FRONTISPIECE - Newly emerged *Hierodoris eremita* Philpott (Lepidoptera : Oecophoridae) on *Celmisia coriacea* leaf. Male at lower left.

INSECTS OF
MOUNT COOK NATIONAL PARK

A thesis
submitted in partial fulfilment
of the requirements for the Degree
of
Master of Agricultural Science
in the
University of Canterbury

by
W.J. Sweney

Lincoln College
1980

Abstract of a thesis submitted in
partial fulfilment of the requirements
for the Degree of M.Agr.Sc.

INSECTS OF MOUNT COOK NATIONAL PARK

by W.J. Sweney

The insect fauna of Mount Cook National Park was surveyed between 1975 and 1977. All of the major areas of the Park were visited and most vegetation types sampled for insects, although effort was concentrated in the alpine zone.

Insects were collected by a variety of techniques including light traps, pitfall traps, sticky traps, malaise traps, sweep nets and hand collecting. Insects associated with plants were investigated in some detail. Plant material was collected and insects reared from it, many pollinators were also taken from flowers.

Over 670 species of insects were collected, including at least 10 undescribed species, mainly from the alpine and nival zones. Several northern-most records of southern distributed insects were made.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF MAPS

CHAPTER 1

INTRODUCTION

The idea of an insect survey to follow on from Hugh Wilson's extensive botanical work (Wilson, 1976, 1978) was moved by Sir Charles Fleming (National Parks Authority) and Dr Henry Connor (Scientific Advisor, Mt Cook National Park Board). A considerable amount of money was required and this was generously supplied by the National Parks Authority as a grant administered by Lincoln College. When the survey was suggested, no inventory of invertebrates had been compiled for any National Park. Floral lists had been compiled in some Parks and were building up in others. Management plans tended to ignore invertebrates completely and yet insects and other invertebrates are important components of ecosystems. The idea of the insect survey was to help fill this invertebrate gap. As a consequence, the insect survey was to cover all vegetation types, and to examine the fauna of the alpine and nival zones in some detail. The Mt Cook flea Pharmacus montanus was one nival insect which was to get special attention. It was hoped that a fairly comprehensive list of insects could be built up coupled with distributions and plant-insect associations. The information gained will provide a broader base for sound ecological Park management decisions. National Parks are valuable resource areas and as further studies of birds, plants, mammals and insects are carried out, management planners will be better able to harmonise the materialistic desires of some with the ecological realities of the environment of both the Park and the "outside" world.

The field work commenced with a two day visit in January 1975, followed by a three week period in February 1975, two longer periods (December 1975-June 1976 and October 1976-May 1977), and a final five day visit in October 1977. Curation was carried out at Lincoln College, identification also made use of the College's facilities and those of Entomology Division, DSIR, Auckland and Lincoln. An insect display has been set up at the Park headquarters at Mt Cook using insects and plants from information collected during the plant and insect surveys. Several insects have been deposited with the National Arthropod Collection (DSIR, Auckland) with the bulk in the Lincoln College collection. A small representative reference collection will be housed at Mt Cook for the Park staff and visitors.

Considerable assistance was given by members of the Mt Cook National Park staff; Entomology Department, Lincoln College; Botany Division, Lincoln; Entomology Division, Auckland and Lincoln; and individuals acting in a private capacity. (A detailed list is given in the Acknowledgements.)

CHAPTER 2

LITERATURE REVIEW

The literature is reviewed under three headings - insect collecting techniques, alpine entomology, and previous collections at Mt Cook.

2.1 Insect Collecting Techniques

2.1.1 Introduction

Detailed accounts of methods for collecting insects are given by Bierne (1955), Southwood (1968), Oldroyd (1970) and Martin (1977). Bierne, Martin and Oldroyd also detail methods of preparation and preservation. Walker and Crosby (1979) outlined preservation, curation and handling of insect collections with particular reference to New Zealand. Sweep nets, funnel extractors, traps and hand collecting are reviewed as some of the techniques and materials for the collection of insects from plants, litter and soil.

2.1.2 Sweep nets and plants

Sweep nets sample insects from plants by both flushing and jarring as well as having an aerial component. The sweep net is a valuable general collecting tool which can be made quite specific if one plant species is concentrated on at a time. Macfarlane (1970) used a sweep net in his quantitative survey of the fauna of lucerne (50-150 sweeps per sample). Janzen and Pond (1975) and Janzen (1973b) used sweep net sampling to determine the arthropod fauna of various areas and evaluated the effects of seasons, vegetation types, elevation, time of day and solation.

2.1.3 Litter and soil

Various extractors have been developed which employ funnels and slow drying by heating. The soil, litter, bark or wood chip samples are placed in funnels and low heat applied from a source such as one 25 watt light bulb above each sample funnel. The insects move downwards away from the desiccating heat source and fall or walk down the funnel into a container of preservative (e.g. alcohol or picric acid solution). For the extraction of arthropods from soil Benham (1975) used Tullgren type funnels (Southwood, 1968). He found that the dry funnel technique was 100% effective when checked against wet flotation and it used less labour. The heat source was one 100 watt light bulb in an aluminium foil lined canopy over 4 funnels. The sample temperature gradually increased to 50°C over 6 days and this slow temperature build up, coupled with subsequent protracted sample drying, appeared to be crucial for effective extraction.

2.1.4 Insect trapping

In contrast to catch per unit effort types of sampling (e.g. sweep netting) where it is mainly the behaviour of the observer which results in a sample, trapping primarily depends on the behaviour of the insects whose actions result in a sample. Traps may catch insects randomly or attract them, or a bit of both may apply. The selection of trap types for the Mt Cook survey was aided by reference to White (1964), Southwood (1968) and Horning (1968). Four types of trap were used : sticky, pitfall, light and malaise.

2.1.4.1 Sticky trap

Southwood (1968) notes that colour, trap size, vegetation and wind speed all affect the sampling of a cylindrical sticky trap as was used in the Mt Cook survey.

The adhesive trapping agent ("Ostico", I.C.I.) was thought to have some attraction for some insects by White (1964). As with other traps the siting of sticky traps is important and generally they should be set somewhere near the level of the adjacent vegetation. Trap colour is important, aphids are particularly attracted to yellow, thrips to white, midges to black and bark beetles to red (Southwood, 1968). Yellow is thought to be a good general colour and was used by White (1964) on his sticky cylinder traps. Perhaps blobs of different colours would be best for general collecting (Southwood, 1968).

2.1.4.2 Pitfall traps

The trapping fluids used in the survey (Gault's, Picric acid and glycerol) were all relatively odourless, with a faint smell similar to formalin from Gault's solution, the strongest detectable odour. Fermenting glycerol acted as bait for some sap feeding nitidulids (Coleoptera) and other baits could have been used (e.g. beer and porridge for wetas) (Southwood, 1968). The efficiency of pitfall traps was evaluated by various authors (in Southwood, 1968) and they found pitfall traps of little value for the estimation of populations or for the comparison of communities... "it is evident that the size of population plays at most a minor role in determining the numbers trapped" (Southwood, 1968). The more important trapping factors were insect behaviour and the situation of the trap. It was found that both the level of the mouth of the trap and the amount of vegetation around it, affected the catch both qualitatively and quantitatively (Southwood, 1968).

Day active species such as Scopodes (Coleoptera : Carabidae) seem to avoid capture in traps (Southwood, 1968). The use of trapping fluids may have enhanced the possibility of capturing agile insects such as Scopodes. White (1964) in his survey of tussock grasslands, found few insects in his pitfall traps and this may have been because he did not use trapping fluids apart from incidental rain water.

2.1.4.3 Malaise traps

Various designs have become established since Malaise built the first model in 1937 (Southwood, 1968). Some of the other models are outlined by Gressitt and Gressitt (1962), Townes (1962, 1972) and Marston (1965). Initially malaise traps were thought to be basically interception traps with no catch bias, however, Juillet (1963) compared malaise trap catches with other traps including a rotary net which is believed to give unbiased catches, and found that malaise traps were unbiased for larger Hymenoptera and some Diptera, but they were biased against Coleoptera and Hemiptera. Comparing the general catches of sticky traps with malaise traps the malaise was better both in quality and quantity of insects trapped. However, not enough is known of the specific differences between the catches of the two traps for selective orientation towards particular insect groups. As general collecting tools both were valuable. For flying Coleoptera a comparison of the efficiency of malaise traps with light and sticky traps found the malaise generally superior (Hosking, 1979). Hosking did not examine other orders.

2.1.4.4 Light traps

Light traps give valuable records but a severe limitation is that it is not known from where or from how far a trap samples. Recent work has shown that 3 m is about the maximum distance for direct attraction (Baker and

Sadovy, 1978). Light traps catch insects because the high illumination in contrast with the surroundings upsets the insects normal photic orientation. In essence, the moon or stars are normally used by the insects as fixed, infinite navigational reference points (Oldroyd, 1970). As a general rule anything which reduces this contrast reduces the catch (e.g. low wattage bulbs, bright moonlight). Bowden and Morris (1975) studied the effect of moonlight on light trap catches and they concluded that changes in catch over a lunation are caused by changes in the effectiveness of the trap. When corrections were made for such changes it was found that all trapped species showed increases in numbers in moonlit periods. For many species this increase was substantial. The Governor's bush trap was amongst tall trees and on moonlit nights contrast down in the bush was high and good catches resulted. This was aided by the relatively dense upper canopy of the Nothofagus forest with little understory vegetation near the trap. The weather influences the trap catches markedly. White (1964) correlated the effect of wind on collections of moths with body size and flight ability. The strongest fliers were hepialids and noctuids, the next strongest were pyralids and geometrids and the weakest included the tinaeids. On a windy night few tinaeids, geometrids and pyralids were caught. Windy Nor-West conditions may often produce numbers of the greasy cutworm (Agrotis ipsilon aneituma) (Noctuidae) which could have been blown across from Australia (Fox, 1973; Tomlinson, 1973). Large numbers of Agrotis may be light trapped at such times.

As with other traps some insects seemed to avoid capture, the high trap illumination would upset their photic orientation, but instead of spiralling into the trap they came down in a shadow near the trap and sat for long periods. Such moths were rarely caught in the trap, but could be picked up by hand if an observer was present.

Various light trap designs have been developed (Southwood, 1968), the Robinson trap (Robinson and Robinson, 1950) was found superior to the Rothamsted trap (Williams, 1948) for larger Lepidoptera. Catches vary depending on the type of lamp used as well as the weather and site. Pressure lamps were found best for a diverse range of insects when compared with blended lights and black lights (Walker and Galbreath, 1979). In the same comparison, blended lights attracted the most insects.

In Australia the Robinson trap attracted many Coleoptera, particularly Scarabaeidae, and these damaged the Lepidoptera making identification difficult. Common (1959) developed a transparent trap which caught fewer Coleoptera and separated the ones it did catch from the Lepidoptera. White (1964) (in Southwood, 1968) developed an effective killing design for light traps which also separated the catch and drained rainwater. White also recommended bolting the perspex baffles in place because weathering caused some glued bonds to break. Perrott (1968) suggested the use of "Vapona" (dichlorvos) pest strips as long-lasting killing agents (up to 6 weeks). The highly volatile nature of ethyl acetate makes it difficult to use as a killing agent in a light trap, to cope with this problem Oldroyd (1970) suggested the use of a spirit lamp as a diffusing agent for volatile chemicals.

2.1.5 Hand collecting

Turning logs, splitting stumps and logs, rolling stones, lifting bark, separating leaves, shaking litter onto white sheets, beating plants onto trays or collecting umbrellas, may all be included as methods of hand collecting. To avoid tedious dissections of plants it is possible to limit cutting and splitting to obviously damaged or distorted stems, fruits, buds and roots (Southwood, 1968). Ideas, materials, habitat lists and other relevant information are given by Bierne (1955), Oldroyd (1970), Miller (1971), and Borror et al. (1976). Helpful collecting tips for Australian and New Zealand insects include : a broad chisel for peeling or splitting wood; emptying 70% alcohol over agile insects (inquilines) in ants nests; searching under dung; sugar baiting certain trees at the edges of forests and picking up the visiting insects (Tillyard, 1926). Insects may be picked up by hand, forceps or aspirator (pooter) (Southwood, 1968; Oldroyd, 1970).

2.2 Alpine Entomology

2.2.1 Introduction

A broad summary of New Zealand alpine fauna is given by Johns (1969) who called all insects above the timberline, nival. This is a broad use of the term and Wilson (1976, 1978) uses nival only for areas above the summer snowline. Wilson also uses a subnival category as well as the usual alpine and subalpine ones (Table 1).

TABLE 1 : Altitudinal Zones at Mt Cook; adapted from Wilson (1978).

Altitude:			
	Nival Zone	Snowfields, bare rocks and nunataks	snowline
c.2150 m			
	Subnival Zone	Rock and debris wet places (summer snow melt)	grassline
c.1850 m			
	Alpine Zone	Alpine grassland, and fell fields, bare rock and debris, scree, moraines and wet places (summer snow melt)	scrubline or timber line
c.1300 m			
	Subalpine Zone	Forest and scrub, shrubland, wetland, grassland, rock, scree, shingle river beds, moraines, wetlands (some winter snow melt)	
c. 900 m			
	Montane Zone	Forest, scrub and shrubland, grassland, shingle river beds, rock and wetlands (some winter snow melt)	
c.600 m			Floor of Tasman Valley

2.2.2 The alpine zone

This zone has its lower limit set as the timberline and its upper limit as the snowline (Table 1). At Mt Cook this covers the range of 1300 - 1850 m. Wardle (1971, 1974) defined the timberline as the average upper limit of forest and trees or erect shrubs. Woody plants can occur at higher altitudes than the timberline as isolated shrubs (plants less than a metre tall). In New Zealand the tree limit and the timberline generally coincide at about 1200 m. At the equator the timberline is usually above 3000 m, whereas in the Arctic or Antarctic trees are absent even at sea level. Throughout the world the timberline is approximated by the position of the 10°C mean diurnal isotherm for the warmest month (Wardle, 1974). (Perhaps a better measure is the tetratherm, a diurnal mean of 6-8°C for the warmest 4 months (Weilgolaski, 1975).)

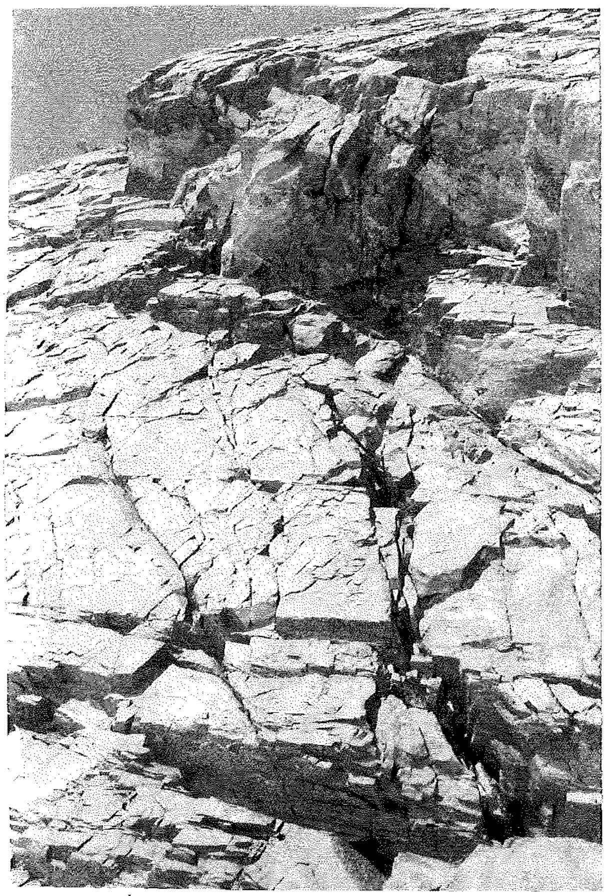
The snowline is the average lower limit of persistent snow (Table 1). Below this level snow melts away completely each season (Wilson, 1978). The snowline varies from 5500 m on Mt Kilimanjaro to 2600 m in the European Alps and to sea level in the arctic and antarctic. In the Mt Cook Park the snowline ranges from 1770 m on the main divide to 2130 m on the Liebig Range (Wilson, 1976). However, the snowline does not represent the upper limit of plant or insect life (Plates 1, 2 and 3). Blow flies have been seen near the summit of Mt Cook, some alpine wetas live above the snowline, the plants <u>Hebe haastii</u> and <u>Parahebe birleyi</u> are found up to

PLATE 1 :

Mt Annan (2915 m) from the head of the Tasman glacier Oct 77. Close up shots (plates 2 and 3) taken at the rock buttress far mid-right. Pharmacus montanus Pictet and Saussure was common on the slopes to the upper left of the buttress in Apr 76, Ranunculus grahamii was flowering nearby at the same time.

PLATE 2 :

Closer view looking up nival rock buttress lower slopes Mt Annan Oct 77 (2400 m). Hebe haastii grows in patches in some of the crevices.



2800 m, and in the Himalayas insects have been found at 6800 m well above the snowline of 5200 m (Mani, 1963).

2.2.3 General features of the alpine and nival zones

The high altitude environment is characterised by reduced atmospheric pressure, low air temperature, low atmospheric humidity, intense radiation, high winds, prolonged snow cover, scanty soil, rugged terrain and a short vegetative season (Mani, 1963).

The general conditions vary widely depending on the latitude of the mountains concerned. Many of the features of life at 5000 m in the Himalayas can be found at sea level in the Antarctic. The short vegetative season gives rise to similar plants and habitats whether it be at high altitude or high latitude. Arctic or Antarctic entomology is similar to high altitude entomology and some examples from high latitudes will be used.

Raven (1973) says that the New Zealand alpine and subalpine habitats developed in the last few million years. During the Pleistocene glaciation the environment underwent repeated alterations which affected both plants and insects. The alpine plants are thought to be mainly of Australian origin, but once established numerous species were produced as a consequence of adaptive radiation, inter-specific hybridisation and recombination. The result so far is that there are more alpine plant species in New Zealand than in the same groups in Australia. The high endemism among the

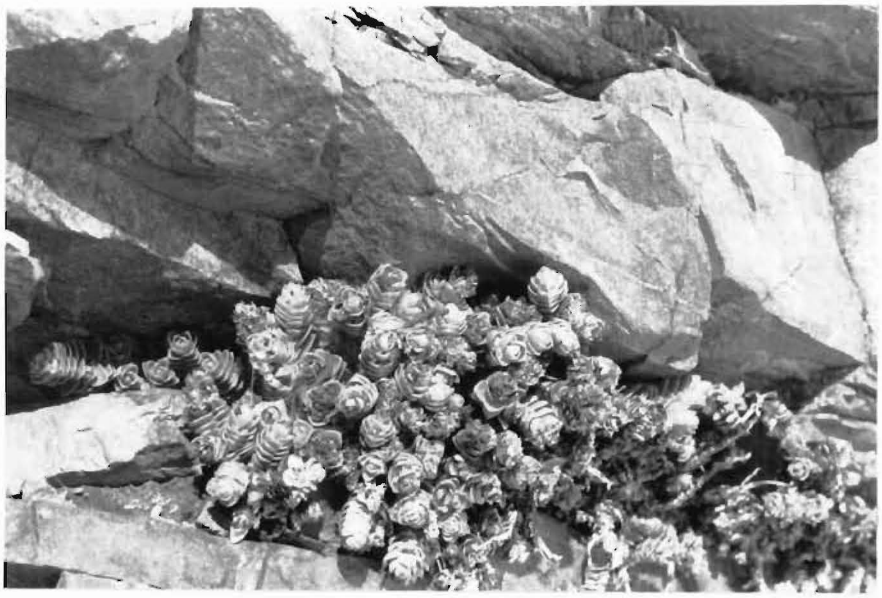


PLATE 3 :

Hebe haastii with Gelechia species nova (Lepidoptera : Gelechiidae) larval webbing, rock buttress Mt Annan Oct 77 (2400 m). The span of a flower head is about 1 cm.

alpine plants is paralleled in at least the Acrididae (grasshoppers) (Bigelow, 1967), Cicadidae (Dugdale and Fleming, 1978), perhaps also among several groups of Carabidae including the Broscinae and Migadopinae and in the subantarctic islands among the Curculionidae (Kuschel, 1971).

In Himalayan insects there is a high species endemism - 70% calculated by Mani (1974). Here Mani thought thermophile lowland forest forms were lifted up as the ground rose and were modified into cryophile mountain autochthone types. Pliocene endemic forms survived on nunataks (rock islands) during Pleistocene glaciations and gave rise to numerous subspecies (Mani, 1974). In the Himalayas there is a tendency for an increase in the number of high altitude species because of the isolation of groups on mountain "islands". The high altitude environment is similar to isolated oceanic islands in this respect. This subspeciation because of isolation is a feature of the New Zealand grasshopper population as exposed in genitalia studies (Bigelow, 1967) and of New Zealand cicadas (Fleming, 1975; Dugdale and Fleming, 1978). Geological history suggests that New Zealand's alpine environment is young, yet a diverse flora and fauna is found there. Fleming (1962, 1979) could not reconcile the youth with the diversity unless rapid evolution had taken place at a short time. Fleming (1962, 1979) suggested that the alpine fauna (and flora) had several sources and not all were "thermophile lowland forest forms" that were lifted up.

Perhaps the main limit to life in the extreme environments of high altitudes and/or latitudes is not severe cold directly but the availability of water. Janetschek (1970) suggests the microtemperature of soil must rise above $0^{\circ}C$, i.e. free the soil water, on at least 30 days during the summer season for life to be sustained. In South Victoria land at the edge of the polar inland ice sheet at $77^{\circ}S$ and 1830 m elevation, the daily air temperatures ranged from $-5^{\circ}C$ to $-15^{\circ}C$, while the soil temperature at the surface remained above $0^{\circ}C$ for most of the 24 hours of daylight (Janetschek, 1970). Most of the environmental features of high altitude life promote high aridity, so organisms are clumped wherever free water is found. A useful review of the adaptations of arthropoda to arid environments has been published by Cloudsley-Thompson (1975).

2.2.4 Adaptations of insects to alpine and nival life

2.2.4.1 Flight loss and apterism

Nearly all of the endemic Curculionidae of the Auckland and other cold temperate islands are flightless and were found at all altitudinal levels (Kuschel, 1971). A high proportion of New Zealand's insect fauna is flightless (Kuschel, 1975). Bigelow (1967) found that all of the endemic alpine grasshoppers (Orthoptera : Acrididae) were apterous. Other New Zealand insect groups which have a significant proportion of flightless members are the

Dermaptera, Blattodea, Coleoptera and a few Lepidoptera (Watt, 1975). Holloway (1963) has published a review of wing development in New Zealand Lucanidae (Coleoptera) and she noted that 50% are flightless. Among the alpine Odontiinae (Lepidoptera : Pyralidae) of North America short wings and compact build were common (Munroe, 1975). An undescribed species of geometrid (*Dichromodes* n.sp. "*chevalier*" (horse rider)) from the Cheval ridge (3050 m) on Mt Malte Brun, has reduced wings and a compact build in at least the female. The Mt Cook flea, *Pharmacus montanus*, is also apterous (Figure 1).

Mani (1962) says that the tendency towards loss of flight and apterism is high among high altitude insects and the tendency increases with altitude, especially among the Carabidae. Of the Carabidae at Mt Cook, all of the alpine Migadopinae and Broscinae were found to be flightless whereas species of *Bembidion* and *Scopodes*, inhabitants of stream sides and valley bottoms respectively, were winged agile fliers. However, typical forest and scrub dwellers like *Holcaspis sternalis* and *Agonum macrocoelus* were also flightless. Apterism has been correlated with the lower oxygen levels and cold temperatures found at high altitudes, but the real cause is not known. On subantarctic islands, one advantage is obvious - of those species that do fly, flight is limited to rare periods of calm and even then a sudden wind gust can blow the insects out to sea.

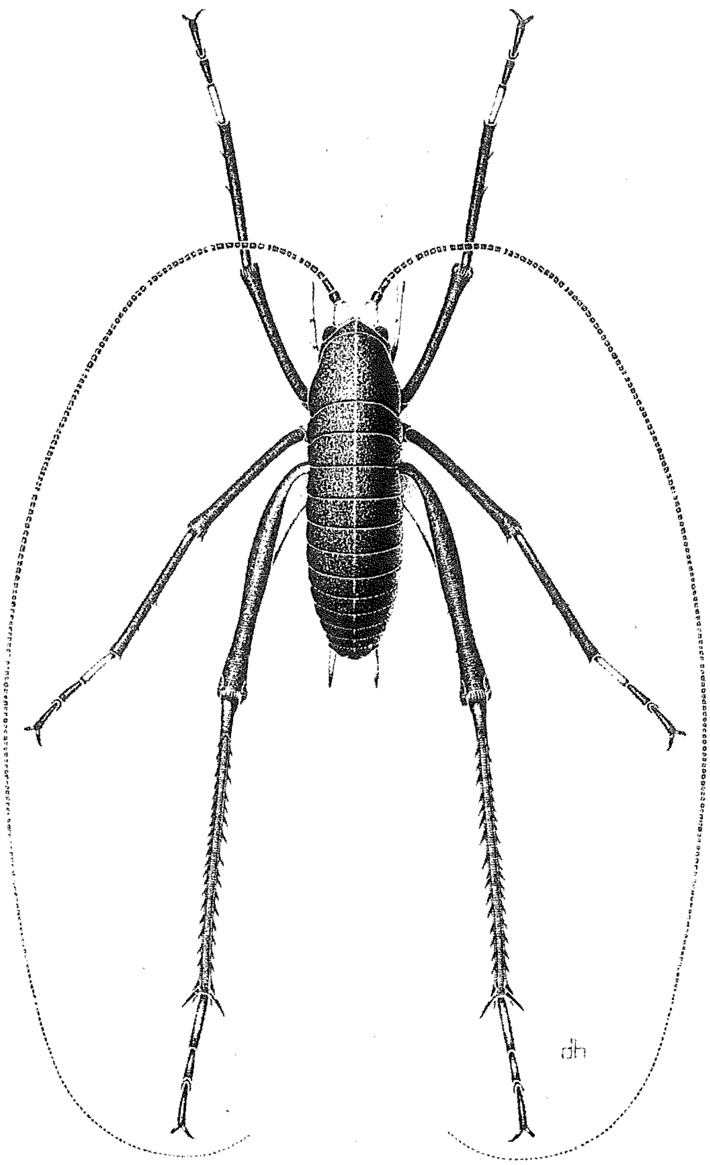


FIGURE 1 : Pharmacus montanus Pictet and Saussure (Orthoptera : Rhaphidophoridae). Commonly known as the Mt Cook flea because of its ability to jump from nival rock crevices when approached by unsuspecting climbers. Illustrated by D. Helmore, Systématics Section, Entomology Division, DSIR, Auckland. Used with permission.

Apterism generally tends to be associated with small size as well, and it seems to be a feature of harsh environments that small flightless insects (or other arthropods) are found in the most extreme habitats. Iablokoff-Khnzorian (1968) found that reduced pressure and increased ultraviolet light seemed relatively unimportant to the distribution of alpine Coleoptera, but the less favourable environment tended to produce apterism. Janetschek (1970) found small apterous arthropods acting as colonists at the "borders of life" in Antarctica. The terrestrial trombidiform mites of South Victoria Land decreased in size with an increase of latitude.

The small body size and/or the lack of wings enable insects to reach sheltered spaces under rocks or plants and thus take advantage of microclimatic niches. With decrease in air pressure and oxygen levels, the relative increase in surface area to volume ratio coupled with size reduction would favour gas exchange. Heat absorbtion (and loss) would also be enhanced. New Zealand's alpine grasshoppers and nival wetas also exhibit clumping associated with apterism, but not a marked reduction in size.

2.2.4.2 Diurnal activity

In the high Himalayas the few rare moths are active during the daytime which is opposite to the more normal nocturnal habits of Lepidoptera (Mani, 1962). Munroe (1975) found that cold nights made diurnal flight common in alpine and desert Lepidoptera, and as a consequence forms with reduced eyes were common. Several of the North American alpine Odontiinae appear to have had a desert origin and the two habitats have many similarities: cold nights, high solar radiance, aridity, temperature extremes, strong winds and sparse plant cover. Several of the Mt Cook alpine moths were active during the day, among them *Hierodoris eremita* (Oecophoridae), the adult female geometrid *Dichromodes* n.sp. "*chevalier*" and a new gelechiid species whose larvae were found actively feeding on *Hebe haastii* in bright sunlight at the head of the Tasman glacier c. 2300 m. The geometrid *Declana glacialis* is a typical example of a conspicuously coloured fast flying diurnal moth of which New Zealand has many other examples: *Dasyuris* and *Notoreas* spp. (Geometridae), *Orocrambus* spp. (Pyralidae), *Metacrias* and *Nyctemera* (Arctiidae) and *Gelophaula* (Tortricidae). These day flying moths help fill the general gap caused by the paucity of New Zealand butterfly species. The black mountain butterfly *Percnodaimon pluto* (Fereday) (Figure 2) flies during the day, but its larvae feed at night (Gibbs, 1970). Warm nights are relatively common in New Zealand in the alpine and nival zones during Nor-West weather conditions and a few Noctuids (Lepidoptera) were taken at light near midnight on the summit of Mt Ollivier (1830 m) on warm nights. Carabidae are often nocturnal but *Mecodema politanum* was observed active and *in copula* during the day in alpine areas of Mt Cook.

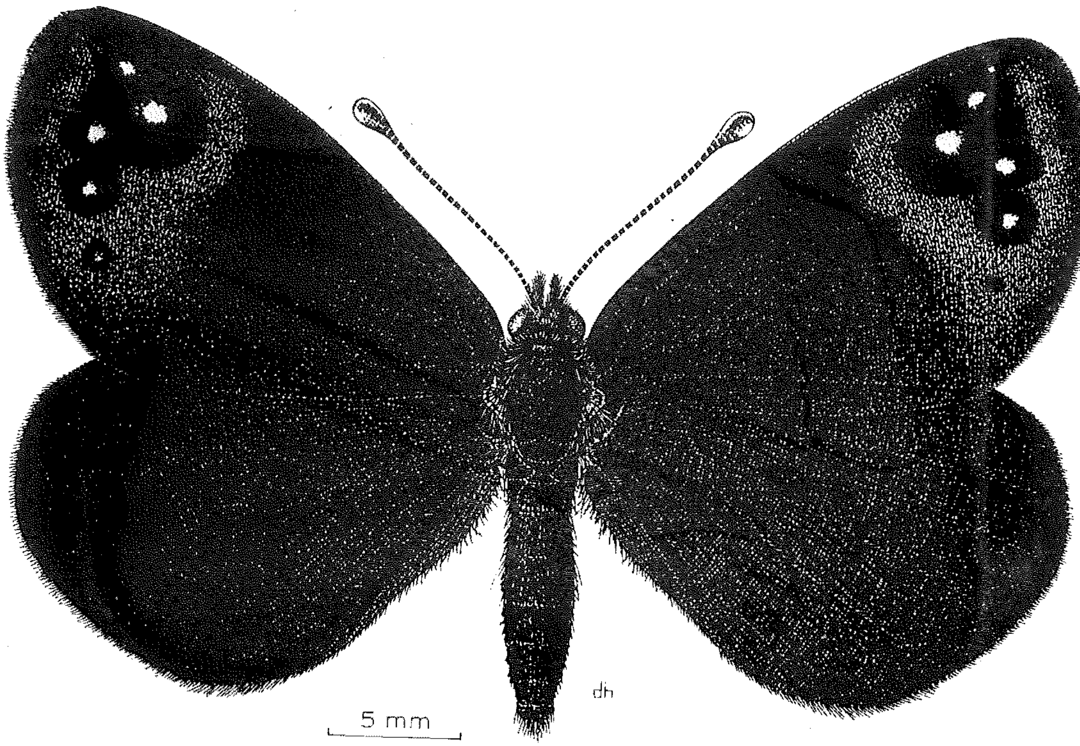


FIGURE 2 : Percnodaimon pluto (Fereday) (Lepidoptera : Nymphalidae). Commonly known as the black mountain ringlet, associated with alpine screes of the Southern Alps. Illustrated by D. Helmore, used with permission.

2.2.4.3 Colouration - melanism and nigrism

Melanism is the tendency of alpine insects for colours to get darker, nigrism is the tendency for already dark spots (such as are found on ladybirds) to get bigger. Alpine and nival insects tend to be dark and hairy, the black mountain ringlet butterfly Percnodaimon pluto (Fereday) is a good New Zealand example of this. Amongst the New Zealand cicadas (Cicadidae : Homoptera) all members of the alpine genus Maoricicada, e.g. Maoricicada nigra nigra (Myers) (Figure 3) are dark and hairy (Dugdale and Fleming, 1978). It is thought that the dark colouration aids in the absorbtion of radiant energy, however, if this is the case then heat losses must also be greater when there is low insolation. (Black radiators lose heat rapidly.) It would seem that the losses must be of little consequence to the insect concerned when it is inactive and the advantage of activation under insolation must outweigh the heat losses incurred at other times. A low resting body temperature may have the advantage of lowering the overall respiration in alpine areas where plant production per year is low. Posture (wing spread) and background also affect the amount of heat lost as radiation from a dark surface and presumably the insects behave in such a way as to minimise heat losses, e.g. fold their wings to reduce the radiant surface area. The black mountain ringlet butterfly (Percnodaimon pluto) (Figure 2) is well adapted for both the gain of heat and the avoidance

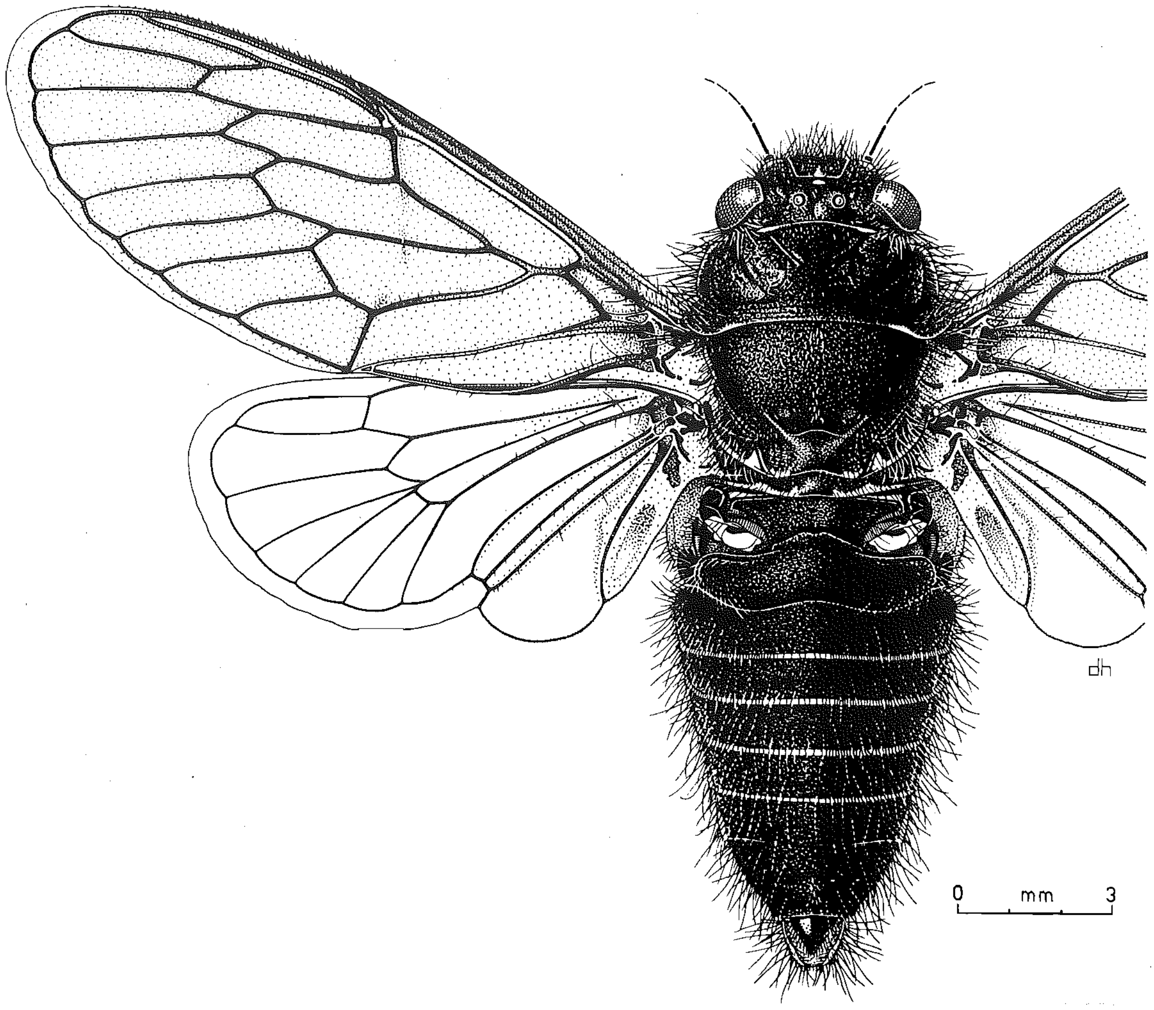


FIGURE 3 : Maoricicada nigra nigra (Myers) (Hemiptera : Cicadidae). A high alpine cicada associated with snowmelt herb fields. Illustrated by D. Helmore, used with permission.

of losses. On sunny days it flies strongly using fluttering flight and hang-glider-like soaring, but when the sun disappears it lands and spreads its dark hairy wings to absorb heat from warm rocks (Gibbs, 1970; Walker, 1978). In more severe weather it takes shelter in rock crevices. Near Mueller hut these butterflies were observed flying above rocks on a cold, windy, cloudy day in turbulence that was bothering keas.

Ladybird beetles in the Himalayas (Mani, 1962) have larger and darker spots when they live above the timberline. This is a mixture of melanism and nigrism (Linsenmaier, 1972). Mani (1962) speculates that this type of phenomenon is for protection against ultraviolet light and intense sunlight as well as for heat gain. The real reasons have not been clarified for the melanic type of response and it has been observed at low altitudes as well. Some Lepidoptera in the Homer-Hollyford area showed an increase in colouration density as well as an increase in overall body size (Salmon, 1953). Salmon considered that this melanism of Graphania nullifera was associated with high rainfall both in protective colouration and heat absorbtion. In a discussion of Salmon's paper Gourlay thought that food might be an important factor in melanism and he pointed out that males of the common tussock butterfly (Argyrophenga antipodum Doubleday) were all larger and lighter in colour than the females, except in Nelson on the Dun mountain mineral belt. Here both size and colouration of the sexes were similar. Recently A. antipodum has been found to consist of three distinct species which negates the specific argument of Gourlay (Craw, 1978). The larvae of *Graphania nullifera* feed on wild spaniards (*Aciphylla* spp.) which are members of the carrot family (Umbelliferae). It is possible that the melanic form of the Homer *Graphania nullifera* may result from a difference in food content between typical lowland *Aciphylla* spp. and the Homer *Aciphyllas*.

In the harsh environment of Antarctic the southernmost free living holometabolous insect is a chironomid (Diptera) midge *Belgica antarctica*, which as well as being melanic is also apterous. Peckham (1971) noted that larvae and adults of *B. antarctica* reacted to insolation in an opportunistic manner, adults could be found basking on rocks in the sun when the general air temperature was low. In this extreme environment the amount of solar insolation is more important than the mean air temperature. (Insolation is a primary factor, temperature a secondary derived one.) Downes (1965) found in the Arctic the amount of insolation was important and in regions of thick cloud the fauna was impoverished. (Light cloud allows quite high insolation.)

White (1974a), in a study of three diurnal alpine grasshopper species in the Craigieburn Range (1500 m) correlated temperature and insolation levels for activity thresholds. The lower activity threshold was 0.5 cal cm^{-2} min^{-1} of insolation. The upper threshold was thought to be about 2.0 cal cm^{-2} min^{-1}, the maximum sustained insolation level obtained at the study site. The temperature required for activation at 0.5 cal cm^{-2} min^{-1} of insolation was 4-5°C in the tussock bases (or rocks) where the grasshoppers shelter.

A normal reaction of insects to heat or cold is the interruption of the ordinary course of colouration to produce a reddish pigment instead (Linsenmaier, 1972). This phenomenon is known as rufinism and appears in many alpine insects (Mani, 1962) and is probably a factor in the development of melanic forms. The alpine scree grasshopper Brachaspis nivalis (Hutton) is usually a grey colour, but red forms are known and rufinism may explain the occurrence of these. South of Kaikoura alpine populations of Mecodema fulgidum Broun (Coleoptera : Carabidae) have red legs, whereas more northern examples in Nelson and Marlborough have black legs (Townsend, 1965).

2.2.4.4 Overwintering, cold hardiness and cold stenothermy

Alpine insects are thought to be characterised by cold stenothermy, that is they have a relatively narrow range of optimal temperature, usually near 0°C and may therefore be called cryophiles (cold lovers) (Mani, 1962). At a given low temperature the metabolic rate of a cryophile is higher than in related forms from warmer regions, because of this they can be called cold adapted or cold hardy. Some examples of this are midges flying at 1°C and a stonefly that can emerge from water at 0°C and mate at $0^{o}C$ with no insolation (Downes, 1965). Compensations appear to be made for the low ambient temperatures either behaviourally (choice or microhabitat) and/or metabolically (increase of metabolic rate with activity from a low level resting metabolism). It is possible that alpine wetas (Pharmacus and Deinacrida spp.) make use of the latter when disturbed. Pharmacus in particular tumbles in controlled somersaults down snow slopes or rocks from where it has been disturbed, hence its common name the Mt Cook flea (Dumbleton, 1935; Walker, 1977). Overall the tempo of life is reduced, many alpine insects crawl or hop rather than fly, bumble bees in the Arctic have been observed visiting flowers by crawling instead of flying (Downes, 1965).

2.2.4.4.1 Supercooling: To cope with the problem of temperatures below freezing some insects resist freezing, that is they supercool (Asahina, 1969; Baust and Morrissey, 1976). The supercooling point is the highest temperature at which spontaneous freezing occurs in an insect's body fluids. Most overwintering insects that supercool go down to $-20^{o}C$ before freezing (Asahina, 1969). Frost resistant adults are rare (Ohyama and Asahina, 1972), of the seven species discovered that have supercooling in adults, they only supercool to $-10^{o}C$ before freezing. Browne (1973) collected active wetas (Hemideina maori), cockroaches (Celatoblatta anisoptera) and grasshoppers (Brachaspis nivalis) at 770 m in July in the Hooker valley at Mt Cook. The actual microhabitat temperatures were not measured, but it appears that these insects must be cold adapted in some way because the mean daily grass minimum in the Hooker valley (Hermitage) is -5.5°C in July. Browne tested the above three species for glycerol but did not find any. Glycerol is the most common "anti-freeze" protective substance found in diapausing insects and Asahina (1969) lists most frost resistant insects with at least 3% of the body weight as glycerol, with some up to 25%. The majority of alpine insects appear to be able to withstand some freezing (that is, they do not supercool at all) and Mani (1962) cites the case of diapausing insects being subject to -80°C without harm. Collembolla have been observed active at -10°C as well (Mani, 1962). Some New Zealand alpine grasshoppers which were kept at minus 9-13°C for 90 hours thawed out and came to (G. White, pers. comm., 1975).

Substances such as glycerol and sorbitol can build up to three molar concentrations in some insects (Baust and Morrissey, 1976). At subzero temperatures such a concentration is non-toxic, however, at 'normal' temperatures above zero such a concentration is toxic. The rate of reacclimation can be very rapid (within 24 hours). One disadvantage of freezing acclimation is that once it is interrupted, say by a transient period of 'warm' weather (above zero temperatures), then some insects become freezing intolerant even if the temperature falls again. To avoid transient and potentially lethal warm reacclimation some insects may even seek out subfreezing areas (Baust and Morrissey, 1976).

2.2.4.4.2 Overwintering: Belgica antarctica the Antarctic chironomid midge, does not supercool and appears to have little control of temperature fluctuations through diapause or glycerol build up (Peckham, 1971). The temperature drops to -10°C in winter and Belgica's reaction to cold is to become dormant when the temperature drops below -2°C. They rapidly recover when the temperature rises above 1°C, and continue feeding up to 25°C. Their upper limit is 58°C so they are certainly not cold steno-thermic. This opportunistic reaction to temperature has been observed by Sutherland (1964) in some New Zealand alpine wetas and he notes that growth of the New Zealand alpine insects and plants is not strictly seasonal, but is rather a product of fortuitous conditions which may occur at any time of year. Winter diapause is very unusual in New Zealand insects (Dumbleton, 1967; Watt, 1975).

Alpine wetas and grasshoppers overwinter as adults and as immatures except for the first one or two instars (Batcheler, 1967; Bigelow, 1967; White, 1974a). Salmon (1950) recorded the weta Deinacrida connectens at 3200 m on Mt Malte Brun and he suggested that winter snows drove the weta down to lower altitudes. White (1975) shows in detail how seasonal migrations take place in the Craigieburn range for a mixed population of grasshoppers. In early autumn at White's study site the grasshoppers on a south aspect slope migrated to a north aspect as the south aspect cooled and became more shaded. Along with the movement to a north aspect there was also a migration to lower altitudes. Overwintering took place wherever low temperatures and/or snow stopped them. In the spring there was a fairly rapid uphill movement after the spring thaw followed by a later movement to the sheltered south aspect once the snow had gone from it. The autumn downhill migration was generally over a longer period of time than the spring uphill migration.

Burrows (1962) suggested that overwintering grasshoppers may actually feed under the snow because frass and chewing patterns had been observed on "Danthonia" (Chionochloa) under melting snow in the spring. Apparently this frass was the result of noctuid larval feeding and not grasshopper (G. White, pers. comm., 1976).

In the Antarctic mountains all collembolla overwinter in all stages in quite severe conditions - the winter minima ranged from -39°C to -43°C on the ground surface (Janetschek, 1970). Some of the Antarctic insects have frost resistances of -50 to -60°C but this degree of resistance is not normal for overwintering insects and even when the surface temperature is very low, snow is such a good insulator that at small depths in it the temperature is nowhere near as extreme. Cold hardened gypsy moth eggs at a depth of only 50 mm in snow needed a surface temperature of $-38^{\circ}C$ to freeze 50% of them. At a depth of 200 mm a surface temperature of $-80^{\circ}C$ was required (Leonard, 1974). Mani (1962) puts great importance on both the insulating effect of snow and as a source of water and he generalises that most insect life is possible above the timberline because of and not in spite of the snow cover. At Mueller hut near pit site 6 (1810 m) the minimum temperature under the winter snow of 1976 was only $-3^{\circ}C$. The surface temperature was not measured but with winds of over 150 km/hr recorded during a proposed cableway survey (Mueller hut book c. 1967) the wind chill factor would have been below $-20^{\circ}C$ at least at times.

2.2.4.5 Microclimates and behaviour

Behaviour is another way insects have adapted to cold and in particular with regard to microclimatic utilisation. Barry and van Wie (1974) in their study of microclimatology in alpine areas, cite some findings of Coe (1967).

Lepidopteran larvae in the African equatorial mountains had two species that built silken tubes within *Festuca* tussock at high altitudes. These tubes ran from the basal portion of the tussock to the outer portion of the leaf. Small spines on the sides of the larvae allowed them to move up and down the tubes as the temperature changed. In the early morning and evening the larvae were at the extremities of the leaves, whereas during the hot part of the day or the cold night the larvae moved to the less extreme temperature at the base of the tussock (Coe, 1967). Barry and van Wie (1974) measured various insect rock niches and found that the relative humidity inside them was seldom below 90% while the ambient humidity was very arid. Mecodema fulgidum lives in moist forests in New Zealand, but it can also be found under rocks in so-called dry alpine screes (Townsend, 1965).

On a larger scale, but still within the aspect of microhabitat, Geist (1971) measured the winter temperatures in a bighorn sheep wintering area. The sheep overwinter well up the mountain slopes and above the timberline. Geist (1971) found that it was warmer up there than in the forest halfway down the slope. The coldest area was in fact the valley floor. Alpine wetas and grasshoppers overwinter in similar areas in the New Zealand mountains and it appears that conditions are not as harsh up there as down in the valleys with regard to temperature lows. For the period 1935-70 the Hermitage mean daily minimums near the floor of the Hooker valley were -2°C and -3°C for June and July respectively. The lowest minimum was -13°C for July and -11°C for June (Connor, 1973). During the period May 1976 - October 1976 the lowest temperature at site 1 (980 m) was only -1°C. Site 1 is above the valley floor and it has a slope of 30-35° thus allowing free drainage of cold air.

The black mountain ringlet butterfly (Percnodiamon pluto) (Figure 2) is a good New Zealand example of microclimatic adaptability (Gibbs, 1970; Walker, 1978). It lives at 1420-2000 m on sunny scree slopes and oviposits under rocks on their lower surface. It also pupates under stones and, contrary to the normal position, the pupae lie parallel to the rock surface instead of hanging vertically (Gibbs, 1970). The larvae overwinter in the fifth instar and pupate early the following summer. This longer life cycle is also an adaptation to the alpine environment and is paralleled by the alpine grasshoppers (Batcheler, 1967; White, 1974a). Mani (1968) and Sutherland (1964) suggest it is an advantage for alpine insects to be able to spend periods of inactivity in any developmental stage in order to survive sudden snowfalls or frosts. P. pluto larvae have this ability as well as the later stage grasshopper nymphs. White (1978) found that alpine grasshoppers (Orthoptera : Acrididae) had very low respiration rates when they were inactive either overnight or for more extended unfavourable periods. When some of the alpine grasshoppers were brought down to lower altitudes White (1978) found that their respiration increased but ingestion did not. This caused stress and may be a factor in the 'stranding' of New Zealand's alpine grasshoppers above 900 m (Bigelow, 1967).

Even in the summer, alpine insects live among temperature extremes - Papp (1978) records a facultative diurnal carabid snow predator (Agonum sp.) which spends some of its time on summer snow patches (3300 m) and some time on adjacent rocks. In this area at the margin of a snow patch, shaded snow ($0^{o}C$), sunlit snow ($6.7^{o}C$), soil at 2 cm depth ($19^{o}C$) and sunlit rock ($56^{o}C$) all provide a wide temperature gradient (c. $60^{o}C$) for the beetle within 1 m^2. Papp (1978) also observed nocturnal insect predation at 2230 m in subzero temperatures and strong winds.

2.2.5 The phenomenon of swarming and insect fallout

Large numbers of lowland insects have been observed to group together and move towards mountain peaks or other prominent geographical points and Mani (1962) cites the case of over 2 million ladybird beetles in one swarm. Many do not feed or breed and heavy snow (10-20 m thick) may cover such swarms for the winter in the Himalayas. When the snow goes the survivors move back down the valley for breeding. This movement en masse to mountain peaks may have arisen from a tendency to over-winter under an insulatory snow layer rather than remain in the sometimes snow free but colder valley floors. The dead insects from these swarms and from aerial flotsam and jetsam (insect fallout) in general can form a food supply for "necrophagous" Collembolla, Staphylinidae, Tenebrionidae, Carabidae, Diptera and mites (Mani, 1962; Papp, 1978). Swan (1963) postulated a widespread biotic zone (the "aeolian zone") in mountainous and polar regions where such wind transported insects are deposited (insect fallout) on snow and act as food for others. Kaisila (1952) and Papp (1978) both record carabid beetles preying on insect fallout. Papp (1978) records several aeolian predatory species (Carabidae and Staphylinidae) but only one was considered to be an obligate insect fallout predator (a Staphylinid-Phlaeopterus n.sp.). Papp (1978) recorded three Bembidion species (Carabidae) feeding on insect fallout and the most common food were psyllids (Homoptera). In general Papp (1978) noted that most of the major fallout components (Aphididae, Cicadellidae, Psyllidae, Nematocera and acalypterate Diptera) were fed on by the nival predators with the exception of Hymenoptera. Another carabid beetle (Agonum fallianum Leng) has been observed feeding on Nematocera, aphids, psyllids, leafhoppers and a small weevil (Coleoptera : Curculionidae) (Papp, 1978).

