VEGETATION STUDIES ON THE HUMBOLDT MOUNTAINS FIORDLAND PART 1: THE ALPINE TUSSOCK GRASSLANDS

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INTRODUCTION

Tussock grassland vegetation on the western slope of the Humboldt Mountains overlooking the Hollyford Valley in northern Fiordland was analysed quantitatively with a series of sample plots at six sites. These plots were located on the prominent spur which runs southwest from the summit of Ocean Peak (1,848 m.—Fig. 1). The study was made to determine whether changes in composition and cover of the grassland vegetation between the silver beech *(Nothofagus menziesii)* timber line and the upper limits of closed vegetation at about 1,640 m., conform to a gradient or whether discrete communities are recognisable. Since the transect began within 3 km. of the Deadman's-Harris Saddle track, it could be considered as an upward extension of the altitudinal gradient already described for the forest (Mark and Sanderson 1962).

The work was carried out by a party of botany students and staff during a University of Otago Science Students' Association expedition in May, 1963.

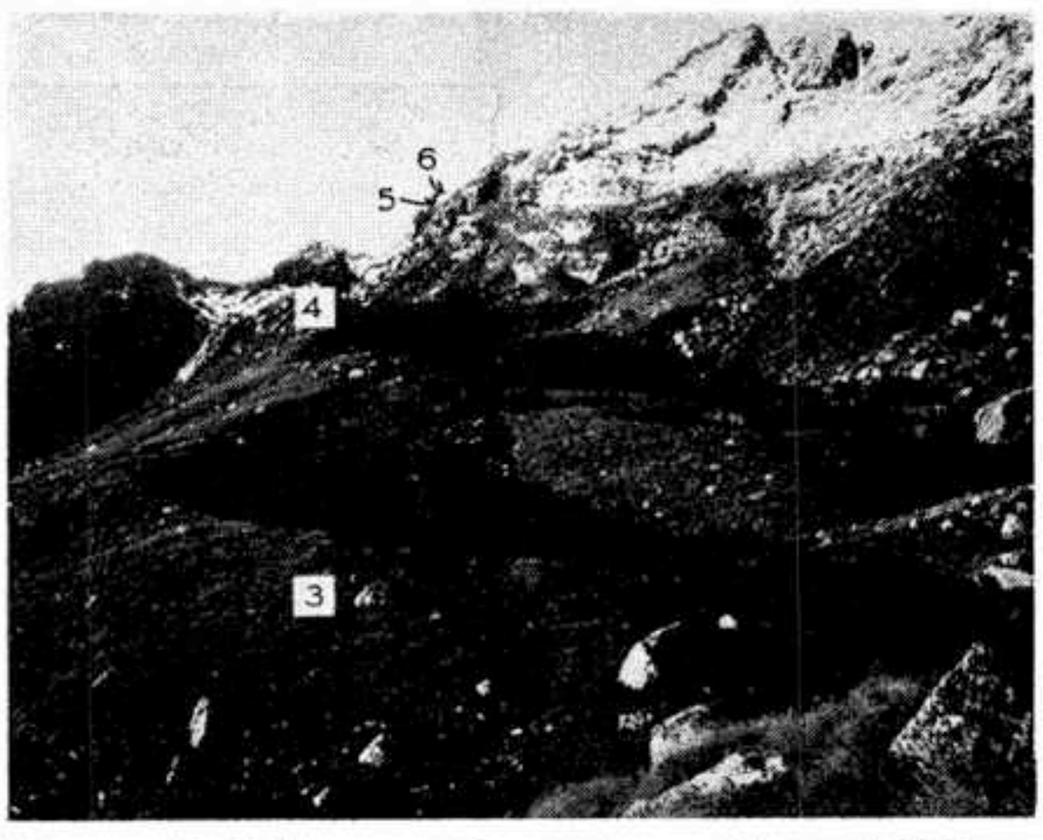

FIGURE 1. *View northeast from about 1,220 m. to the summit of Ocean Peak at 1,848 m., covering the location of four of the six sites.*

NOMENCLATURE

Nomenclature follows Allan (1961) for pteridophytes, gymnosperms, and dicotyledons, and Cheeseman (1925) for the monocotyledons, except for the grass genera *Chionochloa* and *Notodanthonia* which follow Zotov (1963), or where authorities are cited.

