

## A LOW ALTITUDE SNOW TUSSOCK RESERVE AT BLACK ROCK, EASTERN OTAGO

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**SUMMARY:** The Black Rock Scientific Reserve has been set aside to preserve an area of low altitude snow tussock grassland. The reserve consists of gently rolling ridges covered in a narrow-leaved snow tussock (*Chionochloa rigida*) association, substantially intact or in various stages of degradation, and shallow gullies containing *Sphagnum* bog and minor grassland communities. To enable changes in the snow tussock association to be studied, four one hectare permanent quadrats have been established and sampled by Scott's height frequency method. If the reserve is to fulfil its designated purpose, exotic brush weeds and fire must be controlled.

### INTRODUCTION

The low altitude snow tussock communities, a distinctive feature of Eastern and Central Otago vegetation at the time of European settlement, have been drastically modified by agricultural practices and are now threatened with extinction. Following representations from Dr A. F. Mark of Otago University and other scientific interests, in December 1971 the Minister of Lands, the Hon. D. MacIntyre, set aside approximately 144.5 ha of the Lands and Survey Department Block at Black Rock as a scientific reserve (Fig. 1). He stated that the reserve had been created to preserve a natural stand of undisturbed low altitude snow tussock grassland and associated vegetation on a range of landscapes and soils (*Otago Daily Times*, 14 December 1971). It is to be administered by the Commissioner of Crown Lands in Dunedin assisted by an advisory committee representing ecological, scientific and geographical interests. Located on the Lammerlaw Range 61 km from Dunedin, most of the reserve comprises gently rolling ridges of a northerly aspect, tending east or west, with shallow gullies (Fig. 2). The highest ridge crest (at I on Fig. 2) has an elevation of approximately 770 m and the lowest point is at about 690 m. The only extensive aspect contrast is provided by the south-westerly slope from the highest ridge crest towards Lammerlaw Stream (Fig. 2).

Prior to fencing in 1971 the reserve was subject to the usual management of burning and grazing by sheep. Now the narrow-leaved snow tussock (*Chionochloa rigida*) association tends to be least