It has been suggested that the "Mt Cook flea" Pharmacus montanus (Figure 1) feeds on aeolian flotsam (Dumbleton, 1952; Walker, 1977). Dumbleton (1952) examined faecal pellets of Pharmacus and it appeared that their diet consisted in part of insect flotsam. My own examinations of Pharmacus faeces revealed only plant fragments. Wilson (1972) reported that the lowland moth Agrotis ipsilon (Walker) had been found dead and alive in great numbers on neves in Mt Cook National Park at altitudes up to 2500 m. Burrows (1961) reported white butterflies at the same altitude in the Arrowsmith range. Tomlinson (1973) investigated the meteorological aspects of trans-Tasman insect dispersal and he showed how the Southern Alps can cause descent eddies (on both sides of the Alps) in the path of the main wind flow from Australia. Insects (and plant debris) can be deposited as the result of such wind flows and Australian insects have been recorded at Auckland, Taranaki, Nelson, Jacksons Bay, Oamaru and Alexandra (Fox, 1973, 1975).

Agrotis ipsilon (Walker) the Australian greasy cutworm moth is established in New Zealand, but several records at Mt Cook show that influxes are probably still occurring from Australia. Mt Cook records include several Agrotis from the Tasman glacier (2000 m, 17 Feb 77), Tasman saddle (2340 m, 6 Apr 76), Mt Elie de Beamont (3000 m, 17 Feb 77) and Mt Footstool (2300 m, 9 Feb 77).

A light trap run near the old Ball hut (1130 m, 31 Mar 77) during Nor-West weather conditions, yielded many Agrotis ipsilon in varying states of repair. Rainey (1974) examined weather patterns and insect flight and concluded that a population of airborne insects is a bio-meteorological system, i.e. both the flight behaviour and physical weather patterns affect the overall movement of insects.

Gibbs and Ramsay (1960) found lowland butterflies, wasps and beetles on mountain tops (1300-1500 m) in the Tararua ranges, Mt Egmont, the Kaweka ranges and the

Kaimanawa ranges. They concluded that some had arrived of their own volition, aided by air currents, but others including small Hymenoptera and Diptera were part of an involuntary aerial plankton deposited on the snow (similar to Swan's (1963) aeolian zone concept). Kaisila (1952) made extensive collections from snow patches one summer in the Finnish lapland (68^{O}N). At this latitude the timberline was 420-500 m and the insects were on snow patches above the timberline. Kaisila distinguished three components among his insect material :

1. Insects brought by the wind; more or less "passive" occurrence on the snow. Most of Kaisila's insects belonged to this group and the majority had a forest origin.

2. Active visitors captured by the snow, very few insects were in this category.

3. Predatory insects; wingless forms in this group lived near the snow patches, winged forms came in from a greater distance.

Papp (1978), in a study of summer snow at 3300 m in the Sierra Nevadas (California) found that insect fallout onto the snow was positively related to temperature.

Hudson (1950) recorded some of the first swarms in the New Zealand alps that he had observed in 1893 on Mt Enys (2200 m). A large swarm of white butterflies was reported by Elder (1960). Elateridae, Cerambycidae and Belidae were collected in some numbers on Mt Moehau (900 m)

(Coromandel) by Wise (1961) and members of his party. The cerambycid *Navormorpha lineata* was collected in some numbers flying in sunlight in Feb 78 from the summit ridge (875 m) of Mt Moehau by a Lincoln College field party (R. Emberson, pers. comm., 1978). Taylor (1961) visited the summit of Mt Ngauruhoe (2300 m) and collected small numbers of a variety of insects including 11 spotted ladybirds (*Coccinella undecimpunitata* L.) *in copula*. Edwards (1957) discussed the swarming of ladybirds in the western United States mountains and likened them to the mating flights of ants which are also oriented towards prominent geographical features such as trees or knolls. Such a mating swarm of ants was observed at Mt Cook on the knolls to the south of the Blue Lakes (740 m) when hundreds of winged males of *Huberia striata* (Smith) (the striated ant) were observed swarming with a few winged females on 17 Nov 76. Nearby, from Blue stream itself (730 m) a mass flight of thousands of mayflies *Austroclima* sp. (Ephemeroptera : Leptophlebiidae) was observed in the afternoon of a calm sunny day after several fine days on the 22 April 76. The mayflies stopped swarming when the sun went (approx. 1545 h) and although the next day was fine as well, the swarm was not repeated.

Watt and Colebrook (1961) noted large numbers of beetles (mainly *Pyronota festiva* (Fabricius) (Scarabaeidae) and *Luperus vulgaris* Broun (Chrysomelidae)) flying on Mt Tataweka (520 m Great Barrier island). Poulton (1904) explains the landmark seeking phenomenon in terms of area reduction in which to find a mate. However, Watt and

Colebrook (1961) only observed one pair of beetles copulating so there may be more involved than just sexual searching.

The grouping of insects in swarms and their settling areas appears to be consistent from year to year. Mani (1962) found successive swarms assembling under the same rock shelters in the mountains each year. Chapman (1954) and Chapman *et al*. (1955) suggest that the summit seeking phenomenon is inherent among many groups of lowland insects and that mating and aestivation (Common, 1954) are possible reasons. These high altitude mass assemblages have been shown by Chapman *et al*. (1955) to provide food for bears and it is possible in New Zealand that birds (e.g. keas, seagulls) also use such insects as a food source.

Cicadas appear to occur in a clumped distribution pattern above the bushline. This may be because of small swarms but also may be associated with food sources. In a lowland study Fleming and Scott (1970) found that cicadas under *Phormium* (flax) bushes reached a larger size than their counterparts in pasture. Despite their ability to fly long distances, there was a strong tendency for the cicadas to stay on the vegetation that they had occupied as nymphs. Presumably this clumping also occurs among alpine cicadas for the same reasons. Clumping may also be aided by the species specific acoustic behaviour of males attracting females, with click repetition rates varying from c.22 clicks per second in *Maoricicada mangu* to greater than 500 clicks per second in *M. clamitans* (Dugdale and Fleming, 1978).

2.2.6 Alpine and subalpine plants and insect pollination

In high latitudes or altitudes plants have established different reactions to the problem of cross-pollination. In the high Caucasus 90% of the alpine plants were found to be pollinated by insects and the remainder by wind (Billings, 1974). In the arctic the number pollinated by wind is higher - 35%, with bumble bees the main pollinating insects. Amongst bees the bumble bees can fly at lower temperatures and in stronger winds than all of the others, however, flies can operate at still lower temperatures and lower light intensities. Above 4000 m in the Himalayas bee pollinators diminish markedly and bright coloured flowers predominate which are pollinated by Lepidoptera and Diptera (Mani, 1962). In New Zealand brightly coloured alpine flowers are rare, and small, flat, white or yellow coloured flowers are prevalent, which is in contrast to the Northern Hemisphere alpine flora. Heine (1937) noted the lack of long tongued native bees in New Zealand and concluded that most of the pollination of New Zealand alpine plants was by 'small' insects such as flies and short tongued native bees. Earlier work by Thomson (1926) contained a detailed list of plant species and their insect visitors. However, in spite of their small size native bees can visit (and presumably pollinate) such long flowers as are found on the dwarf mistletoe (*Korthalsella clavata* Loranthaceae). Dugdale (1975) records small native bees prising open the corolla lobes of Loranthaceae flowers to get into the corolla tube which is at least three times longer than the bee. Native bees are responsible for more of New Zealand's alpine flora pollination than was first thought (B. Donovan, pers. comm., 1977) but the actual extent is not known and very little quantitative work has been published, apart from some records in Thomson (1926). Some recent work has been carried out by Primack (pers. comm., 1977) in subalpine areas at Cass and Mt Cook (Table 2).

TABLE 2 : Percentage of different insects visiting flowers at Mt Cook and Cass (Primack, pers. comm., 1977). Altitude about 750 m for Mt Cook and about 1000 m for Craigieburn.

	No.	Bees	Flies	Syrphids	Beetles	Others
A. Mt Cook :						
Hebes	67	22	45	21	3	9
Compositae	81	17	46	27	1	9
Others	95	15	36	14	19	16
B. Craigieburn :						
Hebes	56	0	50	30	9	11
Compositae	181	10	46	25	15	4
Others	173	11	50	31	4	4

Primack noted that the number of bees visiting flowers decreased with increased altitude (which is the same as has been noted in the Himalayas by Mani (1962) and in the European Alps). Primack also noted that the weather had a marked effect on flower visitors:

Cold	Cloudy	Calm	Tachinidae (Diptera *Protohystricia*)
Cold	Cloudy	Windy	" (" ")
Warm	Clear	Calm	Hymenoptera (Bees and ants)
Warm	Clear	Windy	Syrphids (Hoverflies)

Out of 115 plant species observed by Primack 70 species were visited by a broad range of insect visitors and 60% of visiting was by Tachinid flies. Dugdale (1975) had earlier reached the same conclusion that visitor-flower relationships were mainly non-specific. My observations at Mt Cook also bear this out with several species of tachinids, syrphids, Apoidea and Coleoptera collected from flowers of plants such as *Ranunculus lyalli*, *Celmisia coriacea* and *Aciphylla*.

Holloway (1976) investigated pollen feeding in 11 species of New Zealand syrphids and she found that a wide range of flowers was visited and that pollen was carried on their bodies and fed on while flying. It appears that hoverflies may effect considerable pollination of many native plants. At Mt Cook I recorded them from the following plants in flower: *Celmisia coriacea*, *Ranunculus lyalli*, *Aciphylla* spp. *Chionochloa*, *Gingidia montana*, *Hebe* spp.

Muehlenbeckia, *Cassinia* and *Hyperica perforatum* (St John's wort). They were very common on *Ranunculus lyalli* flowers in Nov 76 in the Hooker valley. Primack (pers. comm., 1977) also noted that *Muehlenbeckia* flowers were often visited by ants, whether they pollinate or not is unknown. It appears that *Dracophyllum* spp. are the only plant group not visited by a wide range of insects, however, at dusk many noctuids (Lepidoptera) have been observed visiting their flowers. Philpott (1930) collected *Graphania maya* Hudson from *Dracophyllum* flowers in Jan and Feb at Mt Cook and J. Dugdale and I collected *Graphania sequens* (Howes) from *Dracophyllum uniflorum* flowers at Stocking stream (c. 800 m) at dusk in early Apr 77. Microscopic examination of the *G. sequens* collected revealed small pollen grains in masses along the length of the proboscis. Other *Graphania* spp. taken in light traps showed similar pollen masses. These masses may result from regurgitation caused by the killing agents (Vapona and ethyl acetate) but, in spite of this, the proboscis appears to be a good means for the transfer of pollen from plant to plant.

2.3 Previous Collections

Previous published work on insects of Mt Cook includes a short chapter in the Park handbook (Connor, 1973) by Hugh Wilson. Earlier editions of the Handbook (Connor, 1962) contained details included by Jack Dumbleton. Wilson (1976) includes several references to insects in his discussion of

Mt Cook vegetation.

Philpott (1930), in a major work on the Lepidoptera of Mt Cook, made extensive collections from Governor's bush, Kea point, Hooker valley, the foot of Mt Wakefield ("Mt Franklin"), Sebastopol-Red lakes area and the Tasman valley to Ball hut and Ball ridge. He spent a total of five weeks in the months of Dec, Jan, Feb and Dec 1928-1929 at Mt Cook. He recorded over 200 species of butterflies and moths of which eight were new. He included a number of important plant-insect relationships including moths visiting *Dracophyllum longifolium* and recorded a tortricid from *Phyllocladus*. Philpott recorded a number of interesting and rare species, including *Hierodoris eremita* Philpott that was not collected again until the present study. Earlier collections in the Mt Cook area were made by R.W. Fereday in 1888 and in 1899 G.V. Hudson stayed at the Old Hermitage in December for five days and collected "in inclement weather" in the area. T. Hall collected mainly Coleoptera in 1909 and in 1923 R.J. Tillyard made a brief visit to the Hermitage (Philpott, 1930). Many other insect collections have been made in the general Mt Cook area but none have been published separately. Recent collections in the Park that have been made and the localities published include: Carabidae by Lindroth (1976), Leafhoppers (Homoptera) by Knight (1975, 1976) and leaf mining flies (Ayromyzidae-Diptera) by Spencer (1976). Dugdale and Fleming (1978) include several Mt Cook records in their treatment of the alpine genus Maoricicada (Cicadidae : Hemiptera). Walker (1977, 1978) examines two alpine insects found in the Park (Pharmacus and Percnodaimon). Charles Douglas in various reports to the House of Representatives (1892-1896) made early observations on insect life on glaciers and speculated that some of the spiders were "practising for a polar expedition sort of arachnidae nanseaii".

Broun (1893) in his Manual of New Zealand Coleoptera Parts v, vi and vii, lists several records of beetles from Mt Cook. Watt (unpublished ms.) lists "Hermitage" type localities for 23 beetle species (Appendix III). These were mainly collected by Suter who was employed at the Old Hermitage for several years.

Britton (1941) reviewed the carabid beetle tribes of Lebinii and Pentagonicini and listed some records from near the Hermitage of Demetrida lateralis and Scopodes prasinus. Holloway (1961) in her treatment of New Zealand Stag beetles (Lucanidae : Coleoptera) listed records of Ceratognathus alboguttatus and C. cylindricus from Mt Cook. The latter record, one specimen collected by S. Hudson in December 1928 in the Hooker valley, is the only South Island record of the species. In a review of New Zealand water beetles (Dytiscidae : Coleoptera) Ordish (1966) lists four species that were collected at Mt Cook (Sealy tarns and Red lakes) by various people. In an unpublished report on cicadas in New Zealand National Parks C. Fleming (1969) lists 10 species found at Mt Cook. Dumbleton (1972) recorded two sandfly species from Mt Cook - the West Coast black fly Austrosimulium ungulatum and A. unicorne (Simuliidae : Diptera).

Hoy (1962) lists several scale insects (Eriococcidae : Homoptera) from plants at Mt Cook (collected mainly by A. Eyles and I. Townsend). Harrison (1959) in his acalypterate Diptera of New Zealand also lists several species with locality records from Mt Cook. Amongst these is the holotype of Trypaneoides tenuipennis Malloch (Sapromyzidae : Diptera) collected by Philpott in December 1924. Harrison also records three Tephritis species (Tephritidae : Diptera) from Mt Cook.

The Mt Cook flea (Figure 1) (Pharmacus montanus Orthoptera : Raphidophoridae) was originally described by Pictet and Saussure in 1891 from a specimen labelled 2134 m Mt Cook, probably collected by G. Mannering. Dumbleton (1935, 1952) on his many climbing trips into the Mt Cook region and elsewhere noted that Pharmacus occurred in groups on high mountain ridges and would leap out upon approach of climbers. Richards (1972) revised three alpine genera of the Raphidophoridae and established four species within the genus Pharmacus, she also listed some Mt Cook locality records.

Gaskin (1975) published Mt Cook records for three species in his review of New Zealand Crambini (Lepidoptera : Crambinae). In an earlier revision of the Diptychophorini (Lepidoptera : Pyralidae : Crambinae) Gaskin (1971) listed

Mt Cook locality records for six Pareromene species. He also listed three other species from Mt Cook in a revision of the Chilorini (Pyralidae) (Gaskin, 1973).

Dumbleton (1966) listed the type locality of the hepialid moth Aoraia aurimaculata as the Hermitage and also dealt with the zoo-geography of the New Zealand hepialids. Hudson (1928) described and illustrated much of the New Zealand Lepidoptera fauna and listed Mt Cook localities for some species.

CHAPTER 3

STUDY AREA - SITES AND TECHNIQUES

3.1 Introduction To The Study Area

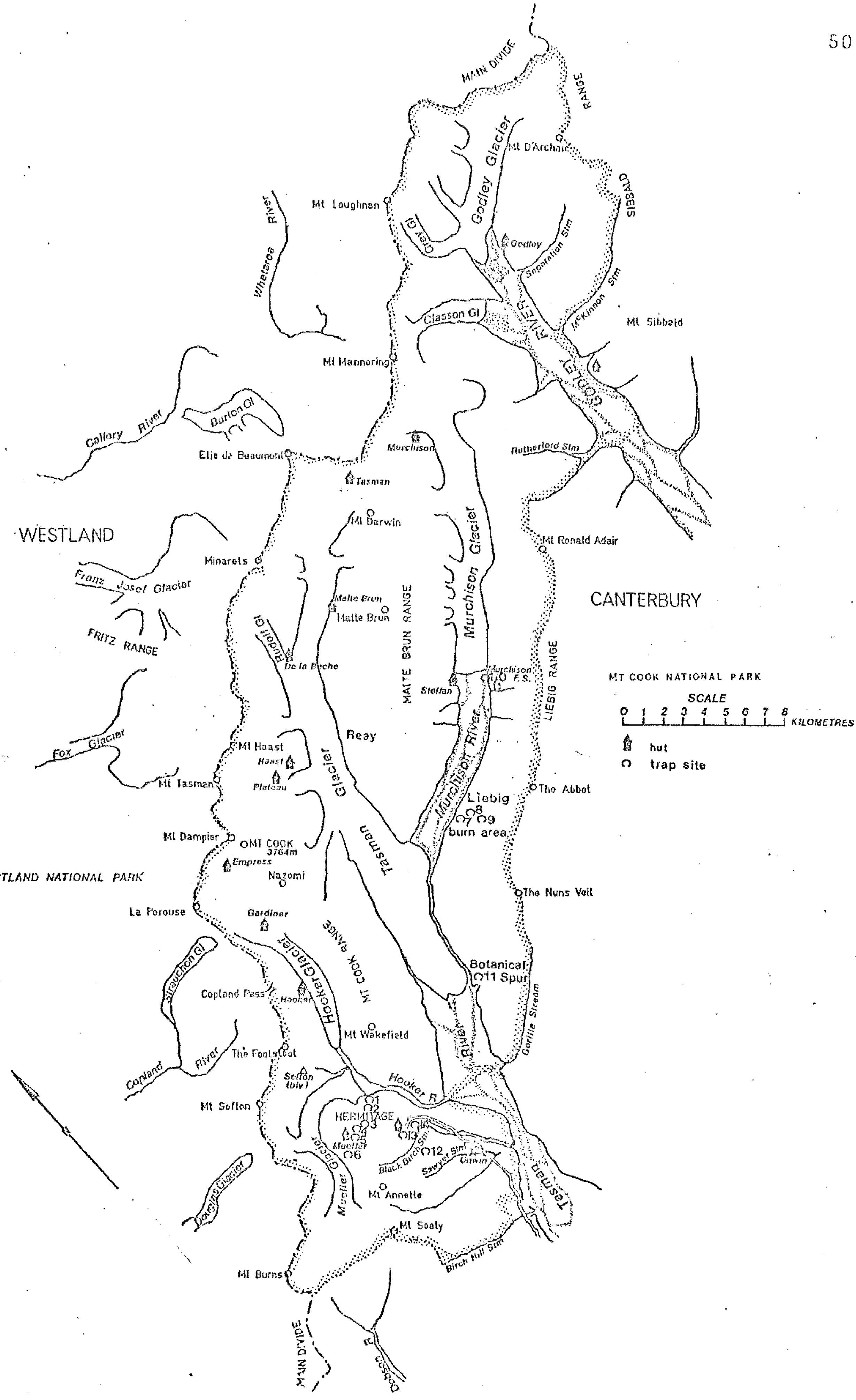
Mt Cook National Park is about 70 000 ha in area and ranges from 600 m to 3764 m in altitude. The vegetation cover varies from valley grassland and forest, to alpine grassland and fell field, to bare rock and permanent snow.

Because of the usually close relationship of insects with vegetation, details of the altitudinal zones and their vegetation have been given (Tables 1 and 3). Although the survey concentrated on the alpine areas most of these vegetation types were represented in the areas frequently visited, Governor's bush, Botanical spur and the Sealy and Liebig ranges (Map 1).

Table 3 shows the main types of habitat present in the Park and the percentage of the Park they cover.

Table 4 details altitude, slope, aspect and vegetation of the trap sites established in the course of the survey. An abbreviated diary of trap visits and main collecting events is included as Appendix I.

Table 5 supplies details of some notable collecting areas other than trap sites.



MAP 1 - Trap sites and areas visited.

3.1.1 The physical environment

The snowline (Table 1) is the average lower limit of persistent snow. Below this level snow usually melts away completely each summer. The grassline is the average upper limit of continuous grassland which may be lowered by erosion. The timberline or scrubline is the average upper limit of erect trees and shrubs. Many low altitude plants reach their upper limits at the upper edge of the montane zone (from Wilson, 1978).

The annual average snow and rainfall is equivalent to about 7500 mm of rain in areas close to the main divide, progressively diminishing further east to about 2500 mm in the Godley valley and Liebig range.

Temperatures vary widely at any time of year and the hottest months at the Hermitage are January and February (19^{o}C mean daily maximum). July is the coldest month with a mean daily minimum of -3^{o}C. At the Hermitage the difference between the lowest minimum and the highest maximum ranges from 28^{o} (-11^{o}C to $+20^{o}$C) for June and 35^{o} (-3^{o}C to $+32^{o}$C) for February (Connor, 1973). Snow is relatively permanent above 2000 m, and from there down is seasonal and variable from year to year. Snow may fall from a northwesterly or southerly weather pattern at any time of the year, in November 1967 1.5 m fell at the Hermitage. During the insect survey the Christmas of 1975 was a white one in the Hooker valley and below. In early May 1976 several snow falls settled at the 750 m level in the valleys whereas in 1977 several falls occurred about two

TABLE 3 : Habitat areas (adapted from Wilson, 1976).

	% age of total area of Park
Perennial snow and ice	32.5
Nival and subnival rock	15.3*
Surface moraine	9.8
Riverbed	6.2
Scree and stony ground	6.0
Alpine *Chionochloa* grassland	5.3*
Subalpine and montane short grassland	4.2*
Upper subalpine shrubland	3.6
Deposited moraine	3.3*
Alpine subalpine and montane rock	3.3
Alpine short grassland	3.3*
Scrub	2.6
Recently burnt (Liebig range)	1.8*
Seral shrub	1.3
Wetland and aquatic	0.8
Hall's totara forest	0.3*
Subalpine and montane tall tussock	0.25
Silver beech forest (*Nothofagus*)	0.05*
Boulderfield	0.05
Artificially disturbed (Village area etc)	0.05

* The insect survey concentrated on these areas, but not exclusively.

weeks earlier. Snow may persist on the ground in the village for the winter, however some winters are snowfree at this level (D. Massam, pers. comm., 1977).

As a result of the plant collections by the geologist Julius von Haast many of the Park's plants were known by 1900 (published in Joseph Hooker's "Handbook of the New Zealand Flora" 1864 and 1867). A comprehensive botanical survey of Mt Cook National Park (Wilson, 1976) and an illustrated field guide to the plants (Wilson, 1978) have been recently published. Wilson (1976) traced some effects on plants of altitude, aspect, substrate, precipitation, fire and introduced animals. Only five plants were found to be unique to the Mt Cook region, an endemic situation in contrast to the areas north and south. For an introduction to the New Zealand flora as a whole see Godley (1975).

Greywackes make up the majority of the rock of the area (Haast, 1879; Gage, 1969). Greywacke screes take longer to stabilise and soils are slower to form than those from the schistose mountains of Otago. Field (1977) studied Liebig range geology and Findlay (pers. comm., 1978) is studying rocks of the main divide. Lillie (1963), and Lillie and Gunn (1964) examined some of the structural geology of mountains, with reference to steeply plunging folds in the Sealy range in the latter paper.

Soil development is poor in most of the Park, podzolised yellow brown earths under Chionochloa grassland were described by Archer et al. (1973).

In the country as a whole a unique flora and fauna has resulted because of the character of the geology and the long isolation of New Zealand from Antarctica (Fleming, 1975; Raven and Axelrod, 1972).

3.2 Sites

Fourteen numbered trapping stations were established in different parts of the Park (Table 4, Map 1, Plates 4-10). At each of these four pitfall traps and a sticky trap were placed. Trap visits are outlined in Appendix I. In addition to these permanent collecting stations intermittent collecting was carried out at various localities (Table 5, Map 1) using a wide variety of techniques detailed below.

3.3 Techniques

3.3.1 Pitfall traps

Four pitfall traps were placed at each of the 14 numbered sites, and a 2 m tall bamboo wand was used to mark each pit's location (Plates 5 and 7). They were visited as conditions permitted at intervals from four days to two months. Plastic pots (200 ml) were sunk into the ground using a garden trowel. The pot was sunk vertically into the ground with at least 1 cm of soil above the lip. About 20 ml of trapping agent (Picric acid or Gault's solution) was added to each pot. Detergent was added in trace amounts to lower the surface tension of the liquid, this allowed

PLATE 4 : Trap site 1 Sealy range (980 m). General view looking north May 77.

PLATE 5 : Trap site 4 Sealy range (1620 m) 10 May 77 just after the first winter snowfall of about 0.5 m. Looking south-east towards Mt Sebastopol and the junction of the Hooker and Tasman rivers. Bamboo wands mark the location of individual pit traps.

small insects to sink more readily. Large active insects such as bumble bees, grasshoppers and blowflies were also trapped, as were a range of spiders.

Glycerol was tried as a trapping preserving agent when it was found that Picric acid, in a concentrated form, dried out rapidly. Glycerol did not preserve specimens very well but the fermenting mixture did act as a bait for some groups of insects. The antifreeze property of glycerol solutions was an advantage as temperatures below zero can occur at any time of year, sometimes for prolonged periods. After trial and error a mixture of 30% glycerol and 70% saturated Picric acid solution was found to be satisfactory. Gault's solution* was used several times and was also suitable.

Rain and snow caused problems with the pit traps, the trapping fluid was sometimes much diluted. Initially plastic covers were employed to protect the traps. The covers were 400 ml pot lids pierced on opposite sides with no. 16 gauge wire. The ends of the wire were stuck into the earth on either side of the pot, leaving a 1-2 cm gap for insects to crawl under. Keas damaged these plastic

---

* Gault's solution:

(Could be mixed dry and the water added later)

(Potassium nitrate 10 g
(Sodium chloride 50 g
(Chloral hydrate 10 g (Trichloroacetaldehyde)

Water to 1 litre

(Instead of plain water 30% glycerol and water gave some measure against freezing and evaporation.)

TABLE 4 : Trap sites (also see map 1).

Site No.	Altitude (m)	Slope (°)	Aspect	Vegetation
Sealy Range :				
1	980	40	East	Subalpine scrub
2	1160	35	N.East	Upper subalpine scrub
3	1360	25-30	East	Alpine *Chionochloa* grassland
4	1620	35	East	Alpine *Chionochloa* herbfield
5	1730	40	N.East	Alpine fell field
6	1810	5-10	Relatively flat	Alpine herbfield
Liebig range				
7	900	5-10	North	*Discaria*, *Poa*, *Blechnum*
8	1080	35	"	Recently burnt (1970) former subalpine scrub
9	1300	40	"	Recently burnt (1970) Upper subalpine shrubland
Murchison Forestry hut				
10	1000	1-20	North	Sand, moss *Racomitrium*, *Coriaria*, *Cassinia*.
Botanical spur				
11	765	1-5	N.West	*Podocarpus hallii* forest
Red lakes				
12	1100	0-5	North	*Poa*, *Podocarpus nivalis* shrubs
Governor's bush				
13	810	25	East	*Nothofagus menziesii* forest
14	740	5-10	S.East	*Nothofagus menziesii* forest

TABLE 5 : Some other areas visited (also see Map 1)

	Altitude (m)	Slope (°)	Aspect	Vegetation
Unwin hut	670	0-5	Flat	<u>Poa</u>, <u>Agrostis</u>, <u>Discaria</u>
Sawyer stream	700-800	0-90	Various	<u>Nothofagus</u>, <u>Hebe</u>, <u>Poa</u>
Hooker corner	670	20-30	S.E.	<u>Dracophyllum</u>, <u>Nothofagus</u>
Blue lakes	730	0-30	Various	<u>Poa</u>, <u>Discaria</u>, <u>Aciphylla</u>
Foliage hill	740	15	"	mixed shrubs <u>Podocarpus</u>
Ball hut area	1130	15-30	E,N.E.	mixed shrubs <u>Chionochloa</u>
Hooker hut area	1130	0-25	S.E.	<u>Celmisia</u>, <u>Chionochloa</u> shrub
Godley hut	1250	0-30	N.W.	<u>Chionochloa</u> shrub
Separation stream	1200 m	0-30	N.W.	<u>Chionochloa</u>, <u>Poa</u>, <u>Dracophyllum</u>
Reay camp	1500	5-30	N.W.	<u>Chionochloa</u>, <u>Aciphylla</u>, <u>Celmisia</u>
Sefton biv.	1710	0-90	S.E.	<u>Celmisia</u> herbfield
Malte Brun hut	1650	0-80	N.W.	<u>Chionochloa</u>, <u>Celmisia</u>
Gardiner hut	1740	0-80	West	rock, <u>Hebe haastii</u>
Mt Hodgkinson	760	20-30	East	<u>Nothofagus</u>
Birch hill stream	760	10-30	S.E.	<u>Nothofagus</u>
Stocking stream	800	0-10	Flat	<u>Chionochloa</u>, <u>Dracophyllum</u>

covers and it was found that stones propped against each other over the pit were better. Sometimes snow completely covered the pitfalls, so bamboo wands about 2 m long were used as markers (Plates 5 and 7).

When the traps were emptied in the field a small amount of Picric acid or Gault's solution was added to each catch. Later this fluid was drained and Fester's fluid* or 70% alcohol and glycerol was added. A wide range of insects was collected using pitfall traps and in general these were well preserved even after trap clearance intervals of six months. Southwood (1968) suggested emptying the catch with a suction apparatus to avoid disturbing the adjacent ground. This was not done because the taper on the 200 ml pot aided withdrawal for emptying the catch. In sandy soil (e.g. Murchison Forestry hut pit site 10) disturbance was more of a factor but it was not serious.

3.3.2 Underground pit trap

A 200 ml plastic pot, raised and lowered by string was placed at the bottom of a presunk plastic tube 70 cm long and 8 cm in diameter. The plastic tube had many

---

* Fester's fluid : Used for the preservation of insects, especially those from pit and sticky traps

glacial acetic acid	6 ml
glycerol	60 ml
isopropyl alcohol	350 ml
water	584 ml

Insects preserved in this fluid remain more supple than those stored in 70% ethanol, glycerol and water

(R. Emberson, pers. comm., 1975).

PLATE 6 : Pitfall trap, 200 ml plastic pot removed from the ground and the trapping fluid drained. Catch - Hemideina maori Pictet and Saussure (Orthoptera : Stenopelmatidae) from Murchison Forestry hut pit site 10 (1000 m).

small holes bored in it below the 10 cm level and was sunk into a hole made with a crow bar. Picric acid was the preserving agent. The tube was sealed with a tight fitting lid. One of these was placed in Governor's bush (740 m) and one at Blue stream (730 m).

3.3.3 Sticky trap (Plates 7 and 8)

One sticky trap was placed at each of the 14 collecting sites. "A.A." yellow was chosen as the trap colour and I.C.I. "Ostico" tree banding grease was used as the attractant trapping medium (White, 1964; Southwood, 1968). The grease was applied to the outside of a cellulose acetate liner which was held onto the cylinder by two wire (16 gauge) clips. The cylinder (10 cm diam. x 30 cm length) was mounted on a wooden stake hammered vertically into the ground. The base of the cylinder was set at 1 m above ground level. The stake was driven into the ground first and then the cylinder was attached. If the reverse procedure was attempted the heavy blows tended to loosen or shatter the attaching screws.

The Ostico changed its tackiness with the temperature, the higher the temperature the more fluid the grease became and some larger insects (tachinid flies and cicadas) sometimes slid off the trap. These could still be collected from the ground beneath the cylinder. Rain clouded the Ostico and made it difficult to dissolve in the solvent (trichloroethylene). Ostico was difficult to apply in cold weather.

PLATE 7 : Sticky trap site 2 Sealy range (1160 m). The bamboo wands mark the location of two of the four pitfall traps at this site.

Insects were removed from the trap with a scalpel. Removal of the grease with the insects minimised damage. Specimens collected from sticky traps varied a great deal in condition and many were in poor condition, especially Diptera. Hymenoptera and Coleoptera were generally in good condition even after periods of 2-3 months.

After the insects were removed more Ostico was applied using a 3 cm paint brush. Cellulose acetate liners weathered rather rapidly and became brittle and dimpled after two months. They were easily replaced. the trichloroethylene grease solution was drained from each sample once it had been dissolved and Fester's fluid was added for storage. One Coleopteran family (Cleridae) was only collected on sticky traps, 14 specimens from two species were from Sealy sticky traps numbers 1 and 2. Many Hymenoptera were collected. In retrospect it would have been better to have made wider use of malaise traps and to have used a few sticky traps, mainly in the alpine zone. In Governor's bush a red trap could also have been employed because according to Southwood (1968) bark beetles prefer red-coloured traps.

3.3.4 Light trapping

Extensive intermittent trapping using a mains operated trap was carried out near Unwin hut (670 m) and in Governor's bush (810 m and 740 m). A blended light (Walker and Galbreath, 1979) was used most often. A portable 1 kw petrol generator was also used to run a light trap near

PLATE 8 : Sticky trap after several weeks operation, site 7 Liebig range (900 m).

Ball hut (1130 m) 1 Apr 77 and at Stocking stream (850 m) 3 Apr 77. Pressure lamps (kerosene) were used at night at all huts visited and Mt Ollivier (1830 m) (Sealy range) was climbed twice at night and a pressure lamp (c.200 watt) was run on the summit for 1 hour each time. A candle at Sealy tarns (1340 m) also attracted several insects on one occasion.

A time switch was connected to the mains trap in Governor's bush, and the trap was turned on before dusk and was left on all night. Conventional and mercury vapour bulbs of 150-180 watts were used in the mains operated traps. The portable generator (supplied by J. Dugdale during 1 week in April 1977) ran a 100 watt mercury vapour bulb which was set on a stand in the middle of a white sheet. As the insects arrived they were collected by placing a test tube (or boiling tube) over them and were then quickly transferred to a jar containing ethyl acetate impregnated tissue paper. Lepidoptera collected in this way suffered a minimum of damage.

Various killing agents were employed in the mains operated trap including cyanide, ethyl acetate, fly spray (pyrethrum) and 'Vapona' strips (dichlorvos). Vapona strips were found to be long lasting (Perrott, 1968) and were used most often. Vapona did not give a quick knock down but the moths were not badly damaged if plenty of tissue paper (toilet roll paper) and/or egg cartons were spread out to give shelter in the collecting box.

The trap had the Robinson type of perspex baffle arrangement (Robinson and Robinson , 1950) and was similar to that used by White (1964). The upright bulb was set in a funnel with four perspex baffles. The funnel fed into the collecting box which had spread out tissue paper and vapona in it.

3.3.5 Beating and sweeping

A sweep net with a handle of 50 cm length and a net diameter of 30 cm was used to sweep shrubs, tussocks, trees and to catch aerial insects. General sweeping of plants was carried out at all sites. The net was also held under branches of trees and shrubs and the branches were rapped sharply against the rim. A beating tray (60 cm x 60 cm) consisting of a white sheet on a collapsible bamboo support frame was also used. The branches in this case were rapped sharply with the handle of the sweep net while holding the tray underneath. Dislodged insects were sucked up with an aspirator (pooter). Some aquatic insects in tarns were collected using the sweep net under water.

3.3.6 Malaise trap (Plates 9 and 10)

Two types of malaise trap were used. The larger one (Plate 9) (courtesy J. Dugdale, DSIR, Auckland) was 2 m high by 3 m long with the high end tapering down to a lower end (1 m high). The collecting jar ('Nulon' plastic) was located at the apex of the high end (Plate 10).

PLATE 9 : Malaise trap - general view of larger trap in *Podocarpus hallii* forest, Botanical spur site 11 (765 m).

PLATE 10 : Detail of collecting jars, malaise trap Botanical spur. The upper jar is clamped to the apex by 'doughnut' plates, the lower jar contains some 'vapona' killing agent wrapped in a calico bag.

The collecting jar had two compartments, one was attached by 'doughnut' plates to the terylene mesh of the trap at the apex and the other compartment was underneath the top one, detachable by means of a screw lid fitting and it contained the 'vapona' killing agent. Because 'vapona' has a tendency to 'sweat' it was wrapped in toilet tissue paper or a calico bag. The smaller trap was supplied by B. May (DSIR, Auckland) and it was simply a sheet of white terylene mesh (80 cm x 60 cm) with a non-return funnel collecting jar (Nulon plastic) sewn and tied into the middle of the sheet on one edge. Several tethering cords allowed pitching of the trap in a variety of ways. The larger trap was pitched in a standard 'A' frame tent fashion using up to six aluminium snap together tent poles at the four corners and at each end. Southwood (1968) stated that malaise traps could not be used in windy conditions, but Sweney and Jones (1975) found that tethering the corners and base as well as the apices gave considerable stability and shape retention even under very windy conditions. However, the winds at Mt Cook are such that in spite of strong tethering and attempts at choosing mild weather the malaise traps were blown down several times. Several good collections resulted from use of the malaise traps and all insects (even Lepidoptera) were collected in good condition. Malaise collections were made at Botanical spur (765 m trap site 11) above Sealy tarns (1400 m and 1600 m), Red lakes (1100 m) and

Governor's bush (740 m). A malaise trap was also used in the Godley valley at Separation stream (1200 m) and at Godley hut (1250 m). Siting of the trap was important, a good site was at the edge of Governor's bush (740 m) in a warm sheltered glade (E. aspect).

A wide range of beetles, flies, Hymenoptera and some Lepidoptera were collected in the malaise traps. At Red lakes a grasshopper climbed the 2 m into the jar and was collected.

3.3.7 Collecting from plants

Plant damage or distortion was particularly looked for and this resulted in the determination of many plant-insect associations.

Plant samples which were suspected of insect infestation were placed in a cupboard in sealed plastic bags filled with air. Several insects were reared in this way. Agee jars with close fitting lids and moistened filter paper inside were also used for rearing insects from plant samples. Many Coleoptera were collected from logs and standing dead trees using axes, hatchets and strong knives to open up the wood or to remove bark. Heat extraction of vegetation, wood chips and litter was carried out using funnels to hold the samples and light bulbs (25 watt) as a heat source. Six days was the usual extraction time. Insects on plants, especially those on flowers, were particularly noted and were collected with a pooter or sweep net. An effective method for collecting insects that live on or attack freshly damaged plants was the cut branch technique suggested by G. Kuschel (DSIR, Auckland). Branches were cut from shrubs or trees and hung from the tree concerned (tying with string if necessary). The cutting date was noted and on subsequent visits the cut branch was beaten over a collecting sheet. The method was used in Governor's bush and Botanical spur and gave good results. Plants were frequently searched at night and at times large numbers of insects were collected (e.g. adult *Odontria* beetles on Matagouri foliage).

3.3.8 Drift net

Lalas (1977) operated a drift net (Southwood, 1968) in Blue stream and several valuable records were made available by him. An example was one specimen of the trechine carabid (Coleoptera) *Duvaliomimus brittoni* Jeannel. This was the only member of this tribe found during the insect survey.

CHAPTER 4

THE INSECT FAUNA

4.1 Taxonomic Categories (Based on the National Arthropod Collection, D.S.I.R., Auckland)

The following list contains the insect orders presented in the results and their common names. The results follow the sequence in the list. For other Arthropoda and Tardigrada see Appendix IV.

Phylum	Class	Order (Families follow C.S.I.R.O. (1970))
Arthropoda	Insecta	Ephemeroptera (mayflies)
		Odonata (damselflies, dragonflies)
		Blattodea (cockroaches)
		Dermaptera (earwigs)
		Plecoptera (stoneflies)
		Orthoptera (grasshoppers, locusts, crickets)
		Phasmatodea (stick-insects)
		Hemiptera - Homoptera (aphids, mealy bugs)
		Heteroptera (shield bugs)
		Thysanoptera (thrips)
		Neuroptera (lacewings)
		Coleoptera (beetles)
		Siphonaptera (fleas)
		Diptera (flies)
		Trichoptera (caddis-flies)
		Lepidoptera (moths, butterflies)
		Hymenoptera (wasps, bees, ants)

4.2 Specific Names, Common Names and Authors

A valuable source of specific and author names for the smaller orders was Wise's synonymic checklist (Wise, 1977). Common names follow the Entomological Society's standard common names list (Ferro *et al.*, 1977). According to conventional use, an author's name in brackets after a specific name signifies a recombination of the original species name with another generic name. When brackets are absent from the author's name the combination of the generic and specific names is the original one.

For example: *Sirex noctilio* F. is the valid original name as described by Fabricius for the sirex wood wasp; whereas -

Sigara arguta (White) is the present valid name for the common water boatman, but White had originally placed it in another genus (*Corixa*). Subsequently, Lundblad recombined *arguta* with *Sigara*.

Ephemeroptera (Mayflies)

In some adults of this family maturity only lasts a few hours. Nymphs may live for two or three years, they are aquatic herbivores. Mating swarms usually are 'stag' affairs with the females visiting the male swarming party, leaving to mate. The eggs are often laid as masses on the water surface. Lalas (1977) records predation by birds on some species.

Leptophlebiidae

Austroclima sepia (Phillips)

740 m Apr 76 over 5000 adults
Blue stream.
Sweep net, and on water.
A mass flight was observed from 1530 h until the sun went down behind the Wakefield spur (1630 h). The flight was not repeated the following day even though the weather was once again fine and warm. The flight day was preceded by a week of fine weather. In the following season no mass flight was recorded, only a few individuals were observed at any time.

Towns and Peters (1979) note that this species occurs throughout New Zealand from near sea level up to 1000 m. Nymphs are often found in clumps in the aquatic moss Fissidens ridgulus, in streams less than 10 m wide.

Deleatidium sp.

730 m Sep-Apr many
Blue stream.
Drift net.
The nymphs and sub-imagos of this species form the main food for the black fronted tern (Lalas, 1977). This species had two peaks of emergence, one in late September at low water level and one in April at high water level (Lalas, 1977).

Odonata (Dragon flies and damsel flies)

Fast flying predacious insects with biting mouth parts, prey is captured on the wing. Nymphs are aquatic, possessing prehensile mouth parts and gills. Sharell (1971) provides some of their biology, Penniket (1966) provides keys to adults and nymphs.

Coenagrionidae

Xanathocnemis zealandica (McLachlan) (red damsel fly)

900-1340 m Jan-Mar 7 adults
Sealy tarn, Red lakes.
Swept in *copula*, swept.
Associated with tarns and *Chionochloa*, adults common near bodies of water from the scrubline down in summer.

Lestidae

Austrolestes colensonis (White) (blue damsel fly)

730 m and 2000 m Jan-Feb 2 adults
Kea pt track, Tasman glacier.
In a plastic bag of red currants, on snow.

Petaluridae

Uropetala carovei (White) (giant dragon fly)

800-1200 m Nov-May 15 adults and nymphs (adults: 2 females, 2 males)
North face Mt Sebastopol, Glencoe walk, Godley valley, Red lakes.
Flying over scrub and in clearings, nymphs recorded in some numbers in swampy ground above the lower Red lakes (Nov 76).

Corduliidae

Antipodochlora braueri (de Selys Longchamps)

740-820 m Dec-Apr 5 adults
Governor's bush, swimming pool.
On water, swept ex *Phyllocladus* and *Dracophyllum*.

Procordulia smithii (White) (Smith's dragon fly)

740 m Feb 77 1 adult
Village.
On pool of water.

Blattodea (Cockroaches)

Blattidae - Johns (1966) covers this family and all others in New Zealand.

Celatoblatta anisoptera Johns

730-1930 m Oct-May 42 adults and immatures plus 19 recorded by Johns (1966).
Tasman glacier 730 m Holotype, White horse hill, Mt Sebastopol, Governor's bush, Wakefield spur, Stocking stream, Red lakes, Hooker valley, camp ground, Liebig range, Murchison forestry hut, Reay, Sealy, Green rock, Bowen bush, Malte Brun hut, Mt D'Archiac.

Under stones at the edge of screes and shrubs, Governor's bush pit, Murchison pit, in logs, under bark, ex *Cassinia* flowers.

Associated with *Coriaria*, *Muehlenbeckia*, *Gaultheria*, *Dracophyllum*, *Acaena*, *Chionochloa*, *Phyllocladus*.

The highest records were four from the Liebig range (1830-1930 m) under stones associated with *Dracophyllum*. Recorded on flowers in the daytime (1350 h Mar 76) and in huts at night (2100 h Nov 75). Common from 730-1500 m.

This species extends from the Mackenzie basin down as far as Lake Wanaka (Johns, 1966), described by Johns from the Tasman glacier specimens.

Dermaptera (earwigs)

Forficulidae - common earwigs, the eggs are laid in the soil as a group and the female stays over them, both before and after hatching showing some parental care.

Forficula auricularia Linnaeus (European earwig)

670-1000 m Oct-Mar 7 specimens
Village, Unwin hut, Hoophorn stream, Hooker flats.
Under rocks and in houses.
Herbivorous, carnivorous and saprophagous.

Plecoptera (stone flies)

Adults are clumsy fliers, often seen near streams at dusk. Eggs are laid in water and the nymphs are carnivorous, often on mayflies. Few stone flies were collected during the survey and the majority are unidentified.

Eustheniidae - a small family confined to Australia, New Zealand and South America. Includes large, mostly brightly coloured stoneflies. Adults emerge over a short period in summer and autumn and are always found near streams.

Stenoperla prasina (Newman) (large green stonefly)

730 m Jan-Feb 75 unknown number
Blue stream.
Lalas observation.
Found throughout New Zealand, associated with upland running water more commonly than lowland plains shingle rivers (Helson, 1934). Both Helson (1934) and Miller (1971) supply illustrations of various life history stages.

Austroperlidae - a small family confined to Australia, New Zealand and South America (McLellan, 1977).

Austroperla cyrene (Newman)

800 m Jan 59 unknown number
Hermitage area.
Specimens in the National collection D.S.I.R. Auckland. Adults are sluggish and black with a whitish front edge to the forewings (Miller, 1971).

Gripopterygidae - a common Australian family with many representatives in New Zealand, Fiji and South America (McLellan, 1977).

Megaleptoperla diminuta Kimmins

800 m Jan 59 unknown number
Hermitage area.
Specimens in the National collection D.S.I.R. Auckland.

Zelandobius furcillatus Tillyard

730 m Jan-Feb 75 unknown number
Blue stream.
Lalas drift net.

Zelandobius unicolor Tillyard

730 m Sep-Nov unknown number
Blue stream.
Lalas drift net.
Common in spring.

Zelandoperla decorata Tillyard

730 m Jun-July unknown number
Blue stream.
Lalas drift net.
Common in winter.

Orthoptera

Stenopelmatidae (ground wetas) - males often with enlarged mandibles and both sexes wingless.

Deinacrida connectens (Ander) (alpine weta)

1250-2100 m Jan-Apr 8 adults 20 immatures
Sefton biv ridge, Reay, Mt D'Archiac, Mt Malte Brun, Mt Wakefield, Sealy range.
Apparently absent from the Liebig range.
Under rocks scree fellfields, associated with *Celmisia* *Chionochloa*, *Blechnum*, *Ranunculus grahami*.
Collection times recorded: 0940 h, 1400 h, 1530 h, 1600 h.
The highest record (2100 m) was in association with *Ranunculus grahami* on the west ridge of Mt Malte Brun. One specimen was collected in March 1916 from the summit of Mt Malte Brun (3100 m) by H.E. Radcliffe (Salmon, 1950).
This species is also known from the Mt Arthur area and the Spenser mountains.
Fairly common in alpine fellfields.

Hemideina maori (Pictet and Saussure) (mountain stone weta) (Plate 6)

600-1600 m Oct-May 61 specimens
Stocking stream, Reay, Godley valley, Liebig range, Red lakes, Sealy range, Murchison pit 10, Rutherford stream, Mt D'Archiac, Ball ridge, Ailsa pass slopes, Mt Wakefield, Blue stream, Sefton biv ridge, Godley hut, Hooker and Tasman valley flats, roadside and village.
Widespread and common.
Under stones associated with Moss, *Chionochloa* and *Poa*.

Hemideina maori continued

Immatures and adults present at the same time, small immatures present Jan-Apr.
Originally collected from near the Hermitage, four other species in this genus live mainly in trees.

Hemideina sp. nova

800 m Nov-Oct 5 males - 2 adults, 3 immatures, 1 female immature.
Sawyer stream.
Near *Nothofagus* forest remnant at the edge of a small scree and near the stream. Plants nearby include *Hebe*, *Poa* and *Blechnum*.

One other female is known from Scone creek outside the northern end of the Park. The area in Sawyer stream has had little disturbance from fires or stock (apart from the odd sheep falling off the cliffs of Mt Sebastopol!). The area is bounded on three sides by steep cliffs, a waterfall pours over the middle cliff and a steep rocky gorge makes up the fourth side.

Rhaphidoporidae (cave wetas) - apterous insects with slender elongate appendages, many are found in damp caves, but New Zealand has several alpine species that live in rock crevices. Stridulation mechanisms are absent. Mature females have conspicuous ovipositors. Little is known of feeding habits but they are probably mainly omnivorous scavengers. Richards (1972) has published a revision of three alpine genera from the South Island. The distributions of *Pharmacus montanus* and some of the other wetas are given in maps 2 and 3.

Pharmacus montanus Pictet and de Saussure

(Mt Cook flea) (Fig. 1)

1700-3400 m Nov-Apr 70 specimens, adults and immatures.

Reay, East ridge Mt Footstool, North face Mt Jean, Sealy range, Mt D'Archiac, Sefton biv, Mt Ollivier, Barron saddle, Gardiner hut, Copland pass, Mueller hut area, West ridge Mt Malte Brun, Ball ridge, Mt Annette, West aspect low peak of Mt Cook, Mt Annan.

On rocks, tumbling off rocks onto snow, in rock crevices, walking on snow, on scree, on rock face tumbling and active at sub-zero temperatures. Associated with *Hebe haastii*, *Parahebe birleyi*, *Chionochloa*, *Senecio scorzoneroides*, *Ranunculus grahami*, rock lichens.

Active during the day and night 0900-2230 h. The snow tumbling is partially controlled by the long hind legs.

Originally described from a specimen collected at Mt Cook from 2134 m. The collector is thought to have been Mannering on one of his early attempts on Mt Cook (Walker, 1977). Other records include: Piton peak, Arrowsmith range, Jollie range, Two Thumb range, Haast ridge, Fritz range, Ben Ohau range, Fox Glacier neve, Mt Lloyd. It appears that *P. montanus* has a distribution which is widespread in various clumps around the central Southern Alps, generally above 2000 m. The lowest known record is from Remarkable ridge, 1676 m in the Craigieburn range. The highest collection record was from the western slopes of Mt Cook when a very young nymph was observed leaping down a steep icy rock face in subzero temperatures, 3400 m Dec 76. The only plants observed in this area were lichens.

Pharmacus brewsterensis Richards

1500-1800 m Nov-Feb 2 males, 2 females
Sealy range, Sefton biv, West aspect Copland pass (Westland).
Walking on snow 1800 h, under fellfield rock, walking on snow 1500 h, dead on path (1500 m).
Formerly listed by Richards (1972) from the Hunter mountains and Mt Brewster, Haast.
The Mt Cook records are the most northern.

Isoplectron sp. 1

765-1160 m Feb-May 16 specimens, 5 females.
Governor's bush pit 13, Botanical spur pit 11, Sealy range pit 2, Murchison pit 10.
Associated with sub-alpine scrub, *Nothofagus* and *Podocarpus*.

Isoplectron sp. 2

730-740 m Apr-May 2 specimens
Bowen bush, Governor's bush.
Associated with *Podocarpus* living and dead.

Isoplectron sp. 3

1050 m Jan 77 1 specimen
Tasman glacier.
On moraine wall 1030 h.

Isoplectron sp. 4

1650 m Mar 77 2 males
Sealy range.
On rock tor, leaping during daylight.

Weta or *Pleioplectron* sp.

1850-2000 m Jan 77 1 mature female, 1 immature female collected, many others seen.
On lichen covered rock tors at night (collection times 2200 h and 2230 h). Common on Mt Ollivier

Weta or Pleioplectron sp. continued

rock tors at night, but difficult to catch as it is a very active leaper and there are many crevices in the tors.

