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Light trap records from southern North Island hill country

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ABSTRACT

Two light traps were operated from February 1977 until July 1981 in hill country near Woodville, southern North Island. Similar faunas were sampled by the traps, one at 110 m a.s.l., the other at 300 m a.s.l. Large differences in individual species records between traps were generally caused either by sporadic outbreaks or by food-plant or habitat distribution. The records were dominated by Trichoptera and *Orocrambus* spp., with the noctuid *Graphania mutans* (Walker) and the hepialid pasture pest *Wiseana cervinata* (Walker) 3rd and 4th most abundant. Species of Noctuidae were

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very abundant and many of the highest-ranked insects were known or possible pests of pasture. The noctuids *Meterana exquisita* (Philpott) and *M. grandiosa* (Philpott) were both common although both have been considered rare in the North Island. The ichneumonid *Netelia ephippiata* (Smith) was abundant despite the apparent absence of its only known host. The records resemble other light trap records for the region and may be typical of southern North Island hill country. The greater topographical and habitat diversity may cause longer flight seasons for insects in hill country than the same species in less diverse habitats.

Keywords: Light trap; species lists; pasture pests; hill country; fauna; *Orocrambus; Graphania mutans; Wiseana; Meterana exquisita; Meterana grandiosa; Netelia ephippiata*

INTRODUCTION

The composition of insect communities in southern North Island (SNI) hill country is poorly known. Insects like grass grub (*Costelytra zealandica* (White)) (Coleoptera: Scarabaeidae) and porina (*Wiseana* spp.) (Lepidoptera: Hepialidae) are widely recognised because they often cause acute pasture damage. Sod webworms (Lepidoptera: Pyralidae) are also occasionally recognised as pests when outbreaks occur, but the relative importance of the species comprising this group is seldom clear. Many other insects are known from SNI hill country but quantitative descriptions of this fauna are lacking. The biology of most species has not been studied.

The only published fauna survey in SNI hill country is included in Cumber's wide-ranging study (Cumber 1958, 1959a, b, c, d, e, f, 1960a, b; Cumber & Harrison 1959). Each site was sampled only once, so no information on seasonal abundance was produced. Other surveys in the region but not in hill country include an examination of the insect and mite fauna associated with ryegrass pasture near Palmerston North (Manson 1959) and several light trap records (Cumber 1950, 1951, 1953; Gaskin 1964a, b, c, 1970).

In 1974 when Grasslands Division DSIR began developing 'Ballantrae' hill country research farm near Woodville, MJE and PJW erected several light traps to investigate the insect fauna associated with SNI hill country pasture. After sporadic trapping during 1974-1976 2 traps were retained and operated regularly during 1977-1981. This paper presents the results, and *post hoc* analysis by PMcG, of this light trapping.

METHODS

Study area

Traps were located at Grasslands Division's moist hill country research farm, 'Ballantrae', in the south-eastern foothills of the Ruahine range. The area was described in detail by Lambert *et al.* (1983). Vegetation was diverse and included low- through high-fertility pastures, *Juncus*-dominated seepages, gorse- (*Ulex europaeus*) and manuka- (*Leptospermum scoparium*) dominant scrub, regenerating native bush, *Pinus radiata* stands, and *Cupressus macrocarpa* shelter-belts. Farm dams were present in several locations and a permanent stream ran through the centre of the area. Ballantrae is noted for its high windspeed (Lambert & Roberts 1976). During the main trapping period 1977-81 average rainfall was highest during spring (345 mm) and lowest in summer (252 mm), while average daily temperatures were highest in summer (15.7 °C) and lowest in winter (7.2 °C) (averages for 3-month seasons; data from Lambert *et al.* 1983). The lower-altitude trap (TL) was located at about 110 m a.s.l. near the main entrance to the research farm and 10 m from the stream. The light was visible primarily from the south-west and although it was adjacent to extensive flat pasture it was partially screened from this area by a bank and shelter belt. This trap was better-sheltered from wind and rain than the higher-altitude trap (TH), which was about 300 m a.s.l. near a large farm dam at the head of a stream. TH was adjacent to an area of manuka-dominant scrub and was easily visible from all aspects.

Trap design and trapping procedure

Both traps were based on the Robinson design (Southwood 1978) modified for use in all weather (Fig. 1). Each trap used a 250W Thorn MBTF mercury-tungsten bulb operated by 240V mains supply run through an isolating transformer and time switch.

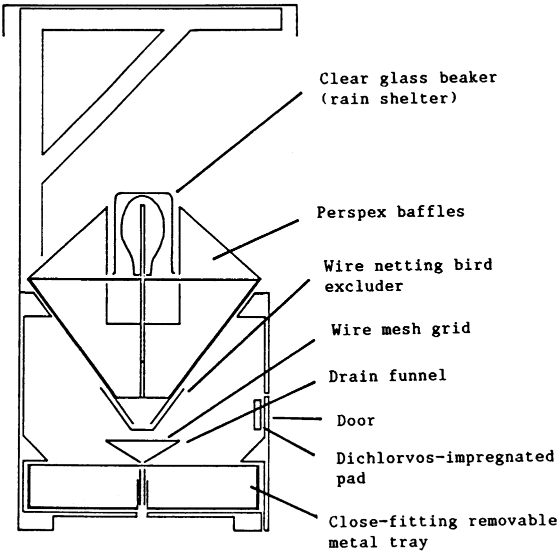


Fig. 1: Diagram of light traps used at Ballantrae

TL operated for 6 hours from just before dusk on 1 night at about weekly intervals from 14 February 1977-3 July 1978. TH operated similarly from 9 February 1977-5 July 1978. From 6 July 1978-29 June 1981 both traps ran every night for about 6 hours from just before dusk and the catches were usually collected twice-weekly. Catches were removed in separate plastic bags to the laboratory where they were either sorted immediately or oven-dried at 60°C and stored for later examination. Each catch was sorted as near to species as the state of individuals allowed. Hereafter 'group' refers to any such taxonomic category that was recognised in this study and these are listed in Table 1. The number of individuals per species or group was obtained either by counting all individuals or, for very abundant species, by counting individuals in a volumetric subsample. Representatives of each species or complex are held in the New Zealand Arthropod collection (NZAC) at Entomology Division, DSIR, Palmerston North.

Analysis

To examine the overall record each group's abundance was estimated simply by summing all records over the 4½ year period, with TL and TH kept separate.

To analyse a group's catch data the 2 types of trapping, viz single-night (1977-1978) cf. continuous (1978-1981), were standardised by dividing the number of insects caught between successive clearings of the trap by the number of nights that the trap operated during that period. The record then comprised a series of estimates of the number of insects caught per night (= C) with up to 9 such estimates per month. These were then averaged for each month to condense the data. These monthly averages were plotted against the weighted mean number of days from the start of trapping (= D). Weights were the mean number of insects of that group caught per night between successive clearings of the trap i.e. = C. Thus the date against which a monthly average was plotted was:

$$D = \frac{\sum_{i=1}^{n} C_i D_i}{\sum_{i=1}^{n} C_i}$$

where there were n trapping periods in a month and D = the midpoint, in days from the start of trapping, of period i. Peaks of insect abundance were more accurately shown by this method than by simply using the midpoint of each month.