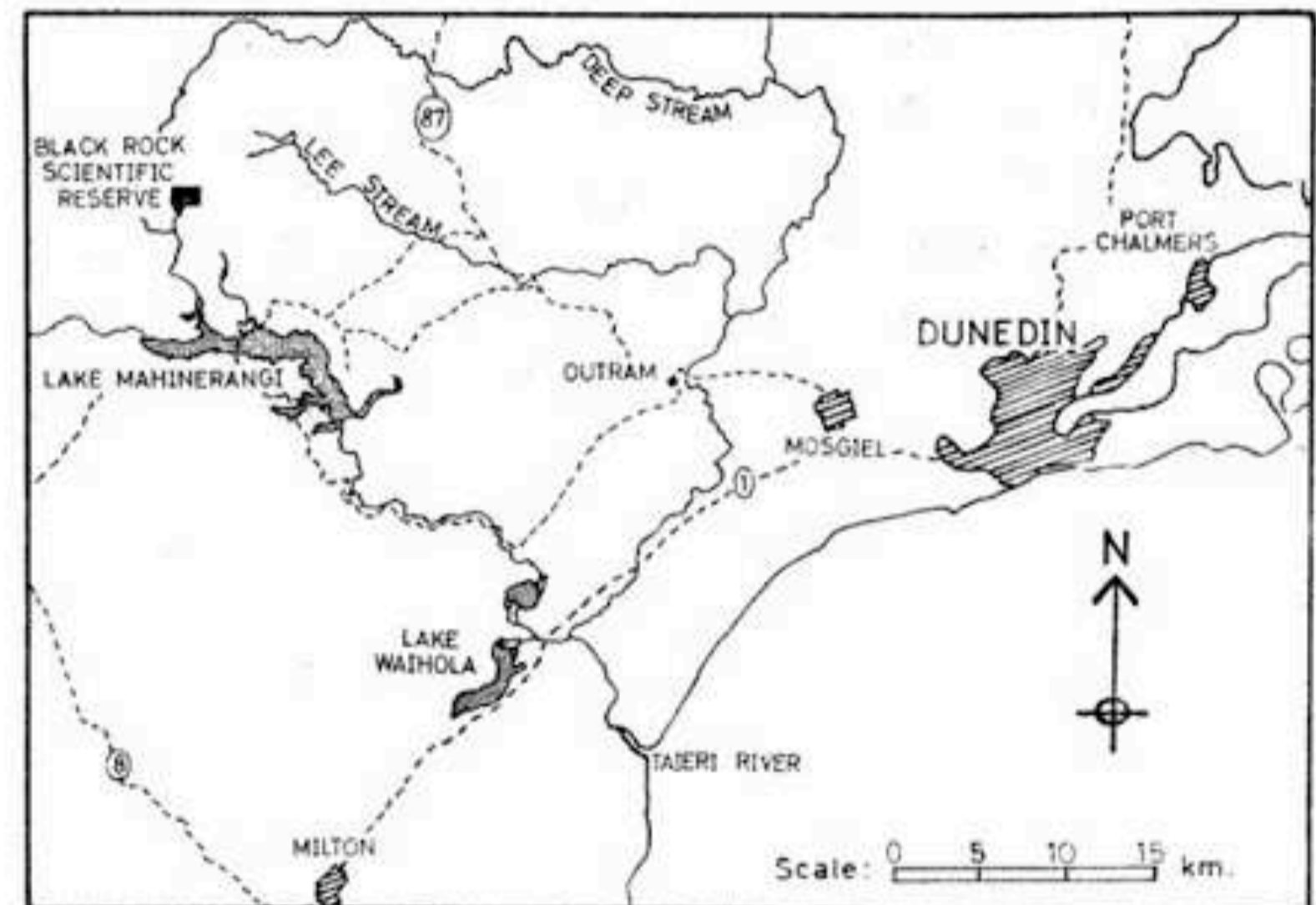


FIGURE 1. *Locality map of the Black Rock Scientific Reserve.*

modified on the slopes of the highest ridge crest where the snow tussock canopy is relatively continuous and associated species inconspicuous. The tussock community is most heavily modified round the boundaries where there is a substantial component of *Agrostis tenuis* either as continuous patches two metres or so across or as an associate of indigenous grassland species. The purity of the native community steadily improves towards the highest ridge crest except that the gullies contain *Sphagnum* and grassland communities with a heavy component of *Agrostis tenuis* throughout, and the entire area east of the vehicle track was accidentally burnt in 1971.

The purpose of this study, conducted during March and April 1972, was to describe the present condition of the reserve, so providing the basis for

