MCLEANS ISLAND
Invertebrate inventory and analysis

Brown banded or garden wolf spider
'Lycosa' hilaris

Major native grassland predator

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COVER PHOTOS

By A. R.G. McLachlan

TURRET WOLF SPIDER

'Pardosa' bellicosa mating

Male above with palps wrapped under female

Special indicator species for McLeans Island

Only N.Z. wolf spider that shelter in hole retreat

MCLEANS ISLAND: invertebrate inventory and analysis

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SUMMARY

- Biodiversity of endemic invertebrate species from this short grassland interspersed with moss and a few trees was moderate at 5.1-5.9 endemic species per native vascular plant species. In all 229 terrestrial insect species (72-84 % endemic) recorded from McLeans Island with 169 species from the short grassland/cushion plant areas with (71-80 %) endemic species. The adjacent pine windbelt was the main reserviour for 42 species and there were at least 16 aquatic species. Gorse, broom and willow supported three more specialist introduced insect species. None of the species were definite vagrants. A further 26 species of the other larger invertebrates (spiders, harvestmen, millipedes, slaters) were found among the grassland.
- From three independent extrapolations there are probably 208-321 resident insect species in McLeans Island grassland. Provisionally four species could well be at least regionally rare, but this may be increased when the moths and moss inhabiting insects have been properly surveyed.
- The most localized known species are characteristic and virtually indicator invertebrate species for mat daisy danthonia grassland on stony to silty ex river bed. This includes day active moths including an undescribed *Kiwaia* moth, *K. thyraula,* the looper moth *Arteshces catapyrrha*, the Canterbury leafroller *Eurythecta robusta* associated with the *Raoulia* cushion field, the litter feeding *Leptocroca lindsayi*, and the kowhai feeding looper caterpillars *Chalastra ochrea*. A further localised moth was the leafroller *Epichorista siriana* Two species of hole inhabiting predators are indicators of silty sites namely the turret spider *'Pardosa' bellicosa* (a wolf spider) and the smallest tiger beetle *Neocicindela dunedinensis.* The turret spider is only known from three South Island sites. However, this spider's abundance in the silty areas at McLeans Island and female use of a retreat suggest it could well occur in similar habitats at least in Otago and Canterbury. A further hole inhabiting and characteristic Canterbury grassland species is an undescribed ground weta *Hemiandrus*. This ground weta has a known limited distribution (Banks Peninsula-Christchurch) and occupies ground galleries made in different soils and it feeds on at least forb foliage. These 30 mm long nocturnal wetas are not readily seen unless either soil in grasslands is dug up or water traps are used to catch them. It is not known if the ground wetas, tiger beetles and chevron wolf spiders all make holes in the ground for shelter independantly. Other characterisitc insects of Canterbury lowland grasslands that were abundant here were the small black field crickets *Pteronemobius* and sod webworm moths *Orocrambus* species.
- At least 1.2 % of the insect species were flightless in both sexes. The largest wingless species was the ground weta *Hemiandrus*, which is a new species. Two moth species have flightless females (the Canterbury tortricid *Eurythecta robusta,* the common bag worm moth *Liothula omnivora*).
- An estimated 4-9 insect (1.8 - 4%) and 2-3 spider (9-13.6 %) species were undescribed. Certain undescribed insect species include two moth species, the ground weta, the soundless cricket and perhaps 2-5 parasitic wasp species. McLeans Island is a favourable 'type locality' for new species descriptions, provided site uniqueness is retained in its present condition so any more specimens can readily be recollected and the natural history studied in situ. The open kowhai-grassland is well suited to scientific research, because there few other large and safe sites readily accessible to Christchurch with its range of researchers and schools.

- The most acute threats of localized extinction of invertebrate species apply to those that feed on the rarer native plants. Less obvious threats include some of the characteristic less common plant species threatened with long term localized extinction e.g. kowhai, native broom species *Carmichaelia* and perhaps the mat plants *Raoulia* and *Scleranthus*. The food plants for the undescribed gelechiid caterpillars remain undiscovered. For the McLeans Island grassland there was a ratio of 7.2 herbivore/detrivore/omnivore species to 1.5 parasite species to 1 predator species. *Muehlenbeckia*,the mat plants *Raoulia* and *Scleranthus*, matagouri and kowhai support at least 27 species of herbivore-woodborer insects that rely on them. Most (20) of these specialist species are beetles and moths. Any parasitoids from hosts of the more localised moths from cushion plants, kowhai, matagouri and lichen on their trunks could be vulnerable to species loss even although their natural enemies are largely unknown.
- Supplimentary planting and at least an area for conservation and then reinforcement of *Olearia odorata* is recommended for inclusion in the parkland landscape plan. This may require fencing to exclude rabbits or at least active better control of rabbits. The long term survival of several characteristic plants of this grassland could be threatened. These plant species are native broom *Carmichaelia australis*, kowhai and the common mat daisy *Raoulia australis*. Hence there could be merit in periodic plant surveys especially after prolonged droughty summers and autumns. Seed and flower feeding weevils and bees from the two native broom species is vulnerable to localized extinction with loss flowering in plants consistently grazed below about 0.5m. Only one of the five *C. australis* patches of plants in the southern field flowered and set seed pods. The short *C. corragata* did not flower or have seed pods in two seasons in any of the areas. The sole *Olearia odorata* plant seems to have lost all its specialist invertebrate fauna and was susceptible to a lack of viable pollination, probably due to the need for cross pollination with another plant. During drier seasons (!998/1999) its low height (less than 0.25m) made it susceptible to rabbit browsing that prevented flowering. Elsewhere in the South island these shrubs support a relatively rich insect fauna. Eight other sparse species of native perennial herbs and the fern in the grassland seemed to have no specialist herbivores. Five other native plant species within the McLeans Island area could well have lost some to all their specialist herbivores due to their existence in small and scattered patches based on this survey and one of Travis wetland. Augmentation of the rarer charateristic plant species and a study of any invertebrates on these species is desirable.
- The water race and Orana park water pools supported a moderately diverse aquatic insect fauna dominated by caddisflies. This diversity is reasonably typical for rural running waterways in the lowland Canterbury plains.
- As a research and education resource McLeans island has a more beginner friendly size of invertebrate community than Travis wetland or native broadleaf forest remnants in Christchurch. This is mainly due to a reduction in species diversity in fungus gnats, book lice, marsh beetles and bugs, but sampling as and ofter after grassland growth ceased may have disadvantaged measurement of bug diversity. Conversely drier soil at McLeans ilsnad clearly favoured most Othoptera compared to Travis wetland. The simpler community should allow graduate students to investigate the commoner species with fewer taxonomic hassles. Many species could be studied to clarify food preference and sources and natural enemy relationships. The area could well suit studies on inter-patch movements and dispersal too. Studies should be encouraged to extend this initial survey to promote a broader understanding of the full invertebrate community for a comprehensive summation of the likely natural history of Christchurch and perhaps ecotourism.
- The perennial moss, dicotyledons and lichens of the McLeans island area reduce the sources of most grassland pest species except for sodweb caterpillers *Orocrambus* species, wheat bugs *Nysius huttoni*, Tasmanian grassgub *Aphodius tasmaniae* and small black cricket populations *Pteronemobius*. These populations are most accessible for study for students or amateur entomologists with a more applied interest in entomology. The pines have populations of the generalised forest pest the black waved brown moth *Pseudocoremia sauvis* and the horticultural leaf roller pests *Ctenopseustis obliquana* and *Planotortrix notopaea*.
- The survey provides a useful basic list of species. Such a list facilitates a rapid detection of new accidental arrivals when exotic Lepidoptera and fruit fly pests are monitored within the vicinity of Christchurch city international airport. The newest arrival is apparently the Australian ground beetle *Notobia* species.

- Major long term threats to the invertebrate fauna are from inappropriately sited pine shelter belts, rabbit browsing and the incursion of the scrub weeds broom and gorse. Further pines planted to the north could well jeopardize invertebrate species associated with some of the 16 less common and rare native plant species there. It is recommended that the meager broom plant population in the study area is eradicated and gorse control is targeted to in and around the matfield. It is desirable to at least contain the spread of gorse elsewhere, monitor the grassland for *Olearia odorata*, kowhai, mat daisy and tall native broom survival and regeneration and the possible establishment of *Hieraceum*. Rabbit grazing threatens shrub regeneration unlike irregular light sheep grazing.
- Sheep apparently pose little direct threat from trampling to a quite restricted range of moth species (perhaps copper butterflies and other herbfield caterpillars), that are active in summer and early autumn. Later autumn and spring grazing, when there are fewer and larger caterpillars may be safer for grazing. It is uncertain whether grazing and no fertilizer has an insidious indirect effect. Fertilizer may aid the spread of browntop *Agrostis capillaris* and so reduce the cover of the native herbs and so reduce moth diversity. The risk of loss of moth species must be balanced with the need to graze to lower the fire hazard.

INTRODUCTION

The site

McLeans Island is on the south bank of the Waimakariri 3 km west of Christchurch airport at the coordinates 43^0 28.5', 172^0 26-27' (altitude 55-60 m). The Christchurch regional council owns the three fields studied. The area of about 180 ha is leased for recreation (gunclub shooting) or for periodic grazing. The study area is at the north end of Chatterton road (Fig. 1) on undulating outwash plain with mainly gravely Lismore soils.

Introduced grasses, herbs and shrub weeds dominated (about 60 % plant cover) the study site. The exotic sweet vernal and Australian needle grass and herbs (mainly haresfoot trefoil, catsear, tall bidibid and stonecrop) were spread throughout much of the area. Marram grass, vipers bugloss, gorse patches and broom plants were much more localized among the grassland. Ridges in places were dominated by stone crop with some *Oxalis*, where sheep camped. Pines *Pinus radiata* provided the main wind breaks. Within 50 m to the north there were poplars along most of the flood bank. Along the road and at Orana park (150-200 m away) there was cootamundra *Racosperma baileyiana* and at least two other ornamental wattle species west of Orana park. A few crack willows *Salix fragilis* grew along the water race in the south part of the study site. A mixed shelter belt with a western row of green wattle *R. decurrens* and pines was 1.1 km away to the south along Chattertons road.

The 23 vascular native plant species in the study area (Table 1) provided about 40% of the plant cover. The native vegetation had four elements:- **1.** sparse kowhai woodland with danthonia/*Muehlenbeckia*, **2.** matagouri/marram/native *Zoysia* turf grass, **3.** common mat daisy *Raoulia* cushion and herbfields **4.** red moss *Polytrichum juniperinum* or wooly moss *Racomitrium lanuginosum* dominated sites interspersed with danthonia/sweet vernal, catsear and *Muehlenbeckia*. The open moss with scattered grass and herbs were on flat (Fig 2) and silty sites with a low incidence of the 9 other low perennials. On the coarsest gravel or on riverbed ridges there were several patches (up to 20 m in diameter) of the common mat daisy *Raoulia australis* (Figs 4, 5) cushion fields interspersed with the lax mat daisy *R. monroi* and other native herb species. At eight small dune sites marram grass dominated this longer grassland sometimes with *Zoysia minima* in the lower fringes. The main marram grass patch was 20 m north of the pine shelter belt (Fig. 3). Within 10 and 50 m of this site were a pair of mature kowhai and matagouri bushes 3-5 m high (Fig. 3). Kowhai grew on deeper sand/silt, but there was a lack of regenerating plants under any of the 33 kowhai trees despite satisfactory seed production. This was probably due to rabbit browsing. Introduced grasses often dominated under the kowhai, where sheep had camped for shade and deposited dung that left a green ring under them (Fig. 9). Two thirds of the kowhai trees were in the smaller field west of Chatterton road. There were five more shrub patches with 0.2-1 m high matagouri and one also with *Olearia odorata* (up to 0.25m, Fig. 6). The only native broom *Carmichaelia australis* (up to 0.65m) was in five patches of 2 to 8 plants along ridges towards the north end of paddock Chatterton 1B. Only the tallest (flowering 0.45 to 0.65m high) eastern patch (Fig. 7) formed seeds. The other patches with plants up to 0.25m high had no flowers or seed on them. The short native broom *C. corrugata* had no seed pods.

Table 1 Plant species and their abundance in naturalized fields of western McLeans Island

Plant species # = eastern S.I. only		**Flowering months**	**Abundance 4 = common to 1 = uncommon**	
Mosses				
Polytrichum juniperinum	Red moss		4	Often on silty flats
Racomitrium lanuginosum	Wooly moss		3	Mainly on stony flats
Hypnum cupressiforme	Moss		2	Mainly on banks
Brentelia affinis	Moss		1	
Rhizocarpon geographicum	Moss		1	
Triquetrella papillata	Moss		1	Patchy on flats
Targionia species	Moss		1	
Cladonia spp	Lichen		2	
Cladia aggregata	Lichen		2	
Trees and shrubs (numbers) = number of trees or shrubs in study area				
Sophora microphylla (33)	Kowhai	spring	2	Leguminosae
#*S. prostrata* (s of site 3, Fig 1)	Prostate kowhai	?spring	1	Leguminosae
Discaria taumotou (10)	Matagouri	10-1	1	Rhamnaceae
#*Carmichaelia australis* (27)	Native broom	11-12	1	eguminosae
#*Olearia odorata* (1)	Shrub (0.25m high)	no record	1	Compositae
**Ulex europeaus*	Gorse	3-11	2	Leguminosae
**Cytisus scoparius*	Broom	9-11	1	Leguminosae
**Salix fragilis*	Crack willow	9-10	1	Salicaceae
Grasses				
Rytidosperma racemosum	"Danthonia"		4	Graminae
Zoysia minima	Turf grass		2	Graminae
**Anthoroxarum odorata*	Sweet vernal		4	Graminae
* *Stipa nodosa*	Australian needle grass		3	Graminae
* *Agrostis* spp, *Vulpia*, etc	Browntop, other grasses		2	Graminae
**Ammophila arenaria*	Marram grass		2	Graminae
Perennial herbs and creepers ** = Fruit a berry rather than seed				
Muehlenbeckia axillaris	Creeping pohuhue	11-3	3	Polygonaceae
Cyathodes fraseri **	Patotara	9-1	2	Epacridaceae
Raoulia australis	Common mat daisy	12-1	2	Compositae
#*R. monroi*	Lax mat daisy	?late spring	2	Compositae
Leptinella perpusilla	"Cotula"	? late spring	2	Compositae
#*Carmichaelia corrugata*	Native broom	? late spring	1	Leguminosae
#*Colobanthus brevisepatus*	Grass plant	10-11	1	Carophyllaceae
Scleranthus uniflorus	Mossy mat plant	11-1	1	Caryophyllaceae
Convolvulus verecundus	Small bindweed	10-3	1	Convolvulaceae
Dichondra repens	Mercury bay weed	9-2	1	Convolvulaceae
Crassula sieberiana		9-1	1	Crassulaceae
Carex breviculmis,comans,resectans	Sedges	Mainly ? 11 onwards	1	Cyperaceae
Geranium sessiflorum	Bronze cranes bill	11-4	1	Geraniaceae
Microtis unifolia	Onion orchid	2-3	1	Orchidaceae
**Hypochaeris radicata*	Catsear	11-3	4	Compositae
* *Acaena agnipila*	Tall bidibid	10-2	3	Rosaceae
* *Trifolium arvense*	Haresfoot trefoil	8-5	3	Leguminosae
* *Sedum acre*	Stone crop	11-3	2	Crassulaceae
**Rumex acetosella*	Sheeps sorrel	12-1	2	Polygonaceae
**Oxalis exilis*	Oxalis	?11-3	2	Oxalidaceae
**Erodium cicutarium*	Stalks bill	9-5	1	Geraniaceae
**Senecio*	Fireweed		1	Compositae
**Gypsophila australis*	Clammy gypsophylla	11-3	1	Carophyllaceae
* *Trifolium repens*	White clover	10-1	1	Leguminosae
Fern *Cheilanthes humilis*			1	

(* = main introduced herbacous species in grassland, also pine, poplar shelter belts, & wattle)

Most of the low growing perennials flower mainly in late spring to early summer (Allan 1961, Salmon 1968, Webb *et al.* 1988) and they have small open flowers that short tongued native bees, flies and even that flower visiting beetles can pollinate.

The native plants and site had high representative, unusualness and naturalness rankings, and the study site is the largest and most diverse for native "savannah woodland" (Kelly 1972, Norton & Molloy 1992, Meurk & McCombs 1994) on the Canterbury plains. The check of native plants to support the survey revealed *Carex comans* at site 3 under the kowhai and small bindweed *Convolvulus verecundus,* which had not apparently been recorded from the gun club field before (Meurk & McCombs 1994). To the SE and east there are three areas (off Miners and school road and the Shipleys area) of ecological heritage sites within 3 km of the study site, which together have 220-240 ha of grassland with less kowhai and no *Raoulia australis.* This grassland had more of the regionally rare native creeping kowhai *Sophora prostrata* (one plant in paddock Chatterton 1B), as well as *O. odorata* and five further native perennial plant species not in the study area. The extra plant species there were silver tussock *Poa cita,* porcupine plant *Melicytus alpinus,* the creeper *Muelenbeckia ephedroides,* a prostrate coprosma *C.oprosma petriei* and the wiry herb *Gonocarpus* (= *Haloragis depressa*) *aggregatus* (Meurk & McCombs 1994).