RESULTS

1,126,946 insects in 201 categories were recorded during the 4.5 years of light-trapping (Table 1). 307,702 of these in 168 categories were from TH; 819,244 in 183 groups were from TL. 153 categories were shared by both traps. Most categories were species but 33 were potentially multi-generic, ranging from 'Gryllidae', comprising *Teleogryllus* and *Pteronemobius*, to 'Trichoptera' with an unknown number of genera and species. Excluding Trichoptera still left a marked difference in total catches between the 2 traps; 185,608 for TH and 400,581 for TL. However, rank correlation showed that the relative importance of each species was similar for the 2 sites (rs = 0.754, p < 0.001, n = 201; Fig. 2). This was not affected by the removal of all multigeneric groups (rs = 0.753, P < 0.001, n = 168).

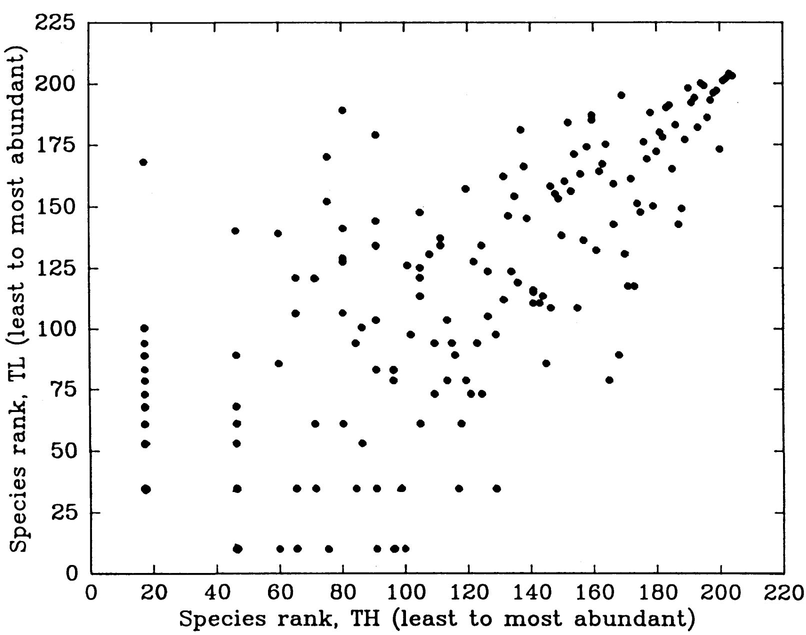
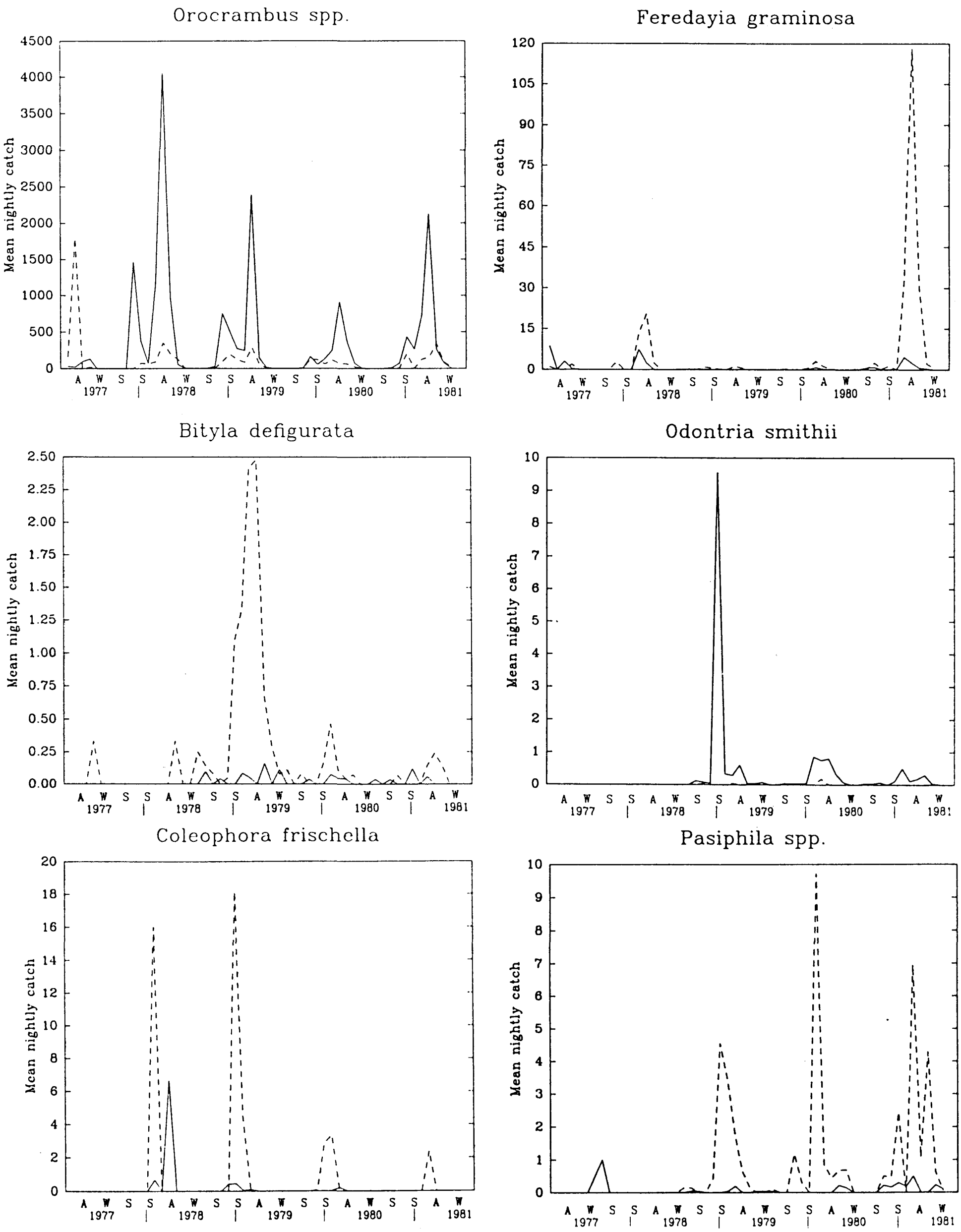