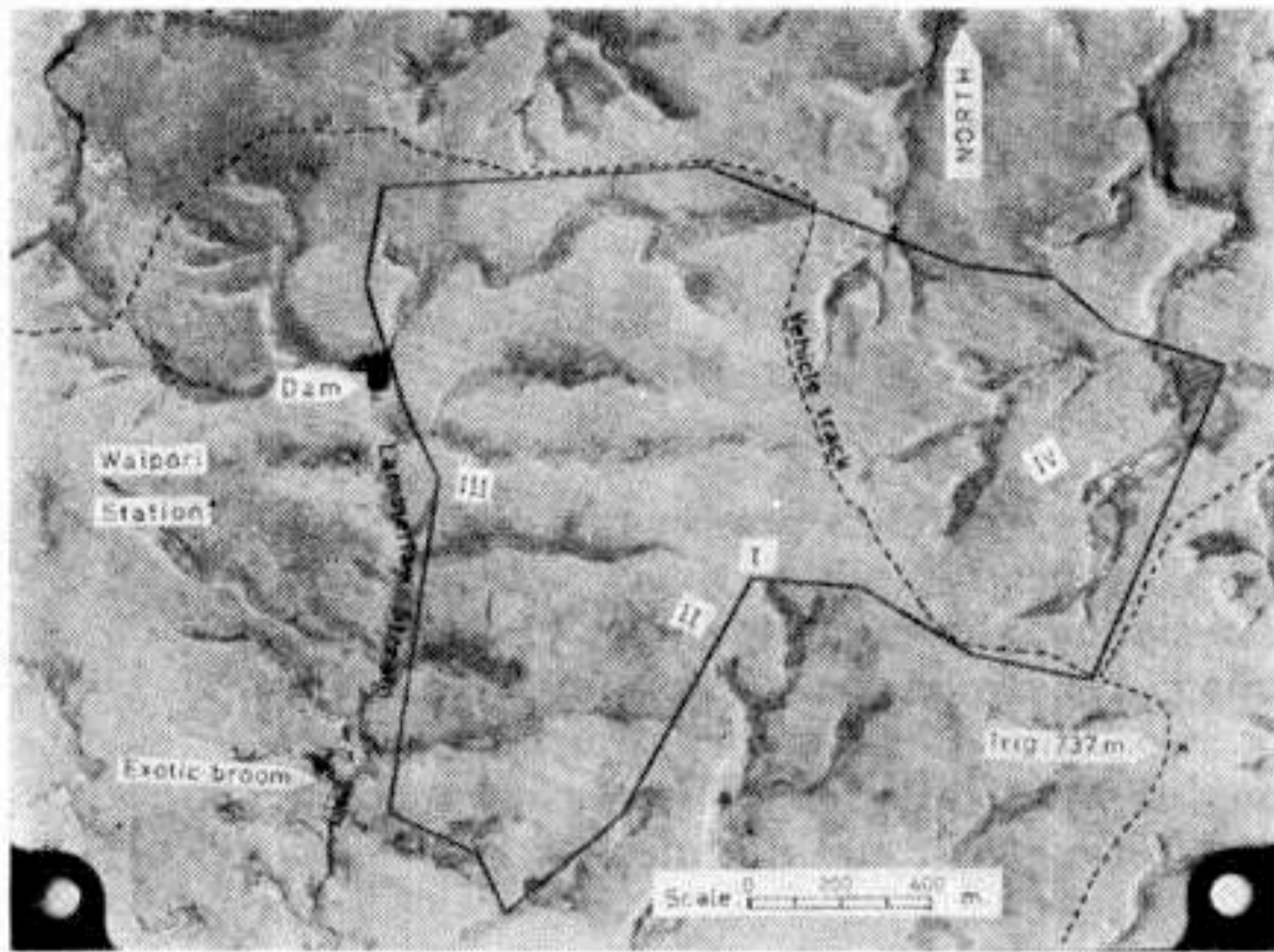


FIGURE 2. Aerial photograph 3497/12 showing the Black Rock Scientific Reserve, reproduced by permission of the Lands and Survey Department. The Roman numerals indicate the permanent quadrats.

recording future changes. The snow tussock communities on the ridges were assessed qualitatively and then four contrasting sites selected for one hectare permanent quadrats. In each quadrat 250 stratified random points were sampled by Scott's height frequency method (Scott 1965). The sampling volume had a basal area of  $20 \text{ cm}^2$  ( $4.71 \times$