On the Canterbury plains, Kaitorete spit (east of Lake Ellesmere) has similarly light soils to McLeans Island and similar key native plants (Table 2). This is especially valid for the short native cushion plant and herbs. However, Kaitorete spit has much less kowhai (one tree) and no *Olearia odorata,* but it does have matagouri, *Carmichaelia, Olearia, Cyathodes, Meuhlenbeckia, Leptinella, Raoulia, Scleranthus* (Pearce 1984, Partridge 1985). Only one Canterbury public reserve (View Hill) had kowhai, matagouri and *Olearia* species with short grassland (Table 2). Key plants in common to both sites are *Raoulia* species, *Leucopogon fraseri* and *Muehlenbeckia axillaris.* Only Eyrewell Reserve, 25 km north west of McLeans Island has appreciable moss areas among short grassland. Bankside and a small open shrubland to herbfield above the Maori lakes had the most similar vegetation (Table 2) apart from Kaitorete spit. No sites had the short native broom *Carmichaelia corrugata* (Table 2) but only Maori lakes (623 m altitude) near L. Heron shared *Olearia odorata.* On the Canterbury plains, only Kaitorete spit and Bankside share *Raoulia australis,* while only four public Canterbury reserves had *M. axillaris, Leptinella perpusilla* and *Scleranthus uniflorus* together (Table 2, Patrick 1994a).

Table 2 Comparison of key plant species in Canterbury shrub/short grassland/herbfields

Reserve & region		Hectare area	Short Grass	Area of Herb or moss*	Tree- shrubs				Grassland			cushionfield	
Kaitorete spit	**CP**	171	-	-	+	+	+	0	+	+	+	+	+
Bankside	**CP**	2.6	2.3	+	0	+	0/3	0	+	+	+	+	+
Eyrewell	**CP**	2.3	0.2	0.8*	0	0	0/1	0	+	+	+	**0/2**	+
Castle Hill	IC	6.1	1.3	1.3	0	+	0/1	0	0	0/1	0	0	0
View hill	**IC**	30.6	+	0.6	**+**	+	**0**	**0/2**	+	0/2	0	0	0
Maori Lakes	**IC**	28.5	1.1	+	**0**	+	**0/3**	+	+	+	+	+	+
Craigeburn	IC	176.8	54.2	+	0	+	0	0	+	+	0	0/1	0
Herbert Peak	BP	240.8	+	5.3	+	0	0/1	0/3	+	0/1	0	0/1	0/1
Mt Fitzgerald	BP	43.7	+	1.7	+	0	0	0/3	+	0	0	0	0
Palm gully etc	BP	23.9	+	1.1	+	0	0/1	0/1	0	0/2	0	0	0
Paeroa River	SC	206.4	42.5	0	+	+	0/1	0/1	+	0/2	0	0/1	+
Tasman Smith	SC	20.2	+	2.8	+	+	0	0	+	0/2	+	0/1	0
Plant species initials - see below					K	D	C	O	C	M	L	R	S

Region BP = Banks Peninsula CP = Canterbury plain IC = inland Canterbury SC = south Canterbury, Hunter foothills Kaitorete spit, Bankside and View hill are 38-43 km from the McLeans island site.

Plant species:- Shrubs K = kanuka, D = *Discaria* matagouri, C = *Carmichaelia* native broom, O = *Olearia* **Grassland** C = *Cyathodes,* M = *Muehlenbeckia* L= *Leptinella* **Cushionfield** R = *Raoulia,* S = *Scleranthus* + = same species present 0/1 to 0/3 = number of species in the same genus 0 = genus not present

Most reserves have other species of *Muehlenbeckia, Olearia* or *Raoulia* so oligophagous herbivores may survive in these sites. Kelly (1972) thought the Bankside reserve should be 3 times larger to retain a reference short grassland for the Canterbury plains. Most of the 12 most similar Canterbury sites for key non grass vegetation (Table 2) have quite limited areas of herbfields.

Banks Peninsula herbfields with their different soils have broadly similarly herbaceous species to those from McLeans Island. The kowhai is mainly associated with broadleaf forest margins and there is a lack of matagouri South Canterbury has two reserves sites at the base of the Hunter hills with partly similar vegetation (Table 2).

Invertebrates of South island grasslands

Insect records from Christchurch airport (Moeed 1976) and some grassy lucerne fields near Lincoln (Macfarlane 1970) provide the nearest partly similar grassland and soil habitats to compare for the fauna to McLeans Island (Table 3). For insects, two other mid Canterbury reserves provide a more similar modified native grassland with cushion plants to McLeans Island. Partial insect community studies are recorded for these reserves with moths from Kaitorete (Patrick 1994a) and a Lincoln University report (Emberson unpublished) from Bankside reserve. Brome and ryegrass seed crops have also been surveyed for insect herbivores, fungus feeders and predators, mites and slugs (Bejakovich *et al.* 1998).

Table 3 Biodiversity and habitat surveys of South Island lowland grasslands

Location & reference **no**		Habitat	Sampling methods	Main taxa studied - excludes mites	Species found	as % of NZ fauna
Christchurch airport,		Grass, lucerne,	Sw Li Lt,	Insects	275	-
S.I.lucerne	**1**	carrot fields	Gt	Spiders	10+	
				Slaters,slugs, worms,etc	6	
Kaitorete Spit	**2**	Low ungrazed flora	Lt Se Re	Moths, butterflies	130	7.4
Banks Peninsula	**3**	Bush, shrubs, tussocks	Se Gt Sw	Insects	1198	10.4
				Spiders	87	9.4
				Larger invertebrates	59	
Travis wetland	**4**	Marsh, tree & grasses	Mt Sw Lt	Insects	457	5.7
			Gt Se So	Spiders	27	2.9
				Snails to worms	28	
Invercargill coast	**5**	Dunes and herbfields	Lt Se Re	Moths	268	15.2
Waimea grassland	**6**	Much grazed pasture	Sw Gt So	Insects	435	2.9
				Spiders, harvestmen	47	5.0
				Myriopods to worms	10	
Grass seed fields	**7**	Rye and brome grass		Insects	68	0.6
				Molluscs	2	
Cass -Broken R	**8**	Tussocks, shrubs	Lt Se Re	Moths, butterflies	222	11.4
			Sw	Other insects	940	8.8
				Spiders	30	5.9
				Centepedes-earthworms	72	
Upper Waitaki basin	**9**	Sparse tussock	Lt Sw	Moths,butterflies	158	9.0
East central Otago	**10**	Tussock,shrubs,bog	Gt Lt	Most insects	464	2.6

References 1 Macfarlane 1970, Moeed 1976, Sivasubramaniam *et al.* 1997, Barratt *et al.* 1998 **2** Patrick 1994a **3** Johns 1986 **4** Macfarlane *et al* 1998 **5** Patrick 1994b **6** Martin 1983 **7** Bejakovitch *et al.* 1998 **8** Hilgendorf 1917, White 1964, 1991, Burrows 1977 **9** Patrick 1989,1992 **10** Barratt 1983, Barratt & Patrick 1987, Barratt & Kuschel 1996

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

Invertebrate biodiversity in the Cass - Broken river tussock grassland (mainly 600-650 m altitude) has been extensively studied (Hilgendorf 1917, White 1964, 1991, Burrows 1977, Table 1) and this includes limited river bed areas with similar vegetation on stony and silty soils. The moths from the upper Waitaki-Mackenzie basin have been investigated (Patrick 1989, 1992) and the central Otago valley floors from Manitoto to the upper Clutha valley (Patrick 1994c). Grassland or lucerne have been surveyed for weevils (Barratt & Kuschel 1996, Barratt *et al.* 1998) and most (Barratt & Patrick 1987) to a few insect groups (Barratt 1983) from three areas in eastern central Otago (Table 3). An appreciable part of the Southland coast with seminaturalised vegetation that shares some species with McLeans Island has been studied for Lepidoptera (Patrick 1994b). A three year study of a short grazed Nelson pasture deals with insects, spiders and myriopods (Martin 1983).

More insect species are known from kowhai (6 moths, 4 bugs,1 weevil) than from matagouri (6 bugs, 5 moths) (Dale & Maddison 1982). *Raoulia australis* can support 2 bug, 3 moth, 1 fly and several native bee species (White 1964, Donovan 1980, Dale & Maddison 1982, Patrick 1994a). *Muehlenbeckia* species of vines are known to support 21 moth and 4 other insect species and native broom *Carmichaelia* (species unidentified) have had 12 moth, 4 bug, 1 weevil, one stick insect and two *Leioproctus* bee species recorded from them (Donovan 1980 pers. comm. 1998, Dale & Maddison 1982, Patrick 1994a, Macfarlane unpublished). One moth species is known to feed on *Cyathodes fraseri* (Patrick 1994a) and *Colobanthes breviseperatus* respectively. *Olearia odorata* supports 3 generalist and 13 more host specific moth species (Patrick 1994c). There is apparently no specific information on any insect species feeding on *Carmichaelia corrugata, Cheilanthes humilis, Leptinella purpusilla, Raoulia monroi* and *Scleranthus uniflorus*.

In the South island studies on other ground dwelling predatory invertebrates from grassland (Martin 1983) or crop communities (Sivasubramaniam *et al.* 1997) are limited. At Lincoln, ungrazed grass and pine shelter belts similar to the study area had 18 times more spiders and 2.6 times more species (18 species) than grazed pastures (McLachlan 1996, unpublished). For web building spiders grazed pasture is a challengingly unstable environment. Despite the instability, 46 spider species were found in an often bare and seasonally dry pasture near Nelson (Martin 1983) and at least 8 species at 3 mid Canterbury sites (Sivasubramaniam *et al.* 1997). A few introduced spider species and the European harvestman *Phalangium opilio* were abundant in summer at Nelson and in mid Canterbury.

Invertebrates of pine forest, shrub weeds and water

Pine (*Pinus radiata*) insect activity has been extensively studied in the North Island forests (Rawlings 1961, Somerfield 1974, Zondag 1982, Dale & Maddison 1982). Species recorded feeding on pine are 37 defoliator, 12 sap suckers and 55 wood borers and scavengers (Rawlings 1961; Gaskin 1966a,b; Dale & Maddison 1982, Zondag 1982). For Canterbury pine forests, there is no overall account of the timber and herbivore species (Knox 1969), but there are notes on insects gathered from pine especially at Balmoral (Anon 1955). For forest beginners there are also a series of coloured illustrations of the most important species, sometimes their damage and life history summations. Pertinant pests and their natural enemy summaries for this survey are on leafroller moths (Kay 1980, Cameron *et al.* 1989) other moths (Kay 1982, Nuttall 1982, 1983a b) weevils (Milligan 1979), wood borers (Milligan 1977 or 1979) and the willow gall sawfly (Kay 1980). The lower layer of pine litter in Canterbury may of may not have fungal growth (Edwards 1971) and litter in pine has far fewer moth species than native forests (Dugdale 1974). Canterbury (Edwards 1971, Somerfield 1974), West Coast (McColl 1974), Kiangaroa (Styles 1967) and Auckland (Somerfield 1974, Kuschel 1990) studies record Collembola, fungus and root gnats, gall midges, *Tingena* species (= *Borkhausenia**) moths, rove, ground and tenebrionid beetles, millepedes, centipedes with few generic or specific identification beyond the larger beetles. Fly family presence and abundance varies with locality, but in Central north island flies were prominent in suction traps (Alma 1971,1972). Auckland, central North Island and Canterbury studies of decaying *Pinus* logs (Clark 1932, Somerfield 1974, Zondag 1982) confirms that huhu *Prionoplus reticularis* and rove beetles are the dominant species of beetles recorded within logs.

* Key changes to genera in older papers with moths are indicated directly in the text with the old name in ( ) so general readers can relate the findings in the literature more readily.

The invasive scrub weeds gorse and broom support a few wood and twig boring insect species (Cameron *et al.* 1989) that may affect pine trees (Zondag 1982, Scott 1984). Broom has only about 3 insect species that feed on it consistently and these are introduced species (Scheele & Syrett 1987, Syrett 1993). Gorse (Cameron *et al.* 1989) and *Hieracium* (Syrett & Smith 1998) are similarly depauperate of consistent sap and foliage feeders.

Threats to the invertebrate fauna

There are several long term threats to the invertebrates in the fields of McLeans Island. The most acute threats are probably the loss or isolation and fragmentation of patches of the rarer native plants, which still sustai characteristic invertebrates. The more drastic reasons for such a loss may include relocation of pine plantings fo shelter, lack of plant regeneration, weed invasion (notably gorse, broom or eventually *Hieracium*), or inappropriately sited new tracks. These weeds have very limited generalist herbivore and wood borers associated with them. Hence, field managers needed guidance on which areas may suit tree planting with the minimum of disturbance to native plants and their associated invertebrates.

Poorly timed grazing could lead to the most severe mortalities of soft bodied immature insects during their main growth with plant removal. Removal of suitable habitat (grass cover) combined with trampling is known to reduce caterpillar densities with porina moths (Scott 1984). Grazing and trampling may influence the vulnerable and least mobile stages e.g. wooly caterpillars (which feed on the common mat daisy *Raoulia australis*, Hudson 1939, White 1985) for part of the season more than the adults, because adults can fly and live for shorter periods too. An increase in stocking rate has been shown to reduce populations of wooly bear caterpillars (White 1985). Hence any caterpillars or nymphs of bugs and stick insects from the 16 species of less common low growing plan species (Table 1) at McLeans Island and less common plants may be vulnerable. Sheep grazed two of the fields mainly to reduce the fire risk. Grazing from sheep or rabbits can have long term affects too. A reduction, fragmentation and eventual loss of host plant populations which are palatable, nutritious and unprotected plant species (e.g. *Olearia odorata*, native broom, kowhai) will increase problems for the less mobile immature stages in finding suitable hosts and eventually even for females seeking hosts to lay eggs on. Hence insect species associated with the more palatable plants may benefit more from protection or reduction in grazing. Little is known about minimum patch sizes of vegetation needed to retain insects in New Zealand, but a combination of grazing and fire that depletes herb biodiversity also reduces the populations of many moth species (White 1991).

Aquatic insects had habitat to the north in water trenches at Orana Park and in wet periods there was a temporary pool in the gap in the pine trees by the water race. Waimakairi river was within a km to the North. The complete networks of creeks in the Avon, Heathcote, Halswell and Styx rivers of Christchurch and the adjacent rural rivers have been surveyed extensively (Macfarlane 1999). New housing and building development threatens silt run off and so degradation especially of the biomass important caddisflies and midges, which are represented by a few species in the lower reaches of the rivers. The site sampled with water races from the Waimakariri river illustrate what diversity even small unpolluted water ways can support on the east coast (Canterbury-Otago) plains ecological zone (Harding & Winterbourn 1997).

Potentially McLeans Island vegetation could support at least another 80 insect species to the species found i the survey (Appendix 1) if it has retained the species known to be associated with perennial dicotyledons (Dale & Maddison 1982) or from similar habitats in Canterbury and lowland Otago (White 1991, Patrick 1994 a,c).

Survey objectives

To improve their assessment of the natural history value and preservation of parts of McLeans Island (Fig. 1) Christchurch city council parks managers wished to have information on:

- an invertebrate inventory of species diversity that distinguishes endemic from native and introduced species.
- to determine which invertebrates are typical of the dry lowland grasslands and specialized native perennials.
- to evaluate and rank different areas of the grassland for invertebrate biodiversity. To define the more critical areas for conserving native insects that represent dry lowland grasslands. To comment on:- any rare, uncommon species. To highlight the most generally or educationally interesting species.
- to provide land management with an assessment of what threats exist for endemic grassland and herbfield species at this site and where possible how to counter these threats. Comment on what extra planting could restore invertebrate biodiversity and where planting will have the least impact on the less common native species.
- provide an initial overall assessment of the invertebrate value of McLeans Island compared to other south island drier native grassland sites. Where possible determine in a dry lowland grassland the percentage of undescribed invertebrate species and what families require taxonomic input more acutely.

METHODS

Site features and sampling procedure

The study focused on comparing representative vegetative areas with 12 sample sites (Fig 1). Eight sites were on the short grassland/moss areas, site 12 on mat daisy *Raoulia* fields and sites 2,6,9 in the pine shelter belt. The flowering, plant height and growth and seed set were checked for both native brooms *Carmichaelia* spp., *Olearia odorata* and mat daisy or scabweed *Raoulia australis* between 28 December 1997 and 21 January 1999.

Grassland and kowhai/matagouri (Figs 2 and 3)

Site 1: Malaise, light, water traps used 17 January to 27 February. The major study site. The silty-sandy site was 40-45 m from the pine shelter with 2 tall kowhai and 2 tall matagouri plants by the major marram grass patch. The malaise trap was by the kowhai and within 5-10 m of matagouri, marram grass and mat daisy on the bank (Fig. 3). 10 water traps were used here in sequence on the silty grass by the trees and among the marram - *Zoysia minima* grasses and sheeps sorrel. Kowhai and matagouri sprayed, mat daisy vacuumed, grass swept here.
Site 3: Used light trap on February 27. 10 water traps used at 2 sites 15 m apart. At least 20-35 m from gorse, 50-65 m from the water race and 55-70 m from the pine shelter belt. Red moss and danthonia dominated silty site much like site 4. No fern, but lichen instead. Seeding native broom *C. australis* within 5 m of the southern site.
Site 4: Red moss dominant with Danthonia/catsear subdominant (Fig. 2) and some fern on silty area. Water traps used at 2 sites 10 m apart from January 20-30 and from February 10-24 (second site).
Site 5: By kowhai trees with sweet vernal grass and stonecrop dominant underneath. Some fern and cushion plant *Scleranthus uniflorus* within 10 m of the water traps. All *S. uniflorus* vacuumed here in January and May.
Site 7 Kowhai/sweet vernal-danthonia grassland site on siltier base with more danthonia in the vicinity than the similar site 5. Light trap used on January 14. 120m from pine shelter belt.
Site 8 Red moss/danthonia grassland within 20 m of pine shelter belt. Light trap used on January 14 th.
Site 10 Kowhai - danthonia grassland site, but with *Muehlenbeckia* dominating under the malaise trap used from Janaury 24 - February 2.
Site 11 Wooly moss dominated site on gravely area 170 m from the pine shelter belt and 10-15 m to the south of the gravel track. Light trap used unsuccessfully on January 30, successfully February 27.