THE AREA

Geologically the area consists of partly schistose greywacke except for a band of undifferentiated basic volcanic rock, commonly schistose and highly altered, along the summit of the range (Wood 1962). Both belong to the Caples Group.

Topography is moderately to steeply undulating with the slope generally between 20° and 35°, but steepening appreciably with a marked increase in bare rock over the last 300 m. of Ocean Peak. The westerly aspect exposes all sites to prevailing winds. Precipitation data are available for Homer Tunnel (650 m.) 16 km. to the west in the Upper Hollyford Valley where mean annual rainfall is 711 cm., and for Marian Camp (344 m.) 10 km. to the southwest on the valley floor where it is 450 cm. An annual precipitation of over 500 cm., evenly distributed throughout the year, can thus be expected on the area. Information on temperature and snow is not available, although snow may fall during any month and usually covers the ground for considerable periods during winter.

There was no evidence of recent fires nor of heavy grazing by deer, although several deer were sighted.

METHODS

Sampling sites were selected to show changes in vegetation which seemed to be due to altitude. There was no fixed interval between them; indeed at the highest altitude (1,640 m.)

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two were contiguous, one being in an area where snow accumulates. The greatest interval in elevation was 200 m.

At each site, measurements were made of plant cover and frequency of species. Cover was measured with point intercepts at 30 cm. intervals along 10 lines each 15 m. long, making a total of 500 points per site. The lines were parallel, about five m. apart, and at right angles to the contour. Three strata were recognised. The upper stratum (> 30 cm. high) included tall subalpine shrubs and herbs which occur close to timber line, and the large snow tussock *Chionochloa flavescens*. The middle stratum (15–30 cm. high) included medium herbs and shrubs such as *Celmisia petriei* and *Hebe hectori*, and the smaller snow tussock *Chionochloa crassiuscula*. The ground stratum (< 15 cm. high) included dwarf shrubs and herbs such as *Myrsine nummularia* and *Astelia linearis*. Tall plants were also included in lower strata if they were intercepted there. Since only the first hits were recorded for plants in each stratum, the term dominance may be more appropriate than cover, to express the results (Hanson 1962). Values for percentage dominance for each species in each stratum were based on the number of interceptions. In addition, species lists were compiled for a rectangular plot 2 m. wide, centred on each line. Frequency values for each species were based on occurrence in the 10 plots.

Voucher specimens of most of the species recorded are deposited in the Otago University Herbarium.

RESULTS

Values for frequency and percentage dominance in each stratum are shown in Table 1, where species are arranged by strata and then according to altitudinal distribution. The habit of each species is also indicated as follows: tall shrubs and herbs, > 30 cm. high; medium shrubs and herbs, 15–30 cm. high; and dwarf shrubs and herbs, < 15 cm. high. The many patterns of species distribution shown in Table 1 suggest an altitudinal gradient. Tall shrubs are almost confined to the vicinity of the timber line where they contribute about half of the dominance in the upper stratum. Several other woody and herbaceous species (nos. 1, 2, 4, 5, 10, 11 and 12 in Table 1) are similarly restricted in distribution. The tall snow tussock *Chionochloa flavescens* (no. 44) is important at all except the high-altitude site (site 6 in Table 1) where snow accumulates. At this site the upper stratum is virtually absent and the middle stratum is also of minor importance. The smaller snow tussock *C. crassiuscula* (no. 51) is absent from the timber line area and of minor importance above 1,500 m., being rare where snow accumulates (site 6). Between 1,100 m. and 1,500 m., however, it is an important co-dominant. *Celmisia petriei* (18) is common as a sub-dominant below 1,500 m., and *Astelia cockaynei* (41) and *Schoenus pauciflorus* (42) occur throughout.

Among the ground layer species *Dacrydium laxifolium* (58) and *Astelia linearis* (32) are important at site 2 (1,140 m.) where the reduced slope somewhat impedes drainage. *Chionochloa oreophila* (101) is confined to the two high-altitude sites but is important and dominant only where snow accumulates (site 6). *Poa colensoi* (37) occurs throughout but increases in importance with altitude to become co-dominant with *C. oreophila* and *Celmisia hectori* (98) at site 6.