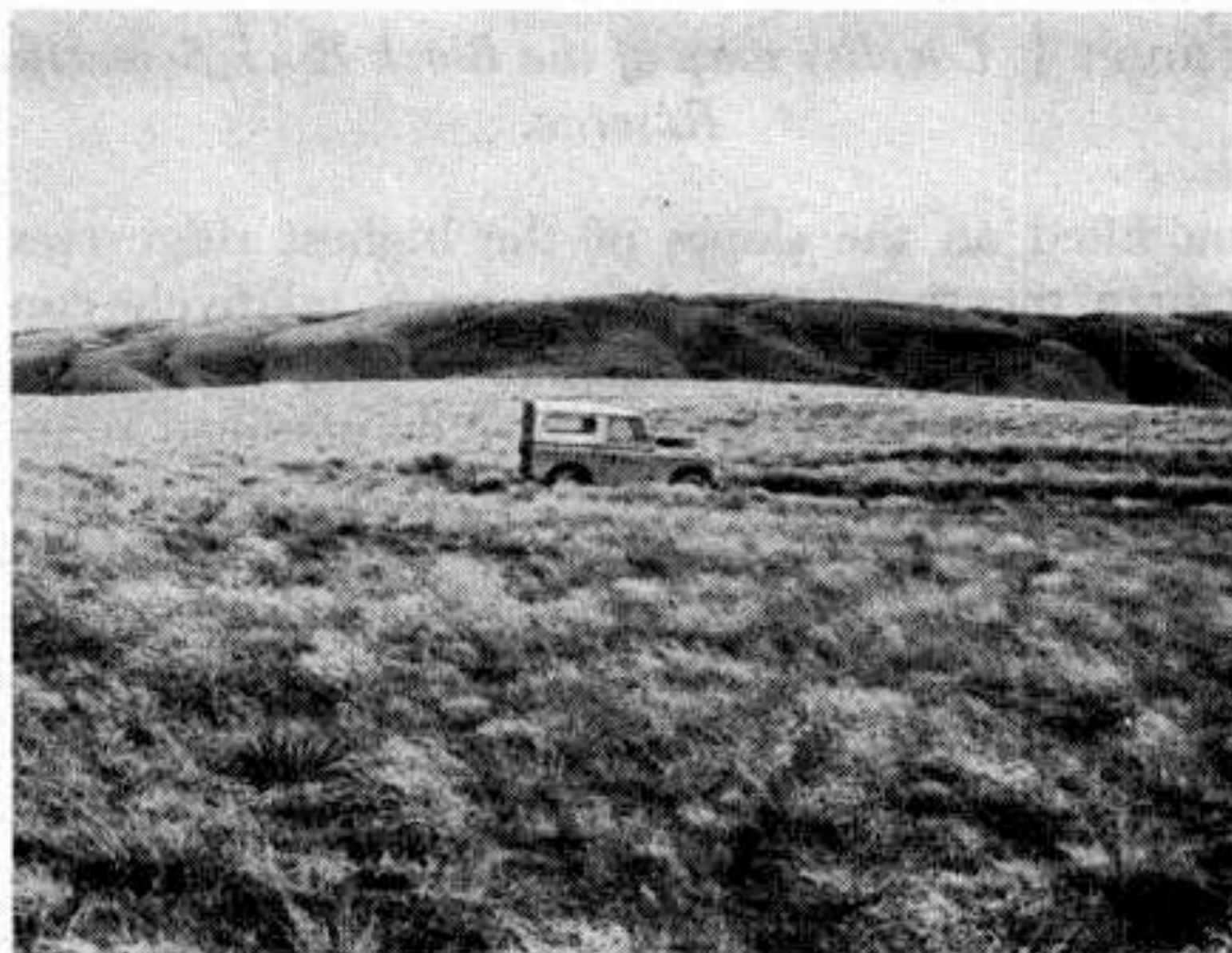


FIGURE 3. Looking towards the Lammerlaw Range summit from east of the track. The tussock in the foreground is in the first season of recovery after burning. Quadrat I is on the ridge crest in the middle distance.

$4.71 \text{ cm}$ ) and a height of five centimetres to give a volume of  $100 \text{ cm}^3$ . Vegetation in the gullies was assessed qualitatively and the more important physiognomic features noted on maps. Where suitable material was obtained Otago University Herbarium voucher numbers are shown in the species list in the Appendix. Nomenclature for native species follows Allan (1961), Moore and Edgar (1970), Zotov (1963), Sainsbury (1955) and Martin (1958).

Details of the sampling procedure, together with field data for both the quadrats and the gullies, are contained in a report (Bulloch 1972) deposited at the University of Otago Botany Department and with the Commissioner of Crown Lands in Dunedin. A diagrammatic representation of the quadrat data is shown in Figure 4.

#### VEGETATION ON THE RIDGES

Quadrat I, situated on the highest point in the reserve (Figs. 2 and 3), includes some of the most complete tussock cover. However, the *Chionochloa rigida* canopy over about half the quadrat is somewhat discontinuous with occasional patches of *Festuca novae-zelandiae* which otherwise is uncommon in the reserve. Accumulation of ground litter between the taller tussocks indicates that they have not been burnt for ten years or more. Both *Hypochaeris radicata* and *Anthoxanthum odoratum* are thoroughly integrated though relatively minor members of the community, but other exotics are sparse, suggesting that exotics can make little inroad into a slightly disturbed indigenous community.

Quadrat II is situated on a  $6^\circ$  slope of southerly aspect (Fig. 2) about 13 m elevation below the ridge crest, and straddles the upper limits of a 200 m wide zone of *Hebe odora* and *H. propinqua* seedlings (Fig. 5). Burnt remains of adult *H. odora* are restricted to a much narrower zone, suggesting that whilst shrubs are a significant component of the mature community here, the width of the present seedling zone is fire-induced. However, shrubs are favoured on the upper part of the south-westerly slope since *Coprosma cheesemani* is more common in Quadrat II than in the others, and it is only here that *Cassinia vauvilliersii* occurs on