Figure 2 Grassland and pine shelter belt : foreground red moss- danthonia grass (Site 4)

Figure 3 Grassland with mature matagouri/kowhai, also marram grass on sand-dune remnant (Site 1) : foreground holes of rabbits - a long term threat to shrub and tree regeneration

Mat daisy *Raoulia* cushion field

The few cushion fields are either on banks (Fig. 4 - near site 1) or on the stoniest ground (Fig 5.) in the east. In the summer of 1997/1998 there was little sign of die back in the common mat daisy plants and dead sections of three plants were carefully inspected for signs of sucking bugs, caterpillers or other insect larva without any sign immature insects within the plants. Nor was there any obvious concentration of potential bugs sucking the growing tips at the surface other than a few wheat bugs. The autumn of 1998 was exceptionally dry and by the summer of 1998/1999 over half of the plants in some of the cushion fields were either completely dead and many of the rest were severely reduced in size (Fig. 5). The rainfall in December 1998 and January 1999 was as low as only 40 % of the regional average in central Canterbury.

Site 12 *Raoulia australis* and low herbfield - 12-15 m wide. Site within 10-15 m of gorse, 6-8 m of grassland and 100-120 m north of pine shelter belts. Important site for vacuum sampling and water traps set in gravel. Unsuccessful light trapping January 30, successful February 27.

Fig. 4 Upper bank margin near site 1 :- healthy mat daisy to the right and dead plants to the left - Jan. 1999

Fig. 5 Extensive die back in common mat daisy *Raoulia australis* in stony cushion field patch - Jan. 1999

Fig. 6 Sole non flowering *Olearia odorata* plant (Asteraceae) among danthonia grass between sites 4 and 1. Maximum height of 0.25m, which was too low to avoid rabbit browsing that prevented flowering in 1999.

Fig. 7 Tallest (0.45-0.65m) native broom *Carmichaelia australis* patch among sweet vernal -danthonia grass. The only seed producers from field Chatterton 1B. Left side:- typical single bush

The long term survival of kowhai trees appears to be threatened at the site due to periodic stress on trees and loss due to old age. Stress (leaf loss) was evident on one of perhaps the older trees in the summer of 1998/1999 (Fig. 8). The stress became obvious in 1998 after the prolonged dry summer and autumn. A ring of green grass under most other trees still showed where sheep dung had been deposited as they sheltered under the kowhai trees (Fig. 9). None of the 33 kowhai trees had any seedlings regenerating under them.

Figure 8 Severely stressed eastern kowhai tree *Sophora microphylla* nearly without leaves - Jan. 1999

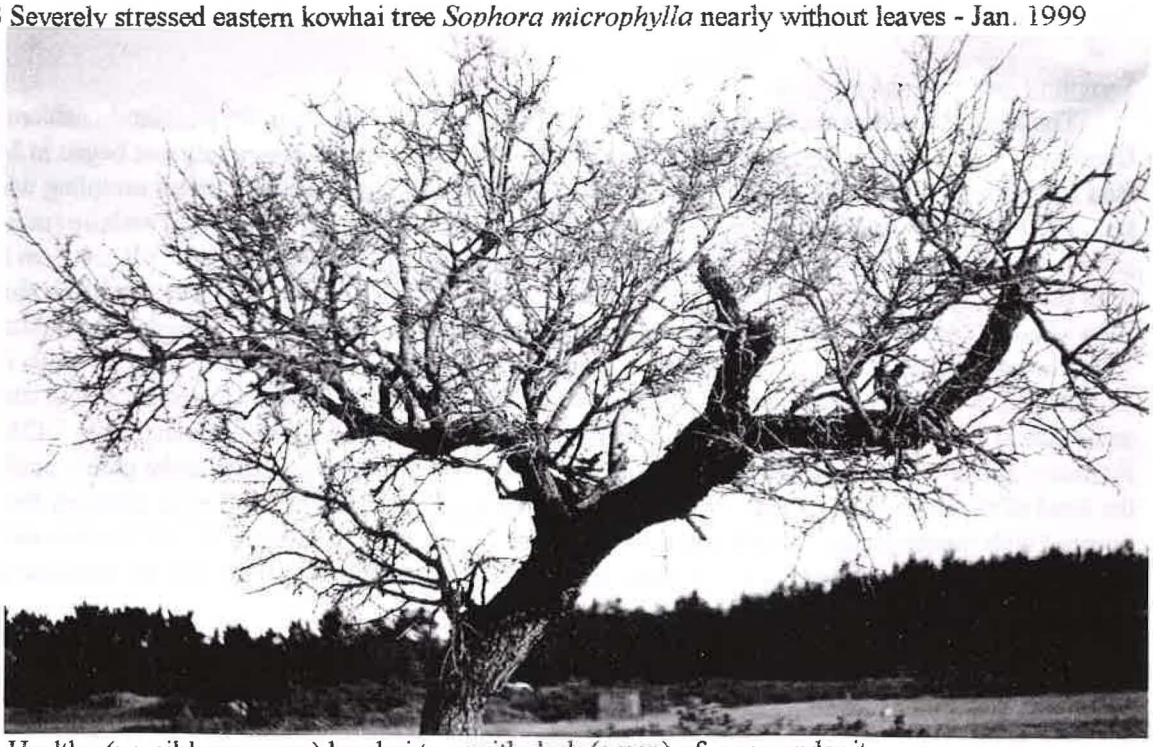
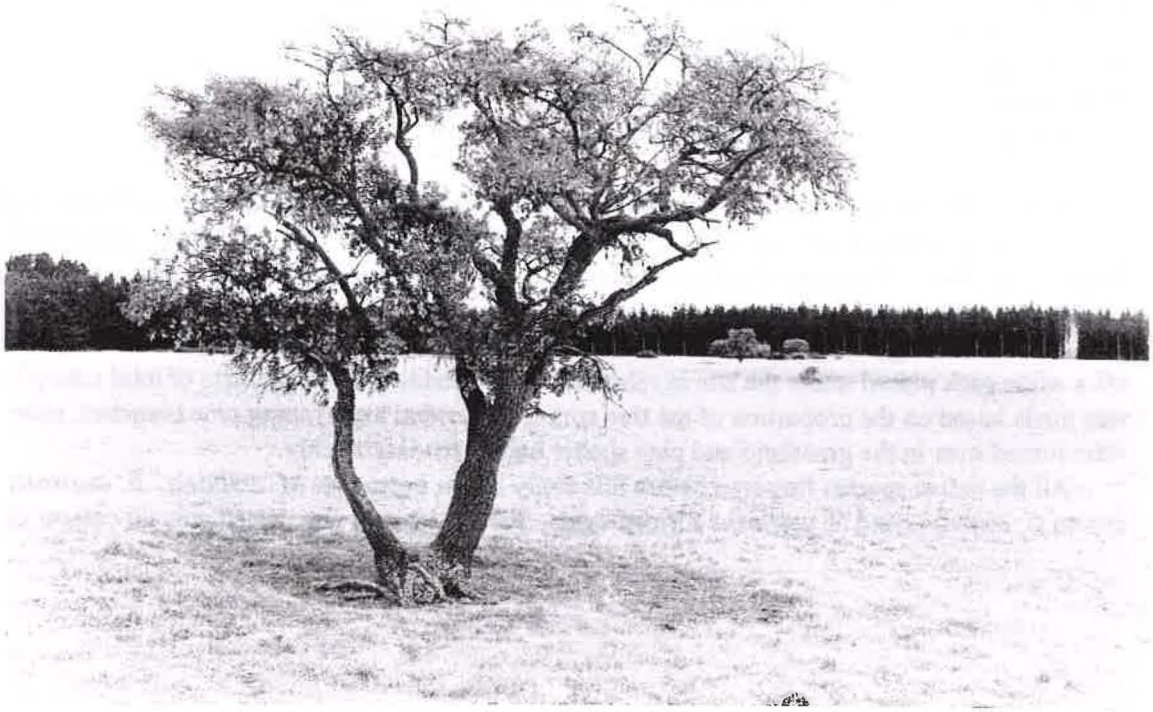


Figure 9 Healthy (possibly younger) kowhai tree with dark (green) of grass under it



Pine shelter belt

Site 2: Malaise and water traps were used between 28 January and 7 February 10 - 15 m within the pine shelter belt and light trap on February 27. The sandy ground was largely covered with pine needles, but has small amounts of moss and fungi as well as rotting logs and branches.

Site 6 Similar to site 2, but more undulating and with more gravely grassland-herb vegetation within 15 m to the north. Water traps used 21-31 January.

Site 9 Similar to site 6, 20 m within the pine belt, but the flattest site. Light trap used January 14.

Sampling methods and duration

The study started when Brian Patrick checked for diurnal moths from the grassland-cushionfield on 29 October, 31 December 1989, and 30 October 1991. The survey of other invertebrates began in May 1996, when Rod Macfarlane began with an initial collection of beetles, moths and slaters. Insect sampling was concentrated between 14 January and 24 February 1997 but extended to 8 May 1997. Light and malaise traps were used to gather most of the flying insects. For nocturnal insects ultraviolet fluorescent lights placed 3 cm above ground level on trays with alcohol on January 14, 30 and February 27. The light traps were run from shortly after dusk from about 10 pm to 1-2 am on as fine, warm and windless nights as possible. Many more moths were obtained with a waning moon (January 14) and on an overcast night (February 27) than during full moon (January 30). Tree trunks and moss areas were checked with a torch at night. Light traps were used once at sites (1-3,7-9,11) and twice at site 12. Two malaise traps operated for 10 days at site 1 (17-27 January), site 2 (28 January - 7 February and site 10 (24 January - 2 February). Strong winds in January, that broke pine branches, tore holes at the head of the traps at site 1 and 2. The catch was reduced compared to site 3 even although the gaps were covered with masking tape. Water traps were used at 7 sites from 17 January to 24 February mostly for 10 days (up to 14 days) at each site (Fig 1). 5 water traps were used at each site. This was the main method to sample active ground dwelling invertebrates (Table 4).

Table 4 Invertebrate collection:- duration, composition and habitats sampled

Collection methods	**Number of sites & type sampled**	**sampling days January- May**	**Duration in days**
Observe, sweep, collect	4 - Grass-cushion plants	Oct. - May 9	10 plus
Spray, vacuum	4 Trees - cushion plants	Dec. 28 - May 9	5
Malaise trap	3 Mobile invertebrates	Jan. 17 - Feb. 7	22
Water traps	9 Ground active species	Jan. 17 - Feb. 24	39
Light traps	7 Nocturnal species	Jan. 14,30 Feb. 27	3

A portable vacuum cleaner was one means of confining insect sampling to a single type of plant - *Raoulia australis, Scleranthus uniflorus, Olearia odorata* or nearly so (*Leucopogon fraseri, Muehlenbeckia axillaris*) in January and May. A sample of red moss was extracted with a Tullgren funnel in January. Sweeping was only used to a limited extent on kowhai and pine foliage, because in January-February danthonia, Australian needle grass and soon clogged the net. Insects were dislodged from kowhai and matagouri with fly spray and recovered off a white sack placed under the site in relatively calm conditions. An estimate of total caterpillar populations was made based on the proportion of the tree sprayed. Kowhai logs, rotting pine branches, other wood debris were turned over in the grassland and pine shelter belt in January mainly.

All the native species flowered before this study began except for *M. axillaris*. *R. australis*, kowhai, native broom *C. australis* and *S. uniflorus* formed seeds. Flower visitors were noted only on catsear and vipers bugloss.

Fauna investigated and identification

Most insect taxa and all spiders were investigated. No attempt was made to identify aphids, thrips and Collembola beyond family. Some beetles such as weevils (Curculionidae) were largely impracticable to identify beyond family, because of a lack of keys and identified specimens. Literature sources for identification have been compiled in the report on Travis wetland invertebrates (Macfarlane *et al.* 1998). Five characteristic insect species are illustrated in Appendix 3 and notes are given on recognition of some parasitic Hymenoptera. Keys and figures are given for the main spider species found in the grassland and wooded habitats (Appendix 2).

Voucher insect specimens of not fully identified and the less common species were lodged in the Canterbury museum, moths in the (Brain Patrick collection) and spiders at Lincoln University. The identification and current nomenclature for the 410 families of insects have been summarized in the initial Christchurch invertebrate community study (Macfarlane *et al* 1998) and identification manuals (Macfarlane 1996).

RESULTS AND DISCUSSION

Invertebrate diversity

229 species of terrestrial insect species (includes 16 aquatic species) and 26 species of other invertebrates were recorded from the McLeans Island study area (Appendix 1). Fully 72-84 % of these insect species are only found in New Zealand. 73 % of the species are characteristic of native grasslands with mosses, lichens and other perennial flowering plants. The strong flying admiral butterflies *Bassaris* species were largely vagrant, because there is little introduced stinging nettle in the study fields. There were no definite vagrants from the surrounding cultivated trees unlike at Travis wetland. About 80% of the moths and all the caddisflies are active at night, while many of the parasitic Hymenoptera other than Pompilidae and Ichneumonidae are small to tiny and so are not readily apparent. Other species e.g. grass grubs, some weevils, some click and rove beetles live in the soil or logs for most of their lives and so are seldom visible.

In the grassland, at least 1.2% of the insects (two species) are flightless. For the wingless spiders, centipedes, millipedes the daily mobility and seasonal dispersal is likely to be lower than for similar sized insects.

Within McLeans Island the species composition of the invertebrates changes with the vegetation (Appendix 1, Table 5). Vegetative habitat ranged from minority areas of the tallest pine shelter belt, kowhai-matagouri-gorse-native broom, to the predominant marram-needle-danthonia grass with patches of mainly moss or cushion fields.

Grassland feeders and their parasites

During summer sodweb worm moths *Orocrambus* and *Eudonia* species were two of the four most common and conspicuous herbivores in the grassland. The pale cream-brown crambid *Orocrambus* species moths with white streaks on their wings during the day sheltered among the grass and up in the kowhai and pine trees in considerable numbers. The three *Orocrambus* species were collected at 147-153 per hour in light traps in the grassland of February 27 and at 6-38 per hour on January 14. The comparative figures for the pine shelter belt were 58 and 5 per hour on February 27 and January 14. The light traps were 10-15 m within the pine shelter belt. They made up 57% of 1571 moths collected in grassland of February 27. The small grey moss feeding *Eudonia diphtheralis* was collected at 45, 15 and 1 per hour in the moss-low grass, pine belt and *Raoulia* area respectively in February. They made up 17 % of the moths collected in the grassland on February 27, but would represent less than 5 % of the biomass in moths. On 14 January, at the moss dominant site 8 they were trapped at 29.3 per hour compared to 8.8 per hour at the grassier site 7 and 1.5 per hour in the pine shelter belt (site 9). In Manawatu light trapping by grassy pastures it accounted for 0.5 and 0.07% of the moths (Gaskin 1970, McGregor *et al.* 1987). Variation in the distribution of *E. diphtheralis* at different sites within McLeans Island combined with the likely lower levels of moss in Manawatu pastures indicate the importance of moss as a host for this species. The survey was made during the likely peak for adult activity of the single generation known for *Eudonia diphtheralis, E. sabulosella, O. vittellus* and perhaps for *O. flexuosellus* in Canterbury (White 1964, 1991) unlike the Manawatu and Waikato, (Gaskin 1970, McGregor *et al.* 1987, Cowley 1988). In the Manawatu, *Orocrambus* moths made up 73-79% of the moth catches (Gaskin 1970, McGregor *et al.* 1987). *Orocrambus* caterpillars shelter in tunnels and all the species (Martin 1983, Cowley 1988) feed on moss and grasses. They prefer moss and wide leafed grasses that include sweet vernal, so 'danthonia' grass may not suit these night feeding caterpillars so well. They

like many of the other moth species will have caterpillars active from autumn to mid to late spring based on adult flight periods (Appendix 1) and the likely need of 2-4 weeks in the pupal stage. The *Orocrambus* species are relatively well adapted to withstand periodic grazing, when the McLeans Island grass is most suitable for livestock, because they shelter within the top soil during the day. In snow tussock areas these species become less dominant as other Crambinae species replace them (Barratt & Patrick 1987).

No parasitic Hymenoptera have been recorded from *Orocrambus* and *Eudonia* species (Valentine & Walker 1991) despite the dominance of these moths in uncultivated pastures in New Zealand. Only the tachinid fly *Gracilcera politiventris* has been reared from *Crambus* species (Valentine 1967). These caterpillars could well provide some to much of the prey for *Saropogon* and *Anabarynchus* larvae in the soil and for ground beetle larvae. The more sporadic populations of grass grub larvae are proven food sources for at least the robber fly larva (Valentine 1967). Wolf spiders may prey on sod webworms too, when they feed among the grass foliage at night. The McLeans Island fields provide a handy suitable site to unravel some of these scientific mysteries.