Fig. 2: Correlation of species ranks for upper (TH) and lower (TL) light traps

Some common species or groups showed large differences in abundance between the higher and lower traps. Flight records for some of these are shown in Fig. 3. Trichoptera (TH:122,094; TL:418,663) and Ephemeroptera (TH:6; TL:969) were both predominant in the lower trap TL with its adjacent stream. *Orocrambus* spp., mainly *O. flexuosellus* (Doubleday) (Lepidoptera: Pyralidae) was consistently far more abundant in TL than TH (TH:82,384; TL:321,872). Reasons for this are unclear but may be related to the greater exposure of TH to high winds. Cowley (1982) noted that flight activity of *O. flexuosellus* was decreased by winds over 20 km/h. The proximate causes of the TH-dominance for *Feredayia graminosa* (Walker) (Lepidoptera: Noctuidae) (TH:5568; TL:386) and *Bityla defigurata* (Walker) (Lepidoptera: Noctuidae) (TH:296; TL:26) were large flights, presumably indicating outbreak populations, of *F. graminosa* in autumn 1981 and of *B. defigurata* in late 1978 and the first half of 1979 (Fig. 3). Ultimate causes cannot be determined from these data, but probably relate to the distribution of food plants. Spiller & Wise (1982) list the food plant of *F. graminosa* as *Melicytus* sp. and that of *B. defigurata* as *Muehlenbeckia* sp. Both plants were present in scrub near TH but were less common


Orocrambus spp.
Feredayia graminosa
Bityla defigurata
Odontria smithii
Coleophora frischella
Pasiphila spp.
Mean nightly catch
A W S S A W S S A W S S A W S S A W
1977 1978 1979 1980 1981

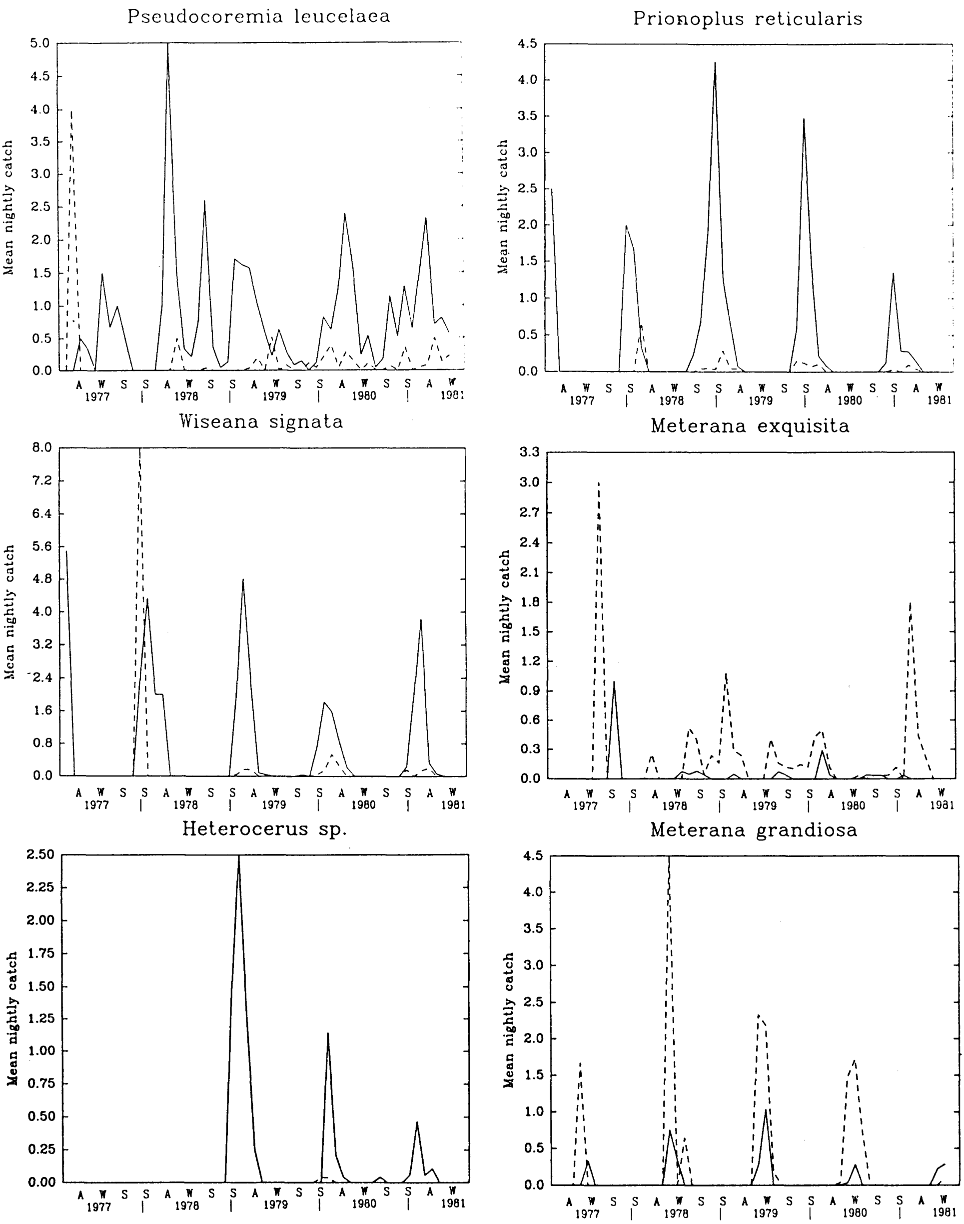


Fig. 3: Standardised records for taxa that differed greatly in total catch between the two traps and for *Meterana grandiosa* Solid line = TL; broken line = TH. Seasons are three-monthly with summer comprising December, January, February.

close to TL. *Odontria smithii* Broun (Coleoptera: Scarabaeidae) was most abundant in the lower trap (TH:9; TL:483). This was primarily a result of a large flight at the end of December 1979, although *O smithii* was generally more abundant in TL.