Distributions of certain species of *Celmisia* are of interest. *C. bonplandii* (35) occurs at all sites but is of minor importance. *C. petriei* (18) is confined to the lower four sites, whereas *C. walkeri* (61) and *C. glandulosa* (62) are common between 1,120 m. and 1,500 m. *C. petiolata* (76) and *C. sessiliflora* (77), on the other hand, were seen above about 1,150 m. and *C. hectori* (98) occurs only above 1,500 m.

Bare earth is uncommon at all sites but litter, mostly leaves of snow tussock and, near timber line, of *Dracophyllum*, covers up to 48% of the ground.

Index of Similarity Between Sites

Sorensen's Quotient of Similarity—K (Sorensen 1948)—was used to assess the degree of relationship between the flora at the various sites. The method involves expressing the species common to each pair of sites as a percentage of the total species present at both, thus:

$$Kab = \frac{2C}{A + B} \times 100$$

where A and B are the number of species at sites a and b, and C is the number shared. Results for the six sites are shown in Table 2. Each coefficient was then tested for significance by the method recommended by Looman and Campbell (1960).

The use of this test of floristic affinity might be questioned on the basis that sites were

selected rather than chosen at random. However, selection was based largely on topography and dominant species, and these species, being a small proportion of the total flora at a site, make only a minor contribution to the results.

Similarities in the vegetation between each of the six sites were determined by a similar method but using different units (Oosting 1956). The cover provided by species common to a pair of sites is expressed as a percentage of the total cover at the two sites, thus:

$$\text{Cab} = \frac{2W}{A + B} \times 100$$

where A and B are the totals of percentage plant cover at sites a and b, and W the sum of the lowest of each pair of percentage cover values of species present at both sites. The dominance values for the three strata were combined for these analyses. No test of significance is available for these coefficients.

Table 2 indicates the presence of an altitudinal gradient in the flora, in that adjacent sites tend to be more closely related than distant sites. Superimposed on this pattern, however, is one suggesting the presence of three separable entities. Thus coefficients exceeding 70% unite sites 2, 3 and 4, and also sites 5 and 6, whereas site 1 does not reach this degree of association with any of the others.

Correlations between sites based on vegetation (Table 2) show only moderate similarity with the floristic affinities. These correlations reflect the degree to which the dominant and important sub-dominant species, rather than the total flora, are shared between sites. This is clearly demonstrated with sites 5 and 6, which show a strong floristic relationship despite a relatively low correlation based on their vegetation.

CONCLUSIONS

A total of 105 plant species is listed from six sites in alpine tussock grassland occupying an altitudinal span of 560 m. above timber line on the western slope of the Humboldt Mountains in Fiordland. Approximately half the total number occurs at every site.

On the basis of physiognomy three communities are obvious. The first, a mixed snow tussock-scrub in which *Chionochloa flavescens* shares dominance with subalpine shrubs especially *Dracophyllum uniflorum*, occupies a narrow zone within 75 m. of the silver beech timber line at about 1,000 m. The second, present above about 1,100 m., is a tussock grassland dominated by *C. flavescens* and the shorter *C. crassiuscula*. In snow pockets above about 1,500 m. this is replaced by the third community, in which the dwarf tussocks *C. oreophila* and *Poa colensoi* share dominance with *Celmisia hectori*. Both grass species characterise snow hollows in other parts of the South Island (Burrows 1962). Tall shrubs are unimportant in the grassland except near timber line, but several species of *Celmisia* are prominent. The grassland dominated by tall evergreen species of *Chionochloa* at sites 1 to 5 would come within the "low(er) alpine" zone, whereas the dwarf grassland occupying the site of snow accumulation (site 6) would be designated "high alpine" (Wardle 1964).

A consideration of floristic affinities between sites substantiates separation of the snow tussock-scrub as a distinct community within the low alpine zone. However, it also suggests the possibility of recognising two communities within the low alpine snow tussock grassland: one below about 1,500 m. where *Chionochloa flavescens* and *C. crassiuscula* share dominance and the other above. The upper community is distinguished by a reduction in *C. crassiuscula*, a corresponding increase in *Poa colensoi* and the appearance of *Celmisia hectori*. Despite obvious differences in physiognomy there is a close affinity betwen the flora of snow hollows and surrounding areas.

As yet, there is very little information on patterns in alpine grasslands in Fiordland. Similar patterns may be widespread in the region, although in certain areas, notably along the western margin, the endemic *Chionochloa acicularis* is an important dominant, at least near timber line (Mark and Baylis 1963). Of the 46 species recorded by Mark and Baylis for snow tussock-herbfield on Secretary Island, 32 are listed here. The relatively narrow range of elevation studied on Secretary Island probably accounts for the fewer species recorded there.