Tettigoniidae (long horned grasshoppers) - usually fully winged, with the antennae longer than the body. Stridulatory specialisations present on the leathery forewing of the male. Females with conspicuous ovipositors. Eggs are laid in soil and on plants.

Conocephalus semivittatum (Walker) (tussock katydid)

670-1800 m Feb-Apr 19 specimens; adults and immatures.
Unwin hut, Sealy range.
Amongst grasses, alive on snow, to light at night.
Common on the Hooker-Tasman flats area around Unwin hut. The one exception was the highest record at 1800 m on snow. Stridulation was heard during the late afternoon and up to 2100 h in February.

Gryllidae (crickets) - as in the Tettigoniidae the members of this family have long antennae, stridulate with the forewings and have tibial auditory organs. Usually the eggs are laid in the ground and the insects are generally omnivorous. A preference for hot sunny aspects is shown.

Metioche maoricum Walker (mute cricket)

740-1000 m Feb-May 9 specimens, 6 adults, 3 immatures.
Village area, Blue stream, Stocking stream, Governor's bush.
Liebig range, Mt Wakefield, Murchison pit 10.
Swept, in house, to light, under rock, ex pit trap.
Widespread below 1000 m. Stridulates during the day.

Orthoptera - Acrididae (short horned grasshoppers) - most of New Zealand's present grasshopper fauna is found above 900 m (Bigelow, 1967). Coupled with introduced herbivores (thar, sheep, hares, chamois and deer) they have aided erosion (Batchelor, 1967; White, 1974, 1978). In most countries Acrididae are usually lowland species, however in New Zealand they are not. It has been postulated that the cold temperatures in New Zealand in Pleistocene times eliminated most of the warm adapted lowland species.

Brachaspis nivalis (Hutton) (Map 3)

730-3000 m Oct-May 75 specimens
Ball hut, Godley, Reay, Gorilla stream, Liebig range, Sealy range, Sefton biv, Copland pass ridge, Mt Malte Brun, Hooker valley, Mt Wakefield, Mueller glacier terminal.
Swept ex Chionochloa, on rock and scree, moss and rock, on snow.
Active from 0830 h - 1800 h depending on temperature and humidity. In copula 1600 h Dec 76 Liebig range 1900 m, 1800 h Feb 77 Copland ridge, 1200 h Feb 75 Ball ridge 1890 m, 1045 h Feb 75 ridge 1830 m.

Brachaspis nivalis continued

The lowest specimen was found amongst rocks at the terminus of the Mueller glacier. The highest was found on rock at 3000 m on the west ridge of Mt Malte Brun. Common on screes from 900 m to 1800 m.

Bigelow (1967) records this species in the South Island mountains from Marlborough to Lake Hawea on rock and shingle above 900 m. One immature pair has been taken *in copula* and it is possible that paedogenesis may occur (Bigelow, 1967). White (1974a, b) details some of the biology.

Sigaus australis (Hutton) (Map 3)

740-1920 m Oct-May over 90 adults and immatures Liebig, Sealy, Wakefield, Godley, Reay, Ball ridge, Kea pt., Red lakes, Hooker, Village, Malte Brun hut, Sefton biv., Ball hut, North face Mt Sebastopol.

Associated with *Chionochloa*, one immature ex malaise.
Collection times noted: 0930-1530 h.
The preferred range appears to be 1200-1500 m, common in alpine *Chionochloa* areas in the central Southern Alps (Bigelow, 1967). In addition to the above records Bigelow (1967) recorded 82 males and 152 females from the Hermitage area.

Consumption and damage of alpine grasshoppers was found to be as high as 2.52 kg (dry wt) per ha for high favourability plants (White, 1974b). Some of the most preferred species were *Anistome aromatica*, *Coprosma* spp., *Gaultheria depressa*, *Gentiana corymbifera*, Sigaus australis (Hutton) continued

Hebe pinguifolia and Wahlenbergia albomarginata (White, 1974b). These plants are all inter-Chionochloa spp., Chionochloa itself is a low favourability plant for S. australis and Brachaspis.

Sigaus campestris (Hutton) (Map 3)

750-850 m Apr 76 1 specimen

Hooker valley.

Two other specimens (♀) are known from Mt Cook - 1 from the Hooker valley and 1 from the Hermitage area (Bigelow, 1967).

Uncommon, known from Hanmer springs to Southland, 300-1200 m the preferred range with the highest recorded at 1500 and 1600 m (Bigelow, 1967).

Phaulacridium marginale (Walker) (New Zealand grasshopper) (Map 3)

730-1130 m Jan-Apr 25 specimens

Sealy range, Mt Sebastopol, Hooker flats, Kea point track, Village helipad, Ball hut, Village lawns.

Common in open lower altitude grasslands, on artificial lawns (Agrostis tenuis).

Widespread in New Zealand, adults are fully winged in very few, rare above 900 m. Bigelow (1967) records a further 17 specimens from the Mt Cook area.

Phasmatodea (Stick insects)

Phasmidae - herbivorous, parthenogenesis is widespread, eggs are laid in litter or in the soil. Phasmids used to be included in the Orthoptera.

Clitarchus hookeri (White) (smooth stick insect)

1000 m Jan 77 1 immature
Sealy range.
On shrubs.

Hemiptera

Mostly phytophagous insects with sucking mouth parts. Two main suborders are recognised: Homoptera (Cicadas, aphids and scale insects) and Heteroptera (bed bugs, backswimmers, water boatmen etc). The majority of Hemiptera collected have been identified to species but many remain sorted only to family.

Homoptera

Cixiidae - nymphs are mainly root feeders.

Koroana arthuria? Myers

850 m Nov 76 3 adults 1810 h
Red lakes.
Swept ex *Olearia moschata*.

Koroana sp.

800-1010 m Feb-Mar 2 adults 1600 h
Blue stream, Stocking stream.
Swept.

Oliarus sp.

1100 m Mar 76 2 adults 1600 h
Red lakes.
Swept.

Cicadellidae (leaf hoppers) - phytophagous, feeding almost exclusively on flowering plants. Knight (1974, 1975, 1976) has revised the New Zealand leaf hoppers.

Arawa salubris Knight

740-1130 m Feb-Apr 7 adults
Governor's bush, Hooker hut, Stocking stream, Rutherford stream.
Swept, to light at night (2100 h).
Associated with *Dracophyllum*, *Chionochloa*, St John's wort.

Batracomorphus adventitiosus Evans

790-900 m Feb 72 56 males, 40 females, 4 nymphs
Kea pt track, Hooker flats.
Associated with shrubs, grasses, Coprosma parviflora, Hoheria glabrata (from Knight, 1974).

Batracomorphus angustatus (Osborn) (introduced?)

670-1000 m Jan-Feb 72 52 males, 36 females
Unwin hut area and Ball road.
Associated with shrubs, grasses, Cassinia (from Knight, 1974).
Known also from Samoa and Tonga.

Deltocephalus vetus Knight

1100 m Feb 72 several
Ball hut road area, ex shrubs.
Collected and described by Knight (1975) from this locality.

Horouta inconstans Knight

740-1700 m Feb-Apr 4 adults
Copland ridge, Governor's bush, Stocking stream.
Swept, to light at night.
Associated with Poa, Dracophyllum, Chionochloa, Hebe.
Described from specimens collected in the Hooker valley.

Limotettix pallidus Knight

610-1160 m Feb 72 several
Tasman valley, Mt Sebastopol, Red lakes.
On rough grass sedges and shrubs.
Described by Knight (1975) from the Mt Cook areas above. Records from Knight (1975).

Limotettix sp.

1100 m Feb 76 1 adult 1810 h
Red lakes .
Swept.

Matatua montivaga Knight

800-1160 m Jan-Feb 72 over 100 males and females
Red lakes, Hooker valley, Governor's bush.
On shrubs and tussock, Coprosma, ferns, shrubs in Nothofagus forest.
Holotype and paratypes from the Red lakes specimens, all records from Knight (1976).
An endemic genus and species.

Novothymbris castor Knight

800-1160 m Jan-Feb 72 over 50 males and females
Red lakes area, Hooker valley, Governor's bush.
Associated with Hebe, Hoheria, Senecio, Coprosma, Nothofagus.

Scaphetus simus Knight

1040 m Feb 72 1 female
Ball hut road area.
Ex lateral moraine shrubs.
Record from Knight (1975).

Xestocephalus oxalis Evans

760 m Jan 72 2 adults
Hermitage.
Ex grass (from Knight, 1974).

Zelopsis nothofagi Evans

700-880 m Jan 66, Jan 72 18 males, 49 females
Tasman valley, Mt Sebastopol.
Associated with Nothofagus. (From Knight, 1974)

Zygina zealandica (Myers)

760-1160 m Jan-Feb over 50 males and females
Hooker, Red lakes, Ball hut road, Governor's bush.
Associated with Cassinia, Leptospermum, Coprosma, grasses and vegetables. Present in Australia and throughout N.Z. (From Knight, 1976.)

Cicadidae - eggs are laid in slits cut in branches, on hatching the young cicadas fall to the ground and spend up to several years as nymphs below ground feeding on plant roots.. Adults emerge from nymphal exuviae, which are often seen discarded on plant stems.

Adults tend to appear in cycles as brood of the same age emerges at the same time. A notable characteristic of cicadas is the sound generation ability of the males. The sounds are produced by tymbals located on the ventral surface of the first abdominal segment.

Dugdale (1971) revised the genus Cicadetta and placed the species involved in several other genera including Kikihia and Maoricicada. Kikihia has relatively close Australian relatives whereas Maoricicada has less obvious connections. Maoricicada is the most modified of the New Zealand genera and in contrast to the typical cicada habitat of warm lowland areas it is common in alpine areas where insolation is high but the air temperature is low. Dugdale and Fleming (1978) detail the Maoricicada species and outline their sound generation capabilities. Distributions are in Map 4.

Kikihia angusta (Walker) (tussock cicada)

730-1500 m Feb-Apr 21 adults
Mt Wakefield, Separation stream, Hooker, Mt Sebastopol, Blue stream, Village, Red lakes, Stocking stream.

Kikihia angusta continued

Swept from shrubs, on lawns, Malaise trap 1200 m Separation stream, associated with scrub and Chionochloa. Often associated with Dracophyllum. Common below 1200 m, the highest record was from 1500 m 24 Feb 77 on the West ridge of Mt D'Archiac.

Kikihia horologium Fleming

800-1300 m Feb-Apr 22 adults
Stocking stream, Sealy range, Mt Wakefield, Rutherford stream, Hooker, Liebig range.
Swept and hand collected from scrub and Chionochloa, Leibig pit 9 (1300 m). Common between 800 m and 1300 m.

Kikihia rosea (Walker)

740-1200 m Apr 76 and Apr 77 6 adults collected, many more seen.
Mt Wakefield, Village area.
Associated with Dracophyllum, Poa, Chionochloa and Hebe.
The northernmost records of a scrub species that extends down to Stewart Island. Common in scrub in April.

Maoricicada campbelli (Myers) (Campbell's cicada)

740-1020 m Jan-Feb 5 adults collected, many more heard.
Sefton biv ridge, Murchison, Village, Camp ground, Black birch stream.
Swept, on moss and rock, in house.
Common from vegetated riverbed areas and up into the mid scrub (1000 m).

Maoricicada clamitans Dugdale and Fleming

950 m Feb 77 1 adult
Rutherford stream, Godley valley.

Maoricicada hamiltoni (Myers)

C. 750 m exact collection unknown
Recorded in Dugdale and Fleming (1978) as ?
Hooker valley from Hudson's collection catalogue. Not recorded in the present survey. Present in the North Island and east of the alps as far south as Lake Pukaki on shingle river beds.

Maoricicada nigra nigra (Myers) (Fig. 3)

730-1830 m Jan-Mar 28 adults 1130-1730 h
Mt D'Archiac, Stocking stream, Sefton biv ridge, Sealy range, Rutherford stream, Blue lake, Tasman glacier.
Alpine fell fields and herbfields, on rocks, on snow, on track, on moraine, under rocks.
The lowest record was from Blue lakes.
One specimen collected as a pupae under a rock Mt D'Archiac Feb 77, 1600 m, 1600 h, emerged as an adult 1 hour later.
Common in the South Island mountains from the Spenser Mts to Fiordland 1200-1600 m.

Maoricicada oromalaena (Myers)

900-2000 m Jan-Mar 36 adults 0820-1750 h
Mt D'Archiac, Sealy range, Sebastopol, Tasman glacier, Sealy tarn, Malte Brun hut, Gorilla stream, Nuns Veil, Ball ridge, Murchison, Sealy pit 2. Mt Rosa, Black birch stream, Beetham.
On flowers, Celmisia coriacea, on snow, on tarns, on moraine, swept ex scrub Sealy site 1, on scree.

Maoricicada oromalaena continued

Males sing on bare rock faces and adults emerge from Dec-Apr throughout the Southern alps, common from 900-1800 m. The highest records were from snow. A pair was observed *in copula* on Mt Sebastopol, 900 m, Mar 77. Three were collected from a *Celmisia coriacea* flower at 0820 h, 1200 m, just above the Godley hut. They appeared to have spent the night on the flower.

Maoricicada phaeoptera Dugdale and Fleming

910, 1000, 1580 m Feb 75, Feb 77 3 adults
Rutherford stream, Ball ridge, Godley valley.
On rock and scree.
The Ball ridge specimen is the only record from the main divide area. Common in South Canterbury and North Otago.

Psyllidae

Trioza falcata (Ferris and Klyver)

740 m Mar 77 1 adult
Governor's bush.
Beaten ex cut branches, Hebe, Nothofagus, Podocarpus.

Aphididae (aphids) - a plant feeding family with sucking mouth parts.

Unidentified genus and species ("black fly")

1200 m Feb 40-50 winged adults, many immature.
Liebig range.
Present in some numbers on one Aciphylla flower stalk. Specimens in fluid misplaced. The only notable record of aphids in the park.

Coccoidea (scale insects and mealy bugs)

Margarodidae

Coelostomidia zealandica (Maskell) great, giant scale.

765-1100 m Mar 76 approx. 50 females and 2 winged males.
Red lakes and Botanical spur.
Associated with Podocarpus hallii, one mature tree in Botanical spur forest remnant was heavily infested under the bark. A black mould was growing on the "dew" excretions on the bark. The Red lakes record was one winged male swept at 1800 h.

Eriococcidae (scale insects) (Hoy, 1962, has revised the N.Z. species)

Eriococcus arcanus Hoy

740 m Jan unknown no.
"Mt Cook" J. Townsend, Hooker flats.
Forming nail head galls on the underside of Phyllocladus alpinus cladodes. Common.

Eriococcus orariensis Hoy . (manuka blight scale)

700-850 m Dec-Apr many

North face Mt Sebastopol, Wakefield spur.

Common on Leptospermum stems and branches. Associated with a black sooty mould. Numbers can be reduced by another fungus M. thwaitessi. Manuka can be killed by the scale.

Eriococcus phyllocladi Maskell

700-800 m Jan unknown no.

Hooker valley area.

Adult females on the underside of cladodes of P. alpinus.

Eriococcus sp.

700-800 m Jan unknown no.

Hooker valley area, village.

Hebe subalpina host plant.

Common on some plants.

Pseudococcidae (mealy bugs)

Pseudodantonina poae (Maskell)

1600 m Jan 77 unknown no.

Sealy range.

On roots of Chionachloa.

Pseudodantonina sp. nova

1600 m Jan 77 1

Sealy range.

On roots of Chionochloa.

Diaspididae ("armoured" scales)

Leucaspis greeni Brittin

700-800 m Dec-Apr many

Governor's bush, Hooker flats.

On the undersides of Griselinia littoralis leaves.

Present in high numbers on some leaves of some trees.

Leucaspis podocarpi Green (white totara scale)

700-800 m Dec-Apr many
Governor's bush, Bowen bush, Botanical spur.
On the undersides of totara leaves, in considerable numbers on a few trees.

Heteroptera

Dipsocoroidea

Schizopteridae

Hypselosoma sp. nova Stys in litt.

800-1700 m Nov-Apr 4 adults
Sealy, Reay, Stocking stream.
Under stones, associated with *Chionochloa*.
A genus known from Madagascar, Japan, China, Philippines, New Guinea, Melanesia, New Caledonia and Tasmania (Stys pers. comm., 1977). According to Stys (pers. comm.) this genus is the most primitive of the schizopterids in the Eastern hemisphere. So far *Hypselosoma sp. nova* has only been recorded from the Southern Alps.

Cimicoidea

Anthocoridae

genus and sp. indet.

1000 m Mar 76 1 specimen
Murchison valley.
Out of *Placopsis* lichen on sand near glacier snout.

Nabidae - insect predaceous bugs with sucking mouth parts, eggs are laid in plant tissues.

Nabis maoricus Walker (tussock damsel bug)

850-1100 m March 3 adults, 1 female
Red lakes, Kea pt, Murchison pit 10.
Swept ex tussocks 1810 h.

Nabis sp.

750-800 m Jan-Apr. 2 immatures
Helipad village, Stocking stream.
On grasses, one on Yarrow flower.

Miridae - predominantly a phytophagous family with some blood - or egg suckers of other insects. Their elongate eggs are laid in plant tissues.

?*Romna* sp.(p.)?

765-2200 m Dec-Feb 20 adults
Governor's bush light 13, Mt Scissors (Park boundary), Sealy range. Botanical spur malaise 11.
On snow (2200 m S.W. asp.) under rock in scrub, associated with *Nothofagus* forest.

?*Sthenarus* aff. *myersi* Woodward (Phylini)

900 m Mar 77 1 adult
Hoophorn stream.
ex *Podocarpus nivalis*.
(Kindly identified by R.T. Schuh, American Museum of Natural History, New York.)

Megaloceroea sp.(p.)?

800-1100 m Feb-May 5 adults
Murchison, Hoophorn, Liebig range, Red lakes.
Swept stream edge, on *Podocarpus nivalis*, swept 1810 h. Red lakes.

Saldidae (shore bugs)

2 genera, 2 spp., undescribed (now held in *Saldula*)
740-1920 m Nov-Apr 7 specimens
Hooker, Massam's pool, Ball ridge, Sealy range, Botanical spur, Stocking stream.
On water, under bark and swept.
Associated with *Chionochloa*, *Dracophyllum*, alpine herbfields, *Pittosporum* and *Hebe*.
Kindly examined by J.T. Polhemus, Colorado, U.S.A.

Aradidae (flat bark bugs)

Aneurus sp.

740-765 m   Apr 76, Apr 77   19 specimens
Birch hill, Botanical spur.
Under bark of *Nothofagus* and *Pittosporum*.

Ctenoneurus sp.

750 m   Apr 76   21 specimens
Birch hill.
Under bark of *Nothofagus*.

Lygaeidae (seed bugs) (many await identification)

Hudsona anceps (White   ) (Hudson's bug)

730-1950 m   Oct-Apr   28 specimens
Murchison pit 10, Hooker, Liebig range, Ball ridge, Reay, Red lakes, Blue stream.
Swept ex *Cassinia* flowers, *Aciphylla* flowers, *Poa*, *Raoulia grandiflora* flowers (1950 m Ball ridge).

Metagerra helmsi (Reuter   )

740-950 m   Feb-May   8 specimens
Governor's bush, Separation stream, Botanical spur.
To light, ex cut branch, pits 11 and 13, under rock, swept. Associated with *Nothofagus*.

Metagerra obscura White

900 m   Apr 76   1
Liebig range, 1400 h.

Nysius huttoni White   (wheat bug)

740-1500 m   Oct-Apr   13 specimens
Reay, Ball ridge, Hooker.
On *Aciphylla* flowers, in *copula*, under rocks.

Rhypodes chinai Usinger

740-1710 m   Oct-May   20 specimens
Sefton biv ridge, Stocking stream, East Hooker, Sealy range, Red lakes, village, Murchison.

Rhypodes chinai continued

Under stones, Malaise trap, on water, ex *Cassinia* seeds.

Ex *Muehlenbeckia*, *Raoulia*, *Celmisia*, *Aciphylla divisa*, *Chionochloa*.

Rhypodes nr. *chinai*

740-1500 m   Nov-Mar   5 specimens

Reay, village, Kea pt track.

On water, ex *Aciphylla* flower, *Poa*.

Rhypodes clavicornis (Fabricius)   (Fabrician lygaeid bug)

750-1130 m   Feb 69   unknown no.

Ball hut, Kea pt track.

Rhypodes myersi Usinger, 1942

700-1400 m   Nov-Feb   5 specimens

Wakefield track, Sefton biv. ridge, Hooker hut, Blue stream.

On flowers day and night (2100 h Feb 77) *Ranunculus lyalli*, *Leucogenes grandiceps*.

Rhypodes nr *myersi*

740-1500 m   Nov-Jan   3 specimens

Reay, village, Sealy.

On water, ex flowers, *Aciphylla*, *Celmisia*.

Woodwardiana evagorata (Woodward)

810-1150 m   Feb-Apr   2 adults

Governor's bush, Sealy.

Pit 13, litter extraction Sealy range 1150 m.

Woodwardiana nr. *nelsonensis*

740 m   Apr 76   1 adult

Ex *Nothofagus*, Birch hill.

Pentatomidae (shield bugs) - most are vegetable feeders, some are predacious.

<u>Cermatulus</u> <u>nasalis</u> (Westwood) (brown soldier bug)

800-1500 m Nov-Apr 10 adults
Sealy range, Liebig, Wakefield spur, Stocking stream, Red lakes, Kea pt, Reay.
Pit 9, on water, on <u>Muehlenbeckia</u>, <u>Olearia</u> <u>moschata</u>, <u>Chionochloa</u>.

Acanthosomatidae

<u>Oncacontias</u> <u>vittatus</u> (Fabricius)

740-1160 m Feb-Mar 2 adults
Village, Stocking stream.
In house, swept ex tussock.

<u>Rhophalimorpha</u> <u>lineolaris</u> Pendergrast

740-2000 m Nov-May 11 adults
Village, West Hooker, Reay, Unwin hut, Sealy, Camp ground, S.E. face Footstool, Kea pt track.
On water, on snow, under stone, in <u>copula</u>, ex <u>Muehlenbeckia</u>, <u>Acaena</u>, <u>Aciphylla</u> flowers, <u>Gingidia</u> <u>montana</u> flowers.

Corixidae (water boatmen) - predacious in some, mainly phytophagous, hind legs are modified for swimming. The nymphs are fully aquatic, whereas the adults use atmospheric oxygen gained on trips to the surface. Adults are capable of flight dispersal.

<u>Sigara</u> <u>arguta</u> (White) (common water boatman)

670-1340 m Jan-May over 50 adults and immatures
Sealy tarn, Blue stream, Murchison river side stream.
Collected by sweep net under water, the Murchison specimens were recorded from a partially iced over backwater.

Thysanoptera (Thrips)

Mainly phytophagous suction feeders, some species are horticultural pests. Common on flowers, most were not curated in the survey.

Thripidae

Thrips obscuratus (Crawford) (N.Z. flower thrips)

740-1100 m May 77 - Aug 78 20
Governor's bush underground pit, Red lakes, Sealy.
Malaise, swept ex flowers *Carmichaelia grandiflora*.

Neuroptera (Alder flies, Lacewings, Ant lions)

Soft bodied insects with biting mouth parts, larvae carnivorous.

Hemerobiidae (Brown lacewings)

Micromus bifasciatus? Tillyard

740 m Apr 77 1 adult
Governor's bush.
Swept.

Micromus tasmaniae (Walker) (Tasmanian lacewing)

740-2000 m Nov-May 10 adults
Red lakes track, Governor's bush, Tasman glacier, Sealy range.
Ex light trap 14, in house, on snow. Swept.
Ex *Olearia moschata*.
An introduced species, widespread.

genus and sp. indet.

810 m Feb 76 1 adult
Governor's bush.
Ex light trap 13.

Neuroptera

Myrmeleontidae - the carnivorous larvae of this lacewing family are known as ant -lions.

Weeleus acutus (Walker)

810 m Dec 4 adults
Governor's bush light 13.
According to Miller (1971) this is a very common native lacewing. Larvae construct pits in sunny sheltered spots, smaller insects such as ants fall or slide down the steep soil walls of the pit into the range of the formidable jaws of the waiting larva. Large insects such as wetas have been known to be captured (Miller, 1971). Adults are large (wing span C. 7.5 cm) sluggish nocturnal fliers, usually found down amongst vegetation during the day.

Coleoptera

Adephaga

Caraboidea

Carabidae (Ground beetles) - a major beetle family with both adults and larvae of most species carnivorous. Adults of most of the large species in New Zealand are flightless. The inner wings are often strongly reduced or absent and the elytra are commonly fused. Carabids can be separated into three main ecological groups; soil dwellers, edge of stream dwellers and tree dwellers but the last mentioned group is poorly represented in New Zealand. Some sub-families such as the Migadopinae, Broscinae and Zolinae have distributions which suggest former land connections between Australia, New Zealand, Southern Chile and the Falkland islands. Some distributions are shown in Map 5.

Cicindellinae - members of this subfamily are commonly called tiger beetles, both adults and larvae are predacious. The larvae live in holes in banks and the adults are active diurnal strong flying predators.

Neocicindella feredayi (Bates)

800-1500 m   Dec-Apr   5 adults
Liebig range, Murchison pit 10, Godley valley.
3 on sand, larvae present in sunny, steep, sloping, clay banks.
A common species of the foothills on the east side of the main divide. R.J. Tillyard also collected this species at Mt Cook in Mar 1923 at 760 m, probably at the second Hermitage area.

Neocicindella latecincta (White)

900-1000 m Mar-May 8 adults
Red lakes track, Liebig range, Murchison pit 10.
On sand or bare ground, larvae in steep sloping, sunny banks.
The most common species in the southern half of the South Island east of the main divide.

Migadopinae - a primitive group with four genera and five species in Australia all from mountain forests and rare. Known from the Subantarctic Islands and mountains and forests in New Zealand.

New genus, new species A.

1680-1810 m Nov-Feb 2 adults
Sealy range pit 6, Sefton biv. ridge.
Under rock 1200 h.

New genus, new species B.

1740 m Dec 1 adult
Upper Hooker valley near Gardiner hut.
On rock at 2200 h.
Johns (1969) records three species from an undescribed genus all taken between 1370 m and 2000 m in the Southern Alps. The above two species may also be in this genus. They represent part of a large undescribed mountain fauna of this subfamily in New Zealand.

Broscinae

Mecodema politanum Broun

1300-1830 m Nov-Apr 33 adults
Sealy range pit 3 & 4, Ball ridge, Liebig range.

Common under rocks in _Chionochloa_ herbfields. Two _in copula_ Ball ridge 1300 m Apr 77. Only five specimens found below 1500 m. The three specimens from the Liebig range were taken at 1830 m from an area which was not burnt during the 1970 fire. Absent from Botanical spur, Godley valley and the main divide. In the Lake Ohau area it has been found as low as Monument hut (600 m) and the Temple forest picnic shelter, both _Nothofagus_ forest areas.
The Mt Cook records are the most northern.

Mecodema rectolineatum Castelnau

670-1620 m   Nov-May   60 adults
Sealy range, pits 1, 2 & 4, Liebig range pits 7 & 9, Murchison pit 10, Red lakes, Governor's bush, Hooker valley, Blue lake, Mt Hodgkinson, Mt Wakefield, Unwin hut; Sefton biv. ridge, village area.
Only five specimens found above 1300 m.
A common widespread species at Mt Cook under logs or stones associated with forest or scrub, but not recorded from the Ohau area. Widely distributed in the southern South Island. The Mt Cook records are the most northern. Found in both burnt and unburnt areas of the Liebig range, but not common in the burnt areas. Not recorded from the Godley valley and Botanical spur.

Zolinae

Oopterus basalis Broun

1500 m   Feb   15 adults
Godley valley - west ridge of Mt D'Archiac
Chionochloa herbfield under stones, all from the same site on the say day.
Apparently very local.

Trechinae

Duvaliomimus brittoni Jeannel

670 m 1975 month unknown 1 adult
Blue stream.
Drift net in stream.
Known from the mountainous areas of the South Island in very wet habitats.

Bembidinae - Lindroth (1976) has published a revision of the genus Bembidion.

Bembidion charile Bates

c.750 m Jan 42 2 adults
Hermitage.
Recorded by Lindroth (1976), usually on bare pebble banks of big rivers.

Bembidion hokitikense Bates

800-1000 m Oct-Mar 6 adults
Stocking stream, Blue stream, East Hooker, Murchison glacier snout.
On sand or rock associated with Raoulia mats, Placopsis lichen.
Widespread in the South Island on gravel banks of small streams and moraines, often near glaciers (R. Emberson, pers. comm., 1978).

Bembidion maorinum Bates

830-900 m Dec-Jan 4 adults
Biretta stream - Liebig range, Blue stream.
Under rocks at the edge of the stream.
Widespread in the South Island (Lindroth, 1976).

Bembidion wanakense Lindroth

800-1000 m   Oct-May   39 adults
Murchison pit 10, Hoophorn stream.
Under rocks and mainly on sand associated with *Placopsis* lichen.
Generally less common than the two previous species although widespread in the South Island, usually on sandy river banks.

Psydrinae

Mecyclothorax rotundicollis (White)

1000 m   Feb   1 adult
Murchison pit 10.
A widespread species often found in rotting logs in other parts of New Zealand.

Molopsida cincta (Broun)

980 m   Jan-Apr   3 adults
Sealy range pit 1.
Three specimens from three visits.
Originally described from Mt Cook.

Pterostichinae

Holcaspis sternalis Broun

740-980 m   Oct-May   25 adults
Sealy range pit 1, Governor's bush pit 13, Botanical spur pit 11, in house edge of Governor's bush, under planks and stones on *Nothofagus* litter in Governor's bush.
Widely distributed in the southern South Island. The Mt Cook records are the northernmost known, apart from an anomolous early record from Akaroa.

Megadromus bullatus (Broun)

850 m May 1 adult

East slopes of Mt Hodgkinson.

Under a large fallen tree trunk in a Nothofagus forest remnant.

The northernmost record, other specimens have been found just south of the Park in Nothofagus forest at Bush stream.

Widespread from Mt Cook south to the Southland coast.

Agoninae

Agonum macrocoelus Broun

670-1200 m Oct-May 98 adults

Sealy range pits 1 & 2, Murchison pit 10, Botanical spur pit 11, Liebig range pit 7, Governor's bush pit 13, Red lakes pit 12, Sawyer stream Nothofagus forest, Birch hill stream Nothofagus forest, Mt Hodgkinson forest, Hooker corner forest, Ball hut road, Blue stream, Foliage hill, Hooker valley, Kea point, Ball hut, Godley valley.

A common species associated with subalpine scrub, Nothofagus forest and Podocarpus forest. It was not found in the Liebig range burnt area.

Colpodes haasti (Broun)

740 m Nov-Dec 76 2 adults

In village, in house at edge of Governor's bush. One in the Glencoe shelter toilet (dead on the floor) and the other in a house. Both buildings were between a road and Governor's bush.

A widespread but not very common species in the South Island.

Notogonum feredayi (Bates)

670-1340 m Oct-May 14 adults
Village, Blue stream, Hooker flat, Liebig range, Sealy range, Sawyer stream, Godley valley.
Usually under rocks at the edge of water.
A widespread species in the South Island.

Lebiinae

Demetrida dieffenbachi White

900 m Feb 2 adults
Godley valley.
Under a rock.
Generally widespread in the South Island, thought to be absent in the southern extremities.

Demetrida lateralis Broun

670-1820 m Oct-Apr 34 adults
Hooker valley, Sawyer stream, Hooker corner *Nothofagus* forest, Sealy range, Ball ridge, Reay, Kea point track, village area, Red lakes, Hoophorn spur.
Under rocks and stones associated with *Muehlenbecia*, *Raoulia*, *Dracophyllum*, *Hebe*, *Chionochloa*.
Described from a unique type at Mt Cook, but the species is perhaps only a variant of *D. moesta* Sharp which is widespread in the South Island.

Demetrida sinuata Broun

980-1340 m Oct-Jan 3 adults
Sealy range, Hooker hut area.
One specimen Sealy range pit 1, 2 others under rocks.
Widespread in the southern South Island.

Pentagonicinae

Scopodes spp.

These are active in daylight, running over mat plants and stones in bright sunshine.

Scopodes laevigatus Bates

900-1000 m Oct-May 9 adults
Murchison pit 10, East Hooker, Godley valley.
Under stones and associated with *Raoulia*.
Widespread, mainly in the northern part of the South Island.

Scopodes prasinus Bates

1200-1500 m Oct-Feb 8 adults
Sefton biv. ridge, Reay, Hooker, Godley.
Under stones amongst *Celmisia* - *Chionochloa* areas, 1 specimen on an *Aciphylla* flower.
A widespread species in the South Island.

Scopodes versicolor Bates

900 m Oct 76 20 adults
East Hooker.
On *Raoulia* mats in flower in sunshine.
Occurs throughout the South Island.

Odocanthinae

Actenonyx bembidioides White

700-970 m Nov-Feb 9 adults
Ball hut road, Liebig range, Stocking stream, Wakefield track, Murchison valley.
On sand and under rocks. One specimen from a *Ranunculus lyalli* flower by the Wakefield track.
One of the most widespread of the carabids, found almost throughout New Zealand, often beside water and in sandy places (R. Emberson, pers. comm., 1978).

In addition to the above species originally described from Mt Cook, Mecodema suteri Broun a synonym of M. rectolineatum Castelnau (Britton, 1949b) and Scopodes speciosus Broun a synonym of S. prasinus Bates (Britton, 1941) were also described from Mt Cook.

Dytiscidae (Predacious water beetles) - Water beetles with smooth boat shaped exteriors and flattened paddle like hind legs for swimming. Both adults and larvae are predacious. Larvae and adults take in air at the surface through a pair of spiracles. The adult can also store air between the abdomen and the elytra. The family is closely related to the Carabidae (ground beetles). Ordish (1966) has published a revision of the 14 species found in New Zealand.

Antiporus strigosulus (Broun)

1340 m   Nov 74   6 adults
Sealy tarn.
G. Gibbs collected four from Sealy tarn Feb 1945 (Ordish, 1966).

Huxelhydrus syntheticus Sharp

Three species recorded by Ordish (1966) collected by T. Broun, Mt Cook, no date.

Lancetes lanceolatus (Clark)

670 m   1975   1 adult
Blue stream.
Drift net (C. Lalas).
Present in Australia and New Zealand, usually in lowland areas and seldom encountered in large numbers (Ordish, 1966).

Liodessus plicatus (Sharp)

1340 m Nov 74 5 adults
Sealy tarn.
Also recorded by Ordish (1966) ex tarn Mt Cook 9 Dec 62. Widespread in New Zealand.

Rhantus pulverosus (Stephens) (Cosmopolitan diving beetle)

670-1200 m Nov 76 5 adults
Red lakes and Blue stream.
Sharell (1971) gives details of its biology. Adults and larvae are carnivorous. Adults may fly from ponds, streams or tarns at dusk, they are sometimes attracted to lights at night. Widespread in New Zealand in tarns, lowland ponds and quiet backwaters of streams.

Polyphaga

Hydrophiloidea

Hydraenidae - small elongate beetles that feed on fungi and algae from decaying leaves. Common in small streams usually in bush. Adults and larvae live close to water, but breathe air and are easily drowned if the surface tension of the water is lowered by a pollutant detergent.

Orchymontia Broun sp. No. 19 (Kuschel ms.)

740 m Apr 77 unknown number
Blackbirch stream (small side stream).
Collected by J.S. Dugdale in a sweep net placed in the stream, small rocks in the stream were dislodged above the net. The mass of litter and water was left to stand, the Hydraenidae floated

up for air and remained on the surface. Formerly placed in the genus Podaena the legs of most male Orchymontia spp. are highly modified. Also known from the following areas: Lindis Pass, Kingston, Lake Hawea, West Otago.

Orchymontia Broun sp. No. 29 (Kuschel ms.)

800 m   Mar 77   unknown number (approx.10)
Hoophorn stream (small side stream).

Hydrophilidae - larvae are usually in damp habitats and the adults feed on vegetable matter or dung.

One unidentified sp.

1100 m   Mar 75   1 adult
Separation stream, Godley valley.
Ex. cow dung.

Histeroidea

Histeridae - normally found in assocation with dry mammal carcasses, preying on maggots. They also occur in animal nests and in stored food.

Saprinus antipodus Dahlgren

1000 m   Mar 76   2 adults
Murchison pit 10.

Staphylinoidea

Leiodidae (Anisotomidae) - members of this family are mainly carrion feeders although some species feed on fungi, while in the northern hemisphere many species live in caves. A widespread New Zealand species is

Paracatops phyllobius (Broun) recorded from leaf litter throughout both islands from Oct-Mar.

Isocolon sp. 1

900 m Mar 77 1 adult
Pit 7 Liebig range.
The decaying matter in the pit trap may have acted as a bait for this insect.

Isocolon spp. 2 & 3?

980-1620 m Mar 75 & 76 6 adults
Sealy pit 1, Murchison pit 10, Sealy sticky 4.

Isocolon sp. 4

1620 m Mar 75 1 adult
Sticky trap Sealy range site 4.

Paracatops phyllobius (Broun)

670-800 m Oct-May 15 adults
Hooker corner *Nothofagus* forest, village in house, Unwin hut, Governor's bush.
In houses, ex. dead hare, on a pool of water, under a decaying hide.
Common on moist decaying protein.

Staphylinoidea

'Silphidae'

Necrophilus prolongatus Sharp (Carrion beetle)

750-1650 m Oct-Jan 29 adults
Sealy range, Sawyer stream, Malte Brun hut toilet.
Associated with faecal matter, decaying peanuts under a rock at Sealy tarns and on dead sheep in Sawyer stream. Common on carrion. (Duncan Darroch collected two specimens in June 1953 from the Hermitage.)

Staphylinidae - these beetles are commonly called rove beetles and are found in a wide variety of habitats, e.g. decaying vegetable matter, in moss, at the edge of streams, in fungi, dung, carrion, seaweed, in flowers and in animal nests. White (1964) found 29 species in tussock areas and concluded that they are a beneficial group. They are one of the major beetle groups and many are undescribed in New Zealand (G. Kuschel, pers. comm., 1976).

Aleochara subaena Fauvel (= *Gyrophaena philanthioides* Broun)

850-1340 m   Oct-Jan   8 adults
Sealy range Ball hut, West Hooker.
Landed on arm in bright sunshine, on a decaying peanut Sealy tarn. Widespread, the earliest record was from Mt Algidus in Oct 1913 collected by T. Hall.

Atheta sp.

740 m   May 77   1 adult
Governor's bush.
Ex. dead *Nothofagus* tree.

Bledius sp.

740 m   Nov 76   1 adult
On water in village.
In Australia *Bledius* spp. are gregarious and live in sand near water. An unusual feature of the group to which *Bledius* belongs (the Oxytelinae) is that some species exhibit a degree of parental care for eggs and young larvae (Hinton, 1944).

<u>Creophilus</u> <u>oculatus</u> (F.) (devil's coachhorse)

600-750 m Nov-May 13 adults
Sawyer stream, "golf" course, village, Unwin hut.
In house, on meat, ex dead cow, ex sheep carcass.
This is the common devil's coachhorse with characteristic orange-red cheeks. The food for this species is blowfly maggots (J. Watt, pers. comm. , 1977).
Common on decaying protein.

<u>Dasytricheta</u> <u>funesta</u> (Broun)

800-950 m Feb 77 3 adults
Godley valley and Stocking stream.
All three specimens under rocks.

<u>Dasytricheta</u> sp.

1820 m Mar 77 1 adult
Sealy range 1730 h.

<u>Ischnoderus</u> sp.

765 m Apr 77 1 adult
Botanical spur.
Under bark of <u>Pittosporum</u>.

<u>Ischnoglossa</u> sp.

740-765 m Apr 2 adults
Birch hill and Botanical spur.
Associated with <u>Nothofagus</u> forest and under <u>Pittosporum</u> bark.

<u>Microsilpha</u> sp.

1650 m Apr 77 1 adult
Sealy range.
Under rock alpine herbfield.

<u>Quedius</u> <u>antipodum</u> Sharp

600-750 m Nov-May 13 adults
"Golf" course Sawyer stream, village.
Ex. dead cow, ex. dead sheep, on water.

Quedius (*sens. lat.*) sp.

740 m Mar 77-Aug 78 1 adult
Governor's bush.
Underground pit trap.

Sepedophilus sp. 1

1500 m Jan 77 2 adults
Reay.
Associated with *Aciphylla* flowers.

Sepedophilus sp. 2

740 m Apr 76 1 adult
To light village.

Stenomalium perplexum (Broun)

670-800 m Oct-Nov 4 adults
Hooker corner and Governor's bush.
Associated with a dead hare and a decaying hide.
Also known from the Routeburn and Mt Earnslaw areas.

Tetrocalea sp. 1

1050 m Jan 77 1 adult
Reay.
On rock.

Tetrocalea sp. 2

1500 m Jan 77 4 adults
Reay.
Aciphylla flowers.

Teropalpus optandus (Broun)

670 m 1975 1 adult
Blue stream.
Drift net (C. Lalas).

Pselaphidae

Staphylinoidea - Pselaphidae

Dalma sp.

740 m May-Oct 1 adult
Governor's bush.
Underground pit trap.

Sagola fuscipalpus Broun

1500 m Jan-Feb 3 adults
Godley valley - Mt D'Archiac, Reay.
Under stones in *Chionochloa* herbfields.
Adults and larvae are usually carnivorous and live amongst decaying plants or in ants nests.

Scarabaeoidea - Map 6 shows some distributions.

Lucanidae (Stag beetles) - Holloway (1961) reviewed the New Zealand species and recognised 24 species in four genera. The larvae feed in logs, dead standing trees, and stumps and closely resemble grass grubs in appearance. Adults are also usually associated with rotten logs. Mandibles of male stag beetles grow allometrically and can reach considerable size. In a later paper Holloway (1963) recognised 13 flightless species and 13 winged.

Ceratognathus alboguttatus Bates

750-980 m Mar-Apr 3 adults
Sealy range pit 1, Birch hill stm *Nothofagus* forest, 2 in logs.
Also recorded by Holloway (1961) 1 male, Sealy lake (1340 cm) Feb 1945, G. Gibbs collector.

Ceratognathus _cylindricus_ (Broun)

Holloway (1961) records 1 specimen from the Hooker valley, the only known South Island record collected by S. Hudson Dec 1928. Apparently widespread in the North Island, the type specimens were collected from under Rimu bark (_Dacrydium_ _cupressinum_) near Wellington.

Ceratognathus _foveolatus_ Broun

670-810 m Apr-May 11 adults
Hooker corner, Birch hill stm, Governor's bush.
In _Nothofagus_ stumps. Larvae of two stages present in stumps, plus some pupae.

Ceratognathus _heliotoides_ Thomson

700-760 m 12 adults
Birch hill, village.
1 larvae in log from Birch Hill _Nothofagus_ forest Apr 76, emerged adult at Lincoln Dec 76. (Reared in log in a plastic bag.)

Scarabaeidae(Chafers) - adults of this group often fly at dusk in early summer, notable exceptions are the bright green manuka chafers, _Pyronota_ spp. which fly during bright sunlight. Larbae of chafers are called grubs and have a general comma shape, white bodies, darker hardened heads and three conspicuous pairs of legs. The larvae feed on roots, dung and decaying plants. Several native species damage introduced plants in "improved" pastures and orchards. Adults feed on the aerial parts of plants.

Costelytra zealandica (White) (common grass grub)

670-900 m   Jan-Feb   5 adults
Liebig range pit 7, Murchison valley, Unwin hut.
Adults fly at dusk.

Odontria australis Given

730-810 m   Dec-May   20 adults
Governor's bush, village, Bowen bush.
Adults to light at night, 1 adult among roots of *Phyllocladus alpinus*.
Locally common.

Odontria sp? *marmorata* Broun

1160-1500 m   Nov-Mar   5 adults   1930-2100 h
Reay, Sealy pit 2, Sefton biv. ridge.
Adults in flight 1930-2100 h, some *in copula*.

Odontria sp. aff. *rufescens* Given

670-920 m   Oct-Apr   35 adults   2100-2230 h
Unwin hut area, Liebig range.
Adults associated with *Discaria* foliage at Unwin hut.
Locally common.

Odontria sp. nov. aff. *striata* White

1620 m   Mar 75   1 adult
Sealy range pit 4.

Odontria striata White

740 and 1700 m   Jan-Mar   2 adults
Sealy range on snow 1700 m, Hooker valley.

Odontria variegata Given

750-1700 m   Nov-May   24 adults   1930-2030 h
Upper Red lakes, Sealy range pits 2 & 5, Sefton biv. ridge, Reay.
Associated with *Muehlenbeckia* and *Chionochloa*.
Adults in flight 1930-2030 h, some *in copula*.
Locally common.

Odontria sp. aff. *variegata* Given

740, 1000 & 1710 m Nov-Feb 5 adults
Murchison pit 10, Camp ground Hooker valley under a stone, Sefton biv.
Two adults crawling on a *Celmisia* plant at 2000 h, Feb 77, 1710 m Sefton biv.

Odontria sp. 1

730-1800 m Nov-Feb 5 adults
Sefton biv. ridge, Reay, Sealy range pit 5, Hooker valley.
On *Poa* 730 m Hooker valley 2100 h, seagulls appeared to be feeding on these.

Odontria sp. 2

900 m Dec 75 1 adult female 1500 h
Murchison valley.

Pyronota edwardsi Sharp (Kiriwai manuka chafer)

900-1100 m Dec-May 9 adults 1400-1700 h
Liebig range pit 7, Sealy range, Ball hut.
Associated with *Discaria* foliage and *Aciphylla scott-thomsonii* flowers.
Adults fly during the day. Locally common.

Pyronota festiva (Fabricius)

740-1500 m Nov-Feb 7 adults (plus 32 adults Kea point walk 8 Feb 69 Lincoln College Ento. staff field trip. 16 adults Hooker valley 7 Feb 69 Lincoln Coll. Ento. staff). 1130-1200 h.
Reay, Murchison, Governor's bush pit 13, Red lakes, village.
Associated with *Chionochloa*, *Nothofagus*, *Leptospermum*, *Coriaria*.
Adults present in large numbers during the day, sometimes causing defoliation of *Coriaria* and damage to young leaves of *Nothofagus*.

Pyronota laeta (Fabricius)

810-1160 m   Dec-Jan   3 adults
Governor's bush pit 13, Sealy Sticky 2.

Pyronota punctata Given (plain manuka chafter)

850-1800 m   Jan-Feb   14 adults   1200 h
Stocking stream, Reay, Malte Brun hut,
Sealy range.
Associated with Chionochloa. Adults fly during the day. The highest records were three on snow, Sealy range, south-west aspect. Locally common.

Pyronota sp. 1

1130 m   Feb 69   2 adults
Ball hut.
Lincoln Coll. Ento. staff collection.

Pyronota sp. 2

1160 m   Dec 75-Jan 76   2 adults
Sealy range, Sticky trap 2.
These two specimens have black heads and pronotums whereas the elytra are a mixture of red, brown and green. These colours could have resulted from the 'Ostico' on the sticky trap and/or the trichloroethylene solvent.

Pyronota sp. 3

810 m   Dec 75   1 adult
Governor's bush pit 13.
The specimen is a dark colour which is perhaps a result of immersion in the pit trap fluid.

Sericospilus advena Sharp

810-1500 m   Nov-Mar   15 adults
Sealy range pits 1 & 2, Reay, Governor's bush to light at night.
Associated with scrub, Nothofagus and Chionochloa. Dusk flight (2100 h) Reay, Jan 77, 1500 m. At 600 m in the Ahuriri valley R. Emberson (pers. comm., 1976) recorded mating flights on 27 Nov 73

whereas in the Craigieburn valley (750 m) a mating flight in 1973 was recorded in early January.

Dascilloidea

Helodidae - the larvae of this family are aquatic or semi-aquatic, the adults are predatory. Larvae may be found in stagnant or running water and have annal gills. White (1964) found 11 "Cyphon" spp. in quite high numbers on plants in flower at Cass such as Hebe salicifolia. A numerous but poorly studied family in New Zealand with many unidentified species.

Atopida sp. 1

810 Feb 76 9 adults
Governor's bush.
To light at night.

Atopida sp. 2

1300 m Apr 76 1 adult
Liebig range pit 9.

Atopida sp. 3

670 m 1 adult
Drift net in Blue stream (C. Lalas).

"Cyphon" oscillans Sharp

1340 m Mar 77 3 adults
Sealy range.
Malaise trap near Sealy tarns.

"Cyphon" sp. aff. trivialis

1100-1500 m Jan-Mar 5 adults
Red lakes and Reay.
Associated with Aciphylla flowers.

"Cyphon" sp. 1

1160 m Mar 75 1 adult
Sealy range sticky trap 2.

"Cyphon" sp. 2

1000 m Feb 77 1 adult
Hooker valley.
On Hebe flowers.

Mesocyphon sp. aff. laticeps Broun

1620 m Feb-Mar 76 5 adults
Sealy range pit 4.

Mesocyphon sp. 1

810-1160 m Dec-Jan 4 adults
Governor's bush, Sealy range.
Light trap (13), Sealy range sticky traps sites 1 & 2.

Mesocyphon sp. 2

810-1160 m Dec 75 6 adults
Governor's bush, Sealy range.
Light trap (13), Sealy range sticky traps sites 1 & 2.

Veronatus longicornis

Jan 43.
Hooker valley.
In National collection, DSIR, Auckland.

Veronatus prob. longipalpus Sh.

1300 m Apr 76
Liebig range, pit 9.

Veronatus tarsalis Broun

740-750 m Jan-Feb 77 12 adults
Village and Foliage hill.
Governor's bush light trap (14), 1 specimen on water of pool, 1 from a dying totara tree. J. Watt (pers. comm. 1978) thought that this association with a dying tree was of shelter only. The larvae of Veronatus are soil inhabiting, but it is unlikely that they were damaging the tree.

Byrrhoidea

Byrrhidae - short stout dark metallic coloured beetles

The adults withdraw their legs when disturbed and remain motionless. The larvae feed on mosses and grass roots. Farrell (1974) studied two species of Epichorius in coastal rata forest on the main Auckland island. Larvae were found associated with bryophytes and hepatics and up to 8 m in the forest canopy. Adults sheltered under leaf litter during the day and fed on bryophytes at night. The larvae were more selective in their choice of bryophyte than were the adults.

Indet. genus Indet. sp.

1160 m Feb 76 1 adult
Sefton biv. ridge.
Under stone.

Epichorius sp.

820-1810 m Feb-May 34 adults
Sealy range pits 1, 4, 5 & 6, Red lakes pit 12, Hooker valley.

Most records above 1100 m, common under rocks in herbfields above 1500 m.
Locally common in alpine herbfields.

Curimus sp.

1000 m Mar 76 2 adults
Murchison forestry hut pit 10.

Synorthus sp.

1620 & 1730 m Mar & May 2 adults
Sealy range pits 4 & 5.

Elateroidea

Elateridae - the adults of these beetles are commonly called click-beetles, whereas the common name of the root feeding larvae is wireworm. Some larvae are carnivorous. White (1964) found a concentration of larvae among tussock roots at Cass and in the McKenzie basin. Little is known of adult behaviour. Larvae were recorded from pit traps at most sites but were not identified.

Agrypnus variabilis (Candeze)

1150 m Feb 75 3 adults
Sealy range near pit 2.
Ex. Dracophyllum, Chionochloa litter.
This is the common variable wireworm which is sometimes an agricultural pest.

Australeeus powelli (Sharp)

800-1650 m Feb-May 7 adults
Murchison pit 10, Stocking stream, Malte Brun hut.
Under rocks in tussocks.

Also recorded in the National collection
from moraine at Franz Josef and from Arthur's
Pass in Jan 1943.

"_Elatichrosis_" sp.

900-1100 m   Nov-Dec   3 adults
Sealy range, Red lakes, Murchison valley.
Ex. _Poa_ and on stones.
(Broun no. 529) also recorded from Arthur's
Pass 900 m   Dec 59.