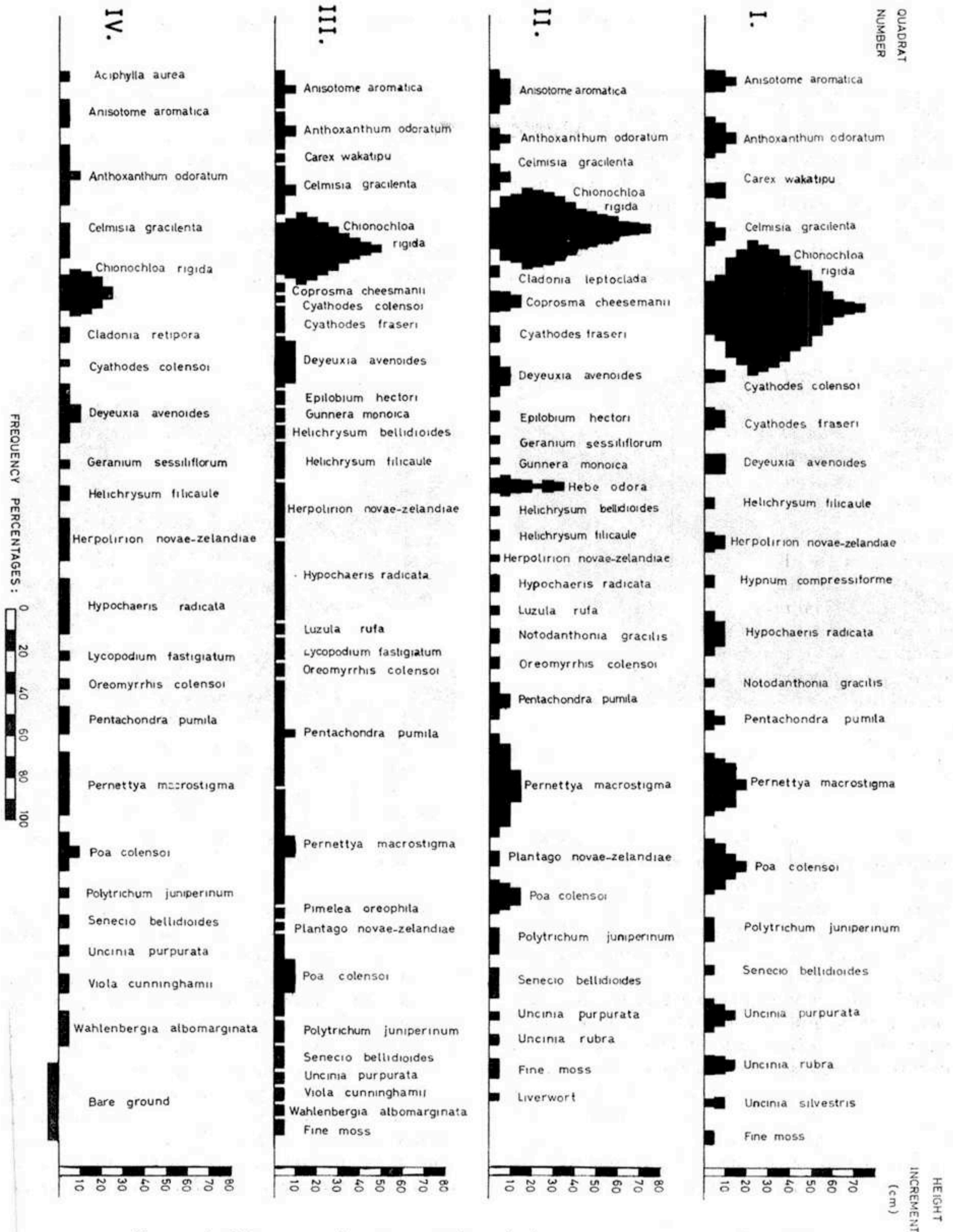


FIGURE 4. Diagrammatic representation of frequency percentages above 3.2.

the ridges and *Hebe propinqua* is common. Dead shrubs also include *Dracophyllum longifolium* which is now present only as seedlings on the outskirts of the zone, and *Leptospermum scoparium* of which only a few young shrubs now occur near the boundary with Waipori Station. Forest dimples (Wardle and Mark 1956) are common on the south-westerly slope, the nearest remnant stands of silver beech being in gullies on the Lammerlaws about three kilometres to the south-west of the reserve.



FIGURE 5. Young *Hebe odora* shrubs around the bases of snow tussocks in Quadrat II. The notebook is 16 x 10 cm.