Several features of the altitudinal pattern of forest distribution on the Humboldt Mountains described earlier (Mark and Sanderson 1962) are repeated in the alpine grasslands higher up. Altitudinal gradients in floristic composition occur in both formations and suggest a general lack of ecological interdependence among the species. An exception is the conspicuous and abrupt ecotone between forest and grassland at about 1,000 m., spanned by only

eight of the 154 species listed. Despite the gradient in composition, rather abrupt changes occur both in structure and composition of dominant and subordinate species at the following altitudes—*c.* 460 m. in the forest, at timber line, and at *c.* 1,100 m. and 1,500 m. in the alpine grasslands. These changes allow recogtion of the separate communities. With increasing altitude from the Hollyford Valley floor, these are: lowland beech-podocarp-kamahi forest, subalpine silver beech forest, low alpine snow tussock-scrub, low alpine snow tussock grassland and high alpine dwarf tussock grassland.

SUMMARY

Values for frequency and percentage dominance are given for 105 species in alpine tussock grassland from six sites located between timber line at about 1,000 m. and the upper limit of closed vegetation at about 1,640 m. on the western slope of the Humboldt Mountains in northern Fiordland. On the basis of physiognomy, three distinct communities can be recognised: (1) A low alpine scrub dominated by the tall tussock *Chionochloa flavescens* and subalpine shrubs, particularly *Dracophyllum uniflorum*, extending for about 75 m. above treeline; (2) a low alpine snow tussock grassland in which *C. flavescens* and the shorter *C. crassiuscula* co-dominate, extending continuously from about 1,100 m. to 1,530 m., but above this being replaced in snow pockets by (3) a high alpine grassland of the dwarf tussocks *C. oreophila* and *Poa colensoi* together with *Celmisia hectori*.

Floristic affinities between the sites indicate an altitudinal gradient, but justify treatment of the snow tussock-scrub as a separate community. Moreover, they suggest the possibility of recognising two communities within the low alpine snow tussock grassland, one below 1,530 m. and one above. In the lower, *Chionochloa flavescens* and *C. crassiuscula* share dominance, whereas the upper is marked by a reduction in the importance of *C. crassiuscula*, a corresponding increase in *Poa colensoi*, and the appearance of *Celmisia hectori*.

Vegetation patterns in the alpine grasslands are compared with those previously described for the forest on the lower slopes of the range.

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TABLE 1. *Values for frequency (F) in 10 plots and percentage dominance (%D) for three strata, in alpine tussock grassland at six sites on the Humboldt Mountains, Fiordland. Species are arranged and numbered according to their pattern of altitudinal distribution. The habit of each species is indicated as follows: tall shrub (TS) and tall herb (TH), > 30 cm. high; medium shrub (MS) and medium herb (MH), 15–30 cm. high; dwarf shrub (DS) and dwarf herb (DH), < 15 cm. high.*