"_Corymbites_" _agriotoides_ Sharp

1100-1160 m   Jan-Mar 76   11 adults
Sealy pit 2, Red lakes pit 12.
Of the 11 adults collected 10 were from the
Sealy pit 2 in Jan 76.

"_Corymbites_" sp.

670-1600 m   May 76   4 adults
Blue stream drift net (C. Lalas) 3 adults,
and 1 adult on snow Sealy range 1600 m.

"_Hypnoidus_" _powelli_ Sharp

1000-1500 m   Feb 76   2 adults
Sealy range Murchison pit 10.
The one from Sealy range was collected between
1700-1800 h from amongst _Chionochloa_ at 1500 m.

Hypnoidus sp. 1

1000 m   Feb 76   1 adult
Murchison pit 10.

Hypnoidus sp. 2

670-1300 m   Apr 76   2 adults
Liebig pit 9, Blue stream drift net (C. Lalas).

Parinus sp.

1340-1500 m   Oct-Jan   2 adults
Sealy tarn area and Reay.

Associated with *Chionochloa*. The one from the Reay was collected at 1800 h on a rock amongst *Chionochloa*.

Protelater huttoni Sharp

810 m Feb 76 1 adult
Governor's bush, light 13.

Zeaglophus pilicornis Broun

740 m Feb 76 1 adult
Governor's bush light trap 14.

Cantharoidea

Cantharidae - adults of this family are usually found on flowers, the larvae are predatory in leaf litter. Adults are commonly known as soldier beetles. White (1964) reared ? *Asilis* sp. adults from a soil sample taken below tussock in the Cass area. The adults emerged from the sample in Oct.

Asilis sp. 1

1500 m Jan 77 5 adults
Reay.
Ex. *Chionochloa* area during the day and up to 2100 h at night.

Asilis sp. 2

1100 m Feb 77 1 adult
Sefton biv. ridge.
Ex. *Hebe*.

Asilis sp. 3

1400 m Feb 77 6 adults
Sefton biv. ridge.
Ex. *Celmisia* flowers.

Melyridae - Carnivorous beetles, often metallic blue and found on flowers. White (1964) suggests that adults may be quite selective pollen feeders and records Dasytes sp. from flowers of: Anisotome, Aciphylla, Hebe, Celmisia and on snow tussock.

Arthracanthus clavatus (Broun)

Collected by J. Townsend and A. Eyles, Mt Sebastopol Jan 66 ex. flower Aciphylla aurea and from Sealy range below Sealy tarns under flax and ex. Muehlenbeckia. Jan 66. Specimens are in the National collection.

Arthracanthus laevulifrons (Broun)

1160 m Dec 75 - Jan 76 4 adults
Sealy range site 2.
Ex. Sticky trap.

Arthracanthus wakefieldi (Sharp)

810-1500 m Jan-Feb 5 adults
Reay, Sealy range, Governor's bush.
On Senecio scorzoneroides flowers, to light at night, swept ex. Chionochloa, on Aciphylla flowers.
Other South Island records in the National collection include specimens from Mt Arthur, Nelson, Pisa range Central Otago, Dore Pass Lake Te Anau, Lewis pass and ex. Aciphylla squarrosa Moorpark Caanan.

Dasytes fuscitarsis Broun

1500 m Jan 77 1 adult 1200 h
Reay.
Chionochloa area.

Dasytes sp.

740-1000 m Nov-Feb 18 adults
Blue lakes, Liebig range, Hooker valley.
On flowers of Hebe, Aciphylla, Aciphylla horrida.

Dermestoidea

Dermestidae - adults are often found on flowers, larvae feed on a high protein diet, many species are pests of stored products. Flower feeding by the adults helps to mature eggs.

Anthremus ? sp.

800 m May 77 several larvae
Governor's bush, ex *Pseudopanax* seeds. Reared through several instars May 77 - Aug 78, but no adults resulted.

Trogoderma sp.

850 m Nov 76 1 adult
West Hooker valley.

Bostrychoidea

Ptinidae - members of this family are close relatives of wood borers, however Ptinidae do not bore wood, instead they feed mainly on dry materials of animals and vegetable origin. They are common inhabitants of animal nests, stored food, skins, furs and museum specimens. The Australian *Ptinus tectus* is now cosmopolitan and a common household pest.

Ptinus tectus Boieldieu (Australian spider beetle)

730-1250 m Oct-May 9 adults
Godley hut, village, Governor's bush, Murchison valley.
On leg in toilet, to light trap, ex. dead *Dracophyllum* stem, ex. box of grasshoppers, ex. Tenebrionid beetle in box, ex. *Placopsis* lichen on sand. 1 reared ex. Tenebrionid beetle.

Cleroidea

Cleridae - most larvae and adults of this family prey on other insects especially those associated with bark or wood, e.g. Scolytinae. Adults are often found on flowers.

Balcus sp.

980-1160 m   Dec 75 - Jan 76   11 adults
Sealy range.
Sticky traps 1 & 2.
Apparently only associated with subalpine scrub.

Parmius longipes Sharp

1160 m   Dec 75 - Jan 76   3 adults
Sealy range.
Sticky trap 2.

Nitidulidae - the biology of this family is varied; some feed on pollen, some feed on fungi, some are predators and some occur in stored food, particularly dried fruit.

Platipidia oculata (Reitter)

900-1300 m   Dec-May   6 adults
Sealy pit 1, Liebig pits 7 & 9.
Feeds on fermenting sap and is associated with sooty mould on *Nothofagus* trees. The glycerol in the pit trap may have acted as a bait.

"Soronia" hystrix Sharp

1100 m   Mar 76
Swept at Red lakes.
This species is associated with sooty mould (J. Watt, pers. comm., 1978) and feeds on fermenting sap.

Languriidae - Insects of Australia (CSIRO, 1970) mistakenly keys the family out to the closely related Cryptophagidae. Small beetles commonly associated with moist decaying matter, but also found in flowers and animal nests.

Loberonotha vestita (Broun)

1160 m   Mar 75   1 adult

Sealy site 2 sticky trap.

Coccinellidae (ladybirds) - adults and larvae of most species are carnivorous, preying on aphids, coccids and mites. Adults sometimes form mass groups and fly to prominent geographical points, Mani (1968) suggests aestivation as a reason.

Adoxellus picinus (Broun)

740-1340 m Jan-Apr 5 adults
Governor's bush and Sealy tarn.
Swept ex. Nothofagus, beaten ex. cut branch of Nothofagus, under a rock amongst decaying peanuts.

Coccinella leonina Fabricius (orange spotted ladybird)

730-1600 m Oct-May 11 adults, 4 larvae
Kea point, Sealy range, Stocking stream, Liebig range, East Hooker valley, village, Separation stream Godley valley.
Under rocks, on snow at 1600 m, swept ex. Chionochloa, ex. Raoulia, on water.
Larvae present in Feb.

"Scymnus" prolongatus Broun

1150 m Feb 75 2 adults
Sealy range.
Ex. Dracophyllum litter.

"Scymnus" sp. aff. minutulus

730 m Feb 75 1 adult
Hooker valley.

Veronicobius tristia (Broun)

740-900 m Mar 77 4 adults
Governor's bush and Hoophorn spur.
Beaten ex. cut branch Podocarpus, and beaten from live Podocarpus nivalis. J. Watt (pers. comm., 1978) reports that this is a widespread species.

Lathridiidae - Minute beetles (less than 3 mm), the adults and larvae feed on moulds and fungi or are associated with ants. The single "Melanophthalma" sp. collected does not resemble the Australian Melanophthlama australis very closely and it may belong to the closely related family Merophysiidae.

"Melanophthalma" sp.

740 m May 77 - Aug 78 1 adult
Governor's bush.
Underground pit trap.
White (1964) recorded six unidentified species of this genus from various traps (mainly sticky) and one was taken from a soil sample. Spain (1967) recorded one unidentified species of this genus from Olearia colensoi foliage in Dec 66 in the Ruahine mountains.

Colydiidae - Imms (1964) states that members of this family are often found in the tropics, but the family is very well represented in New Zealand. Form is varied and habits include fungal feeding and parasitism.

"Pristoderus" sp. aff. discedens

This is an undescribed genus and it is not a true Pristoderus (J. Watt, pers. comm., 1978).
670-1300 m Oct-May 57 adults
Murchison river, Botanical spur, Hooker valley, Ball ridge, terminus Murchison glacier.

All adults were collected in Placopsis trachyderma (Cowpat lichen), a lichen which grows on sand or bare earth.
Locally common.
Most Pristoderus spp. are fungal feeders under bark (J. Watt, pers. comm., 1976).

Drytops sp. aff. undosus Broun

765 m Apr-May 4 adults
Botanical spur pit 11.
The surface of this insect is highly sculptured and resembles decaying wood, this is perhaps an example of protective colouration and texture. These beetles are of reasonable size, but they were not hand collected, probably because of their camouflage.

Pycnomerus ruficollis Broun

740 m Apr 76 4 adults
Birch hill.
Ex Nothofagus log.

Pycnomerus sp.

810 m Feb 76 1 adult
Governor's bush light trap 13.

Tarphiomimus wollastoni Sharp

740 m Mar 77 1 adult
Governor's bush.
Ex. cut branch at forest edge.
This species is also known from Mt Arthur, the Wangapeka, Dun Mt, Riccarton bush and the North Island (National collection, DSIR, Auckland).

Unidentified genus and sp.

810 m Oct 76 1 adult
Governor's bush.
Pit 13.

Cucujoidea

Cucujidae - Little is known of the biology of New Zealand species. Some are stored products pests.

<u>Dendrophagus capitao</u> Pascoe

765 m Apr 77 1 adult
Botanical spur.
Under bark on a dead <u>Pittosporum</u> tree.
In the National collection, DSIR, Auckland, this species had been recorded from a variety of tree hosts - Rata, <u>Nothofagus</u> and <u>Pseudopanax</u>. It probably feeds on sub-cortical fungi (J. Watt, pers. comm., 1976).

Tenebrionidae - Many larvae and adults of this family feed on lichens at night (Watt, pers. comm., 1976). The larvae resemble wireworm larvae and are commonly called false wireworms or mealworms. They live in a similar range of habitats to Staphylinids but can usually tolerate drier situations. Most adults are found either on the ground under logs and stones or on trees under bark. Some species are pests of stored cereals which are usually very dry situations.

<u>Artystona obscura</u> Sharp (Map 7)

700-1000 m Nov-May 5 adults
Birch hill, village, Governor's bush, Bowen bush, Hoophorn spur.
Associated with <u>Nothofagus</u> logs, <u>Phyllocladus</u>, houses and to light. A similar species to <u>A. wakefieldi.</u>

Other collections of this species from Mt Cook have been made by Esson and Townsend, 760 m Jan 1964; and A.E. Brookes, Hooker valley, 5 male, 6 female, Jan 1943; Sealy range Mar 1953, Governor's bush Mar 1953.

Artystona rugiceps Bates (Map 7)

900 m Feb 77 1 adult
Godley valley, Totara point.
1 adult under a rock.
Widespread in the North and South islands - reared from mountain totara in the Awatere, apple trees Nelson and dead Discaria Hells gate Wairau (National collection, DSIR, Auckland).

Artystona wakefieldi Bates (Map 7)

700-900 m Oct-Apr 21 adults
Glencoe walk, Liebig range, Governor's bush, Birch hill, Bowen bush.
Under bark of Podocarus nivalis, dead on sand, in logs of Nothofagus, under bark of dead Phyllocladus. Locally common under bark of decaying trees.

Pheloneis sp. aff. bullatus (Map 7)

740-1620 m Oct-Apr 17 adults
Sealy range, Birch hill, Red lakes, Sawyer stream, Sealy pits 1 - 4, Red lakes pit 12.
Under rocks, dead on track, in stream bed.
This species may be a geographical variation of P. bullatus (Watt, pers. comm., 1976). Isolated flightless populations can give rise to such variations. This species is close to Broun no. 3254. Brookes also collected 3 female and 1 male of this form in the Hooker valley in Jan 1943 and Esson collected it in Bush stream at 760 m in Jan 1964.

Pheloneis chalmeri (Broun) (Map 7)

810 m Feb 75 - Mar 75 7 adults
Governor's bush pit 13.
This species was formerly only known from Otago and Stewart island in wet areas (J. Watt, pers. comm., 1976).

Pheloneis intermedius (Broun)

1200 m Feb 77 1 adult
Rutherford stream, Godley.
Under stone.

Pheloneis sp. (Map 7)

1600-1800 m Feb 77 4 adults
Godley valley Mt D'Archiac.
Under rocks amongst Chionochloa. This may be an undescribed species, the National collection specimens are not yet sorted (Watt, pers. comm., 1976).

Pheloneis zealandicus Bates (Map 7)

740-1100 m Nov-May 12 adults
Governor's bush, Liebig range pit 7, Murchison pit 10, Godley valley, Red lakes, Birch hill.
In logs and under rocks.

Salpingidae - The larvae of this family are reputed to be predators under bark, however they may also feed on fungi (Watt, pers. comm., 1976).

Salpingus unguiculus Broun

730-740 m Mar-Apr 2 aduls
Village and Governor's bush.
Two specimens, one attracted to light, the other beaten ex. Nothofagus cut branch.

Pyrochroidae (Cardinal beetles) - larvae of this family usually live under bark where adults are also found. Adults also occur on leaves and flowers. Until recently this family was regarded as absent from Australia.

Techmessa sp. prob. *telephoroides* Bates

670 m   1 adult
Blue stream.
Drift net (C. Lalas).
This species is fairly rare.

Scraptiidae - small beetles with deflexed heads. Adults are found on flowers and the larvae are thought to feed in decaying wood.

Unidentified genus and sp.

765 m   Apr-May 77   1 adult
Botanical spur site 11.
Malaise trap.

Mordellidae - adults are found on flowers and are very active, larvae may be predatory, parasitic or leaf miners.

Mordellistena neglecta Broun

980 m   Mar 75   1 adult
Sealy sticky trap 1.

Oedemeridae - the larvae are usually found in moist rotting wood. Adults are often found on flowers.

Baculipalpus mollis (Broun)

740 m   Feb 76   1 adult
Governor's bush light trap 14.

Selenopalpus aciphyllae

970-1500 m   Jan-Jul   4 adults
Sealy range pit 2, on track to Sealy tarns, Reay.
The specimen from the Reay was swept at 1800 h at 1500 m in Jan.

Chrysomeloidea

Cerambycidae (long horn beetles) - the larvae of this family bore into wood tissue in dead or damaged plants. The *Brounopsis* spp. recorded were few in number, but considerable boring of an unknown species was observed in *Cassinia* stems, particularly on the south slopes of Mt Wakefield overlooking the airport. G. Kuschel (pers. comm., 1976) considers that adults emerge soon after dawn and are weak fliers.

Astetholea lepturoides Bates

670 & 810 m   Feb 76   5 adults
Governor's bush and Blue stream.
To light and drift net (C. Lalas).

Brounopsis sp. nov. (Ent. Div. no. 1)

900 m   Dec 75   1 adult
Murchison valley.
On sand near *Cassinia* in flower.

Only one other specimen has been recorded. This was collected Jan 76 at 1200 m on *Cassinia vauvillierii* in the Takitimu range. National collection, DSIR, Auckland.

Brounopsis sp. nov. (Ent. Div. no. 3)

1000 m May 77 1 adult
Murchison pit 10.
Possibly associated with nearby *Cassinia* plants.

Eburida picta (Bates)

740 m Apr 76 1 adult
Birch hill stream.
Dead on log in *Nothofagus* forest.

Ptinosoma ptinoides (Bates)

765-980 m Oct-May 5 adults
Botanical spur pit 11, Governor's bush pit 13 and Sealy pit 1.
In *Podocarpus halli* forest, *Nothofagus* and subalpine scrub.

Somatidia sp.

1160 m Jan 76 1 adult
Sealy range pit 2.
Seldom collected, the National collection (DSIR, Auckland) has only one other specimen.

Chrysomelidae (leaf beetles) - The larvae and adults of this family are both phytophagous. It is one of the larger beetle families and is closely related to the Cerambycidae. *Adoxia cheesmani* (Broun) was the only species collected in large numbers.

Adoxia cheesmani (Broun)

700-1800 m Oct-Mar 63 adults
West Hooker valley, Stocking stream, Hooker hut, Sealy range, Blue stream, Unwin hut, Sefton biv. ridge, Sealy tarn, Reay, village.

On flowers of: Ranunculus lyalli, Leucogenes grandiceps, Celmisia, Senecio scorzoneroides, Anisotome aromatica, Gingidia montana.
Swept ex. Coriaria, Muehlenbeckia, Chionochloa, Aciphylla divisa.
On snow (1800 m), in house, in malaise trap Sealy tarn.
Common on flowers in subalpine and alpine areas. The highest record on a plant was at 1500 m in the Reay on Chionochloa and Aciphylla divisa in January. The flowers it was most common on were: Ranunculus lyalli, Senecio scorzoneroides and Anisotome aromatica. One adult was collected at night (2100 h) on a Leucogenes grandiceps flower near Hooker hut.
The adults appear to be pollen feeders and they may aid pollination.
The species was described from specimens collected near the Hermitage in Jan 1909.

Adoxia pubicollis (Broun)

1700 m Feb 77 2 adults
Copland pass ridge, east aspect.
Swept ex. Poa.
Also known from Ben Lomond (Otago?) March 1914.

Adoxia sp. (Ent. Div. no. 1)

800 m Nov 76 1 adult
East Hooker.
Swept ex. Hebe and Cyathodes.

Adoxia sp. (Ent. Div. no. 2)

730-1620 m Nov-Feb 6 adults 1230-2130 h
Sealy range and Hooker valley.
On flowers of: Anistome aromatica and Ranunculus lyalli. Swept ex. Poa and Chionochloa, Sealy pit 4.

Adoxia ? sp.

1700 m   Feb 77   1 adult   0830 h
Copland pass ridge.
Under a stone amongst *Celmisia* and *Chionochloa*.

Arnomus sp.

1010 m   Feb 76   1 adult
Stocking stream.
Swept.

Caccomolpus hallianus Broun

1650 m   Nov 76   1 adult
Sealy range.
Under a stone amongst *Chionochloa*.

Chrysomela hyperici (Forster) (St John's wort beetle)

900-910 m   Feb-Mar   10 adults
Park boundary Godley valley, Rutherford stream Godley valley.
Swept ex. St John's wort (*Hypericum perforatum*) plants in flowers. A species introduced from Europe for the 'control' of St John's wort, the larvae feed on the plants in winter and early spring. Adults appear in late spring and feed on the growing plants for 6-8 weeks. When numbers build up extensive defoliation of the wort may occur (Miller, 1971).

Curculionoidea

Anthribidae - Larvae of this family feed in dead wood, grass stems, fungi and galls. Little is known of the habits of most New Zealand species.

Eugonissus proximus Broun

740 m   Apr 77   1 adult
Governor's bush.
Swept ex. *Nothofagus*.

Attelabidae - Specific habits of the New Zealand and Australian species are unknown, but elsewhere adults lay eggs in cuts in leaves or terminal shoots.

Undetermined genus and sp.

980-1340 m Dec-Mar 6 adults
Sealy range and Sealy tarn.
Sticky traps at sites 1 & 2. On water Sealy tarn 1330 h. Mar 75.

Curculionidae (Weevils) - The largest beetle family, chiefly characterised by the development of the head into a rostrum (snout). Both the adults and larvae feed on plant material, the legless larvae feed mainly in concealed situations on wood, seeds, leaves and roots. Several interesting species were only collected as single specimens from pitfall traps and so lack any detailed habitat data.

Alloprocas spinifer (Broun)

750-900 m Oct 3 adults
Red lakes and Governor's bush.
Swept 1500 h ex. *Poa*, beaten 1100 h ex. *Nothofagus*.

Bryocatus iridescens (Broun) (moss weevil)

1000 m Feb 76 2 adults
Murchison pit 10.

Bryocatus sp. 1 (Map 8)

1810 m Mar 76 1 adult
Sealy pit 6.

<u>Bryocatus</u> sp. 2 (Map 8)

1730 m Mar 76 1 adult

Sealy pit 5.

<u>Catoptes</u> <u>dorsalis</u> (Broun)

810-980 m Dec-Mar 4 adults

Sealy range pit 1, Governor's bush pit 13.

<u>Crisius</u> sp.

1150 m Feb 75 1 adult

Sealy range, ex. <u>Dracophyllum</u> litter.

<u>Dendrotrupes</u> sp.

740-900 m Oct 76 & Apr 77 16 adults, many larvae.

Governor's bush, Sealy range.

Ex. dead shoot tip of <u>Pseudopanax</u>, also feeding on live apical meristems of <u>Pseudopanax</u>. Abundant in some shoot tips. A potential killer of <u>Pseudopanax</u>, especially where track cutting damages the roots or shoots of plants. Locally abundant.

<u>Eugnomus</u> <u>dispar</u> Broun

800-1100 m Dec-Mar 5 adults

Sealy range and Red lakes.

Ex. broken <u>Aciphylla</u> flower heads and swept from <u>Podocarpus</u> <u>nivalis</u>.

<u>Eugnomus</u> <u>durvillei</u> Schoenherr

740-1500 m 1100-2230 h Oct-Jan 32 adults

Blue lakes, Liebig range, Red lakes, Sealy range, Reay.

Ex. flower heads of <u>Aciphylla</u> <u>horrida</u>, <u>Aciphylla</u> <u>divisa</u>, <u>Aciphylla</u> <u>scott-thompsonii</u>, and beaten from <u>Discaria</u> on burn regrowth on the Liebig range. The larvae mine dying leaves and the adults eat <u>Aciphylla</u> pollen and may act as pollinators (Kuschel, pers. comm., 1976).

Euophryum confine (Broun)

740 m Apr 76 2 adults
Birch hill.
Ex. *Nothofagus*.

Gromilus sp. (Map 8)

1160-1730 m Jan-May 22 adults
Sealy pits 4 & 5, Sefton biv. ridge under rock in *Celmisia*-scrub zone, Mt D'Archiac. Associated with *Celmisia* and *Aciphylla divisa*. The larvae are associated with *Celmisia* plants, usually around the base of of the plant (B. May, pers. comm., 1978).

Irenimus sp.

1930 m Dec 76 1 adult
Liebig range.
Under stone herbfield.

Lyperobius carinatus Broun

950 m Feb 77 1100 h 3 adults
Rutherford stream, Godley valley. Under a stone adjacent to a surface grazed *Aciphylla montana* plant in flower. 2 females, 1 male. This species is not common - other records are: 24 Dec 57 Godley river; 23 Dec 12 Mt Hutt; Rangitata - Challies creek 4 500' (1400 m) 15 Feb 65 feeding in a *Aciphylla* flower head; Craigieburn 1400 m ex. *Celmisia spectabilis* 18 Dec 56. Two specimens have been deposited with DSIR Auckland, and the other is with Mt Cook National Park H.Q. in the insect display.

Mecistostylus douei Lacordaire

810 m May 77 22 adults
Governor's bush.

Ex. dead stem of Pseudopanax colensoi. Adults and larvae. Most had emerged as adults at Lincoln by 31 May 77.
Locally abundant.

Mesoneda sulcifrons (Broun)

765-810 m   Apr 76 & 77   28 adults
Governor's bush and Botanical spur.
Associated with dead logs of Pseudopanax and under the bark of a dead Pittosporum tree. 28 specimens from two trees. This species is usually found in dead wood but entry to living trees could be via a wound (B. May, pers. comm., 1976).
Locally common.

Microcryptorhynchus sp.

740 m   Mar 77   1 adult
Governor's bush.
Beaten ex. cut branch of Podocarpus nivalis.

Nicaeana sp. (Map 8)

1930 m   Dec 76   2 adults
Liebig range.
Under a stone amongst Dracophyllum.

Otiorhynchus sulcatus (F.) (black vine weevil)

640-740 m   Dec-Mar   4 adults
Airport, village, Sawyer stream.
One specimen on air terminus window at 2300 h, one ex. house and two under stones at the edge of a Nothofagus area.
This is the introduced black vine weevil, a common pest of strawberries, blackcurrants, grapes and pot plants such as cyclamen.
It is parthenogenic, flightless and the adults are nocturnal. All of the four specimens were found near buildings or roads, larvae or adults may have been bought into the Park on vehicles

or in soil, or gravel. Over 50 plant species (mainly introduced) have been recorded as hosts for this weevil so it has considerable pest potential.

Pachycotes peregrinus (Chapuis) (Scolytinae - "bark" beetles)

740-765 m Jan-May 23 Adults
Foliage hill, Bowen bush, Botanical spur pit trap 13.
Ex. stem bases and upper roots of dying Phyllocladus alpinus trees. More adults were reared from tree bases at Lincoln June-Dec 77. Confined to podocarps (Bain, 1977) including exotics. Generally found in moist logs and is found throughout New Zealand except in dry eastern forests in Canterbury. Sporadic clumped distribution in at least Phyllocladus trees, I consider that this species is a potential pest. Trees stressed by track cutting or earth movements (artificial and natural) would be more susceptible to attack. Similar in appearance to a close relation, the cosmopolitan Hylastes ater (black pine bark beetle), a pest in pine forests (Milligan, 1978).

Nonnotus albicans (Broun)

670-1100 m Feb-Mar 11 adults
Unwin hut, Red lakes, Ball hut road, Blue stream.
To light, swept ex. Poa, swept ex. Podocarpus nivalis, Drift net, Blue stream.

Platypus caviceps Broun

740-810 m   Feb-Mar   12 adults

Governor's bush to light.

This species is one of four native pinhole borers that are found in all species of *Nothofagus*. Their larvae live off an 'ambrosia' fungus which grows in the pinholes. *Platypus* sp. may transmit other fungi which can cause serious mortality of *Nothofagus* trees (Milligan, 1974). A healthy tree can be killed within two years. The first gross symptom is a yellowing of the crown of the tree, caused by the blocking of the xylem by pathogenic fungi.

Platypus gracilis Broun

740 m   May 77   3 adults

Governor's bush.

Cut from *Nothofagus* wood from a dying mature tree.

Three adults were collected, however there were many more present in this, and in a few other trees. Not many trees were observed to be be affected, but a pest potential exists for both of the *Platypus* species. If a number of *Nothofagus* trees were stressed by a drought or windthrow then *Platypus* beetles could build up to large numbers.

Peristoreus celmisiae (Broun) (Map 8)

1730-1830 m   Feb-Mar.   6 adults

Sealy range, under rocks and pit 5.

The larvae are found in dead leaf bases and lateral roots of *Celmisia* (B. May pers. comm., 1976).

Peristoreus sudus (Broun)

900 m Nov 76 13 adults
North face of Mt Sebastopol.
In *Carmichaelia* seed pods.
A New Zealand wide species. Sporadic attacks can affect seed production, only the native brooms are affected by this species (G. Kuschel, pers. comm., 1978).

Peristoreus veronicae (Broun)

900-1050 m Mar-Apr 4 adults
Red lakes, Mt Wakefield, Separation stream Godley valley.
Swept ex. *Cassinia* flowers. White (1964) records this species from Dec to late Mar at several sites at Cass.

Peristoreus sp. 1

900 m Feb 76 2 adults
Sealy range.
Two specimens swept ex. flowers of *Carmichaelia grandiflora*.

Peristoreus sp. 2

1050 m Mar 76 2 adults
Separation stream - Godley valley.
Two specimens ex. scrub.

Rhophalomerus caluulus (Broun)

810-1150 m Feb 4 adults
Governor's bush, Sealy range.
To light and ex. *Dracophyllum* litter.

Rhophalomerus tenuirostris Blanchard

900 m Feb 76 1 adult
Sealy range.
On *Carmichaelia grandiflora* flowers.

<u>Rhinorhynchus</u> <u>rufulus</u> Broun

740-1340 m Mar 77 11 adults
Governor's bush Hoophorn spur, Sealy range sticky traps 1 & 2, Sealy tarn.
Ex. cut branch beaten ex. <u>Podocarpus</u> <u>nivalis</u>, on sticky traps and on tarn water. Several more collected by J. Dugdale and deposited in the National collection in Auckland. A common weevil on totara (<u>Podocarpus</u>). Both the adult and larvae feed on native podocarp pollen (G. Kuschel, pers. comm., 1978).

<u>Sargon</u> <u>sulcifer</u> (Broun) (Map 8)

900-2150 m Dec-Mar 29 adults
Liebig range, Ailsa pass, Murchison valley, Godley valley - Mt D'Archiac.
All but one specimen above 1500 m under stones and associated with <u>Chionochloa</u>, <u>Aciphylla</u>, <u>Dracophyllum</u> and <u>Anisotome</u>. Recorded feeding on <u>Aciphylla</u> <u>monroi</u> at 1200 h and on <u>Anisotome</u> flowers at 1315 h.
The genus <u>Sargon</u> is almost exclusively associated with alpine herbfields (May, 1977). The larvae are ground dwelling and live on the roots of grasses, <u>Celmisia</u> and <u>Aciphylla</u> (B. May, pers. comm., 1976).

<u>Sargon</u> <u>turricola</u> (Marshall) (Map 8)

1160-1830 m Nov-May 56 adults
Sealy range pit 6, Sefton biv. ridge, Copland pass ridge, Mt Annette.
Under rocks alpine herbfield, feeding on flowers <u>Senecio</u> <u>scorzoneroides</u> during the day.
A common species on the Sealy range and Main Divide but apparently absent from the Godley and Liebig range. One specimen was found at

1160 m on the Sefton biv. ridge amongst *Celmisia* and *Chionochloa*, the remaining 55 specimens were all above 1500 m and most of these were above 1700 m.

Stephanorhynchus curvipes White

740 m Feb-Mar 5 adults
Governor's bush.
Light trap. The larvae feed on *Pseudopanax* (G. Kuschel, pers. comm., 1978).

Siphonaptera (fleas)

Wingless, laterally compressed, ectoparasites of birds and mammals with piercing and sucking mouth parts. Both sexes normally live exclusively on blood, however the larvae and adults can live for long periods free of a host, withstanding unfavourable environmental conditions.

Ceratophyllidae

Ceratophyllus gallinae (Schrank, 1803) (European chicken flea)

650 m unknown date and number
Hooker valley.
In building, associated with introduced birds nesting in a roof, causing annoyance to pilots.
An introduced flea.

Diptera (two winged flies)

Adults possess only one pair of functional wings, the other pair exist as modified structures called halteres. Mosquitoes, black flies, houseflies and blow flies are all common almost ubiquitous dipterans. Eggs are generally small, elongated and oval and are laid in moist situations. The larvae do not have any true legs. Larvae may be phytophagous, animal parasites, or saprophages. Adults are usually polyphagous. The house fly (Musca domestica L.) is a cosmopolitan vector of human gut diseases. The black or sand flies are especially notable New Zealand dipterans.

Many Diptera were collected during the survey, the majority are in fluid extractions from sticky traps and most families are unsorted and unidentified.

The Diptera are divided into two suborders - Nematocera and Brachycera. Nematocera are usually slender flies with longish simple antennae. A stouter build and shorter modified antennae are characteristics of the more 'advanced' Brachycera. Most Nematoceran larvae are aquatic whereas Brachyceran larvae are usually terrestrial.

Nematocera

Tipulidae (crane flies) - a common fly family, narrow bodied, slender legged and having conspicuous wings and halteres. The larvae are elongated and legless, some larvae called "leather jackets" feed on roots of pasture plants, other larvae feed on decaying lichens, mosses and other vegetation. Adults are weak fliers and were common jétsam at times on snow slopes such as the Minarets and Mt De la Beche. Most tipulids are not yet identified, those that are were mainly collected by P.M. Johns when he visited the park (Jan 77) to help with the survey. He also supplied distribution records from other areas.

In the Northern Hemisphere, soil dwelling Tipulidae larvae are important decomposers in tundra ecosystems. Tipula exisa (Schum.) an artic tipulid had a prolonged life cycle and characteristic of other artic tundra insects, larvae were strongly restricted to specific vegetation types (Hofsvang, 1975). The New Zealand genus Leptotarsus also follows vegetation patterns in its specific distribution.

Leptotarsus minutissimus (Alexander)

750-1810 m   Jan   several adults
Ball hut road, Hooker flats, Mueller hut area.
Swept ex roadside and on snow (1810 m).
The larvae live in tussock tillers, widespread in sub-alpine tussock from Central Otago to North Canterbury (P. Johns, pers. comm., 1977).

Leptotarsus montanus (Hutton)

1600-1800 m   Jan   a few adults
Mueller hut.
Moribund on snow, ex alpine grassland.
The larvae live in tussock tillers, widespread from Mt Aspiring to Arthur's Pass (P. Johns, pers. comm., 1977).

Leptotarsus vulpinus (Hutton)

900-1800 m Jan several adults
Ball hut road, Mueller hut.
Larvae in wet tussock, lowland Stewart Island to alpine areas in Nelson (P. Johns, pers. comm., 1977).

Limonia sublacteata (Edwards)

740-900 m Jan several adults
Governor's bush, Hooker flat, Ball hut road.
Swept.

Simuliidae (black or sand flies) - a cosmopolitan family of biting flies, relatively small with a stout build and wings with a large anal lobe. Some species require a blood meal for egg maturation. Recently Dumbleton (1972) and Crosby (1974) have both added considerable information on New Zealand Simuliidae. In New Zealand Maoris called blackflies 'namu', mosquitoes (Culicidae) were called 'naeroa' or 'waeroa'. Blackflies have bitten men in New Zealand since the earliest explorers (Polynesian and Caucasian). An interesting point is what the adult females fed on before man introduced animals or himself into areas where mammals were either scarce or non-existent. Miller (1971) lists two species of native bats, lizards, birds and seals as possible vertebrate blood donors for the blackflies. Perhaps one factor contributing to the extinction of moas was loss of blood to blackflies feeding on the long exposed legs of the flightless birds! Adult flight of females peaks 1-2 hours after dawn and about 1 hour before sunset (Dumbleton, 1972). Falling barometric pressure, decreased light intensity and increased humidity also produced peaks of activity. In contrast to popular belief some activity does occur at night.

Mating takes place in flying swarms over water, land or on the ground. More than one batch of eggs may be laid but the maturation of the second batch requires a blood meal even if the first batch did not. Eggs are laid in or near water, larvae are filter feeders in aerated streams. The immature stages have not been found in high densities (adults certainly have) and it appears that adults are fairly long lived tending to collect on the margins of streams and lakes (Dumbleton, 1972). Adults return to higher elevations for oviposition in favourable localities (usually in smaller streams under heavy shade in forests). Dragonflies and some diptera prey on adults while larvae are taken by various fish and aquatic predatory insects (Trichoptera, Odonata, Chironomidae).

<u>Austrosimulium</u> <u>bicorne</u> Dumbleton

1100 m Mar 77 1 adult
Red lakes.
Malaise trap.
Known also from Templeton basin 1500 m, Homer tunnel 920 m, and Takahe valley (Dumbleton, 1972).

Austrosimulium multicorne Tonnoir

Recorded in passing by Dumbleton (1972) from Black Birch stream Mt Cook. Known from Mt Ruapehu and South Island mountains.

Austrosimulium ungulatum Tonnoir (West Coast blackfly)

670-900 m Feb-May 25 adult females, many more observed.
Hooker corner, Botanical spur, Village, Hoophorn stream, Governor's bush.
Ex human flesh, in house, swept ex *Podocarpus nivalis*.
Locally common in mid-late summer, known from Nelson, Reefton, Marlborough, West Coast, Peel Forest, Fiordland (Dumbleton, 1972). Dumbleton (1972) also recorded some from Bush stream and Black Birch stream in the Mt Cook area. Larvae prefer smaller streams under heavy shade in forest.

Austrosimulium unicorne Dumbleton

800-900 m Feb-Mar 5 adults
Hoophorn stream, Murchison, Red lakes, Sealy range.
Swept ex *Podocarpus nivalis*, on flowers of *Carmichaelia grandiflora*, swept 1015 h and 1800 h. Some paratypes from Black Birch stream were used by Dumbleton (1972), he collected others from Sawyer and Hoophorn streams. Known from either side of the main divide in the central alps. Larvae are unusual in their locality on the undersurface of large stones in relatively large open streams (Dumbleton, 1972). In other species larvae are on the upper surfaces of stones. *A. unicorne* usually occurs without other *Austrosimulium*

Austrosimulium unicorne continued

species, however in Black Birch stream Dumbleton (1972) found it associated with *A. ungulatum* and *A. multicorne*.

Austrosimulium sp. indet.

730-740 m   Apr   3 adults
Governor's bush and Village.
Light trap 14 and to house light at night.

Bibionidae - adults are weak fliers, larvae are saprophytes.

Dilophus crinitus (Hardy)

740-1600 m   Nov-May   45 adults
Sealy range, Ball ridge, Hooker, Leibig, Blue lake, Mt Wakefield.
Swept ex *Chionochloa*, ex *Aciphylla* flowers, on snow, on manuka.
Common at times in the open *Chionochloa* areas.
Known also from the Wilberforce and Rahu saddle.

Philia insolita (Collin)

800 m   Jan 77   unknown number adults
Governor's bush.
Swept, P. Johns' collection.

Mycetophilidae (fungus gnats) - a large family, common in wet forests, adults are active mainly at dusk or nocturnal. Many were collected and the majority remain unidentified.

Morganiella fusca Tonnoir

740 m   May-Aug   1 adult
Governor's bush underground pit.

Mycetophila dilata Tonnoir

740 m May-Oct 1 adult
Governor's bush underground pit.

Brachycera

Acroceridae (bladder-flies) - the larvae are parasitic in spiders. Adults have a bladder-like abdomen and a hump-backed thorax.

Oncodes sp.

910 m Feb 77 1 adult
Rutherford stream.
Swept ex St John's wort 1100 h.
Miller (1971) illustrates the common O. brunneus.
Mating swarms have been observed in summer on
Mt Herbet (C. 900 m) Canterbury.

Asilidae (robber flies) - adults are predators of Diptera and Hymenoptera in particular and of most other insects. Eggs are laid in soil, in bark, or on plants. Larvae live in soil and rotting wood and are sometimes predacious.

Neiotamus varius Walker

740-1250 m Dec-Feb 6 adults collected, several others seen.
Village, Liebig range, Rutherford stream.
Swept ex Celmisia angustifolia, swept over sand, in house.

Genera and spp. indet.

Five other species were taken at several sites.

Lonchopteridae - slender flies, the only New Zealand species has been introduced from the Northern Hemisphere. Males are rare, females reproduce parthenogenetically, larvae live in decaying vegetation.

Lonchoptera dubia Curran

800 m Mar 76 1 adult
Blue stream.
Swept 1600 h.

Syrphidae (hover flies) - adults are important pollinators of flowers (Miller, 1971; Holloway, 1976). Larvae may be predatory, phytophagous or saprophagous. About 20 species were collected from flowers of Ranunculus lyalli, Celmisia spp. and various other plants such as Hebe. Detailed species determinations have not been done but the following are some that were collected and identified : Eristalis tenax (L.) (drone fly); Helophilus sp. (rat tailed hover fly); Melanostoma fasciatum (Macquart) (small hover fly): Melangyna novaezelandiae (Macquart) (large hover fly).

Tephritidae - larvae of Tephritis spp. live in the flower heads of Compositae. The other genus is Trypanea (Harrison, 1959), it appears that they also feed on Compositae flower heads. All New Zealand species in these two genera are endemic (Harrison, 1959).

Tephritis fascigera Malloch

740 m Mar unknown number of adults
Governor's bush light 14.
One other Mt Cook record is listed by Harrison (1959), adults present Dec-Apr through most of New Zealand. Recorded as reared ex Senecio flower heads (Harrison, 1959).

Tephritis plebeia Malloch

No details of location.
Record from Mt Cook from Harrison (1959), adults present Dec-Apr throughout New Zealand.

Tephritis marginata Malloch

750 m Jan 77 several adults
Hermitage area.
Swept ex Cassinia and Aciphylla.
Recorded from Mt Cook by Harrison (1959), adults also recorded from Cass and Waitati Dec and Feb.

Trypanea spp. - no attempt was made to determine species because wing patterns are used by Harrison (1959) and these are very variable.

700-1650 m Nov-Apr many adults and larvae
Wakefield track, Rutherford stream, Ball ridge, Red lakes, Hoophorn spur, Ailsa pass, Mt Wakefield, Sealy range.
Swept, reared ex seed head Celmisia coriacea (Plate 11) (larvae collected 3 Feb 77, adults emerged 20 Feb 77), adults associated with Olearia moschata, Podocarpus nivalis, Raoulia, St John's wort and Hebe lycopodioides.
Larvae common in some Celmisia flower heads. Considerable damage was recorded amongst Celmisia coriacea seed heads, in particular from plants adjacent to Wakefield track. Harrison (1959) had no Mt Cook records for the nine species he listed, but he did include a reared record of T. centralis Malloch from a Celmisia spectabilis flower head C. 900 m Torlesse range.

PLATE 11 : Larvae of Trypanea sp. (Diptera : Tephritidae) in a Celmisia coriacea flower head.

Sciomyzidae - the larvae of typical forms are predators or parasites of freshwater and terrestrial snails.

Huttonina abrupta Tonnoir and Malloch, 1928

740 m Mar 76, Jan 75 2 adults
Governor's bush, Blue stream.
Swept edge of *Nothofagus* forest, ex shrubs and grasses stream edge.
Harrison (1959) records this species from the Tararua ranges in the North Island down through Nelson and Canterbury in the South.

Huttonina brevis Malloch, 1930

810 m Mar 76 1 adult
Governor's bush.
Sticky trap 13.
Recorded by Harrison (1959) as known only from the holotype which was taken at Kumara.

Huttonina claripennis Harrison, 1959

1200 m Jan 77 1 adult
Reay.
Associated with *Dracophyllum* and *Chionochloa* near stream.

Formerly only recorded from the Routeburn (Harrison, 1959).

Neolimnia castanea (Hutton, 1904)

900-1300 m Jan-Feb 23 adults, males and females
Sealy, Stocking stream, Liebig, Tasman, Reay.
Pits 1, 2, 7, on clothing, lateral moraine shrubs, by stream.
Associated with *Dracophyllum*, *Chionochloa*, *Poa*, *Aciphylla*, *Phormium*.

A revision of the endemic genus *Neolimnia* (Barnes, 1979) includes the information that these flies have larvae predatory on terrestrial snails.

The closely related *Pseudolimnia* feed on aquatic snails. Barnes (1979) includes several Mt Cook records of *N. castanea* along with distribution records from Wellington, the South Island and Stewart Island.

Neolimnia striata (Hutton, 1904)

800-1600 m Jan-Mar 2 adult females
Blue stream, Reay.
Swept ex grass, pooter ex *Chionochloa* (1200 h).
Widespread from North Cape, through the South Island, Stewart Island and the Chathams (Barnes, 1979).

Lauxaniidae (Sapromyzidae) - one of the largest and most common of the acalypterate families, adults occur in a wide range of habitats.

Sapromyza dichromata Walker

740-810 m Feb-Mar 8 adults
Governor's bush lights 13 and 14, Hooker.
Swept 1600 h.
Not common, present throughout New Zealand.

Trypaneiodes tenuipennis Malloch

Not recorded during the present survey.
The holotype is from Mt Cook, Dec 1924 collected by A. Philpott (Harrison, 1959). Known only from Mt Cook.

Agromyzidae - small or minute fliers, larvae are phytophagous leaf and stem miners and gall makers. Spencer (1976) collected at Mt Cook during his tour of New Zealand and most records listed below are from his data. Spencer (1976) updates Harrison's (1959) work, both give details of plant hosts. Species are usually host specific with 34 endemic species in New Zealand (Spencer, 1976). A detailed list of plant hosts is given by Spencer (1976).

Cerodontha (Cerodontha) australis Malloch

750 m Jan 75 unknown number
Hermitage.
Both native and introduced grasses are hosts.

Hexomyza coprosmae Spencer

740-750 m Jan 75 unknown number immatures
Village, Governor's bush.
Ex galls Coprosma propinqua.

Liriomyza flavocentralis Watt

750 m Jan 75 adults reared from immatures
Village.
Ex Hebe salicifolia emerged Feb 75.
Distributed throughout New Zealand Nov-July (Harrison, 1959).

Liriomyza umbrina (Watt)

670-750 m Jan 75 several adults
Unwin hut, Village.
Ex mines Hebe salicifolia.

Liriomyza umbrosa (Watt)

740-1130 m Jan 75 several
Ball hut, Hooker.
Ex Hebe subalpina.

Liriomyza wahlenbergiae Spencer

no ht. Jan 75 unknown number
Hoophorn spur.
Host *Wahlenbergia albomarginata*.
Described by Spencer (1976) from these specimens.

Liriomyza sp. nov.

1340 m Dec 75 several mines and puparia
Sealy range near Sealy tarns.
Ex *Gentiana corymbifera* stems and leaves.
Attempts failed to rear the adults from plant samples, Spencer (1976) also recorded mines in *G. corymbifera* from Mt Hutt.

Phytomyza ? *lyalli* Spencer

800 m Apr 77 several pupae
Kea point walk.
Ex *Ranunculus lyalli* petioles.
Rearing attempts failed. Probably *P. lyalli*, a species described by Spencer (1976) from Arthur's Pass *Ranunculus lyalli* material.

Muscidae (house flies)

Musca domestica L. (house fly)

730 m Apr 76 1 adult
Village.
To light in house.
Not common.

Calliphoridae (blow flies) - adults are ubiquitous, active day and night, food includes nectar, honey dew and decaying organic matter. Larvae generally feed on moist dead organic material.

<u>Calliphora</u> <u>hortona</u> (Walker) (small blue blow fly)

740-1200 m Feb-Apr 4 adults
Hooker, Separation stream, Governor's bush light 14.
Swept ex shrubs, malaise.
Not very common.

<u>Calliphora</u> <u>quadrimaculata</u> (Svederus) (N.Z. blue blow fly).

730-2200 m Nov-May 37 adults collected, many more seen.
Hermitage, Mueller hut, Sealy, Village, Tasman saddle, Godley hut, Murchison F.S. hut, Governor's bush, Plateau hut.
In house, in hut, in toilet, swept, on snow, in sun on house.
Common, an unconfirmed sighting was made in Dec near the high peak of Mt Cook.

<u>Calliphora</u> <u>stygia</u> F. (brown flow fly)

740 m Apr 77 1 adult
Village.
Ex house.
Not common.

<u>Calliphora</u> <u>vicina</u> Robineau-Desvoidy (European blow fly)

740 m Feb 77 3 adults
Village.
In sun on house.
Not very common.

<u>Calliphora</u> sp. indet.

765 m Apr-May 77 1 adult
Botanical spur malaise.
Intermediate in size between the two blue blow flies, similar colouring.

New genus? and sp.

1200 m   Feb 77   5 adults
Separation stream.
Malaise trap.

Sarcophagidae (flesh flies) - similar to calliphorids, adults usually viviparous, the larvae are saprophagous.

Hybopygia varia (Walker) (striped dung fly)

750-800 m   Jan-Feb 70   unknown number
H. Wilson collection.
Sometimes common in alpine grasslands, usually associated with sheep and cow droppings in lowland areas (J. Dugdale, pers. comm., 1970).

Tachinidae - a conspicuous parasitic dipteran family, larvae parasitise larvae, nymphs and adults of various insect orders. Adults are strongly bristled and are usually stout-bodied. Eggs (sometimes larvae) may be laid in, on, or near the host, or often on the host's food plant as 'microtype' eggs. Ingested eggs hatch inside their host's gut and the larvae penetrate the host via the gut wall. Usually the host dies late in its larval life and the parasites pupate in soil. Principal arthropod host families include Lepidoptera, Coleoptera, Hemiptera and Orthoptera. Many pest species of insects have their numbers regulated by tachinid parasites. A few of the New Zealand tachinids are illustrated by Miller (1971). Some of the native grass grub pasture pests (Scarabaeidae-Coleoptera) are parasitised by tachinids in the genera Proscissio, Avibrissina and Neotachina (Given, 1945; Thomas, 1963). (Map 10)

New genus and sp. (Voriinae) (Map 12)

2850 m Feb 77 1 adult collected, 2 others seen.
Mt Walter (North face).
On steep rock 1100 h, flying close to rock in sunshine.
Probably an endemic nival insect; fairly small, dark and hairy. It's host is probably another nival insect such as Pharmacus or a Lepidopteran.

Altaia geniculata ? Malloch

900 m Mar 77 1 adult
Hoophorn stream.
Ex Podocarpus nivalis.

Avibrissia isolata (Malloch)

1200-2000 m Jan-Apr 13 adults
Malte Brun hut, Mt Wakefield, Annette Plateau, Reay, Mt D'Archiac, Ailsa Pass.
Swept, on rock, ex Celmisia coriacea flowers (0820-1200 h).
Widespread but not in great numbers at any one time. Apparently restricted to subalpine-alpine-nival areas.

Avibrissia sp. ? longirostris Malloch

1500 m Jan 77 1 adult
Reay 1200 h.
Swept.

Avibrissia sp. nova ("major" Dugdale ms.)

1020-2000 m 7 adults
Nuns Veil, Mt Ollivier, Sefton biv ridge, Ball ridge.
Ex snow, on rock, on rock in copula, ex Ranunculus lyalli flower, 1200-2000 h.
Known also from Marlborough (J. Dugdale, pers. comm., 1978).

Avibrissina brevipalpis Malloch

1100-1820 m Feb-Mar 11 adults
Ball ridge, Sealy, Red lakes.
Swept, malaise traps (Red lakes and Sealy tarn).
Grass grubs (Pyronota spp.) are recorded as hosts for this fly (Given, 1945). Associated with Chionochloa tussocks and shrubs such as Hebe lycopodioides.

Calcager apertum Hutton

740 m Nov 76 1 adult
Chalet area.
Swept ex Podocarpus nivalis.

Calotachina tricolor Malloch

800-1200 m Mar-Apr 3 adults
Blue stream, Red lakes, Mt Wakefield.
Swept 1800 h, swept.

Campylia nudarum Malloch

1100 m Feb 76 1 adult
Red lakes.
Swept.

Campylia temerarum Hutton

740-1100 m Mar-May 3 adults
Liebig range, Red lakes, Governor's bush light 14.
Swept edge stream, swept.

Gracilicera _politiventris_ Malloch

740-900 m Dec-Apr 4 adults
Sealy, Stocking stream, Blue lake.
Swept, on _Aciphylla_ flowers.

Heteria _atripes_ Malloch

700-1820 m Mar 77 3 adults
Sealy range 1730 h, Red lakes, Wakefield track.
Swept, ex _Gingidia_ _montana_ flowers

Heteria _punctigera_ Malloch

740 m Nov 76 2 adults
Village.
Ex pool.

Mallochomaquartia _vexata_ (Hutton)

1300-1890 m Oct-Nov 5 adults
Ball ridge, Mt Annette.
Swept, under rocks.

Medinella _flavofemorata_ Malloch

800-1160 m Jan-Mar 5 adults
Governor's bush, Sealy pits 1 and 2, Blue stream.
Swept.

? _Medinella_ sp.

810-1160 m Jan-Mar 2 adults
Governor's bush, Sealy pit 2.
Swept 1600 h.

Pales _casta_ (Hutton)

1130 m Feb 77 1 adult
Hooker hut.
To lamp 2100 h.
A relative (_Pales_ _funesta_) parasitises
leafroller caterpillars.

Pales efferata group (Hutton)

850-1800 m Feb-Mar 5 adults
Red lakes, Stocking stream, Ball ridge.
Separation stream, Sealy.
Swept ex Chionochloa and Hebe lycopodioides, on snow, ex malaise.

Pales nyctemeriana (Hudson)

810 m Feb 75 2 adults
Governor's bush light 13.

Pales usitata (Hutton)

740 m Nov 76 1 adult
Village.
Swept ex helipad.

"Peremptor" modica Hutton

800 m Feb 76 1 adult
No locality.
Swept.

Plagiomyia longicornis (Malloch)

900-1100 m Nov-Feb larvae in Nov, 5 adults in Jan-Feb.
Red lakes, Rutherford stream.
Larvae in live late instar noctuid caterpillar Nov 76, adults emerged 26 Jan 77 and 15 Feb 77. One adult swept ex St John's wort in flower.