Other common species were also consistently more abundant in 1 trap but the difference was not explicable by isolated outbreaks. Such species include the clover case-bearer *Coleophora frischella* L. (Lepidoptera: Coleophoridae), which was dominant in the more typical hill country environment surrounding TH (TH:1082; TL:60). The high numbers of *C. frischella* during the summers of 1977-78 and 1978-79 followed oversowing of the area with white clover (*Trifolium repens* L.) and *Lotus pedunculatus* Cav. in October 1977 and may have been caused by the possibly greater availability of clover seed heads. *Pasiphila* spp. (Lepidoptera: Geometridae) (TH:1153; TL:73) had a distribution perhaps related to the association of this genus with plants typical of indigenous scrub (Spiller & Wise 1982), while *Pseudocoremia leucelaea* (Meyrick) (Lepodoptera: Geometridae) (TH:107; TL:909) was found predominantly near its food plants totara *(Podocarpus totara)*, miro *(P. ferrugineus)*, and *Pinus radiata* (Gaskin 1966). *Prionoplus reticularis* White (Coleoptera: Cerambycidae) (TH:43; TL:520) was unsurprisingly predominant near a log dump and numerous gymnosperms (Watt 1983). Reasons for the greater abundance of *Wiseana signata* (Walker) (Lepidoptera: Hepialidae) in the lower trap (TH:81; TL:617) are unclear. *Meterana exquisita* (Philpott) (Lepidoptera: Noctuidae), described as 'very rare' by Hudson (1928) and still infrequently encountered (J. S. Dugdale pers. comm.), was within the top 20% of species in TH (TH:235; TL:26). Nothing is known of its food plant. The mud beetle *Heterocerus* sp. (Coleoptera: Heteroceridae) was most abundant in the lower trap (TH:5; TL:216). Britton (1970) stated that adults and larvae tunnel in stiff mud at the sides of ponds and streams. This habitat would have been more common and possibly more stable temporally along the banks of the permanent stream near TL than around the dam near TH. Perhaps the most singular record was that of *Strepsicrates parthenia* (Meyrick) (Lepidoptera: Tortricidae), with no records from TH but 200 individuals from TL, all caught between 18 December 1978 and 8 January 1979. *S. parthenia* larvae eat *Cyathodes*, which was not recorded at Ballantrae during the trapping period. Adults of *S. parthenia* may have been carried by wind into the vicinity of TL from the northernmost Tararua range where *Cyathodes fasciculata* was locally abundant (Esler 1978).

A particularly interesting record is that of *Meterana grandiosa* (Philpott) (Lepidoptera: Noctuidae) (Fig. 3). *M. grandiosa* is absent from the extensive collecting records of Fox (1970, 1982) and Davies (1973); Gaskin (1970) recorded the first North Island specimen from Palmerston North and *M. grandiosa* is generally considered rare in the North Island (J. S. Dugdale & K. J. Fox pers. comm.). It was previously known also from 3 specimens from coastal Southland and south-eastern Central Otago. At Ballantrae *M. grandiosa* was ranked within the top 15% of categories in TH. Its food plant, like most of its biology, is unknown, but the Ballantrae records clearly confirm an autumn-winter flight pattern and suggest a univoltine life cycle, on a nearby host.

Records for the most abundant species not already shown in Fig. 3 are given in Fig. 4. The most abundant groups were mainly species of Noctuidae, with the notable exceptions of *Orocrambus* and Trichoptera (Fig. 5). These 2 groups together comprised about 84% of the total record. The *Orocrambus* record indicates a bivoltine life cycle, supporting the contention that this record was predominantly that of *O. flexuosellus* (see Gaskin 1975). Two of New Zealand's worst pasture pests, porina and grass grub, were the 4th and 9th most abundant insects respectively. A surprising observation was the very high ranking of *Netelia ephippiata* (Smith) (Hymenoptera: Ichneumonidae), which was the 5th most common insect in TL and the 8th most common overall. The only published certain host record of this parasitoid is *Orthoclydon praefectata* Walker (Lepidoptera: Geometridae) (Valentine 1967). *O. praefectata* was not recorded from either light trap on Ballantrae. Its host plant, flax, was abundant surrounding the Manawatu Gorge about a km distant, but occurred only in small areas on Ballantrae. *N. ephippiata* probably parasitises presently unrecognised hosts. One must wonder whether *N. ephippiata,* like *N. producta*, parasitises some Noctuidae which in terms of numbers and body size appear very suitable for supporting a large *N. ephippiata* population.

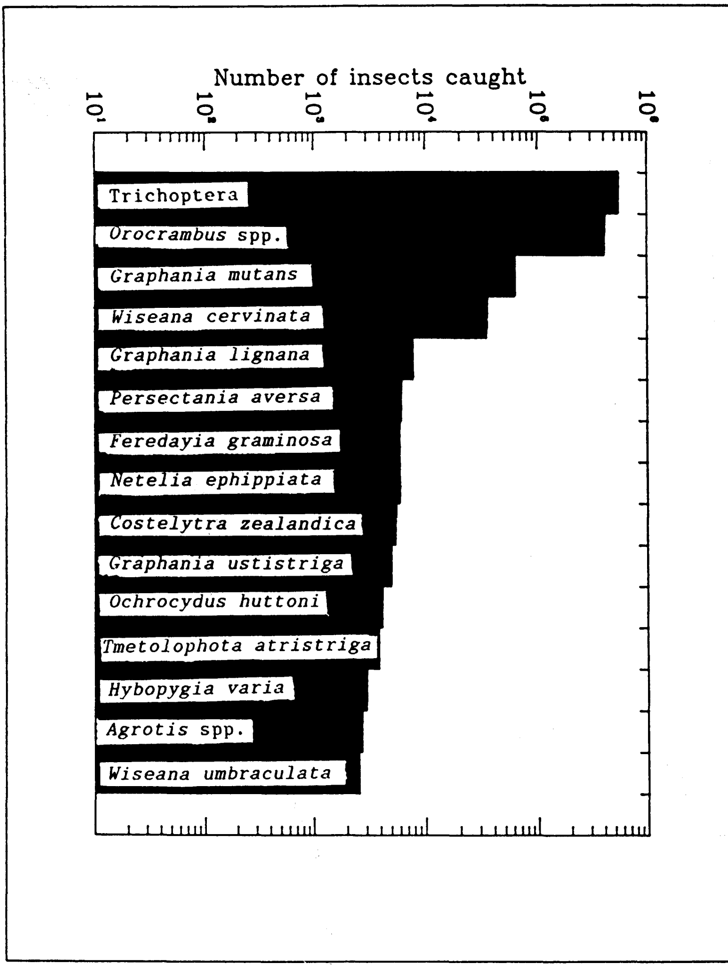
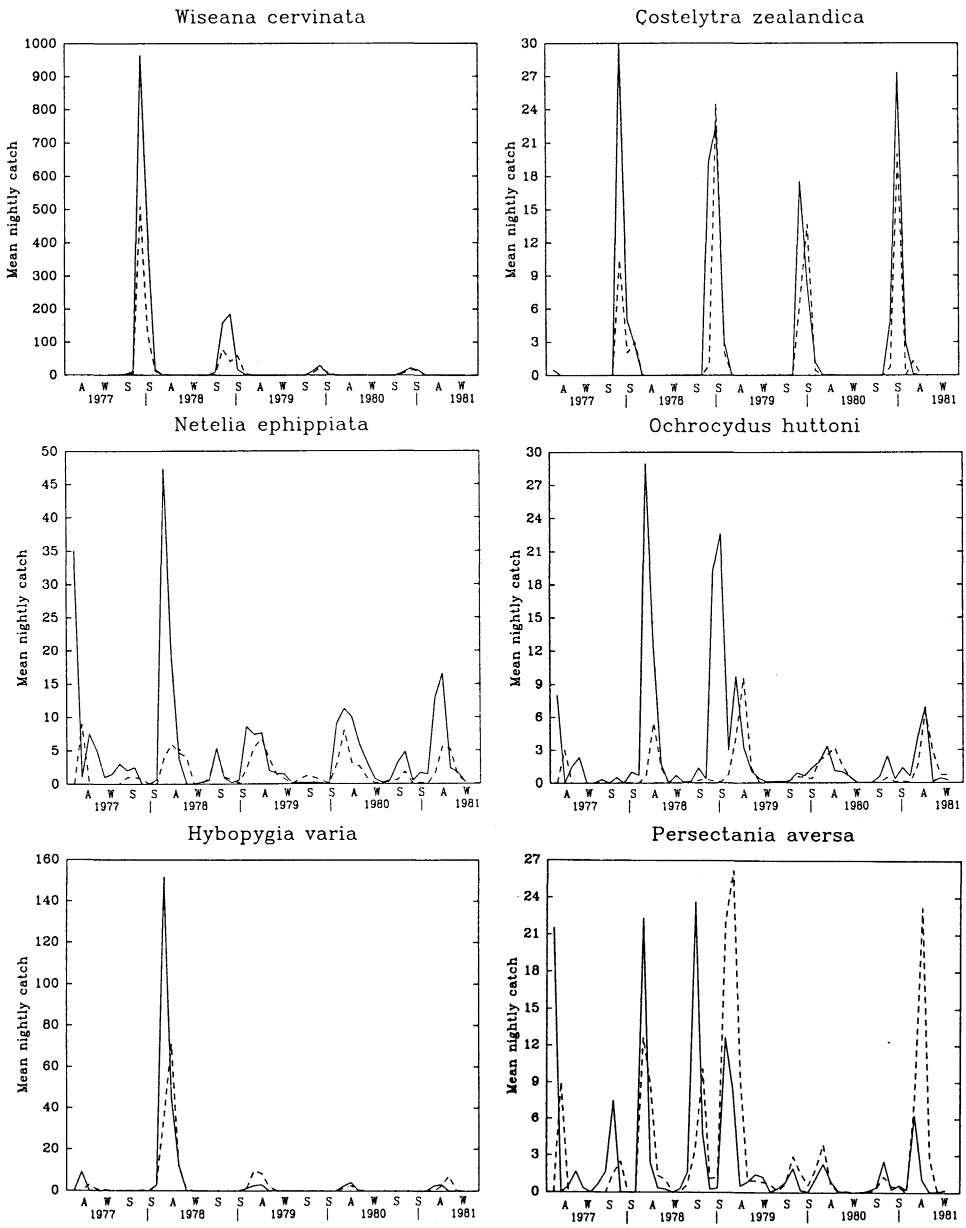