			SITE 1		2		3		4		5		6	
No.	Species	Habit	F	%D	F	%D	F	%D	F	%D	F	%D	F	%D
	GROUND STRATUM													
1	*Podocarpus nivalis*	MS	4	0.0	–	–	–	–	–	–	–	–	–	–
2	*Coprosma serrulata*	MS	6	0.2	–	–	–	–	–	–	–	–	–	–
3	*Hebe subalpina*	TS	10	1.2	–	–	–	–	–	–	–	–	–	–
4	*Phormium colensoi*	TH	9	1.8	–	–	–	–	–	–	–	–	–	–
5	*Aciphylla aurea*	TH	9	1.6	–	–	–	–	–	–	–	–	–	–
6	*Hebe odora*	TS	8	0.0	–	–	–	–	–	–	–	–	–	–
7	*Dracophyllum longifolium*	TS	4	0.0	–	–	–	–	–	–	–	–	–	–
8	*Neopanax colensoi*	TS	2	0.0	–	–	–	–	–	–	–	–	–	–
9	*Coprosma pseudocuneata*	TS	1	0.0	–	–	–	–	–	–	–	–	–	–
10	*Blechnum minus*	MH	7	1.2	–	–	–	–	–	–	–	–	–	–
11	*Polystichum vestitum*	MH	5	0.0	–	–	–	–	–	–	–	–	–	–
12	*Gaultheria crassa*	DS	8	1.6	–	–	–	–	–	–	–	–	–	–
13	*Blechnum penna-marina*	DH	8	1.0	1	0.0	–	–	–	–	–	–	–	–
14	*Hebe macrantha*	MS	4	0.0	–	–	7	0.0	–	–	–	–	–	–
15	*Dracophyllum uniflorum*	TS	10	7.8	10	2.2	3	0.0	–	–	–	–	–	–
16	*Caladenia bifolia*	DH	2	0.0	–	–	1	0.0	–	–	–	–	–	–
17	*Hymenophyllum multifidum*	DH	8	0.6	–	–	1	0.0	–	–	–	–	–	–
18	*Celmisia petriei*	MH	10	5.8	9	2.0	10	1.2	6	2.0	–	–	–	–
19	*Rhacomitrium lanuginosum* (Hedw.) Brid. var. *pruinosum* H.f & W.	DH	7	1.0	4	0.2	10	0.8	7	0.4	–	–	–	–
20	*Agrostis dyeri*	DH	2	0.0	2	0.0	2	0.0	1	0.0	–	–	–	–
21	*Coprosma cheesemanii*	MS	9	0.8	1	0.0	10	0.6	1	0.2	–	–	–	–
22	*Gentiana montana*	DH	10	0.6	9	0.4	8	0.0	9	0.2	–	–	–	–
23	*Forstera sedifolia*	DH	2	0.0	6	0.6	10	2.8	10	0.6	–	–	–	–
24	*Ourisia ?cockayniana*	DH	2	0.0	1	0.0	–	–	1	0.0	–	–	–	–
25	*Myrsine nummularia*	DS	6	1.4	10	4.8	10	3.6	8	0.8	–	–	–	–
26	*Euphrasia zelandica*	DH	1	0.0	7	1.4	6	0.2	5	0.0	–	–	–	–
27	*Wahlenbergia* sp.	DH	3	0.0	4	0.0	2	0.0	2	0.0	–	–	–	–
28	*Oreobolus impar* Edgar	DH	1	0.0	5	0.0	8	0.0	8	0.2	2	0.0	–	–
29	*Dicranoloma robustum* (H.f. & W.) Par.	DH	9	1.6	8	1.6	9	3.6	9	3.6	1	0.0	–	–
30	*Lycopodium fastigiatum*	DH	3	0.0	10	2.2	10	5.6	9	0.6	1	0.0	–	–
31	*Anisotome haastii*	DH	9	0.2	10	0.2	10	0.2	10	0.6	3	0.2	–	–
32	*Astelia linearis*	DH	1	0.0	10	10.2	9	8.6	6	2.0	1	0.2	–	–
33	*Petriella colensoi* Zotov	DH	1	0.0	1	0.0	5	0.0	5	0.0	3	0.0	1	0.2
34	*Senecio bellidioides*	DH	5	0.0	5	0.4	10	6.2	10	0.8	1	0.2	1	0.0
35	*Celmisia bonplandii*	DH	5	0.0	4	0.0	10	0.8	10	2.0	4	0.2	6	0.4
36	*Polytrichum juniperinum* Hedw.	DH	3	0.0	3	0.0	4	0.0	8	0.2	4	0.0	3	0.0
37	*Poa colensoi*	DH	7	1.6	10	4.2	9	3.2	10	9.4	10	14.9	10	15.4
38	*Gaultheria depressa*	DS	6	0.0	4	0.2	10	1.4	10	0.4	9	0.9	6	0.6
39	*Anisotome aromatica*	DH	5	0.6	9	5.2	10	4.6	10	4.2	10	4.4	10	5.4
40	*Coprosma pumila*	DH	6	0.8	7	0.2	10	6.6	10	2.0	10	0.4	10	6.4
41	*Astelia cockaynei*	TH	10	6.4	9	1.0	10	0.4	9	2.0	9	7.6	3	0.2
42	*Schoenus pauciflorus*	MH	9	3.2	8	0.2	10	1.0	10	2.0	9	4.0	8	0.4
43	*Hebe hectori*	MS	5	0.2	6	0.0	9	0.4	10	1.0	10	2.0	5	0.0
44	*Chionochloa flavescens*	TH	10	7.0	10	3.0	10	0.8	8	5.8	10	13.8	4	0.2
45	*Plantago lanigera*	DH	3	0.0	5	0.6	9	1.2	8	1.0	7	0.0	9	0.4
46	*Uncinia* spp.	DH	1	0.2	1	0.2	2	0.0	5	0.0	9	3.6	6	0.0
47	*Hierochloe fraseri*	DH	2	0.0	–	–	–	–	3	0.0	1	0.0	1	0.0
48	*Epilobium* spp.	DH	1	0.0	–	–	–	–	5	0.0	9	1.6	8	0.6
49	*Hydrocotyle* sp.	DH	1	0.2	–	–	–	–	9	1.0	7	0.2	3	0.2
50	*Schizeilema ?haastii*	DH	1	0.0	–	–	–	–	–	–	3	0.0	1	0.0
51	*Chionochloa crassiuscula*	MH	–	–	9	3.0	10	4.4	10	3.8	9	2.9	1	0.2
52	*Pimelea oreophila* Burrows	DS	–	–	1	0.0	–	–	–	–	–	–	–	–
53	*Forstera tenella*	DH	–	0.0	–	1	–	–	–	–	–	–	–	–

