas and presumably the larvae feed on decaying organic matter. Hemlock flowers supported some parasitic tachinid flies, muscid flies and especially the small grey dance fly *Hilarempsis*, and a few blow flies (*Calliphora vicina*; *Xenocalliphora hortona*), which are additional records to those provided in Dale & Maddison 1982). The small black twig nesting native bees *Hylaeus capitosus* foraged on chickweed flowers and especially manuka. Proximity to drier soils awaiting development for sections suited the ground nesting *Podagritus cora*, which prey on flies (Harris 1994). The few present probably took prey from among the hemlock, dock and grass.

Only about 100 m away to the north of the willows a range of insects favoured the flowers of manuka. Solitary wasps that nest in old beetle holes in twigs and branches had suitable fly (*Rhopalum zelandum*) and thrip prey *Spilomena* (Harris 1994) available. Modest numbers of the larger *Odontomyia atrovirens* and the smaller *O. chloris* and *O.* new species with their green faces and margins to the body and the metallic bluish *Beris* visited a range of flowers in the herb fields and the manuka (Appendix 1). Other faster moving flies and a few *B. terrestris* visit the flower faster and so should be relatively more effective pollinators of manuka in Travis Marsh. Honey bees were only foraging on flowers (mallow, buttercup, lupin) on the fringes of Travis Marsh.

Cabbage tree flowers supported the most of the small slender light blue beetle *Dasytes* sp. The light brown and almost black marsh beetle species were gathered on cabbage tree, manuka, and hemlock flowers and to a lesser extent vegetation throughout the marsh. Very few marsh beetles extend into drier pastures in the South island (Macfarlane 1970, Barratt & Patrick 1987) or even the higher rainfall North island farmland (Cumber 1959 b, Eyles 1961) and any in the wettest rushy hill country light trap catches were included in the minor miscellaneous beetle category (McGregor *et al.* 1987). Marsh beetle larvae tend to be aquatic (Waterhouse *et al.* 1992) so the occasional beetle from pasture surveys could come from the adjacent drains or stock water races.

<u>The predators</u>

Spiders with 27-28 species are the main source of predatory biodiversity in the marsh vegetation and litter (Appendix 1). Eight or nine of the 27 or 28 species are undescribed and 74 % are endemic to New Zealand.

The Australian *Eriophora pustulosa* was the introduced spider species in the marsh with prominent populations. Characteristic endemic marsh inhabiting species are:- *Clubiona cambridgea*, *Subantarctia dugdalei* (Forster & Blest 1979, Forster & Platnick 1985) and perhaps *Cambridgea* new species. The most unusual finds among the spiders on Travis marsh were *Cambridgea* new species. The nursery spider *Dolomedes minor* was the largest spider at Travis Marsh. There was limited species overlap between the manuka and the two raupo-flax sites. The main species at the raupo-tussock sedge were *S. dugdalei*, *C. cambridgea* and *Erigone wiltoni* among 12 species. *C. cambridgea* spiders were predominant among the dead raupo, but none were found in the malaise trap adjacent to the raupo, so these spiders hunted less than 0.5 m from the raupo in January. In spring 7-8 species were found in the flax. At the manuka area the most abundant of the 15 species were *Eriophora pustulosa*, *Clubiona convoluta*, *Dolomedes minor*, *Diaea* sp 2 and *Tetragnatha* in summer. In spring, the common brown wolf spider *Allotrochosina schauinslandi* was common under large pieces of wood in the willows. In the soft rush area the dominant species were the common brown wolf spider and the common banded wolf spider *Zeocosa hilaris*. Next in importance among 11 species were *D. minor* and *Oxyopes gregarius*. Six of these species were found at either site B or site C. Hence the spiders showed the most extensive and clear-cut variation between sites for any of the invertebrate groups. The species from the marsh included part of the more numerous forest species complex at Deans Bush and Banks Peninsula (Forster 1956, Forster & Blest 1979, Johns 1986, Molloy 1995) except for the lynx spider and Linyphiidae. Six species and four more genera mainly of Clubionidae are in common with the 46 species of spiders from a Nelson pasture (Martin 1983). The ground spiders *Z. hilaris* were a common element between these two areas too, but Travis Marsh appears to have less biodiversity mainly in Theridiidae. A similar extended seasonal collection at Travis Marsh may well have found more spiders, because in Nelson more species were found only in spring and many species were represented by only 1-3 spiders. Greater vegetation diversity and especially biomass clearly increases spider biodiversity. Most spider species are not obvious, because they are either tiny, nocturnal or they hide in shaded sites.

A full range of aphid predators (ladybirds, two brown lacewing species, syrphid flies and nabid bugs were found virtually exclusively in the pasture- grass and through to the grass the raupo- tussock sedge area, but were not present or for the lacewings less common in the grey willow-manuka area. This trend also applied to aphid parasites Aphidiinae (Braconidae) and their hyperparasites Megaspilidae, Charipidae as well as hover fly parasites *Diplazon laetatorius* and lacewing parasites *Anacharis zealandica*.

Two ant species were found in the manuka area with the larger southern ant *Monomorium antarticus* with perhaps some *M. smithi* foraging on the honey dew in manuka. This habitat is where *M. smithi* has also been collected from in the North Island (Cumber 1959). The small brown bush ant *Prolasius adversa* was present in lowish numbers among willow litter, and this ant is associated with low growing vegetation litter in bush in the North island (Cumber 1959). Examination of more rotting logs could perhaps have extended the list of ant species by 2-3 based on examinations of native forest at Banks Peninsula, but the main diversity of unrecorded predators are probably ground dwelling beetles.

Ground, litter and tree trunk dwellers

Fungus gnats were a numerous fly component in traps (light, malaise, impact, water) from the soft rush-raupo and manuka areas. The spectrum of species and their relative dominance changed markedly from the soft rush area to the willow-manuka area at the other extreme. Overall the stouter more spiny legged Mycetophilidae were more abundant than the more slender Keratoplatinae and Ditomyiidae. The Travis Marsh habitat supports rather more species than grasslands (Cumber & Harrison 1959b, Martin 1983) flax wetland (Cumber & Harrison 1959a) or crops (Cumber & Eyles 1961), but much less than the 110-130 species from mixed broadleaf bush north of Kaikoura (Didham 1992) and inland from Napier (Davies 1988). *Anomalomyia guttata* populations were predominant in light traps from the soft rush area but were a minor component at the edge of the willow woods and manuka. *A guttata* was a minor element of the fungus gnat fauna in flax (Cumber & Harrison 1959a) and even rarer among lucerne (Macfarlane 1970) and was absent from other pasture sweeping (Cumber & Harrison 1959b, Martin 1983). *A guttata* therefore seems to prefer bush (Davies 1988) and ungrazed wet rushy pastures. Conversely the willow-manuka area was the main source for Keratoplatinae fungus gnats (Appendix 1), which in the coastal flax wetland were only represented by *Macrocera* near *scoparia* in modest numbers (Cumber & Harrison 1959a). Fly larvae were common among the willow litter in spring and among an intact decaying base of wiwi rush (raupo area) there was a pupae of correct size for a fungus gnat or the commoner Dolichopodidae. Fungus gnats probably help with litter decomposition and fungal consumption. The spectrum of species of the fly parasitic Diapriidae as well as the numbers also seems to be modest compared to beach (kelp fly hosts) or bush.

The root gnats (Sciariidae) were moderately common throughout the marsh. The larger mainly black *Ctenosciara hylapennis* (introduced) and the similar native '*Sciara* B' *zealandica* were minor elements in both malaise traps. *S. zealandica* was less significant at Travis Marsh than in the Manawatu flax marsh, which was poorer in sciariid species (Cumber & Harrison 1959a) than Travis Marsh. The other introduced species *Lycoriella agraria*, which predominates in pastures (Cumber & Harrison 1959b) and was common in the flax marsh (Cumber & Harrison 1959a) was apparently not represented at Travis Marsh. Bush tends to have even more species than Travis Marsh (Davies 1988, Didham 1992).

The soft rush area (Site A) gathered ground beetles at the best rate of 0.5 and 0.1 beetles per trap/day in water and pitfall traps respectively. In the rush, low sedge and grass community the largish ground beetle *Anisodatylus binotatus* and banded wolf spiders were prominent in pitfall traps. This more recent European immigrant (Pilgrim 1963) is not recorded in the ground beetle literature cited below. The now almost cosmopolitan *Laemostenus complanatus* (Pterostichinae) from Southern Europe and north Africa (Lawrence *et al* 1987) was only found in the willow - grassland area mainly in rotten willow. This ubiquitous pasture and suburban species (Lawrence *et al* 1987, Kuschel 1990) is a general predator of ground invertebrates (Hinton & Corbet 1945). It was recorded from lucerne at Christchurch airport (Moeed 1976), by students from the Burwood pine forest and among bumble bee field hives in Canterbury and Marlborough (Macfarlane unpublished). At Travis Marsh the ground beetle species with the strongest links to wetlands are the small *Bembidion* (Bembidiinae) *Euthenaris* (Harpalinae) and *Notogonum* (Agoninae). *Euthenaris* (Harpalinae) can be a common species in wet lowland areas in New Zealand (Johns 1986, Townsend 1994) and Australia too along with *Notogonus* species (Lawrence *et al* 1987). The various *Bembidion* species include sand dune to tussock grassland occupying species (Lindroth 1976, Barrat & Patrick 1987, Towsend 1994). The two Australian species, *Mecyclothorax rotundicollis* (Psydrinae) and somewhat less often the herbivorous *Clivinia vagans* (= *C. rugithorax*) (Scaritinae) have been recorded from central Otago to a range of beach, pasture and bush sites in the North island (Eyles 1961, Barratt & Patrick 1987, Kuschel 1990, Townsend 1994). The generalist *M. rotundicollis* is not a marshland species (Lawrence *et al.* 1987). More *Demetrida diefenbachi* and perhaps *M. antatarticus* could have been collected if more wooded or aerial sites and bark from logs had been investigated, because *Demetrida* is more arboreal (Britton 1941, Lawrence *et al.* 1987, Kuschel 1990) and *Megadromus* species tend to be found in bush (Lawrence *et al* 1987, Molloy 1995, Johns 1986, unpublished). Overall, Travis Marsh had a relatively restricted diversity of ground beetles compared to the bush and tussock Banks Peninsula reserves (Johns 1986).

The 11 rove beetle species collected include four subfamilies known with predatory species (Klimaszewski *et al* 1996). Few of the species are certainly common to a study of rove beetles in a mid Canterbury cropping habitat in pastoral areas (Sivasubramanian *et al.* 1997), which had only 9 ground beetle species compared to the 11 found at Travis Swamp. The ratio of rove to ground beetle species appears to increase with more liter from a national (Klimaszewski *et al* 1997) and coastal mid Canterbury (Sivasubramanian *et al.* 1997) ratio of 2.3-2.9 to 7 to 1 in a range of Auckland habitats dominated by broadleaf forest (Kuschel 1990). This is due partly to the concentration of Pselphinae in forest habitats (Kuschel 1990, Klimaszewski *et al* 1996) so it is likely that 30- 60 rove beetle species exist in the Travis swamp reserve. Even with such an adjustment to the likely beetle diversity at Travis Marsh, the total beetle fauna is only at best 12 % of the beetle fauna diversity found at Auckland (Kuschel 1990) and 88 % of the beetle diversity recorded from beech and mixed podocarp forests on the Kaikoura coast with impact traps among the canopy (Didham 1992).

The few slaters gathered largely came from the hard fern/willow litter or from the topsoil/grass turf tops. The dark native landhoppers *Makawi hurleyi* preferred grass, rush and grey willow litter to the wetter oval sedge litter. Landhoppers were a prominent component of the pitfall trap catch at least in the soft rush area. The millepedes were similar to those from Riccarton bush (Molloy 1985) and household gardend (Johns 1966). The introduced species The record of *Icosidesus falcatus* is quite an extension to the range for this species from Wellington to the Kaikoura coast (Johns 1964).

Large plump greyish larvae of crane flies (probably *Zealandotipula novarae*, because *Leptotarsus huttoni* lives in rotting wood) were quite common in cluster in the upper peat to peaty sand in the rush, low sedge and sedge areas to the south and north of the main willow patch. The marsh foxtail dominated pasture, yorkshire fog and couch grass were the main source for the smaller crane flies *Erioptera*. These crane flies were also reported in much lower numbers from the barer heavily grazed sheep pasture in Nelson (Martin 1983) and could well have been one of the few species (all unidentified) recorded from North Island grassland (Cumber & Harrison 1959b). None of the 11 species recorded from Travis Marsh coincide with the 35 species of larger crane flies (over 8 mm long body length) recorded from beech forest near L Rotoroa (Toft & Beggs 1995).

Four native snail species (brown with darker bands, black, partly translucent) were confined to hard fern and grey willow litter during the dry period on the marsh. Wells to the east were at their lowest level for 10 years and the January-February rainfall was only 70% of the average. The rate of collection of five snails per hour at night is likely to be the lower limit, due to the dry period. In autumn to spring native snails may extend their habitat use somewhat. Only *S. igniflua* was common to eight species of land snails known from Riccarton bush (Powell 1979, Molloy 1995). None were shared with a species from Christchurch airport (Moeed 1976), 5 species from Somes Island (Grehan 1990), 22 species from coastal Hawkes Bay bush (Moeed & Meads 1992)33 species from Stewart Island (Dell 1954). *Mitodon wairarapa* has a patchy distribution with inland and upland locations in Canterbury and a suggestion that bush is favoured so the Travis Marsh records extends it lowland distribution (Climo 1970). *C. buccinella* seems to favour bush too and Travis Marsh is one of the south east records for this species (Climo 1970). The biodiversity appears to be rather lower than the 15 or so species suggested as likely from a central south Island area (Climo 1975). The large common garden snails was taken in pitfall traps 20m from the western margin (Freeman pers. comm.) but otherwise was not seen more than 10 m from where there were sections. The garden snail was locally abundant in the day in the sheltered and moist heads of cabbage trees. At night well over 100 were seen along the western path just over the ditch.

The brown native slug *Acathophorus bidentaculatus* was confined to sites among the base of raupo and flax. The rate of collection was two per hour. This species was beyond its reputed bush habitat and an annual rainfall minimum of 1250mm and members of this family are so far known to consume fungi on leaves (Burton 1963). The introduced slugs were readily collected in the soft rush and raupo areas at the base of rushes and areas where grass litter remained damp in December and in water traps among oval sedge. The presence of introduced slugs beyond grassland may be important for the native slug species, because some of the introduced species repel other slugs by biting conflicts for the best sheltered spots (Barker & McGhie 1984).

<u>Drains, seepage and bare wet spot inhabitants</u>

The total aquatic insect fauna includes 27 species of flies, bugs, beetles and damsel flies, which is 5.9 % of the species found in this survey. Drains and seepage support at least 16 fly species in 6 families and the bare wet spots favour the small black bug *Salda*, a springtail species and part of the habitat of the ground beetle (Appendix 1). As well there are the two fully aquatic damselflies so these species account for 3.6 % (405 spp) of the insect species biodiversity in the marsh measured in this survey. An estuarine *Salda* can develop on a fly species similar to *Scatella* (Mason 1973) and other overseas species feed on encytaeid worms, fly larvae, midges and invertebrates stranded in the wet sites (Budgeon 1977).