Fig. 4: The 15 most abundant categories of insects recorded from Ballantrae between February 1977 and July 1981.

Ochrocydus huttoni Pascoe (Coleoptera: Cerambycidae) the kanuka longhorn, in 11th position overall, merely confirmed the abundance of manuka and the 13th placing overall of the striped dung fly *Hybopygia varia* (Walker) (Diptera: Sarcophagidae) is only surprising because it is diurnally active and therefore would not be expected in light traps. However, Lewis & Taylor (1964) found that insects that fed on decaying organic matter flew most actively at dusk. They suggested that the still, moist air of dawn and dusk allows food to be easily detected by scent.

Of the noctuid (Lepidoptera: Noctuidae) complex that figured so significantly in the top-ranked insects, *Persectania aversa* (Walker) (southern armyworm), 6th overall, and *Agrotis* spp., mainly *A. ipsilon aneituma* (Walker) (greasy cutworm), in 14th position, are recognised but only sporadic pests (Pottinger 1977; Scott 1984). *Graphania mutans* (Walker) was clearly the 3rd most common insect in both traps and like *G. lignana* (Walker) and *Tmetolophota atristriga* (Walker), in 5th and 12th positions overall, it may eat pasture plants including grasses and clovers (J. S. Dugdale pers. comm.). *F. graminosa* has already been mentioned, its 7th overall placing resulting from the large TH record. *Graphania ustistriga* (Walker), 10th overall, feeds on a range of shrubs and small trees (Spiller & Wise 1982).

The 15th most abundant insect overall was *Wiseana umbraculata* (Guenee) (Lepidoptera:


Wiseana cervinata
Costelytra zealandica
Netelia ephippiata
Ochrocydus huttoni
Hybopygia varia
Persectania aversa
Mean nightly catch
A W S S A W S S A W S S A W S S A W
1977 | 1978 | 1979 | 1980 | 1981