54	*Notodanthonia nigricans*	DH	–	–	2	0.0	–	–	–	–	–	–	–	–
55	*Oreobolus strictus*	DH	–	–	1	0.0	–	–	–	–	–	–	–	–
56	*Celmisia alpina*	DH	–	–	6	0.0	–	–	–	–	–	–	–	–
57	*Deyeuxia setifolia*	DH	–	–	1	0.0	2	0.0	–	–	–	–	–	–
58	*Dacrydium laxifolium*	DS	–	–	10	17.2	2	0.0	–	–	–	–	–	–
59	*Viola ?lyallii*	DH	–	–	6	1.6	7	6.2	–	–	–	–	–	–
60	*Cyathodes pumila*	DS	–	–	10	2.8	6	1.2	–	–	–	–	–	–
61	*Celmisia walkeri*	DS	–	–	1	0.0	10	7.6	10	5.2	–	–	–	–
62	*C. glandulosa*	DH	–	–	1	0.0	10	2.4	10	1.2	–	–	–	–
63	*Oreobolus pectinatus*	DH	–	–	6	0.8	–	–	1	0.0	–	–	–	–
64	*Pentachondra pumila*	DS	–	–	4	1.2	3	1.2	3	0.2	–	–	–	–
65	*Lycopodium australianum*	DH	–	–	1	0.0	7	0.2	8	0.0	–	–	–	–
66	*Celmisia laricifolia*	DH	–	–	8	4.2	9	3.4	7	1.2	3	0.0	–	–
67	*Carpha alpina*	DH	–	–	7	2.6	–	–	–	–	1	0.0	–	–
68	*Gnaphalium traversii*	DH	–	–	3	0.0	–	–	1	0.0	–	–	2	0.0
69	*Oreomyrrhis colensoi* v. *colensoi*	DH	–	–	4	0.0	8	0.0	5	0.0	6	0.0	4	0.8
70	*Trisetum youngii*	DH	–	–	1	0.0	–	–	2	0.0	–	–	1	0.0
71	*Viola* sp.	DH	–	–	3	0.0	3	0.0	–	–	1	0.7	2	0.0
72	*Hebe cockayniana*	DS	–	–	–	–	2	0.0	2	0.0	5	0.2	–	–
73	*Dracophyllum politum*	DS	–	–	10	2.2	6	1.0	–	–	–	–	–	–
74	*Phyllachne colensoi*	DH	–	–	–	–	1	0.0	4	1.0	2	0.0	2	0.4
75	*Aciphylla ?lyallii*	MH	–	–	–	–	1	0.0	–	–	2	0.0	1	0.0
76	*Celmisia petiolata*	MH	–	–	–	–	2	0.0	7	0.8	10	1.1	9	0.4
77	*C. sessiliflora*	DH	–	–	–	–	7	3.0	5	2.6	4	0.9	7	0.8
78	*Drapetes villosus*	DH	–	–	–	–	6	0.8	7	0.0	3	0.0	7	1.2
79	*Haastia sinclairii*	DH	–	–	–	–	–	–	1	0.0	–	–	–	–
80	*Ourisia sessilifolia* v. *sessilifolia*	DH	–	–	–	–	–	–	5	0.0	7	0.0	–	–
81	*Cardamine ?debilis*	DH	–	–	–	–	–	–	1	0.0	1	0.0	–	–
82	*Raoulia grandiflora*	DH	–	–	–	–	–	–	7	0.0	3	0.0	1	0.0