Plagiomyia turbidum (Hutton)

1650 m Mar 77 1 adult
Malte Brun hut.
Swept ex tussock.

Platytachina latifrons Malloch

1220-1900 m Feb-Mar 7 adults
Ailsa pass, Sealy, Sefton biv ridge, Kea point.

Platytachina latifrons continued

On Celmisia coriacea flower, Malaise (Sealy tarn), swept.

Proscissio albiceps Malloch

1340-2000 m Feb-Mar 2 adults
Sealy, Tasman glacier.
Malaise (Sealy tarn), on snow.
A relative (Proscissio cana) is a parasite of the common grass grub (Costelytra zealandica) (Thomas, 1963). P. albiceps possibly parasites other scarab beetle larvae such as Odontria spp. and Pyronota spp.

Proscissio kumarensis group

850-1650 m Dec-Apr 16 adults
Sealy, Separation stream, Gorilla stream, Malte Brun hut.
Malaise trap, swept ex totara, swept.
Nearly common during summer, associated with scrub and tussock.

Proscissio lateralis Malloch

740-1340 m Feb-Mar 14 adults
Sealy tarn, Governor's bush, Separation stream, Sefton biv ridge.
Malaise, swept, in house in sun, on Carmichaelia grandiflora flowers. Widespread and probably nearly common in Feb-Mar. Possibly parasitises Odontria and Pyronota scarab larvae.

Proscissio rufa n. sp. Dugdale m.s.

1340 m Feb-Mar 4 adults
Sealy tarn, Mt Sebastopol.
Malaise trap, swept.

<u>Protohystricia</u> <u>huttoni</u> Malloch

900-925 m Dec 75 3 adults
Liebig range.
Swept 1430-1500 h.

<u>Protohystricia</u> <u>signata</u> Walker

1000 m Jan 76 1 adult
Red lakes track.
Swept 1800 h.

<u>Pygocalcager</u> sp.

1650 m Feb 76 1 adult
Sefton biv.
Collected at 1600 h.

<u>Zealandotachina</u> <u>nigrifemorata</u> Malloch

740-1100 m Feb-Mar 4 adults
Governor's bush, Red lakes.
Light trap 13, in house in sun, swept ex grass and shrubs.

<u>Zealandotachina</u> sp. cf. <u>setigera</u>

1100 m Mar 76 1 adult
Red lakes.

Trichoptera (caddisflies)

Caddisfly larvae are aquatic, adults are active at dusk and at night. Common in light traps in Governor's bush, none were identified.

Lepidoptera (moths and butterflies)

Overlapping scales give texture and colour to the two pairs of overlapping wings and the body. One of the largest insect orders, adult mouthparts are reduced, often in the form of a suctorial proboscis. The larvae have chewing mouthparts and a wide variety of material is fed on (plants, carpets, flour, wax and timber). Some of the smallest larvae are leaf-miners. Adults lay large numbers of eggs amongst suitable plants. Map 9 shows some alpine and subalpine distributions.

Nepticulidae - larvae tunnel directly from the eggs into leaves, forming slender tortuous mines, which later expand into blotches.

Nepticula sp. cf. *progonopsis* Meyrick (*Hoheria* miner)

850 m Apr 77 unknown number larvae and pupae
Stocking stream.
Ex *Hoheria lyalli* (pupa - adult emerged 20 Sep 77
Auckland, J.S. Dugdale, pers. comm.).
This species appears to show true diapause, over-wintering as a pupa. Philpott (1930) recorded several adults in December. He also recorded adults of *N. lucida* Philpott in the same month.

Hepialidae - adults lack functional mouthparts and cannot feed, the females are heavy bodied and short lived. Eggs are laid in large numbers, but larval mortality is usually high. Some species have larvae which "graze" introduced pastures and when present in high densities they may reach pest status. Males are readily attracted to lights at night, but not so for females. A well represented family in Australia and New Zealand, few species occur in the northern hemisphere. Dumbleton (1966) classified the New Zealand species and examined their zoogeography, concluding that the nearest relations were Australian.

Aoria aurimaculata Philpott

730-1120 m March-May 26 adult males. 2000-2400 h.
Governor's bush, village, near Ball hut, Hermitage.
Ex light traps 13 and 14, to light in house, to light in rain, in house, dead on ground.
Moreporks may feed on the adults (M. Heine, pers. comm., 1978). Described from a specimen collected by F.S. Oliver, Hermitage, Mt Cook. Known also from Milford, Landsborough, Lake Ohau and Franz Josef glacier.

Wiseana cervinata cplx. (Walker) (porina)

700-810 m Oct-Nov 8 adults 2100 h
Hooker flat, house, Birch Hill stream, Governor's bush.
To light at night, flying at dusk, in a small pine tree (1030 h).
This species is a pest of lowland pastures. The larva lives on the surface amongst grass stems for 6-7 weeks, it then goes underground, emerging from its tunnel at night to feed on grasses and clovers. Larvae have been recorded alive and well in tunnels that emerged through 10 cm of frozen ground. Seagulls were observed at nights (Nov 76) feeding on ground dwelling insects which included porina.

Psychidae - males are strong swift fliers, sometimes in sunshine, females are apterous and immobile. Larvae are active and feed on a variety of shrubs and trees.

Liothula omnivorus (Fereday) (bag moth)

C. 800 m Mar 70 unknown number of larvae and bags
Hermitage, Chalet area.
Some collected by Hugh Wilson, bags taken from European larch.

Tineidae - larvae sometimes case bearing, usually feeding on dried animal or vegetable matter.

Oxythecta austrina (Meyrick)

800 m Nov 76 1 adult
E. Hooker.
Swept ex *Hebe* and *Cyathodes*.

Gracillariidae - elegant tiny moths, leaf miners and pouch makers.

Caloptilia elaeas (Meyrick)

800-1139 m Nov-Apr unknown number
Ball hut and Hermitage.
Larvae ex buds of fine leaved tutu (*Coriaria*).
Adults common in Jan (Philpott, 1930).

Caloptilia "gaultheriae" (Dugdale m.s.)

800 m Apr 77 unknown number larvae
Kea pt.
Ex *Gaultheria* mines and pouches. Reared J.S. Dugdale, 1977.

Caloptilia linearis (Butler)

740 m Apr 77 unknown number
Governor's bush.
Ex *Nothofagus* leaf pouches.

Caloptilia selenitis (Meyrick)

670-1130 m Nov-Apr unknown number larvae and adults.
Ball hut, Hooker corner.
Larvae ex pouches of *Nothofagus* leaves, 1 adult blown onto arm ex *Nothofagus*. Philpott (1930) recorded several adults in Dec.

Parectopa aethalota (Meyrick)

800 m Apr unknown number
Governor's bush.
Larvae in stems of *Pseudopanax*.

Parectopa ? *panacivagans* Watt

800 m Apr unknown number
Governor's bush.
Larvae in leaves of *Pseudopanax*.

Tortricidae - larvae often have anal forks, their habit is to join leaves and shoots or tunnel in flower spikes, fruit and galls. The adults usually fly in the late afternoon or at sunset. Colour and habit are both protective for adults and larvae. Some species resemble bird droppings, lichens or mosses.

Capua semiferana (Walker)

670-810 m Feb 2 adults
Unwin hut, Governor's bush.
Light trap 13, to light.
Larvae feed on detritus in swards (J. Dugdale, pers. comm., 1977).

Catamacta alopecana (Meyrick)

730-810 m Feb-May 30 adults, several larvae
Village, Governor's bush, Hooker flat.
Light traps 13 and 14.
Reared ex Phyllocladus alpinus cladodes.
Also reared by Philpott (1930) from the same host. Parasitised in the larval and pupal stages by a braconid wasp.

Ctenopseustis obliquana (Walker) (brown headed leaf roller)

740-810 m Feb-Apr several adults
Governor's bush.
Light traps 13 and 14.
Polyphagous, recorded by Philpott (1930) as common in Feb.

Epicharista aspistana Meyrick

730 m Apr 76 1 adult
Village.
To house light.
A few were recorded by Philpott (1930) in Jan-Feb.

Epicharista emphanes Meyrick (beech leaf roller)

810 m Feb 76 1 adult
Governor's bush.
Light trap 13.
Several were recorded by Philpott (1930) in Jan.
A leaf roller of Nothofagus.

Epicharista persecta Meyrick

800 m Apr 77 A few adults
Governor's bush.
Light trap.
A few were recorded in Jan and Feb by Philpott (1930). Larvae on Coprosma (J. Dugdale, pers. comm., 1977).

Epiphyas postvittana (Walker) (light brown apple moth)

730 m Apr 76 1 adult male
Village.
In house.
Introduced from Australia, a pest of fruits, berries, clovers, shrubs and young conifers.
Not recorded by Philpott (1930).

Ericodesma melanosperma (Meyrick)

800 m Apr 77 several larvae
Hooker flat area.
Larvae ex *Dracophyllum longifolium*, not reared.

"*Eurythecta*" *leucothrinca* Meyrick

1350 m Apr 76 3 adult males
Wakefield spur (west aspect).
Swept ex *Poa*. 1200 h.
The females are unknown (J. Dugdale, pers. comm., 1977).

Gelophaula sp. nr. *lychnophanes* (Hudson)

1250 m Dec 76 2 adults
Liebig range.
Swept while flying (1200 h).

Harmologa sisyrana Meyrick

740-810 m Mar-Apr several adults
Governor's bush.
Light traps 13 and 14.
Larvae on *Cassinia* (J. Dugdale, pers. comm., 1977).

Planotortrix notophaea (Turner) (black legged leaf roller)

800 m Apr 77 several adults
Governor's bush.
To light.
Larvae on conifers and some dicotyledonous shrubs and trees.

Pyrgotis chrysomela (Meyrick)

1240 m   Mar 75   1 larva
Sealy.
Ex _Podocarpus nivalis_, adult emerged May 75.

Pyrgotis plagiatana (Walker)

1500 m   Apr 77   several
Wakefield spur.
Ex _Gaultheria_, the larva is a leaf tyer.

Pyrgotis pyramidias Meyrick

730-740 m   Apr 76 and 77   a few adults
Governor's bush, light 14 and village.
To light.
Larvae on _Nothofagus_ (J. Dugdale, pers. comm., 1977).

"Tortrix" pictoriana Felder, Felder and Rogenhofer

810 m   Feb 75   2 adults
Governor's bush.
Light trap 13.

Glyphipterigidae - larvae form webs and feed on leaves, seeds or tunnel into shoots. Adults are usually diurnal.

Glyphipterix sp.

800 m   Apr 77   unknown number larvae
Hooker valley.
Larvae reared ex _Dracophyllum_.
Terminal buds can be killed by larvae (J. Dugdale, pers. comm., 1977).

Yponomeutidae - slight webbing on leaves and flowers, gregarious in webs, tunnelling in shoots, mining in leaves, or feeding exposed are the various habits that larvae of this family adopt.

<u>Orthenches</u> "<u>duplicis</u>" Dugdale m.s.

740 m Mar-Apr 4 adults
Governor's bush.
Light trap 14.
Larvae have been reared ex <u>Dacrydium</u> <u>bidwilli</u> (J. Dugdale, pers. comm., 1977).

<u>Orthenches</u> "<u>phyllocladi</u>" Dugdale m.s.

740 m Mar-Apr 21 adults
Governor's bush, in house.
Light trap 14, ex cut branch.
Larvae reared ex <u>Phyllocladus</u> <u>alpinus</u> (J. Dugdale, pers. comm., 1977).

<u>Orthenches</u> <u>porphyritis</u> Meyrick

740-850 m Mar-Apr 5 adults
Hoophorn, Governor's bush.
Light trap 14 and ex <u>Podocarpus</u> <u>hallii</u> also associated with <u>Phyllocladus</u>. Listed as common Dec-Jan by Philpott (1930).

<u>Orthenches</u> sp. cf. <u>similis</u>

740 m Apr 77 1 adult
Governor's bush
Light trap 14.

<u>Protosynaema</u> <u>quaestuosa</u> Meyrick

670 m Apr 1 adult
Unwin hut.
In house.

Protosynaema matutina Philpott

740 m Apr 77 several larvae
Clod cottage area.
Ex grass heads *Agrostis tenuis* (J.S. Dugdale, pers. comm., 1977).

Coleophoridae - a leaf miner in the first larval instar, then a case bearer, feeding externally on leaves or flowers.

Coleophora sp. (clover case bearer)

740 m Feb 77 1 adult
Village.
On pool of water.
The larvae feed on white clover flowers, reducing seed production.

Elachistidae - leaf or stem miners usually in grasses or sedges.

Cosmiotes ombrodoca (Meyrick)

740 m Nov-Apr several adults and larvae
Camp ground, Clod cottage area.
Associated with grasses, *Festuca*. Philpott (1930) recorded the adult as common in Dec.

Euproteodes helonoma (Meyrick)

800 m Apr 77 several adults
Hoophorn, Stocking stream.
Associated with *Festuca*, common in Feb (Philpott, 1930).

Euproteodes sp. *sagittifea* cplx.

800-1100 m Mar-Apr 2 adults
Red lakes, Stocking stream.
Malaise, to light.

Gelechiidae - the larvae usually feed among spun leaves or shoots.

Anisoplaca achyrota (Meyrick)

C. 800 m Mar 72 unknown number
"Hermitage" area.
Hugh Wilson collection ex *Hoheria glabrata*.

Anisoplaca sp. nr. *fraxinea*

740-810 m Feb-Mar 2 adults
Governor's bush.
Ex cut branch, light trap 13.

Gelechia sensu Hudson (1928, 1939) *sp. nova*

2400 m Oct 77 several larvae
Head of Tasman glacier, slopes of Mt Annan N.W. aspect.
Larvae ex silk webbed *Hebe haastii* plants on rock bluff (plate 3). Reared at Lincoln, adults emerged Dec 77.

Oecophoridae - larva in a portable case, tunnelling in wood or in flowers or galls, joining leaves, amongst litter, or in tunnels in soil.

Cremnogenes spp. Philpott (1930) recorded 11 spp. of Cremnogenes (then *Borkhausenia*).

Cremnogenes sp. cf. *grata*, *apertella*

810 m Feb 76 10 adults
Governor's bush light trap 13.
Larvae in silk galleries in litter (J. Dugdale, pers. comm., 1977).

Cremnogenes sp. cf. *horea* Meyrick

700-850 m Apr unknown number
Hoophorn, Governor's bush.
Ex litter.

Cremnogenes sp. cf. *sordida* (Butler)

740-800 m Apr 77 unknown number
Hoophorn, Governor's bush.
Ex litter.

Cremnogenes sp. A

810 m Feb 75 2 adults
Governor's bush light trap 13.

Cremnogenes sp. B

810 m Feb 75 2 adults
Governor's bush light trap 13.

Cremnogenes sp. C

810 m Feb 75 1 adult
Governor's bush light trap 13.

Cremnogenes sp. D

810 m Feb 75 1 adult
Governor's bush light trap 13.

Cremnogenes sp. indet.

740 m Jan 77 1 adult
Foliage hill.
Ex *Podocarpus*.

Gymnobathra sp.

740 m Apr 77 unknown number in leaf cases
Governor's bush.
Ex litter. Philpott (1930) recorded *G. parca* (Butler, 1877) as common in Jan.

Hierodoris eremita Philpott (Frontispiece)

750-1300 m Dec-June 10 adults, several larvae and pupae.
Sealy range, Leibig range, Wakefield track, N. face Mt Sebastopol (Red lakes track), Ball ridge. Reared ex *Celmisia coriacea* leaves, larvae collected in leaves Apr 77 emerged at Lincoln 13-21 Jun 77. Swept ex scrub Dec 75 Sealy range,

the first known male. Philpott (1930) collected five females in Dec, three from the Hooker valley and two near Ball hut. The species was not collected again until the solitary male of Dec 75. The Apr 77 visit of J. Dugdale resulted in his discovery of larvae and pupae in Celmisia coriacea leaves, which he thought might be Hierodoris. Subsequent successful rearing at Auckland and Lincoln confirmed the rediscovery of this distinctive day flying moth.

Izatha peroneonella (Walker)

740-810 m Feb-Mar 12 adults
Governor's bush light traps 13 and 14.
The larvae bore in dead wood (J. Dugdale, pers. comm.).

Carposinidae - the larva tunnels in living bark, fruit, seeds or galls.

Carposina canescens Philpott

740 m Apr 77 unknown number adults
Governor's bush light trap 14.
Philpott (1930) described this species from four males and one female collected from Governor's bush in Feb.

Carposina epomiana Meyrick

740 m Apr 77 unknown number adults
Governor's bush light trap 14.
One other was recorded by Philpott (1930) in Feb.

Carposina sp. cf. adreptella (Walker)

740 m Apr 77 unknown number adults
Governor's bush light trap 14.

Carposina ignobilis Philpott

800 m Feb 28 1 adult male

Governor's bush, Philpott collection.
The holotype (Philpott, 1930). Not collected during the present survey.

Pyralidae - a large and ubiquitous family, many are pests of cultivated plants and stored products. Larvae in shelters of webbed leaves or shoots, stems, seed heads, galls, or in silken galleries amongst mosses and leaf litter. Three sub-families are used - Crambinae, Pyraustinae and Scopariinae.

Crambinae (grass moths) - larvae feed on grasses, living in tubes of silk in the crown of tussocks. The wings are often striped longitudinally, this tends to make the moths inconspicuous as they rest parallel to the grass stems. Gaskin (1971, 1973, 1975) reviews the New Zealand Crambinae and suggests these moths arrived in New Zealand via a route along the former Melanesian arc islands. A well represented group in New Zealand, Crambinae are few in species numbers in Australia.

Gardira acerella Walker

740-900 m Jan-Feb several adults in Jan and one in Feb.
"Mt Cook".
Lowland, subalpine A. Philpott collection (Philpott, 1930; Gaskin, 1973).
Not recorded during the present survey.

Orocrambus aethonellus (Meyrick)

740-1200 m Nov-Jan 5 adults
Camp ground, village, Helipad, Sealy.
On water, ex. *Festuca*, possibly associated with *Chionochloa rubra* bogs (Gaskin, 1975).

Orocrambus apicellus (Zeller)

740 m Jan 77 unknown number adults
Governor's bush light 14.

Orocrambus callirrhous (Meyrick)

740 m Jan-Feb unknown number adults
Governor's bush light 14, Philpott (1930).
The host plant is *Festuca novaezealandiae* (hard tussock) (Gaskin, 1975, White, 1964).

Orocrambus corruptus (Butler)

800-1130 m Nov-Dec 3 adults
E. Hooker, Ball hut.
Swept ex *Hebe* and *Cyathodes*.
Apparently restricted to the eastern and central South Island (Gaskin, 1975).

Orocrambus flexuosellus (Doubleday) (common grass moth)

740-810 m Jan-Feb unknown number adults
Governor's bush light traps 13 and 14.
Common in Feb. Host plants *Poa*, *Dactylis*, *Festuca*. The dominant *Orocrambus* spp. in all lowland North Island pastures, less common in the South Island (Gaskin, 1975).

Orocrambus machaeristes Meyrick

800 m Oct 76 1 adult
Hooker track.
Ex *Poa*, an alpine association with *Chionochloa pallens* is noted by Gaskin (1975).

Orocrambus melampetrus Purdie

1400-1800 m Feb-Apr 6 adults
Sealy range, Sefton biv ridge, Hooker valley.
Flying in mist near Mueller hut 1600 h Apr 77, same locality 1200 h flying in sunshine Mar 77, ex *Celmisia* flowers 1400 h Sefton biv ridge.
Associated with higher alpine grasslands, herb-fields and fell fields in the South Island (Gaskin, 1975). Philpott (1930) recorded one in the Hooker valley in Dec.

Orocrambus philpotti Gaskin

1700 m Feb 77 3 adults

Copland ridge.

Swept ex Poa.

Associated with alpine and subalpine grasslands of the central South Island (Gaskin, 1975).

Orocrambus vitellus (Doubleday)

670-810 m Jan-Feb several adults

Unwin hut, Governor's bush lights 13 and 14.

Common in grasslands both native and introduced (Gaskin, 1975; White, 1964). Fairly common in Jan-Feb (Philpott, 1930).

Orocrambus vulgaris (Butler)

670-810 m Jan-Feb at least 15 adults

Unwin hut, Governor's bush lights 13 and 14.

Associated with Matagouri, grasses. A species with considerable variation in colour (Gaskin, 1975). An autumnal peak is usual for flights, Philpott (1930) notes that it was common in Feb.

Orocrambus xanthogrammus (Meyrick)

740 m Jan 77 several adults

Governor's bush light 740 m.

Larvae associated with Raoulia mat plants (Gaskin, 1975).

In shingle river bed areas South Island and eastern North Island.

Orocrambus sp. nr. harpophorus (Meyrick)

730 m Apr 76 1 adult

Village.

To light at night.

Pareromene elaina Meyrick

? m Feb 29 a few adults
"Mt Cook".
Recorded by Philpott (1930), not recorded during the present survey.
Associated with mosses as a host plant (Gaskin, 1971) in the northern South Island.

Pareromene epiphaea (Meyrick)

? m Jan 29 adults common
"Mt Cook".
Recorded by Philpott (1930), not recorded during the present survey. Associated with alpine moss bogs (Gaskin, 1971).

Pareromene helioctypa (Meyrick)

? m Feb 29 3 males, 1 female (adults) plus several others.
"Mt Cook", Red lakes (C. 1100 m).
Collected by C.E. Fenwick (in Gaskin (1971) and Philpott (1930)), not recorded during the present survey. Known from the South Island's lowland and subalpine areas (Gaskin, 1971).

Pareromene interrupta (Felder, Felder and Rogenhofer)

700-1250 m Dec-Feb 20 adults
"Mt Cook" Godley hut.
In Godley hut 2100 h Feb 77, other records from Gaskin (1971) and Philpott (1930). Known from Mt Ruapehu, Wellington, and throughout the South Island.

Pareromene lepidella (Walker)

? m Dec 25 1 female
"Mt Cook".
Collected by S. Lindsay (Gaskin, 1971), not recorded during the present survey.

Pareromene pyrsophanes Meyrick

810 m Jan-Feb several adults
Governor's bush light 13.
Present in subalpine areas throughout New Zealand (Gaskin, 1971).
Philpott (1930) recorded it as common in Jan-Feb.

Tauroscopa gorgopis Meyrick

850-1130 m Dec-Jan a few adults
Ball hut, Kea point.
Records from Philpott (1930). Associated with alpine regions of the South Island, J.S. Dugdale (in Gaskin, 1973).

Tauroscopa notabilis Philpott

? m Jan 64 1 male, 1 female
Mt Wakefield.
Collected by J. Dugdale (in Gaskin, 1973), not recorded during the present survey.

Tawhitia glaucophanes (Meyrick)

No collection details.
"Mt Cook".
Records from Mt Cook examined by Gaskin (1975) but no specific details given other than "alpine - sub nival", "Fiordland to Mt Cook". Flight period late Dec-Jan. Not recorded during the present survey.

Pyraustinae - larvae in webbed shelters amongst foliage, adults easily flushed during the day. Adults often rest with their wings partly expanded.

?Diasemia grammalis Doubleday

2000 m Nov 76 1 battered adult
Above Sefton biv.
On snow.

Mecyna flavidalis sens. latu. (Doubleday)

730-740 m Mar-Apr 8 adults
In house, Governor's bush light trap 14.
Also recorded by Philpott (1930) as common in Feb. The larvae feed on Muehlenbeckia (Hudson, 1928).

Mecyna marmarina (Meyrick)

730-810 m Dec-Feb 2 adults
In house, Governor's bush light trap 14.
Several also recorded by Philpott (1930) in Dec and Jan (as Mecyna maorialis). The larva feeds on Urtica and brooms (Hudson, 1928).

Nesarcha hybrealis (Walker)

810 m Dec-Feb 3 adults
Governor's bush light 13.
Associated with Ranunculus lyalli and Clematis (J. Dugdale, pers. comm., 1977).

Scopariinae - larvae often feed on mosses (sod webworms).

Eudonia octophora sp. grp. (Meyrick)

730 m Apr 76 2 adults
In house.
To light at night. Philpott (1930) recorded it as common in Feb.

Eudonia psammittis sp. grp. (Meyrick)

670-730 m Feb-Apr 2 adults
Unwin hut, Village.
To lights at night. Recorded by Philpott (1930) as common in Jan.

Eudonia sabulosella (Walker)

730-2000 m Nov-Apr several adults
Murchison valley, Stocking stream, Hooker flat, above Sefton biv.

Eudonia sabulosella continued

Swept 1100 h, one on snow 2000 m, to light at night. Recorded by Philpott (1930) as common Dec-Feb. Common 730-850 m.

Scoparia spp. Philpott (1930) recorded 36 spp. in this complex genus and described two new species from Mt Cook specimens - *S. sinuata* Philpott and *S. limatula* Philpott.

Scoparia cataxesta Meyrick

670-970 m Feb- Apr 8 adults
Unwin hut, Murchison valley, Governor's bush light traps 13 and 14, Village.
To light, under rock in *copula* 0930 h Apr 76.
Also recorded as common Dec-Jan (Philpott, 1930).

Scoparia characta Meyrick

740 m Mar-Apr several adults
Governor's bush light 14, in house.
Common in Feb (Philpott, 1930).

Scoparia ejuncida Meyrick

740 m Apr 77 several adults
Governor's bush light 14.

Scoparia melanaegis Meyrick

850-1130 m Apr 77 several adults
Stocking stream, Ball hut.
To light at night, several others recorded by Philpott (1930) in Jan.

Scoparia minusculalis Walker

810 m Feb 75 3 adults
Governor's bush light 13.
One other recorded by Philpott (1930) in Feb.

Scoparia paltomacha Meyrick

1200 m   Feb 77   1 adult
Godley valley, Separation stream.
Malaise trap. Several others recorded in Dec-Jan by Philpott (1930).

Scoparia niphospora Meyrick

740 m   Mar-Apr   several adults
Governor's bush light 14.
Several others recorded by Philpott (1930) in Feb.

Scoparia philerga grp. Meyrick

670-810 m   Feb-Apr   5 adults
Village, Governor's bush light 13, Unwin hut.
Several others recorded Jan-Feb by Philpott (1930).

?*Scoparia submarginalis* (Walker) (sod webworm)

850-1400 m   Feb 77   9 adults
Sefton biv ridge, Stocking stream, Hooker hut.
Ex *Cassinia* flowers 1700 h, swept ex *Cassinia* and *Dracophyllum* 1530 h, to light at Hooker hut 2100 h.
Formerly very abundant throughout the country, Hudson (1928) said its numbers had diminished somewhat.

Scoparia trivirgata (Felder, Felder and Rogenhofer)

Collection data unknown.
H. Wilson collection. "Mt Cook" 1969.

Scoparia sp. cf. *asterisca* (Meyrick)

810 m   Feb 75   2 adults
Governor's bush light 13.
Recorded by Philpott (1930) as common in Jan.

Scoparia sp. aff. critica Meyrick

810-1100 m Feb-Mar 2 adults
Governor's bush light 13, Red lakes malaise.

Scoparia sp. cf. crypsinou Meyrick

1500 m Jan 77 1 adult
Reay, northern aspect.
Swept ex scree 1300 h.

Scoparia sp. nr. legnota (Meyrick)

810 m Feb 75 2 adults
Governor's bush light 13.

Scoparia sp. nr. parmifera Meyrick

730 m Apr 76 3 adults
Village.
To light at house.

Scoparia sp. cf. petrina Meyrick

740-850 m Apr 77 2 adults
Governor's bush light 14, Stocking stream.

Scoparia sp. cf. philerga Meyrick

740-810 m Feb-Mar 2 adults
Governor's bush lights 13 and 14.

Scoparia sp. aff. scripta Philpott

810 m May 76 1 adult
Governor's bush light 13.

Scoparia sp. aff. trivirgata (Felder, Felder and Rogenhofer)

900 m Oct 76 1 adult
Red lakes track.
Swept ex Poa 1500 h.

Scoparia spp.

670-850 m Feb-Apr several adults

Scoparia spp. continued

Governor's bush light 14, Unwin hut, Village, Stocking stream.
To light, at least three species are in this group.

Pterophoridae - plume moths, larvae sometimes mining, later feeding exposed on plant stems.

Platyptilia falcatalis Walker

730-1500 m Dec-Apr 4 adults
In houses, Ball ridge, Ball road.
To light at night, flying during the day.
The larvae are associated with Hebe plants.
Also recorded by Philpott (1930) as several in Feb. Philpott also records three other species from Mt Cook - P. deprivatalis, Alucita monospilalis and Stenoptilia charadrias, all fairly common in Feb.

Pieridae - a sun loving tropical family.

Pieris rapae (L.) (white butterfly)

740 m Mar-Apr 77 2 adults
Governor's bush.
Ex thistle flower, ex bush edge.
The larvae of this introduced butterfly eat crucifers. Some of the cabbages in village gardens are possible host plants.

Nymphalidae - ("four" legged butterflies). The first pair of legs are rudimentary in the adult, larvae feed on plants.

PLATE 12 : *Argyrophenga antipodum* Doubleday (Lepidoptera : Nymphalidae) Hooker flats (740 m), 31 Jan 76, 1200 h.

Satyrinae - brown is the common colour in this subfamily.
The underwings are often cryptically coloured with streaks and spots, larvae feed mainly on grasses.

Argyrophenga antipodum Doubleday (tussock butterfly) (Plate 12)

670-850 m Oct-Apr 17 adults collected, many more observed.
Sealy range, Camp ground, Unwin hut, Red lakes track, Hooker valley.
Swept ex *Poa* 1200-1500 h.
Common throughout the South Island's alpine-subalpine *Poa* tussock areas. Also recorded at Mt Cook as common Dec-Jan by Philpott (1930).

Erebiola butleri Fereday (Butler's mountain ringlet butterfly)

1500 m Feb-Mar 9 adults collected, a few others seen.
Sealy range, Sefton biv ridge.
Associated with *Chionochloa* tussocks, adults only fly in sun (1200-1500 h). Philpott (1930) noted several specimens in Dec-Mar collected by Tillyard. Tillyard had collected "a good series of the rather local butterfly, '*Erebia*' *butleri*..." Philpott (1930). Philpott did not see any himself during his visits.

Percnodaimon pluto (Fereday) (black mountain ringlet butterfly) (Fig. 2)

1230-1830 m Dec-Apr 7 adults collected, several others seen.
West aspect Mt Wakefield, Haast ridge, Sealy range, Ball ridge, Wakefield spur.

Percnodiamon pluto continued

Swept ex screes, a strong flier and glider, difficult to net. The larvae feed on *Poa colensoi* (Gibbs, 1970). Walker (1978) notes that it is our hardiest native butterfly. The pupae are found under rocks, parallel to their surface, fifth instar larvae overwinter and pupate the following summer (Gibbs, 1970). Philpott (1930) recorded the species as fairly common in Dec-Jan but not seen in Feb (as *Erebia merula*).

In common with the above two species, *P. pluto* is confined to the South Island's mountain zones.

Nymphalinae

Bassaris gonerilla (Fabricius) (red admiral butterfly)

1160-2300 m Feb-Apr 3 adults collected, 1 other seen.

Tasman glacier, Mt Elie de Beaumont, Sealy range sticky trap 2, Liebig range.

Alive on snow (2130 m and 2300 m), observed gliding down from C. 2000 m Liebig range.

Recorded as common in Feb (as *Pyrameis gonerilla*) by Philpott (1930). Not common during the survey. The larval food plant *Urtica* (stinging nettle) occurs locally in shrublands in the park (Wilson, 1976). Known from throughout New Zealand, less common in recent years because of introduced pupal parasites (Miller, 1971). The native shield bug (*Cermatulus nasalis*) also attacks pupae, sucking out the body contents with its proboscis.

Lycaenidae - another mainly tropical butterfly family, larvae are often associated with ants.

Helleia salustius (Fabricius) (common copper)

(Plate 13)

730-1340 m Jan-Apr 14 adults collected, many others seen.
Governor's bush, Sealy range, Red lakes, Hooker flats, camp ground, Botanical spur.
Swept 1200-1600 h, Malaise (Sealy torn area).
Recorded as common in Jan and Feb by Philpott (1930) (as *Crysophanus sallustius*). The larvae feed on *Muehlenbeckia* spp. (Craw, 1975). Adults feed on flowers of *Muehlenbeckia* and *Hypochaeris*. Until recently the generic name was *Lycaena*, however, Sibatani (1974) has temporarily placed the "egnimatic isolated" New Zealand species in *Helleia* retaining the name "*Lycaena*" for the boulder butterfly only. Craw (1975) has stated that the two *Helleia* spp. (*H. salustius* and *H. feredayi* are sympatric, he also examined the behaviour of adults during their 7-10 day life span and found very low dispersal behaviour.

"*Lycaena*" *boldenarum* (White) (boulder copper)

740-1100 m Nov-Mar 10 adults collected, many more seen.
Hooker flats, Red lakes, Sealy torn track, Chalets, Village area, north face Mt Sebastopol, Mt Wakefield.
Swept ex tracks and scree, on water, ex tussock.
Common 1200-1500 h. Also recorded by Philpott (1930) (as *Chrysophanus boldenarum*). Abundant in semicolonised old river bed and scree areas. Probably associated with ants as well as *Muehlenbeckia*, its larval and adult food plant. Adults rarely fly very far above the ground (up to 30 cm maximum (Craw, 1975)).

PLATE 13 : Helleia salustius (Fabricius) (Lepidoptera : Lycaenidae) Hooker flats (740 m), 31 Jan 76, 1200 h.

Zizina otis oxleyi (Felder) (southern blue)

900 m Feb 77 1 adult
Godley valley.
Ex river bed plants.
Philpott (1930) recorded this species as common in Feb in the lower Hooker river bed. Noticeably absent in any numbers during the present survey. The depletion of the original larval food plant (native brooms - _Carmichaelia_ spp.) within the park and its neighbourhood by introduced sheep, cattle, rabbits and hares may have been a reason. Another larval food plant (introduced clover) is relatively common, so the present paucity of _Zizina_ is an enigma. According to G. Gibbs (pers. comm., 1979) _Z. o. oxleyi_ is "fascinatingly rare" in the Mt Cook area even though it is common in the Lake district further south.

Geometridae - a well represented family in New Zealand, caterpillars are often twig like and are commonly called loopers.

Ennominae

Declana egregia (Felder) (South Island lichen moth)

740-810 m Oct-Dec 15 adults
Governor's bush lights 13 and 14.
Restricted to the South and Stewart Islands, larvae on _Pseudopanax_. Philpott (1930) recorded 1 adult in Jan at the flowers of _Dracophyllum longifolium_.

Declana glacialis Hudson

820-1130 m Nov-Mar 3 adults collected, a few others seen.
Hooker valley, Hooker hut, Ball hut.
Flying quickly among _Dracophyllum_, several others were recorded by Philpott (1930) in Jan. Present

Declana glacialis continued

survey flight time records 1500-1530 h. Hudson (1928) noted that it had a "rushing headlong flight in sunshine towards sunset".

Declana hermione Hudson

730-740 m Oct-Nov 2 adults
Village area, Governor's bush light 14.
Hudson (1928) notes that it is a very rare species, not recorded by Philpott (1930).

Declana junctilinea Walker

670-850 m Jan-Apr 3 adults
Unwin hut, Village area, Stocking stream.
To light at night.
The larvae feeds intermittently on manuka during the winter (Hudson, 1928). Philpott (1930) recorded it as common in Feb.

Declana niveata Butler

740-1130 m Feb-Mar 8 adults
Governors bush lights 13 and 14, Ball hut.
The larvae feed on Hoheria (J. Dugdale, pers. comm.). Fairly common in Feb according to Philpott (1930).

One other species of Declana, D. floccosa Walker was recorded by Philpott (1930) "a few in February". The larvae of this species feed on Nothofagus (J. Dugdale, pers. comm., 1977).

Gellonia pannularia (Guénée)

740-810 m Feb-Mar 9 adults
Governor's bush lights 13 and 14.
The larvae is oligophagus on plants such as Gaultheria and Aristotelia (J. Dugdale, pers. comm., 1977).

Ischalis fortinata Guenee

810 m Dec-Feb 3 adults
Governor's bush light 13.
The larvae of this species feed on the moss *Polystichum vestitum* (Hudson, 1928). Philpott (1930) recorded this species as common Dec-Feb (as *Azelina fortinata*).

Pseudocoremia spp. formerly *Selidosema* spp. except for *S. suavis*.

Pseudocoremia ampla (Hudson)

740 m Apr 77 several adults
Governor's bush light 14.

Pseudocoremia berylia Howes

1130 m Apr 77 several adults
Ball hut area.
To light at night 2100-2400 h.

Pseudocoremia colpogramma Meyrick

740 m Apr 77 2 adults
Governor's bush light 14.

Pseudocoremia indistincta Butler

740 m Apr 77 several adults
Governor's bush light 14.
Philpott (1930) notes that this species was abundant in Feb. The larvae feed on *Astelia* and *Muehlenbeckia* (Hudson, 1928).

Pseudocoremia leucalaea (Meyrick)

740-810 m Feb-Mar 3 adults
Governor's bush lights 13 and 14.
The larvae feed on *Podocarpus* (Hudson, 1928). Philpott (1930) records adults as "several" in Jan-Feb.

Pseudocoremia melinata (Felder)

740-1130 m Mar-Apr 77 several adults
Ball hut, Governor's bush light 14.

Pseudocoremia monacha (Hudson)

740-810 m Nov-May 10 adults
Governor's bush lights 13 and 14.
The larvae feed on Phyllocladus. Philpott (1930) records the adults as fairly common Dec-Feb.

Pseudocoremia productata (Walker)

730-780 m Oct-Apr 5 adults
Governor's bush light 14, Sawyer stream, Village.
On wing 1100 h near Sawyer stream Nothofagus forest. Hudson (1928) states that the larvae feed on white rata (Metrosideros). Nothofagus is another food plant (J. Dugdale, pers. comm., 1977). Also recorded by Philpott (1930) as common Dec-Feb.

Pseudocoremia sp. indet. nr. productata

740 m Apr 77 1 adult
Governor's bush light 14.

Pseudocoremia spp. indet.

730-810 m Mar-Apr several adults
Village, Governor's bush lights 13 and 14.
Two or three species are in this group.

Selidosema suavis (Butler) (common forest looper)

750 m Oct-Nov 69 unknown number larvae and adults.
Hermitage area, larvae on trees and shrubs, probably including European larch.
Collected by H. Wilson, not recorded during the present survey. Formerly abundant in Dec (Philpott 1930). A polyphagous native that has

Selidosema suavis continued

become a pest of exotic pines (Emberson, 1976). Native host plants include Podocarpus spp. and various broadleaved shrubs. Hudson (1950) beat several small larvae out of Phyllocladus alpinus in Governor's bush in Jan 1945. He reared the larvae through to adults which emerged in May 45.

Zermizinga indocilisaria Walker (lucerne looper)

670-810 m Feb 75 6 adults
Unwin hut, Governor's bush light 13.
The larvae feed on lucerne and Discaria.

Larentiinae - adults have a distinct wavy line wing pattern, larvae feed on foliage, buds and flowers.

Asaphodes abrogata (Walker)

810-850 m Feb-Apr 2 adults
Kea point, Governor's bush.
Hand collected 1800 h Governor's bush.
Common in Feb during Philpott's (1930) visits.

Asaphodes cataphracta (Meyrick)

1200-1400 m Feb-Apr 4 adults
Green rock area Sealy range, Stocking stream.
Flying in mist 1200 h, on Celmisia coriacea flowers. Philpott (1930) recorded a few in Feb. The larvae feed on Chionochloa.

Asaphodes clarata Walker

740 m Mar-Apr several adults
Governor's bush.
Usually present in open grassy places (Hudson, 1928), Philpott (1930) recorded it as very common Jan-Feb. Not common during the present survey.

Austrocidaria callichlora (Butler)

810 m Feb 75 1 adult
Governor's bush light 13.
Philpott (1930) recorded 1 other adult from Governor's bush collected by S. Lindsay.
Larvae on Coprosma.

Austrocidaria praerupta (Philpott)

740 m Mar 77 1 adult
Governor's bush light 14.
The larvae feed on Coprosma (J. Dugdale, pers. comm., 1977).

Chloroclystis sphragitis Meyrick

C. 800 m Mar 70 unknown number
"Hermitage" area.
H. Wilson collection, the caterpillar feeds on Muehlenbeckia.

Dasyuris anceps (Butler)

1100-1400 m Feb-Apr 3 adults
Mt Wakefield, Red lakes, Sealy range.
Swept, under rock.
The larvae are thought to be associated with Aciphylla spp. (J. Dugdale, pers. comm., 1977).

Dasyuris callicrena (Meyrick)

1350 m Oct 76 1 adult
Sealy range.
Ex Chionochloa 1230 h.

Three other Dasyuris spp. were recorded by Philpott (1930) - D. austrina, D. transaurea and D. leucobathra, none of which were common.

Epiphryne charidema (Meyrick)

740 m Apr 77 several adults
Governor's bush light 14.
Larvae are associated with Dracophyllum (J. Dugdale pers. comm., 1977). Philpott (1930) recorded a few Jan-Feb.

Epiphryne undosata (Felder)

810 m Feb 11 adults
Governor's bush light 13.
The larvae are known to feed on Hoheria (J. Dugdale, pers. comm., 1977). Philpott (1930) recorded it as fairly common Dec-Feb.

Epiphryne xanthaspis (Meyrick)

740 m Feb 75 1 adult
Sealy range Kea point track.
Philpott (1930) recorded a few in Feb.

"Euchoeca" rubropunctaria (Doubleday)

740-1460 m Feb-Apr 2 adults
Ball ridge, Governor's bush.
The Ball ridge specimen was swept at 1800 h, the larvae feed on Haloragus and Geranium (J. Dugdale, pers. comm.).

"Eucymatoge" gobiata spp. cplx. (Felder)

740-1130 m Feb-Apr 17 adults
Governor's bush lights 13 and 14, Sawyer stream, Ball hut, Village.
One specimen taken 1100 h flying near Nothofagus forest (Sawyer stream), all other specimens to light. The larvae feed on Coprosma, Philpott (1930) found it common Dec-Feb.

Helastia spp. formerly in Xanthorhoe spp.

Helastia cinerearia grp. (Doubleday)

810-1130 m   Feb-Apr   several adults
Governor's bush light 13, Ball hut.

Helastia eupitheciaria Guenee

740 m   Mar 77   1 adult
Governor's bush light 14.
Philpott (1930) found this species common in Feb.

Helastia orophyla (Meyrick)

670 m   Mar 77   1 adult
Unwin hut to light.
Recorded by Philpott (1930) as common in Feb.

Helastia semifissata (Walker)

740 m   Mar   a few adults
Governor's bush light 14.
Record as common in Feb by Philpott (1930), Hudson (1950) gives details of its biology. Larvae are known to feed on daisies.

Helastia subobscurata (Walker)

810 m   Feb 76   1 adult
Governor's bush light 13.

Homodotis megaspilata Walker

740-810 m   Feb-Apr   a few adults
Governor's bush lights 13 and 14.

Lythria perornata (Walker)

900 m   Oct 76   1 adult
Red lakes track.
Ex dead bracken 1400 h.

Notoreas spp. an endemic genus, brightly coloured, day flying, mainly in mountainous regions.

Notoreas brephos (Walker)

740-2000 m Feb 2 adults collected, several others seen.
Nun's veil, south aspect, river beds of Tasman and Hooker valleys.
On snow, flying in sunshine amongst Epilobium.
Philpott (1930) recorded it as "not uncommon" Dec-Feb (as N. brephos and N. zopyra, Hudson (1928) combines the two species as one).

Notoreas omichlias (Meyrick)

1550 m Apr 77 1 adult
Sealy range Green rock area.
Flying in mist (1130 h) over Chionochloa, possibly visiting Gentian flowers.

Notoreas sp. cf. isoleuca Meyrick

1550 m Jan 77 1 adult
Sealy range.
Swept ex Chionochloa 0900 h.

Orthoclydon chlorias (Meyrick)

1130 m Mar-Apr several adults
Ball hut area.
To light at night, associated with Dracophyllum (Hudson, 1928).

Orthoclydon praefectata (Walker) (flax looper)

740 m Mar 76 a few adults
Governor's bush light 14.
The larvae feed on flax (Phormium) (Hudson, 1928, 1950).

Pasiphila "lunata" cplx. (Philpott)

810-1130 m Oct-Apr a few adults
Governor's bush light 13, Ball hut, Red lakes track.
On wing 1800 h Oct 76 ex Celmisia, Dracophyllum,

Pasiphila "*lunata*" cplx. continued

Chionochloa. The larvae probably feed on *Hebe* plants at night (Hudson, 1928).

Pasiphila melochlora (Meyrick)

800-850 m Dec-Apr several adults
Governor's bush light 13, Stocking stream.
The larvae feed on *Carmichaelia*. Philpott (1930) captured a few specimens Dec-Feb (as *Chloroclystis melochlora*).

Pasiphila paralodes (Meyrick)

740 m Apr 77 a few adults
Governor's bush light 14.
The larvae feed on *Hebe* at night (Hudson, 1928).

Pasiphila rubella cplx. (Philpott)

1130 m Apr 77 a few adults
Ball hut area.
Associated with *Hebe*.

Pasiphila sp. nr. *bilineolata* (Walker)

810 m Feb 75 3 adults
Governor's bush light 13.

Pasiphila sp. cf. *furva* (Philpott)

740 m Mar 77 3 adults
Governor's bush light 14

Poecilasthena pulchraria (Doubleday)

810 m Feb 75 2 adults
Governor's bush light 13.
The larvae are associated with *Leptospermum* and *Cyathodes*. Philpott (1930) recorded it as fairly common in Jan.

Tatasoma alta Philpott

730 m Nov 77 1 adult
Village.
To light in house.
Philpott (1930) records it as common in Jan.
The larvae feed on *Phyllocladus* (J. Dugdale, pers. comm., 1977).

Tatasoma apicipallida Prout

1700 m Nov 76 1 adult
Sefton biv.
On snow.

Two other species of *Tatasoma* were recorded by Philpott (1930), *T. topea* and *T. tipulata*, several of each in Jan.

"*Xanthorrhoe*" *stricta* Philpott

1130 m Apr 77 a few adults
Ball hut.
To light. The larvae feed on *Coprosma* (J. Dugdale pers. comm., 1977). Philpott (1930) recorded one in Feb.

Oenochrominae - some species in this subfamily have adults that rest with their wings and abdomens twisted, and resemble withered leaves. Larvae are phytophagous.

Dichromodes sp. nova ("*chevalier*" - horse rider)

3050 m Feb 77 1 adult female
Mt Malte Brun Cheval ridge.
Holding onto rock in crevice, first observed by Stella Sweney. A strong wind was blowing from the west. The wings (5 mm) are reduced on a dark grey body (7 mm). Eggs were

Dichromodes sp. nova continued

deposited in the tube after collection. The larvae of other Dichromodes spp. are associated with alpine lichens (Hudson, 1928). Hudson (1928) notes that the six described species are a homogenous endemic group derived from an Australian genus. D. sp. nova "chevalier" is probably a nival endemic. (Map 12)

Epirrhanthis alectoraria Walker

510 m   Feb-Mar   3 adults
Governor's bush light 13.
Associated with Pseudopanax and Griselinia (J. Dugdale, pers. comm., 1977). A single worn specimen in Jan was collected by Philpott (1930).

Epirrhanthis ustaria (Walker)

740 m   Mar-Apr   several adults
Governor's bush light 14, Village.
In house, the larvae feed on Coprosma (Hudson, 1928).

Epirrhanthis veronicae Prout

1130 m   Apr 77   a few adults
Ball hut area.
To light, the larvae feed on Hebe (J. Dugdale, pers. comm., 1977).

One other Epirrhanthis sp. (E. hemipteraria) was recorded by Philpott (1930), as a few in Jan-Feb.

Scopula rubraria (Doubleday)

2070 m   Feb 75   1 adult
Ball neve.
Stranded alive on snow (1430 h).
The larvae feed on Plantago, known also from Australia and the Kermadec islands (Hudson, 1928).

Arctiidae (Tiger moths) - some members of this family are capable of sound generation and reception. The mountain tiger moths *Metacrias* spp. have brightly coloured day flying males known from alpine regions. The female is flightless and nearly wingless. Philpott (1930) recorded a possible sighting of *Metacrias* sp. near Ball hut in Dec. No definite records were made and it may have been *Declana glacialis* (Geometridae) which has similar colourings, markings and flight.

Nyctemera annulata Boisduval (magpie moth)

760 m Apr 76 2 adults
Botanical spur.
In flight near ragwort (*Senecio jacobaea*).
An endemic representative of an Indo-Malayan genus, similar to some Australian members (Hudson, 1928). Philpott (1930) also found that numbers were few and far between.

Noctuidae - the largest Lepidopteran family, adults are nocturnal on flowers or "attracted" to lights. Cryptic, sombre colouring of the forewings aids concealment when resting during the day on or under bark, stones and plants. Larvae are phytophagous, usually polyphagous, again many are nocturnal while a few are stem borers. A few species have larvae predacious on some scale insects (Coccidae).

Agrotis ipsilon aneituma (Walker) (greasy cutworm)

730–2800 m Dec–Apr over 25 adults
Tasman saddle, Governor's bush lights 13 and 14, Mt Elie de Beaumont, Ball hut, Mt Footstool. On main divide snow 2000–2800 m Apr 76, Feb 77. Philpott (1930) recorded several other specimens (no date). An introduced insect with a widespread distribution (Australia, China, India, Africa, Europe, North and South America) (Hudson, 1928). Also recorded on neves in the park by Wilson (1972). Tomlinson (1973) showed how various weather patterns could cause descent eddies in the path of the main wind flow from Australia. Fox (1973, 1975) has made many records of insects from Australia arriving during such air flows. It seems likely that the *Agrotis* moths recorded in the park had arrived from Australian sources. Unconfirmed sightings of gum leaves were also noted by some Australian climbers near the neve moths (J. Lorenz, pers. comm., 1976).

Aletia, *Melanchra*, *Meterana* and *Graphania* spp. A large group of Noctuids. The ones placed in *Aletia* were stated by Hudson (1928) to have 8 more species in the South Island than the North. Dugdale (1971) revises this picture somewhat after the intensive recent collecting of Dr K.J. Fox in the North Island was taken into account. Dugdale (1971) placed at least 30 spp. of *Melanchra* into *Graphania* along with at least 1 species of *Aletia* ("*A.*" *nullifera*). Both *Melanchra* and *Aletia* are based on Palaeartic spp. and the continued use of their names was "invalid and biogeographically confusing" (Dugdale, 1971). *Aletia* has been retained for some species, *Melanchra* is not used and *Meterana* includes *Erana*.

Aletia agorastis (Meyrick)

670-740 m   Feb-Apr   several adults
Governor's bush light 14, Unwin hut.
Also recorded by Philpott (1930) as very common in Feb.

Aletia cuneata Philpott

740-1130 m   Mar-Apr   several adults
Governor's bush light 14, Stocking stream, Ball hut.
Philpott (1930) recorded 1 in Feb.

Aletia griseipennis (Felder)

670-1700 m   Oct-Apr   over 20 adults
Governor's bush lights 13 and 14, Godley, Unwin hut, Hooker hut, Malte Brun hut, Stocking stream, Ball hut.
On snow, on rock in stream bed 1700 h, to lights in huts 2000-2200 h. One pre-pupal caterpillar ex snow 1700 m Sealy Nov 76 emerged as adult 10 Dec 76.
Common, Philpott (1930) found it common in Feb.

Aletia longstaffi Howes

850-1130 m   Apr 77   several adults
Ball hut, Stocking stream
To light.

Aletia maya (Hudson)

740-1130 m   Mar-Apr   several adults
Governor's bush light 14, Ball hut.
Philpott (1930) recorded several Jan-Feb taken at flowers of Dracophyllum.

Aletia olivea (Watt)

740-1130 m   Apr 77   several adults
Governor's bush light 14, Ball hut.
Philpott (1930) recorded 1 in Feb.

Aletia pachyscia Meyrick

850-1130 m Mar-Apr 77 several adults
Stocking stream, Ball hut
To light.

Aletia plena (Walker)

740-810 m Oct-Apr several adults
Governor's bush lights 13 and 14.