Most of the south-westerly slope is a mosaic of communities in differing conditions suggesting repeated local burnings. Since the main canopy was disrupted the fires have tended to run only relatively short distances. Quadrat II straddles the transition from this mosaic to the more continuous snow tussock cover towards the ridge crest and it should enable any improvement in the transition zone to be recorded. It will also facilitate a critical assessment of the role of *Hebe* scrub in the absence of fire. Since the taller snow tussocks overtop the adult *Hebe odora* shrubs, and *Hebe* seedlings are rare beneath a closed tussock canopy, *Chionochloa rigida* is likely to remain dominant or regain dominance over most of this zone with the scrub persisting as a subcanopy associate.

Quadrat III has an elevation of about 740 m and a 7° slope of westerly aspect. Its vegetation is typical of at least half of that part of the reserve not burnt in 1971 and probably represents the state of much of the remaining area before the fire. The *Chionochloa rigida* tussocks here are healthy but their canopies are discontinuous and provide little cover over the inter-tussock vegetation. Litter is sparse but the ground cover of indigenous species between the tussocks is dense (Fig. 6), denying exotics other than *Hypochaeris* and *Anthoxanthum* any substantial foothold (Fig. 4).



FIGURE 6. The dense inter-tussock ground cover of Quadrat III. The species include *Poa colensoi*, *Pernettya macrostigma*, *Coprosma cheesmanii*, *Lycopodium fastigiatum*, *Deyeuxia avenoides*, *Herpolirion novae-zelandiae*, *Cyathodes fraseri*, *Epilobium hectori*. The matchbox is 5 x 4 cm.

Over most of the area burnt in 1971 the snow tussocks have been reduced to tufts of tillers arising from charred bases. On the steeper inclines with a northerly aspect *Aciphylla aurea* had been a significant component of the community, possibly induced by burning and grazing. The adult *Aciphylla* have survived the 1971 fire better than the snow tussocks and there are numerous *Aciphylla* seedlings. The bare ground exposed by the fire (Fig. 4) seems highly susceptible to invasion by exotics but only *Hypochaeris* is poised for imminent occupation. Though most subshrubs or *Pernettya macrostigma* and *Pentachondra pumila*

were killed by the fire, these and other indigenous ground cover species will probably again limit *Hypochaeris* after a few seasons. Quadrat IV, located on such an area of *Aciphylla* prominence, has an inclination of 4° and a north-easterly aspect. Besides the opportunity for monitoring the post-fire recovery of the tussock community and assessing the ability of *Aciphylla aurea* to maintain its fire-induced status, Quadrat IV should offer instructive long-term comparison with the other quadrats since it is of a somewhat different character. For example, it is the only quadrat in which a significant amount of *Cladonia retipora* was sampled (Fig. 4) or in which *Oreostylidium subulatum* and *Coprosma pumila* were noted as contributing locally to ground cover.

The number of *Chionochloa rigida* seedlings sampled, approximately nine per quadrat, seem adequate for the natural regeneration of such a long-lived species (Mark 1969).

#### VEGETATION IN GULLIES

The gully floors are generally waterlogged although some tend to be drier—especially if there is a streamlet to facilitate drainage. All members of the tussock community are found to varying degrees on the gully floors. Additional species largely confined to the gullies are noted in the Appendix.

The first of three basic associations recognised on the gully floors is *Sphagnum* bog. It is of very limited extent and is characterised by waterlogged *Sphagnum* about 50 cm deep with only a few associated species such as *Centrolepis ciliata*.

The second is a *Sphagnum*/grassland association which occupies about half of the gully floors. A sparse cover of *Chionochloa rigida* and/or *Hebe* and *Cassinia* shrubs emerge above the *Sphagnum*, whilst other moisture-tolerant grassland species often make significant contributions to cover. *Carex coriacea* and *Juncus gregiflorus* frequently dominate along streamlet banks, while *Carex lachenalii* and *C. echinata* are more local *Sphagnum* associates. *Dacrydium bidwillii* and *Dracophyllum politum* are distinctive but minor

members of the community. This mixed association may result from accumulated *Sphagnum* building up the gully floor above the water table and so facilitating the invasion of grassland species from drier sites.

Thirdly, there is a grassland association on the drier gully floors. Brown top (*Agrostis tenuis*) is always an important member of this association and often forms pure swards. At the heads of some of the gullies large *Chionochloa* tussocks are scattered through the browntop sward, seemingly protected from fire by their isolation from adjacent tussocks. Up to a third of these isolated snow tussocks are *Chionochloa rigida* x *rubra* hybrids. The browntop sward in the gullies and the hybrid tussocks coincide with persistent snow-lie for periods of a week or so after most snowstorms.