83	*Luzula campestris*	DH	–	–	–	–	–	–	5	0.4	2	0.0	1	0.0
84	*Geum uniflorum*	DH	–	–	–	–	–	–	3	0.4	1	0.0	1	0.0
85	*Celmisia "linearis"*	DH	–	–	–	–	–	–	4	0.0	–	–	2	0.0
86	*Geranium microphyllum*	DH	–	–	–	–	–	–	–	–	1	0.0	–	–
87	*Oxalis lactea*	DH	–	–	–	–	–	–	–	–	1	0.0	–	–
88	*Leucogenes grandiceps*	DH	–	–	–	–	–	–	–	–	3	0.0	–	–
89	*Gentiana ?bellidifolia*	DH	–	–	–	–	–	–	–	–	1	0.0	–	–
90	*Euphrasia petriei*	DH	–	–	–	–	–	–	–	–	2	0.0	5	0.2
91	*Ranunculus lappaceus* v. *villosus*	DH	–	–	–	–	–	–	–	–	3	0.7	4	1.2
92	*Gentiana ?patula*	DH	–	–	–	–	–	–	–	–	6	0.0	6	0.2
93	*Colobanthus affinis*	DH	–	–	–	–	–	–	–	–	2	0.0	4	0.0
94	*Taraxacum magellanicum*	DH	–	–	–	–	–	–	–	–	1	0.0	1	0.0
95	*Aciphylla monroi*	DH	–	–	–	–	–	–	–	–	1	0.0	4	0.2
96	*Senecio ?scorzoneroides*	DH	–	–	–	–	–	–	–	–	1	0.2	5	0.0
97	*Craspedia uniflora*	DH	–	–	–	–	–	–	–	–	2	0.2	7	0.0
98	*Celmisia hectori*	DS	–	–	–	–	–	–	–	–	8	0.9	10	2.6
99	*Caltha obtusa*	DH	–	–	–	–	–	–	–	–	9	3.6	10	14.4
100	*Ranunculus sericophyllus*	DH	–	–	–	–	–	–	–	–	1	0.0	6	0.0
101	*Chionochloa oreophila*	DH	–	–	–	–	–	–	–	–	1	0.0	10	30.0
102	*Aciphylla ?crosby-smithii*	DH	–	–	–	–	–	–	–	–	–	–	1	0.0
103	*Colobanthus* sp.	DH	–	–	–	–	–	–	–	–	–	–	1	0.0
104	*Ranunculus buchananii*	DH	–	–	–	–	–	–	–	–	–	..	2	0.0
105	*Pratia angulata*	DH	–	–	–	–	–	–	–	–	–	–	2	0.0
	Other Bryophytes	DH	–	0.4	–	4.4	–	1.2	–	5.6	–	0.2	–	0.2
	Lichens	DH	–	0.4	–	0.6	–	1.0	–	0.4	–	0.2	–	–
	TOTAL			49.4		79.4		88.6		66.8		66.0		83.2
	Bare Earth		–	2.2	–	1.4	–	0.2		1.6	–	4.4	–	4.6
	Litter		–	47.8	–	19.0	–	8.0	–	29.6	–	24.9	–	2.4
	Rock		–	0.6	–	0.2	–	3.2	–	2.0	–	4.7	–	9.8
	TOTAL		–	100.0	–	100.0		100.0		100.0		100.0		100.0