Flies are prominent at times over and by the ditches. The slow running ditch water had many black dance flies of the *Hilara fossalis* species group, which at this stage of the season were ready to lay eggs in the ditch. *Hilara* sp were the predominant Diptera species found in the light trap near the Manawatu river, but no *Neolimnia* (Cumber & Harrison 1959a). Considerable *Hilara* populations occur in favoured ditch sites, while a series of *Neolimnia* (Barnes 1979a) has only accumulated after a considerable collecting effort. There were a few *Scatella* too in the malaise trap, but they were abundant 15 m to the east in wet muddy ooze. The closely related *S. vittithorax* and *Ephydrella novaezealandiae* are some of the few insects along the tidal shore of the estuary (Jones 1983). Sedge on Long I sheltered the common midge *Chironomus zealandicus* and the large biting midge ?*Forcipomyia tapleyi* and these midges and two more common smaller midge species were taken in the malaise trap here. There were only a few smaller biting midges at the manuka site, which was much further from a ditch, and Orthocleinae midges were among the more numerous fly larvae collected from the ditches (Sagar 1996). The large *C. zealandicus* breeds in large numbers in the oxidation sewerage ponds by the estuary (Jones 1983). A few biting midge larvae were recorded from the southern part of 'Travis stream') (Meurk 1995) and elsewhere (Sagar 1996). The aquatic molluscan predators *Neolimnia sigma* and the new *Neolimnia* species were collected here, at Long I., and among jointed rush just north of the N.E. raupo patch in sweeping or the malaise trap. The mainly reddish brown adults seem to be rather localized in the marsh within 10 m of ditches or among the wetter areas as indicated by clumps of jointed rush. *N. sigma* will develop entirely on the aquatic gastropod snails *Physa* and *Gyraulus* (Barnes 1979b), which are both recorded from Travis Marsh ditches (Appendix 1). Two mosquito adults (probably *Culex pervigilens* were collected from a water trap and the Malaise trap by the manuka, which was about 30 m from the western ditch. Mosquitoes were not found in the initial sample from the lower Travis stream (Meurk 1995). *C. pervigilens* was recovered in low numbers elsewhere (Sagar *et al.* 1996) and they are the major mosquito in coastal freshwater in the South Island (Laird 1995). Extension of ponding would tend to increase both mosquito and the larger midge populations so extra ponds are best kept towards the centre of the marsh so residents are not affected by them. Both of the smaller *Erioptera* crane fly species are aquatic, and one species extends to brackish estuarine sites (Jones 1983). However, only *Z. cubitalis* is in common with the 20 crane fly species from the generally peaty Chatham Islands (Macfarlane *et al* unpublished).

At least three of the four species of aquatic snails are endemic except perhaps for *Pisidium* (Powell 1979). They are common in other slow flowing drains leading towards L. Ellesmere (Barnes 1979b) and at Lake Ellesmere (Hughes *et al.* 1974) and elsewhere in New Zealand (Winterbourn 1973, Powell 1979).

<u>Cattle and pukeko dung</u>

Both cattle and pukeko dung were conspicuous on the grazed pastures and the lower ungrazed pasture. These attracted a reasonably standard compliment of blow and Acalypterate flies (Appendix 1). A few more rove and other beetle species probably occur in the dung at Travis Marsh based on studies in Nelson (Martin 1983), Wellington (Moeed *et al.* 1993) and the North Island (Cumber 1959a). Fresh pukeko dung may attract a subtly different spectrum of flies, which it was not possible to examine in such a broad initial survey.

Pukeko diet and feeding

All the pukeko faeces had some grass leaves and marsh foxtail seedheads, with seedheads predominating in about half the sample and a fairly even mix of leaves and seedheads in the other faeces. In 17 % of the faeces oval sedge seeds were a minor plant component. Invertebrate remains were in 25 % of the faeces. However, these were single items (beetle larvae, the lower leg possibly a ground beetle, an abdominal tergite perhaps of a spider) in each scat. More digestible and nutritous invertebrates in the diet like any aphids or caterpillars, would have disappeared from this relatively indigestible material. The more mobile acalypterate flies and seed feeding mirids that are so characteristic grassland sweeping presumably escape accidental predation during diurnal feeding by pukekos. Moist grass pasture at sites F and G had no signs of holes probed by bills that a starling can make or disturbed scratched surface areas. Nor was there any sign the pukekos scratched among dried or old cattle dung, which had wheat bugs under it and by autumn plenty of earthworms in it. It was possible to get within 25 m of the pukekos without disturbing their feeding.

The paucity of invertebrates in the faecal contents of the pukeko from short to medium length grass contrasts with the considerable element of surface dwelling weevils, wheat bug and other less digestible invertebrates found in starling diets from the Christchurch airport (Moeed 1976) and magpies mainly around Canterbury (McIlroy 1968). During late spring at least pukeko appear to prefers to feed among the mid and upper sections of grass pastures based on the plant remains, lack of surface dwelling invertebrates eaten and any evidence of probe marks on the soil surface. Most the invertebrates in our study and many of the main invertebrates recorded in the literature are slower moving species. We suggest many of the invertebrates in the pukeko diet may come from accidental ingestion.

Seasonal and territory differences in the diet of the pukekos and what are the more digestible items in the diet have yet to be properly elucidated. When these questions are being investigated the pukeko could provide useful training for non destructive methods. Such innovative methods of the seasonal study of the gizzards might modify gassing or tranquilizer shooting and netting to capture methods used on mammals and so avoid the killing of birds that has yielded gizzard contents in the past. With live birds a crop sample of the food may be extracted with some of the newer medical types of equipment. Then it should be possible to verify some of the inferences made on their diet from the limited faecal examinations made in our survey.

Skinks

The native skink was only trapped in the pitfall traps in the manuka area, with three being trapped in two pitfall traps by the hard fern near the manuka and willow in mid December and one was trapped again in this area. Ground spiders were present in the litter not far away, but only a few ground beetles were left in the pitfall traps with the skinks. The *O. zealandicus* group of skinks rely almost entirely on invertebrates although a little fruit e.g. of *Coprosma* may be eaten (Berwick 1959). The combined trapping of our survey and by Freeman (1996) suggest that ungrazed grass and sedge to rush areas are most crucial for the skink as secure places to live.

Sampling methods and input needs for an invertebrate community study

Sweep netting provided the clearest associations between most plants for the mirids and indicated some plant communities (grass, low sedge, soft rush : manuka/*Coprosma*, hard fern) had more species than mature glaucous sedge and tussock sedge. However, a beating action may be needed to reveal the insects that consumed quite noticeable parts of the ends of hard fern fronds.

Pit fall traps in the rush, low sedge, grass area were the most successful in collecting ground beetles, spiders and landhoppers. They collected much less in the manuka/hard fern site. This was partly because up to half the traps gathered skinks, which may have eaten most pitfall trapped invertebrates. Long island had a few ground beetles, spiders and landhoppers in the pitfall traps, when they were cleared within 2 days. Otherwise no insects were left possibly because pukekos ate them.

The water traps gathered some extra fly species especially at site A and at Long I., they obtained springtails and the saldid bug that were difficult to collect. However, water traps collected few insects among the raupo, bare spots, under tussock sedge, near hard fern, and the base of manuka. Their value seems to be for sampling in modified habitats of low growing vegetation that humans or stock would disturb. Impact traps collected moderate numbers of flies in spring, and could be less effective than malaise and lights traps, which were best for collecting many insect species in summer. Malaise traps captured most species (Appendix 1).

Soil sampling is better done in winter or spring, when the numerically dominant invertebrate species have the highest populations. This probably also applies to investigations of the mollusc fauna in litter.

The balance of sampling methods used and duration of sampling seem to have an important impact on the assessment of beetle biodiversity. The diversity of beetles species found in our survey with a predominance of species collected with a malaise trap at 1.3% is well below the 18.8 % of the known beetles species in New Zealand (Klimaszewski & Watt 1997) found in the much longer Auckland beetle survey (Kuschel 1990). The Auckland survey relied more on beating, extraction of insects from wood, twigs, litter and less on impact or malaise trapping. The disparity in beetle diversity seems to be mainly due to differences in sampling methods, sampling duration and perhaps regional differences too. Didham (1992) recorded only 2 times more beetle species than our survey with a concentration on impact trapping in beech and broadleaf forest north of Kaikoura.   Collection of up to 80% of the beetle species from mixed habitats seems to require a considerable sampling effort. The inability of even specialists to precisely identify some of the significant beetle species beyond the family level make some families of beetles relatively unsuitable candidates for initial insect community studies such as this survey. In wooded sites beetles do not make up the bulk of the biomass of flying insects that are available to bush birds as a relatively rich source of protein, so in initial studies of insect communities a more holistic approach to the community study that ignores expensive beetle families to identify and includes the major Diptera, Hymenoptera and Lepidoptera appears to be a more balanced approach.

Those that are unfamiliar with invertebrate communities seldom appreciate the scale of the biodiversity involved or complex web of interactions of the different invertebrate species on the plants, litter and their role as food for vertebrate animals.   An initial survey of an invertebrate community requires of the moderate complexity of Travis Marsh requires at least 3-4 months effort to provide the overall framework of the community that has been revealed in our survey. Native forest with their greater biomass and plant species diversity would probably need 5-6 months effort with a competent team of invertebrate identifiers to provide a reasonably comprehensive initial study of the biodiversity.   Simpler coastal dune, saltmarsh or short dry grasslands may have marginally simpler invertebrate communities then the Marsh community we have studied. A lower biodiversity and the decision to exclude parts of the habitat e.g. the soil fauna that are slow to sample, extract and prepare for identification may make a reasonably rounded faunal study possible of these habitats within 2-3 months by a small and competent team of invertebrate specialists. The scale and complexity of invertebrate communities has contributed to a the relatively poor documentation of invertebrate communities in New Zealand to date along with the need to deal with the more pragmatic issues of pest control and other applied insect management. However, as the population of New Zealand increase some more effort must be applied to a selection of invertebrate communities to allow city and rural planners to preserve and manage New Zealand’s unique nature heritage and justify our clean and green ‘tourist image’.

ANALYSIS AND CONCLUSIONS

Biodiversity and similarity to other sites

Wet peaty soils and the component flora on Travis Marsh support a reasonably rich invertebrate fauna. This fauna accounted for 5.8±1.6% of insect species in New Zealand from the 18 larger (12 or more New Zealand species) insect orders or classes found in this survey. Previous surveys of Lepidoptera (Davies 1973, McGregor *et al* 1987, White 1991, Patrick 1994 1995, Molloy 1995) and beetles (Kuschel 1990) over several years suggest 25-30 % of the species are uncommon. This survey was made over a quite limited period and resources did not allow thrip, springtail and apparently beetle biodiversity to be sampled and identified properly. Hence the suggested overall upper limit for species representation from Travis Marsh is probably 6-8% of New Zealand invertebrate species. The 5.8 % average is lower than the 7.5±1.6 (range 1.1-20) % recorded for specific locations in 17 previous studies (Mycetophilidae study excluded) (Table 1) and our survey. The aquatic invertebrate representation at 5.9% is on the low side for this suggested upper limit, because the slow flowing water has not enough oxygen for the important insect orders:- caddisflies, mayflies and stoneflies. A further 15-20 species of winged or parasitic insects should be in the grass, litter, flowers (thrips, mealy bugs), on birds (fleas -Smit 1965, lice - Pilgrim & Palma 1982) and various herbs (aphids, other scale insects) if these insect groups could have been checked properly. In pastures, there are 19-26 springtail species (McMillan 1969, Adams 1971, Martin 1983) and in Waikato peat soils 15-17 species (Luxton 1982, 1983). This diversity represents 5.4-7.3 % of the species in New Zealand, but less than 6 species make up over 93 % of the springtails in soil (McMillan 1969). These insect groups were accorded low priority for this initial investigation for several reasons. These insects have low levels (30-50%) of endemic species, their small size and special habits add extra extraction techniques to the standard ones we used, while processing for identification is slow because voucher specimens need to be mounted on slides. If a further 40 species are added from the cursorily sampled orders, then 507 “proven” species is the very minimum for the marsh. If it is assumed a further 20 % of the more uncommon or localized species were missed then there are at least 610 species of insects at Travis Marsh. This is 109 less species than is obtained by adding those that were found (Appendix 1). A 6 % representation of the known and 8 % representation of the estimated New Zealand insect fauna would give estimates of 750-1840 species at the marsh. A fourth way to estimate the likely number of species is to take the average number of known (12500) and estimated insect species at 18,000-23,000 (Emberson 1996), which gives 5-10 insect species for every native vascular plant species in New Zealand. With 62 indigenous plant species in the Travis Marsh with average diversity there should be 310-640 insect species there. The 507 “proven” species would suggest that the list of insects collected from the survey represents virtually all but the rare and localized species. It seems more likely when it is considered some habitats such as rotting wood, and litter were so cursorily examined that ultimately 650-800 insect species will be found living in this marsh.

For the other 10 invertebrate groups studied the species found represented 4.0±0.6% of the known fauna. This suggests further studies may well find relatively more species of these invertebrates. the survey at these groups will contain rather more species Using the vascular plant to other invertebrate ratio then 30-60 spider and 30-60 mite species, 6-12 slug and snail species, and 3-6 centipede and millipede, 6 earthworm and harvestmen species should be found in the marsh environment. This along with the known landhoppers and slaters gives a total expected of 85-155 larger invertebrate species at the marsh.

A provisional estimate of 20-30 species that are locally rare or even some approaching endangered status in the marsh is made assuming the average rate for rare and endangered species of 3 % applies to this area. Of these only *Gynoplystria pedestris* and perhaps the undescribed *Oxyserphus* species are indicated to be regionally restricted. If the orchid flower thrip survives at Travis Marsh, then will be a third species with regionally isolated populations. Eventually when more of the insect species from Riccarton bush, Hinewai reserve have been identified the status of both rare, localized and characteristic species for the marsh should be much clearer.

The marsh could be rather species rich in Hymenoptera (parasitic wasps) and perhaps Diptera (flies) and may be rather species poor in Coleoptera (beetles). It is certainly depauperate in aquatic caddisflies, mayflies and stoneflies with no adults from the survey. Sampling of the generally small and inconspicuous (they do not move) scale insects was not acute enough to be certain how many plant species support this group of bugs, but some of the flax at least could well do so and most other families of bugs including the plant hoppers (Cicadellidae) were not prominent in the numbers of insects swept from the top of the plants not were they abundant in the malaise traps or night lights. Very few wingless aphids were collected during the survey and none of the plants were definite hosts, which normally reveal noticeable numbers in the net from lush foliage of susceptible hosts. The grasses probably support considerably more aphids during at least part of the season, because their predators (brown lacewings, mainly the small hoverfly, nabid bugs, and ladybird beetles) in the malaise trap and sweeping were much more abundant on and to the east of Long Island than at any of the other sample sites. The small hover fly was seen to use lotus, Californian thistle (nectar, pollen) and grass (pollen) flowers as a food source.

For moths, Travis Marsh shares 76 % of its species with Riccarton bush (Molloy 1995), 53 % with Southland lowland marshes and sand dunes (Patrick 1995), 46 % with the salt Marsh community near Dunedin (1994b), 49 % with pastures in the Manawatu (Gaskin 1970, McGregor *et al.* 1987), 31 % with the flax dominated marsh in the Manawatu (Cumber 1951), 40 % with the upland tussock area of mid Canterbury (White 1991). Riccarton bush lacks some of the dominant and characteristic marsh species that are in Travis Marsh notably *Orocrambus apicellus*, *Scieropelpa typhicola*, *Limnoecia phragmatiella*, *Batrachedra tristicata, Glyphipterix iocheaera* and *Megacraspedus* new species that were partly present at the Aramoana. salt marsh area . Travis Marsh had more *M. plena*, *Rhapsa scotosialis*, *H. rixata* and *O. apicellus* and less *G. ustistriga*, *C. eriosoma* and *Scoparia diptheralis* than the pasture dominated Manawatu studies.

For beetles, Travis Marsh shares 50-62 % of the named beetle species recorded from Auckland bush, pasture and wetlands (Kuschel 1990), 35 % with North Island pastures and crops (Cumber 1959b, Eyles 1961, McGregor *et al.* 1987) and 32 % with the mainly bush reserves of Banks Peninsula (Johns 1986).

For other insect orders, the crickets and katydids were characteristic grassland species (Cumber 1959, Hudson 1972, Swan 1972). The cave wetas were different from the 3 species found in birds feeding around Christchurch airport and sheltering in wooden bumble bee hives by Canterbury pastures (Moeed 1976, Macfarlane unpublished) or from 2 species in Banks Peninsula reserves (Johns 1986). For booklice, only *H. brunellus* from among 13 species from Banks Peninsula reserves (Johns 1986) were definitely shared with the 10 species from Travis Marsh.

The spider complex from near pastures in Travis Marsh resemble that from grassland most closely for Linyphiidae and Oxyopidae (Martin 1983, Forster *et al* 1988, McLachlan 1996, unpublished). The described species in the other families coincide with the richer forest fauna (Forster 1956, Forster & Blest 1979, Johns 1986, Molloy 1995), because it is moist enough to allow some of the forest species to extend into the ungrazed parts of the marsh. A similar trend seems to apply to the terrestrial snails and slugs.