Bityla defigurata (Walker)

710-740 m Mar-Apr 6 adults
Governor's bush light 14, Sawyer stream *Nothofagus*, Hooker corner *Nothofagus*.
Under bark dead standing trees during the day. The larvae feed on *Muehlenbeckia* (J. Dugdale, pers. comm., 1977). Philpott (1930) recorded 1 adult in Feb.

Graphania Hampson An endemic genus (Dugdale, 1971) restricted to the New Zealand Islands and some of the Subantartic Islands. Larvae are ground dwellers by day.

Graphania chryserythra (Hampson)

740-810 m Dec 75 Oct 76 3 adults
Governor's bush lights 13 and 14.
Hudson (1928) states that this is a very rare species known from Southland and Lake Wakatipu areas.

Graphania disjungens (Walker)

670-810 m Oct-Feb 3 adults
Governor's bush lights 13 and 14, Unwin hut.

Graphania furtiva (Philpott)

730-1900 m Jan-Apr several adults
Governor's bush light 13, Village, Mt Ollivier, Ball hut.

Graphania furtiva continued

The Mt Ollivier specimen was taken at light 2300 h from the summit. Philpott (1930) recorded it as fairly common Jan-Feb.

Graphania infensa (Walker)

730-810 m Nov-Dec 2 adults
Governor's bush light 14, Village.
To light.
The larvae is oligophagous (Gaskin, 1966).

Graphania insignis (Walker)

730 m Apr 76 4 adults
Village.
To light in house.
Not common, common elsewhere in New Zealand, the nocturnal larvae are polyphagous (Gaskin, 1966).

Graphania lignana (Walker)

740-1130 m Feb-Apr several adults
Governor's bush lights 13 and 14, Ball hut.

Graphania lithias (Meyrick)

670-740 m Mar several adults
Governor's bush light 14. Unwin hut.
Philpott (1930) recorded a few in Jan and 1 in Feb.

Graphania mitis (Butler)

670-1800 m Mar-Apr 12 adults
Governor's bush light 14, Unwin hut, Mueller hut.
To light, 1 adult to light 2130 h Mueller hut (1800 m) Mar 76.

Graphania moderata (Walker)

670-810 m Dec-Apr 6 adults
Governor's bush light 13, Village, Unwin hut.
Uncommon during the present survey.
Common in Jan-Feb as recorded by Philpott (1930), the larvae feed on *Raoulia* mats forming silk lined burrows among the roots (Hudson, 1950).

Graphania mollis (Howes)

740 m Mar 77 1 adult
Governor's bush light 14.

Graphania morosa (Butler)

740 m Apr 77 a few adults
Governor's bush light 14.
Recorded as common in Feb by Philpott (1930), common in central and eastern South Island on blossoms at night (Gaskin, 1966).

Graphania mutans (Walker)

670-810 m Oct-Apr over a dozen adults
Governor's bush lights 13 and 14, Village, Unwin hut.
Listed as common by Philpott (1930), the larvae are polyphagous (Gaskin, 1966).

Graphania nullifera (Walker) (great grey mountain moth)

670-1000 m Jan-Mar 10 adults 30 larvae
Unwin hut, Governor's bush, Sealy range, Gorilla stream, Stocking stream.
To light at night, dead in stream bed, larvae feeding on rotting and healthy plants of *Aciphylla scott-thomsonii*. Larvae can cause considerable damage to host plants. A few adults in Jan-Feb were recorded by Philpott (1930). The pupae overwinters. Common at times.

Graphania oliveri (Hampson)

740-1250 m Dec-Apr several adults
Governor's bush lights 13 and 14, Ball hut, Godley hut.
To light, ex spider's web Mar 76 Godley.
Nearly common. Recorded by Philpott (1930) as 1 in Jan and 2 in Feb at flowers of Dracophyllum longifolium.

Graphania omoplaea (Meyrick)

740 m Mar a few adults
Governor's bush light 14.
Kindly identified by Frank Chambers.

Graphania paracausta (Meyrick)

740-1130 m Oct-Feb 12 adults
Governor's bush lights 13 and 14, Hooker hut.
To light, Hooker hut 1130 m 2200 h Feb 77 (1), all others in an Oct 76 flight. Philpott (1930) recorded a few in Dec-Jan. Known from Southland near sea level and from alpine regions of the South and central North Island (Gaskin, 1966).

Graphania phricias (Meyrick)

670-1130 m Oct-Apr 45 adults
Unwin hut, Governor's bush lights 13 and 14, Ball hut light.
Common, however Philpott (1930) recorded only 1 in Feb.

Graphania rubescens (Butler)

740-1130 m Mar 77 14 adults
Governor's bush light 14, Ball hut, Stocking stream. Recorded as fairly common Jan-Feb by Philpott (1930).

Graphania sequens (Howes)

740-850 m Mar-Apr. 20 adults
Governor's bush light 14, Stocking stream.
On *Dracophyllum* flowers at dusk, common.
Philpott recorded it as very common in Jan.

Graphania temuenaula (Meyrick)

740 m Mar 50 adults
Governor's bush light 14.
Common in Mar.

Graphania ustistriga (Walker)

740-810 m Oct-Dec 10 adults
Governor's bush lights 13 and 14, Village.
In house 2200 h.
A few were recorded in Feb by Philpott (1930), the larvae have been recorded from a variety of host plants (Gaskin, 1966).

Graphania sp. nr. *xanthogramma* or *plena*

740 m Oct 76 3 adults
Governor's bush light 14.

Helicoverpa armigera conferta (Walker) (tomato fruit worm)

850 m Apr 77 a few adults
Stocking stream to light.
An introduced sp. noted for feeding on buds, inflorescences and fruits of both cultivated and wild plants (Miller, 1971). Not recorded by Philpott (1930).

Homohadena fortis (Butler)

900 m Dec 75 1 adult
Leibig range 1100 h.
The larvae feed on *Hymenanthera* (J. Dugdale, pers. comm., 1976).

<u>Ichneutica</u> <u>ceraunias</u> Howes

810 m Jan 76 1 adult
Governor's bush light 13.
The larvae feed on <u>Chionochloa</u> (J. Dugdale, pers. comm., 1976), a rare species with several varieties (Hudson, 1950).

<u>Ichneutica</u> <u>marmorata</u> (Hudson)

810 m Dec 75 1 adult
Governor's bush light 13.
Philpott (1930) also recorded 1 adult (in Jan).

<u>Ichneutica</u> sp. cf. <u>cana</u> or <u>fibrata</u>

1900 m Jan 77 1 adult
Mt Ollivier.
To light at 2300 h (Tilley lamp).

<u>Leucania</u> <u>semivittata</u> Walker

670-1000 m Dec-Feb 11 adults
Governor's bush light 13, Unwin, Gorilla stream, Liebig range.
One adult active in grass 960 m 1610 h N. aspect Leibig Feb 76. Several recorded by Philpott (1930). The larvae (armyworms) feed on grasses (J. Dugdale, pers. comm., 1976).

<u>Meterana</u> <u>asterope</u> (Hudson)

810 m Jan 76 1 adult
Governor's bush light 13.
Philpott (1930) recorded several in Jan.

<u>Meterana</u> <u>dotata</u> (Meyrick)

740-1130 m Oct-Apr 15 adults
Governor's bush light 14, Ball hut light.
The larvae feed on <u>Nothofagus</u> (J. Dugdale, pers. comm., 1977). Philpott (1930) recorded it as very common in Feb.

Meterana octhistis (Meyrick)

730-740 m Apr . 4 adults
Governor's bush light 14, Village.
Philpott (1930) recorded 1 in Jan.

Meterana pictula (White)

850-1130 m Mar-Apr several adults
Ball hut light, Stocking stream light.
The larvae feed on Pimelea (J. Dugdale, pers. comm., 1977).
Not recorded by Philpott (1930), similar to M. rhodopleura.

Meterana praesignis (Howes)

740-810 m Oct 76 7 adults
Governor's bush lights 13 and 14.

Meterana rhodopleura (Meyrick)

730-1130 m Mar-Apr 15 adults
Governor's bush light 14, Village, Ball hut light.
The larvae feed on Pimelea (Gaskin, 1966).

Meterana tartarea (Butler)

740 m Mar-Apr 10 adults
Governor's bush light 14.
Widely distributed in the South Island, Gaskin (1966) records adults on blossoms of rata.
Common in autumn.

Meterana vitiosa (Butler)

730 m Apr 76 2 adults
Village.
To light, the larvae feed on Coprosma (J. Dugdale, pers. comm., 1976).

Persectania aversa (Walker) (southern armyworm)

730-2000 m Oct-Apr 40 adults
Village, Governor's bush lights 13 and 14, Tasman glacier, Sefton biv ridge, Stocking stream, Ball hut.
To light, on snow (2000 m Feb 77), on wet plant 1700 h Feb 77.
The larvae feed on grasses including tussocks (Miller, 1971; Gaskin, 1966). One of New Zealand's most common moths and fairly common in the park. The winter is passed as a pupa (Gaskin, 1966).

Physetica caerulea (Guene)

670-740 m Oct and Feb 13 adults
Unwin hut, Governor's bush light 13.
Philpott (1930) recorded a few in Jan-Feb.

Tmetolophota atristriga (Walker)

740 m Mar-Apr a few adults
Governor's bush light 14.
The larvae feed on grasses (J. Dugdale, pers. comm., 1977).
Philpott (1930) recorded it as fairly common in Feb, usually common in Feb throughout New Zealand (Gaskin, 1966).

Tmetolophota lissoxyla (Meyrick)

850 m Apr 77 a few adults
Stocking stream.
To light.
The larvae feed on grasses (J. Dugdale, pers. comm., 1977).

Tmetolophota propria (Walker)

670-2000 m Feb-Apr over 20 adults
Unwin hut, Governor's bush lights 13 and 14, Stocking stream, Tasman glacier.
To light, on snow (2000 m Feb 77).
Relatively common in late summer.
Larvae feed on grasses, Philpott (1930) recorded it as common in Feb.

Tmetolophota steropastis (Meyrick) (flax notcher)

810-1130 m Feb-Apr a few adults
Governor's bush light 13, Ball hut light.
The larvae feed on Phormium leaves and toe toe grass (Miller, 1971). Not common in the park, but very common in other areas at times (Gaskin, 1966).

Tmetolophota sp. cf. arostis

850-1130 m Apr a few adults
Stocking stream, Ball hut.
To light.
An undescribed species near T. arotis, but with pectinate male antennae. Other specimens are known from N.W. Nelson to Fiordland from sub-alpine localities (in the National collection D.S.I.R. Auckland, J. Dugdale, pers. comm., 1977).

Hymenoptera (wasps, bees, ants)

An abundant order of insects with many parasitic members. They are notable for exploitation of nectar and pollen of flowering plants and organised forms of social life. A few are predatory and some are phytophagus. Many Hymenoptera were collected, most remain unidentified.

Symphyta

Siricidae - females normally lay eggs in dead or weakened trees, the larvae have symbiotic associations with wood-rot fungi.

Sirex noctilio (F.) (sirex wood wasp)

670-760 m Dec-May 2 adults several larvae
Foliage hill, White horse hill, Village area, Unwin hut.
In exotic pine stumps, common as larvae in logs of European Larch at Unwin hut. These logs were from Ferintosh Station at the head of Lake Pukaki and are used as firewood.
An introduced pest of all pine tree species, but basically a secondary invader of trees stressed by drought or disturbance (Emberson, 1976).
Several parasites check the growth of sirex in pine plantations. Not recorded from native trees within the park, but the introduction of larvae in logs from outside the park is not recommended because of the danger to native conifers.

Ichneumonidae - a large, diverse, parasitic wasp family. Adult females lay eggs in larvae and pupae of various insects; immature and adult spiders; and pseudoscorpions. Moist conditions are favoured for adult flight. Many ichneumonids were taken during the survey, most are unidentified.

Aucklandella pyrastis Cameron

810 m Mar 76 1 adult
Governor's bush.
Swept 1600 h.
The host is *Selidosema suavis* (Geometridae-Lepidoptera) larvae (E. Valentine pers. comm., 1976).

Australophion peregrinus (Smith)

670-900 m Dec-Apr 50 adults
Unwin hut, Governor's bush lights 13 and 14, Hooker.
Mostly to light at night, 1 was taken (1630 h) on *Ranunculus lyalli* flowers. Common in light traps at times (Mar-Apr), generally distributed throughout New Zealand (Parrott, 1954). Two peaks of abundance were noted by Parrott (1954) one in Dec and one in Apr.

Degithina solicitorus (F.)

740 m Mar 20 adults
Hooker flat.
Swept ex tussock.
Common in Mar.

nr. *Lissonota flavopicta* Smith

700-1920 m Jan-May 10 adults
Ball ridge, Blue stream, Liebig, Red lakes, Stocking stream, Wakefield spur.
Swept, malaise, associated with *Coriaria* and *Cassinia*.

nr. *Lissonota flavopicta* continued

A parasite of moth larvae (E. Valentine, pers. comm., 1976).

Netelia sp.

730-810 m Mar-Apr 4 adults
Governor's bush lights 13 and 14.
Ex house light.
Miller (1971) illustrates *N. producta* (Brulle) and states that it parasitises various caterpillars.

Braconidae - another parasitic hymenopteran family, similar to ichneumonids in appearance and habit. Most remain unsorted.

Genus and species indet.

740-1100 m Nov 18 adults collected, many others seen.
Foliage hill, Red lakes, Village.
Swept ex *Podocarpus nivalis*, reared ex *Catamacta alopecana* (Tortricidae-Lepidoptera) a leaf tying caterpillar among *Phyllocladus alpinus* cladodes. (Collected pupae 11 Nov 76 emerged 18 Nov 76.)

Gasteruptiidae - long thin wasps parasitic in nests of bees and wasps. Adults are common flying close to clay banks, tree stumps and other nesting sites of their hosts. The wings remain coupled, so the forewing is folded longitudinally when at rest.

Pseudofoenus pedunculatus Schlett

950 m Jan 76 1 adult
Red lakes track.
Swept ex gravel and clay bank; in hot sun 1200 h.

<u>Pseudofoenus</u> <u>pedunculatus</u> continued

A parasite of native bees (B. Donovan, pers. comm., 1976).
An endemic genus, Tillyard (1926) states it is 'very common'.

Apocrita

Diapriidae - small species (1-6 mm) from damp situations, parasitic on larvae and pupae of Diptera, Coleoptera and Lepidoptera. Wing venation is reduced.

Ambostrinae

Genus and species indet.

810 m Mar 3 adults
Governor's bush pit 13.

Belytinae

Stylaclista sp.

765 m Apr-May 77 3 adults
Botanical spur 11 Malaise trap.

Diapriinae

Trichopria sp.

1160 m Feb 76 1 adult
Stocking stream.

Malvina sp.

800-810 m Mar 76 2 adults
Blue stream, Governor's bush pit 13.
Swept 1600 h Blue stream.

Spilomicius sp.

1100-1600 m   Mar-Apr   3 adults
Red lakes, swept Sealy range, west aspect.

Scelionidae - small species that parasitise the eggs of arthropods. Most adults are collected from leaf litter.

Genus and sp. indet.

1580 m   Feb 75   1015 h   1 adult
Ball ridge, on arm.
A possible parasite of grasshopper eggs.

Genus and sp. indet.

1800 m   Feb 77   1500 h   1 adult
West ridge, Mt D'Archiac.

Genus and sp. indet.

810 m   Nov-Mar   5 adults
Governor's bush pit 13.

Genus and sp. indet.

800 m   Mar 76   1 adult
Governor's bush swept.

Platygasteridae - very small (1-3 mm), usually shiny black parasites.

Genus and sp. indet.

740 m   Mar 77   1 adult
Governor's bush, ex cut branch.

Genus and sp. indet.

1340 m   Mar 77   1 adult
Sealy.
Malaise.

Proctotrupidae - small (3-10 mm) usually shiny black parasitic wasps, remarkable in that the mandibles have no teeth. Coleoptera are their hosts.

Fustiserphus intrudens (Smith)

1100 m   Mar 76   1 adult
Red lakes.
Swept, White (1964) recorded it as fairly common at Cass Nov-Apr.

Genus and spp. indet.

800-1500 m   Jan-Mar   4 adults
Stocking stream, Sealy, Blue stream, Reay.
Swept 1200 h, Swept 1600 h, Malaise.

Eulophidae - small (103 mm), parasites of scales, some are plant gall formers.

Genus and sp. indet.

1340 m   Mar 77   2 adults
Sealy.
Malaise.

Pteromalidae - parasites and gall formers.

Genus and sp. indet.

1100 m   Mar 77   3 adults
Red lakes.
Malaise.

Genus and sp. indet.

1160 m   Feb 76   1 adult
Stocking stream.
Swept.

Pompilidae (spider hunters) - females have a powerful sting, a large family with active predatory habits. Paralysed spiders are provision for each nest, which is usually in the ground. When prey is secured the female wasps usually drag the spider to the nest by walking backwards.

<u>Priocnemis</u> <u>carbonarius</u> Smith

950 m Jan 76 1 adult
Red lakes.
On track.

<u>Priocnemis</u> <u>nitida</u> (F.) (golden hunting wasp)

850-900 m Mar 76 2 adults
Red lakes track, source Blue stream.
Swept ex moss and rock 1830 h, swept ex track 1800 h.
Not common. Miller (1971) supplies an excellent colour illustration of this striking golden brown wasp.

<u>Priocnemis</u> <u>nitidiventris</u> (Smith)

830-1930 m Dec-Apr 4 adults
Murchison, Liebig, Rutherford stream.
Swept ex sand 1100 h, ex <u>Dracophyllum</u>, ex St John's wort, under stone.

<u>Priocnemis</u> "<u>ordishi</u>" Harris ms.

765-850 m Oct-Nov, Apr-May 5 adults
Botanical spur, West Hooker, Black birch stream.
Swept, ex pit trap.

Vespidae - social wasps.

<u>Vespula</u> <u>germanica</u> (F.) German wasp

670 m Feb 75 1 adult worker
Unwin hut.
Swept.

Vespula germanica continued

Not common in the park, a real problem at times elsewhere, Miller (1971) provides details of its social life. An introduced species, it became established in the early 1950s.

Sphecidae - predatory wasps, usually black with simple body hairs. Most have specific prey, a few are general predators.

Rhopalum spp. (policeman wasps)

750-1340 m   Dec-Mar   6 adults
Sealy tarn, Leibig, Separation stream, Village.
Swept ex bare flat ground, ex *Aciphylla* flowers malaise.

Genus and sp. indet.

1600-1650 m   Feb 77   2 adults
West ridge Mt D'Archiac.
Swept ex *Chionochloa*.

Apoidea - basically sphecoid type wasps that use pollen rather than insect or spider prey as a protein source for their larvae.

Apidae - pollen carrying social bees, such as bumble bees and honey bees. No honey bees (*Apis* sp.) were recorded in Mt Cook National Park during the survey. Two species of drone flies (Syrphidae-Diptera) may be mistaken for bees as they look and sound similar to honey bees. Some distributions are shown in Map 11.

Bombus hortorum (L.) small garden bumble bee

670-1250 m Dec-Apr 6 adults
Unwin hut, Birch hill, Village, Liebig range.
In houses, on flowers of thistles (one at 0730 h Apr 77), the highest record was from the Leibig range. Not common.
Of the four introduced *Bombus* spp. in New Zealand *B. hortorum* is mainly confined to Canterbury and is common in the vicinity of towns and cities (Macfarlane, 1976).
A possible pest in that it pollinates undesirable plants such as thistles.

Bombus terrestris (L.) large earth bumble bee

670-2500 m Nov-Apr 27 adults
Leibig range, Hooker flats, Governor's bush, Sealy range, Red lakes, Unwin hut, Nuns Veil, Murchison forestry hut, West bank Godley river, Ball hut road, Governor's bush pit 14.
Swept from grass, thistles and shrubs. On flowers of thistles, *Carmichaelia*, *Dracophyllum* and White clover. Four queens were recorded from one pit pot in Governor's bush. The pot was at the base of a dead tree on the northern side. The highest record was on snow at 2500 m, 1200 h Nuns Veil Feb 76. The next highest record was at 1700 m in the Liebig range near Ailsa pass, 1130 h, Mar 76 north aspect on *Dracophyllum* flowers. Common below 1000 m.

Colletidae - short tongued native bees, moderate size and hairy. Burrows are made in clay type soils; the middle and hind femora have well developed pollen carrying hairs. The family contains no social species and very few parasitic ones. Their cells are lined with a cellophane like substance applied by the female. Australia has many species in this group. The Colletidae can be described as solitary but gregarious, that is each cell is serviced by only one female, many females may of course be working adjacent to each other in a suitable nest area.

Hylaeus spp. (yellow faced bees) not very densely haired and lacking special hairs on the hind legs for pollen. The pollen is carried in the mouth, into which it is brushed by the foreleg (Miller, 1971). Nest places are usually in hollow plant stems.

Hylaeus capitosus (Smith)

800-1200 m Feb 10 adults
Separation stream, Rutherford stream.
Malaise trap, swept.
Apparently common in the Godley valley.

Hylaeus relegatus (Smith)

750-1200 m Feb-Mar 13 adults
Red lakes, Hooker, Separation stream.
Ex *Hebe* flowers, swept, malaise.
Nearly common.

Leioproctus spp. (hairy colletid bees) a major group of bees with many Australian spp. and others from New Guinea, New Caledonia, a few from New Zealand and a large group from South America (Michener, 1965).

Leioproctus fulvescens (Smith) (Plate 14)

950-1220 m Jan-Feb 20 adults
Red lakes track, Liebig, Sefton biv ridge.
Ex flowers *Celmisia coriacea*, swept ex nest site 1600 h N.E. aspect bare ground Liebig range Feb 76, swept ex track.
Common in mid summer.

Leioproctus hiwiihu Donovan

1900-2000 m Feb 76 3 adults
Sealy.
On snow 1300 h (moribund).

Leioproctus sp. nr. *imitatus* Smith

750 m Jan 76 several adults
Village helipad.
Ex nest holes in bare ground (1630 h).

Leioproctus lincolni? Donovan

800 m Feb 76 2 adults
Murchison.
Pooter from *Hebe* flowers.

Leicoproctus monticola Cockerell

1000 m Feb 77 2 adults
Hooker.
Ex *Hebe* flowers.

Leioproctus nuipeka Donovan

800-1770 m Jan-Mar 10 adults
Ball ridge, Sefton biv ridge, Sealy tarn, Godley, Malte Brun hut, Reay, Stocking stream.
On tarn, ex flowers *Celmisia coriacea* 1200 h, swept 1100 h ex St John's wort, malaise.
Common in alpine areas in Feb.

PLATE 14 : Leioproctus fulvescens (Smith) (Hymenoptera : Colletidae) ex. Celmisia coriacea flower 1200 h Sefton biv. ridge (1220 m) Feb 76.

Leioproctus runga Donovan

800 m Feb 69 a few adults
Hooker.
Swept during Lincoln Ent. Dept. field trip.

Halictidae ("sweat" bees) - smooth flower haunting bees usually smaller than colletids. Nests are usually in the ground, less commonly in rotten wood (Michener, 1965). Several females may jointly occupy a single nest giving a semisocial habit. Some adults are attracted to sweating bodies.

Lasioglossum spp. (N.Z. halictid bees) important native plant pollinators.

Lasioglossum maunga Donovan

700-1500 m Oct-Feb 22 adults
Sealy, Hooker, Wakefield track, Blue stream, Red lakes, Blue lakes, Reay.
Ex Hypochaeris radicata flowers, ex Ranunculus lyalli flowers, ex Aciphylla flowers, ex Anisotome flowers (1100-1330 h).
Malaise.
Very common, nearly as abundant as L. sordidum.

Lasioglossum sordidum (Smith)

730-1400 m Oct-May 30 adults
Red lakes, Sealy, Liebig, Wakefield track, Blue stream, Hooker, Village, Blue lake.
Malaise, swept stream edge, on track, ex Chionochloa, ex ant swarm, ex pool, ex flowers of - Aciphylla, Hebe, Ranunculus lyalli (1100-1430 h).
The abundant bee, common on Ranunculus lyalli flowers.

Formicidae (ants) - social insects, colonies consisting of winged male, winged or deciduously wingless female, and wingless neuter-female worker castes. Some workers are specialised 'soldiers' with larger heads and mandibles. Workers may sting. The majority of ants have a nodal or binodal "waist" where the abdomen attaches to the thorax. Virgin queens bear wings and in species with winged males mass mating flights take place. After copulation males die, females shed their wings when founding another colony. Established nests may have from one to several laying queens, a multiplicity of queens is an advantage if one dies. This is in contrast to honey bee colonies where only one laying queen is the norm.

Chelaner antarticus (White) (southern ant)

700-1700 m Oct-May 1 winged queen, 9 winged males, 150 workers, plus larvae.
Ailsa pass, Liebig pit 8, Wakefield spur, Sealy pit 1, Sealy sticky 2, Ball hut, Sawyer stream, Botanical spur, Copland ridge, Hooker flats, Red lakes, Kea point track.
Malaise, ex *Placopsis* lichen, under stones, swept ex *Poa*, ex litter, on snow.
The queen was recorded ex sticky trap Mar 75, the males were recorded ex malaise trap Mar 77, on snow May 77 and swept ex scrub 1245 h Apr 76. Very common, a variable and widespread species in New Zealand, two colour forms are known - an orange one and the one recorded here was the darker blackish form. *C. antarticus* is thought to be a species complex (Brown, 1958). Food is honeydew excretions from both subterranean and

Chelaner antarticus continued

aerial plant sucking insects. The caterpillars of the boulder copper (*Lycaena boldenarum*) may also excrete nourishing fluids (Miller, 1971). During prolonged drought it gathers and stores seeds (Miller, 1971).

Huberia striata (Fr. Smith) (striated ant)

670-980 m Oct-Feb 18 winged females, 800 winged males, 60 workers plus larvae.
Red lakes track, edge Governor's bush, Blue lake, Hooker, Unwin hut.
Under rocks ex large swarm Blue stream 17 Nov 76 - many winged males and only 1 winged female collected. The other 17 females were under a stone amongst *Muehlenbeckia*. Other plant associations - *Celmisia*, *Dracophyllum*, *Discaria* and *Poa*.
Common, at times locally abundant, widely distributed in New Zealand. A general feeder and homopterans are kept in the populous colonies (Brown, 1958). Small native slaters are also 'housed' (Miller, 1971). The genus is peculiar to New Zealand (Tillyard, 1926).

CHAPTER 5

DISCUSSION

5.1 General Features of the Fauna

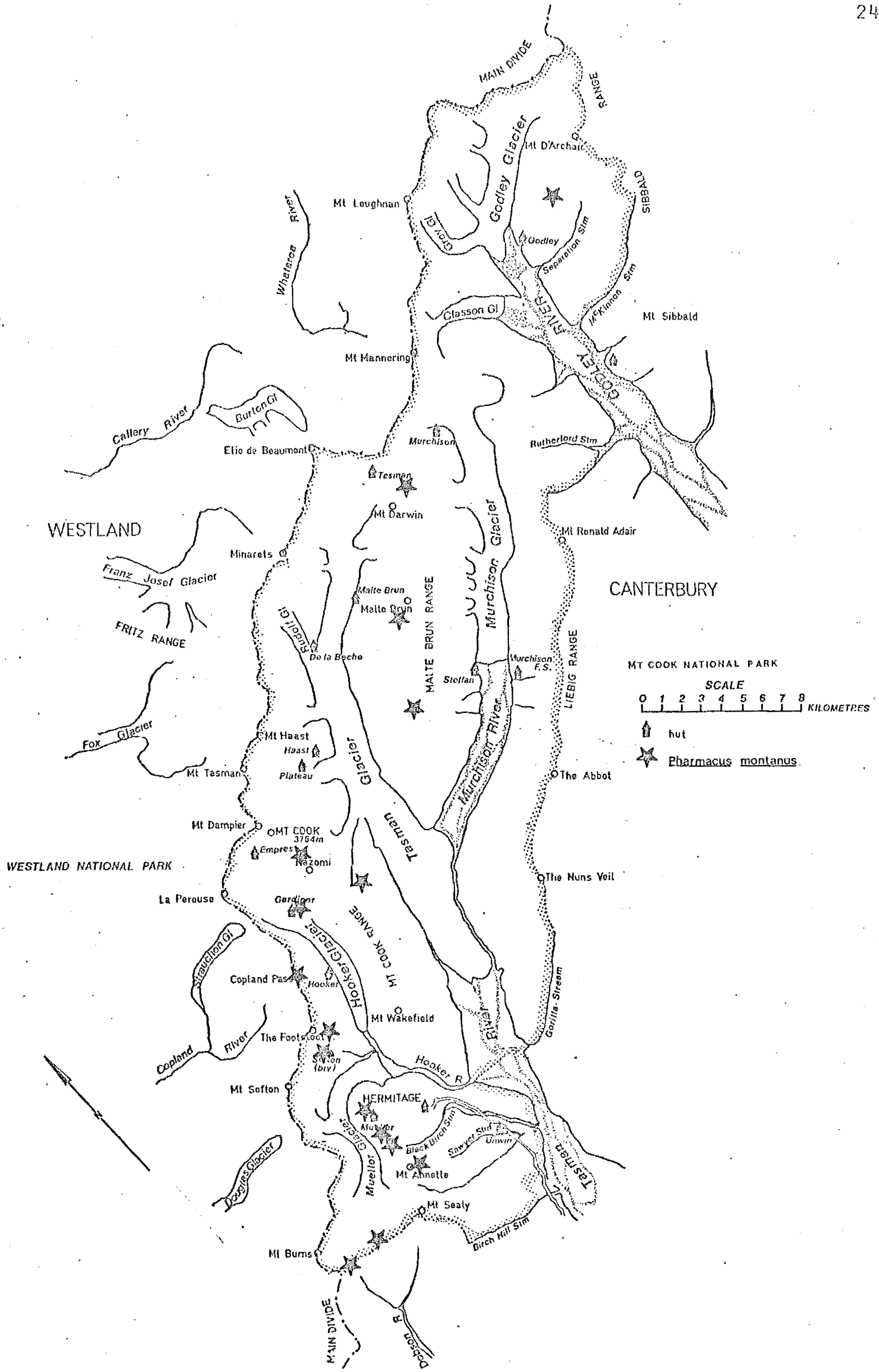
Generally the insect fauna varies with vegetation types. The montane tussock grassland areas of the valley floors have a generalised fauna typical of such areas elsewhere, for example Cass where White (1964) found many insects that are also common at Mt Cook. The Noctuidae, Hepialidae, Pyralidae and Satyridae are Lepidopteran families with many genera from tussock areas. *Orocrambus*, *Scoparia*, *Graphania*, *Wiseana* and *Argyrophenga* are the common genera from these families. Two other insect orders that are conspicuous elements in the lower tussock grasslands are the Diptera and Hymenoptera. Both of these orders have numbers of parasitic genera with Lepidopteran hosts. Amongst the Coleoptera the scarab genus *Costelytra* stands out by its very low numbers, however, the related genera *Odontria* and *Pyronota* have several species in the montane tussock vegetation. *Hemideina maori* (Orthoptera) was common under rocks in tussock areas which contrasts with the low numbers of wetas found at Cass.

The two main forest areas of the Mt Cook Park are Governor's bush and Botanical spur. Birch Hill stream, Mt Hodgkinson and Sawyer stream have important *Nothofagus* remnants as well, but unfortunately both the flora and fauna are being damaged by sheep and cattle. Within these forest remnants many important insect groups are found in some numbers. Coleoptera are a common insect order in the forests, Cerambycidae, Lucanidae, Carabidae and Curculionidae are some of the important families. Geometridae and Noctuidae (Lepidoptera) have many forest feeding larvae.

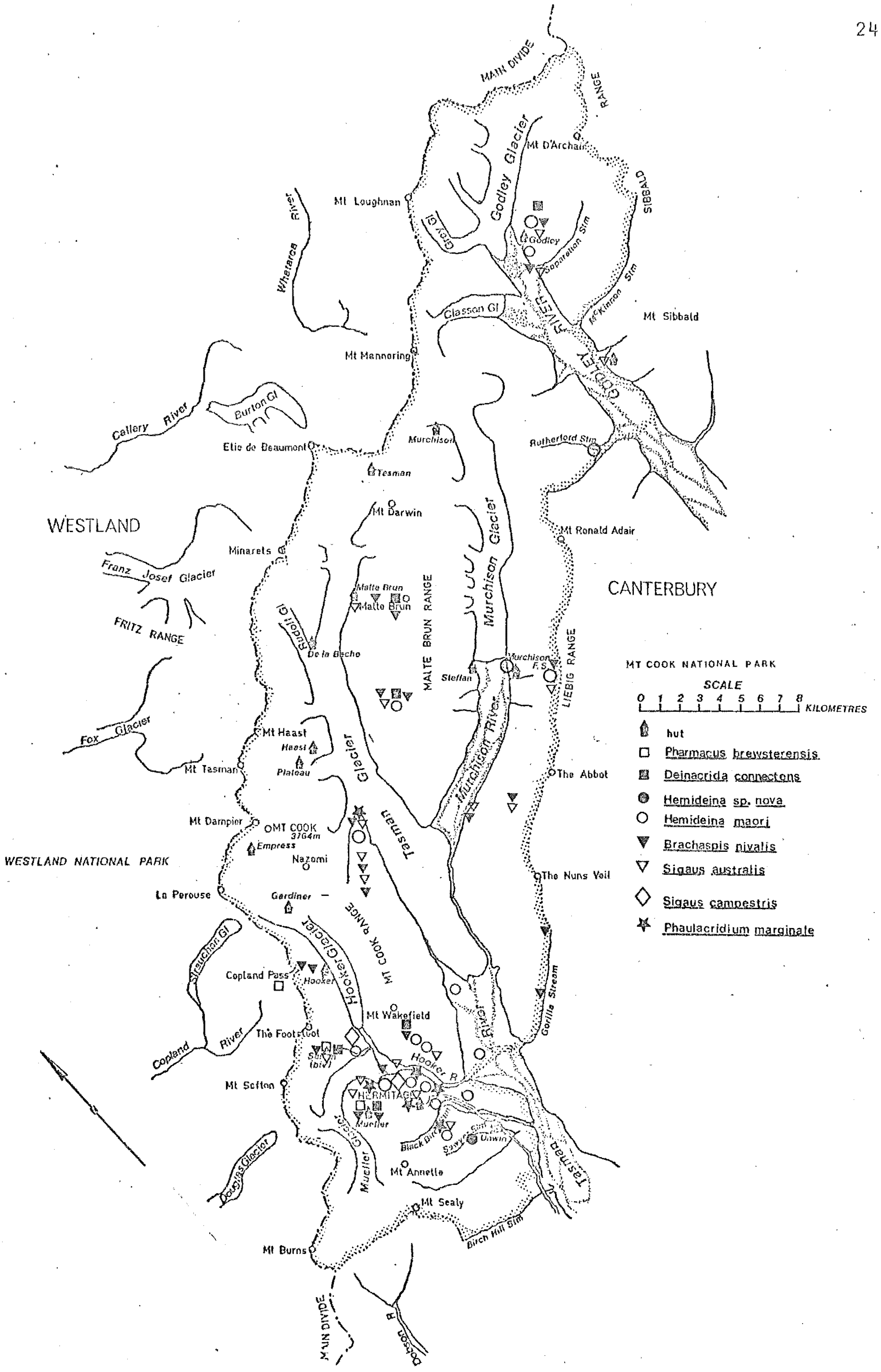
The subalpine scrub is a major vegetational type at Mt Cook. It has been much modified in the last century by fires, some recent, thar, chamois and sheep, some still present. Most insect orders are found in the scrub, and as in other vegetational zones, some species are harmful to the vegetation and others are beneficial. Probably the widest variety of insects at Mt Cook occurs in this zone.

Above the scrubline the alpine tussocks contain many insect species not found at lower levels, Pyralidae, Satyrinae, Carabidae, Tachinidae, Curculionidae and Ichneumonidae are particularly noticeable groups. Up in the nival zone, above the summer snowline, several new species (Tachinidae, Carabidae, Geometridae and Rhaphidophoridae) represent part of a unique endemic nival element, not necessarily confined to the Mt Cook area, but certainly to altitudes above 1800 m.

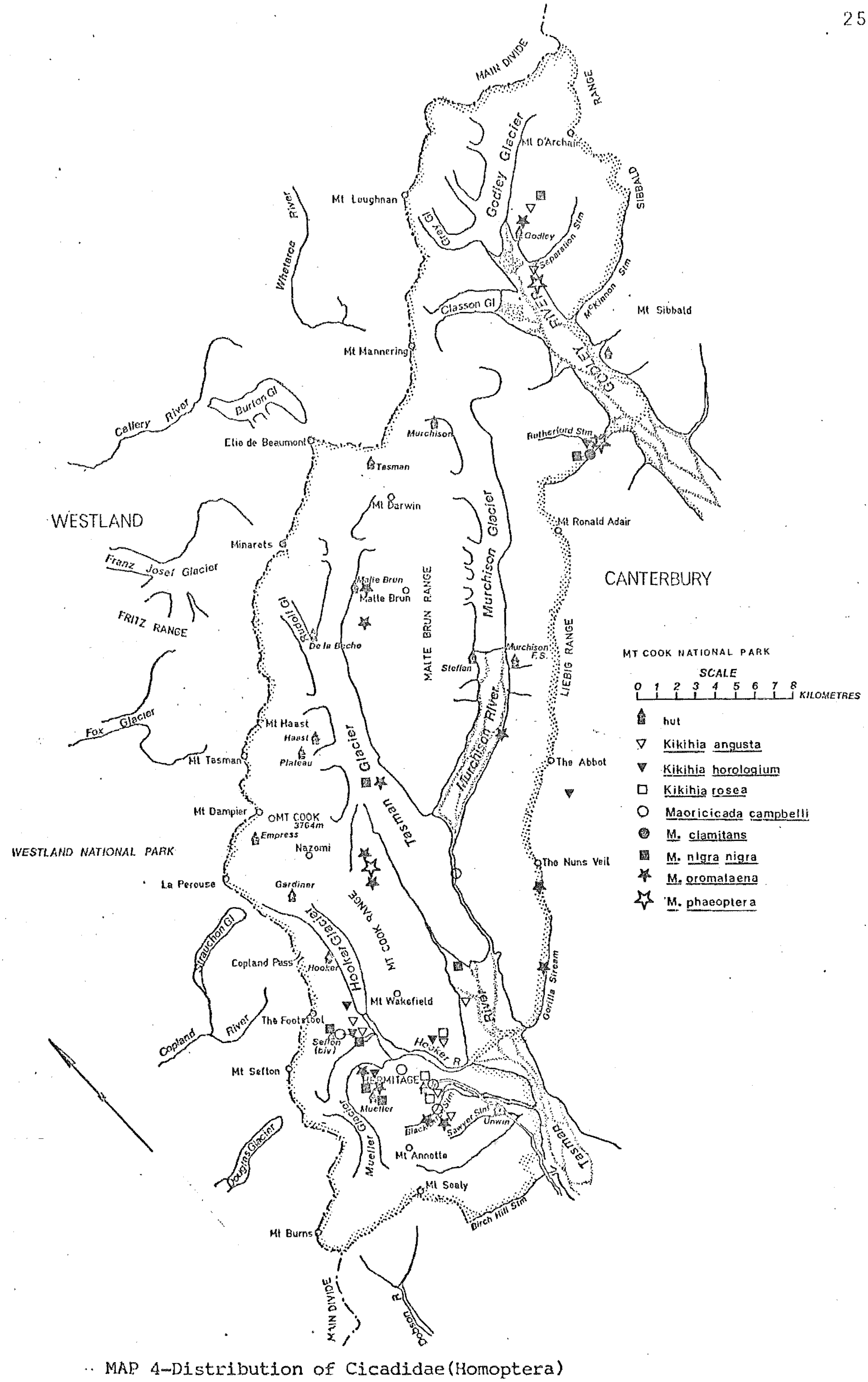
Distributions of some of the insects are presented in Maps 2 - 12.



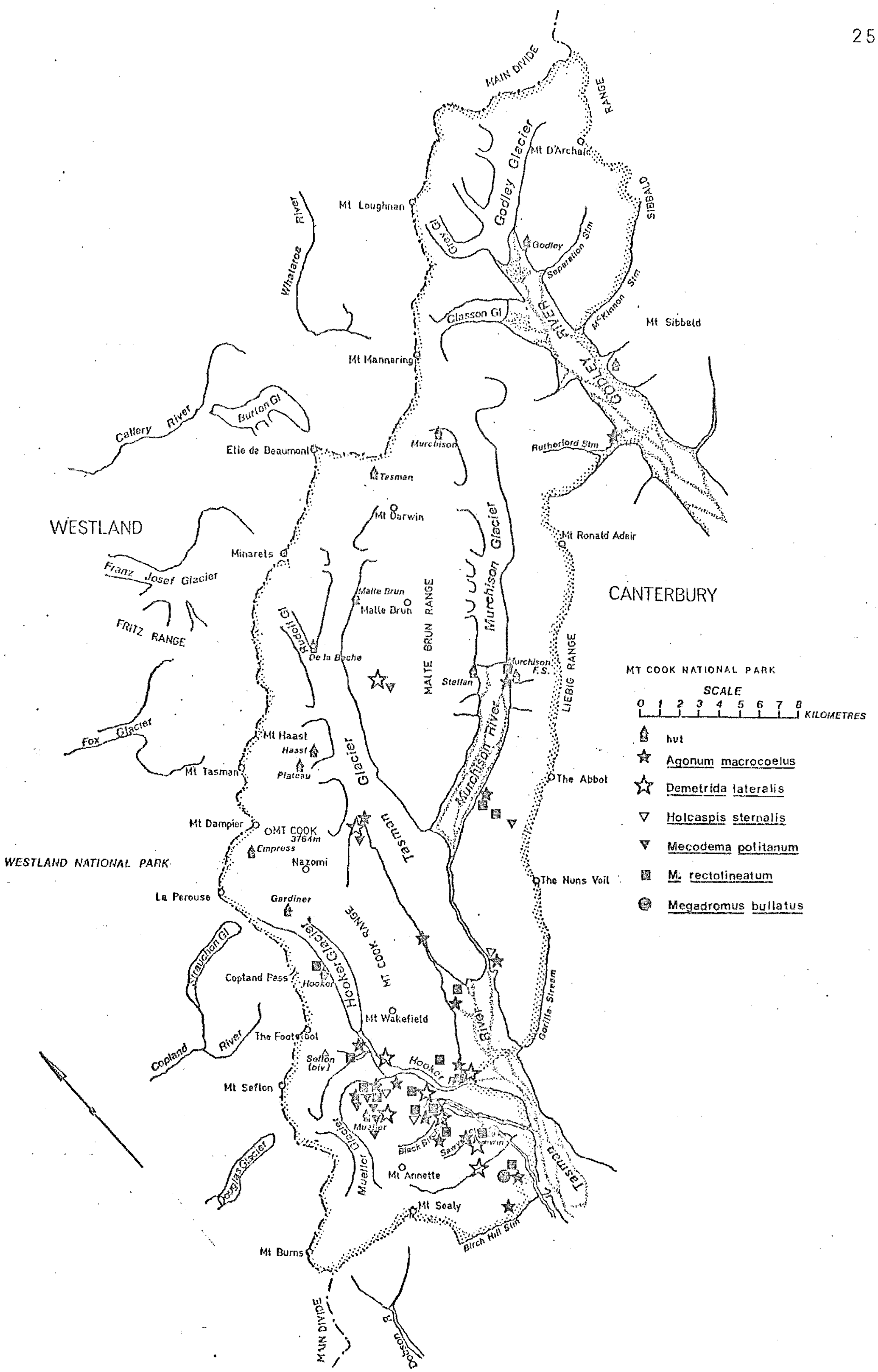
MAP 2- Distribution of Pharmacus montanus, the Mt Cook flea
(Orthoptera:Rhaphidophoridae)



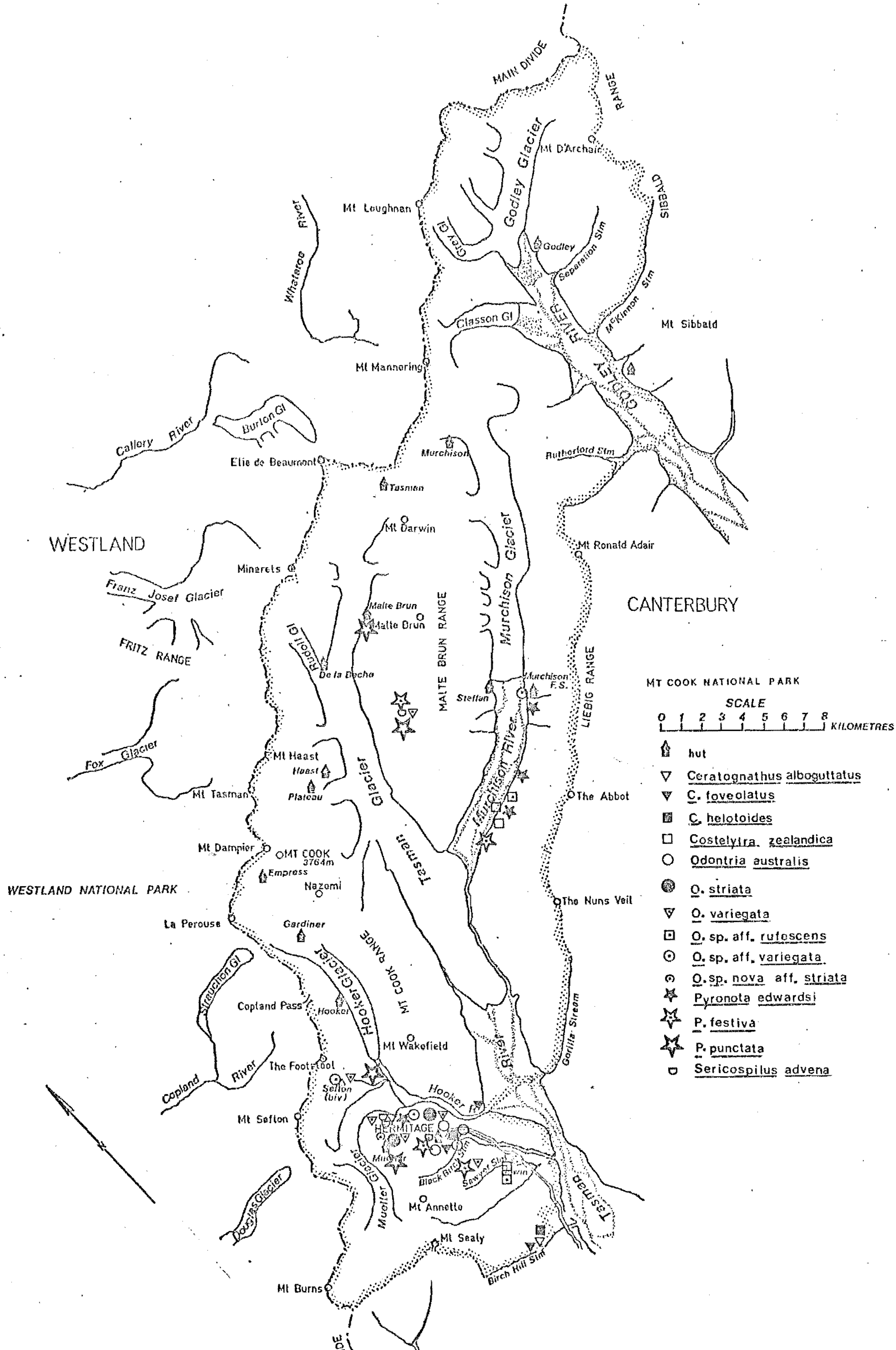
MAP 3- Distribution of some other Orthoptera-grasshoppers(Acrididae) and wetas(Stenopelmatidae,Rhaphidophoridae)



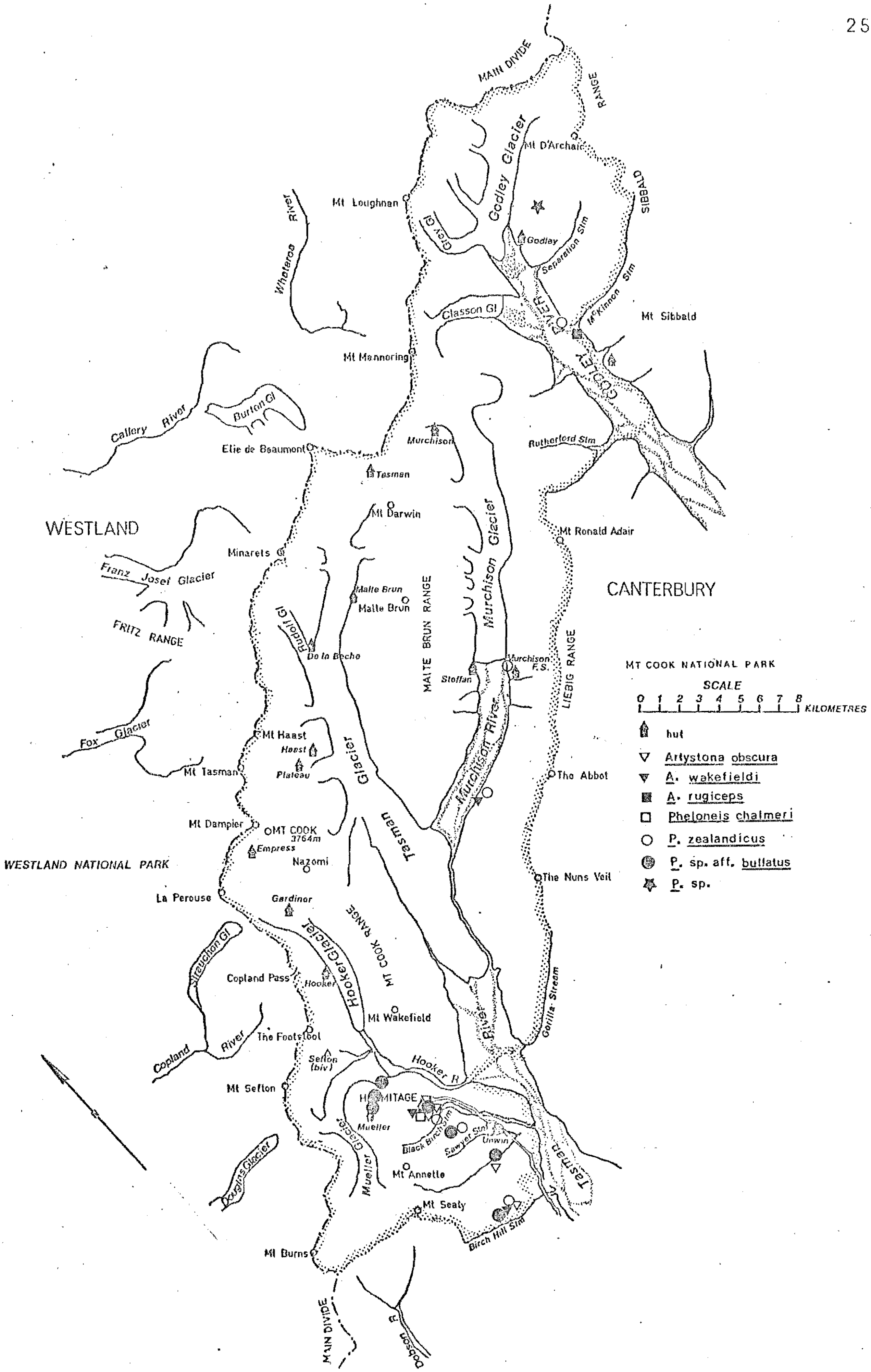
MAP 4-Distribution of Cicadidae(Homoptera)