No.	Species	Habit	SITE 1 F	1 %D	2 F	2 %D	3 F	3 %D	4 F	4 %D	5 F	5 %D	6 F	6 %D
	UPPER STRATUM													
3	*Hebe subalpina*	TS	10	0.2	–	–	–	–	–	–	–	–	–	–
4	*Phormium colensoi*	TH	9	5.8	–	–	–	–	–	–	–	–	–	–
5	*Aciphylla aurea*	TH	9	3.2	–	–	–	–	–	–	–	–	–	–
6	*Hebe odora*	TS	8	0.0	–	–	–	–	–	–	–	–	–	–
7	*Dracophyllum longifolium*	TS	4	1.2	–	–	–	–	–	–	–	–	–	–
8	*Neopanax colensoi*	TS	2	0.0	–	–	–	–	–	–	–	–	–	–
9	*Coprosma pseudocuneata*	TS	1	0.0	–	–	–	–	–	–	–	–	–	–
15	*Dracophyllum uniflorum*	TS	10	31.6	10	1.0	3	0.0	–	–	–	–	–	–
41	*Astelia cockaynei*	TH	10	1.8	9	0.2	10	0.0	9	0.0	9	0.0	3	0.0
44	*Chionochloa flavescens*	TH	10	34.8	10	29.8	10	7.2	8	30.6	10	38.2	4	0.0
	TOTAL		–	78.6	–	31.0	–	7.2	–	30.6	–	38.2		0.0
	MIDDLE STRATUM													
1	*Podocarpus nivalis*	MS	4	0.0	–	–	–	–	–	–	–	–	–	–
2	*Coprosma serrulata*	MS	6	0.0	–	–	–	–	–	–	–	–	–	–
3	*Hebe subalpina*	TS	10	0.2	–	–	–	–	–	–	–	–	–	–
4	*Phormium colensoi*	TH	9	4.0	–	–	–	–	–	–	–	–	–	–
5	*Aciphylla aurea*	TH	9	1.6	–	–	–	–	–	–	–	–	–	–
6	*Hebe odora*	TS	8	0.0	–	–	–	–	–	–	–	–	–	–
7	*Dracophyllum longifolium*	TS	4	1.0	–	–	–	–	–	–	–	–	–	–
8	*Neopanax colensoi*	TS	2	0.0	–	–	–	–	–	–	–	–	–	–
9	*Coprosma pseudocuneata*	TS	1	0.0	–	–	–	–	–	–	–	–	–	–
10	*Blechnum minus*	MH	7	0.2	–	–	–	–	–	–	–	–	–	–
11	*Polystichum vestitum*	MH	5	0.0	–	–	–	–	–	–	–	–	–	–
14	*Hebe macrantha*	MS	4	0.0	–	–	7	0.0	–	–	–	–	–	–
15	*Dracophyllum uniflorum*	TS	10	30.0	10	9.2	3	0.0	–	–	–	–	–	–
18	*Celmisia petriei*	MH	10	8.8	9	6.8	10	7.6	6	4.6	–	–	–	–
21	*Coprosma cheesemanii*	MS	9	0.4	1	0.0	10	0.0	1	0.0	–	–	–	–
41	*Astelia cockaynei*	TH	10	9.4	9	6.6	10	2.0	9	0.0	9	2.2	3	0.4
42	*Schoenus pauciflorus*	MH	9	4.0	8	5.8	10	13.4	10	6.2	9	4.7	8	5.0
43	*Hebe hectori*	MS	5	0.4	6	0.0	9	0.0	10	0.0	10	0.0	5	0.0
44	*Chionochloa flavescens*	TH	10	12.6	10	27.2	10	6.6	8	20.2	10	39.1	4	1.2
51	*C. crassiuscula*	MH	–	–	9	23.4	10	43.2	10	23.8	9	8.9	1	0.0
75	*Aciphylla Hyallii*	MH	–	–	–	–	1	0.0	–	–	2	0.0	1	0.0
	TOTAL		–	72.6	–	79.0	–	73.0	–	55.2	–	56.2	–	6.8

NOTE:

Site no.	1	2	3	4	5	6
Altitude (m.)	1080	1140	1240	1430	1640	1640
Slope (deg.)	30	12	25	30	34	34
Aspect (°T.)	260	260	260	260	300	300
No of species	50	52	51	55	55	48

TABLE 2. *Community coefficients on both floristic (F) and vegetational (V) bases for six sites in alpine tussock grassland on the Humboldt Mountains, Fiordland. For descriptions of sites see Table 1.*

			SITE 1	2	3	4	5	6
	1	F		60.7*	63.4*	61.0*	43.8	36.7
S		V						
I	2		46.4		79.6***	72.9***	44.9	38.0
T	3		22.9	51.7		77.4***	54.7	44.4
E	4		47.3	67.8	53.2		63.6*	56.3
	5		45.6	54.9	26.3	64.9		79.6***
	6		8.5	13.5	21.9	20.1	30.9	

* = Relationship significant at P = 0.05
** = " " " " = 0.01
*** = " " " " = 0.001