This survey provides an evaluation for one habitat of the minimal level of undescribed land invertebrate species, which is readily available for study being so close to a major population centre. At Travis Marsh, 15-30 % of the species of the larger land invertebrates remain undescribed despite considerable invertebrate studies made by university, government, museum and amateur entomologists mainly in this century from Canterbury. The level for some orders is lower than predicted for New Zealand generally (Emberson 1997), but opportunities for naturalists to readily collect and describe new species is still wide open in this accessible marsh.

Localized species losses

On the Travis Marsh the local extinction of toetoe from the marsh has probably lead to the loss or at least diminuation (where other hosts are used) of the moths *Megacraspedus calamogonus* (Gelechidae) from seed heads, *Orocrambus angustipennis* (Crambidae) *Dipaustica epiastra*, *Tmetolophota arotis* (Noctuidae), the mealy bug *Balanococcus cortaderiae* and the plant hopper *Zygina toetoe*. Some of these species may have survived on pampas grass. Any parasitic species of monophagous raupo herbivores would appear to be vulnerable to localized extinction due to the small and isolated (over 300m apart) patches. The larger, but long narrow raupo patch at Cockayne reserve has only been improved in seed production in the last few year after an improved water supply, so it may not have acted as a reserve for such parasites. Along the Southland coast 11 species (5 %) of Lepidoptera alone become locally extinct with the loss of their food plants (Patrick 1993), which illustrates the general scale of the threat with habitat modification and destruction.

In the southern area the elimination of moss could jeopardize local survival of the less common Crambidae moth species of the genera *Eudonia* and *Scoparia* and perhaps moss inhabiting beetles too. Seven Crambidae species feed on mosses in inland Canterbury (White 1991) and the Chatham Islands (Macfarlane *et al.* unpublished), while in Central Otago a Byrrhidae and weevil species inhabited moss (Barratt & Patrick 1987). Restoration planting in the south must consider the conservation significance of moss, and perhaps relocate any moss closer to another area to also protect the associated invertebrates. The swamp willow weed *Polygonum alicifolium* is from the only native Polygonaceae on the marsh so it could support a few distinct species of moths, beetles, plant sucking bugs and their parasites. These insects may feed in the stems, or on the leaves, flowers and seeds. The swamp willow weed should be examined properly for invertebrates to assess if it does have distinctive insects especially if drainage or management of the grazed pasture is changed. After several years of recent study of the bush at Riccarton, circumstantial evidence indicated over 10 species may have become locally extinct there as well due to the small patch size of their hosts (Molloy 1995).

Parasitic insects are likely to be more vulnerable than their hosts to local extinction, for two main reasons. The dispersal of the always smaller (solitary) to much smaller (gregarious) parasites (than the hosts) must restrict their flight range. Secondly populations levels of solitary parasites are more limited as illustrated by any parasite from raupo moths. If the seed feeding moths normally experience a quite heavy level of parasitism of 30 % then there could be 1000 to 1800 parasites in the Long Island site. A considerable number of parasite species only affect 5 or less % of the population so with a 1 % parasitism level and a weak ability to spread beyond gaps of 300 m will pose problems for any such natural enemy of a specialized herbivore.

Until the hosts of many of the parasites are known it is difficult to predict, which or any of the uncommon or distinctly localized Ichneumonidae or Braconidae within the marsh are vulnerable to local extinction. Patch size and isolation are likely to be most critical for parasites that rely on monophagous (e.g. raupo, tussock sedge) or oligophagous (e.g. *Carex* sedges) insect hosts.

Litter inhabiting landhoppers, slugs and native snails, which face desiccation may well have had their range and abundance in the marsh reduced substantially since European occupation, due to the more open grazed pastures, which desiccate more easily and the loss of dense vegetation patches of toetoe and manuka. Improved drainage with the ditches could have been even more important. For instance better drainage has placed the north east raupo patch in longterm jeopardy, because it is now probably too dry for part of the season to allow for seeding. In Christchurch suburbs three introduced woodlice species are an easily collected element of the litter, but any woodlice were at best uncommon on the marsh. Similarly more intensive further examination may yet reveal some of the other landhopper species are present in localized parts of the marsh, but in the modified soft rush habitat only the most adaptable species was present and also common.

Characteristic marsh and native woodland species

Marsh beetles at Travis Marsh were abundant as they were in light trapping from a Manawatu flax marsh (Cumber 1952), which contrasts with the paucity of specimens of a single species taken from pasture surveys (Cumber 1959, Cumber & Eyles 1961, Macfarlane 1970, Martin 1983). The seven species at Travis Marsh compares favourably in biodiversity with three undetermined *Cyphon* species from the Manawatu flax Marsh (Cumber 1952) and the Chatham Islands (Macfarlane *et al.* unpublished), but 22 species were found in the Auckland beetle survey (Kuschel 1990). New Zealand is reputed to have about 200 species, which is over twice the number of Scirtidae (Helodidae) species known from Australia (Watt 1982, CSIRO 1991). The moderate number of species recorded from four wetland areas indicate that synonyms from 110 year old studies may well outweigh any undescribed species by a considerable margin, which would mean the New Zealand Scirtidae estimate for species is rather high.

The wooded and tall marsh plants supported very few weevil or longhorn beetle species and no leaf feeding beetles (Chrysomelidae), which contrasts sharply with about 100 beetle species found among Cyperaceae and woody plant species in Auckland (Kuschel 1990). There was no corresponding predominance of the kanuka longhorn *Ochrocydus huttoni* at Travis Marsh, that ranked as the 11 th most common species in Manawatu hill country pasture with some manuka (McGregor *et al.* 1987). This large longhorn should become more common as the area of manuka increases.

Many of the plant hopper species that favour marsh plants, were not verified in our study. Perhaps this is due to greater plant specificity than is indicated from general sweeping of plants in a marsh, but maybe patch size is also too small and isolation too great. No *Leioproctus* species (the most effective manuka pollinators) visited the manuka flowers, because they need drier soils to nest in. This lack of a key pollinator group could account for the delay in cessation of the flowering with a lack of seed formation. Flowering ended towards the end of January after peaking relatively late for manuka around the end of December. Eventually the bumble bees and flies seemed to have achieved the necessary pollination.

Research and education prospects

The proximity of Travis Marsh to scientists, proficient natural history amateurs and schools and the size which allows for a stable ‘mini wilderness’ offers considerable potential for research and education in the future. The fauna is large enough to allow plenty of scope for biology, natural history and ecology studies. To sharpen invertebrate community comparisons and to provide sounder guidance on the local invertebrate community would be to conduct similar “opening” community studies to this survey. The priority is probably to start with the least known and probably simplest communities locally (salt marshes and dry moss-herb-lichen grasslands) and then proceed to complete an overall survey of Riccarton bush. A review and update of the better investigated and locally recorded (only partially available in university thesis and honours projects) invertebrate communities would be desirable and studies of the new grassland reserves near the Waimakariri river. The role of a considerable number of the taxa as decomposers, omnivores or herbivore currently has to be derived from cogeneric species or even other species in the same family. The actual role of many species is partly to completely unknown and should eventually be investigated. The likely impact of proposed changes to the vegetation could be investigated. The significance of soil type on this less mobile fauna and the environmental preferences of marsh or even some pest species may be derived from appropriate research. At Travis Marsh in the short and medium term there are even prospects for some more applied projects dealing with some agricultural seed crop pests and the weed community in a favourable stable ownership for Christchurch residents. The fascination of small game hunting and scientific discovery to develop the picture of the invertebrates of marshes begun by this survey should be an integral part of the future value of Travis Marsh. On an ecological and biological basis even some of the more distinct moth species e.g. the cabbage tree moth, and the endemic moths associated with raupo and tussock sedge have yet to have Hymenoptera parasites reared from them. Thus there is plenty that could interest mainly university students, scientists, or proficient amateur entomologists.

Recreational value and restoration potential

Flower sources for bees, flies and nectar feeding birds (bellbird, tui) on Travis Marsh are impoverished from autumn to mid spring. In early spring gorse and then broom provide limited mainly pollen sources. Manuka, flax, cabbage trees, hemlock, square stemmed St Johns wort, the buttercups, lotus, white clover, blackberry, mallows to the north west provide summer nectar and pollen sources which scotch thistles will tend to extend to late summer. For flies and nectar loving beetles:- manuka and cabbage trees were favoured sources and later yarrow is likely to extend sources for flies. The better drained loam soils offer the best potential for integrated restoration that may successfully combine a more aesthetic reserve with the chance for restablishment of some arboreal birds (bellbirds and perhaps tuis) as well providing a better sequence of flowers for more species of native bees (Donovan 1980), flies, parasitic wasps and moths. Plants to consider for this role are the winter flowering five fingers *Pseudopanax*, spring flowering kowhais *Sophora microphylla*, *Pittosporum* spp, ornamental manukas, early summer flowering flax *Phormium tenax* and perhaps native brooms and a few late summer flowering gums or spring flowering e.g. *E leucoxylon rosea*. On the Chatham Islands grazing livestock and pigs have greatly reduced the incidence and range of *Astelia* and Umbelliferae and this could have contributed to the decline and low incidence of the tui there with a reduction in summer nectar sources and berries (Macfarlane unpublished). Flowers such as kowhai and flax were originally largely bird pollinated (Godley 1979), but now honey bees (Matheson 1992) and bumble bees contribute to their pollination. The pollination of kowhai is complicated by the short tongued bumble bee, because they bite holes at the base of the flowers and then this species and the honey bee will use this basal hole to gather nectar without affecting pollination. Macfarlane has noted flax is not well visited by either native bees (some *Hylaeus* use the flowers but are unlikely to contact the stamens) and bumble bees.

The proposed redevelopment of the southern area with bush species will need the litter, which provides the fungal and decaying leaf food sources that produce more of the slower medium sized flies (e.g. Mycetophilidae, Stratiomyiidae) that dominate the biomass of insects collected in broadleaf forests in Banks Peninsula and Christchurch bush (Macfarlane unpublished).. These fly resources (which may peak in abundance in late spring anf autumn) and caterpillars on foliage, could well be vital to tui in providing a relatively stable (year to year) range the associated invertebrate protein source for them to rear their young and to aid egg development. Berry formation. Coprosmas should be included among the replanting, because their berry formation is likely to favour native birds by providing food and *Coprosma* is among the best genera of native plants in supporting a diversity of native insects (Dugdale 1975).

The restoration use of the fill and beach dune remnants will need careful consideration to achieve the full multipurpose potential for ornamental recreation, possible restoration of some land birds and yet retain an element of conservation of the native plants and their associated invertebrates. The northern area is probably too small to develop an effective area for tree inhabiting bird species, so eventually it would be important to replace the willows in the east with a range of nectar and berry forming native with perhaps 2-3 strategically placed clusters of tagasaste (tree lucerne) or 1-6 *Eucalyptus* trees to ensure successful multipurpose use of public recreation areas.

Housing development south across Travis Road will increase the contamination along about a 30-60 m band of vagrant insect species and so complicate future studies on the invertebrate community. The formation of a walkway around Travis Marsh will improve access and so the probability of vandalism to general invertebrate trapping (malaise, impact, light). Prospects for undisturbed invertebrate studies will diminish with more use of the reserve for recreation.

It is encouraging that 81 % of the species of insects and probably a similar proportion of other larger invertebrates are species only found in New Zealand even although the native plant species only occupy about 10 % of the area of the northern marsh. Travis Marsh has a value for biodiversity, that can only be properly appreciated by further studies of invertebrate communities in other Christchurch reserves e.g. Riccarton bush and the coastal salt marsh areas to determine how the species composition changes with vegetation types. The publication of this study may also eventually encourage some comparative studies from other major marsh communities in the Waikato, Wairarapa, and the large Sinclair-Lake Waihola wetlands as well as some Southland sites.

The education potential of the marsh is initially to allow non-entomologists aware of the extent of the biodiversity and how invertebrate studies can link with other aspects of interest to managers and naturalists. These aspects include the role of aquatic insects as food for the ducks, as a possible source of dietary enrichment for pukekos and probably a seasonal supply of food in late winter early spring. The insects provide some of the native plants with essential pollination, and a major species complex *Leioproctus* that normally provides much of the more effective pollination to manuka.

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Appendix 1 Invertebrates recorded from Travis Marsh in 1995-1996 summer (467 insect species, 88 introduced or indigenous species)

LEGENDS, CODES

Common names follow Ferro *et al.* (1977) and Kuschel (1990). (A) = Introduced and indigenous species; the others endemic species only found in New Zealand % = of total New Zealand species

Size length in mm: L = large > 25 mm, M = Medium 10-25 mm, S= Small 5-10 mm, T=Tiny, under 5 mm
Action = Mainly flies or moves in the day or night.

Sampling method (CO) =collected-hand gathered, (MT) = Malaise trap, (NL) =Night light, (OB) = observed (PT) = Pitfall trap, (SW) = swept, (S or L) =Soil or litter, (WT) = water trap

Habitat for immatures of invertebrate species: A = aquatic, C= carrion, D = dung, F = flowers GR = grass, G = generalist -common in more than one habitat L/RW= litter, rotting wood M = marsh, T/S =tree, shrubland inhabitant, U = unknown V = vagrant to marsh

Abundance: Abundant = over 20 insects in malaise or night light traps per site, common = 10-20 insects, less common 4-10 and uncommon 1-3 insects. With any other sampling method the insect numbers are halved and for all spiders the numbers are also halved, because they do not fly. Habitat and host records from the literature is listed after abundance.

INVERTEBRATE TAXA	Size	Action	Sampling, habitat, abundance
BLATTODEA		**(3.3 %)**	**(30 NZ spp)**
Blattidae Cockroaches			**Most species are omnivores**
Celatoblatta	Medium	Night	(MT),T/S Raupo area, litter feeder, uncommon
COLEOPTERA	**68-70 species (1.3%)**		**(5235 NZ spp)**
Anthribidae Fungus weevils			**Mainly fungal feeders**
Euciodes suturalis (A)	Small	Day	(MT SW) GR,Grass stems: hosts yorkshire fog, tall fescue, cockfoot
Helmorius sharpi	Small	Day	(MT) T/S Lupin in rush/grass and by manuka,uncommon
Phymatus phymatodes	Small	?Day	(MT) ?T/S by manuka, Dead branches, breds in ascomyces fungi, uncommon
Brenthidae Giraffe, seed weevils			**Seed and stem feeders**
Apion ulicis (A) Gorse seed weevil	Tiny	Day	(SW) T/S From gorse among rushes,uncommon
Carabidae Ground beetles			**Most species are ground predators**
Anisodactylus binotatus (A)	Medium	Day	(PT) G, Commonest among rushes,long grass,upper soil - possible prey slugs,worms and perhaps millepedes & landhoppers
Bembidion cf *rotundicole*	Small	Day	(PT) GR/M, Grass,rush,sedge area, locally common
Clivina vagans (A)	Small	Night	(PT L) G, Grass, sedge associate herbivore,less common
Dimetrida dieffenbachi	Small	Night	(MT) T Manuka area,uncommon
Euthenaris sp	Medium	Day	(MT PT) M/GR,common
Laemostenus complanatus (A)	Medium	Night	(CO) RW-G Grass and rotting willow wood, site H, common
Mecyclothorax rotundicollis (A)	Small	Night	(PT) G Ubiquitous drier grass to rotten wood, uncommon
Megadromus antarticum	Large	Night	(PT) T/S Willow area,uncommon
Notogonum feredayi	Small	Night	(CO) RW-G Among rotting willow wood, site H, common
N. submetallicum	Small	Night	(CO) RW-G Among rotting willow wood, site H, common
Zabronothus species	Small	Night	(CO)
Cerambycidae Longhorn beetles			**Mainly wood feeders**
Psilocnaemia species	Small	Night	(MT OB WT) T most common by manuka,uncommon near raupo
Zorion guttiferum	Small	Day	(MT NL OB) T/S, Many small open flowers includes manuka, yarrow
Cleridae Checkered beetles			**Larvae in wood, predators, adults flower visitors**
Phymatophoea species 1	Small	Day	(MT) Raupo area, less common
Coccinellidae Lady birds			**Pradators,aphids, scales, small caterpillars**
Adalia bupunctata (A) Two spotted ladybird	Small	Day	(MT) G, Least common grassland species
Coccinella leonina Orange spotted ladybird	Small	Day	(MT) G, Localized, less common rush-sedge area
C. undecimpuncata (A) Eleven spotted lady bird	Small	Day	(CO MT) G, Locally common, pasture grasses, herbs, raupo
Rhyzobius forestieri (A)	Small	Day	(MT SW) T, Manuka, scale insect probable prey
Species 1	Tiny	?Day	(MT) Manuka area, uncommon
Colydiidae Rough mold beetles			**Fungi among leaf litter and trees**
Pristoderus species	Small	?night	(CO) Among willow litter, manuka area, uncommon