The sloping sides of the gullies are generally clad in a degraded *Chionochloa rigida* association often with a browntop component, while the steeper south-facing slopes also have a shrub belt. Because of continuous shading during winter these shrub belts are subject to persistent snow-lie, and persistent snow-lie probably also influences the shrub zone in the vicinity of Quadrat II.

A few metres outside the north-western boundary of the reserve there is a small dam (Fig. 2) surrounded by *Juncus lampocarpus* and containing *Eleocharis acuta*, *Potamogeton cheesemani* and *Myriophyllum propinquum*.

#### CONCLUSION

Whilst the Black Rock Scientific Reserve will prove essential for studying the dynamics of the pre-European low altitude snow tussock association of Eastern Otago, and for studies of microfauna and natural soil formation, its value will be determined by its management. For instance, the stand of exotic broom (*Cytisus scoparius*) on Waipori Station about 100 m from the boundary of the reserve could pose a threat in the near future. Uncontrolled burning is undesirable but controlled burning and grazing may be necessary to prevent an upsurge of browntop and *Hebe odora*. However, since browntop is a significant component of only the most modified tussock communities

and undamaged snow tussock overtops the adult *Hebe* shrubs, at least initially stock and fire should be excluded. Finally, to enable informative scientific comparisons, there is a need for further low altitude native grassland reserves to be set aside whilst their preservation is still possible, particularly a low altitude hard tussock association and a Southland red tussock association.

#### ACKNOWLEDGMENTS

I am grateful for helpful supervision from Associate Professor A. F. Mark, and advice and assistance from Professor G. T. S. Baylis, Dr J. B. Wilson, Mrs Elspeth McRae, and Miss Lynda Chapman.

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#### APPENDIX

##### Species List

##### For the Black Rock Scientific Reserve

Legends: G = largely confined to gullies.

E = exotic.

D = in dam.

The figures are OTA (Otago University Herbarium) voucher numbers.

##### Pteridophytes.

*Lycopodium australianum*

„ *fastigiatum*

„ *scariosum*

*Blechnum minus*

„ *penna-marina*

*Polystichum vestitum*

*Pteridium aquilinum* var. *esculentum*

##### Gymnosperms.

#### PODOCARPACEAE

*Dacrydium bidwillii*

G

##### Monocotyledons.

#### AGAVACEAE

*Phormium cookianum*

G

#### CENTROLEPIDACEAE

*Centrolepis ciliata*

G 032362/73

#### CYPERACEAE

*Carex coriacea*

G

„ *echinata*

G 032366

„ *lachenalii*

G 032367

„ *wakatipu*

032347

*Cyperus alpina*

G

*Eleocharis acuta*

D 032370

*Oreobolus pectinatus*

*Uncinia purpurata*

032349

„ *rubra*

032350

„ *silvestris*

032348

#### JUNCACEAE

*Juncus antarcticus*

„ *gregiflorus*

G 032353

„ *lampocarpus* Ehr.

G, E 032363

*Luzula rufa*

#### GRAMINEAE

*Agrostis muscosa* T. Kirk

„ *tenuis* Sibth

E

*Aira caryophylla* L.

E

*Anthoxanthum odoratum* L.

E

*Chionochloa rigida*

„ *rigida x rubra*

*Deyeuxia avenoides* Buch.

*Erythranthera pumila*

032360

*Festuca novae-zelandiae* Cockayne

*Hierochloa antarctica* (Labill) Brown

G 032355

*Holcus lanatus* L.

E

*Notodanthonia gracilis*

*Poa colensoi* Hook.f.