The larger and presumably stronger flying noctuid moth fauna were often collected in other South Island grassland or bush light trapping with 7 of the 11 species common with Travis wetland and 8 with Riccarton bush (Appendix 1). The highest collection rates for noctuids were from three sites among or within 10 m of grassy - herb dominated areas with 1.5 per hour on January 14 and 10 and 18 per hour on February 27. The lowest rates for the collection of noctuids were 0.25 per hour on the moss dominated site 8 on January 14 and 3.7 per hour at the mossiest site 3 on February 27. *Persectania aversa* accounted for 42 % of the noctuid moths and noctuid moths made up 5.4 % of moths collected on 27 February. They probably made up 15-20 % of the biomass of the moths collected. In the grassy-herb pastures of the Manawatu, noctuids were 2-3 times commoner and made up 10.8 and 17.5 % of the moths collected (Gaskin 1970, McGregor *et al.* 1987). Only 6.4-13.9 % of the noctuids were *P. aversa*. Most of these species are generalist feeders that consume either grasses or a range of herbs. Perhaps the range of herbs and exposed dry site at McLeans Island do not suit *Graphnia mutans* well, because it was much more common in the Manawatu (Gaskin 1970, McGregor *et al.* 1987) Canterbury lucerne fields (Macfarlane 1970) and tussock grasslands (White 1991). The varied bush and grasses area of Riccarton bush shared 67 % of the species found at McLeans island (Appendix 1).

The more unusual moth species were associated with the mat daisy *R. australis* cushionfields rather than grassland/moss. These moths include the undescribed gelechiid species *Kiwaia* also known from Kaitorete Spit and near Tekapo (Patrick 1994a). The type locality for *K. thyraula* is Christchurch (1883 description). McLeans Island is probably the nearest site still with a habitat that approaches the original type locality. Its retention near Christchurch in the grasslands of McLeans island caste doubt that this moth uses forested areas as Hudson (1928) states. Recent records of *K. thyraula* are only from central Otago (Patrick 1994c) and Omarama valleys (Patrick 1992). The species composition of another 11 described *Kiwaia* species varies considerably between the less modified grassland-cushion plant communities in Canterbury and Otago (White 1991, Patrick 1992,1994a c). Looper caterpillars of *Arteshces catapyrrha* were vacuumed quite consistently from *R. australis*. The grey Canterbury tortricid with a black band *Eurythecta robusta* has flightless females (Patrick 1994a). It was collected in pitfall traps and netted in the cushion field (Site 12). Hudson (1928) incorrectly attributes *E. robusta* to central Otago, which has the similar moth *E. zelaea*. These three species are virtually only active during the day and so were not recorded in the Manawatu (Gaskin 1970, McGregor *et al* 1987), Cass (Burrows 1977) or from central Otago (Barratt & Patrick 1987) or Tara Hills (Patrick 1989).

Leptocroca lindsayi (Yaldhurst type locality) is quite common in mid Canterbury, but was not found in extensive studies of grassland moths in the South Island (Table 3, Patrick 1994c). *Prepalla (=Oxythecta) austrina*, which feeds on *Muehlenbeckia axillaris*, was originally known from inland and upland central Plateau and central Otago sites (Hudson 1928, Patrick 1994c). Kaitorete spit (Patrick 1994a) and McLeans Island extend the known range to isolated suitable lowland Canterbury sites. This indicates a potential shrinkage in distribution of this moth with cultivated pastoral development in the Canterbury plains and elsewhere. The overall lack of literature records of the leaf rolling moth *Epichorista siriana* apart from the upper Central Otago lowland valleys (Patrick 1994c) and localised long grass near Wellington (Hudson 1928) hardly reflect the quite common and widespread current distribution of *E. siriana*. The undescribed moth *Heliostibes* species is a quite common sward feeding species, represented in the best Lepidoptera collections in New Zealand.

Mid spring sampling may well have revealed the moths *Zermizinga indocilisaria* and *Rictonis comma* in the area, although limited matagouri and alternative hosts at McLeans island could restrict the populations of these moths. Further moth species probably inhabit McLeans island. *Muehlenbeckia, Carmichaelia, Raoulia* and *Leucopogon* species all warrant further checking for less common species recorded from them elsewhere in Canterbury (White 1991, Patrick 1992, 1994a).

McLeans Island had 28 Lepidoptera species (47 %) in common with Kaitorete Spit by Lake Ellesmere (Appendix 1, Patrick 1994). Kaitorete Spit had no *Eudonia diphtheralis* (Patrick 1994a) unlike McLeans Island, which emphasizes the importance of moss to this moth. For moths, McLeans Island shares 76 % of its species with Southland lowland marshes and sand dunes (Patrick 1995), and 53 % with the upland tussock area of mid Canterbury (White 1964,1991, Burrows 1977). The grassland/herb community still seems to be of reasonable quality, because the herb feeding *L. rubraria, H. deltoidata* and *H. corcularia* remain at McLeans Island along with a considerable population of *Orocrambus vulgaris*. At Cass, the first two species seem to have died out and populations have declined considerably of the other two species along with *Graphania mutans* due to invasion of brown top *Agrostis tenuis* (White 1991).

The third conspicuous and numerous herbivore group were adults of little blue butterflies *Zizina labridus*, which have stout plain green caterpillars (Hudson 1950). The small copper butterfly *Lycaena bolderanum* became more apparent in February. Both species and a few of their larvae were collected in water traps. The green caterpillars of *L. bolderanum* with their striking reddish bands (Gaskin 1966, Gibbs 1983) were vacuumed off its host *Muehlenbeckia* or close to this low creeper. There can be two generations per year (Craw 1975).

The grassland reverberated to the soft chirping of the small black field crickets *Pteronemobius* throughout the day and the study period from December to May. These crickets were prominent in the Nelson pasture during summer too, along with a scelionid species (Martin 1983). Johns (1986) noted nymphal populations declined with the loss of green herbage and the sound of these crickets had declined considerably by January 1999 after the previous summer-autumn drought followed by further drought from December 1998. Their acoustics and diapause (overwintering) have been investigated (McIntyre 1977, 1978). The onset of diapause requires prolonged exposure to temperatures between 0-5^0 C and *Pteronemobius* species have one generation per year (univoltine) with eggs as the main overwintering stage (Swan 1972, McIntyre 1978). The concentration of these crickets in grassy areas (Table 5) rather than mossy or cushion fields could be due to grass being preferred to herbs for food, protection that the grass offers from bird predation and suitable soil for egg development. An initial cursory student project, which tested some introduced grasses, dandelion and tall bididi showed that these crickets would not eat these plants, even although some starved to death (Ware 1997 - Zoology 205 project). Thus caution should be applied before assuming these crickets have little in the way of plant preferences, even although they will consume *Hieracium* when starved on it (Syrett & Smith 1998). Scelionids parasitise the larger Australasian field crickets (Hill 1983) and so perhaps these egg parasites may extend their host range to *Pteronemobius* crickets. The smaller brown and songless *Metioche*, which is probably undescribed (Johns 1986), and another cricket species were collected from McLeans Island grassland beyond the study fields (Ware 1997). The proportion of grasses versus herbs in the diet of these crickets and determination of their main natural enemies, which are unknown (Valentine 1967, Valentine & Walker 1991) are only two of the ecology aspects about these crickets that merit further investigation. The green long horn katydid was virtually confined to marram grass and long grass near the pine shelter belts and most *Conocephalus bilineata* could escape from the water traps unlike many *Pteronemobius*. These katydids lay their eggs in grass stems (Cumber 1959c), which seems to contribute to their preference for undisturbed long grass. A second *Conocephalus* species was recorded from tussock grassland on Banks Peninsula (Johns 1986), and further collection may have revealed *C. semivittatus* at McLeans island too.

The most obvious and probably most important seed feeders among the grassland were chaffinches and other birds in January. The larger southern ant *Monomorium antarticus*, which is often near black, was the main ant in the area. The most prominent populations were in mat daisy fields, but limited numbers were found in the more open sandy grassland and the pine tree shelter belt. Flights of males from maturing colonies were observed in mid February, and in Nelson peak activity was noted from January to March (Martin 1983). This ant feeds on seeds (Barratt & Patrick 1987) as well other invertebrates.

In spring the wheat bugs *Nysius huttoni* were concentrated on *Scleranthus uniflorus* mats. In summer, wheat bugs were the most consistent insect associated in vacuum samples from these plants, which had mature seed. The wheat bug may feed on immature rather than mature *S. uniflorus* seeds, because there was a little discolouration of mature seeds. The wheat bug is well known to feed on at least a moderate range of other growing seeds notably wheat and cereal grains (Scott 1984, Bejakovich *et al.* 1997), crucifers and perhaps lucerne (Macfarlane 1970). Abortion of developing seed checks need to be made earlier in the season (December - early January). However, no insects were consistently vacuumed from the common mat daisy with seeds, and no weevils were seen on the two bushes of native broom with seed. An unidentified small dark brown Lygaeidae, that Butcher identified as *Plinthisis* species, was associated with *Scleranthus uniflorus* and so was one species of undetermined weevil. Thus there is a possibility that the few plants of this and the other two Carophyllaceae may support a modest range of semi-specialist (oligophagous) herbivore insect species. The other larger speckled broad unidentified Lygaeidae was not represented in the Lincoln University collection and so it may originate from some other of the less common native plant species.

The grassland weevil fauna is clearly more diverse than at Travis wetland and could contain several species that rely on a limited range of low growing herbs in the grassland. It is remarkable that no argentine stem weevil *Listroderes bonariensis* or *Steriphus* species were collected given their abundance in Canterbury and Otago grasslands (Barratt *et al.* 1998), insect collections (Lincoln University) or even lucerne with grass (Macfarlane 1970). The lack of argentine stem weevil is probably because the dominant grasses do not favour this stem mining weevil, but night sampling was mainly done on cooler overcast evenings, which are unfavourable for argentine stem weevil activity. The inability of entomologists to identify weevils without costly specialist assistance prevented a proper comparison of the McLeans Island weevils with the other most comprehensive surveys of South Island grassland at Cass (Burrows 1987) in Canterbury and Otago lowlands (Barratt *et al.* 1998).

The sweet vernal, danthonia, Australian needlegrass and brown top dominated grassland had few plant bugs and by summer low aphid populations and no pale slender grass mirids *Megaloceroea recticornis* or the darker green mirid *Stenotus binotatus* that were common in the drier areas at Travis wetland or even the potato mirid *Calocoris norvegicus* (Macfarlane *et al* 1998). The two or so main Cicadellidae species are typical grass inhabiting species (Macfarlane 1970, unpublished, Knight 1975, Martin 1983). More sampling and experience with species determination may reveal more *Arawa* species. The sole aphid collected came from *Scleranthus uniflorus,* but the presence of modest numbers of brown lacewing adults indicates that low aphid populations may exist in the grassland in spring, when the grasses are growing or forming seeds. Spittle bug, *Philaneus spumarius* populations were also low.

The surface feeding herbaceous and dung feeding Tasmanian grass grub *Aphodius tasmaniae* and the soil inhabiting omnivorous click beetle *Conderus excel* were apparently common throughout much of the grassland. The dominant root feeding scarab beetles were apparently *Odontria smithii* grass grub beetles, which concentrated in the sandy marram grass area along with larvae of the large brown sand scarab *Pericoptus ? truncatus*. The sand scarab was collected in limited digging to set up pitfall traps. Sampling was too late to detect if the main grass grub (*Costelytra zealandica*) of New Zealand was even present. It is likely to occur in the area, but in this type of grassland may be less common than Tasmanian grass grub and the click beetles.

Tree, shrub and weed insects

Native and pine trees supported a largely different set of insect herbivores and parasites. The micro Lepidoptera were substantially different from those found at Travis wetland, but often a few South island studies had the same species (Appendix 1). Misting matagouri with spray revealed moderate numbers the host specific *Trioza discariae* and a larger booklice with spotted wings was prominent too. The host for the other Psyllidae *Psylla apicalis* collected in a malaise trap by kowhai is unknown, but perhaps it could be kowhai.

Table 5 Abundance of insects trapped in water traps (species within families arranged in approximate decreasing biomass) Upper densities* Initial January sampling # = later sampling 14-24 February

Insect and spider taxa	Habitat and site no				marram grass	mat daisy	Pine shelter belt	Total specimens
	Grass to moss							
	1	2 & 8#	3	9#	6	12	2 & 5	
	Number of specimens per trap per day							
Pteronemobius cricket	0.52	0.72*, 0.2	0.28	0.09	0.45	0.02	0.02	126*
Aphodius tasmaniae grassgrub	0.24	0,0	1.04*	0	0	0	0	64*
Nysius huttoni wheat bug	0.04	0.38,0.11*	0.14	0.06	0.13	0.08	0	52*
Zizina labridus little blue	0	0.16,1.1*	0.02	1.06*	0	0	0	155*
Odontria smithii grassgrub	0.3*	0	0	0	0	0	0	15*
Caterpillars,other lepid. adults	0	0.04,0.18*	0	0.14*	0	0.12*	0.01	30*
Conoderus excel Click beetle	0.08	0.06,0	0	0	0	0	0	7*
Arawa,Horoutia planthoppers	0.02	0.08,0.07*	0	0	0.02	0	0	12*
Honey bee : or native bees	0	0.02,0.03	0	0.05*	0.02	0:0.02	0	7*
Phaulacridium marginale grasshopper	0	0, 0.11**	0	0.02	0	0	0	9*
? *Irenimus* sp 1-2, weevil sp. 1	0.04*	0,0	0	0	0.05*	0	0.02	7*
Herbivore total numbers	**62**	**70,**	**74**		**39**	**12**	**4**	
'Lycosa' hilaris wolf spider	0.84*	0.46,0.06	0.36	0.05	0.17	0.02	0.14	**115***
'Pardosa' bellicosa turret spider (a wolf spider)	0.02	0,0.59*	0	0.82*	0.25	0.08	0	**94***
Other spiders	0.06	0,0	0	0	0.02	0	0.09*	**13***
Phalangium opilio harvestman	0	0.08,0.06	0	0.11*	0.05	0.02	0.03	**23***
Metaglymma tibiale carabid	0.1	0.04,0.03	0.16*	0.02	0.05	0.02	0.18*	**36**
Harparphax ground beetles	0.04	0.32*,0	0.26*	0.09	0.1	0	0	**37**
Notobia ground beetles	0.12*	0.06,0.01	0.04	0.09*	0	0	0	**6**
Neocincindela dunedinense small tiger beetle	0	0.46*,0.04	0.14	0	0.08	0.12	0	**44***
Saropogon sp. robber fly	0.02	0.06,0.21	0.06	0.59*	0	0	0	**55***
Monomorium antarticus ant	0.04	0.02,0.01	0.02	0	0.02	0.98*	0	**55***
Priocnemis crawi spider wasp	0.1*	0,0	0.02	0.03	0.02	0	0	**9***
Anabarynchus sp. stilleto fly	0.04*	0,0	0	0	0	0	0	**2***
Predator total numbers	**64**	**75,**	**53**		**46**	**62**	**18.5**	
Hemiandrus sp. ground weta	0.02	0.02,0.07*	0.12*	0	0.04	0.02	0	16*
Pleioplectron simplex Cave weta	0.02	0,0	0	0	0	0	0.05*	6*
Porcillio scaber woodlouse	0.1*	0,0	0.04	0.03	0.05	0	0.02	14*
Hybopygia varia dung fly	0.02	0.08*,0.03	0.02	0	0.02	0.02	0	14*
Sciaridídae root gnats	0	0	0		0.02	0	0.14*	15*
Psocoptera (book lice)	0	0,0	0	0	0	0	0.14*	14*
millipedes	0	0,0.02	0	0	0.02	0	0	2*
Decomposer total numbers	**8**	**6**	**9**		**8**	**2**	**34**	
Diapriidae wasp	0.06*	0	0	0	0.02	0	0.09*	**13***
Other parasites	0	0.04,0.03	0	0	0	0.04	0	**5***
Parasite total numbers	**3**	**2,2**	**0**	**0**	**1**	**2**	**9**	

Other Lepidoptera copper butterfly 17, *Eurythecta robusta* 6, caterpillars 4, Crambus 3,
Other spiders Clubionids 8, *Hemicloea rogenhofferi* 3, *Cambridgea antodiana* 1, salticid 1

Kowhai trees had a few of the seed feeding *Stathmopoda aposema* moths, but in January the fallen kowhai seed were undamaged by their caterpillars. At Lincoln, Landcare Macfarlane has noted at least 20% of the seed may be damaged by the end of April. Kowhai foliage had 20-30 looper *Chalastra ochrea* caterpillars in January/ February per tree and only 5-15 kowhai moth *Uresiphita polygonalis* caterpillars per tree in May. The leaves remained virtually free of any chewing damage during this period. This provides a marked contrast with Riccarton bush, where the kowhai moth was clearly the dominant species associated with kowhai (Molloy 1995). At New Brighton in late spring the kowhai moth outbreak occurs at times, where lupin and kowhai occur together The introduced lupin allows for faster development of the kowhai moth (Kay 1980). The few slaters were all the European *Porcillio scaber*. These slaters were conspicuous at night on kowhai tree trunks and under kowhai and pine logs or stones during the day.