Corylophidae **Hooded beetles**			**Mainly among leaf litter**
Species 1	Tiny	Day	(MT) Manuka area,uncommon
Cryptophagidae **Cryptic beetles**			**Rotting litter in bush and pasture**
?Micrambia species 1	Tiny	Day	(MT) Manuka area, common
Curculionidae **Weevils**			**Root, plant, twig, wood, litter feeders**
Listronotes bonariensis (A) Argentine stem weevil	Tiny	Night	(CO MT S WT) GR, Raupo area, hemlock flower, grass stem miner, locally common
Brachycerinae species 1	Tiny	Day	(CO) Dead raupo, uncommon
Cossininae species 1	Tiny	Day	(CO) Dead raupo,uncommon
Species 1	Small	Day	(NL SW) G, Raupo area & associated with wiwi rush
Species 2 &3	Tiny	Day	(CO) Willow litter, manuka area, uncommon
Dytiscidae **Diving beetles**			**Water predators**
Rhantus pulverosus (A)	Small	Day	(CO) A In stream -Sagar *et al* (1996)
Elateridae **Click beetles**			**Mainly omnivorous root feeders, soil predators**
Conoderus excel (A)	Medium	Day	(MT NL) G Soft rush -raupo areas, pasture roots locally common
Species 1	Medium	?Night	(PT) ?GR, Grass ,uncommon
Helodidae (Scirtidae) **Marsh beetles**			**Immatures can develop in water**
Species 1	Tiny	Day	(MT SW) M, general vegetation throughout, abundant
Species 2	Tiny	Day	(MT SW) M, hemlock,cabbage tree flowers,locally common
Species 3	Tiny	Day	(MT SW) M, Manuka,common
Species 4	Tiny	Day	(MT SW) M, Mainly trapped rather than swept,common
Species 5	Tiny	Day	(MT NL SW) M, More localised and less common species
Species 6 &7	Tiny	Day	(MT NL SW WT) M, Throughout, abundant
Species 8 &9	Tiny	Day	(MT) M, Manuka area, less common
Hydrophilidae			
Unidentified species	Small	Day	(CO) Dried pond, manuka area in willow litter, also Sagar *et al* (1996)
Lathridiidae **Mildew beetles**			**Fungal feeders**
Cortinicara hirtalis (A)	Tiny	Day	(MT) pasture area,common
Melanophthalma gibbosa	Tiny	Day	(SW) G, Among grass, shrubs and trees,fungus feeder
Lucanidae			
Ceratognathus irroratus	Medium	Night	(NL) Manuka area, uncommon
Melyridae **Flower beetles**			**Adults flower visitors**
Dasytes sp	Small	Day	(CO SW) G, Buttercup, manuka,cabbage tree flowers, uncommon
Ptilidae			
Species 1	Tiny	Day	(CO) G Grass litter site A, uncommon
Scarabaeidae **Grassgrub,dung,manuka beetles**			**Major soil root and organic matter feeders**
Costelytra zealandica N.Z. grassgrub	Medium	Night	(NL S) GR, Grass soil, water traps, locally common
Odontria ? *colorata*	Medium	Night	GR, Grass area, least common scarabid
O. striata	Medium	Day	(MT S) GR/M Sedges, willow soil, manuka, localised, uncommon
Scraptidae			
Nothotelus species 1	Tiny	Day	(CO) Manuka area, uncommon
Staphylinidae **Rove beetles**			
Myllaeuas species (?A)	Tiny		(MT) Raupo area, probably predator, uncommon
Atheta 2 species	Small		(MT) Manuka-raupo areas, probable predator/parasite, uncommon
Aleocharinae 2-3 species	Small		(PT S) Manuka-raupo areas, hemlock flowers, soil, litter, less common
Oxytelinae species	Tiny		(SW WT) Soft rush area, on lupin, probably decomposer, uncommon
Pselphinae species 1	Small		(PT) T Willow-grass area, probable predator, uncommon
Xantholinini species (Staphylininae)	Medium		(PT,S WT) Soft rush -raupo-pasture areas, in soil, predator, uncommon
Species 1-4	Small		(WT,CO) Litter in willows, food source uncertain, less common
Tenebrionidae **Darkling beetles**			**Mainly feed in rotting wood,vegetation**
Zealandium zealadicum	Medium	Day	(CO) Rotten willow, less common
Species 1	Medium	Day	(PT S/L) Soft rush -manuka areas, among grass grey willow litter locally common

COLLEMBOLA	**Springtails (6 spp) (1.7%) (354 NZ spp)**		
Entomobryidae			
Species 1	Tiny	Day	(CO WT) Willow and litter, locally abundant
Hypogastridae			
Hypogastrura ?*rossi*	Tiny	Day	(PT) willows, locally common
Isotomidae			**Possible litter feeder**
Species 1	Tiny	Day	(WT,MT) M, on wet bare spots manuka litter,locally abundant
Onychiuridae			**Possible litter feeder**
Species 1 (A)	Tiny	Day	(MT) Long I, on bare wet spots, localised, abundant
Poduridae			**Possible litter feeder**
Species 1 (A)	Tiny	Day	(CO) Long I, damp areas, less common
Sminthuridae			**Herbivore**
?Bourletiella hortensis (A)	Tiny	Day	(WT) Raupo- site F Creeping bent,jointed rush, uncommon
DERMAPTERA	**Earwigs (9 %) 22 N Z species**		
Chelisochidae			**General omnivore**
Chelisothes morio (A)	Medium	Day	(CO WT) Cabbage tree shoot debris common, grass uncommon
Forficulidae			
Forficula auricularia (A)	Medium	Night	(PT) Soft rush -willow area, uncommon
DIPTERA	**134 species (5.7%) (2348 NZ spp)**		
	SUBORDER NEMATOCERA 60 SPP		
Anisopodidae Wood gnats			**Feed on dung and other decaying matter**
Sylvicola sp	Small	Night	(SW) G, decomposer, uncommon
Bibionidae March flies			**Larvae may mainly be decomposers, adults use flower**
Dilophus nigrostigma	Medium	Day	(SW) M Semiwet bogs, lupin, yarrow flowers, common early summer
Cecidomyiidae Gall midges			**Herbivores or predators can be rather host specific**
?Contarinia geniculata (A)	Tiny	Day	(MT) GR Swept tussock sedge, small red body, common
?C. tritici (A)	Tiny	Night	(MT) GR Raupo area, common
Lestremia species	Tiny	?Night	(MT) U Raupo area, less common
?Miastor sp	Tiny	?Night	(MT) U Raupo area, uncommon
?Porricondylin new genus	Tiny	Night	(MT) U Raupo area, uncommon
Porricondylinae species 1 & 2	Tiny	Night	(MT) U Raupo area, uncommon
Ceratopogonidae Biting midges			**Larvae aquatic or in damp areas**
? undetermined genus sp	Small	Day	(MT WT) A Raupo-soft rush areas, uncommon
Forcimyia ?tapleyi	Medium	Day	(MT) M/?A Among rush community,tussock sedge at night
F. sp.	Small	Day	(MT) ?T/S A Among tussock sedge,uncommon
Chironomidae Midges			**Larvae aquatic**
Chironomus zealandica	Medium	Day	(MT NL SW WT) A Raupo -manuka, common, more near ditches
Chironimini species 1	Small	?Day	(MT) A Raupo area, uncommon all yellow body
Chironimini species 1	Small	?Day	(MT) A Manuka area, uncommon mainly yellow, brown notum
Orthocladius species	Small	Day	(MT SW) A Raupo -manuka areas, uncommon
Polypedilum ? longicrus	Small	?Night	(MT) A Raupo area, uncommon
? *Semiocladius* spp. 1	Tiny	?Night	(MT SW) A Throughout, generally abundant but less common manuka area Light creamy spp with brown bands on top of thorax
? *Semiocladius* spp. 2	Tiny	?Night	(MT) A Raupo area, uncommon
?Smittia verna	Small	Night	(MT SW) GR Throughout,locally common, small all black spp
Culicidae Mosquitoes			
?*Culex pervigelans*	Small	evening	(WT) A Manuka area, & Sagar *et al* (1996), uncommon
Ditomyiidae			**Mainly feed among rotting material**
Australosymmerus trivittata	Small	?Night	(MT) Manuka area,uncommon
Nervijuncta nr *filicornis*	Small	Day	(SW) Shelter in *Blechnum*
Keroplatidae Fungus gnats			**Includes predatory glow worms**
Macrocera milligani	Small	?Night	(MT) Manuka area,uncommon
M. scoparia	Small	?Night	(MT) Manuka area,uncommon
Pyrtaula campbelli	Small	Night	(MT) ?rush/sedge,grass area, uncommon

Mycetophilidae Fungus gnats			**Mainly feed among rotting material**
Anomalomyia guttata	Small	Night	(MT) GR More soft rush-raupo areas, abundant
Aphelomera longicauda	Small	?Night	(MT,WT) Soft rush area, uncommon
Cycloneura ?triangulata	Small	?Night	(MT) Manuka area,uncommon
Mycetophila colorata	Small	Night	(MT) Manuka area,
M. nitens	Small		(MT)
M. *solitaria*	Small		(MT)
Zygomyia group	Small		(MT)
Z. trifasciata	Small	?Night	(WT) rush,sedge,grass area, uncommon
Psychodidae Moth flies			**Feed among decaying vegetation in wetter sites**
Psychoda pencillata	Tiny	Day	(MT) M/GR Among *Blechnum* fern, abundant
P. sp 1 & 2 *cinerea* group	Tiny	Day	(MT) Manuka area,common
P. ? new species 1 -3	Tiny	Day	(MT) Manuka area,less common
Scatopsidae Tiny black scavenger flies			**Feed on decaying vegetation, mature carrion**
Scatopse notata (A)	Tiny	Day	(SW) Scavenger among tussock sedge, abbreviated wings,uncommon
Sciariidae Root gnats			**Feed of seedling roots,decaying vegetation**
Ctenosciara hyalipennis (A)	Small	Day	(MT) GR Throughout, commoner in grass & rushes than elsewhere
'Sciara B' ? L. agraria (A)	Small	Day	(MT) Grass community,abundant
'Sciara A'	Tiny	Night	(MT) Grass community,less common
'Sciara A' new species 1	Tiny	Night	(MT) Grass area,less common
'Sciara B' zealandica	Tiny	Night	(MT) Manuka area,common
'Sciara B'	Tiny	Day	(WT) Wingless, soft rush area,common
'*Sciara B'* new species 1 &2	Tiny	Night	(MT) Manuka area,uncommon
Tipulidae Crane flies, Daddy long legs			**Feed among roots,decaying vegetation**
Erioptera confluens	Small	Day	(CO MT NL SW) GR Soft rush-raupo areas, raupo, hemlock flowers, common
E. inconstans	Small	Day	(MT NL SW WT) Soft rush-raupo areas. Grass -rush associate,
Gynoplistia pedestris	Large	Day	(MT SW) M Shelter sedges, near wingless, less common
Leptotarsus huttoni	Large	Night	(MT NT) Long antennae, dominant spp near manuka, locally abundant
Limonia vicarians	Medium	Night	(NL) Less common
Molophus multicinctus	Small	Day	(SW) Manuka area, uncommon
M. quadrifidus	Small	Day	(MT NL SW WT) throughout, *Drosera* prey, less common
Paralimnophila skusei	Large	Night	(NT SW) Manuka - site E areas, common
Zealandoglochina cubitalis	Small	Day	(SW) T Manuka area, hard fern -manuka associate,less common
Z. unicornis	Medium	Night	(MT NL) Manuka area, less common
Zealandotipula novarae	Large	Day	(MT) M/T Sheltering on cabbage tree, larvae probably widespread
	SUBORDER BRACHYCERA 74 SPP		
Agromyzidae Leafminer flies			**Leaf mining herbivores**
Cerodontha australis (A)	Tiny	Day	(MT) GR, Grass leaf miner in rush community,abundant
Phytomyza atricornis	Tiny	Day	GR, Ungrazed rushes, mines plantain, thistles,locally common
P. costata	Tiny	Day	(MT) GR, Ungrazed soft rushes;mines buttercups,locally abundant
Anthomyiidae			
Delia platura (A)	Medium	Day	(NL) G Grass Area F, feeds on seedlings, litter, uncommon
Asteiidae			
Asteia tonnoiri	Small	Day	(NL) May breed on fungi, new Canterbury record, uncommon
Calliphoridae Blow flies			**Breed mainly in carrion, but adults use dung, flowers for food**
Calliphora vicina (A)	Medium	Day	(MT) GR, Hemlock flowers, uncommon
Lucilia sericata (A)	Medium	Day	(SW) GR TCE block-soft rush areas, hemlock flowers, fresh cattle dung, grazed area, common
Xenocalliphora hortona	Small	Day	(MT) Hemlock flowers, fresh cattle dung, grazed area, common
Chloropidae Frit, stem flies			**Includes pasture pests in Northern hemisphere**
Aphantotrigonum huttoni	Tiny	Day	(CO) Hemlock flowers, locally common
Gaurax new species	Tiny	Day	(CO) Hemlock flowers, uncommon
Hippelates insignificans	Small	Day	(SW) G Manuka area, associated with *Coprosma propinqua*,
Species 1	Tiny	Day	(MT) Manuka associate, uncommon
Species 2	Tiny	?Night	(MT) Black ball shaped spp, uncommon

Dolichopodidae Long legged flies			**Adults predators smaller soft bodied prey**
?Chrysotus vicinus	Small	Both	(NL SW) area
? *C.* sp	Tiny	Day	(MT) Raupo area, uncommon, small dark metallic green,
Parentia mobile	Small	Day	(MT) G Long grass, buttercup, manuka underlayer common
Tetrachaetus bipunctatus	Medium	Day	(MT) GR/M Wet sedge -drain mud, locally abundant
Sympycnus campbelli	Small	Day	(NL SW) ?T/S Manuka area, less common
S. distinctus	Small	Day	(MT NL SW WT) M Throughout, abundant
Species 1	Small	Day	(MT) Manuka area
Drosophilidae			**Tend to breed in rotting vegetation**
Scaptomyza graminum	Tiny	Day	Ungrazed rush-grass, probably litter feeder
Empididae Dance flies			**Mainly in damp areas, adults use smaller soft bodied prey**
Hilara fossalis group	Small	Day	(NT,WT) A, Slow running ditches,locally abundant
Hilarempsis species	Small	Day	(WT) Hemlock flowers,mainly in soft rush area,locally common
Chelipoda sp	Small	Day	(MT) Localised willow/manuka area,uncommon
Ephyridae			**Varied decomposers to herbivores**
Ephydrella aquaria	Small	Night	(MT) M,A most by diches & seepage, localised
Hydriellia tritici	Tiny	Day	(MT) GR, Dry grass common, uncommon elsewhere,leaf miner
Psilopa huttoni	Tiny	Day	(MT) GR, Soft rush-raupo areas, hemlock, common in grassland, perhaps it is a litter decomposer
Scatella nebeculosa	Tiny	Day	(MT) Raupo area, less common
S. nelsoni	Tiny	Day	(SW) A Seepage - ungrazed rushes,? feed on sludge, abundant
S. nitidifrons	Tiny	Day	(SW) A Ungrazed rushes,? feeds on litter abundant,
Helicomyzidae			**Perhaps feed among litter**
Allophylopsis ?lineata	Small	Day	Manuka area, perhaps a decomposer, uncommon
Helosciomyzidae			**May feed among litter**
Helosciomyza subalpina	Medium	Day	(MT) Jointed rush,manuka, less common
Lonchopteridae			**Probable litter feeder**
Lonchoptera dubia (A)	Small	Day	(MT) GR Grass, locally common, more at raupo -soft rush areas
Muscidae House,stable,testse flies			**Scavenging to blood sucking flies**
Limnohelina dorsovittata	Small	Day	(MT) M uncommon
L. smithii	Small	Day	(SW) M Raupo area,bare damp areas,common
L new species 1	Small	Day	(MT,SW) M locally common
L. new species 2	Small	Day	(MT) M uncommon
Paralimnophora new species	Small	Day	(MT) M uncommon
Spilogona aucklandica	Small	Day	(SW MT)M throughout, ungrazed rush,sedge, grass associate, common
S. dolosa	Medium	Day	(SW) M uncommon
S. new species 1 & 2	Small	Day	(MT SW) M common
S. new species 3	Small	Day	(MT) M uncommon
Stomoxys calcitrans(A) Stable fly	Medium	Day	(SW) GR Sunning along garage wall Site G.
Phoridae Hump backed flies			**Mainly feed on smaller carrion and rotting vegetation**
Aphiura breviceps	Small	Day	(MT) Raupo area, less common
Distochophora crassimana	Small	Day	(MT) Raupo - manuka area, uncommon
Megaselia halterata	Small	Day	(MT) Raupo area, uncommon
M. impariseta (A)	Small	Day	(MT, PT SW) G Throughout, hemlock flower, rushes, common
M. rufipes (A)	Tiny	Day	(MT) Raupo area, uncommon
Sapromyzidae			**Probably feeds among litter**
Poecilohetaerella bilineata	Small	Day	(MT) GR, Raupo area,uncommon
Poecilohetaerus punctatifacies	Small	Day	(NL) Uncommon
Sapromyza arenaria	Small	Day	(NL) Uncommon
Sarcophagidae Flesh flies			**Dung feeders**
Hybopygia varia (A) Striped dung fly	Medium	Day	(MT) D/GR, Fresh cattle dung, pastures,locally common
Sciomyzidae			**Predators of molluscs**
Neolimnia sigma	Medium	Day	(MT) Soft,jointed rush,prey aquatic snails, localised,uncommon
N new species	Medium	Day	Similar to above but less common
Sphaeroceridae			**Feed on decaying material**
Kimosima thomasi	Tiny	Day	(MT) G, Breeds in decaying material