#### LILIACEAE

*Astelia nervosa*

*Bulbinella angustifolia*

*Herpolirion novae-zelandiae*

ORCHIDACEAE			
<i>Aporostylis bifolia</i>			
<i>Microtis unifolia</i>			
<i>Thelymitra longifolia</i>			
POTAMOGETONACEAE			
<i>Potamogeton cheesemanii</i>	D		
Dicotyledons.			
CAMPANULACEAE			
<i>Wahlenbergia albomarginata</i>			
CARYOPHYLLACEAE			
<i>Cerastium holoseoides</i> Fries	G, E		
<i>Scleranthus brockiei</i>		032365/68	
<i>Stellaria media</i> (L.) Vill.	G, E		
COMPOSITAE			
<i>Brachycome sinclarii</i>		032356	
<i>Cassinia vauvilliersii</i>			
<i>Celmisia gracilentia</i>			
" <i>prorepens</i>			
<i>Cirsium vulgare</i> (Savi) Ten.	E		
<i>Craspedia uniflora</i> var. <i>uniflora</i>			
<i>Gnaphalium japonicum</i> Thunb.	E	032371	
" <i>traversii</i>		032361	
<i>Helichrysum bellidioides</i>			
" <i>flicaule</i>			
<i>Hieracium pilosella</i> L.	E		
<i>Hypochaeris radicata</i> L.	E		
<i>Lagenophora cuneata</i>			
<i>Olearia virgata</i> var. <i>rugosa</i>	G		
<i>Raoulia subsericea</i>			
<i>Senecio bellidioides</i>			
CORIARIACEAE			
<i>Coriaria sarmentosa</i> *			
DROSERACEAE			
<i>Drosera arcturi</i>	G		
EPACRIDACEAE			
<i>Cyathodes colensoi</i>			
" <i>empetrifolia</i>			
" <i>fraseri</i>			
<i>Dracophyllum longifolium</i>			
" <i>politum</i>	G	032354	
<i>Pentachondra pumila</i>			
ERICACEAE			
<i>Pernettya macrostigma</i>			
<i>Gaultheria crassa</i>			
GENTIANACEAE			
<i>Gentiana bellidifolia</i>		032351	
" <i>grisebachii</i>		032352	
GERANIACEAE			
<i>Geranium microphyllum</i>			
" <i>sessiliflorum</i>			
HALORAGACEAE			
<i>Gunnera monoica</i>			
" <i>strigosa</i>		032364	
<i>Haloragis depressa</i>			
<i>Myriophyllum propinquum</i>	D		
OBELIACEAE			
<i>Pratia angulata</i>			
MYRTACEAE			
<i>Leptospermum scoparium</i>			
POLYGONACEAE			
<i>Muehlenbeckia complexa</i>			
<i>Rumex acetosella</i> L.			E
ONAGRACEAE			
<i>Epilobium hectori</i>			032357
PAPILIONACEAE			
<i>Cytisus scoparius</i> L.**			E
<i>Trifolium repens</i> L.			E
PLANTAGINACEAE			
<i>Plantago novae-zelandiae</i>			032359
RANUNCULACEAE			
<i>Ranunculus lappaceus</i>			
ROSACEAE			
<i>Acaena anserinifolia</i>			
" <i>caesiiglauca</i>			
<i>Geum leiospermum</i>			
RUBIACEAE			
<i>Coprosma cheesemanii</i>			
" <i>propinqua</i>			
" <i>pumila</i>			
<i>Galium perpusillum</i>			
<i>Nertera balfouriana</i>			032358
" <i>depressa</i>			
SCHROPHULARIACEAE			
<i>Hebe odora</i>			
" <i>propinqua</i>			
<i>Euphrasia zelandica</i>			
STYLIDIACEAE			
<i>Forstera tenella</i>			G
<i>Oreostylidium subulatum</i>			
THYMELAEACEAE			
<i>Drapetes dieffenbachii</i>			
<i>Pimelea oreophila</i>			
UMBELLIFERAE			
<i>Aciphylla aurea</i>			
" <i>scott-thompsonii</i>			G
<i>Anisotome aromatica</i>			
<i>Hydrocotyle novae-zelandiae</i>			G
<i>Oreomyrrhis colensoi</i>			
" <i>ramosa</i>			G 032369
VIOLACEAE			
<i>Viola cunninghamii</i>			
Mosses.			
<i>Hypnum compressiforme</i>			
<i>Polytrichum formosum</i>			
" <i>juniperinum</i>			
<i>Rhacomitrium lanuginosum</i> var. <i>pruinatum</i>			
<i>Sphagnum cristatum</i>			
Hepatics.			
<i>Marchantia</i> sp.			
Lichens.			
<i>Cladonia aggregata</i>			
" <i>alpestris</i>			
" <i>leptoclada</i>			
" <i>retipora</i>			

\* Actually found in Waipori Station 2 m outside reserve.

\*\* Two specimens found in the reserve were removed.