The pine shelter belt light traps collected 88 % (17 moths) of tree feeding *Pseudocoremus sauvis*, at 2.25 moths per hour. At 70 and 120 m from the pine shelter belt on January 14, they were collected at 0.25 per hour a sites 7 and 8. Similarly 86% of 29 scavenging and litter feeding *Monopsis ethella* moths were collected in the pine shelter belt. All 8 *Declana floccosa* were collected within the pine shelter belt. Hence the low light traps used seem to exert some selectivity in their catches for moths that rely most on habitats 10-40 m away. The distance of sensitivity depends on moth size. This contrasts with the light traps set well above the ground in studies of tussock grassland moths were flight ranges of up to 300 m were recorded from distinctive host plants (White 1991). The semi-specificity in light trapping with low set traps makes it possible to distinguish approximately which habitats are favoured by some moth species. This can help narrow the range of likely host plants where this is unknown. In this study, the food sources are unknown for 13 of the 60 species of moth and butterflies. Malaise traps collected the pine tree aphid and small numbers of the well known wood boring beetles (Appendix 1). There were low numbers of the yellowy and small bush ant *Prolasius advena* among the pine shelter belt litter. This ant is associated with low growing vegetation litter in bush in the North island (Cumber 1959).

No insects or their damage was apparent on the gorse and broom, but small numbers of the gorse seed weevil and the broom twig miner were recovered during sweeping and in the malaise traps respectively. The nearest broom was over 60 m from the malaise trap, so it was probably more common than it is rated in Appendix 1 on the basis of the number of specimens. The biology of this twig miner has been investigated in New Zealand (Scheele & Syrett 1987). It usually reduces both twig growth and flower production (Memott *et al.* 1997), and infrequently it kills patches of broom plants. Nevertheless it is still important to remove isolated broom plants before they become four years old, because seeds are spread up to 3.5 m from each plant and within 6 years seed banks of about 400 per m^2 form in drier areas such as Mcleans Island (Allen *et al.* 1995). Only three other insect species are usually recorded from broom:- the aphid *Brachycaudis helychrysi*, the leaf roller *C. obliquana* (twigs) and *Thrips obscuratus* (flowers) (Syrett 1993). These insects are likely to be present on broom and the thrips in gorse flowers at McLeans Island. Catsear galls were quite common. There were leaf mines in fireweed *Senecio* sp., which were probably *Chromatomyia syngenisae* (formerly *Phytomyza atricornis*). This western European fl favours various Compositae leaves (Spencer 1973), and fireweed is among the recorded hosts (Harrison 1959).

Predators and parasites

Spiders and ground beetles were the dominant ground predators with limited biodiversity (Table 5). The main spider species hunt rather than using webs to capture their prey except for *Lepthyphantes tenuis* and *Eriogone wiltoni,* which use sheet webs. Only the brown banded or garden wolf spider *'Lycosa' hilaris* was relatively common at both McLeans Island and Travis wetland (Macfarlane *et al.* 1998). Barer silty sites favoured the turret spider *'Pardosa' bellicosa* with its grey chevron pattern. Up to 0.84 of these wolf spiders were collected per night per trap. The turret spider uses holes 50-75 mm deep (Forster & Forster 1973). Vink in our survey found *P. bellicosa* do not make their own holes in tests in uncompacted silt. These spiders, the nursery spider *Dolomedes minor*, the yellow with dark banded *Cambridgea antipodiana* and the long tipped spider *Aranea feredayi* are all relatively large spiders with striking colour patterns (Appendix 2). A small grey bodied undescribed species of jumping spiders (Salticidae) were quite common hunters in the sandy marram grass area.

The commonest parasitic tachinid fly species were *Pales ?nyctemeriana* was relatively common at sites A and C, and its hosts (sodwebworm moths) were readily seen in this grass habitat. 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). A grey tachinid was associated with *Raoulia* later in the season and several flies were collected in May.

The ratio of insect species at McLeans Island was 7.2 herbivores to 1.5 parasites to 1 predatory species compared to a 5.4 to 2.5 to 1 ratio at Travis wetland. The parasite to ratio at McLeans Island is probably higher than that measured, because of losses to the malaise trap catches, when these were damaged in the wind. This problem was not experienced at Travis wetland. Malaise traps collected seven Ichneumonidae and seven Braconidae species. There were two species of Diapriidae wasps at McLeans island (Appendix 1). Bethylinae species are only known to parasitise fungus and root gnats (Goulet & Huber 1993).

More of the tiny parasitic wasps (superfamily Chalcoidea, Megaspilidae, Scelionidae, Platygasteridae) were trapped at the pine shelter belt in the malaise trap. Only in the vicinity of the long marram grass were any chalcoids prominent. There were nine species in the grassland and two species in the tree shelter belt areas.

Flower visitors and pollination

Catsear had the most prominent flowers throughout McLeans island in January/February. Bumble bees *Bombus terrestris* and honey bees *Apis mellifera* visited catsear flowers sporadically. Honey bees used the white clover flowers by the gun club headquarters, and *B. terrestris* used the limited patch of viper bugloss flowers. No insect were seen visiting the flowers of *Muehlenbeckia axillaris* even in fine quite warm weather, which indicates low nectar secretion much like the commoner *M australis*.

Leioproctus fulvescens apparently had low populations, because none were seen on the catsear flowers and no nests among the silt were apparent during the study. However, the water traps among the *R. australis* patch collected one male and in coastal Canterbury this species is most active in nesting in December (Macfarlane pers. observations). This common south island yellow species visits catsear, *Raoulia* and mainly other Compositae flowers (Donovan 1980, Quinn 1984). Mat daisies *R. australis* had formed seeds apparently quite satisfactorily, which inferred that pollination presumably by the introduced bees, flies or native bees had been achieved earlier. Only the taller native broom plants of *Carmichaelia australis* flowered and also formed dark purple seeds. This silty and sandy area would have suitable ground for the other *Leioproctus* species, which are the most frequent visitors of their flowers in Canterbury known to Macfarlane. Honey bees may visit the flowers and were possibly responsible for its pollination, because the other less common generalist pollinator in the area *B. terrestris* does not visit their flowers readily. No certain assessment was possible on which bee species was responsible for the pollination because observations were limited to a few minutes during flowering on 9 December 1998 and native bees were at best apparently uncommon in the area.

For research on pollination of native subalpine plants at McLeans Island (Table 1) offers considerable potential as a readily accessible site during spring and early summer. The low growing perennials and *Olearia odorata* have small shallow flowers (Alan 1961, Salmon 1968) and so short tongued native bees, flies and even beetles are likely to be effective pollinators provided they move adequately among plants needing cross pollination (Roubik 1995). Pollination of the flowering perennials remain unstudied except for kowhai and matagouri (Primack 1978, Godley 1979) and accessibility is favourable compared to Cass, where most of the previous studies have been made.

Ground and litter dwellers

Grassland ground dwelling and litter decomposing invertebrates were dominated by the large ground weta. This weta *Hemiandrus* is a new species, that was confined to the grasslands and it is nocturnal. This grey weta is one of seven described and about 25 undescribed species in New Zealand (Johns 1997). It is quite common within its quite restricted known range of Banks Peninsula and Christchurch (Johns pers. comm.). In Canterbury, this undescribed *Hemiandrus* ground weta feed on grasses and forbs, and even climbed trees to feed on apricot fruit (Wahid 1978), but what other plants they prefer not to eat apart form *Oxalis* is unknown.

By contrast the litter and wood decomposing invertebrate fauna of the tree and shrubland patches was much richer in smaller beetles species and fungus gnats. Within the pine shelter belts, the brown cave weta *Pleioplectron simplex* was important in terms of biomass and it was confined to sites with pine or kowhai trees (Table 5). This is among the more common weta species (Johns pers. comm.) and is widespread within Canterbury with records from Banks Peninsula reserves (Johns 1986), Cass beech forest (Burrows 1977) and Hamner State Forest park (Johns 1980). These wetas are reputed to feed on decaying litter from apparently from only cursory examination of their diets (Salmon 1956, Richards 1961ab,1962). Banks 1995 (Zoology 205 project) showed the gut contents from wetas taken at Travis wetland was largely a dark vegetation free slurry with a some fungal spores and an occasional mite. Fungus gnats were most numerous and diverse in the *Pinus radiata* shelter belt in the malaise traps and also in light traps with 36 per hour (83 % *Mycetophila fagi*) being collected among the pines. Rotting wood or litter did support the less spiny legged Keratoplatinae *Macrocera ?milligani* at site 1. The species diversity was at least a good as at Travis wetland, but the population were considerably lower due to fewer *Anomalomyia guttata* being present. The thickest grassland light traps attracted 5 Mycetophilidae per hour and only 0.7 per hour at the *Raoulia* patch. This emphasizes the importance of litter bearing fungi to these flies. The two gall midge species were concentrated in the pine shelter belt, and may have been fungus feeders from among the litter. In terms of biomass the beetles were least important, but it is apparent that at least kowhai-matagouri site within 30 m of the pine shelter belt maintained a modest part of the fungal and decomposing beetle species that Macfarlane identified from among Christchurch broadleaf forest remnants (Cone *et al.* 1999, Keesing *et al.* unpublished).

Aquatic insects

Only caddisfly adults were collected. The presence of 14 species is of moderate biodiversity and the common species in Canterbury are well represented (Appendix 1, Knox 1969). The best sites in Canterbury with native bush can have 25-40 caddisfly and several mayfly, dobsonfly and the Mecoptera species present. 86% of the 49 caddisflies were collected within 70 m of the stock water race at sites 1,2 and 3. They were mainly taken in light traps, but 3 were collected in the malaise traps. Several pond species including two damselfly species and a few water beetles and bugs may inhabit the small pond between the southern shelter belt.

Curiously the highest rate of midges collected at night was at the *Raoulia* site 12, and perhaps these included aquatic species from Orana park trenches. Others were seen in the evening in the vicinity of the water race. These flies were not readily identifiable. The majority of Chironomidae species in New Zealand are aquatic.

Sampling methods and skinks

Pit fall traps in the shelter belts collected a wider range of insect species (beetles, flies, booklice and parasitic wasps) than in the grassland. Malaise trapping indicated that the pine shelter belt favoured fungus feeding flies of Mycetophilidae, Phoridae, Cecidomyiidae and booklice, but the combination of strong tree damaging winds and exposure of the open bottomed pine shelter belt damaging the head of the malaise traps prevented faunal differences from being measured properly. Malaise traps still captured most of the species in Appendix 1.

The common skinks was seen twice during the course of the survey in the longer marram grass and long grass in the vicinity of site 1 and in long grass by the pine shelter belt. One skink fell into the water traps, which was a much lower rate than in the willow/manuka area at Travis wetland.

ANALYSIS AND CONCLUSIONS

Biodiversity and similarity to other sites

The dry grassland of McLeans Island on gravely and silty soils supported a reasonably diverse invertebrate fauna considering the moderate native and introduced plant diversity. This fauna accounted for 4.2±2.1% of insect species in New Zealand from the average for 10 terrestrial insect orders found in this survey. Previous more extensive surveys among tussock grasslands at Cass (White 1964, 1991, Burrows 1977) from the gravely Ellesmere spit (Patrick 1994) and in central Otago upland grasslands (Barratt 1983, Barratt & Patrick 1987) recorded 2.6-9.7% of the respective New Zealand fauna examined. 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. Overall an estimated 209-274 insect species probably dwell in the grasslands. If it is assumed a further 25 % of the more uncommon or localized species were missed then there are at least 209 species of insects in the McLeans Island grassland. An estimate of 262 species for the grassland is derived from the 168 species found in grassland (Appendix 1) and at least 94 more species likely to occur in lowland Canterbury grasslands (species-moths 25, beetles 20, bugs 17, springtails 15, thrips 8, flies 4). An alternative estimate of 147-274 insect species for the area is obtained by assuming the 23 indigenous plant species at McLeans Island have the national average of known and estimated insect species (Emberson 1998) per vascular plant species and 21 introduced species also have the average diversity of one insect species per plant species. The 229 "proven" species would suggest that the list of insects collected from the survey represents most of the commoner and even many of the more localized species. The proven diversity also indicates that the lower plant biomass support only a modestly lower diversity of invertebrates per plant species compared to Travis wetland. More rigorous sampling of moss, lichen and litter that involves extraction with light and heat (Tullgren funnels) is likely to reveal a few small to tiny bug and beetle species characteristic of these habitats. Eventually when badly overdue (110 years old studies) taxonomic revisions of the extensive New Zealand Staphylinoidea and Byhrridae beetles have been completed, then some of these presumably less mobile small insects are likely to be found in localized in parts of New Zealand including Canterbury. A few more unusual species of Phoridae flies may be associated with toadstools growing in the grassland and these might be readily revealed by rearing from the decaying fruiting bodies of these fungi.

At least four insect species (three moth species, a ground weta) and one spider species at McLeans Island are confined to similar areas in Canterbury or parts of Canterbury and central Otago. The extensive moss and limited cushion plant community harbour other characteristic weevil, moth and perhaps moss beetles and bugs that have limited representation in Canterbury reserves. Any parasites on these insects could well be locally rare or even approaching endangered status at McLeans Island. Further sampling of moth, herbivore Diptera (Cecidomyiidae) and beetles could eventually reveal a few more species associated with the native herb species, where no known insect species have been recorded so far. Hence for conservation it is advisable to keep the cushion and herbfield parts of this area as free from invading weeds as possible and to use other sites free of these native plants, when the pine shelter belt area is modified.

The grassland could be rather species rich in Hymenoptera (parasitic wasps) and perhaps Diptera (flies) and may be rather species poor in Coleoptera (beetles). 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, 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 in spring, because their predators (brown lacewings, mainly the small hover fly, nabid bugs, and ladybird beetles) were still present in the grassy areas.

The grassland with its unusually extensive amount of moss provides a valuable complement to the range of habitat for Canterbury invertebrates and it has only moderate levels of common species with Travis wetland or a native forest reserve (Table 3). For herbivores the beetles, moths and Orthoptera of McLeans island are mainly characteristic grassland species found in much of New Zealand pastures. McLeans Island shares 40-52 % of the species with pastures from lowland Canterbury and eastern South Island sites (Macfarlane 1970, Moeed 1976, Johns 1986, Sivasubramaniam *et al.* 1997), but only 14 % with the wetter Travis wetland and North Island pastures and crops (Cumber 1959b, Eyles 1961, Kuschel 1990).

For flies, the least similar grassland were from the North Island with 24-44 % of species in common (Cumber & Harrison 1959, McGregor *et al.* 1987) compared to 46-63 % from Travis wetland (Macfarlane *et al.* 1998) and 44-73 % from the drier Canterbury grass and lucerne fields (Macfarlane 1970, Johns 1986, Bejakovitch *et al.* 1998). A continuum of litter accumulation and wetness ranges from the dry and relatively litter free McLeans Island to the higher littered lucerne (Macfarlane 1970) and the wetter North Island pastures, roadside long grass and crops. Unlike these wetter or more heavily littered habitats McLeans Island grassland had no *Psilopa metallica, Poeciloheteraerella* species, *Scatella* species, *Prosopantrum flavifrons, Scaptomyza fuscitarsis* and most *Hydriellia.* Other *Scaptomyza* and *Hydriellia* species include one leaf mining species so perhaps the other *Scaptomyza* and *Hydriellia* species feed on pastoral and crop herb species not at McLeans island. The other small fly species are likely to feed on either the decaying litter or the fungi or bacteria that grow on it. However, the dry grassland had none of the introduced herbivorous gall midges that were present in Travis wetland pastures and the only fungal or detrivore Cecidomyiidae were confined to the litter of the pine shelter belt. No galls from gall midges were seen on the native brooms, but galls are known on native broom at Cass (Burrows 1977).

The crickets, grasshoppers 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). The three booklice were not identified but most probably were common to the 13 species from Banks Peninsula reserves (Johns 1986).

The spider complex from near pastures at McLeans island resemble that from grassland most closely for Linyphiidae and Lycosidae (Martin 1983, Forster *et al* 1988, McLachlan 1996, unpublished). However, it does have the relatively unknown grey wolf spider previously only recorded from Ellesmere spit and central Otago. The spiders in the pine shelter belt, marram grass and kowhais include the more adaptable native and introduced woodland species. The overall spider complex had a higher 33 % of introduced species than the 19-26% estimate for the insects, which is not surprising because the bulk of the native spider species are confined to forests.

Characteristic dry grassland species and localized species losses

Many moth, beetle and bug species that favour short grassland, moss or kowhai plants were shown to be present at McLeans Island. However, the more limited areas of cushion plants and all the climax shrubs and trees (kowhai, matagouri, native broom and *Olearia odorata*) had either lost all their characteristic fauna or the populations appeared to be precarious. The sole *O. odorata* has apparently lost all its herbivores and it remains to be determined if any of the known moths from this species (Patrick 1994c) are retained in the scattered plants in the miners road area (Meurk & McCombs 1994). *Olearia* with monophagous herbivore groups is among the best genera after *Coprosma* in sustaining specific insect hosts (Dugdale 1975). Part of this is due to a combination of plant specificity and limited plant populations resulting in the real absences from McLeans island and partly it is due to the smaller, more cryptic and less mobile insects escaping detection during the limited period of this study. Perhaps these ground nesting bees need more friable soils to nest in.