Stratiomyidae Soldier flies			**Mainly feed on decomposing vegetation,adults pollinators**
Beris sp	Small	Day	(SW) Rotting vegetation associate, common through ungrazed
Neoexaireta spiniger (A) Garden soldier fly	Medium	Day	(MT) V, characteristic species that breeds in compost, uncommon
Odontomyia atrovirens	Medium	Day	(SW) Hemlock,manuka, yarrow flowers, less common
O. chloris	Small	Day	(SW) Hemlock,manuka flowers,uncommon
O. new species	Small	Day	(SW) Hemlock flowers,uncommon
Syrphidae Hover flies			**Aphid predators, decomposers or herbivores, adults pollinators**
Eristalis tenax (A) Drone fly	Medium	Day	GR, Grass associate breeds in rotting vegetation, uncommon
Eumerus strigatus (A) Onion bulb fly	Medium	Day	(MT) V, feed on bulbs, uncommon
Helophilus hochstetteri	Medium	Day	(OB) G, Hemlock flowers, uncommon
Melangyna zealandica Large hover fly	Medium	Day	(MT) Hemlock, small buttercup flowers, aphid predator
Melanostoma fasciatum Small hover fly	Small	Day	(MT) Common celery buttercup and Long I, uncommon elsewhere
Merodon equestris (A) Narcissus bulb fly	Medium	Day	(SW OB) V, Buttercup flowers, maggots from garden bulbs, locally common
Tachinidae			**Mainly caterpillar parasites**
Caligeria ? new species	Medium	Day	(MT) Ungrazed rush, sedge, grass associate (Black, short wings)
Heteria ?plebia	Small	Day	(MT) Manuka raupo areas, uncommon,
Hexamera alcis	Large	Day	(MT SW) Soft rush raupo areas, *Wiseana* parasite, uncommon
Huttonobesseria verecunda	Small	?Night	(MT) M Ungrazed grasses, common, host may be sedge shield bug
Pales ?nyctemeriana	Medium	Day	(MT SW) Ungrazed grass-rushes, cutworm parasite
Therevidae			**Larvae light soil predators, adults non predatory**
Anabarhynchus sp.	Large	Day	(OB SW) SD, Near landfill margin, locally uncommon
HEMIPTERA	**46 species (5.1%)**		**(907 NZ spp)**
	Suborder Homoptera		
Aphididae Aphids			**Herbivores that may transmit plant viruses**
Acyrthosipon kondoi (A)	Tiny	Day	(SW) Grasses, common
A. pisum (A)	Tiny	Day	(NL,SW) *Carex flacca*, grass, common
Cavariella aegopdii (A)	Tiny	Day	(SW) Soft rush area, hemlock, soft rush, grass
Hyadaphis foeniculi (A)	Tiny	Day	(SW) Hemlock, common
Macrosiphum euphorbiae (A)	Tiny	Day	(SW) Grass, less common
Myzus cerasi (A)	Tiny	Day	(MT) V, Manuka area, uncommon
Rhopalosiphum nymphaea (A)	Tiny	Day	(MT) Manuka area, less common
R. padi (A)	Tiny	Day	(MT, SW) Raupo area, grass,soft rush, mainly winged females
Sitobion near *fragariae* (A)	Tiny	Day	(MT) Raupo area, grasses, mainly winged females
Aphrophoridae Spittle bugs			**Mainly generalised shrub-herb feeders**
Philaenus spumarius (A) Meadow spittlebug	Medium	Day	(MT SW) G Polyphagous, thistles, blackberry, less common Also known from bracken, lotus, grasses
Cicadellidae Leafhoppers		**Often rather host specific herbivores**	
?Arahura sp	Small	Day	(MT) Manuka area, less common
Batraeomorphus ? adventitiosus	Small	Day	(MT) T, *Coprosma*/manuka associate,uncommon
Novothymbris castor	Small	Day	(SW) T *Coprosma propinqua*, uncommon
?N. zealandica	Small	Day	(MT) Manuka area, uncommon
Paradocyclium sp	Small	Day	(MT NL) Wiwi rush litter, jointed rush, uncommon
Ribautiana tenerrima (A)	Tiny	Day	(MT WT) Blackberry leaves, localized, less common
Zygina zealandica (A)	Tiny	Day	(MT) Grass, pasture herbs, common
Deltocephalinae sp 1	Small	Day	(MT) Raupo area, uncommon
Delphacidae			**Seem to be rather host specific herbivores**
Sulix ?meridionalis	Small	Day	(MT) Manuka -raupo areas, glaucous sedge probable host, locally common
Flatidae			**Generalised herbivore**
Siphanta acuta Lime green flatid	Small	Day	(SW) Associated with *Coprosma propinqua*,uncommon
Pseudococcidae Mealybugs			**Mainly above ground herbivores**
?Balanococcus poae	Tiny	Both	(S) Site G among ryegrass roots, common. Feeds on Poa, *Carex* sedges
Eriococcus orariensis (A) Blight scale	Tiny	Day	(CO) T Manuka area,locally common

Psyllidae			**Hosts often one or a few plants**
Species 1	Tiny	Day	(MT) Manuka area, uncommon
Acanthoscomatidae	**Suborder Heteroptera**		
Oncacontias vittatus	Large	Day	(MT) T Manuka area, uncommon
Rhopalimorpha obscura	Medium	Day	(MT SW) M *Carex secta* seeds, flowers; long grass, sedges,locally abundant
Corixiidae Water boatmen			
Sigara arguta	Medium	Day	(CO) A In slow streams, recorded in Sagar *et al.* (1996)
Cryptostemmatidae			
Undescribed species 1	Small	Day	(MT) Raupo area, less common
Lygaeidae			**Can be flower and seed feeders**
Brentiscerus putori	Small	Day	(CO) Soft rush, site C, feeds on introduced rushes, uncommon
Nysius huttoni Wheat bug	Small	Day	(CO MT) G Soft rush & Site F, locally common on drier pasture & under old dung
Rhypodes cognatus	Medium	Day	(MT SW) *Matricaria,* hemlock flowers, site F,less common
Metagerra obscura	Small	Day	(CO) Manuka area, willow litter, uncommon
Miridae			**Tend to be semihost specific herbivores**
Calocoris norvegicus (A)	Medium	Day	(SW) G Buttercup: Lotus, clover seed pods, flower buds
Chinamiris aurantiacus	Small	Day	(SW) M Raupo area, tussock sedge, less common
C. laticinctus	Small	Day	(MT SW) M/GR Soft, wiwi, jointed rush association, throughout, common
Deraeocoris maoricus	Small	Day	(MT SW) GR/M Raupo area, predator associated with sedges, locally common
Lincolnia lucernina	Medium	Day	(SW) GR/S Soft rush area, off dock seed heads, less common
Lygus species 1	Small	Day	(MT SW) M/T Manuka area, feeds on manuka flowers & perhaps sedge, locally common
Megaloceroroea recticornis (A)	Medium	Day	(SW) GR From Yorkshire fog, other grass hosts Soft rush
New species 1 (Stout green spp)	Small	Day	(SW) Soft rush area, Hemlock flowers-oval sedge (nymph), local, uncommon
Sejanus albisignatus	Small	Day	(CO) T/S Sites B,D,F Cabbage tree shoot, manuka and hemlock,
Sidnia kinbergi (A)	Small	Day	(MT SW) G Hemlock, buttercups dock: Lotus, clover seed pods, flower bud pest, locally common
Stenotus binotatus (A)	Small	Day	(SW) GR Yorkshire fog grass,locally common
Nabidae Damsel bug			**Aphid, small caterpillar, small mirid predators**
Nabis sp	Small	Day	(SW) GR Soft rush area, soft rush-oval sedge associate,uncommon
Notonectidae Backswimmer			
Anisops sp	Small	Day	(CO) A Recorded by Sagar *et al* (1996)
Saldidae			**Predator in damp seepage areas**
Saldula sp.	Small	Day	(MT CO) M Damp to bare wet spots (e.g. Long I.), locally common
Veliidae			
Microvelia macgregori	Small	Day	(CO WT) A Litter, rushes sites A,B. Water see Sagar *et al.* (1996).
HYMENOPTERA	**Wasps, bees, ants, sawflies**		**134 species (12.1%) (1106 NZ spp)**
Aphelinidae			**Parasitic wasps mainly of eggs**
Euxanththellus philippiae (A)	Tiny	Day	(MT) U Manuka-raupo area,yellow species, black eyes,uncommon
Apidae Social bees			**Major pollinators of introduced and some native plants**
Apis mellifera (A)	Medium	Day	(MT,uncommon), F, Buttercup,blackberry, thistle flower Honey bee, hives at Beach road
Bombus hortorum (A)	Large	Day	(MT OB) F Manuka area, buttercup flowers,uncommon
	Long tongued, garden bumble bee, flexible surface to aerial nest sites		
B. terrestris (A)	Large	Day	(MT OB) F throughout Buttercup,manuka blackberry flowers
	Short tongued bumble bee,commonest species, prefers dry underground nest sites		
Bethylidae			**Parasites mainly in NZ on caterpillars**
Gonozius ? new species (A)	Small	Day	(MT) G Manuka-raupo area,probable leafroller parasite,uncommon
Species 1	Tiny	?Day	(MT) U Smaller species
Braconidae			**Parasitic on many insect groups**
'Apanteles' sp 1-3	Tiny	Day	(MT NL WT) Raupo -rush areas mainly. Sundew prey. Hosts mainly caterpillar, abundant
'? *A*'. new species	Small	Day	(BT MT) Manuka area, common
Aphaereta aotea	Tiny	Day	(MT) Manuka area, uncommon (Dung fly parasite)
Aphidius ? *eadyi* (A)	Tiny	Day	(BT MT) Manuka,raupo & lotus site E, less common (aphid parasite)
A. ? *ervi*(A)	Tiny	Day	(MT) Raupo area, common
Ascogaster parrotti	Tiny	Day	(MT) Manuka area, uncommon (October- March, native bush)
A. strigosa	Tiny	Day	(BT MT) Manuka area, uncommon

? *Aspicolpus* species 1	Tiny	Day	(MT WT) Rush -raupo areas, less common
? *Aspicolpus* species 2 & 3	Tiny	Day	(MT) Raupo area, uncommon
Choreus helespas	Tiny	Day	(MT SW) Throughout, raupo -rush areas mainly, common
Dinocampus coccinella (A)	Tiny	Day	(MT) Raupo site C, uncommon (common introduced ladybird parasite)
Heliconinae species 1	Tiny	?Night	(NL)
?Helconinae species 2	Tiny	Day	(BT) Manuka site C on *Coprosma propinqua*, uncommon
Meteorus pulcricornis (A)	Small	?Night	(NL) Raupo,manuka areas, less common
Meteorus species	Tiny ?Night		(NL) December, uncommon
Micronotus zealandicus	Tiny	?Day	(NL) Rush grassland site A. *Irenimus aequalis* weevil host, uncommon
Non cyclostone species 1& 2	Tiny	Day	(MT) Mostly raupo also manuka area, common
Non cyclostone species 3	Tiny	Day	(MT) Manuka area, uncommon
?Opiinae species	Tiny	Day	(MT) Manuka area, acalypterate fly host, uncommon
Rogas species 1	Small	Day	(MT) Hosts cutworms
Rogas species 2	Tiny	Day	(MT) Raupo area, hosts cutworms
Trioxys species 1 & 2 (A)	Tiny	Day	(MT SW)Grass- low rush,hemlock flowers Area A,C Host aphids, uncommon
Chalcoidea			**Parasitic on insects,etc**
Species 1	Tiny	?Day	(MT) U Manuka area, mainly light brownish species,uncommon
Charipidae			**Aphid hyperparasites**
?*Alloxysta victrix* (A)	Tiny	?Day	(MT) GR Manuka area, hosts braconids wasps,uncommon
?*Phaenoglyphis villosa* (A)	Tiny	?Day	(MT) GR Host braconid wasps,uncommon
Colletidae **Native solitary bees**			
Hylaeus capitosus	Small	Day	(MT SW) G Manuka, buttercup, bog stitchwort flowers, uncommon
Diapriidae			**Mainly parasites of flies**
Belytinae species 1	Tiny	Day	(MT SW) Manuka-raupo areas, less common
Belytinae species 2	Tiny	Day	(NL) Manuka area, uncommon
Diphoropria sinuosa	Tiny	Day	(MT SW WT) Manuka -soft rush areas, on *Coprosma propinqua* less common
Entomacus new species	Tiny	Day	(MT) Raupo area, uncommon
Hemilexomyia ?*spinosa*	Small	Day	(MT SW) Raupo -soft rush areas, hemlock flowers uncommon
Paramesius new species	Tiny	Day	(MT) Raupo area, uncommon
Spilomicrus new species 1	Tiny	Day	(MT SW) GR Raupo and site E, among jointed rush, common
Spilomicrus new species 2	Tiny	Day	(MT) Manuka area, less common
Spilomicrus new species 3-5	Tiny	Day	(MT) Raupo area, uncommon
Spilomicrus new species 6	Tiny	Day	(MT) Manuka area, uncommon
Spilomicrus new species 7 & 8	Tiny	Day	(WT) Soft rush area uncommon
Trichopria new species 1	Tiny	Day	(WT) GR Soft rush among grass, common
Trichopria new species 2 & 3	Tiny	Day	(MT) Manuka area, uncommon
Trichopria new species 4	Tiny	Day	(WT) Soft rush area, common
Elasmidae			**In NZ apparently only caterpillar parasites**
Elasmus new species	Small	Day	(MT) GR, Soft rush area, moth leafminer parasite - yorkshire fog uncommon
Encyrtidae			
Odiagylptus biformis	Tiny	Day	(MT) ?Raupo area, parasite of grass mealy bug, locally abundant
Species 1	Tiny	Both	(NL) Wingless, less common
Eulophidae			**Mainly parasites of insects**
?Chrysocharis pubicornis	Tiny	Day	(SW) GR, Grass associate, bright green spp.
?Chrysocharis new species	Tiny	Day	(MT) GR Manuka area Grass associate, species patterned wings
?Pediobius bruchicida	Tiny	Day	(SW) S/GR, Grass, secondary parasite of leafroller caterpillers
P. epigonus (A)	Tiny	Day	(SW) GR, host leafmining flies
Species 1-5	Tiny	Day	(MT) U Manuka area,
Eupelmidae			**Parasitic wasps to herbovores**
Macroneura vesicularis (A)	Small	Day	(MT SW) GR, among grass, wingless,polyphagous pasture parasitoid
Eurytomidae			**Herbivores**
Tetramesa ?linearis	Small	Day	(SW) GR Soft ruch area, among grasses, stem herbivore, really localised but abundant there
?Tetramesa sp 2	Small	Day	(SW) ?GR Soft rush area, among grasses, herbivore
Figitidae			**Parasitic wasps of flies**
Anacharis zealandicus (A)	Small	Day	(MT) Mainly at raupo area, hoverfly hyperparasite, common