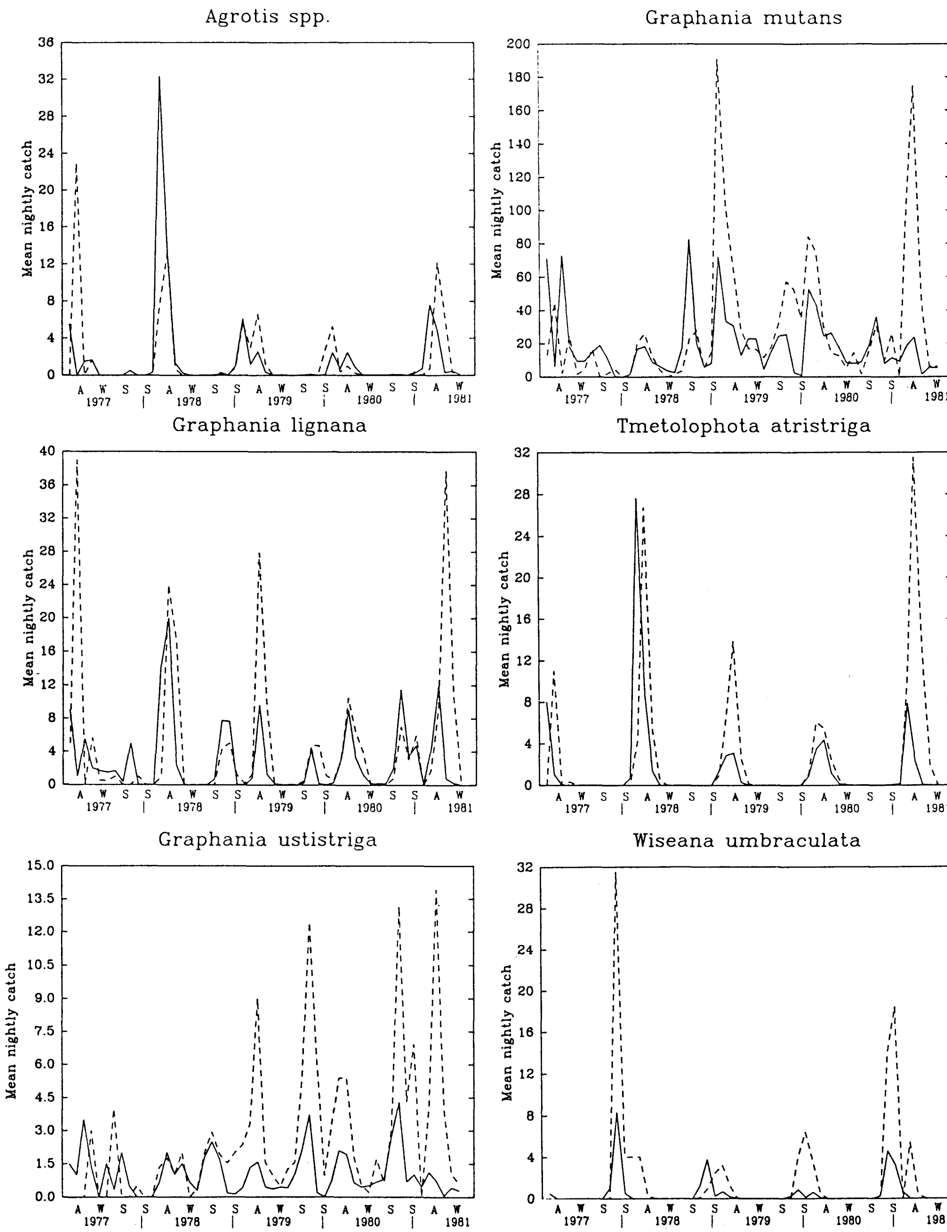


Fig. 5: Standardised records for some common taxa recorded from Ballantrae. Solid line = TL; broken line = TH. Seasons are three-monthly with summer comprising December, January, February.

Hepialidae), another economically significant species. Larvae of *Wiseana* species cannot be distinguished easily in the field, but it is likely that although *W. umbraculata* and the *W. cervinata* complex have similar effects on pasture, *W. umbraculata* is restricted to wetter (rush-infested) areas (J. S. Dugdale pers. comm.).

DISCUSSION

The disadvantages of light trapping as a sampling method are well known (Southwood 1978). Nevertheless light trap records provide at least 3 reliable pieces of information. Firstly, they can indicate the presence, but not the absence, of a species. Only if a species is attracted to light can its absence in a light trap record be interpreted as its absence from the trap's area of attraction. Thus, light traps give a minimum estimate of the number of species in an area ('species richness'; S). S may be at least as useful as more elaborate indices for describing the concept of diversity (Wolda 1983), although its use for this purpose has been criticised (Taylor *et al.* 1976).

Secondly, a light trap record can reasonably be expected to show variation in a species' abundance at 1 site between years, but not necessarily between generations in any single year, provided the effective trapping area remains constant. Large variations in weather patterns among years may also affect the accuracy of light trap records as estimators of insect abundance.

Thirdly, light traps describe the seasonal pattern of abundance of some insects. This may be of little use for insects that fly for long periods, but when a species flies for only part of the year, the times of appearance and disappearance of adults in the trap can give useful phenological comparisons. Unlike abundance estimates, timing of peak or first flights can be compared among traps, years, or even generations, unless one posits the existence of morphologically similar forms of the insect that occur at different times and have varying responses to different traps. This assumption may complicate the interpretation of light trap records but can be taxonomically useful.

The Ballantrae records can be used for all these purposes despite the inclusion of multi-species categories. The effect of including groups is to underestimate S, but since light trap records grossly underestimate S anyway by excluding most flightless and diurnally-active insects, this is not serious. Approximate site comparisons can be made simply by comparing the number of species in groups where identification of individuals has been taken to the same level.

The records most directly comparable with those from Ballantrae are those of Gaskin (1970) from Palmerston North. He recorded 219 species of Lepidoptera, compared with 96 named species and 6 either unnamed species or multi-species groups from Ballantrae. About 75% of the named Lepidoptera from Ballantrae also occurred in Gaskin's records and of those that were apparently unique to Ballantrae, most occurred in low numbers. Disregarding the anomalous *S. parthenia* record, the only species common at Ballantrae but not recorded from Palmerston North by Gaskin was *G. scutata*, which Gaskin may not have recognised. The Noctuidae were the best-identified group from the Ballantrae records and the number of species in this family was nearly identical for Ballantrae (46) and Palmerston North (43). The 2 localities seem to have quite similar faunas and this may reflect the similarity of many of the habitats found in the 2 areas, particularly the large areas of pasture and cut-over native bush.

The methods and light trap designs used in Cumber's (1950), Gaskin's (1970), and the present study were all different so the results from these cannot be compared quantitatively. On a gross scale the dominance of *Orocrambus* and the high rankings of *G. mutans, Wiseana*, and *Coleophora* in all 3 records are noteworthy from an agricultural perspective especially since this pattern seems to be common for many light trap records. The vegetation, climate, and topography of Ballantrae encompass much of the variety of SNI hill country and one can assume that these records would be typical for most hill country farms in the region.

In northern North Island hill country *Eudonia sabulosella* (Walker) (Lepidoptera: Pyralidae) may be the most economically important sod webworm (Cowley 1982) but it did not appear in the Ballantrae records unless under the 'Pyralidae (misc.)' category. This apparently substantial difference may be a sampling artefact. Cowley (1982) found that *E. sabulosella* flew late at night, whereas the Ballantrae traps did not operate after about 1 a.m. Gaskin (1970) also recorded moderate numbers of this insect in his first year of trapping continuously throughout each night.

The 1 a.m. shut-off may have underestimated the relative abundance of other insects, but would not have affected comparisons between the 2 traps. However, since light traps are very poor estimators of insect abundance anyway, the effect is not serious. The qualitative effect of not trapping between 1 a.m. and dawn is to miss species that fly only during this early morning period. During the 4½ years of trapping at Ballantrae, individuals of some of these species would have flown earlier in the night and may have been caught. Therefore the several years' trapping would have counteracted to some extent the qualitative effect of an early morning shut-off. The data of Lewis & Taylor (1964) for British insects suggest that few Lepidoptera fly exclusively between 1 a.m. and dawn and there is no reason to expect New Zealand Lepidoptera to differ from this pattern. The similarity between Gaskin's (1970) Palmerston North records and those from Ballantrae also suggests that all-night trapping would not have greatly altered the Ballantrae results.

The importance of several years' trapping becomes clear when the individual records of species like *B. defigurata, F. graminosa*, and *C. frischella* are examined. A single year's trapping could have drastically affected the interpretation of these species' abundance, depending on the year during which a trap was operated. For *C. frischella* even 2 years' trapping may have underestimated population variability.