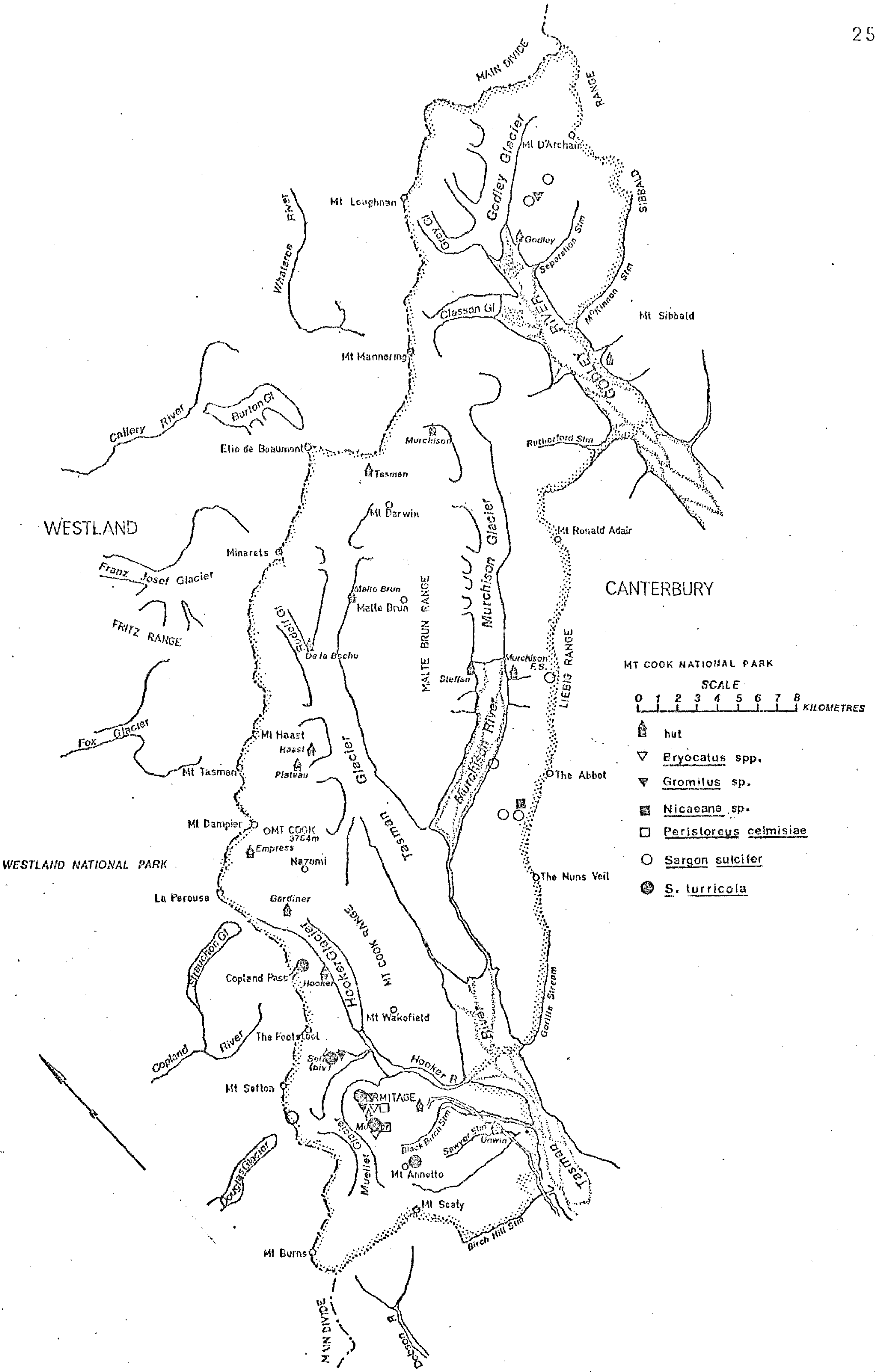
MAP 5 - Distribution of some Carabidae (Coleoptera)



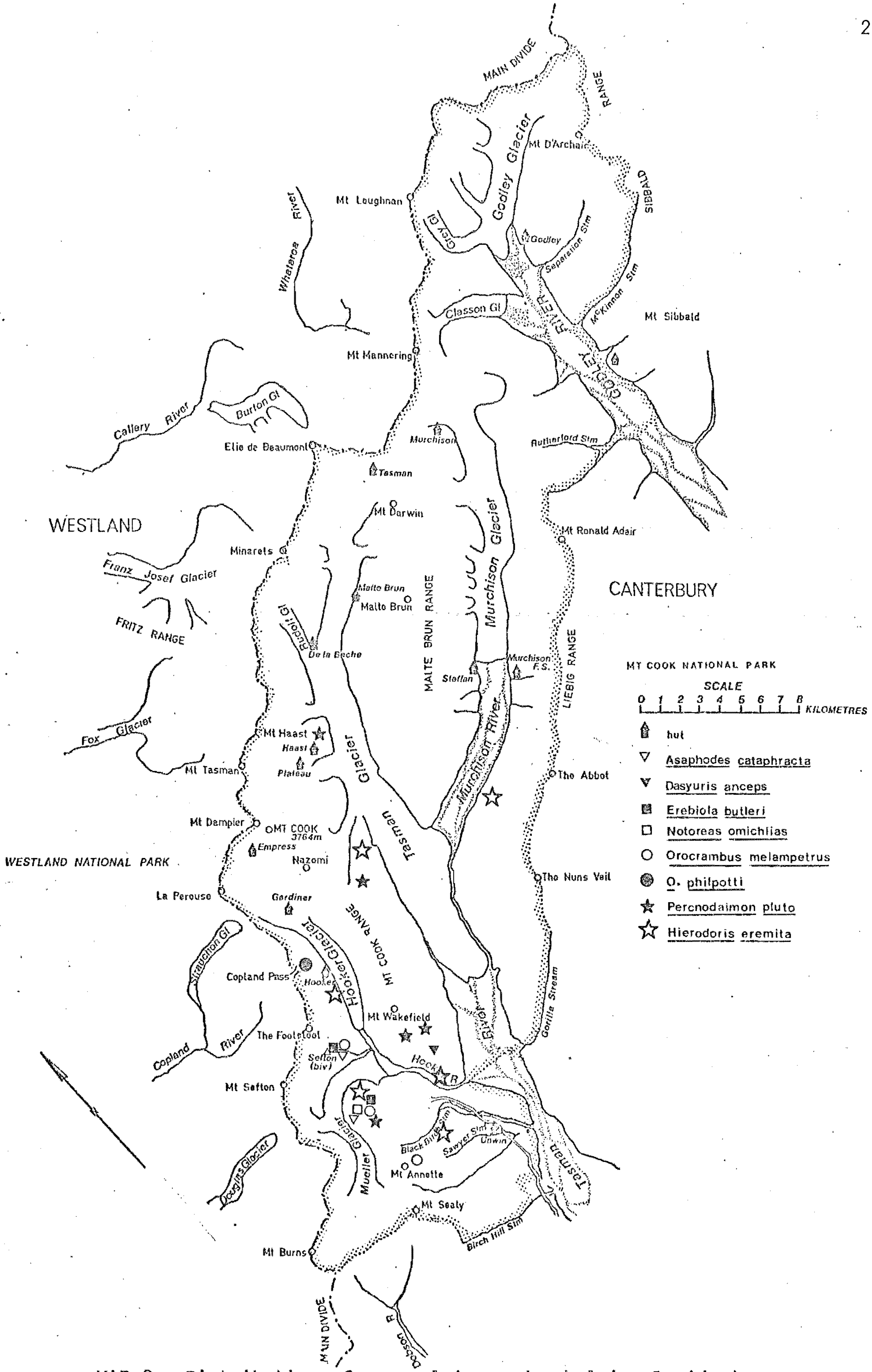
MAP 6 - Distribution of some scarab and stag beetles
(Coleoptera: Scarabaeidae, Lucanidae)



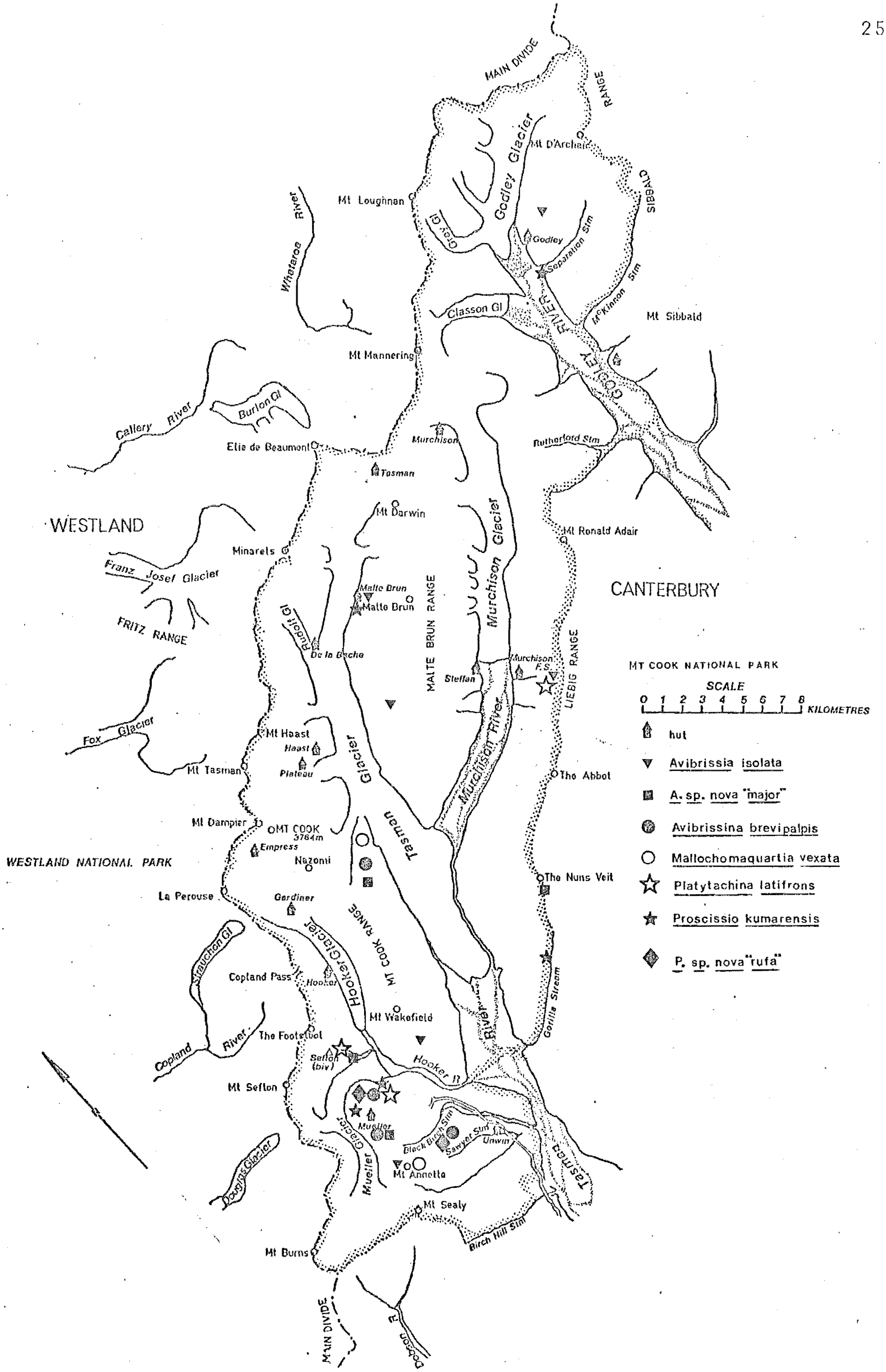
MAP 7 - Distribution of some Tenebrionidae (Coleoptera)



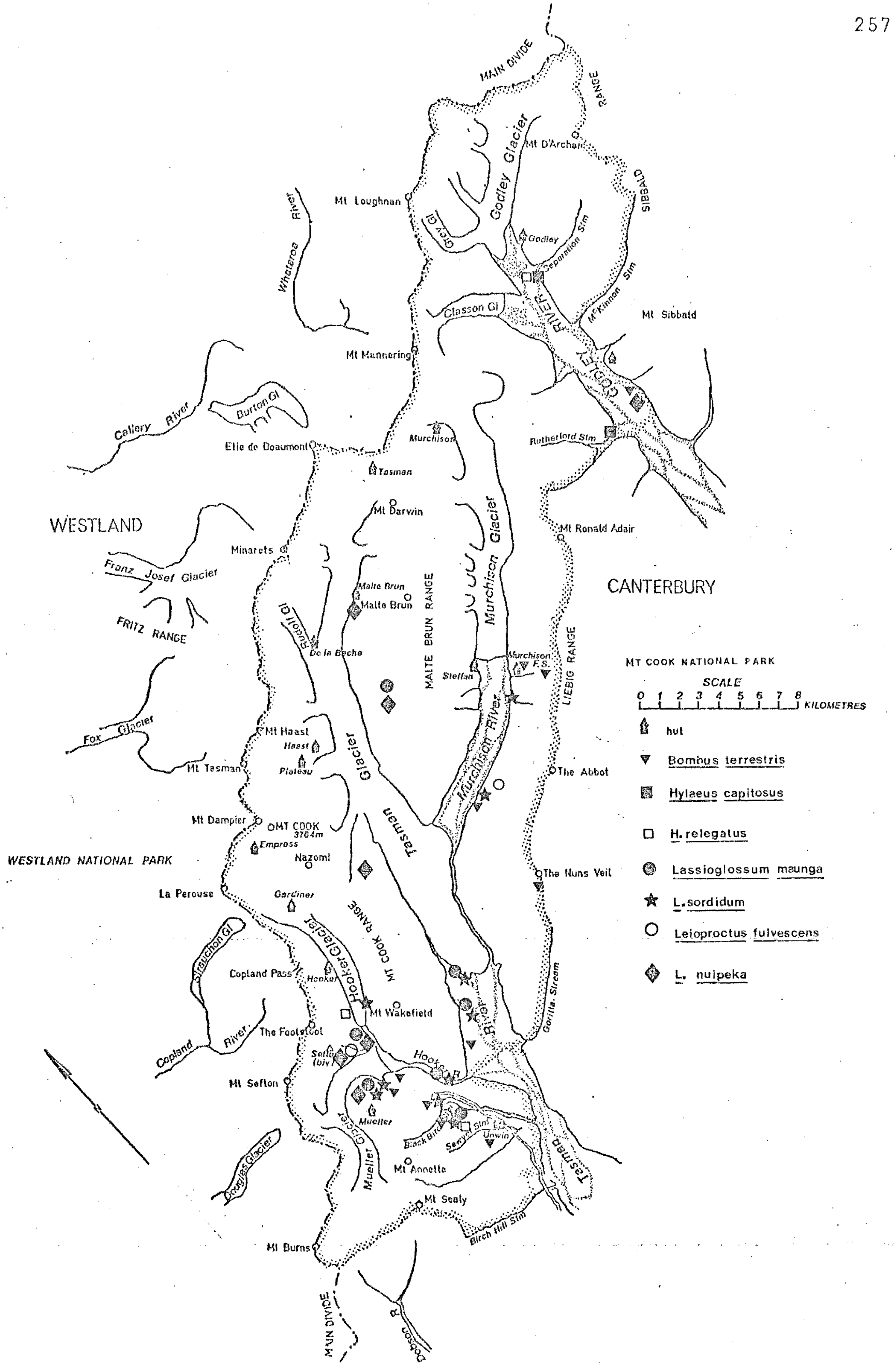
MAP 8 - Distribution of some alpine weevils (Coleoptera: Curculionidae)



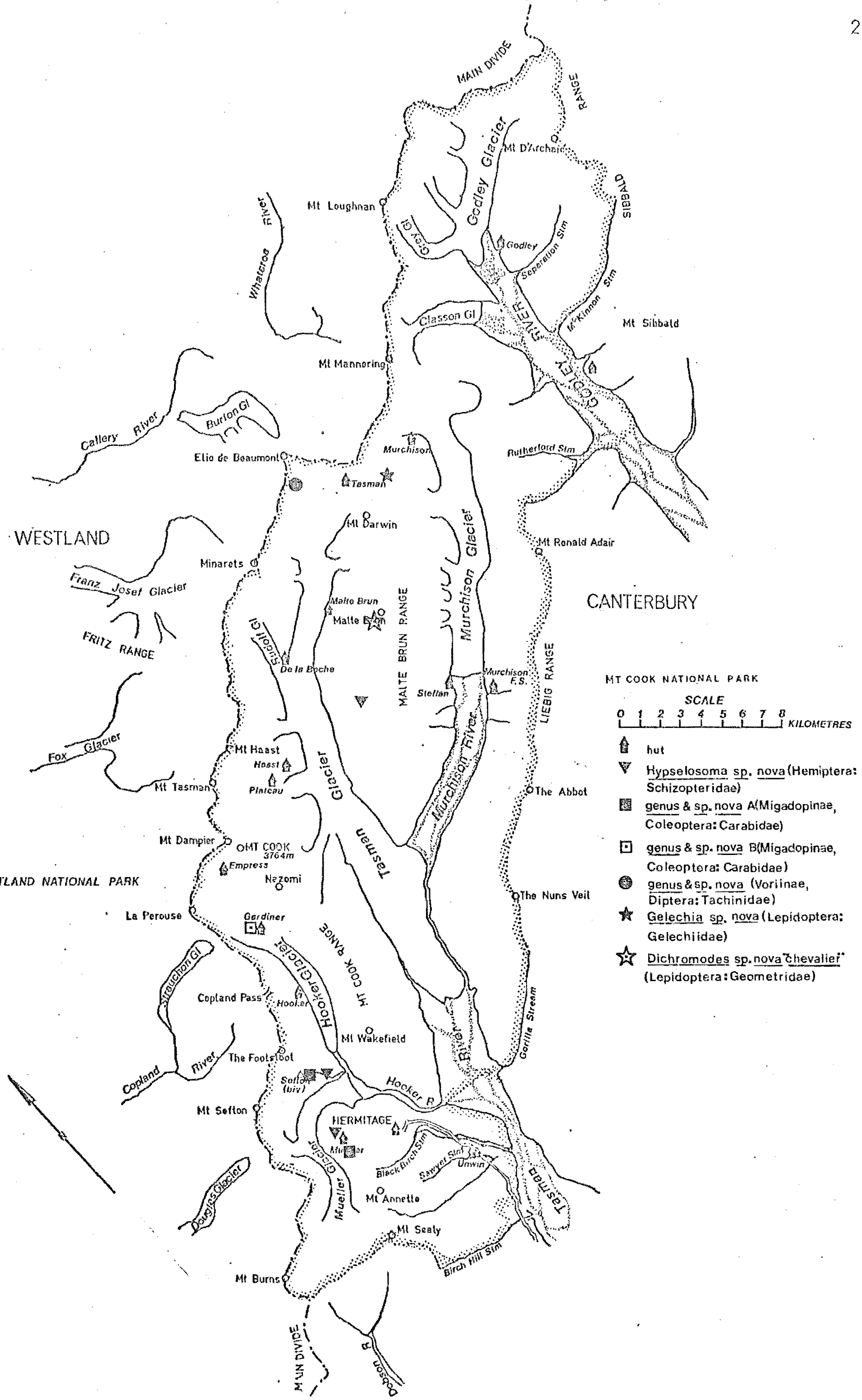
MAP 9 - Distribution of some alpine and subalpine Lepidoptera



MAP 10 - Distribution of some alpine and subalpine Tachinidae (Diptera)



MAP 11 - Distribution of some bees (Hymenoptera)



MAP 12 - Distribution of some rare alpine and nival insects

5.2 Insect and Plant Relationships Known From Mt Cook

5.2.1 Introduction

The visitation of flowers by insects is dealt with in the alpine entomology section of the literature review.

Dugdale (1975) showed that many insect-host plant associations in New Zealand are highly host specific with a higher incidence of monophages on cold-adapted plants than on warmth-adapted ones. The plant genera with the greatest number of monophage insect genera are listed by Dugdale (1975): *Pittosporum*, *Astelia*, *Carmichaelia*, *Dracophyllum*, *Cassinia*, *Celmisia*, *Chionochloa*, *Muehlenbeckia*, *Olearia*, *Coprosma*, *Nothofagus* and *Hebe*. All of these plant genera are colonisers of young sites and have alpine representatives except for *Nothofagus*. The archipelagic nature of the alpine zone has led to new hosts, or niches on hosts - in the weevil genus *Gromilus* for example, the alpine ones feed only on angiosperms, while the non-alpine ones feed only on ferns (Dugdale, 1975). On the Sealy range at 1620 m (pit site 4) *Gromilus* sp. adults were often pitfall trapped from February to May after the snow had melted and the angiosperms (*Celmisia*, *Senecio*) had flowered.

5.2.2 Grazing pressure and plant production

Most plant feeding insects (phytophages) recorded during the survey appeared to have some sort of balance with their host. For example, *Sargon turricola*

(Marshall) (Curculionidae : Coleoptera) was recorded feeding on *Senecio scorzoneroides* leaves in a fashion that left alternate notches up each side of the leaf. Plants eaten in this way still carried on and flowered. Alpine grasshoppers can also feed in this notching fashion, but White (1978) records that grazing pressure on certain species (e.g. *Gentiana corymbifera*) can be high even though the overall effect is low (no more than 5% of annual primary production and usually lower than 2%). Figures obtained in a high arctic study (76°N 85°W) by Ryan (1976) showed that arctic insects assimilated 0.8% of the net yearly primary production (on par with the arctic mammals in the area). In a European study in an area with inner continental alpine climate characteristics, Janetschek (1976) found that near the end of the season estimates of production biomass were three times larger at a high alpine site (2650 m) than in the valley meadow (1900 m). Production values at peak times were the same at each site. The shorter vegetative period in the high alpine area was well compensated for by a population development which could be 2-6 times faster than the valley meadow. As in New Zealand the alpine arthropod populations are well adapted opportunists and can make use of periods of good weather conditions.

Janetschek (1976) also investigated soil types, relief and vegetation and found that the vegetation and soils formed very complicated small scale mosaic patterns, the influence of relief increased with increasing altitude.

In two earlier studies in the European high alps (in Macfadyen, 1957) four main zones were established based on the age of soils and the associated flora (Janetschek, 1949). On the whole, these zones corresponded with the associated animals, but there was incomplete dependence of animal association with the obvious plant zones - the mechanical structure of the soil particles, the spaces between them and the vegetation density seemed more significant than the plant species. Not all animals were restricted in their range to one zone and Gretschy (1952) in a second study found that some animal groups such as snails and myriapods were strictly related to plant types, while other groups, including the collembolla, followed details of soil structure in their distribution. The New Zealand alpine-animal-plant associations are becoming better known (Dugdale, 1975, lists many specific associations), but soil type and vegetation density have not been generally correlated with distributions to any extent. Presumably the general picture would be similar to the European alps, with many differences in detail because of the younger age of New Zealand soils and its present isolated oceanic situation. Also the two European studies dealt mainly with soil dwelling animals detected in pit traps (Coleoptera and mites) and close relationships with soil characteristics would be expected.

5.2.3 Feeding damage at Mt Cook

Dugdale (1975) selected some characteristic phytophage types in New Zealand and dealt with them, under the headings of: defoliaters; flower, fruit and seed eaters; gall-makers; miners; live stem borers and shoot apex destroyers. In the following I use Mt Cook plant and insect examples.

5.2.3.1 Defoliaters

Larvae of Lepidoptera and Coleoptera may live free on their host or emerge to feed from a shelter that they construct. The Geometridae (Lepidoptera) genus *Declana* has larvae that resemble twigs of the host plant. Whipcord, *Hebe hectori* has several geometrid genera that feed on it (*Pseudocoremia*, *Pasiphila*, *Dasyuris*). Adult *Pyronota* (Scarabaeidae : Coleoptera) beetles can cause extensive defoliation of Tutu (*Coriaria*) and new leaves of *Nothofagus*. The St John's wort beetle (*Chrysomela hyperici*) can defoliate the introduced noxious weed St John's wort (*Hypericum perforatum*).

5.2.3.2 Flower, fruit and seed eaters

The weevils (Coleoptera : Curculionidae) are the largest single insect group attacking flowers and fruit. Amongst plant families the Compositae are favoured by several orders of insects and with the genus *Celmisia* (Mountain daisy) for example, four different insect orders compete for the food in the capitulum of the flower (Diptera, Lepidoptera, Coleoptera, Hemiptera). Celmisia coriacea at Mt Cook has had large numbers of a Tephritid fly reared from the capitulum (Plate 11). Tortricidae (Lepidoptera) larvae eat the flesh but leave the seed.

Seed eating Lepidoptera include the Carposinidae and Pterophoridae with the respective plant families attacked including Compositae, Malvaceae, Myrtaceae, Epacridaceae, Rosaceae, Scrophulariaceae and Gentianaceae. Seed eating Hemiptera included Nysius huttoni White commonly called the wheat bug, which was common on Aciphylla flower stalks. Peristoreus sudus (Broun) (Coleoptera : Curculionidae) was present in quite high numbers in Carmichaelia seed pods. The number of seeds can be controlled by Peristoreus but attack is sporadic (G. Kuschel, pers. comm., 1976). An unidentified weevil larvae was common in Cassinia flower heads where it spends part of its life cycle, it has not yet been reared (B. May, pers. comm., 1976). Two species which were not recorded in the survey but are widespread on Chionochloa seeds in alpine areas (White, 1974) are: Megacraspedus calamagonus (Lepidoptera : Gelechiidae) and Diplotoxa neozelandica? (Diptera : Chloropidae).

5.2.3.3 Gall makers

Mites, coccids and psyllids cause most of the New Zealand plant galls. Weevils (Curculionidae) and Cecidomyidae (Diptera) also cause galls, some of which are quite striking (e.g. the trumpet gall in the rosette centre of some Celmisia sp.). A false gall is caused by a weevil in Hebe buds, the weevil cements the apices of bud leaves together and causes the bud to bend at right angles by feeding on the bud tissue (Dugdale, 1975). "Nail Head" galls on Phyllocladus alpinus cladodes are caused by an Erioccidae (Eriococcus arcanus).

5.2.3.4 Miners

The majority of plants support only one miner species each. Some exceptions are: Nothofagus which may have two Lepidopteran miner species from two families (Nepticulidae, Gracillaridae); Coprosma may have miners from the following families: Nepticulidae, Tortricidae, Cecidomyidae and Curculionidae; and Astelia may support miners from two Lepidopteran families (Glyphipterygidae, Yponomeutidae) and a weevil (Curculionidae) (Dugdale, 1975).

Pupae of Phytomyza sp. (Agromyzidae : Diptera) were collected from stems of Ranunculus lyalli in Apr 77 and it appears that it overwinters in this form. Other Agromyzidae recorded (in part Spencer, 1976) were: Hexomyza coprosmae, galls on Coprosma propinqua; Liriomyza n. sp. mines and puparia ex. Gentiana corymbifera, and three other Liriomyza spp. on Hebes and Wahlenbergia.

5.2.3.5 Live root and stem borers and shoot apex destroyers

Graphania nullifera (Lepidoptera : Noctuidae) the great grey mountain moth, causes considerable damage as larvae to Aciphylla spp. (Speargrasses). Sargon larvae (Curculionidae) feeding on Aciphylla roots can cause early yellowing of the crown (B. May, pers. comm., 1976). Phyllocladus alpinus (Celery pine) from Bowen bush and Foliage hill had many Pachycotes peregrinus (Curculionidae) boring in the stem bases and roots (larvae and adults) in Jan and May 77, causing yellowing of apical and stem cladodes. Amongst alpine Celmisia a small, shiny, black weevil (Peristoreus celmisiae) has larvae which feed in dead leaf bases and in lateral roots. Cerambycidae (long horn beetles) have larvae which can cause considerable damage to live stems. Brounopsis spp. (Cerambycidae) larvae bore holes in live Cassinia stems and the branches often break off in the region of the exit hole. The introduced black vine weevil Otiorhynchus sulcatus (Coleoptera : Curculionidae) has larvae which feed extensively on roots of over 50 plant species (mostly introduced). Platypus spp. (pinhole borers) (Curculionidae) live in Nothofagus stems and transmit pathogenic fungi which can kill a tree in two years.

A detailed list of plant-insect associations found at Mt Cook is included in Appendix II.

5.2.3.6 The effect of fire on insects and plants

Both the flora and fauna of much of the Park have been profoundly altered by fire. Details of fires, prehuman, Polynesian and Caucasian, are given by Wilson (1976). During the insect survey attention was focused on the Liebig range (Map 1) in the extensive area (1200 ha) that was accidentally burnt in March 1970. Since the fire considerable regeneration of the vegetation has occurred with Phormium, Aciphylla, Celmisia and Chionochloa particularly noticeable. The introduced Hypochaeris radicata was also common (Wilson, 1976). In general insects associated with these plants were the same as elsewhere with a marked exception of some soil dwelling insects. In particular carabids (Mecodema spp.) and wetas (Hemideina sp.) were absent in areas that had been completely burnt. Pockets that had not been burnt occurred in scattered patches and ground dwelling insects were found in these. With time, and no further fire, the flora and fauna should approach their original composition.

5.3 Undescribed Species

Several undescribed species were collected during the course of the survey. Those listed below are known to be undescribed. Other species, particularly some parasitic Hymenoptera are probably new species, but not enough is known about them to be sure.

1. *Hemideina species nova* (Orthoptera : Stenopelmatidae) from Sawyer stream remnant *Nothofagus* forest, 6 males from two instars, one of 3 cm body length and one of 4 cm body length. One immature female of 3 cm body length. Two other specimens are known from areas to the north-west of the Park.

2. New genus new species (Voriinae : Tachinidae : Diptera) from the north face of Mt Walter 2850 m Feb 77. Collected in sunshine flying from warm rock, 6 mm long, dark and hairy. Probably an endemic nival zone dweller, parasitic on other nival insects such as Lepidopteran larvae (Map 12).

3. New genus new species Migadopinae : Carabidae : Coleoptera. Two new species of an undescribed genus of this sub-family were collected from nival areas. Species A was found at 1810 m on the Sealy range and at 1680 m on the main divide (Sefton biv. ridge). Species B was found walking on a rock face at 2200 h near Gardiner hut (1740 m). All three specimens were in summer snow melt areas (Map 12). Johns (1969) records three species from an undescribed Migadopine genus, all taken between 1370-2000 m in the South Island mountains. The Mt Cook species are probably in this same genus.

4. *Gelechia species nova* (Lepidoptera : Gelechiidae). Larvae were collected with *Hebe haastii* plants complete with silk webbing (Plate 3, Map 12). The larvae were active in bright sunlight and one adult was reared at Lincoln (now in DSIR collection, Auckland). The larvae are possible hosts of the new genus of Tachinidae-Voriinae. Similar larvae have been collected ex *Nothothlaspi* plants (Penwiper plant) (Cruciferae) from Camp creek in the Craigieburn range by J.S. Dugdale (pers. comm., 1977).

5. *Dichromodes species nova* ("*chevalier*" horse rider) (Geometridiae : Lepidoptera). This female with reduced wings was collected from the Cheval ridge 3050 m (Mt Malte Brun west ridge) from a rock crevice in Feb 77 (Map 12). The dark grey body is 7 mm in length, with lighter grey wings of 5 mm. The larvae probably feed on lichens. Probably a nival endemic species.

6. *Odontria species nova* aff. *striata* (Coleoptera : Scarabaeidae). One specimen was collected of this species from 1620 m, Sealy range pitfall trap site 4, March 1975.

7. *Brounopsis species nova* 1 (Kuschel ms.) (Coleoptera : Cerambycidae). Collected from a sandy beach on the floor of the Murchison valley

900 m December 1975. *Cassinia* shrubs overhung the beach. The specimen is deposited in the National Arthropod Collection, DSIR, Auckland. One other record is known from the Takitimu range collected by L. Dietz ex. *Cassinia vauvilliersii* 1200 m January 1976.

Brounopsis species nova 3 (Kuschel ms.) (Coleoptera : Cerambycidae). One specimen of this undescribed species was found in the last clearance of the pitfall traps, site 10 Murchison Forestry hut, 1000 m May 1977.

8. *Pseudodantonina species nova* (Hemiptera : Pseudococcidae). One specimen of this undescribed species was taken from *Chionochloa* roots, Sealy range 1600 m, January 1977.

9. *Hypselosoma species nova* (Hemiptera : Schizopteridae). Four specimens of this species were collected 800, 1500, 1650 and 1750 m Stocking stream, Reay and Sealy. All were under stones associated with *Chionochloa* (Map 12). P. Stys (pers. comm., 1977) states that the genus is primitive and that *H. sp. nova* occurs only in the Southern Alps.

5.4 Potential Pests

For detailed plant-insect relationships see Appendix II.

A plant pest is a plant growing where it is not wanted; an insect pest is an insect feeding where it is not wanted (an anthropocentric viewpoint, Given, 1979).

Some phytophagous insects occur in such numbers that they can seriously damage the vegetation on which they feed. It is possible with some outbreaks of native insects in National Parks, that the protection of the vegetation may occasionally warrant some form of artificial control. During the course of the survey no insect outbreaks were observed that warranted remedial action to protect the plants.

Wiseana spp. (Lepidoptera : Hèlialidae) the so-called porina moth, is a potential pest of montane grasslands in the Park. Its numbers were not high during the survey and nocturnal seagull feeding was observed to be further depleting the numbers on the Hooker flats. Grass moths (*Orocrambus* spp.) do a large amount of grazing as larvae on grass stems, while various scarab larvae (*Odontria*, *Pyronota*) feed on the roots. Adult scarabs can cause partial temporary defoliation of Matagouri, *Nothofagus* and *Coriaria*. The large caterpillars of the great grey mountain moth (*Graphania nullifera*) can cause marked damage to individual *Aciphylla* plants, sometimes plant death results.

A so-called bark beetle, *Pachycotes peregrinus* (Coleoptera : Curculionidae), is a potential pest of *Phyllocladus alpinus* and other podocarps. Several trees which had aerial apical die back were found to have larvae of this beetle in the woody root zone and stem base. Pinhole borers *Platypus* spp. (Curculionidae) are known killers of *Nothofagus* trees and are present in several dying trees in Governor's bush. An epidemic of these borers could result from a stress such as a drought lowering the healthy mature trees' gum-reaction resistance to xylem penetration. Such an epidemic could lead to an opening of the canopy and the rapid growth of forest floor seedlings to replace the dead trees.

The main herbivores of lowland grasses before the sheep moved in and after the moas were killed off was probably a balance between the *Hemideina* wetas and various Lepidopteran larvae such as *Wiseana* and *Orocrambus*. The original lowland grasslands are now much modified (e.g. with the exotic *Agrostis tenuis*) and the native grasses are strongly influenced by exotics. Present grazing by sheep and cattle especially in the *Nothofagus* bush remnant areas such as Mt Hodgkinson, Birch Hill and Sawyer stream, is to the detriment of the Park's flora and insect fauna. This grazing should be closely managed, carefully controlled, and if possible terminated in the near future. An undesirable side effect of animals such as chamois, cows and sheep is that their deposited faeces offer ideal oviposition sites for potential pests.

In general a close watch must be kept on the introduction of insects to the Park in shingle, soil and on vehicles such as buses and aeroplanes. The distribution of the introduced black vine weevil, Otiorhynchus sulcatus (Coleoptera : Curculionidae), is a case in point. Of the four specimens collected one was on the windows of the airport terminus, one was in a house and the other two were relatively close to the main road into the Park near Unwin hut. For species already in the Park any disturbance by pruning, track cutting and road making could lead to sporadic but serious insect damage to plants.

5.5 Traps

5.5.1 Traps in general

In general all of the trap types, apart from the pitfall traps, were only used for records of occurrence and no detailed examination of catches was made. On a broad comparison the Diptera from Malaise traps were better preserved and sampled than from sticky traps. Many sticky trap catches are preserved in fluid but have not been examined closely. A broad range of insects was caught by the light traps and the majority of these were identified.

For a discussion of all traps see section 2.1 - Insect collecting techniques.

5.5.2 Pitfall traps

Many active insects were successfully trapped in the pitfalls. Among them Carabidae were frequently collected with some interesting features emerging. Agonum macrocaelus was collected from pit sites 1, 2, 7, 10, 11, 12 and 13, all in forest and scrub zones, and it was also collected by hand from under stones at several similar sites. It appears that pit traps sample A. macrocaelus reasonably well. The same can be said for Mecodema politanum and M. rectolineatum. However, for the genus Scopodes three species showed different results. S. laevigatus was only trapped by pit 10 in the Murchison valley, seven specimens were collected from three trap visits, only two others were collected and these were by hand from the Hooker and Godley valleys. S. prasinus was never recorded from a pit trap even though it has a wide distribution - Sefton biv. ridge, Hooker valley, Reay and Godley valleys. S. versicolor was another species never recorded from a pit trap, but it was recorded on Raoulia mats in some numbers from the East Hooker. These collections may only reflect the small areas covered by the pit traps and that not all vegetation types had traps placed in them, but the differences in trapping members of the same family, or even genus, are apparent. Day active species such as Scopodes are a special case and as I have noted in the literature review trap avoidance or non-retention (even if the trap was entered) must account for some species gaps in the traps.

5.6 Biogeography

It appears that New Zealand's alpine biota came from three sources (Fleming, 1979) -

1. Old alpines from Antarctica,
2. Old alpines from the Northern Hemisphere,
3. Facultative alpines with a wide plasticity and tolerance.

Generally, the alpine environment is rather young, as based on the geological record, but the high endemism in the biota indicates a long history of adaptation and change (Watt, 1975; Fleming, 1979). An explanation of the origin of some of the biota is given by Fleming (1979). He suggests that many species are tolerant lowland organisms and have not speciated much at higher altitudes (e.g. amongst plants - *Blechnum*, *Cyathodes*, *Wahlenbergia*; and animals - New Zealand Pipit and Falcon). Other plants and animals have speciated from lowland relatives (e.g. the kea and two genera of lowland wetas - *Hemideina* and *Deinacrida*. Other notable speciated alpine examples are the Acrididae - *Brachaspis*, *Sigaus* and *Lyperobius* weevils.) The *Lyperobius* weevils have been largely eliminated from lowland areas by the introduced rats (Watt, 1975).

To focus on speciation in the Mt Cook region it appears that apart from the several new nival endemics there are few truly local species. The source of the alpine species other than widespread ones appears to have been from the south rather than the north, for example, the two Mecodema species and Megadromus bullatus are the northernmost records of southern distributed carabids.

In times past glacier barriers prevented many plants and animals spreading from so-called scrub refugia in Nelson and Otago and it is only fairly recently that movement has taken place. A "central alpine waist" between Canterbury and Westland has gained many plants recently (Burrows, 1969). Along with the plants has been a movement of insects including a scrub inhabiting cicada Kikihia rosea which is now distributed as six allopatric populations differing in morphology and/or acoustic behaviour (Fleming, 1979). Two alpine cicadas, Maoricicada cassiope and M. clamitans, only meet at this waist (Dugdale and Fleming, 1978) which is located just to the north of the Mt Cook Park. My own findings tie in with the waist distributions. For example, M. clamitans was recorded as far north as the Godley valley, but no records of the more northern M. cassiope were made.

It appears that isolation in refugia (scrub zones or nunataks) has given rise to local endemics in various areas. At Mt Cook it is possible that several of the local nival endemics survived the glaciations on nunataks, isolated above the masses of snow and ice on these rock islands jutting up from the frigid landscape.

5.7 Management of the Park's Insects

5.7.1 A few thoughts on management philosophy

"Exploration is a physical expression of
an intellectual passion"
A. Cherry-Garrad Antarctic explorer

Does wildlife have a right to existence? No, if evolution is used as a basis ... "the message of evolution is that no creature has a right to exist, either as an individual or a species" (Ratcliffe, 1976).

The view of: God is there, he created man amongst plants and animals and gave him a unique position of self consciousness, leads to a conclusion that both man and nature have a right to exist. It could be argued that since corruption entered the created world (symbolised by the fall of Adam) decay has steadily increased and evolution has given rise to less fit organisms than the originals. For example, Bonhoefer the German theologian, may have been more fit for civilised life than Hitler but Hitler killed him. "Survival of the fittest", but fit for what? Less fit organisms arising by "devolution" would mean more plant and insect pest problems (even without conscious intervention) and a decay of relationships such as Ms Goodall has seen in her primate studies when "murders" occur amongst "natural" families of chimps. In the physical world it is possible that elemental decay rates are increasing and have never been constant. This could perhaps be measured. Continental drift is perhaps another example of the physical decay of the original world.

In the hundred years or so that evolution has been studied (a very short time) many arguments have been raised to promote "better" life from the competition of "fitter" organisms. I consider that the arguments could be reversed to say that nature is "groaning for release" from a corruptive devolution in which things get worse not better. A symbolism of the return to the original "good" created forms is the lamb and lion both eating grass together.

However, until creation is released man and nature exist in a state of tension where man can harmonise himself with present ecological problems by serious sensible sweat of his brow type activities. Hence applying a philosophy of nature conservation to Mt Cook National Park involves tension between several aspects :

1. Economic - men can make money from people who desire to visit conserved and scenic areas, e.g. hotel and ski-plane companies. People who prefer to walk have clashed with such business persons.

2. Scientific study of plant-soil-animal relationships in such areas can also lead to economic returns (as well as intellectual and spiritual satisfaction) (e.g. minimising erosion to lessen catchment management costs).

3. Spiritual - two groups derive benefit here - those who take a leap of faith and say nature is there, it has meaning for me because I like it, even though I am a product of evolutionary meaningless chance just as nature is; and those who say God is there, he created, he gives absolute

meaning to a relative world. Both groups show in Schweiter's phrase "a reverence for life".

4. Popularity - for most people flowers are more popular than say ferns. Invertebrates, apart from moths and butterflies, are unpopular "creepy-crawlies" in general. Perhaps a revised "Ms Muffet" may help -

> "Little Ms Muffett sat on her tuffet
> eating her curds and whey,
> there came a big spider
> and sat down beside her
> and there they spent the whole day."

The present administration of the park has been struggling with the pluralism of the spiritual approach, educating the biased "flower people" and battling the business persons. It is hoped that the insect survey will help arm the administrators with knowledge for the education of both tourists and economists, including so called developers.

5.7.2 Towards consistent management

5.7.2.1 Introduction

Insects occupy a unique place in National Park ecosystems, they are biochemical recycling agents, parasites, predators and pollinators. Some of their activities are obviously beneficial to plants, for example, pollination, and biological control of some pests by predation and parasitism. Other activities are to the detriment of plants, for example, phytophagous insects such as alpine grasshoppers. Disturbance, artificial or natural, of any part of the ecosystem can have profound effects on plant-insect relationships. As a consequence management must aim to preserve as much as possible both in theory and practice. Up until now insects have been protected by the general National Park dictum - "take nothing but photos, leave nothing but footprints". In practice the insect fauna has been the "ugly sister" of the flora, for example, some conservation minded visitors avoided treading on daisies, but thought little of killing moths, sandflies or blowflies. It has been encouraging to see the emphasis on rational consistent interpretation that the Mt Cook National Park has promoted to its visitors through walks and talks, slide interpretation sessions, information hand-outs and the plant and insect displays. The in-service training courses for rangers run by Lincoln College have also opened up a wide intercourse of ideas, information and interpretation.

5.7.2.2 Some management suggestions

1. Herbicide sprays are used in some Parks for control of weeds, however, some of the sprays are also insecticidal and this should be considered before spraying.

2. As a general rule no soil, shingle or plants should be introduced to National Parks from outside. In particular, all soil movements should be minimised and confined as near to local soils as possible.

3. Cars, buses and aeroplanes should be regarded as possible vectors of outside insects. Ideally there should be no vehicle movements in National Parks at all, in practice such practices as the washing of buses should not occur within the Park, or if they do then drainage should be into the local sewerage system and not onto vacant ground. Climbing or tramping boots could also be vectors of undesirable insects or plants from outside sources and soles should be clean before use in a Park.

4. Track cuttings should be removed or scattered from the cutting site, plant wounds dressed, soil replaced and root damage guarded against. Many of these types of actions are already part of track cutting techniques in Parks.

5. Serious insect epidemics could warrant some form of non-residual insecticide application to the plants affected. In practice no such spraying has been carried out and the only need at Mt Cook would perhaps be to safeguard some individual plants with

spot applications of insecticide. Pruning of infested plants may be more desirable and as effective as insecticide applications.

5.7.2.3 Summary of insect management

Management of the insects must allow for the whole range of insect activities with the status quo preserved in general, but with the monitoring of some specifics and perhaps even conscious manipulation of the ecosystem at times.

CHAPTER 6

SUMMARY

The survey was aimed at as broad a range of habitats as possible, with emphasis placed on alpine areas. Sticky and malaise traps were placed amongst vegetation at several sites on the Sealy and Liebig ranges. Various other collecting techniques were used throughout the Park and in particular light traps were run near Governor's bush and malaise trapping was carried out at Red lakes, Sealy tarn, Botanical spur and also at Governor's bush. A comprehensive faunal list resulted from an extensive search of the literature and almost a year's work in the field spread over 1975-1977. Many detailed plant-insect relationships were noted. The Mt Cook flea *Pharmacus montanus* was found to be associated with nival plants such as *Hebe haastii*. Over 40 insect species were recorded visiting flowers and extensive pollination occurs. At least 10 undescribed species were found, nearly all from the alpine and nival zones, with at least several more to be looked at. *Hierodoris eremita* Philpott (Lepidoptera : Oecophoridae) was rediscovered and the first males recorded. No major outbreaks of plant pests were recorded during the survey, but a few insect species were causing quite serious damage to isolated plants at times. The recently burnt area of the Liebig range was generally impoverished in its insect

fauna, especially ground dwelling insects such as carabid beetles and wetas.

From the collection 677 species were identified from 16 orders, 129 families and 368 genera (Table 6). Amongst the orders Lepidoptera with 231 species, was the most common, followed by Coleoptera 200 species and Diptera 100 species. Coleoptera had the most genera and families of all orders. Three Lepidopteran families had the most species - Geometridae, Noctuidae and Pyralidae. The next most common families for species were Tachinidae (Diptera), Curculionidae (Coleoptera), Carabidae (Coleoptera) and Syrphidae (Diptera).

Apart from widespread species and the apparently local nival endemics, it appears that the majority of the insect fauna is from sources to the south of the Park. This is borne out by northernmost records of southern distributed insect species, for example, Megadromus bullatus and Mecodema spp. (Coleoptera : Carabidae). Also no southernmost records were made of more northern distributed insects. Some insect fallout on glaciers, probably from Australian sources, was recorded during Nor-West wind flows.

TABLE 6 : Summary of the insect fauna by orders, and number of families, genera and species.

Orders	Family	Genera	Species
Ephemeroptera	1	2	2
Odonata	4	5	5
Blattodea	1	1	1
Dermaptera	1	1	1
Plecoptera	3	5	6
Orthoptera	5	10	16
Phasmatodea	1	1	1
Hemiptera	10	40	62
Thysanoptera	1	1	1
Neuroptera	2	3	4
Coleoptera	36	128	200
Siphonaptera	1	1	1
Diptera	16	48	100
Trichoptera	+	+	+
Lepidoptera	21	88	231
Hymenoptera	17	34	46
Totals :	129	368	677

ACKNOWLEDGEMENTS AND IDENTIFICATIONS

ACKNOWLEDGEMENTS

The survey was funded by a grant from the National Park Authority. Field collection assistance was given by the Mt Cook National Park staff, in particular: G. Ayres, M. Clarborough, M. Heine, K. Joyce, D. Massam, J. Moore, B. Posthill, B. Thomas and B. Thompson. Other people who helped in the field were: R. Archibald, J. Anderson, J. Barnes, A. & G. Braun-Elwert, M. Conway, J. Dugdale, R. Emberson, B. Featherstone, D. Given, R. Harrison, P. Johns, W. King, M. Neeson, K. Newbold, P. Read, J. Reardon, M. & J. Seymour, C. & P. Smith, B. Stephenson, A. E. & S. Sweney, H. Verhoef, A. Walker, G. White and H. Wilson.

I acknowledge the help with curation that I received from K. Mason, C. Muir and R. Halligan. R. Emberson, R. Harrison and S. Goldson greatly aided the writing process. S. Worner kindly helped with maps. The drawings by D. Helmore are copyright of Entomology Division, DSIR, Private Bag, Auckland, and their use is gratefully acknowledged. The frontispiece, *Hierodoris eremita*, was photographed by Entomology Division, DSIR, Auckland, from reared material collected by J. Dugdale and J. Sweney.

Accommodation was difficult to find because several building projects were underway in the village,

as a consequence various dwellings were provided. Initially the resources of the New Zealand Alpine Club were used at Unwin hut. Gilbert Seymour of Ferintosh then provided some comfortable shearer's quarters 35 kilometres down the road. Later "Clod Cottage" and House 5 (both National Park buildings) were generously supplied and another gap was filled by the use of the warden's house (courtesy S. & J. Norman and New Zealand Alpine Club) at Unwin hut. Many of the Park's other artificial resources were also used, these included most huts, several vehicles, workshop equipment, and plane rides.

IDENTIFICATIONS

Ephemeroptera	W.J. Sweney
Odonata	W.J. Sweney
Blattodea	R. Archibald M.A.F. Auckland; W.J. Sweney
Dermaptera	W.J. Sweney
Plecoptera	W.J. Sweney
Orthoptera	R.S. Bigelow, Canterbury University; G. Ramsay, DSIR, Auckland; W.J. Sweney
Hemiptera	L. Dietz, DSIR, Auckland; M.B. Malipatil (Lygaeidae); P. Dale (Psyllidae); P. Schuh, USA, Miridae; J.T. Polhemus, USA, (Saldidae); W.J. Knight, British

	Museum (Cicadellidae); P. Stys, Czechoslovakia (Schizopteridae); J. Cox, M.A.F., Auckland (Coccoidea); L. Emms, M.A.F. Lincoln (Margarodidae); W.J. Sweney
Thysanoptera	A.K. Walker, DSIR, Auckland
Neuroptera	W.J. Sweney
Coleoptera	G. Kuschel, DSIR, Auckland (Curculionidae); C. Watt, DSIR, Auckland (most families); R. Emberson, Lincoln College (Carabidae, Lucanidae); W.J. Sweney, K. Somerfield and B. Stephenson, M.A.F., Lincoln.
Diptera	P. Johns, Canterbury University (Tipulidae); R. Halligan, Lincoln College; J.S. Dugdale, DSIR, Auckland (Tachinidae); B.A. Holloway, DSIR, Auckland (Mycetophilidae); J. Barnes, Lincoln College (Sciomyzidae); W.J. Sweney
Lepidoptera	J.S. Dugdale, DSIR, Auckland; F. Chambers, Te Namu; W.J. Sweney
Hymenoptera	A.K. Walker, DSIR, Auckland (Ichneumonidae, Braconidae); E. Valentine, DSIR, Auckland; J. Early, Lincoln (Diapriidae); A. Harris, Otago (Pompilidae); W. Don, Otago (Formicidae): B. Donovan, DSIR, Lincoln (Apoidea); R. Macfarlane, DSIR,

	Lincoln (*Bombus* spp.); F. Chambers, Te Namu (Ichneumonidae, Braconidae).
Tardigrada	D.S. Horning and R.O. Schuster, University of California.
Onycophora	W.J. Sweney
Arachnida	R. Forster, Otago
Millipedes	P.M. Johns

REFERENCES

ARCHER, A.C., SIMPSON, M.J.A. and MACMILLAN, B.H. 1973. Soils and vegetation of the lateral moraine at Malte Brun, Mount Cook region, New Zealand. New Zealand Journal of Botany 11 : 23-48.

ASAHINA, E. 1969. Frost resistance in insects. Advances in Insect Physiology 6 : 1-49.

BAIN, J. 1977. Pachycotes peregrinus (Chapius). N.Z.F.R.I. Forest and timber insects in New Zealand. No. 19. 4 p.

BAKER, R.R. and SADOVY, Y. 1978. The distance and nature of the light trap response of moths. Nature 276 : 818-821.

BARNES, J.K. 1979. Revision of the New Zealand genus Neolimnia (Diptera-Sciomyzidae). New Zealand Journal of Zoology 6 : 241-265.

BARRY, R.G. and VAN WIE, C.C. 1974. Topography and microclimatology in alpine areas, p.73-83. In: Ives, J.R. & Barry, R.G. (eds). Arctic and Alpine Environments. London: Methuen. 999 p.

BATCHELER, C.L. 1967. Preliminary observations of alpine grasshoppers in a habitat modified by deer and chamois. Proceedings N.Z. Ecological Society 14 : 15-26.