Formicidae Ants			**Omnivores-predators**
Monomorium antarcticus Southern ant	Small	Day	(MT,WT) G, Omnivore,localized,drier areas,willow woods and less commonly in the soft rush area.
Prolasius adversa Small brown bush ant	Tiny	Day	(CO) T, manuka area among willow leaf litter, predator
Halictidae			**Native ground nesting subsocial bees**
Lasioglossum sordidum	Small	Day	(MT) G Raupo, Compositae, Umbelliferae and other shallow flowers, uncommon
Ichneumonidae	**Parasitic wasps**		**of many insects orders (host unknown unless stated)**
Diplazon laetatorius (A)	Medium	Day	(MT) Raupo area parasite of syphid flies, less common
Ecthromorpha intractoria (A)	Large	Day	(MT) Manuka area, moth parasite uncommon
Ichneumon promissorius (A)	Medium	Day	(SW) GR Soft rush, Host grass inhabiting cutworms
Degithina apicalis	Large	Day	(MT) ?GR, Raupo area, less common
D. decepta	Large	Day	(MT SW) GR/M Soft rush-manuka, host *Wiseana*, locally common
Xanthocryptus novozealandicus (A)	Medium	Day	(MT) Site B, hosts medium-small longhorn beetles, uncommon
Species 1	Small	Day	(MT) Raupo area, locally common
Species 2 & 3	Small	Day	(MT) Raupo -manuka areas, less common
Species 4	Small	Day	(MT) Manuka-raupo areas, common
Species 5, 8 & 9,13, 16 -17,19	Small	Day	(MT) Raupo area, uncommon
Species 6	Small	Day	(MT NL) Raupo-manuka areas,less common
Species 7	Small	Day	(MT NL) Raupo -manuka areas, common
Species 10	Small	Day	(CO MT) Manuka -site E areas, hemlock flowers, uncommon
Species 11,26-29, 31 &32	Small	Day	(MT) Manuka area, uncommon
Species 12	Small	Day	(MT) Throughout, hemlock flowers, abundant
Species 14	Small	Day	(MT SW) Throughout, rush associate, locally less common
Species 15 & 18	Small	Day	(MT) Raupo area, less common
Species 20	Small	Day	(MT NL) Manuka area, less common
Species 21	Small	Day	(MT SW WT) Manuka -soft rush areas, locally common
Species 22,24 &25,30	Small	Day	(MT) Manuka area,less common
Species 23	Small	Day	(MT) Manuka -sites D,E jointed rush,hemlock flowers,locally abundant
Megaspilidae			**Includes aphid hyperparasites**
Dendrocerus sp 1 (A)	Tiny	Day	(MT) Manuka-raupo area, parasite of braconid aphid parasites, uncommon
Dendrocerus sp 2 (A)	Tiny	Day	(MT) Manuka area, parasite of braconid aphid parasites, uncommon
Mymaridae			**Mainly egg parasites**
Species 1	Tiny	Day	(MT) Host unknown
Platygasteridae			**Fly and moth parasites in NZ**
Zelostema oleariae	Tiny	Day	(MT) Manuka area, probably gall midge parasite, uncommon
Genus nr *Platygaster*	Tiny	Day	(MT) Manuka area, probable gall midge parasite, uncommon
Pompilidae Spider hunters			**Spider predators**
Epipompilus insularis	Medium	Day	(MT) manuka area,uncommon
Priocnemis nitiventrus group	Medium	Day	(OB) G Small black spp, sighted,soft rush area, uncommon
?Priocnemis	Small	Day	(CO WT) prey of sundew
Proctotrupidae			**Apparently mainly beetle parasites**
Oxyserphus new sp 1	Small	Day	(MT) ?T/S Hemlock flowers, beetle host, in E locally common
Oxy*serphus* new sp 2	Small	Day	(MT) ?G Rush and sedge associate, uncommon
Species 1	Tiny	Day	(MT SW) Pasture-raupo area, hemlock flowers, uncommon
Pteromalidae			**Parasites of many insect orders**
Species 1	Tiny	?Day	(MT) U Small,large head,yellow legs,antennae
Species 2	Tiny	?Day	(MT) U Raupo area, standard dark species, uncommon
Species 3	Small	?Day	(MT) U Larger, C shaped dark wing mark
Scelionidae			**Hosts include cricket eggs**
Beinini new species	Tiny	Day	(MT) U Manuka area, wingless, spider parasite, uncommn
Sphecidae			**Mainly ground nesting, insect-spider predators**
Pison spinolae (A) mason wasp	Medium	Day	(MT) Manuka area,uncommon
Podogritus ? cora	Small	Day	(SW) ?G Hemlock flowers, mainly fly predator
Rhopalum zelandum	Small	Day	(SW) T/S Manuka flowers, mainly fly predator
Spilomena eleganta	Tiny	Day	(SW) T/S Manuka flowers, thrip predator

Tenthredinidae **Sawflies, larvae rather sluglike rather host specific herbivores**
Pontania proxima (A) Small Day (MT-uncommon) T Red gall,abundant crack willow leaves
Willow gall sawfly
Trichogrammatidae
New species Tiny Day (MT) Raupo area, egg parasite possibly of moth, uncommon
Vespidae **Generalized invertebrate predators-omnivores**
Vespula vulgaris (A) Large Day (MT) G Manuka area,uncommon Common yellow jacket

LEPIDOPTERA Moths and butterflies 59 species (3. 3 %) (1765 NZ spp)
MACROLEPIDOPTERA 33 species Large bodied stronger flying moths
Crambidae Grass moths **Main species pasture-soil pests**
Eudonia dinodes Small Night (MT) Raupo area, mosses,turf, less common
E. leptalea Night (MT) GR Raupo area,less common
E. octophora Night (MT) M Raupo area, moss-rush wetlands, common
Mnesictena flavidalis Medium Day (SW) M Grass rush areas, herbs polyphagous, commonest soft rush area, common
Rusty dotted moth
Orocrambus apicellus Medium Night Night (MT NL) GR Raupo -manuka areas,common
O. flexuosellus Medium Night (MT,SW) GR Grasses, soil surface caterpillars,common
O. ramosellus Medium Night (MT NL) Raupo -site D areas,damp grassland, common
Scoparia diphtheralis Moss moth Medium Night (NL) Throughout Mosses, turf, common
Uresiphita polygonalis Medium Night (NL) Soft rush area, Clovers, kowhai,broom,lupin foliage uncommon
Clouded brown moth
Geometridae **Looper caterpillars herbivores**
Asaphodes aegrota Medium Night (NL) Soft rush-manuka areas, herbs, common
Chloroclystis inductata Night (MT) Raupo area,less common
Declana floccosa Large Night (NL) T/S Manuka area,manuka-polyphagous, uncommon
Common manuka moth
Epyaxa rosearia Medium Night (MT NT) GR/M Raupo area, herbs,dock, stream *Nasturtion*, common
Epiphryne verriculata Medium Night (CO) T Caterpillars often common among leaves at shoot
Cabbage tree moth
Homodotatis megaspilata Night (NL) Manuka area, leaf litter, uncommon
Hydriomena deltoidata Night (MT) GR Manuka area, Plantago,herbs, abundant
Dark banded carpet moth
H. rixata Medium Night (MT NL) GR Throughout most soft rush area Plantain, willoweed, herbs,less common
Brownbanded carpetmoth
[*Orthoclydon praefectata*] Large Night (OB) M Flax, from signs on leaves (White flax moth)
Xanthorhoe semifissata Medium Night (NL) GR Raupo area, herbs, uncommon
Zermizigina indocilsaria Night (NL) Legume herbs, matagouri, uncommon, female flightless
Hepialidae Porina moths **Very large non sugar feeding moths**
W. umbriculata Late flying porina Large Night (MT, NT) M/GR peat soft rush -site D, uncommon
Lycaenidae Blue and copper butterflies
Lycaena salustius Medium Day (OB) Southern area (Meurk 1995) Sheep sorrel, dock
Common copper butterfly
Noctuidae **Large caterpillar (cutworm) herbivores**
Agrotis ypsilon (A) Large Night (NL) G Throughout, polyphagous feeds on leaves and lower stems less common
Greasy cutworm
Chrysodeixis eriosoma (A) Large Night (SW) G Larvae on lupin, herbs, locally less common
Silver y moth
Graphania infensa Drab red moth Large Night (NL) GR/M Manuka area, herbs *Uncinina* sedge, uncommon
G. insignis Large Night (NL) G Manuka area, polyphagous,common
Green marked cutworm moth
G. mutans Large Night (MT, NL) G throughout, larvae on lupin flowers, pastoral herb foliage, common mostly in soft rush and willow/manuka interface
Greybrown cutworm moth
G. plena Common green cutworm Large Night (NL) G Manuka area, Herb,shrub foliage,locally abundant
G. ustistriga Large Night (NL) G Manuka area Herb,shrub foliage uncommon
Large grey cutworm moth
Rhapsa scotosialis Large Night (NL) T/S Manuka area Dead leaves, debris,common
Slender owlet moth
Rictonis comma Large Night (NL) Soft rush -to site D, less common
Tmetolophota atristiga Large Night (NL) GR Throughout, grasses, common only in willow/manuka area
T. semivittata Large Night (NL) GR/M Throughout Grasses, *Carex* sedge, common only in willow/manuka area
[*T. steropastis*] Large Night (OB) M Flax leaves,uncommon

Flax notcher moth

Pieridae	**White and sulfur butterflies**			**Crucifer herbivores**
Pieris rapae (A)	White butterfly	Large	Day	(MT,OB) V, Around marsh borders,may breed on water cress
MICROLEPIDOPTERA 24 species				
Batrachedridae				
Batrachedra tristicta		Small	Day	(SW) M Soft rush area, rush flowerheads to inland Canterbury, common overall to locally abundant
Coleophoridae	**Casebearer moths**			
Coleophora spissicornis (A) Banded clover casebearer		Small	Night	(MT) GR Site C,clover seed feeder,common only near pastures
Cosmopterigidae				
Limnoecia phragmitella (A)		Small	Night	(CO) M Reared raupo seed heads-stems, monophagous, very localized common
Depressariidae				
Agonopterix alstromeriana (A)		Medium	Day	(SW) GR Caterpillars common from hemlock
Elachistidae				**Leaf, stem, seed miners**
Cosmiotes ombrodoca		Small	Night	(MT) GR Raupo area, Poa grass stem miner, common
Elachista gerasmia		Small	Night	(MT NL) GR/M Rush stems, lowland-tussock grassland,common
Gelechiidae				**Web spun leaves, shoots**
Megacraspedus new sp			Night	(MT) M Raupo area, feeds in *Carex* flowerhead,uncommon
Glyphipterigidae				**Tiller miners**
Glyphipterix iocheaera		Small	Night	(MT) M Raupo area, rush stems, abundant
Oecophoridae				
Gymnobathra tholodella			Night	(MT) T Manuka area litter, uncommon
Phaeosaces apocrypta			Night	(MT) T/S Raupo area, arboreal on lichens, common
Scieropepla typhicola		Small	Night	(MT) M Raupo area, reared raupo seedhead,common
Stathmopoda horticola			Night	(MT) T/S Manuka area Dry fruit, seeds,dead plant tissue, common
Tingena siderodeta			Night	(MT) T/S Manuka area, litter,uncommon
Trachypelpa contritella			Night	(MT) T/S Raupo area, uncommon From litter,lichens
Tachystola acroxantha (A)			Night	(MT) VT Manuka area, uncommon Feeds on gum foliage
Pyralidae				
Diplopseustis perieresalis			Night	(MT) S/M Raupo area, locally common. Feeds on *Carex secta*
Psychidae				
Liothula omnivora Common bagworm moth		Large	Night	(OB) T/S Manuka tree, shrub foliage polyphagous,less common
Tineidae				
Opogona comptella			Night	(NL) Larvae on detritus, common
O. omoscopa (A)		Medium	Night	(MT NL) Raupo area,uncommon
Tinea mochlota			Night	(MT) Raupo area, litter,dead twigs, common
Tortricidae				**Common pest species generalised herbovires**
'Cnephasia' jactatana Hook marked bell moth			Night	(MT) Raupo area, polyphagous dying leaves, locally common
Epiphyas postvittana (A) Light apple brown moth		Medium	Night	(MT NL) Throughout, common. Polyphagous shrub to herb feeder,
'Eurythecta' eremana		Medium	Night	(MT NL) GR Raupo -soft rush area,abundant. Grass feeder
Planotortrix octo			Night	(NL) Common. Polyphagous shrub feeder

MANTODEA		**50 %**		**(2 NZ mantid species)**
Mantidae	**Praying mantid**			**General predator of flying insects**
Orthodera novaezelandiae		Large	Day	(OB) T/S Manuka area, Mikimiki, uncommon

NEUROPTERA		**16.7 %**		**(12 NZ species)**
Hemerobiidae	**Brown lacewings**			**Aphid, soft body insect predators**
Drepanacra binocula (A)		Small	Day	(MT) Manuka area only,uncommon
Micromus tasmaniae (A)		Small	Day	(MT) G Localized commonest among grass and buttercup

ODONATA	**Damsel and dragonflies 11.8 % (17 NZ spp) Nymphs aquatic, adults general predators**		
Coenagrionidae and	**Suborder Zygoptera**	**Damselflies**	
Xanthocnemis zealandica Common red damselfly	Large	Day	(OB) A Raupo area. Breeds in slow running water, predator, locally common
Lestidae			
Austrolestes colensonis Blue damselfly	Large	Day	(OB) A Raupo area. Breeds in slow running water, predator, less common
ORTHOPTERA	**Grasshoppers, wetas, crickets, katydids 5 species (4.8 %) (104 NZ spp)**		
Gryllidae Crickets			
Metioche maoricum	Medium	Day	(SW) GR Among marsh foxtail grass E of Long I, uncommon
Pteronemobius sp.	Medium	Day	(WT) GR Grass, uncommon
Rhaphidophoridae Cave wetas			
Isoplectron calcaratum	Large	Night	(SE) T/S Under mature willow bark, fungal remains in gut, uncommon
Pleioplectron pectinatum	Large	Night	(CO) T/S Under foam rubber pasture-willow area
Tettigoniidae Katydids			
Conocephalus bilineatus	Medium	Day	(MT NL SW) GR Manuka -soft rush areas, among long grass, common
PSOCOPTERA	**Booklice**		**(16.4 %) (61 NZ spp)**
Elipsocidae			
Pentacladus eucalypti (A)	Tiny	Day	(MT) Manuka area,uncommon
?Lachesilidae/Mesospocidae			
Species 1	Tiny	Day	(MT) Manuka area, uncommon Larger all lighter spp
Species 2 & 3	Tiny	Day	(MT) Raupo area,uncommon
Peripsocidae			
Interpsocus axillaris	Tiny	Day	(MT) Manuka,raupo commonest species
Peripsocus morulops (A)	Tiny	Day	(MT SW) Among shrubs,manuka area,uncommon
P. sp ?*Ectoposus*	Tiny	Day	(MT) Manuka -raupo areas, less common Spotted bare wings
Philotarsidae			
Aoroniella rawlingsi	Tiny	Day	(MT) Manuka area,uncommon
Zealandopsocus sp	Tiny	?night	(MT) Manuka area,uncommon
Pseudocaecilidae			
Heterocaecilius brunellus (A)	Tiny	?Night	(MT) Manuka area,uncommon
THYSANOPTERA	**Thrips**	**2.5 %**	**119 NZ species**
Thripidae			
[*Frankliniella occidentalis*] (A)	Tiny	Day	(SW) Lupin flowers, common
Thrips obscuratus Common flower thrip	Tiny	Day	(SW) Clover,broom, gorse, other flowers
Phloethripidae			
Species 1	Tiny	Night	(NL) Grey willow litter
CHILOPODA Centipedes	**2.7 %**	**(37 NZ species)**	
Lithobiidae			
Lithobius (A)	Long	Day	(S) Sites F and G, soil under grass and old cattle dung, common
DIPLOPODA Millipedes	**5.0%**	**(60 NZ species)**	
Julidae			
Cylindroiulus britanicus (A)	Long	Night	(S/L) Soft rush -manuka areas, common Prefers rotten logs, litter
Sphaerotrichopidae			
Icosidesmus falcatus	Medium	Night	(S) Damp topsoil soft ruch area, locally common
I. species	Medium	Night	(L) Manuka area, grey willow litter, ?less common
AMPHIPODA Landhoppers	**3.7 %**		**(27 NZ species)**
Talitridae			
Makawe hurleyi Common native landhopper	Medium	Day/night	Grass, rush litter, abundant

ISOPODA Slaters (4.2%) 48 NZ species

Oniscidae

Porcillio scaber (S) Under and among rotting wood, pasture Site G. locally common

Undetermined family

Species 1 (CO) Manuka area, litter

OPIOLONES Harvestmen (1.8 %) 170 NZ species

Phalangiidae

Phalangium opilio (A) Large Night (L/S) Raupo area

Triaenonychidae

Algidia multispinosa Large Night (CO) Willows, uncommon

Nuncia Large Night (CO) Willows, uncommon

ARACHNIDA Spiders 27 species (3.1%) (926# N.Z. species)

Anapidae

Novanapis spinipes Tiny Night (MT) Raupo area, uncommon

Araneidae Orb weaver spiders

Eriophora pustulosa (A) Medium Night (BT) G Raupo-manuka areas, less common, spider of open spaces, fly,bug to bee prey

unidentified species -juveniles (BT SW) Soft rush-manuka areas, locally abundant

Clubionidae Two clawed hunting spiders

Chiracanthium stratioticum (A) Small Night (BT) G Soft rush area, uncommon Grass to dunes & forest margins

Clubiona cambridgea Medium Night (MT) T/S Raupo area mainly in between dead raupo leaves, locally less common. Known from marshes in flax, cabbage trees, and grassland

C. clima Small Night (SW) GR Manuka area, uncommon. Beach, grasslands & marshes

C. convoluta Small Night (MT BT) GR/T Manuka -raupo area, locally abundant near manuka

Linyphiidae Sheet web spiders

Erigone wiltoni (A) Tiny Night (MT) GR Raupo area, less common. Grassland, moss to beach forest

Haplinis mundenia Small Night (MT) Raupo area, less common.