The lack of knowledge concerning the biologies of many of the very abundant species raises questions about their possible effects on pasture. Work is needed on the in-field distributions and host plant preferences of species like *G. mutans, G. lignana*, and *Tm. atristriga.* The noctuid complex is recognised as a possible serious problem in South Island rangeland (White 1984) and may also damage pastures in SNI hill country. White (1984) cautioned that damage to tussock grasslands was often caused by a species complex, not by individual species and this must be considered if noctuids in SNI hill farms are investigated. In this environment acute pasture damage by porina and grass grub is common; *Coleophora* and *Orocrambus* both appear to be important faunal elements, and *Pyronota* spp. (Coleoptera: Scarabaeidae) cause locally severe pasture damage (Thomson *et al.* 1979; Miln *et al.* 1983). Cumber & Harrison (1959), Manson (1959), and McGregor & Watts (in prep.) found that the leaf- and shoot-mining flies *Hydrellia tritici* Coquillet (Diptera: Ephydridae) and *Cerodontha australis* Mallch (Diptera: Agromyzidae) were very numerous in SNI pasture and these flies may contribute to the overall pest loading of pasture (Barker *et al.* 1984). The interaction of several or all of these insects may cause many of the common problems of establishment and maintenance of good quality pasture in SNI hill country. Pasture pest interactions deserve investigation, particularly in hill country, but have largely been ignored in New Zealand.

The noctuid complex has another economic significance because of recent attempts to use porina flights as a sampling method for control programmes (MAF 1984). Many noctuids superficially resemble *Wiseana* spp. and, despite the actual ease of discrimination, large catches of noctuids like *G. mutans* or *G. lignana* during or near porina flight seasons may ultimately restrict the acceptance of light trapping by farmers for porina control programmes.

The grass grub *(C. zealandica)* record was interesting because the time of peak flights was consistently very late (December/January) and flights occurred over a longer period than at other North Island sites (See Henzell & Lauren 1978). Henzell & Lauren (1978) noted that grass grub flights were longer on steep or rolling sites than on flat sites. Topographical diversity is only 1 aspect of the habitat diversity that can cause variation in insect development times and hence increase the length of the flight period. Ballantrae's complex topography and wide range of pasture types, soil moisture, and micro-climates may explain the extended flight period for grass grub. The peak flights in late December and early January are characteristic of southern New Zealand and other cool or dry regions. In these areas some grass grubs may have a hemivoltine life history, suggesting that 2-year grass grub could occur at Ballantrae.

Flights of the *W. cervinata* complex at Ballantrae generally occurred between October and February, with peak flights in late November and early December. This agrees well with Carpenter & Wyeth's (1980) data from light trapping in other southern North Island sites. There is some suggestion that flights of the *W. cervinata* complex were more protracted at Ballantrae and at Carpenter's hill country sites than at his sites outside hill country. This supports the hypothesis, previously discussed for grass grub, that increased habitat diversity in hill country causes longer flight periods. The bimodal flight activity of the *W. cervinata* complex at TH in 1978 but not in other years also agrees with Carpenter & Wyeth's (1980) finding of variable polymodality of flight activity.

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Table 1: Insects collected by light trap in Southern North Island hill country.

	TH	*TL*	*Total*
LEPIDOPTERA			
Aenetus virescens (Doubleday)	15	72	87
Cladoxycanus minos (Hudson)	0	7	7
'Trioxycanus enysii' auct.	3	2	5
Wiseana cervinata (Walker) complex	15511	19104	34615
Wiseana signata (Walker)	81	617	698
Wiseana umbraculata (Guenee)	1995	564	2559
Strepsicrates parthenia (Meyrick)	0	200	200
Tortricidae (misc.)	771	1044	1815
Monopis spp.	9	7	16
Tineidae (misc.) mainly *Opogona omoscopa* (Meyrick)	116	801	917
Carposina eriphylla (Meyrick)	0	1	1
Coleophora frischella (Linnaeus)	1082	60	1142
Vanicela disjunctella (Walker)	1	1	2
Borkhausenia (= *Tingena*) spp.	32	29	61
Izatha peroneonella (Walker)	86	109	195
Diasemia grammalis Doubleday	16	34	50
Deana hybreasalis (Walker)	182	115	297
Eudonia aspidota (Meyrick)	21	10	31
Mecyna marmarina (Meyrick)	1	0	1
Scoparia diphtheralis Walker	248	139	387
Scoparia halopis Meyrick	10	0	10
Scoparia rotuella	15	28	43
Scoparia ustimacula Felder & Rogenhofer	1	1	2
Scoparia (misc.)	51	24	75
Uresiphita polygonalis maorialis (Felder & Rogenhofer)	136	157	293
Pyralidae (misc,)	307	83	390
Orocrambus spp. (mainly *O. flexuosellus* (Doubleday))	82384	321872	404256
Asaphodes camelias (Meyrick)	20	6	26
Asaphodes sp.	87	252	339
Austrocidaria gobiata Felder & Rogenhofer	1	0	1
Chloroclystis indicataria (Walker)	112	36	148
Chloroclystis testulata (Guenee)	218	34	252
Cleora scriptaria (Walker)	1	0	1
Dasypodia selenophora Guenee	1	0	1
Declana atronivea (Walker)	35	19	54
Declana floccosa (Walker)	101	392	493
Declana leptomera (Walker)	38	29	67
Elvia glaucata Walker	28	32	60
Epiphryne verriculata (Felder)	6	32	38
Epyaxa rosearia (Doubleday)	2	0	2
Gellonia dejectaria (Walker)	14	11	25
Helastia semisignata (Walker)	0	10	10
Pasiphila dryas (Meyrick)	0	1	1
Pasiphila spp.	1153	73	1226
Poicilasthena pulchraria (Doubleday)	1002	596	1598
Pseudocoremia leucelaea (Meyrick)	107	909	1016
Pseudocoremia suavis Butler	45	190	235
Tatosoma tipulata (Walker)	3	1	4
Xyridacma spp.	0	1	1
Geometridae (misc.)	756	1026	1782
Liothula omnivora (Fereday)	0	12	12
Bassaris gonerilla (Fabricius)	0	1	1
Antherea eucalypti Scott	1	4	5
Nyctemera annulata (Boisduval)	1	0	1
Utetheisa pulchelloides vaga (Jordan)	0	1	1