BAUST, J.G. and MORRISSEY, R.E. 1976. Strategies of low temperature adaptation. International Congress Entomology XV : 173-184. Washington, D.C.

BEIRNE, B.P. 1955. Collecting, preparing and preserving insects. Canada Department of Agriculture. 133 p.

BENHAM, G.S. 1975. A funnel apparatus for the extraction of micro-arthropods from agricultural soils. Annals Entomological Society of America 68 (3) : 529-532.

BIGELOW, R.S. 1967. The grasshoppers (Acrididae) of New Zealand. University of Canterbury Publications No. 9. 110 p.

BILLINGS, W.D. 1974. Arctic and alpine vegetation : plant adaptations to cold summer climates, p. 403-443. In: Ives, J.R. & Barry, R.G. (eds) Arctic and Alpine Environments. London : Methuen. 999 p.

BORROR, D.J., DELONG, D.M. and TRIPLEHORN, C.A. 1976. An introduction to the study of insects. New York: Holt, Rinehart and Winston. 852 p.

BOWDEN, J. and MORRIS, M.G. 1975. The influence of moonlight on catches of insects in light traps in Africa. III. The effective radius of a mercury vapour light trap and the analysis of catches using the effective radius. Bulletin Entomological Research 65 : 303-348.

BRITTON, E.B. 1941. The Carabidae of New Zealand. Part II. Tribes Lebinii and Pentagonicini Transactions Royal Entomological Society, London (B) 10 : 185-196.

BRITTON, E.B. 1949b. The Carabidae (Coleoptera) of New Zealand. Part III. A revision of the tribe Broscini. Transactions and Proceedings of the Royal Society of New Zealand 77 : 533-581.

BROUN, T. 1893. New Zealand Institute Manual of the New Zealand Coleoptera. Parts V, VI, VII. Wellington: Government Printer. pp v-xvii, 975-1504.

BROWN, W.L. 1958. A review of the ants of New Zealand. (Hymenoptera). Acta Hymenopterologica 1 : 1-50.

BROWNE, W.M.M. 1973. High altitude arthropods with special reference to New Zealand. Unpubl. minor B. Sc. Hons (Zoo) project University of Canterbury, Christchurch. 21 p.

BURROWS, C.J. 1961. Insects in high mountain grasslands in New Zealand (South Island). New Zealand Entomologist 2 (6) : 51.

BURROWS, C.J. 1962. Insects in high mountain grasslands. New Zealand Entomologist 3 (1) : 61.

BURROWS, C.J. 1969. Alpine grasslands, pp 133-166. In: G.A. Knox (ed) The Natural History of Canterbury. Wellington: A.H. & A.W. Reed.

CHAPMAN, J.A. 1954. Studies on summit frequenting insects in Western Montana. Ecology 35 (3) : 41-49.

CHAPMAN, J.A., ROMER, J.I. and STARK, J. 1955. Ladybird beetles and army cut worm adults as food for grizzly bears in Montana. Ecology 36 (1) : 156-158.

CLOUDSLEY-THOMPSON, J.L. 1975. Adaptions of Arthropoda to arid environments. Annual Review Entomology 20 : 261-283.

COE, M.J. 1967. Microclimate and animal life in equatorial mountains. Zoologica Africana 4 : 101-28.

COMMON, I.F.B. 1954. A study of the adult Bogong moth Agrotis infusa (Boisd.). Australian Journal Zoology 2 : 223-263.

COMMON, I.F.B. 1959. A transparent light trap for the field collection of Lepidoptera. Journal Lepidoptera Society C.S.I.R.O. Australia 13 (2) : 57-61.

CONNOR, H.E. 1962. Mount Cook National Park. 1st Edition. Mount Cook National Park Board.

CONNOR, H.E. 1973. Mount Cook National Park. Mount Cook National Park Board. 70 p.

CRAW, R.C. 1975. Seasonal dissociation, habitat selection, population structure, and adult behaviour in New Zealand Lycaena (Lepidoptera : Lycaenidae). New Zealand Journal Zoology 2 : 51-62.

CRAW, R.C. 1978. Revision of genus Argyrophenga (Lepidoptera : Satyridae). New Zealand Journal of Zoology 5 : 751-768.

CROSBY, T.K. 1974. Life history stages and taxonomy of Austrosimulium (Austrosimulium) tillyardianum (Diptera : Simuliidae). New Zealand Journal of Zoology 1 : 5-28.

C.S.I.R.O. 1970. The Insects of Australia. Victoria: Melbourne University Press. 1029 p.

DARLINGTON, P.J. 1965. Biogeography of the southern end of the world. Cambridge: Harvard University Press. 236 p.

DOWNES, J.A. 1965. Adaptations of insects in the Artic. Annual Review Entomology 10 : 257-274.

DUGDALE, J.S. 1971a. Entomology of the Aucklands and other Islands south of New Zealand : Lepidoptera, excluding non-Crambine Pyralidae. Pacific Insects Monograph 27 : 55-172.

DUGDALE, J.S. 1971b. Genera of New Zealand Cicadidae (Homoptera). New Zealand Journal of Science 14 : 856-882.

DUGDALE, J.S. 1975. The insects in relation to plants, pp 561-589. In: G. Kuschel (ed) Biogeography and Ecology in New Zealand. Hague: Dr Junk. 689 p.

DUGDALE, J.S. and FLEMING, C.A. 1978. New Zealand cicadas of the genus Maoricicada (Homoptera : Tibicinidae). New Zealand Journal of Zoology 5 : 295-340.

DUMBLETON, L.J. 1935a. The alpine weta. New Zealand Alpine Journal 6 : 172.

DUMBLETON, L.J. 1952. Notes on insects (snow weta). New Zealand Entomologist 1 (2) : 14-15.

DUMBLETON, L.J. 1962. Mount Cook National Park Insects, pp 44-46. Handbook. 3d ed. (rev.) Christchurch: Pegasus Press. 70 p.

DUMBLETON, L.J. 1966. Genitalia, classification and zoogeography of the New Zealand Hepialidae. New Zealand Journal of Science 9 : 920-81.

DUMBLETON, L.J. 1967. Winter dormancy in the New Zealand biota and its Paleoclimatic implications. New Zealand Journal of Botany 5 : 211-22.

DUMBLETON, L.J. 1972. The genus Austrosimulium Tonnoir Diptera : Simuliidae with particular reference to the New Zealand fauna. New Zealand Journal of Science 15 (4) : 48-584.

EDMUNDS, G.F. 1972. Biogeography and evolution of Ephemeroptera. Annual Review of Entomology 17 : 21-42.

EDWARDS, J.G. 1957. Entomology above the timberline : II. The attraction of ladybird beetles to mountain tops. Coleoptera Bulletin II : 41-46.

EMBERSON, R.M. 1976. Forest and timber insects, pp 173-184. In: D.N. Ferro (ed). New Zealand Insect Pests. Lincoln College. 311 p.

FARRELL, J.A.K. 1974. Observations on Epichorius spp. (Coleoptera : Byrrhidae) in Auckland Island rata forests. New Zealand Journal of Zoology 1 : 165-169.

FERRO, D.N. et al. 1977. Standard names for common insects of New Zealand. Bulletin 4. 42 p. Entomological Society of New Zealand, DSIR, Auckland.

FIELD, B. 1977. Geology of the Torlesse rocks of the central Liebig range Mt Cook. Thesis, M.Sc. (Geology), University of Auckland.

FLEMING, C.A. 1962. New Zealand biogeography, a paleontologists approach. Tuatara 10 (2) : 53-108.

FLEMING, C.A. 1969. Cicadas in New Zealand. National Parks. Unpublished. 5 p.

FLEMING, C.A. 1975. The geological history of New Zealand and its biota, pp 1-86. In: G. Kuschel (ed). Biogeography and Ecology in New Zealand. Hague: Junk. 689 p.

FLEMING, C.A. 1979. The Geological History of New Zealand and Its Life. Auckland and Oxford University Presses. 141 p.

FLEMING, C.A. and SCOTT, G.H. 1970. Size differences in cicadas from different plant communities. New Zealand Entomologist 4 (4) : 38-42.

FORSTER, R.R. and FORSTER, L.M. 1973. New Zealand Spiders - An Introduction. Auckland: Collins. 254 p.

FOX, K.J. 1973. Trans-oceanic dispersal of insects to New Zealand. New Zealand Entomologist 5 : 240-243.

FOX, K.J. 1975. Migrant Lepidoptera in New Zealand 1973-74. New Zealand Entomologist 6(1) : 66-69.

GAGE, M. 1969. Rocks and landscape, pp 25-43. In: G.A. Knox (ed). The Natural History of Canterbury. Wellington, Reed.

GASKIN, D.E. 1966. The Butterflies and Common Moths of New Zealand. Christchurch: Whitcombe & Tombs. 219 p.

GASKIN, D.E. 1971. A revision of New Zealand Diptychophorini (Lepidoptera : Pyralidae : Crambinae). New Zealand Journal of Science 14 : 759-809.

GASKIN, D.E. 1973. Revision of the New Zealand Chilonini (Lepidoptera : Pyralidae) and redescription of some Australian species. New Zealand Journal of Science 16 : 435-463.

GASKIN, D.E. 1975. Revision of the New Zealand Crambini (Lepidoptera : Pyralidae : Crambinae). New Zealand Journal of Zoology 2 (3) : 265-363.

GEIST, V. 1971. Mountain Sheep : A Study in Behaviour and Evolution. University of Chicago. 383 p.

GIBBS, G.W. 1970. The life history of the black mountain ringlet butterfly Percnodaimon pluto Fereday. New Zealand Entomologist 4 (4) : 12-18.

GIBBS, G.W. and RAMSEY, G.W. 1960. Lowland insects on mountain tops. New Zealand Entomologist 2 (5) : 1-5.

GIVEN, B.B. 1945. Tachinid parasites attacking Melolonthid larvae in New Zealand. Transactions Royal Society of New Zealand 75 : 321-323.

GIVEN, D.R. 1979. Rare and endangered plants with particular reference to high mountains. New Zealand Man and Biosphere Report No. 2 : 59-63.

GODLEY, E. 1975. Flora and vegetation, pp 177-229. In: G. Kuschel (ed). Biogeography and Ecology in New Zealand. Hague: Junk. 689 p.

GRESSITT, J.L. 1967. Entomology of Antarctica. American Geophysical Union. 395 p.

GRESSITT, J.L. and GRESSITT, M.K. 1962. An improved malaise trap. Pacific Insects 4 : 87-90.

GRETSCHY, E. 1952. "Veroff. Bundesanst. alp. Landwirts." Admont 6 : 25-85.

HAAST, J. Von. 1879. The Geology of the Provinces of Canterbury and Westland, New Zealand. Christchurch: The Times. 486 p.

HAGVAR, S. and OSTYBE, E. 1975. Occurrence and role of different invertebrate groups in alpine *Salix herbacea* snowbeds at Hardangervidda, pp 88-93. In: F.E. Wielgolaski (ed). Fennoscandian Tundra Ecosystems, Part 2, Animals and Systems Analysis. Berlin: Springer-Verlag. 337 p.

HARRISON, R.A. 1959. Acalypterate Diptera of New Zealand. New Zealand Dept. of Scientific and Industrial Research Bulletin 128. 382 p.

HEINE, E.M. 1937. Observations on the pollination of New Zealand flowering plants. Transactions Royal Society of New Zealand 67 : 133-148.

HELSON, G.A.H. 1934. The bionomics and anatomy of *Stenoperla prasina* (Newman). Transactions Royal Society of New Zealand 64 : 214-248.

HENNIG, W. 1960. The Diptera of New Zealand as a problem of systematics and zoogeography. Pacific Insects Monograph 9 : 1-131.

HINTON, H.E. 1944. Some general remarks on sub-social beetles, with notes on the biology of the staphylinid *Platystethus arenarius* (Fourcroy). Proceedings of the Royal Entomological Society, London (A) 19 : 115-128.

HOFSVANG, T. 1975. Life cycle and energy budget of *Tipula excisa* (Schum.) (Diptera, Tipulidae), pp 145-150. In: F.E. Wielgolaski (ed). Fennoscandian Tundra Ecosystems. Berlin: Springer-Verlag. 337 p.

HOLLOWAY, B.A. 1961. A Systematic Revision of the New Zealand Lucanidae (Insecta : Coleoptera). Dominion Museum Bulletin 20. 139 p.

HOLLOWAY, B.A. 1963. Wing development and evolution of New Zealand Lucanidae (Insecta : Coleoptera). Transactions of the Royal Society of New Zealand, Zoology 3 : 99-116.

HOLLOWAY, B.A. 1976. Pollen feeding in hoverflies (Diptera : Syrphidae). New Zealand Journal of Zoology 3 : 339-350.

HORNING, D.S. 1968. Insects of craters of the moon National Monument Idaho. University of Idaho Miscellaneous Series No. 8. 118 p.

HOSKING, G.P. 1979. Trap comparison in the capture of flying Coleoptera. New Zealand Entomologist 7 : 87-92.

HOY, J.M. 1962. Eriococcidae (Homoptera : Coccoidea) of New Zealand. Dept. of Scientific and Industrial Research Bulletin 146. 219 p.

HUDSON, G.V. 1928. The Butterflies and Moths of New Zealand. Wellington: Ferguson & Osborn. 386 p.

HUDSON, G.V. 1950. Fragments of New Zealand Entomology. Wellington: Ferguson & Osborn. 188 p.

IABLOKOFF-KHNZORIAN, S.M. 1968. Considerations sur la faune alpine des Coleopteres et sa genese. Beitr. Entomol. 18 : 177-211.

IMMS, A.D. 1964. A General Textbook of Entomology. London: Methuen. 886 p.

IVES, J.D. and BARRY, R.G. 1974. Arctic and Alpine Environments. London: Methuen. 999 p.

JANETSCHEK, H. 1949. "Tierische Successionen auf hochalpinen Neuland." Ber. naturwiss - mediz. Vereins Innsbruck 49 : 1-215.

JANETSCHEK, H. 1970. Environments and ecology of terrestrial Arthropods in the high Antarctic. pp 871-885. In: M.W. Holdgate (ed). Antarctic Ecology. London: Academic. 998 p.

JANETSCHEK, H. 1976. Altitude and time related changes in Arthropod faunation. pp 185-207. XV International Congress of Entomology.

JANZEN, D.H. 1973b. Sweep samples of tropical foliage insects : effects of seasons, vegetation types, elevation, time of day and insularity. Ecology 54 : 687-708.

JANZEN, D.H. and POND, C.M. 1975. A comparison by sweep sampling of the arthropod fauna of 2° vegetation in Michigan, England and Costa Rica. Transactions of the Royal Entomological Society 127(1) : 33-50.

JOHNS, P.M. 1962. Introduction to the endemic and introduced Millipedes of New Zealand. New Zealand Entomologist 3 (1) : 38-46.

JOHNS, P.M. 1964. The Sphaerotrichopidae (Diplopoda) of New Zealand. 1. Introduction, revision of some known species and description of new species. Records of Canterbury Museum, Vol. VIII No. 1. pp 1-49.

JOHNS, P.M. 1966. The cockroaches of New Zealand. Records of the Canterbury Museum, Vol. VIII No. 2. pp 93-136.

JOHNS, P.M. 1969. The mountain invertebrate fauna, pp 391-399. In: G.A. Knox (ed). The Natural History of Canterbury. Wellington: Reed.

JUILLET, J.A. 1963. A comparison of four types of traps used for capturing flying insects. Canadian Journal of Zoology 41 : 219-23.

KAISILA, JOUKO. 1952. Insects from Arctic mountain snows. Suomen Hyonteistieteellinen Aikakauskirja 18 (1) : 8-25.

KNIGHT, W.J. 1974a. Revision of the New Zealand genus Novothymbris (Homoptera : Cicadellidae). New Zealand Journal of Zoology 1 : 453-474.

KNIGHT, W.J. 1974b. Leafhoppers of New Zealand: subfamilies Aphrodinae, Jassinae, Xestocephalinae, Idiocerinae, and Macropsinae (Homoptera : Cicadellidae). New Zealand Journal of Zoology 1 : 475-494.

KNIGHT, W.J. 1975. Deltocephaline of New Zealand (Homoptera : Cicadellidae). New Zealand Journal of Zoology 2 (2) : 169-208.

KNIGHT, W.J. 1976. Typhlocybinae of New Zealand (Homoptera : Cicadellidae). New Zealand Journal of Zoology 3 : 71-87.

KUSCHEL, G. 1971. Entomology of the Aucklands and other islands south of New Zealand : Coleoptera : Curculionidae. Pacific Insects Monograph 27 : 225-259.

KUSCHEL, G. 1975. Biogeography and Ecology in New Zealand. Hague: Junk. 689 p.

LALAS, C. 1977. Food and feeding behaviour of the black fronted tern Chlidonias hybrida albostriatus. Thesis, Ph.D., University of Otago.

LEONARD, D.E. 1974. Recent development in the ecology and control of the gypsy moth. Annual Review of Entomology 19 : 199.

LILLIE, A.R. 1963. Structural geology in high mountains especially the New Zealand alps. New Zealand Alpine Journal 50 : 161-1-8.

LINDROTH, C.H. 1976. Genus Bembidion Latreille (Coleoptera : Carabidae) in New Zealand : a revision. New Zealand Journal of Zoology 3 : 161-198.

LINSEMNAIER, W. 1972. Insects of the World. New York: McGraw-Hill. 392 p.

MACFADYEN, A. 1957. Animal Ecology. London: Pitman 264 p.

MACFARLANE, R.P. 1970. A preliminary study of the fauna associated with lucerne Medicago sativa L. variety wairau in New Zealand, with special reference to pests, sampling methods, and lucerne seed production. Thesis, M.Agr.Sci. Lincoln College, N.Z.

McLELLAN, I.D. 1977. New alpine and southern Plecoptera from New Zealand, and a new classification of the Gripopterygidae. New Zealand Journal of Zoology 4 : 119-147.

MANI, M.S. 1962. Introduction to High Altitude Entomology. London: Methuen. 302 p.

MANI, M.S. 1963. High altitude insects. Agra University Journal of Research (Sic) 12 (1) : 171-196.

MANI, M.S. 1968. Ecology and Biogeography of High Altitude Insects. Hague: Junk. 527 p.

MANI, M.S. 1974. Biogeography of the Himalaya, pp 664-681. In : M.S. Mani (ed). Ecology and Biogeography in India. Hague: Junk. 725 p.

MARSTON, N. 1965. Recent modifications in the design of Malaise insect traps with a summary of the insects represented in collections. Journal of the Kansas Entomological Society 38 : 154-162.

MARTIN, J.E.H. 1977. The insects and arachnids of Canada. I - Collecting, preparing and preserving insects, mites and spiders. Canada Department of Agriculture. 182 p.

MAY, B.M. 1977. Immature stages of Curculionidae : larvae of the soil dwelling weevils of New Zealand. Journal of the Royal Society of New Zealand 7 : 189-228.

MICHENER, C.D. 1965. A Classification of the Bees of the Australian and South Pacific Regions. Bulletin of the American Museum of Natural History, New York, 130. 362 p.

MILLER, D. 1971. Common Insects in New Zealand. Wellington: A.H. & A.W. Reed. 178 p.

MILLIGAN, R.H. 1974. Insects damaging beech (Nothofagus) forests. Proceedings of the New Zealand Ecological Society 21 : 32-49.

MILLIGAN, R.H. 1978 Hylastes ater (Paykull). N.Z.F.R.I. Forest and Timber Insects in New Zealand. No. 29. 8 p.

MUNROE, E. 1975. Biogeography of North American Odontiinae (Lepidoptera, Pyralidae). Canadian Entomologist 107 : 129-154.

OHYAMA, Y. and ASAHINA, E. 1972. Frost resistance in adult insects. Journal of Insect Physiology 18 : 267-282.

OLDROYD, H. 1970. Collecting, Preserving and Studying Insects. London: Hutchinson. 336 p.

ORDISH, R.G. 1966. A systematic revision of the New Zealand water beetles Coleoptera : Dytiscidae. Records of the Dominion Museum 5 : 217-264.

PAPP, R.P. 1978. A nival aeolian ecosystem in California. Artic and Alpine Research 10 : 117-131.

PARROTT, A.W. 1954. New Zealand Ichneumonidae subfamily Ophioninae tribe Ophionini. Transactions of the Royal Society of New Zealand 81 : 627-645.

PECKHAM, V. 1971. Notes on the Chironomid midge Belgica antarctica (Jacobs) at Anvers Island in the maritime antartic. Pacific Insects Monograph 25 : 145-166.

PERROTT, D.C.F. 1968. A killing agent for light traps. New Zealand Entomologist 4 (2) : 37.

PHILPOTT, A. 1930. The Lepidoptera of the Mt Cook district with descriptions of new species. Transactions and Proceedings of the New Zealand Institute 61 : 419-439.

POULTON, E.B. 1904. A possible explanation of insect swarms on mountain tops. Transactions of the Entomological Society London, 24 : 23-26.

RAINEY, R.C. 1974. Biometeorology and insect flight: some aspects of energy exchange. Annual Review of Entomology 19 : 407-439.

RATCLIFFE, D.A. 1976. Thoughts towards a philosophy of nature conservation. Biological Conservation 9 : 45-53.

RAVEN, P.H. 1973. Evolution of subalpine and alpine plant groups in New Zealand. New Zealand Journal of Botany 11 : 177-200.

RAVEN, P. and AXELROD, D.I. 1972. Plate tectonics and Australasian Paleobiogeography. Science 176 : 1379-1386.

RICHARDS, A.M. 1972. Revision of the Rhaphidophoridae (Orthoptera) of New Zealand. Part XIV. Three alpine genera from the South Island. Journal of the Royal Society of New Zealand 2 (2) : 151-174.

ROBINSON, H.S. and ROBINSON, P.J.M. 1950. Some notes on the observed behaviour of Lepidoptera in flight in the vicinity of light sources, together with a description of a light trap designed to take entomological samples. Entomologists Gazette 1 : 3-20.

RYAN, J.K. 1976. Insects in the high Artic. Proceedings XV International Congress of Entomology, Washington, D.C. 167-170.

SALMON, J.T. 1950. Revision of the New Zealand wetas - Anostostominae (Orthoptera : Stenopelmatidae). Dominion Museum Records in Entomology 1 : 121-177.

SALMON, J.T. 1953. Melanism and size in relation to climate among New Zealand insects. Proceedings 7th Pacific Science Congress Volume IV Zoology. pp 87-90.

SHARELL, R. 1971. New Zealand Insects and Their Story. Collins. 268 p.

SIBATANI, A. 1974. A new genus for two new species of Lycaeninae (S.Str.) (Lepidoptera : Lycaenidae) from Papua New Guinea. Journal Australian Entomological Society 13 : 95-110.

SOUTHWOOD, T.R.E. 1968. Ecological Methods With Particular Reference to the Study of Insect Populations. London: Chapman & Hall. 391 p.

SPAIN, A.V. 1967. A study of the arthropoda associated with Olearia colensoi Hook. f. Thesis, M.Agric. Sci., University of Canterbury. 288 p.

SPENCER, K.A. 1976. The Agromyzidae of New Zealand (Insecta-Diptera). Journal of the Royal Society of New Zealand 6 : 153-211.

SUTHERLAND, O.R.W. 1964. Alpine wetas in New Zealand. New Zealand Entomologist 3 (3) : 16-17.

SWAN, L.W. 1963. Aeolian zone. Science 140 (3562) : 77-78.

SWENEY, W.J. and JONES, A.E. 1975. Methods for sampling foliage and insect populations of the beech forest canopy. New Zealand Journal Forest Science 5 (1) : 119-22.

TAYLOR, R.W. 1961. Notes on a collection of insects from the summit of Mt Ngauruhoe. Tane 8 : 75-86. (Journal of the Auckland University Field Club)

THOMAS, W.P. 1963. A natural enemy of the common grass grub Costelytra zealandica (White). New Zealand Entomologist 3 P 15-18.

THOMSON, G.M. 1926. The pollination of New Zealand flowers by birds and insects. Extract from the Transactions of the New Zealand Institute 57 : 106-125.

TILLYARD, R.J. 1926. The Insects of Australia and New Zealand. Sydney: Angus & Robertson. 560 p.

TOMLINSON, A.I. 1973. Meteorological aspects of trans-Tasman insect dispersal. New Zealand Entomologist 5 : 253-268.

TOWNES, H. 1962. Design for a Malaise trap. Proceedings of the Entomological Society, Washington, 64 : 253-262.

TOWNES, H. 1972. A lightweight Malaise trap. Entomology News 83 : 239-247.

TOWNS, D.R. and PETERS, W.L. 1979. Three new genera of Leptophlebiidae (Ephemeroptera) from New Zealand. New Zealand Journal of Zoology 6 : 213-235.

TOWNSEND, J.I. 1965. Notes on the genus Mecodema (Coleoptera Carabidae) with descriptions of new species from the South Island of New Zealand. New Zealand Journal of Science 8 : 301-318.

TROLL, C. 1973a. The upper timberlines in different climatic zones. Arctic and Alpine Research 5 : (3) A3-A18.

WALKER, A.K. 1977. A unique high alpine insect. New Zealand Alpine Journal 1977 30 : 96-97.

WALKER, A.K. 1978. New Zealand's hardiest native butterfly. New Zealand Alpine Journal 90 : 91.

WALKER, A.K. and CROSBY, T.K. 1976. Preservation, curation and posting of specimens of the New Zealand National Arthropod Collection. Entomology Division, Auckland. 31 p.

WALKER, A.K. and CROSBY, T.K. 1979. The preparation and curation of insects. Department of Scientific and Industrial Research Information Series 130. 55 p.

WALKER, A.K. and GALBREATH, R.A. 1979. Collecting insects at lights : a test of four types of lamps. New Zealand Entomologist 7 : 83-85.

WARDLE, P. 1971. An explanation of the alpine timberline. New Zealand Journal of Botany 9 : 371-402.

WARDLE, P. 1974. Alpine timberlines, pp 371-402. In: J.D. Ives and R.G. Barry (eds). Arctic and Alpine Environments. London: Methuen. 999 p.

WATT, J.C. 1975. The terrestrial insects, pp 507-533. In: G. Kuschel (ed). Biogeography and Ecology in New Zealand. Hague: Junk. 689 p.

WATT, J.C. and COLEBROOK, J.G. 1961. A "swarm" of beetles on Tataweka, Great Barrier Island. Tane 8 : 80-86.

WHITE, E.G. 1964. A survey and investigation of the insect fauna association with some tussock grasslands. Thesis, M.Agr.Sci. (Horticulture), Lincoln College, University of Canterbury, N.Z.

WHITE, E.G. 1974a. A quantitative biology of three New Zealand alpine grasshopper species. New Zealand Journal of Agricultural Research 17 : 207-227.

WHITE, E.G. 1974b. Grazing pressures of grasshoppers in an alpine tussock grassland. New Zealand Journal of Agricultural Research 17 : 357-372.

WHITE, E.G. 1975a. An investigation and survey of insect damage affecting Chionochloa seed production in some alpine tussock grasslands. New Zealand Journal of Agricultural Research 18 : 163-178.

WHITE, E.G. 1975b. Identifying population units that comply with capture-recapture assumptions in an open community of Alpine Grasshoppers. Researches on Population Ecology 16 (2) : 153-187.

WHITE, E.G. 1978. Energetics and consumption rates of Alpine Grasshoppers (Orthoptera : Acrididae) in New Zealand. Oecologia (Berl.) 33 : 17-44.

WIELGOLASKI, F.E. 1975. Functioning of Fennoscandian Tundra ecosystems, pp 300-326. In: F.E. Wielgolaski (ed). Fennoscandian Tundra Ecosystems, Part 2, Animals and Systems Analysis. Berlin: Springer-Verlag. 337 p.

WILLIAMS, C.B. 1948. The Rothamsted light trap. Proceedings of the Royal Entomological Society London (A) 23 : 80-85.

WILSON, H.D. 1972. Moths stranded on neves. New Zealand Entomologist 5 (2) : 177.

WILSON, H.D. 1976. Vegetation of Mt Cook National Park, New Zealand. National Parks Authority Scientific Series No. 1. 138 p. 294 p.

WILSON, H.D. 1978. Wild plants of Mount Cook National Park. Field Guide Publication.

WISE, K.A.J. 1961. Beetles flying onto Mt Moehau. Tane 8 : 75-86.

WISE, K.A.J. 1977. A Synonymic Checklist of the Hexapoda of the New Zealand Subregion. The smaller orders. Bulletin No. 11 Auckland Institute and Museum. 176 p.

APPENDICES

APPENDIX I : COLLECTING EVENTS

1975 : January

21 to Mt Cook, reconnaiscence
22 Mueller hut

February

7 to Mt Cook
10 Light trap Unwin hut
11 Set up 5 trap sites Sealy
12 Ball hut
13 Set up 810 m Governor's bush pit and sticky
14 Cleared site 1 Sealy
17 Cleared Sealy put in 1810 m (6) pit, sticky
18 Light trap Gov. bush
20 Cleared Sealy
26 Ball pass

March

1 Sealy cleared
17 Light trap Gov. bush
18 Sealy cleared Thermometers placed 1, 4, 6

May

15 Haast hut) Storm. No insects seen
16 Plateau) or collected

November

14 Copland pass

December

4 Sealy cleared resited 2, 5 & 6 under snow
8 Sealy cleared
13 Gov. bush pits sticky and light cleared
14 First Liebig-Murchison trip, site 7 established
21 Light trap Gov. bush
27-30 Minarets.

1976 : January

27-30 Zurbriggen's-Linda Mt Cook
5 Gov. bush light trap
7 *Graphania nullifera* adults
12 Red lakes
17 Mueller, 5 under snow
19 Red lakes traps set up
31 Thar lodge - photos of butterflies

February

4 Liebig set up 8 & 9 pits and sticky
21 Sefton biv.
24 Sealy cleared, 5 re-established
28 Nuns Veil

March

1 Gov. bush light & trap
6 Botanical spur 4 pits set up
7-10 Godley hut, West Ridge Mt D'Archiac
17 Hooker cnr. Lucanidae
25 Sealy cleared: details of slope & altitude
29 Liebig - 1 April, Ailsa pass

April

3-8 Malte, Tasman saddle, Mt Annan
16 Botanical spur Malaise set up
18 Light trap house 5, changed baffles to perspex
24 Wakefield spur
28-30 Hooker cnr, Birch hill stream. Snow.

May

1 Sealy new snow 1 m deep
3 Copland pass
12 More snow
25 Botanical spur - removed Malaise
26 Sebastopol - Red lakes trap clearance
28 Rotten Tommy
31 Tasman valley, Hooker cnr

<u>June</u>

2 Cleared Gov. bush traps

<u>September</u>

26 Identifications, Auckland DSIR

<u>October</u>

20 to Mt Cook

21 Red lakes

25 Gov. bush pit 810 m cleared

27 East and West Hooker valley

29 Ball ridge, light trap Gov. bush 740 m

30 Sealy sites 1 & 2 cleared, snow on others

<u>November</u>

2 Birch hill stream

4 Sawyer stream

7 Red lakes traps cleared

8 Snow

9 Snow

10 Snow

11 Cleared Gov. bush 810 m pits removed sticky trap. Hooker cnr.

12 Wakefield spur

13 Blue stream, Wakefield track

14 West Hooker *Ranunculus lyalli* flowering

15 " " " " "

16 Helipad, Red lakes

17 Botanical spur cleared pits

18 Emergence of parasite from *Phyllocladus* 'leaf' roller. Foliage hill.

19 Sebastopol ridge - Annette Plateau - Mueller hut - Sealy tarns. Sites 4, 5, 6 still under snow.

20 Hooker - *Ranunculus lyalli* visiting

21 Tasman glacier, light trap Gov. bush 740 m large catch

22 Blue lakes - Ball hut, Hooker cnr. *Aciphylla horrida* starting to flower

23 Red lakes pits and sticky traps cleared, sticky removed

25 Hooker flats (730 m) seagulls feeding on *Odontria*?

27 Ball hut

28 Swarm of ants on Foliage hill, many *Pyronota* flying, bush lawyer flowering

29 Sefton biv. ridge *Ranunculus lyalli* flowering to 1300 m, *Senecio scorzoneroides* emerging from snow patch melt areas. Several active moths seen - none collected.

30 E. ridge Mt Footstool from Sefton biv. Several insects on snow. *Pharmacus* at 2100 m on steep rocks with *Hebe haastii* and *Parahebe birleyi* and lichens. Some faeces examined.

December

2 Examined faecal pellet (*Pharmacus*) plant fragments?

3 Malaise 740 m Gov. bush

4 Foliage hill

5 Very heavy rain 11" in 24 hrs

6 Murchison - camp at Monastery Pk stream. Collected weevils and *Odontria* from *Aciphylla* flowers at night.

7 Cleared Liebig traps 7, 8 & 9

8 Out from Monastery stream

10 Gardiner hut - *Pharmacus* at 2200 h, Migadopine carabid.

11 Empress hut

12 West face low peak Mt Cook, 1 weta nymph (*Pharmacus*) at 3200 m.

13 Out via Hooker valley

17 Glencoe walk, Kea point

18 Kea point, Sealy tarn, Foliage hill

24 Sebastopol

25 Wakefield track

January

4 Snow to 1300 m

5 Blue lakes

7 Sealy sites 1-4, Foliage Hill

13 Mueller hut

14 Mueller-Annette-Sealy-Darby-3 Johns

15 Mt Scissors-Mueller glacier-Muller hut. Night collection to 2400 h on Mt Ollivier

16 Out from Mueller

19 Tasman glacier opposite Ball hut

20 Mt Novara

21 Reay camp at 1500 m night collecting

22 Reay

23 "

24 "

25 Washed out of Reay

27 Underground pit at Blue stream and Gov. bush

28 Foliage hill

30 Very strong wind and rain (3 Johns hut blew away)

February

4 Hooker hut - night collecting 2300 h

5 Copland pass and out Gentians and Hebe flowering up to 1700 m

8 Sefton biv.

9 Footstool and out

15 Cleared Gov. bush pits and the underground pit

16 Tasman saddle

17 Mts Elie de Beaumont, Walter and Green & to Malte Brun hut (new Tachinid)

18 Mt Malte Brun (new Geometrid) night collecting (2100 h)

19 Out from Malte Brun hut - Whipcord Hebe in flower at hut

22 Godley hut

23 Rutherford stream

24 West Ridge Mt D'Archiac

25 Out from Godley

March

9 Sealy - camped at Sealy tarns repainted all sticky traps Sealy, Malaise at tarns; site 6 (1810 m) sticky trap repositioned into sheltered snow hollow.

10 Out from Sealy - light trap Gov. bush

14 Red lakes malaise, pits cleared

17 Cleared Red lakes malaise

18 Blue lakes

24 Gov. bush light trap all night

25 Cleared and removed Red lakes malaise

28 Kea point

30 Gov. bush light trap, Hoophorn ridge

31 Black birch stm, Kea point Ball hut light trap 2430 h.

April

1 Ball ridge, light trap 720 m Gov. bush

3 & 4 Stocking stream camp, light trap at Stocking stream and at Gov. bush 740 m.

5 Wakefield spur

11 Red lakes pit cleared, light trap Gov. bush 740 m

15 Mueller-malaise at 1600 m

16 Green rock area and out via all Sealy trap sites (cleared)

17 Light trap Gov. bush 740 m

20 Snow down to 900 m overnight

23 Botanical spur - cleared pits erected malaise

24 Ball hut, Blue stream cleared underground pit

26 More snow

30 Snow above 850 m

May

1 Snow above 850 m

6 Light trap Gov. bush 740 m

7 Murchison Forestry hut cleared and removed pits and sticky

8 Cleared and removed Liebig traps 7, 8 & 9

10 Mueller, cleared and removed sites 1, 2, 3 and 4. Sites 2, 3 & 4 under snow. Sites 5 & 6 not found (snow 1-2 m deep)

12 Cleared and removed Botanical spur malaise and pits

13 Foliage hill, Blue stream underground pit removed, Hooker corner.

14 Governor's bush

15 Mt Hodgkinson

16 Red lakes pits cleared and removed

17 Final clearance Governor's bush pits (underground pit left)

19 Back to Lincoln

August

22 To Auckland DSIR until September 22nd. Insect identifications.

October

17 to Mt Cook

18 Sawyer stream, Governor's bush underground pit cleared and replaced

19 Red lakes track

20 Tasman saddle and Malte Brun hut (Gelechiid on *Hebe*)

21 Out from Malte Brun hut to Ball hut.

APPENDIX II

SOME PLANTS AND ASSOCIATED INSECTS COLLECTED FROM MT COOK

(in part J. Dugdale, pers. comm., 1977)

The plants are arranged in the order used in Wilson's (1976) vegetation survey.

Plant	Insect
Polystichum vestitum	Azelina fortinata (Geometridae)
Podocarpus nivalis	Selidosema fenerata (Geometridae) larvae on foliage Orthenches porphyritis (Yponomeutidae) larvae on young shoots Rhinorhynchus sp. (Curculionidae) larvae in male strobili Pyrgotis chrysomela (Tortricidae)
Podocarpus halli	Selidosema fenerata S. suavis and S. leucelaea larvae on foliage Declana floccosa, D. hermione (Geometridae) on foliage Orthenches porphyritis (Yponomeutidae) Leucaspis podocarpi (Diaspididae) white totara scale, larvae on leaves
Dacrydium bidwillii	Trioza sp. (Psyllidae) sapsucker Orthenches sp. young shoots Declana hermione (Geometridae) shoots
Phyllocladus alpinus	Eriococcus arcanus (Eriococcidae) nail head galls Tatosoma alta (Geometridae) Selidosema monacha (Geometridae) Declana hermione (Geometridae) Orthenches sp. (Yponomeutidae) Catamacta alopecana (Tortricidae) (can strip shrubs)

Ranunculus lyalli	Nesarcha hybrealis (Pyralidae) larvae on leaves Phytomyza sp. (Agromyzidae) in flower stems Phytomyza costata miner in leaves
Hymenanthera alpina	Meterana sp. (Noctuidae) Homohadena fortis (Noctuidae)
Muehlenbeckia axillaris	Lycaena boldenarum (Lycaenidae)
Muehlenbeckia complexa	Helleia salustius (Lycaenidae) Bityla defigurata (Noctuidae) Pasiphila muscosata (Geometridae) flowers Trioza sp. Peristoreus spp. (Curculionidae) fruits
Geranium sessiliflorum	sp. indet. (Agromyzidae) miner (Wakefield spur)
Haloragius spp.	Euchoeca rubropunctaria (Geometridae)
Epilobium spp.	Dasyuris anceps
Drapetes lyalli	Notoreas spp. (Geometridae)
Pimelea sp.	Meterana rhodopleura (Noctuidae) M. pictula
Coriaria sarmentosa	Caloptilia linearis (Gracillariidae) leaf miner and tyer Planotortrix sp. (Tortricidae) Tatosoma estevata (Geometridae) Zelleria sp. (Yponomeutid webber)
Coriaria angustissima	Caloptilia elaeas (Gracillariidae) (miner and pouch maker)
Leptospermum scoparium	Planotortrix notophaea (Tortricidae) tyer Pyronota spp. (Scarabaeidae) adults on foliage, larvae on roots Ericoccus orariensis (Ericoccidae) manuka blight scale indet. Cerambycidae (stem borer) Poecilasthena pulchraria (Geometridae)
Aristotelia fruticosa	Trioza sp. (Psyllidae) sap sucker Declana junctilinea (Geometridae)

Hoheria lyalli	Declana niveata (Geometridae) Epiphryne undosata (Geometridae) Nepticula "hoheriae" (Nepticulidae) miner Anisoplaca sp. (Gelechiidae) seedeater
Rubus schmidelioides	Carposina sp. (Carposinidae) stem borer Elvia glaucata (Geometridae)
Sophora microphylla	? one Pyralidae, ? one miner on leaf pinnules
Carmichaelia grandiflora	Selidosema melinata cplx. (Geometridae) Pasiphila sp. (Geometridae) Peristoreus sudus (Curculionidae) in seed pods Anisoplaca ptyoptera (Gelechiidae) stem borer
Nothofagus menziesii	Declana feredayi (Geometridae) Selidosema productata (Geometridae) S. suavis (Geometridae) Declana floccosa (Geometridae) "Tortrix" pictoriana) Epichorista emphanes) (Tortricidae) Pyrgotis pyramidians) Caloptilia selenitis (Gracillaridae) leaf miner/pouch maker Platypus spp. (Curculionidae) stem borers Pyronota spp. (Scarabaeidae) leaf eater (adults) Meterana dotata (Noctuidae)
Discaria toumatou	Odontria spp. (Scarabaeidae) adults eat leaves Psyllidae indet. sap sucker indet. Noctuid (grey larvae)
Pseudopanax colensoi	Declana egregia (Geometridae) Parectopa spp. (Gracillariidae) (mines in stems and leaves) Dendrotrupes sp. (Diaspididae) white scale Epirhanthis alectoraria (Geometridae)

Aciphylla spp.	*Graphania nullifera* (Noctuidae) larvae on stalks and leaves *Lyperobius carinatus* (Curculionidae) *Sargon sulcifer* (Curculionidae) *Eugnomus* spp. (Curculionidae) larvae and adults on pollen and stems *Dasyuris* sp. (Geometridae)
Anisotome spp.	*Dasyuris* spp. (Geometridae)
Gaultheria crassa	*Pyrgotis plagiatana* (Tortricidae) the larva is a leaf tyer *Caloptilia "gaultheriae"* (Gracillariidae) miner and pouchmaker
Dracophyllum spp.	*Eriodesma melanosperma* (Tortricidae) bud killer *Glyphipterix* sp. (Glyphipterigidae) bud killer *Carposina* sp. (Carposinidae) bud killer *Declana glacialis* (Geometridae) *Peristoreus* sp. (Curculionidae) larvae in flowers *Epiphryne charidema* (Geometridae)
Coprosma spp.	*Eucymatoge* spp. (Geometridae) *Asaphodes* spp. (Geometridae) *Pasiphila* spp. (Geometridae) *"Epichorista"* persecta (Geometridae) *Xanthorrhoe stricta* (Geometridae) *Austrocidaria praerupta* (Geometridae) *"Melanchra" vitiosa* (Noctuidae)
Celmisia	*Hierodoris eremita* (Oecophoridae) leaf grazer Tephritidae (Diptera) larvae in flower capitulum Curculionidae (various larvae among roots, adults on shoots and flowers)
Raoulia	*Eudonia* spp. *Scopodes* spp. (Carabidae) predatory beetles
Cassinia	Curculionidae indet. (larvae part feeds in flowers) *Brounopsis* sp.(Cerambycidae) stem borer *Harmologa sisyrana* (Tortricidae-Lepidoptera)

Gentiana	Liriomyza sp. Agromyzidae (Diptera) leaf miner
Hebe	Platyptilia repletalis Pterophoridae (Lepidoptera) (polyphagous)
Phormium	Tmetolophota steropastis (Noctuidae) flax notcher
Poa	Graphania spp. Eurythecta leucothrinca (Tortricidae) Eudonia spp.
Chionochloa	Ichneutica ceraunias (Noctuidae) I. marmorata (Noctuidae) Asaphodes cataphracta (Geometridae)
Agrostis tenuis (an introduced grass)	Protosynaema matutina (Yponomeutidae) Persectania aversa (Noctuidae) southern armyworm Wiseana cervinata (Hepialidae) larvae feed on shoots from subterranean tunnels Odontria spp. (Scarabaeidae) larvae on roots Pyronota spp. (Scarabaeidae) larvae on roots

APPENDIX III

BROUN TYPE SPECIES OF COLEOPTERA FROM MT COOK
(Watt unpublished ms.)

Mecodema suteri	Broun, 1893 Manual of NZ Coleoptera
Tarasthethus cinctus	Broun, 1893 Manual of NZ Coleoptera
Scopodes speciosus	Broun, 1893 Manual of NZ Coleoptera
Huxelhydrus virgatus	Broun, 1893 Manual of NZ Coleoptera
Omalium stenosoma	Broun, 1893 Manual of NZ Coleoptera
Priasilpha obscura	Broun, 1893 Manual of NZ Coleoptera
Pycnomerus impressus	Broun, 1893 Manual of NZ Coleoptera
Saphophagus ferrugineus	Broun, 1893 Manual of NZ Coleoptera
Chamaepsephis aurisetifer	Broun, 1893 Manual of NZ Coleoptera
Pachyura albocoma	Broun, 1893 Manual of NZ Coleoptera
Coccinella coriacea	Broun, 1893 Manual of NZ Coleoptera
Adolpus montanus	Broun, 1893 Manual of NZ Coleoptera
Anchomenus macrocoelis	Broun, 1908 Ann.Mag.Nat.Hist(8)2.
Pycnomerus suteri	Broun, 1909 Ann.Mag.Nat.Hist(8)3.
Synorthus mandibularis	Broun, 1910 Trans.NZ Inst.41:151-215
Demetrida lateralis	Broun, 1910 Bull. NZ Inst.2 Byrrhidae
Holotrochus montanus	Broun, 1910 Bull. NZ Inst.1(1) 1-78
Telmatophilus vestitus	Broun, 1910 Bull. NZ Inst.1(1) 1-78
Dasytes veronicae	Broun, 1910 Bull. NZ Inst.1(1) 1-78
Lorelus nigrescens	Broun, 1910 Bull. NZ Inst.1(1) 1-78
Luperus cheesemani	Broun, 1910 Bull. NZ Inst.1(1) 1-78
Luperus obscurus	Broun, 1910 Bull. NZ Inst.1(1) 1-78
Luperus diversus	Broun, 1910 Bull. NZ Inst.1(1) 1-78

APPENDIX IV

SOME OTHER ARTHROPODS AND CLOSE RELATIONS

These results are presented in the following order:

Phylum	Class	Order
Onycophora		
Arthropoda		
	Diplopoda (millipedes)	
	Arachnida	Pseudoscorpiones (pseudoscorpions) Araneae (spiders) Acarina (mites, ticks)
Tardigrada		

Phylum Onycophora

An ancient group showing a curious blend of annelid worm and arthropod characteristics. Onycophorans walk on 15-40 pairs of legs but they are not as well coordinated as millipedes or centipedes. A tracheal system similar to that of terrestrial arthropods is used for breathing. Concealed moist habitats such as under logs, under leaves and at the edge of streams, are common places to find these animals. For their size (2-3 cm) they can spit non-toxic defensive material a long way (up to 500 cm!). Their food is small insects and other animals.

Ooperipatus viridimaculata

740-810 m Dec-Feb 2 specimens
Governor's bush.
In *Nothofagus* litter and ex underground pit trap.
A double row of green spots down the dorsal surface is an external characteristic in contrast to *Peripatoides* sp. which has no such spots and is velvety blue in colour. *Peripatoides* lays live young whereas *Ooperipatus* lays eggs.

Phylum Arthropoda

Class Diplopoda (millipedes)

A class that is mainly herbivorous, well known for their many pairs of legs, body circular in cross section. When disturbed they may roll up and eject toxic substances from specialised glands. Many millipedes were collected in pit traps and are stored in fluid. Only one sample was identified. Johns (1962) gives an introduction to the species occurring in New Zealand, he also covers some other species recorded from Mt Cook (Johns, 1964).

Cylindroiulus brittannicus (Verhoeff, 1891)

740 m May 77 - Apr 78 20 (males and females)
Governor's bush underground pit trap.
Nothofagus forest.
An introduced species that is widespread. A similar species was widespread in the Liebig burn pit traps.

Icosidesmus nanus Carl, 1902

740 m May 77 - Aug 78 1 male, 2 females, 3 immatures
Governor's bush underground pit trap.
Mt Cook is the type locality for this species.

Somethus sp. nova

740 m May 77 - Aug 78 2 specimens
Governor's bush underground pit trap.
Endemic to Mt Cook, unrevised and unknown (P. Johns, pers. comm., 1978).

Class Arachnida

(spiders, pseudoscorpions, harvest men,
ticks and mites)

A class of Arthropoda with the first pair of appendages used for grasping; the second pair may be grasping, sensory or locomotory; the remaining four pairs are locomotary. They lack antennae.

Acarina (mites and ticks)

Many mites were taken in pitfall traps, but none were identified. The collection of mites is held in an unsorted state in fluid.

Acaridae

Aceria waltheri (Keifer) (beech bud mite)

730-800 m Dec-Feb many
North face Mt Sebastopol, Governor's bush.
Ex. *Nothofagus* terminal buds on branches, the so-called "witches broom".
Present in large numbers on parts of a few trees.

Pseudoscorpionida

A few of these small arachnids were taken in pit traps and under logs or stones. None were identified and they remain in the unsorted fluid collection. Pseudoscorpions have silk glands on their chelicerae and well developed pedipalps with poison glands.

Araneae (spiders)

In common with mites and pseudoscorpions, spiders have a single carapace. The chelicerae are of two segments with poison glands. The pedipalps are leg-like and are modified for copulation in males. A widespread and successful order - "spiders are small and easily crushed yet they are found in King's palaces" (anon. Hebrew proverb). Spiders were commonly taken in pit traps in Governor's bush and elsewhere but the majority remain in fluid, unsorted and unidentified.

Pisauridae (nursery web and water spiders)

Dolomedes aquaticus (Goyen) (water spider)

740 m Feb 77 1 adult male
Village area.
On rocks edge of stream.
Several other specimens were noted associated with streams at altitudes below 850 m. Forster and Forster (1973) supply details of its biology and some illustrations.

Dolomedes minor Koch (nursery web spider)

730-1300 m Jan-Feb several adults and immature
Mueller glacier terminus area, Sealy range.
Amongst scrub and tussock.
This species has been recorded from lowland regions up to 1500 m (Forster and Forster, 1973).

Araneidae (orbweb spiders)

Araneus pustulosus Walckenaer (garden orb web spider)

740-750 m Feb several
Mueller glacier terminal moraine.
Under rocks.
Widespread in New Zealand (Forster and Forser, 1973).

Lycosidae (wolf spiders) - fast moving daylight active hunting spiders.

Lycosa sp. indet. ("sand" wolf spiders)

1830-2100 m   Dec-Feb 2 adult females, 20-30 spiderlings.

Ball pass, Haast ridge.

On rock, on rock amongst fell field vegetation, on snow.

Collection times noted as 0930 h (active on sub-zero snow in the shade) 1200 and 1500 h. A true hunting spider, it uses a lightning burst of speed to close on its prey. The captured prey is held with the spider's two front pairs of legs while the fangs are raised then inserted to administer the paralysing poison. The prey of these alpine Lycosa is unknown, possibilities include aeolian jetsam such as tipulid flies and Agrotis moths. Alpine wetas such as Pharmacus are another possible prey, however in spite of extensive collecting in likely areas no association was noted between the two arthropods.

Phylum Tardigrada (Water bears)

Very small animals (less than 1 mm) with bilaterally symmetrical bodies possessing four small stumpy appendages with claws. Most tardigrades are semi-aquatic, living in mosses, lichens and liverworts. Long periods can be spent in a dessicated anabiotic state (very low metabolism rate), but when water is supplied reactivation occurs. Sharp mouth parts pierce plant cells and the contents are sucked into the water bear. Samples of moss etc. should be dried slowly (in a paper bag) and then wet extracted in a Berlese funnel. All identifications from dried moss samples sent to Davis, California - R.O. Schuster and D. Horning.

Hypsibius sp.
1500 m? unknown date and number
Sealy range.
Ex moss sample.

Macrobiotus intermedius
1700 m? Jan 76 unknown no.
Nun's Veil.
Moss samples from rocks amongst Nun's Veil glacier (South aspect).

Macrobiotus montanus
C. 1800 m Dec 1907 uncertain date and number
(Holotype - since lost)
Nun's Veil, moss sample (*Dicranum* sp. similar to *Ditrichum* sp.).
Moss samples collected by Peter Graham during the first ascent of Nun's Veil. The samples were for a Mr Murray, a biologist with the Shackleton-Nimrod Antarctic expedition. This species has not been collected since. Further moss samples awaiting curation may reveal more records.

<u>Milnesium tardigradum</u>

C. 1500 m unknown date and no.

Nun's Veil and Sealy range.

Ex moss samples.