Until the hosts of many of the parasites are collected and known from this short dry grassland it is difficult to predict, which or any of the uncommon or distinctly localized Ichneumonidae or Braconidae are vulnerable to local extinction. Patch size and isolation are likely to be most critical for parasites that rely on monophagous (e.g. matagouri) or oligophagous (e.g. kowhai & native broom, native Compositae) insect hosts.

Research and education prospects

The proximity of McLeans Island 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. 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 the short grassland and cushion herbfield at McLeans Island. 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

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. Development of alternative pine shelter belt plantings for control of sand blowing should endeavor to use grassland with few native herbs and if where possible also endeavor to restrict gorse and broom areas. Any new tracks or planting of amenity trees in the southern part of the gun club area should avoid the least fertile cushion plant gravel areas for the sake of conserving plant and invertebrate species and to improve the success in growing such trees.

The education potential of the short grassland has some real merit, because the more restricted abundant flora and invertebrate species allows for potential to study such common grassland invertebrates as the sod web worms and the native crickets and the biology and incidence of their parasitoids or pathogens with few complications. There remains after this introductory investigation quite an amount of plant/insect relationships to discover too.

Flower sources for bees, flies and parasitic wasps at McLeans island are impoverished until summer and even then quality nectar sources (vipers bugloss, white clover) are scarce. In early spring gorse and then broom provide limited mainly pollen sources and the limited amount of kowhai quality nectar secretion. For two distinct species groups of *Leioproctus* native bees the flowers of the common mat daisy *Raoulia* and native broom *Carmichaelia australis* will provide their main food source (Donovan 1980) if the species still survive in the area. This must be in doubt for the native broom, because the amount of flowers available was tiny. Flowers of the sole *Olearia* shrub are likely to support nectar loving beetles and flies.

The development of shelter belt fringes to include extra species of native shrubby species would benefit from the use of summer flowering *Hoheria*, autumn flowering *Olearia* and any of the hardiest late spring to summer flowering *Hebe* and *Parahebe* species for fly, bee and parasitic insects. Amongst the introduced species incorporation of late spring to autumn flowering *Eucalyptus* trees will improve nectar resources in this area.

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APPENDIX 1 INVERTEBRATES RECORDED FROM MCLEANS ISLAND (229 terrestrial insect species, 40-67 introduced or indigenous species)

LEGENDS, CODES (A) = Introduced and indigenous species; the others endemic species only found in New Zealand
% = of total New Zealand species

Habitat for immatures of invertebrate species: A = aquatic, C = carrion, D = dung, Gen = generalist to both tree and grasslands T = tree or shrubland, includes litter or rotten wood V = vagrant to grassland/pines Unstated generalist or grassland species

Abundance: Abundant = over 20 insects in malaise or 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.

Biology: (Literature summary of phenology, habitat and host records are listed at the end in brackets).

Shared with studies either in grassland:- **1** = East Otago & Mackenzie basin (Barratt & Patrick 1987, Patrick 1989, 1992, 1994 c, Barratt & Kuschel 1997) **2** = Cass (White 1964, 1991, Burrows 1977) **3** = Kaitorete spit, by L Ellesmere (Patrick 1994a) **4** = Travis wetland, east Christchurch (pasture-regenerating forest) (Macfarlane *et al* 1997) **5** = Nelson grazed pasture (Martin 1983) **6** = Canterbury lowland pasture, lucerne or carrot fields Macfarlane 1970, Johns 1986, Sivasubramaniam *et al.* 1997, Bejakovich *et al.* 1998, Barratt *et al.* 1998) **7** = Manawatu and North island grassland (Cumber 1959a-d, 1960 a-b; Cumber & Harrison 1959, Gaskin 1970, McGregor *et al.* 1987) or mature Christchurch native forest **8** = Riccarton Bush (Molloy 1995, Keesing *et al.* unpublished, Cone *et al.* 1999)

INVERTEBRATE TAXA	**Literature**	**Habitat, abundance**
COLEOPTERA	**42 species**	**(0.8% of 5235 NZ spp)**
Anobiidae		**Wood borers**
Ernobius mollis		**T** Pine shelter belt, uncommon Jan.
Undetermined species	8	**T** Pine shelter belt, uncommon
Anthicidae	**Ant beetles**	**Scavengers in litter and logs**
Undetermined species	?5	Pitfall trap, marram grass area, uncommon
Anthribidae	**Fungus weevils**	**Mainly fungal feeders**
Helmoreus sharpi	4,6,8	**T** Kowhai-matagouri site (also beech, podocarp, willow bark or wood), uncommon Dec. (September-March)
Brenthidae	**Giraffe, seed weevils**	**Seed and stem feeders**
Apion ulicis (A)	2,4-6,8	**T** From gorse, uncommon Jan. Gorse seed weevil
Carabidae	**Ground beetles**	**Most species are ground predators**
Harparphax antarticus (A)	6-7	Commonest moss open grassland, uncommon dense grass, locally abundant Jan-Feb.
H. australis (A)	6	Grassland, less common, Jan. (medium size)
Megachlothorax rotundicollis (A)	2,4-7	Grassland, uncommon, Dec. (smaller)
Metaglymma monolifer	2,6	**Gen.** Grassland & pines except for barest sandy or gravel sites, common (largest)
Neocicindela dunedense	6	Bare & mossy sites mainly, locally common Dec.-Feb. Smallest tiger beetle
Notobia species (A)	6	Grassland, uncommon (medium size) Jan.
Cerambycidae	**Longhorn beetles**	**Mainly wood feeders**
Hybolasius species	?6,8	**T** Kowhai-gorse site, locally common Jan.,Feb.
Prionoplus reticulatus	6-7	**T** Pine shelter belt, flight at night Jan. Huhu beetle
Xylotoloides species		**T** Pine shelter belt, uncommon Jan/Feb.
Coccinellidae	**Lady bird beetles**	**Immatures, adults aphid, scale predators**
C. undecimpuncata (A)	2,4-8	**Gen** On kowhai trees Hemiptera predator, less common Dec.- Jan. 11 spotted lady bird
Rhyzobius forestieri (A)	4,8	**T** On kowhai tree, likely prey, nymphs of booklice or psyllids, uncommon Feb.
Undetermined species		Vacuumed off *Scleranthus*
Corylophidae	**Hooded beetles**	**Fungi, decaying material or moss eaten**
Species 1	?5,8	**T** From kowhai-matagouri area, uncommon Dec.

Cryptophagidae Silken fungus beetles		**Funfi or plant debris**
Species 1	?2,8	**T** From kowhai-matagouri area, uncommon Dec.
Curculionidae Weevils		**Plant, twig, wood feeders**
Cossinine species	?6,8	**T** Pine and kowhai ground zone, uncommon Jan.,Feb. (Often in dead twigs)
Desiantha maculata (A)	6	**Gen** Pine ground zone, uncommon Jan. Carrot weevil
Hylastes ater (A)	6	**T** Pine shelter belt, uncommon Feb. Black pine bark beetle (pine logs)
? *Irenimus* species 1	?2,6	**T** Pine ground zone, uncommon Jan.
? *Irenimus* species 2		Associated with *Raoulia australis,* less common Jan.
? *Irenimus* species 3		Kowhai-moss site, uncommon, Jan.
Otiorhynchus ovatus (A)	6	**V** Grassland, uncommon Jan. Strawberry root weevil
Species 1		Marram grass ground zone, uncommon Jan.
Species 2		Associated with kowhai/matagouri site, uncommon Feb.
Species 3		Ground zone, kowhai -mossy area, Dec. uncommon
Species 4		Associated with *Scleranthus uniflorus,* uncommon
Elateridae Click beetles		**Mainly omnivorous root feeders can be predatory**
Conoderus excel (A)	4-7	Under stones in May, common (Pasture roots) Pasture wireworm
?Languriidae Slender beetles		**Associated with litter and flowers**
Species 1		Water trap, *Raoulia* site
Lathridiidae Mildew beetles		**Fungal feeders**
Cortinicara hirtalis (A)	5	Pasture, kowhai, locally common
Melanophthalma gibbosa	5-6, ?2	Among grass, shrubs and trees, less common
Salpingidae Bark mould beetles		**Foliage or fungus feeders**
Species 1	?8	**T** From kowhai-matagouri site, uncommon, Dec.
Scarabaeidae Grassgrub,dung,manuka beetles		**Major soil root and organic matter feeders**
Aphodius tasmaniae (A)	6	Grassy sites, common (pasture & dung feeder) Tasmanian grass grub
Odontria smithii	2,6-7	Site 1 Marram & introduced grasses,locally common
Pericoptus ?truncatus	6	Larva in sandy marram grass area, uncommon Sand grass grub
Staphylinidae Rove beetles		**Often predators but some fungi feeders**
Species 1-3	?2,4-6	Light brown, kowhai-marram grass area, uncommon Feb.
Species 4		**Gen** Pine and kowhai ground zones, uncommon Dec. - Jan.

COLLEMBOLA	**Springtails 4 species**	**(1.1 % of 354 NZ species)**
Entomobryidae		
?Entomobrya nivalis (A)	?4,6,8	Kowhai-marram grass, less common
Hypogastridae		
Hypogastrura rossi	4,6,8	Moss, grass sites, abundant
Species 1		Mainly pine and moss areas, locally common
Sminthuridae		**Herbivore**
?Bourletiella species (A)	?4-6	Introduced grassland, uncommon

DERMAPTERA	**Earwigs 1 species**	**(4.5 % of 22 N Z species)**
Forficulidae		
Forficula auricularia (A)	2,4,5-8	Kowhai trunk at night, uncommon European earwig

DIPTERA	**41 species**	**(1.7% of 2353 N Z species)**
	SUBORDER NEMATOCERA 17 Species	
Cecidomyiidae	**Gall midges**	**Herbivores or predators can be rather host specific**
Species 1-2	?5	Pine shelter belt, less common and uncommon
Ceratopogonidae	**Biting midges**	**Larvae aquatic or in damp areas**
Species 1	?6	Pine shelter belt, uncommon
Chironomidae	**Midges**	**Larvae aquatic**
Species 1	?5-6	Aquatic, water race and mat plant ara,
Keroplatidae	**Fungus gnats**	**Includes predatory glow worms**
Macrocera milligani	4,6	Kowhai -marram grass area, less common

Mycetophilidae		**Fungus gnats** **Mainly feed among rotting material**
Anomalomyia guttata	4,6	General, quite common
Mycetophila colorata	2,4,6	Pine shelter belt - Kowhai -marram grass area, less common
M. fagi	2,6	Pine belt, common (Widespread common forest species)
M. marginepunctata	2,6	Pine belt,uncommon (Widespread common forest species)
M. subspingera	5-6	Pine belt, uncommon
M. species	?6	Pine belt
Tetragoneura species	?6	Pine belt, uncommon
Zygomyia fusca-penicillata		Pine belt, uncommon
Psychodidae		**Moth flies** **Feed among decaying vegetation in wetter sites**
Psychoda species	?2,4-6	Pine shelter belt, uncommon
Sciariidae		**Root gnats** **Root, organic matter,fungus feeders**
Species 1	?2,4-7	Mainly grassland, but also pine area, common
Species 2	?2,4-7	Mainly grassland, less common
Tipulidae		**Crane flies, Daddy long legs Feed among roots, decaying vegetation**
Species 1	?2,4-7	? aquatic, Grass -rush associate, less common
		SUBORDER BRACHYCERA 24 SPP
Agromyzidae		**Leafminer flies** **Leaf mining herbivores**
Cerodontha australis (A)	2,4-7	Grassland, locally common,mainly diurnal, (Grass leaf miner hosts Spencer 1976)
Chromatomyia syngenisae (A)	4,6,7	Grassland, leaf mines in fireweed *Senecio* species (also plantain, thistles).
Asilidae		**Robber flies** **Predators of soil larvae, medium and larger flying insects**
Neoitamus melanopogon	2,6,?7	Grass area,uncommon (larvae general soil predator, adult flying insects)
Saropogon sp	2,6,?7	Grass -moss areas, locally common (larvae general soil predator, adult flying insects)
Calliphoridae		**Blow flies** **Breed mainly in carrion, but adults use dung, flowers for food**
Calliphora vicina (A)	2,4-7	On dead hare,localized uncommon, Jan. (carrion, all year, especially spring)
Lucilia sericata (A)	2,4-7	On dead hare,localised uncommon, Jan. (carrion, commonest mid summer)
Xenocalliphora hortona	4,6,7	Sunning in *Raoulia* patch, uncommon, May (carrion, commonest early summer, pastures)
Chloropidae		**Frit, stem flies** **Includes pasture pests in Northern hemisphere**
Gaurax ? flavoapicalis	?4,6	Grassland, attracted to invertebrate carrion, locally common
Dolichopodidae		**Long legged flies** **Adults predators of smaller soft bodied prey**
?Chrysotus vicinus	4,6	Grassland, uncommon
Parentia mobile	4,?6-7	Long grass associate, uncommon
Tetrachaetus bipunctatus	4,6,?7	Grassy areas, less common
Muscidae		**House, stable, testse flies** **Scavenging to blood sucking flies**
Spilogona aucklandica	4,?6,7	Ungrazed rush,sedge, grass associate
S. dolosa	4,?6,7	Grassland, uncommon
Species 1	?6	Grassland, uncommon
Phoridae		**Hump backed flies** **Mainly feed on smaller carrion and rotting vegetation**
Species 1 & 2	?2,4,6	Pine trees
Sarcophagidae		**Flesh flies** **Dung feeders**
Hybopygia varia (A)	2,4-7	Grassland-*Raoulia* areas common (Fresh cattle dung, pastures) Striped dung fly
Sphaeroceridae		**Feed on decaying material**
Kimosima thomasi	4-6, ?2	Grassland mainly, breds in decaying material
Syrphidae		**Hover flies** **Aphid predators, decomposers or herbivores, adults pollinators**
Melangyna zealandica	2,4-6	Uncommon (aphid predator) Large hover fly
Melanostoma fasciatum	2,4-6	*Raoulia* area, uncommon (aphid predator) Small hover fly
Tachinidae		**Mainly caterpillar parasites**
Pales ?nyctemeriana	2,4	Grassland, ? sod webworm parasites
Protohytricia alcis	2,4	Grassland, porina parasite
Species 1		*Raoulia* area, less common, May
Therevidae		**Stilleto flies** **Larvae light soil predators, adults non predatory**
Anabarhynchus sp.	?2,4,6	Grass and pine area,less common

HEMIPTERA		**13 species (1.4% of 907 NZ spp)**
Adelgidae		**SUBORDER HOMOPTERA**
Pinus laevis (A)	?6	Sap feeder of pine foliage,less common
Aphrophoridae		
Philaneus spumarius (A)	4	On catsear, uncommon Dec. (polyphagous) Meadow spittle bug
Cicadellidae		**Leafhoppers** **Often rather host specific herbivores**
Arawa ? salubris	?6	Grassland, less common Dec.
Horouta inconstans	?4,6	Grass & marram grass, uncommon Dec.- Jan
?Nesoclutha obscura	?6	Grassland, dark species, uncommon Dec.
Zygina zealandica (A)	4-6	Grass,uncommon, probably mainly on herbs
Delphacidae		**Seem to be rather host specific herbivores**
Species 1	?2,6	Grass, uncommon Jan.
Pseudococcidae		**Mealybugs** **Mainly above ground herbivores**
?Balanococcus poae	4	On marram grass roots/ may be pemphigine aphid *Aploneura lentisci*
Psyllidae		**Hosts often one or a few plants**
Trioza discariae	2,6	T Matagouri, less common, restricted to matagouri host Jan.
Psylla apicalis		Associate with kowhai -matagouri area Jan.
		SUBORDER HETEROPTERA
Lygaeidae		**Can be flower and seed feeders**
Nysius huttoni	2,4-6	Mainly mat plants *Raoulia-Scleranthus*, common (Mostly Nov.-April) Wheat bug
?Plinthisis species		On *Scleranthus uniflorus*, uncommon Dec.,Feb.
Species 1		Grassland site 1, uncommon Jan.