Table 1: *—continued*

	TH	*TL*	*Total*
Agrotis spp.	1596	1119	2715
Aletia lacustris Meyrick	1	0	1
Aletia moderata (Walker)	61	106	167
Bityla defigurata (Walker)	296	26	322
Chrysodeixis eriosoma (Doubleday)	50	66	116
Ctenoplusia albostriata Bremer & Grey	1	0	1
Dipaustica epiastra (Meyrick)	51	17	68
Feredayia graminosa (Walker)	5568	386	5954
Graphania agorastis (Meyrick)	8	12	20
Graphania infensa (Walker)	34	1	35
Graphania insignis (Walker)	316	403	719
Graphania lignana (Walker)	5011	2822	7833
Graphania mollis (Howes)	10	6	16
Graphania mutans (Walker)	39739	21877	61616
Graphania pansicolor (Howes)	7	10	17
Graphania paracausta (Meyrick)	52	17	69
Graphania plena (Walker)	182	60	242
Graphania prionistis (Meyrick)	25	6	31
Graphania scutata (Meyrick)	426	75	501
Graphania ustistriga (Walker)	3761	1189	4950
Graphania 'xanthogramma' not of Meyrick	3	1	4
Diarsia intermixta (Guenee)	42	15	57
Heliothis armigera conferta (Walker)	71	51	122
Mythimna separata (Walker)	67	96	163
Meterana alcyone (Hudson)	15	30	45
Meterana badia (Philpott)	4	1	5
Meterana coeleno (Hudson)	0	5	5
Meterana decorata (Philpott)	17	5	22
Meterana diatmeta (Hudson)	1	1	2
Meterana exquisita (Philpott)	235	26	261
Meterana grandiosa (Philpott)	315	72	387
Meterana levis (Philpott)	1	4	5
Meterana merope (Hudson)	1	0	1
Meterana ochthistis (Meyrick)	31	37	68
Meterana pascoi (Howes)	1	1	2
Meterana stipata (Walker)	55	8	63
Persectania aversa (Walker)	3844	2308	6152
Rhapsa scotosialis Walker	30	10	40
Rictonis comma (Walker)	24	3	27
Tmetolophota arotis (Meyrick)	34	11	45
Tmetolophota atristriga (Walker)	2969	906	3875
Tmetolophota purdii (Fereday)	0	1	1
Tmetolophota semivittata (Walker)	22	9	31
Tmetolophota steropastis (Meyrick)	17	10	27
Tmetolophota sulcana (Fereday)	20	13	33
(Noctuidae) sp. (resembles *Bityla*)	5	0	5
Le131	0	1	1
(unidentified; mainly Geometridae)	344	912	1256
COLEOPTERA			
Clivina rugithorax Putzeys	1	3	4
Neocicindela sp.	0	3	3
Co18 (Carabidae)	35	140	175
Co19 (Carabidae)	0	2	2
Rhantus pulverosus (Stephens)	58	113	171
Sternaulax zealandicus Marseul	1	54	55
Creophilus oculatus (Fabricius)	1	0	1
Necrophilus prolongatus Sharp	926	163	1089

Table 1: — *continued*

	TH	*TL*	*Total*
Ceratognathus sp.	9	13	22
Costelytra zealandica (White)	2208	3230	5438
Odontria smithi Broun	9	483	492
Odontria spp.	5	93	98
Pyronota spp.	8	2	10
Heterocerus sp.	5	216	221
Agrypnus variabilis (Candeze)	19	37	56
Conoderus exsul Sharp	1184	429	1613
Thoramus wakefieldi Sharp	10	7	17
Elateridae (misc.)	90	16	106
Stegobium spp.	0	2	2
Adalia bipunctata (Linnaeus)	0	1	1
Coccinella undecimpunctata Linnaeus	1	4	5
Enarsus bakewelli Pascoe	3	0	3
Thelyphassa lineata Fabricius	3	15	18
Arhopalus ferus (Mulsant)	0	6	6
Ochrocydus huttoni Pascoe	1272	2874	4146
Oemona hirta (Fabricius)	4	3	7
Prionoplus reticularis White	43	520	563
Cerambycidae (misc.)	4	3	7
Eucolaspis spp.	19	43	62
Paropsis charybdis Stal	0	2	2
Irenimus compressus (Broun)	9	62	71
Listronotus bonariensis (Kuschel)	3	28	31
Scolytinae (misc.)	1	0	1
Coleoptera (misc.)	588	510	1098
HYMENOPTERA			
Rogas spp.	0	3	3
Braconidae (misc.)	6	58	64
Cynipidae (misc.)	0	1	1
Degathina spp.	0	4	4
Enicospilus spp.	6	33	39
Lissonota spp.	6	3	9
Netelia ephippiata (Smith)	2047	3873	5920
Ophion spp.	41	104	145
Ichneumonidae (misc.)	73	122	195
Huberia brouni Forel	0	2	2
Mesoponera sp.	4	28	32
Monomorium spp.	58	16	74
Salius wakefieldi Kirby	0	1	1
Pompilidae (misc.)	2	8	10
Vespula germanica (Fabricius)	0	9	9
Bombus spp.	1	1	2
Hymenoptera (misc.)	36	70	106
DIPTERA			
'Gynoplistia' spp.	198	1284	1482
'Heterolimnophila' spp.	317	212	529
Di74A (Tipulidae)	0	12	12
Asilidae (misc.)	0	5	5
Tabanidae (misc.)	53	20	73

Table 1: *— continued*

	TH	*TL*	*Total*
Dolichopodidae (misc.)	2	53	55
Eristalis tenax (Linnaeus)	7	1	8
Syrphidae (misc.)	51	25	76
Neolimnia spp.	11	1	12
Hylemyia spp.	0	1	1
Hybopygia varia (Walker)	1735	1260	2995
Calliphora vicina Robineau-Desvoidy	98	148	246
Calliphora stygia (Fabricius)	137	195	332
Calliphora quadrimaculata (Swederus)	42	27	69
Lucilia sericata (Meigen)	0	6	6
Xenocalliphora hortona (Walker)	15	20	35
Calliphoridae (misc.)	23	1	24
Campylia spp.	27	5	32
Gracilicera spp.	31	5	36
Heteria spp.	3	0	3
Mallochomacquartia vexata (Hutton)	1	2	3
Protohystricia alcis (Walker)	15	3	18
Tachinidae (misc.)	195	9	204
Di122 (Muscidae)	149	402	551
Limnophora sp.	1	9	10
Muscidae (misc.)	448	305	753
Diptera (misc.)	705	432	1137
MEGALOPTERA			
Archicauliodes diversus Walker	25	111	136
ORTHOPTERA *sens. strict.*			
Conocephalus sp.	1	2	3
Gryllidae *(Teleogryllus + Pteronemobius)*	9	37	46
Orthoptera (misc.)	13	31	44
ISOPTERA			
Kalotermes brouni Froggatt	34	1	35
Stolotermes ruficeps Brauer	10	0	10
DERMAPTERA			
Forficula auricularia Linnaeus	0	12	12
MANTODEA			
Orthodera ministralis (Fabricius)	0	9	9
HEMIPTERA			
Scolypopa australis (Walker)	0	1	1
Cicadelloidea (misc.)	152	6	158
Cicadidae (misc.)	6	15	21
Oncacontias vittatus (Fabricius)	5	0	5
Pentatomidae (misc.)	1	3	4
Hemiptera (misc.)	99	39	138
EPHEMEROPTERA (misc.)	6	969	975
ODONATA (misc.)	12	0	12
BLATTODEA (misc.)	3	1	4
NEUROPTERA (misc.)	0	4	4
TRICHOPTERA (misc.)	122094	418663	540757