Laetesia trispathulata Tiny Night (BT) Soft rush area, uncommon

Laperousea blattifera Tiny Night (BT) Manuka area, less common

Lepthyphantes tenuis (A)Tiny Night (MT) GR Raupo-manuka area, uncommon. Often in pastures, also pine & bush

Microtenonyx subitaneus (A) Tiny Night (BT) GR Soft rush area, uncommon Grass to pine forest

Lycosidae Wolf or ground spiders

Allotrochosina schauinslandi Medium Night (PT WT) T/M Soft rush-raupo,willow areas, locally common
Brown wolf spider Forest to damp pasture species

Zeocosa hilaris Medium Day (PT WT) GR Soft rush-raupo areas, ungrazed grass-rushes, locally common

Orsolobidae

Subantarctia dugdalei Small ?Night (MT) T/S Raupo area, locally abundant. Bush foliage to moss

Oxyopidae Lynx spiders

Oxyopes gregarius Small Day (BT) GR Soft rush area, local, less common. Favours ungrazed sites

Pisauridae Nursery web spiders

Dolomedes minor Large Night (CO MT) G Throughout, open grass to shrubs, common mainly in manuka area

Salticidae Jumping spiders

Trite auricome Small Day (CO) Among meadow foxtail litter, uncommon

New species Small Day (BT MT) Manuka-raupo areas, uncommon

Stiphiidae

Cambridgea new species Medium Night (CO MT) T Manuka -cabbage tree area, less common

Tetragnathidae Four jawed spiders

Orsinome new species Small Night (BT) Manuka area, uncommon

Tetragnatha new species Medium Evening (MT BT) T/S Manuka area, less common, a long species

Theridiidae Cobweb or comb footed spiders

Achaearanea veruculata (A) Small Night (MT BT) Manuka- site E area, uncommon, likes settled sites, prey flies, ants, walking prey

Argyrodes new species Small Night (BT) ?T/S Manuka area, quite common among *Coprosma*

Steatoda capensis (A) Small Night (BT) Cabbage tree, uncommon, often in open areas to shrubland
False katipo Recent immigrant to S.I., feeds on landhoppers, and beetles

New species Small Night (BT) Soft rush area, uncommon

Thomisidae Crab spiders

Diaea new species 1 Small Day (MT BT) Manuka-rush areas, flowers, less common

Diaea new species 2	Small	Day	(BT) TS Manuka area, flowers, common
MOLLUSCA Snails (382 species/subspecies, 27 freshwater) slugs (NZ 33 species) 9 % slugs, 2.6 % snails 12 species			**GASTROPODA**
Athorocophoridae Native mantleless slugs			
Acathophorus bidentaculatus	Large	Night	(SE) M Among litter at base of raupo and flax, uncommon
Arionidae			
Arion hortensis (A) Garden slug	Large	Night	GR/M Commonest among litter and topsoil in grass,soft rush area
Flammulidae			
Salicohelix ignflua	Tiny	Night	(SE) T Among hard fern/grey willow litter, localised, less common
Helicidae			
Helix aspera (A) Brown garden snail	Large	Night	(SE OB PT) G Cabbage tree leaves, along west margin of marsh, locally abundant
Hydrobiidae			
Potamopyrgus antipodarum	Small	Day	(CO) A Ditches (Sagar *et al* 1996), fresh to brackish water.
Limacidae			
Deroceras panormitanum (A) Brown field slug	Large	Night	(SE) GR/M Base of *Juncus gregiflorus*
Phaenacohelicidae			
Cavellia bucinella	Small	Night	(SE) T/S Hard fern/grey willow litter, less common
Mitodon wairarapa	Small	Night	(SE) T/S Hard fern/grey willow litter, less common
?Punctidae			
Rohopapa new species	Small	Night	(SE) T/S Hard fern/grey willow litter, less common
Planorbidae			
Gyraulus corinna	Tiny	Day	(CO) A Ditches, moderate populations (Meurk 1995, Sagar *et al* 1996)
Physidae			
Physa acuta (A)		Day	(CO) A Ditches, moderate populations (Meurk 1995, Sagar *et al* 1996) agricultural to urban areas
Pisidiidae	**and**	**BIVALVIA**	
Pisidium endemic sp		Tiny	Day (CO) A Ditches (Sagar *et al.* 1996)
OLIGOCHAETA Earthworms 2.6 %			**(192 N Z species)**
Lumbricidae			
Apporectodea caliginosa	Long	both	GR Main species under grass in non peat soil, common
A. rosea Long	both	GR Minor species under grass in non peat soil, uncommon	
A. trapeyoides	Long	both	GR Minor species under grass in non peat soil, less common
Lumbricus rubellus	Long	both	GR Minor species under grass,major species in old cattle dung,locally common
Megascolecidae			
Maoridrilus sp.	Long	night	T/S S.W. pasture in peat soil (Meurk 1995)

References habits-Travis Marsh: Winterbourn 1973,Laing 1988, Hann 1994, Meurk 1995, Sagar *et al.* 1996

Appendix 2 Site, plant and method details for the survey

Code for the sites (Figure 1):
Site A Ungrazed rush/sedge climax Soft rush,introduced sedges,grasses dominant: plants include minimal native species
Site B Willow/swamp shrub interface: Grey willow/manuka/*Coprosma* dominant with glacous sedge and hard fern.
Site C Tall marsh plants: Tussock sedge, raupo with wiwi rush, flax and crack willow.
Site D Two sampling points in NW marsh.
Site E Five sampling sites in NE marsh
Site F Four sample sites on grazed pasture, willow woodland margin.
Site G Pasture dominant. Pasture soil, logs, and dung examined and garage wall.
Site H Stream/pasture margin. Willow logs, flax and raupo examined.

Sample date	Site code	Sampling conducted
November 29	C	Swept tussock sedge, mud ooze
	F	Observed galls on willow
	F	Collected off Californain thistle
	F	Collected off the few Hemlock flowers
	F	Checked buttercup flowers, blackberry foliage
	E	Swept near dead soft rushes
December 1	A	Swept insects from soft rush, lupin flowers, oval sedge,hemlock, glacous sedge
4	A	Swept stichwort, hemlock, twitch/yorkshire fog,broom flowers
	A	Installed water, pitfall traps by willow, near ditch and broom/ soft rush
	A	Soil invertebrates taken from pitfall trap spots
7	B	Swept manuka flowers,foliage, hard fern
	B	Installed water pitfall traps by manuka/hard fern
	A	Swept flowering creeping buttercup
10	D	Swept flowers, gather from live and dead leaves of cabbage tree
	B	Swept glaucous sedge, mikimiki, Gathered prey from sundews
13	B	Gathered invertebrates from glaucous sedge litter and its peat
16	C	Swept celery buttercup, tussock sedge, creeping bent-jioneted rush-biddibidi
	C	Collected from raupo seedhead,stem,dead tillers,bare wet spots, tussock sedge litter
	B	Swept glaucous sedge,manuka
	A	Swept dock seed heads upper leaves
20	C	Swept *Juncus gregiflorus* gathered spider from nursery web
	B	Gathered insects caught in sundew ,swept manuka,mikmiki
21	D	Ran light trap by tussock sedge near spiked sedge
	A-C	Ran light traps
27	A	Swept yorkshire fog and soft rush at sandier spot
31	E	Swept flowering lotus, jionted rush
31	C	Set up malaise trap in evening between raupo and tussock sedge.
January 3	F	Gathered insects off hemlock, fresh pukeko and under cow dung
8	C	Checked invertebrates among *Juncus gregifloris* litter
12	A	Gathered beetles from under board from dried water pool , shifted malaise
12	B	Shifted malaise trap to willow margin by manuka from raupo/tussock sedg site
February 11	C	Soil and jointed rush/marsh foxtail litter sample within 5 m of Raupo on Long I.
11	F	Soil and marsh foxtail litter sample 20 m to the east
11	F	Flower visitors taken off hemlock
12	B	Night collection among grey willow, hard fern litter
12	A-C	Light trap
14	B	Gathered snails from grey willow litter
17	C F	Gathered snails from flax and raupo bases
May 2	G	Gathered invertebrates from pasture soil, under logs, sticks and dung
Sept 17-23	B	Used impact traps, collected and extracted from litter
	H	Gathered invertebrates with impact traps, collected from willow logs, flax & raupo

Appendix 3 Selected invertebrate species: simplified keys, informal family characters and some reasons to consider species are undescribed.

PART A FLY DIPTERA FAMILIES

Calliphoridae

Stocky species. Abdomen metallic blue (*Xenocalliphora, Calliphora)* or metallic green (*Lucilia*). *C. vicina* is more active earlier in spring and has a lighter orangy brown cheek compared to an evenly dark cheek for the smaller *X. hortona*. Associated with dung, dead bodies and flowers.

Cecidomyiidae

The commonest two Cecidomyiidinae species are tentatively identified as the European *Contarinia* species (Evenhius 1989). It is assumed these *Contarinia* species are common among New Zealand grasslands in the same way two sciariid species are. Unidentified gall midges are a feature of the New Zealand grassland fauna (Cumber & Harrison 1959, Barratt & Patrick 1987). Certain recognition of subfamilies and some tribes is possible as some genera occur in both New Zealand and North America. However, adult New Zealand gall flies described more recently from *Coprosma* (Barnes & Lamb 1954) were not illustrated, and this species may not extend to the *Coprosma* species at Travis Marsh. The very limited illustrations of the 33 known species in New Zealand (Marshall 1896, Evenhuis 1989) make identification without properly verified specimens tenuous. A minority of the gall midges (at least five species), which may have fairly specific native hosts, are certainly not Cecidomyiidini.

Dolichopodidae

These smallish slender flies with rather long legs include the other common brightly and uniformly metallic green with nearly closed cell in centre of the wing *Parentia* (Bickel 1991) through to bodies with yellow and blackish patterns and clear wings with semitriangular ends to the antennae - *Sympychnus*. Two small spots on the vertical wing veins and a light green central stripe in the thorax distinguish --*Tetrachnus bipunctatus* (Parent 1933) from other species at the marsh. The other species are smaller and either dark metallic green (?*Chryosotus*) or larger and dark (undetermined species).

Empididae

These flies are mainly blackish or grey. The lack of illustrations and reliably named specimens in New Zealand make identification beyond species groups uncertain for the characteristic genera. Most *Hilara* males are readily recognized by the large flattened sword or blade like genitalia (Miller 1923). *Chelipoda* has lighter yellowish legs with a long coxa and swollen grasping tibia (McAlpine *et al.* 1981).

Helosciomyzidae/Sciomyzidae

These are medium sized reddish brown flies found more in damp areas and two have clearly spotted wings --see Harrison 1959, Barnes 1981). The undescribed *Neolimnia* species would key to *N. repo*, but it has stump veins and an extra closed cell off the CU vein towards the distal end of the wing, which is not present on the *N. repo* paratype at Lincoln University or any other *Neolimnia* species. There are some differences in the colouring of the wing too.

Keratoplatidae/Mycetophilidae

Tonnoir & Edwards (1927) and CSIRO (1991) include Keratoplatidae as a subfamily of Mycetophilidae. The main genus *Mycetophila* illustrated (McAlpine *et al* 1981,CSIRO 1991). The New Zealand study (Tonnoir & Edwards 1927) has reasonable photos of the often distinct darkened wing spots and variations in veination. However, the subfamily and generic key uses some rather obscure features and the species descriptions are often too brief for accurate identification. Comparison with faded 50 year old flies in Canterbury museum only partly resolved this difficulty. Readily seen features (Figure nos Tonnoir & Edwards 1927) of the main Mycetophidae-Keratoplatine genera from Travis Marsh are:

1. Slender antennae about as long as the body, pleura with dark near vertical band towards the front ----------- *Macrocera*
   Antennae no longer than about half the body length, any contrasting vertical band incomplete ------------------------- **2**

2(1) No bristles on tibia & spurs short; legs long, thin; abdomen slender (Patterson *et al.* 1987, CSIRO 1991 -*Orfelia*) cross veins form a central basal cell on the wing (Tonnoir & Edwards 1927, CSIRO 1991) -------- other Keratoplatidae
   Tibia 2-3 rows of bristles, tibial spur up to 1/3 as long as 1st tarsal segment, abdomen stouter (CSIRO 1991, Patterson *et al.* 1987), long narrow cell between CU and M veins --- Mycetophilidae **3**

3. Small partly circular cell near base of CU vein on inner hind part of wing, no fork on the front-central M^1 and M^2 veins (Fig 63, 64) -- *Cycloneura*
   CU vein usually forked but never forming a cell on the outer lower part -- **4**

4(3) Incomplete base to the M veins in the centre of the wing (Fig 85) -- *Aphelomera*
   Central M veins complete, forming a fork in the outer centre of the wing ---**5**

5(4) Broad base to M and CU forks, the CU fork (see hind inner wing part) begins well before the base of the M fork (Figs 66-70) --- *Anomalomyia*
   Any fork on CU starts close to the base of MU; the forks are long & narrow (Figs 96-119, CSIRO 1991) --------------- **6**

6(5) No fork on lower CU veins (Figs 87-95) --- *Zygomyia*
   Fork on Cu long and narrow and costa ends on tip of Rs on the outer wing end ----------------------------- *Mycetophila*