HYMENOPTERA	**Wasps, bees, ants, sawflies**	**41 species (3.7 % of 1106 NZ spp)**
Aphelinidae		
Near *Ablerus* (new species)		Pines, ground level, uncommon
Pteroplex new species		Kowhai, uncommon
Species 1		Matagouri, uncommon
Apidae	**Social bees**	**Major pollinators of introduced and some native plants**
Apis mellifera (A)	2,4-6	Grassland, uncommon (all year) Honey bee
B. terrestris (A)	2,4-6	Catsear, vipers bugloss flowers,less common (all year) common earth bumble bee
Bethylidae		
Goniozus ? antipodus (A)	6	Mat daisy *Raoulia* area, (leaf roller parasite), uncommon
Braconidae		**Parasitic on many insect groups**
Apanteles sp	?2,4-6	Kowhai site 10, grassland,uncommon Jan Hosts mainly caterpillar, common
Rogas sp	5-7	Kowhai site 10, grassland,uncommon Jan. Hosts cutworms
Species 1-2	?6	Kowhai site 10, grassland,uncommon Jan. Hosts unknown
Species 3		Pine shelter belt, uncommon Feb. Host unknown
Species 4		Mat daisy *Raoulia* area, uncommon Jan. Host unknown
Species 5	?6	Moss-lichen area, uncommon Feb. Host unknown
Colletidae		
Leioproctus fulvescens	2,6 ?5	Mat daisy area, uncommon (summer visitor of Compositae flowers), uncommon
Cynipidae		
Phanacris hypochaeridis (A)	2,6	Gall of catsear stems, common
Diapriidae		**Mainly parasites of flies**
Species 1 and 2	?6	Pines ground level, uncommon possibly fungus gnat larva
Encyrtidae		
Species 1 (?A)	?6	Marram grass area,ground level, common
Eulophidae		
? *Elarchartus* species		Kowhai-matagouri, aerial, less common
Species 1		Pine trees ground level, uncommon
Species 2	?6	Kowhai grassland, ground level, abundant
Species 3		Matagouri associate,uncommon
Eupelmidae		
Macroneura vesicularis (A)	4	General grassland parasite

Formicidae	**Ants**	**Omnivores-predators**
Hypoponera eduardi queens (A)	5	Kowhai tree, locally common, May
Monomorium antarcticus	2,4-7	Omnivore, commonest in bare drier *Raoulia* area, uncommon grassland Southern ant
Prolasius advena	4,6	Pine shelter belt, localised, less common small bush ant
Halictidae		**Native ground nesting subsocial bees**
Lasioglossum sordidum	4,6	Marram grass area, uncommon (generalised visitor mainly of small shallow flowers)
Ichneumonidae		**Parasitic wasps of many insects orders (host unknown unless stated)**
Aclosmathlon new species 1		Pine shelter belt, less common
A. new species 2		Kowhai area, uncommon
Aucklandella 3 species	?4-6	Grassland, uncommon
Degithina species	?2,4,6	Grassland, uncommon
Lissonota flavopicta		Pine shelter belt, uncommon
Megaspilidae		
Dendrocerus species (A)	4-6	Matagouri, uncommon (hyperparasite, hosts Aphidiinae)
Pompilidae		**Predatory spider hunters**
Priocnemis crawi	?4,6	Grassland, locally common, smaller black species (Tends to use tiger or native bee holes) Prey day active spiders probably includes common brown wolf spider
Pteromalidae		
Species 1	?2,4-6	Kowhai-red moss areas, ground level & aerial, less common
Species 2	?6	Marram grass, ground level, uncommon
Species 3	?2,5-6	Kowhai-grassland, groundlevel, uncommon
Species 4	?6	Pines, ground level, uncommon
Sphecidae		**Mainly ground nesting, insect-spider predators**
Rhopalum zelanum	4	Kowhai, uncommon
Tenthredinidae		**Sawflies, larvae rather sluglike rather host specific herbivores**
Pontania proxima (A)	4,6-7	T By Pine trees on crack willows Willow sawfly
Trichogrammatidae		
Trichogramma ? new species	?2,4,5	Kowhai, ground level, uncommon, moth egg parasite

LEPIDOPTERA **Moths and butterflies** **61 species (3. 5 % of 1765 NZ spp)**
*** = flight period in the Manawatu**

Cosmopterygidae		
Pyroderces deamatella	6	T Pine belt, Jan. (Nov.-March,dead twigs)
Crambidae **Grass moths**		**Main species pasture-soil pests**
Eudonia cataxesta	1,2,7	Common, Feb. (Oct.-April, grasslands,riverbed cushion herbs)
E. diphtheralis	1,5-7	Moss associate, abundant Jan.-Feb. (Nov.-Feb.) Mother of pearl moth
E. leptalea	1-4	Common Feb. (Oct.- May,dry open grass associate)
E. sabulosella	1-3,5-7	Common, Jan.-Feb. (Oct.-April,grasses,herbs)
E. submarginalis	1-3,5-7	?moss associate, abundant Jan. (Nov.-April, turf associate)
Orocrambus flexuosellus	1-7	Grassland,abundant , Jan.-Feb (Nov.-May,Oct.-July* grasses native and adventive)
O. vittellus	1-3,5-7	Common Jan.-Feb. (Nov.-March, grasses native and adventive)
O. vulgaris	1-3,6-7	Common Feb. (Jan-mid April, grasses native and adventive)
Scoparia chalicodes	3,6	Feb. (Oct.-Apr.,turf-matagouri,shrub associate,Lyford 1994, Molloy 1995, Patrick 1995)
Elachistidae		**Leaf, stem, seed miners**
Cosmiotes ombrodoca	1-4,6	Grassland,uncommon Jan. (Aug.-May, *Poa* grass stem miner)
Gelechiidae		**Web spun leaves, shoots**
Kiwaia new species	1,3	Cushionfield associate,diurnal **Dec.** (Sept-Oct.)
K. thyraula	1	Cushionfield associate,diurnal Oct.,Dec. (Nov.)
Geometridae		**Looper caterpillars herbivores**
Arctesthes catapyrrha	1-3	Larvae on *Raoulia australis*,locally common Dec.-Jan. (Oct.-March,also various herbs)
Chalastra ochrea	6	T Kowhai foliage,less common, larvae & adults Feb. (Feb.-April,kowhai)
Chloroclystis filata (A)	1-3,6	Jan. (Aug.- May, a tasmanian moth,shrub flowers)
Declana floccosa	4-7	T Pine belt, Jan. (Nov.-April polyphagous tree foliage) Common manuka moth

Geometridae **Looper caterpillars herbivores**

Epyaxa rosearia 1-4,6,7 Jan. (Aug.-May, herbs) Common looper moth

E. venipunctata 3,6,7 Jan. (Oct.-May, herbs)

Helastia corcularia 1,3,6 Jan. (Oct.-April, larvae on mosses,herbs,lichens)

Hydriomena deltoidata 1,2,4,6,7 Jan. (Nov.-April, Plantago,herbs) Dark-banded carpet moth

Pseudocoremia indistincta 6,7 (Dec.-May, *Muehlenbeckia*) Grey green moth

P. sauvis 6,7 **T** Jan.-Feb. Pine area mainly, common (Oct.-May, polyphagous tree foliage) Black waved brown moth

Scopula rubraria (A) 1-3,5,7 Jan. (Oct.-April, *Plantago,* grassland) Common brown grass moth

Uresiphita polygonalis 6,7 **T** Kowhai, larvae, uncommon, May (Feb. -May, Nov., kowhai, clovers,broom foliage) Kowhai or clouded brown moth

Hepialidae **Porina moths** **Very large non sugar feeding moths**

Wiseana umbriculata 1,2,4,6,7 Tall grass site 1, uncommon Jan. (Nov.-March) Late flying porina

Lycaenidae **Blue and copper butterflies**

Lycaena bolderanum 1,3,4,6 Barer grass areas, less common.,diurnal Jan.-Feb. (Dec.- Feb., host sheep sorrel) Common copper butterfly

Zizina labridus 1,2,5,6 Grassy areas, common,diurnal Jan.-Feb. Haresfoot trefoil likely main host (Oct.-May, clover leaves, short *Carmichaelia*) Little blue butterfly

Lyonetiidae

Leucoptera spartifoliella (A) 2,6 **T/S** Uncommon, Jan. (Jan.-April) Broom twigminer

Noctuidae Cutworm moths

Agrotis ypsilon (A) 1,3,4,7 Grassland, Jan. (Oct.-May, Sept.-June*, polyphagous on leaves & lower stems) Greasy cutworm

Aletia sistens(=*moderatus*) 1-3,6 Grassland, common Jan.-Feb. (Oct.-April,*Poa* grasses, herbs & *Raoulia*)

Euxoa admirationis 1-3,6 Grassland, less common,Jan.-Feb. (Oct.-April,grasslands)

Graphania insignis 1-2,4-7 Uncommon, Jan.-Feb. (Oct.-July, general herb & shrub feeder) Drab red moth

G. mutans 1-7 Less common, Jan.-Feb., (Oct.-May,lupin flowers, pastoral herb) Greybrown cutworm

G. ustistriga 1-7 Less common, Jan.-Feb. (Oct.-April, herb,shrub foliage) Large grey cutworm

Persectania aversa 1-3,5-7 Long grass area,locally common, Jan.-Feb. (Oct.-May, grasses, pastoral herbs) Streaked armyworm

Rhapsa scatascialis 4,6,7 **T** less common Feb. (Oct.-Jan.,dead leaves, debris) Slender owlet moth

Tmetolophota atristiga 1-7 Grassland, Jan.-Feb. (Nov.-April, native & exotic grasses, *Muehlenbeckia*)

T. propria 1,2,6 Grassland,less common,Jan.-Feb. (Dec.-March,native & exotic grasses)

Nymphalidae

Bassaris gonerilla 1,6,7 **V** Dec., uncommon,diurnal (Jan.-Mar., stinging nettle) Red admiral butterfly

B. itea 6 **V** Dec.,uncommon,diurnal (Jan.-Mar., stinging nettle) Yellow admiral butterfly

Oecophoridae

Barea exarcha (A) 6 **T** Pine belt, uncommon, Feb. (Feb.-March, dead wood)

Heliostibes new species Jan. (Sward feeder, quite widely distributed in the South Island)

Leptocroca asphaltis 1 Jan. (Dec.,probably litter, also central Otago & Wellington, Hudson 1928)

L. lindsayi 6 Uncommon, Jan. (Feb., litter)

Prepalla austrina 1 Less common,diurnal, Oct., Dec. (Oct.-Feb.,larvae feed on *Leucopogon fraseri*)

Stathmopoda aposema 6 **T** Kowhai,less common,diurnal Jan. (Oct.,Nov.,March,kowhai pods,seeds)

S. plumbiflua 6 **T** Pine & kowhai areas, uncommon Jan.

Psychidae

Liothula omnivora 4,6,7 **T** Matagouri, uncommon May -larvae (Polyphagous trees,shrubs, Oct.-Mar.) Common bagworm moth

Reductoderces sp 6 **T** Larvae on pines, Jan. (adults often diurnal & females flightless, algae of trunks)

Pyralidae

Crocydophora cinigerella 3,6,7 Herbfields, Oct.,Dec., diurnal (Sept.- April, all year*, host unknown)

Tineidae

Erichthias fulguritella 3,6 **T** Jan. (Oct.-Feb.,in dead wood)

Monopis ethelella (A) 1-3,6 Pine litter-dead grass association, Jan.-Feb. (May-April.,grassland & dead wool)

Tortricidae		**Common pest species generalised herbovires**
Capua semiferana	1-3,5-7	Pine belt mainly,common Jan.-Feb. (Sept-May, all year*,grassland litter)
Ctenopseustis obliquana	7	T Pine belt, Jan.-Feb. (all year*,leaves, seeds, shrubs to orchard trees) Small mottled bell moth, green headed leafroller
Epichorista siriana		Grassland, Jan. (grasses)
Epiphyas postvittana (A)	4,6,7	(Nov.-May,polyphagous trees,shrubs, herb foliage) Light brown apple moth
Eurythecta robusta	3	Diurnal, in *Raoulia* area, less common, Jan. (Oct.-April, grassland)
Harmologa scoliastis	2	Jan. (January, *Muehlenbeckia*)
Planotortrix notopaea	6	T Pine belt, ?uncommon, Feb. (Sept-July, Polyphagous shrub feeder)
MANTODEA	**1 species**	**(50% of 2 N.Z. species)**
Mantidae	**Preying mantids**	
Orthodera novaezealandiae	4,6	T Egg case, Kowhai tree, uncommon May General predator
NEUROPTERA	**1 species**	**(8.3 % of 12 NZ species)**
Hemerobiidae	**Brown lacewings**	**Aphid, soft body insect predators**
Micromus tasmaniae (A)	4-6	Localized commonest among grass and buttercup
ORTHOPTERA	**Grasshoppers, wetas, crickets, katydids 7 species (5.6 % of 124 NZ spp)**	
Acrididae		
Phaulacridium marginale	2,6	Grass to mat daisy area, less common Jan.-May
Gryllidae	**Crickets**	
Pteronemobius 1-2 spp	2,4-6	Grasses, abundant, Jan.-May (Dec.-April, open grassland)
?*Metioche* new species	?2,4-6	Grasses, student collection, uncommon August
Species 1		Undetermined, student collection, uncommon August
Rhaphidophoridae	**Cave wetas**	
Pleoplectron simplex	2,4,6	T Pine site 5, uncommon (also in eastern beech forest)
Anostostomatidae (formerly Sternopelmatidae)		**Wetas or king crickets**
Hemiandrus new species	6	Silty moss areas, locally common Ground weta
Tettigoniidae	**Katydids**	
Conocephalus bilineatus	2,4	Long grass, localized, less common Jan.-May
PSOCOPTERA	**Booklice 3 spp**	**(4.9 % of 61 NZ spp)**
3 species	?2,5-6	Kowhai, matagouri & pine trees
TRICHOPTERA	**Caddisflies 14 species (8.1 % of 172 N.Z. species)**	
Conoescidae		
Pycnocentrodes aureolum	2,6	Aquatic, uncommon
P. evecta	6	Aquatic, uncommon
Hydrobiosidae		
Hydrobiosis clavigera	2,6	Aquatic uncommon
H. parumbripennis	2,6	Aquatic, uncommon
H. umbripennis	2,6	Aquatic, uncommon
Psilochorema bidens	2,6	Aquatic, uncommon
Hydropsychidae		
Aoteapsyche catherinae		Aquatic, uncommon
A. colonica	2,6	Aquatic, pine belt, uncommon
Hydroptilidae		
Oxyethira albipes	2,6	Aquatic, uncommon
Leptoceridae	**Long horned caddisflies**	
Hudsonema amabilis	2,6	Aquatic, less common
Oecitus unicolor	6	Aquatic, uncommon
Triplectides cephalatus	2	Aquatic, common
Polycentropodidae		
Polyplectropus pueralis	2,6	Aquatic, marram grass, less common

TRICHOPTERA **Caddisflies Sericosomatidae**
Olinga feredayi 6 Aquatic, uncommon

DIPLOPODA **Millipedes** **(1.8 % of 60 NZ species)**
Julidae
Cylindroiulus britanicus (A) 4,6 Under kowhai logs, locally less common

ISOPODA **Slaters** **(2% of 48 NZ species)**
Oniscidae
Porcillio scaber (A) 4,6 Among rotting kowhai wood, marram grass, locally common

OPIOLONES **Harvestmen** **(1.2 % of 170 NZ species)**
Phalangiidae
Phalangium opilio (A) 4-6 Grassy area, uncommon (Mainly Jan.-April,pastures-crops, from Europe)
Daddy long legs
Triaenonychidae
Nuncia undet. species ?4,6 Pine litter zone, uncommon
ARACHNIDA **Spiders** **22 species (2.4% of 926 N.Z. species)**
Illustration sources * = Forster 1973, ** Forster *et al* 1988, # Green & Lessiter 1987
Araneidae **Orb weaver spiders, webs vertical or nearly so**
Arachnura feredayi * Web in marram grass, uncommon, prey in web dung fly *Hybopygia varia*
Long tailed spider 15-18 mm long
Argiope protensa * 5 Stout tailed spider
Colaranea viriditas *# ** On gorse Green orbweb spider
Eriophora pustulosa (A)* 4 ** On kowhai trees and matagouri, localised, uncommon. Prey included *Monomorium antarticum* ants. Prefers open spaces, fly, bug to bee prey (Laing 1988)
Clubionidae **Two clawed hunting spiders**
Clubiona undet. species * # ?4-6 Mainly tall grass and pine sites, uncommon, immatures
Corinnidae **Hunting spiders**
Supunna picta (A) 6 (Mainly drier grassland -forest & buildings, body 9 mm long, no web, from Australia
Ctenidae
Horioctenoides undet. sp 5 Body 13 mm long with longitudinal band; mid hind eyes larger,eye rows in double
Gnaphosidae **Hunting spiders**
Anzacia gemmea (?A) * 5-6 (Grassland to bush, likes stone retreats)
Hemicloea rogenhofferi (A) * 6 Pine shelter belt (Prefers bark, log shelters) Flat bark spider
Taiera erebus 6 (Wooded to suburban sites, confined to Christchurch - Banks Peninsula)
Lycosidae **Wolf or ground spiders**
'Lycosa' hilaris *# 4,?6 Mainly in grassy sites, throughout, abundant except for scabweed area (all year)
Banded brown wolf spider
'Pardosa' bellicosa Dunes-silt area, localised in open grass/moss, ground hole retreat in silty soil
Turret spider
P. canescens River bed wolf spider probably unnammed grey wolf spider in Forster 1973
Linyphiidae **Sheet web spiders, webs may be horizontal**
Areoncus humilis (A) Grassland, (Pasture to mossy sites, European spider)
Erigone wiltoni (A) 4,5 Grassland, (Oct.-Feb., pasture to disturbed native beech bush)
Lepthyphantes tenuis (A) * 4,5 (Often in pastures, also pine & bush)
Pisauridae **Nursery web spiders**
*Dolomedes minor** # 4-6 On gorse south of pine shelter belt,uncommon Nursery web spider
Salticidae **Jumping spiders, hunters**
2 undescribed species * Small dark grey species, sandy area by marram grass, prey leafhopper
Stiphiidae
Cambridgea antipodiana Pine shelter belt, uncommon
Theridiidae **Cobweb or comb footed spiders**
Achaearanea veruculata * # 4 Likes settled sites, prey flies,ants, walking prey Garden cobweb spider
Stetoda lepida Pine forest, quite common

APPENDIX 2 KEY TO DISTINGUISH SPIDERS

MAIN GRASSLAND SPIDERS - Plate,figure & page numbers in Forster & Forster 1973
 # = Photograph and comments in Forster and Forster 1970

1 Spider on ground or in grassland, often no web or with horizontal sheet web (Green & Lassiter 1987) ----------2
Spider on shrub or tree, webs vertical or nearly so, form orb (with spokes - cartwheel) or dense tent web (Fig 44 p 96) ---------- Key next section

2 Grey spiders, without a distinct band on the abdomen, on ground in grassland -moss, riverbeds ---------- 3
Brown or yellow abdomen some with lighter bands, orb or no web ---------- 4
Dull black to grey abdomen; brown cepahalothorax; body 1.5-2.5 mm long; hanging sheet web ---------- 6

3 Dark grey, 4-5 mm long; eyes in U formation, larger inner pair face forward, not in ground holes (Plate 59 p 128 - same or similar spider) ---------- ? Riverbed jumping spider Salticidae new species
Body medium grey, off brown abdomen - see cover figure (over 6 mm long); larger 4 eyes on side & upper margin; females shelter in holes in silty areas ---------- Turret spider *'Pardosa' bellicosa*
Body all bright grey; eyes as for turret spider; shelter under rocks-stones ---------- River bed wolf spider *P. canescens*

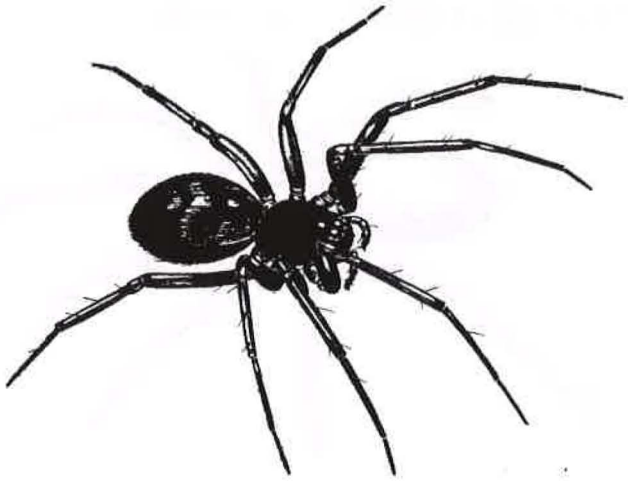
4 Brown, globular abdomen no tapering tip (Plates 25-27, p 80, p 92-93); 4 larger eyes on side & upper margin, parallel to outer eyes (Fig 41 p 87), 6-8 mm long, no web ---------- # Banded brown or garden wolf spider *'Lycosa' hilaris*
Body with black & white marks e.g. (Forster & Forster 1970); front legs red-orangy; compact eye group with hind row in inverted C; no web ---------- # *Supunna picta*
Fully or mainly pale yellow abdomen with tapering tip at least 1/3 of abdomen length (e.g. Fig 101); eyes of same size; 15-18 mm long; orb web ---------- 5

5 Abdomen tip at least 1/2 of abdomen length, with 3 fine darker lines (Plate 84, Fig 101, p 152,165) ----------
---------- # Long tipped or tailed forest spider *Arachnura feredayi*
Abdomen tip up to 1/3 of abdomen length & broad central and side brown bands (Fig 85 p 152) ----------
---------- # Stout tipped or tailed grass spider spider *Argiope protense*

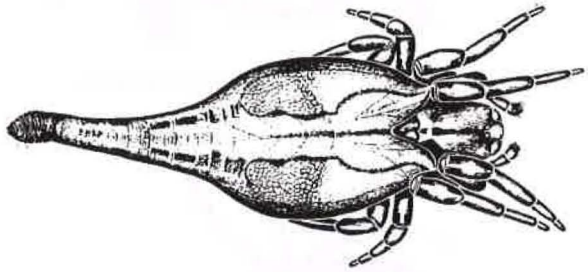
6 Abdomen grey with white blotches and black cross bands; body up to 2.5 mm long ---------- *Lepthyphantes tenuis*
Abdomen only grey, no white and black pattern; body 1.5 - 2 mm long ----------7

7 Jaws or chelicerae with spines at the front; cephalothorax no groove on upper surface ---------- *Erigone wiltoni*
Jaws with no spines, cephalothorax with cross groove uneven upper surface (Forster *et al.* 1988) ----- *Araneonus humilis*

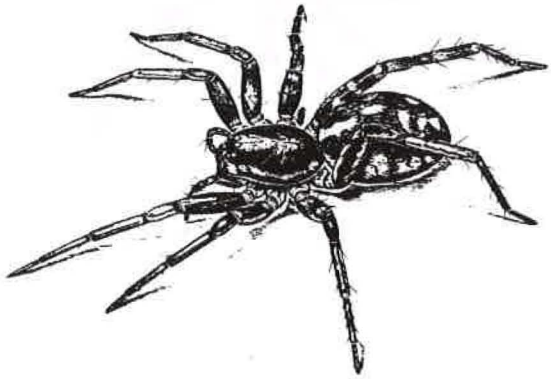
Lepthyphantes tenuis (Forster *et al.* 1988 Figure)



Long tipped spider *Arachnura feredayi*
(Forster & Forster 1973 figure)



Black and white banded Australian spider *Supunna picta*
(Forster & Forster 1970, Forster & Blest 1979, Figures)

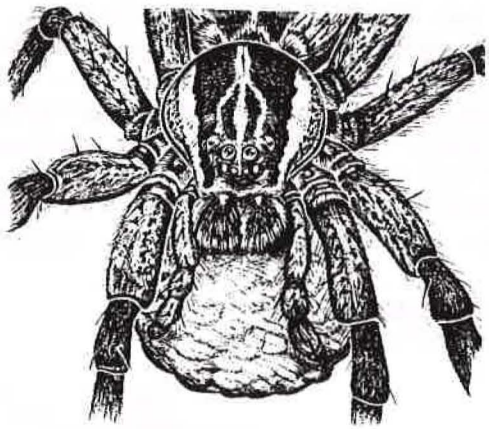


KEY FOR MAIN SPIDERS ON SHRUBS, TREES OR IN LOGS # = Photographs in Forster and Forster 1970

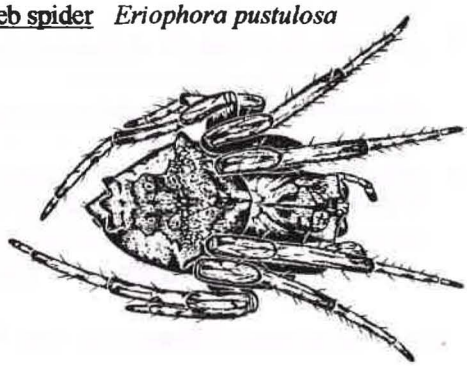
1 Spider on tree or shrub ----------
Spider on ground or among twigs or logs ----------
2 Green, maybe cream spider; orb web; 7 mm long, (Plates 75,76 p 152) -------- Green orb web spider *Colaranea viridi*
Browny spiders with dull finely haired cephalothorax ----------
Browny spiders with shiny brown to pale brown cephalothorax ----------
All shiny black spider, abdomen spherical, body 6-8 mm long; irregular 'cob ' web (Fig 158 p 229) ----- *Stetoda lepi*
3 5-11 mm long; irregular central pattern; eyes same size; sparse orb web ----------
Large 19 mm long; body 3 longitudinal lighter bands; 4 hind eyes larger, on side & upper margin; dense white tent w
(Plate 28, Figs 44 -47 p 96-97) ---------- # Nursery web spider *Dolomedes min*
4 Abdomen reddish to pale brown with uneven bumps on it; cephalothorax near rectangular upper surface; medium size
11 mm long, spoked orb web (Plates 71,72, Fig 100 p 152,164) ---------- # Common orb web spider *Eriophora pustulo*
Abdomen brown, no uneven bumps on it, cephalothorax rounded and narrows to the front; small 5 mm long; irregular
'cob' web (Plates 94-95 Fig 111 p168 178) ---------- Cobweb spider *Achaearanea verucula*
5 Abdomen pale brown to grey often spotted; body nearly tubular, 6-9mm long (Plates 39-44 p 96/97) ----- # *Clubiona s*
Silvery or blackish abdomen, body more globular, at least cephalothorax partly flattened ----------
6 Only cephalothorax slightly flattened, abdomen hairs give it a silvery sheen (Fig 69 p 117) ---------- *Anzacia gemm*
Body flattened, abdomen blackish, often in logs (Fig 70 p 119) ---------- # Flat bark spider *Hemicloea rogenhoffe*

MAIN WOODLAND TO GENERAL SPIDER SPECIES Figures from Forster and Forster 1973

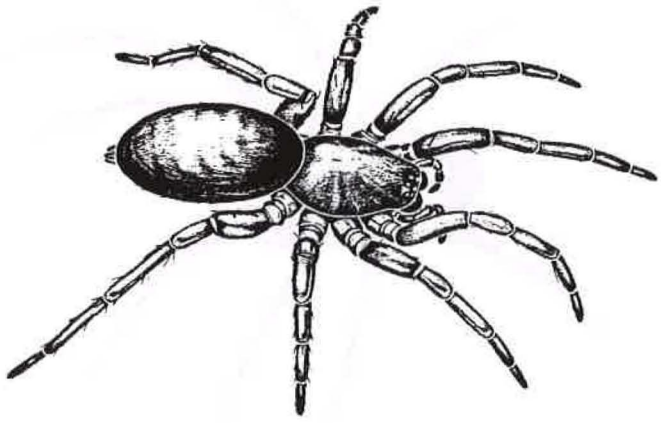
Nursery web spider *Dolomedes minor*



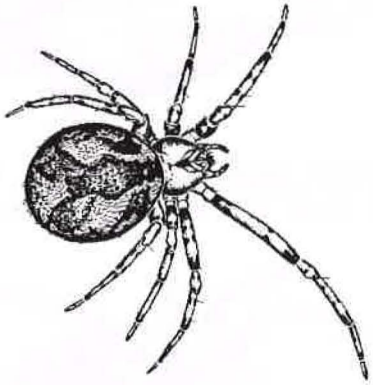
Common orb web spider *Eriophora pustulosa*



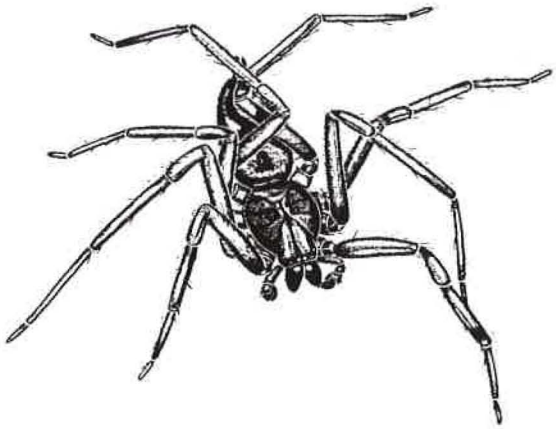
Silvery sheened abdomen *Anzacia gemma*



Cobweb spider *Achaearanea veruculata*



Flat bark spider *Hemicloea rogenhofferi*



APPENDIX 3 IDENTIFICATION GUIDANCE FOR SELECTED INSECT SPECIES

HYMENOPTERA

Aphelinidae

Pteroptrix species Head and much of thorax yellow, eyes reddish, chocolate brown V mark on front of the top of the thorax, abdomen near black, base of front wing to stigma brown, rest clear. Tapering 7 segmented yellow antenna. 25 undescribed species in New Zealand (Noyes & Valentine 1989)

Near *Ablerus* species Keys close to *Ablerus*. May be an undescribed genus. The stigma vein is longer and makes a wider angle into the wing than *Ablerus*. Chocolate brown head and thorax, underside-front margin of thorax and legs near transparent pale brown. Broad short waist (petiole) to the abdomen. 6 segments to antenna with brown basal and end and near transparent short central segments, long club segment at the end, so it resembles Signophoridae. Either identification suggests a new literature record for the South island.

Species 1 Dark species with white legs, weak club at end of antenna.

Diapriidae

Species 1 Dark brown-blackish body, small protruderance on hind upper end of thorax, medium length, trace of veination on inner - hind part of front wing.

Species 2 Chocolate brown, abdomen globular centre.

Eulophidae

? *Elarchartus* species Body thin & long, metallic green

Species 1 Dark body, 2 dark brown C shaped vertical bands on wings, abdomen tapers to its far end.

Species 2 Mainly dark brown to black, legs paler & last tarsal segment darker than the others, beaded antenna

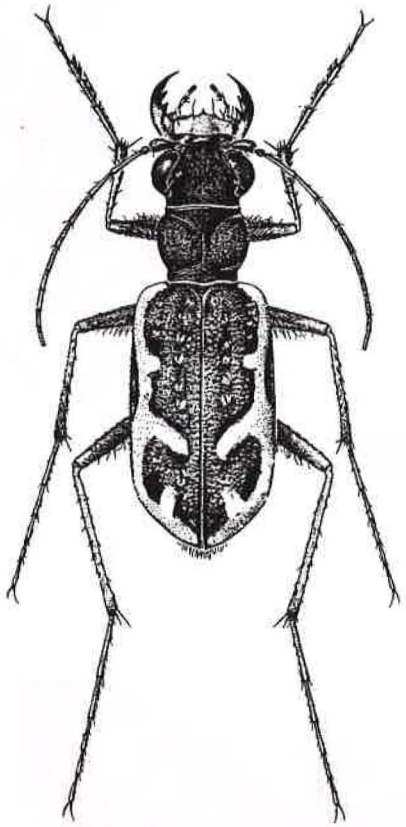
Species 3 Similar tapering abdomen to species 1, 1 central almost horizontal chocolate brown mark on front wing

Trichogrammatidae Short broad rounded wing with lines of hairs distinct from other species in this habitat

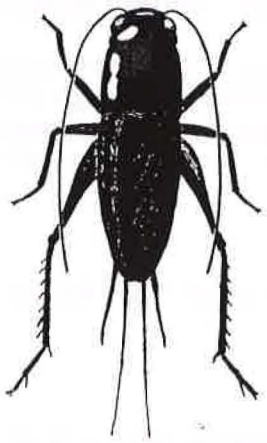
Trichogramma species

PREDATORY TIGER BEETLE

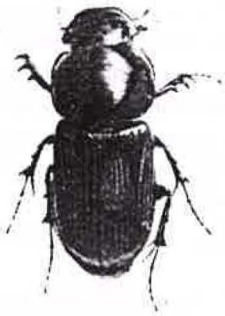
Neocicindela dunedinense



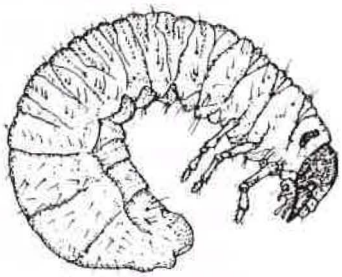
Small field cricket
Pteronemobius species
(modified from Miller 1984)



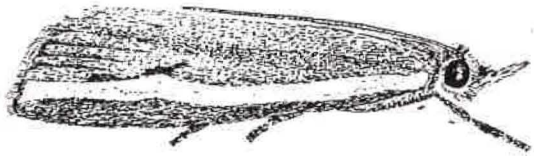
Tasmanian grass grub
Aphodius tasmaniae adult
(After Atkinson *et al* 1956)



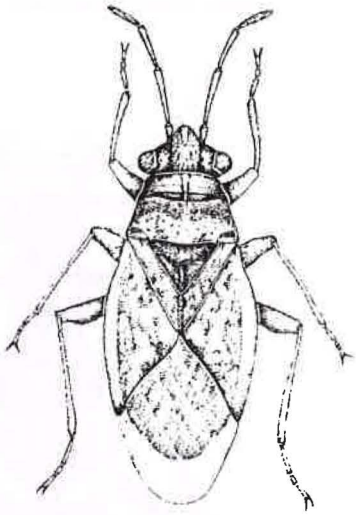
ground dwelling larvae
(After Scott 1984)



Common sod webworm moth
Orocrambus flexuosellus
(After Miller 1984)

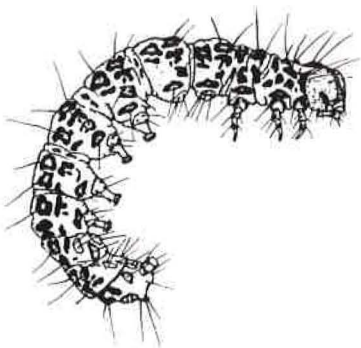


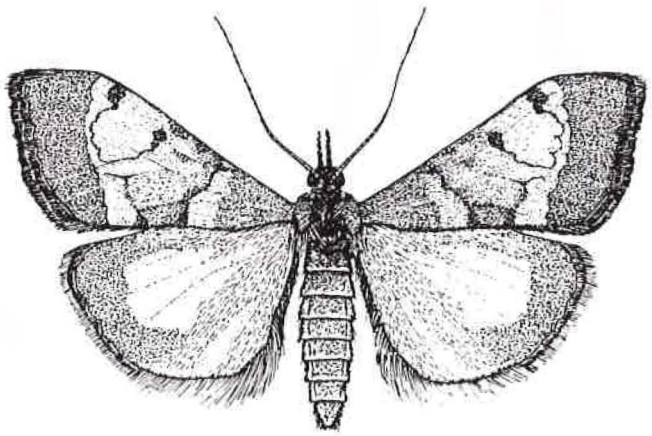
Wheat bug
Nysius huttoni
(After Scott 1984)



IN TREES

Kowhai moth
Uresiphita polygonalis
(after Scott 1984)





Kowhai moth larva (left) and adult (right).