Muscidae
When the 200 or so species of New Zealand Muscidae have been revised most of the genera like *Spilogona* will no longer be shared with the Northern hemisphere. The status of ‘*Spilogona’* auct (= as currently used by authors) and other genera similarly affected are indicated by ‘quotation’ marks.
Paralimnophora new species - The yellow palpi distinguish this species from other muscids in the marsh
Limnophila smithii - has a brick red scutum with indefinate almost black stripes along the dorsocentral bristle rows
L. dorsovittata - has a pattern of color bands on the scutum
Spilogona dolosa Narrow frons 0.2 width of head, hind tibiae with paired setae, parafacials well haired (over 20).
S. aucklandicus Ventral surface of stem wing vein haired, long antennae, katepimeron haired.
Psychodidae
Only one of the species represented here has the markedly hairy wing markings throughout combined with a rather pointed wing of all species. Most of the *Psychoda* species could not be readily named, because the last five species rely on male genitalia features (Satchell 1954) and besides this over 40 species of females already awaited description by 1950 (Satchell 1950). It seems that 2-3 of the predominately yellowed bodied species are undescribed, and one listed in the five species *P cinerea* may be the introduced *P. cinerea*.
Sciariidae
Species that were included in the genus *Sciara* auct in the key of Edwards & Tonnoir (1927) are now allocated to several genera, which at this stage can not be precisely defined until slides have been made of the species and even then perhaps the genera verified by a competent authority on this family overseas. *‘Sciara A’* are either *Sciara* or perhaps *Phytosciara* species, while ‘*Sciara* B’ are in the genera *Bradysia, Scatopsciara* or *Lycoriella* based on the English and American keys to their genera. There are clearly either some new species or more accidentally introduced species that do not fit the key of (Edwards & Tonnoir 1927). These species are quite distinct, when antennal segment dimensions and shape as well as colour are added to the features used in the Northern hemisphere keys and that by Edwards & Tonnoir (1927).
Tachinidae
1(1) Bristles all along ridge of face below antennae, scutellum all brown in contrast to dark thorax -- *Pales?nyctemeriana*
No bristles on nearly all of the side of face (1 species excepted with no bristles on the face margin; scutellum & thorax similar colour -- 2
2(1) Small slender species, with front of the abdomen orange, few and weak bristles along the abdomen, female with crescent shaped genitalia (see Dugdale 1969) -- *Huttonobesseria verecunda*
Abdomen stouter less than twice as long as it is deep, bristles well over a 1/3 as wide as a mainly black abdomen ----- 3
3. Evenly black very bristly species, wings only very slightly longer than abdomen, hind out crossvein vein slants and ends towards middle of wing see (Dugdale 1969) -- *Caligeria nr varius*
Dark species that tend to have darker bands along the top of the thorax, wings at least 1/5 th longer than the abdomen, Hind outer crossvein well out towards the end of the wing see (Dugdale 1969) -- 4
4. Large species 10# mm long, with 4 contrasting bands on the abdomen, terminal segment of the antennae even in width throughout -- *Hexamera alcis* (see Miller 1984, plate 7, fig 1)
Smaller almost evenly dark species, last antennal segment considerably wider at its end - (Malloch 1930 - p
Heteria ?plebia
The species provisionally assigned to *Heteria ?plebia* could well be an undescribed species, because it does not have the spotting on the wings of this species and has hairs under the scutellum. *Calcigeria* near *varius* could be a new species, because it has four rather than the unusual one upright scutellar bristle that Malloch mentions in his description.

PART B BEETLE FAMILIES

Carabidae -ground beetles

1 Elytra short end by the hind end of the femur, 1-2 abdominal segments exposed; Body uniformly medium rather dull brown -- *Demetrida dieffenbachi*
Elytra long normally covers (when alive) all the abdomen: Body dark brown-black, shiny, often with bronze,blue or green metallic sheen; legs may be paler -- 2
2(1) Legs yellow especially the femur much paler than the body -- 3
Legs and abdomen almost evenly brown to near black --- 4
3(2) Body small 5 mm long, almost uniformly dark brown -- *Euthenaris* sp
Body medium 9-11 mm long: pronotum with distinct pale margins ------------------------------ *Notagonum submetallicum*
4(2) Obvious waist between the prothorax and wing base with the much reduced hind corners of the prothorax ---------- 5
No obvious body waist, hind (= posterolateral) pronotum corners square, or rounded and relatively broad and flat ---- 7
5(4) Pronotum roughly circular, hind corners much reduced appearing as small marginal points ---------------------- 6
Pronotum and body distinctly elongate, hind corners of pronotum rounded and margins parallel immediately in front ----- --- *Clivina vagans* (Fig Atkinson *et al* 1956)
6(5) Pronotum with many small pits along its hind edge, end segment of maxillary palp elongate; semislender species with almost circular prothorax, body 6 mm --- *Mecyclothorax rotundicollis*
Pronotum almost smooth with few pits; end segment of maxillary palp greatly reduced and pointed, subterminal segment with slighly expanded apex, body 4-5mm long ----------------------- *Bembidion* (cf *rotundicole*) (Lindroth 1976)
7(4) A single seta above each eye; faint red spot between the eyes, pronotum with many pits and fine setae over the hind surface, basal segment of antennae brown rest black, male with broader pads on legs 1 & 2 ---- *Anisodactylis binotatus*
A pair of setae above each eye; pronotum relatively smooth, no pits or fine setae, basal antennal segment seldom lighter or male without expanded tarsal pads -- 8
8(7) Large evenly broad body 18-25mm long often with greenish reflections on the upper body sides ------------------------- -- *Megadromus antarticus* (Figs Britton 1941, Scott 1984 p 296)
Medium (15mm) to small (lees than 7 mm) long bodies, black, blackish brown or with bluish body reflections --------- 9
9(8) Pronotum distincly rounded on hind corners;body black, smaller 7-8mm ------------------------- *Notogonum feredayi*
Face underside (mentum) with 2 deep pits (often filled with material), body black to brownish black --- *Zabronothus* sp
Mentum smooth, prothorax sides sharply angled, body with a blue sheen 12-15mm long ----- *Laemostenus complanatus*

A limited number of other species may occur in the swamp. *Triplosarus fulvescens* and *Hyphapax* species are both similar but smaller than *A binotatus* and should occur in the sandier margins, while *Agonum* species (similar to *Notogonum* spp) prefer wetter sites. Perhaps the large black *Metaglymma monilifer* which is simialr to the smaller *C. vagans* may also be present.

Coccinellidae --Ladybird beetles (convex rounded with 3 tarsal segments on each leg)

1 Red outer wings (elytra) with 2 or 11 black spots, black prothorax with yellow or red fringe ------------------------------ 2
Black body with 16 orange spots on the wings ------------------------------------- *Coccinella leonina* (Miller 1984,plate 5)
Uniformly black wings --- 3
2(1) Wings with 11 spots --- *Coccinella unidecimpunctata* (Miller 1984,plate 5)
Wings with 2 spots --- *Adalia bipunctata* (Miller 1984,plate 5)
3(1) Smallish species ------------------------- *Rhizobius forestieri* (No figure in New Zealand literature, rather smaller than *R. ventralis*. All but two of the other smaller black ladybird species known from Canterbury have a few fine spots on the wings too (Canterbury Museum, Lincoln University collections).
Tiny -- unidentified possibly undescribed species

Scirtidae (Helodidae)

1 Legs and underside of body evenly black, brown or yellow-brown --- 6
Legs yellow, ventral surface of body darker brown -- 2
2(1) Body up to 2mm long -- 4
Body 3-3.5mm long --- 3
3(2) Basal & last 2-4 antennal segments dark brown, other 8-10 segments yellow; elytra with 4-10 lighter yellow flecks --- Species 5
Only last 2-3 antennal segments darker, elytra near black --- Species 2
4(2) Elytra with dark spots and 2 irregular dark bands (fig 3); prothorax & elytra similarly light brown --------- Species 8
Elytra without darker bands, posterior 3/4 or all of prothorax lighter than elytra & head ----------------------------------- 5
5(4) Narrow dark band on front of prothorax (Fig 2) -- Species 6
Dark band and central cup projection on head only (Fig 1) -- Species 7
6(1) Uniform black species, 2.5-3mm long -- Species 3
Uniformly reddish, light or dark brown species; darker species 2mm long -- 7
7(6) Near uniform dark brown, 2mm long --- Species 9
Body 2.5-3.5mm long, reddish or light brown --- 8
8(7) Reddish body -- Species 4
Light brown body --- Species 1

PART C HYMENOPTERA

Braconidae

Apanteles species 1 Almost black thorax, mid chocolate brown abdomen, brown legs

Apanteles species 2 Yellow below base of abdomen, dark brown head & thorax, lighter brown abdomen

Apanteles species 3 Yellow legs

These species are not apparently *A. bicolor* (*circumscriptus*) because the ovipositor is too short for *A.* species 2, nor is the vein from the mid stigma darker like *Cotesia glomeraturus* and *C. kazak*.

? *Apanteles* new species 2nd submarginal cell smaller (not much longer than deep) than *C. hesperas*, the faint vein to complete a marginal cell raises doubt it is *Apanteles* (broad sense). Orangy legs. Apparently only *Choreus helespas* has a small second submarginal cell among described New Zealand Braconidae.

? *Aspicolpus* species 1 Evenly brown, smaller species

? *Aspicolpus* species 2 Near black, larger, front part of stigma near transparent

? *Aspicolpus* ?new species 3 Black head, thorax, evenly brown legs, dark brown near black abdomen. There are only 2 described species in New Zealand.

Heliconinae species 1 Head & body all black, legs yellow

?Heliconinae species 2 Dark brown body, ovipositor about 1/3 longer than abdomen, white mark covering the space (malar) between the eyes and top of the mandible, legs partly orangy and dark brown.

Non cyclostone species 1 Species 1 & 2 are slender and have a long narrow marginal cell and stigma and the 2nd submarginal cell is not quite complete. Blackish body and legs.

Non cyclostone species 2 Blackish body and orangy legs.

Non cyclostone species 3 Slender orangy brown body, with longish (about 1/2 body length) ovipositor, ovipositor sheaths tend to curl.

Rogas species 1 Almost evenly red-brown medium sized species, front of stigma near transparent

Rogas species 2 Front coxa near transparent against dark brown body, smaller, front of stigma near transparent

Ichneumonidae : Key for described species and host guide.

1. Abdomen tergites 2 & 3 with transverse grooves. Hind tibiae red at end, white, central white band flanked by black, (hover fly larvae) --- *Diplazon laetatorius* (Gauld 1984 p 349).

Abdomen tergites no grooves across them, hind tibia one or two colours, no white band ---------------------------------- 2

2(1) Antenna with wide white band. Abdomen black with white stripes. Thorax side black with 8 white patches. (longhorn beetle species) -- *Xanthocryptus novozealandicus* (Scott 1984 p 288, Miller 1984, plate 3)

Antennae no white band. Abdomen, thorax no distinct white and black bands or spots ------------------------------------ 3

3(2) Abdomen segment 2 red; 3rd onwards black with white bands, legs mainly red (hosts cutworms, Noctuidae) ------------------------------- *Ichneumon* (= *Pterocormus) promissorius* (Miller 1984, plate 3, Gauld 1984 p 183)

Abdomen only two colours -- 4

4(3) Abdomen broadly joined to thorax, black with white spots on the side (hosts medium and larger macro Lepidoptera excluding *Wiseana*) --------------------------------------- *Ecthromorpha intricatoria* (Miller 1984,plate 3,Scott 1984, p 294).

5(4) Abdomen no spots, waist thin similar to *Ichneumon* or *Xanthocyrptus*. Thorax black, often one or more yellow spots on the side, hind end with pattern of ridges on top and vertical hind part, hairs only hind part. Wing aerolet closed, 5 sided, 2nd discal cell with vestigial vein on the front vein --- *Degithina* 6

Abdomen, thorax reddish brown, if black hind end of thorax seldom with both ridges or hairs only the vertical hind part, no closed 5 sided aerolet and 2nd discal cell with vestigial vein on the front edge ---------------------------------- 8

6(5) Thorax side yellow band at top. Abdomen 1st to at least 3rd segments reddish brown ----------------------------------- 7

Side of thorax (pleura) no yellow spots or any bands, and propodeum too. Abdomen only part of 1st and all of 2nd segment red-brown (hosts *Wiseana*) -- *D. decepta*

7(6) Legs black base, reddish from femur, 3 yellow spots on front, middle and hind side of thorax ------------*D. buchanani*

Legs front, midle yellow spot on the underside of trochanter, 3rd leg black base and reddish. Thorax side, 2 yellow spots on middle and hind side --- *D. apicalis*

8(5) Body mainly black or near evenly brownish, smaller species -- species 1-11

Body mainly with red to red-brown, short stings, smaller species -- species 12 & 13

Abdomen red, larger species, with stings more than half the length of the abdomen ------------------------- species 13-19

Body distinctly brown, thorax with yellow pattern --- species 20-27

Thorax black, contrasting often only or mostly reddish abdomen --- species 28-32

Most of the unnamed species are undescribed, because they do not belong to Pimplinae, Ophioninae, Tryphononinae or the introduced Ichneumonidae species. Unnamed species: short colour guide and some distinguishing features. Venation terms (Goulet & Huber 1993)

Species No **A. Mainly black to brown species, -smaller**

1. Minor brown band on thorax, narrow yellow abdominal stripes
2. Mainly brown thorax, light brown abdomens with near clear dorsal spots on segments 1-3.
3. Minor brown band on thorax, almost evenly dark brown abdomen
4. Square ended abdomen, yellow under 1st half of abdomen
5. Larger dark male, with slender hind tibiae, yellow stripes under front of slender abdomen
6. Open aerolet cell, 2M Cu vein with one clear spot
7. Open aerolet cell, 2 small clear areas on vein 2M Cu
8. 4 sided aerolet, larger mainly black spp with short sting
9. 4 sided aerolet, larger mainly black spp with longer sting
10. Smallish species, brown on thorax, dark bands on the wing
11. Larger black species, rounded enlarged tibia

B. Smaller species, mainly red to red brown abdomen, short stings

12. All black thorax, red with black and yellow banding on abdomen, Hypopygium (ovipositor guides) mainly black but contrasting yellowish ventral mark. Male seems to have all black head with yellow mandibles and palps
13. Only first segment with much black and yellow under first 3 segments, ovipositor guide evenly brown

C. Larger species with red abdomens and longer stings

14.. Front of abdomen red, last 3 segments virtually all black, <u>Male</u> narrow yellow strip behind eye, and narrow yellow strip up the face
15. As in 14, abdomen red throughout
16.. Broad yellow stripe behind the head, face below antennae entirely yellow
17. Black thorax with rear 1/3 reddish, forepart of stigma white hind part black smaller species
18. Front and mid coxa yellow, basal two antennal segments with some yellow
19. All coxa reddish brown, antennae uniformly black

C Brown and yellow thorax pattern

20. Very pale stigma, open aerolet, brown antennae
21. Ovipositor sheath and sting often together, rhomboid aerolet, pale brown stigma
22. Black thorax, all red legs and thorax almost as long as sting, smaller species, light narrow stigma, small aerolet
23. Slender smaller mainly light reddish brown species, sting medium length, no aerolet
24. Prominent yellow stripe on lower pleura, thinner one on notal border, abdomen often all red and legs too.
25. Solid lower block of yellow on pleura, abdomen red except for last three black segments hind femur and fore femur red
26. Antennae crenulate, rather like species 24, but last abdominal segments, black, fore and mid femur yellow
27. Brown, yellow band and central black area on the prothorax, face all yellow and much of the pleura too.

A Mainly black thorax

28. Fairly evenly reddish-brown abdomen, sting medium length, rather like species 2
29. Short sting, rounded abdominal end, colour much as species 4
30. Long sting, black abdomen, yellow under abdomen, dark stigma.
31. Reddish and black banded abdomen, with small eye marks, fore and mid coxa yellow
32. Light brown stigma, abdomen and legs reddish.

Colletidae

Hylaeus are relatively hairless bees, which carry the pollen internally, so they can be confused with Sphecidae.

H. capitosus females with small near round light yellow spot near antenna. Males lower face with more yellow

Eulophidae

Species 1 Large yellow legs and under abdomen otherwise dark body Species 2 small, short petiolate abdomen Species 3 antennae terminally larger Species 4 standard dark spp, yellow legs Species 5 slender spp, near white legs, banded wing

PART D OTHER INSECT ORDERS

PSOCOPTERA

Three of the species of booklice seem to be from a family previously unrecorded from New Zealand.

HEMIPTERA

Acanthosomatidae

These species have 2 tarsal segments rather than 3 as in shield bugs (Pentatomatidae), which they resemble. The tree inhabiting *Oncacontias vittatus* is broad like a shield bug, but it has a flange on the front underside and a forward pointed spine unlike the narrower *R. obscura* from tussock sedge, which has no such special structures under it.

Miridae

The *Lygus* species from manuka is probably a described species. The small green mirid with dark bands on the prothorax is an undescribed species (Eyles pers. comm.).