VEGETATION PATTERN OF A LOWLAND RAISED IN EASTERN FIORDLAND, NEW ZEALAND

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SUMMARY: The vegetation pattern of Borland Mire, a 250 ha lowland raised mire near Monowai, in the rainshadow of the Fiordland mountains, is described using several numerical analyses of quadrat data collected at regular intervals along parallel transects across 430 m of a typical segment. A weak zonation pattern of both flora and vegetation is revealed amolng the 24 vascular species and the more abundant cryptogams present. The most abrupt change, some 90 m from the margin, is marked by decline in importance of the "*Dacrydium*" and "*Empodisma-Campylopus*" communities and is associated with changes in slope and water table depth, as well as in the depth, colour, and the water, organic matter and ash contents of the peat.

INTRODUCTION

This paper describes the vegetation of Borland Mire, a 250 ha area of wetland or "mire" (as defined by Burrows and Dobson, 1972) situated near Borland Lodge, adjoining Fiordland National Park, about four kilometres north-east of the outlet of Lake Monowai (Fig. 1). As with the mires in the Manapouri-Te Anau region (Burrows and Dobson, 1972) Borland Mire has developed under relatively low rainfall (*c.* 1100 mm annual mean based on official values for nearby Monowai and Borland Lodge) at an elevation of 180 m on an outwash gravel plain of the most recent (Monowai 3) ice advance, formerly occupied by meltwater streams (Fitzharris, 1968; Wood, 1966). Some of the deeper channels are now occupied by rivers, including the Monowai River draining the lake, and streams. Steeper slopes and higher terraces surrounding the basin are covered with mountain beech (*Nothofagus solandri* var. *cliffortioides)* forest, while the area around much of the mire is in modified short tussock grassland dominated by blue tussock *(Poa colensoi),* hard tussock *(Festuca novae-zelandiae)* and *Raoulia subsericea,* in which the lichens *Cladia retipora,* C. *aggregata* and *Cladonia mitis* are conspicuous. Small shrubs of bog pine *(Dacrydium bidwillii)* and manuka *(Leptospermum scoparium)* are scattered through the grassland and increase both in height and cover with approach to the margin of the mire. A woodland of manuka and bog pine up to 4 m tall, but of varying width because of past burning, surrounds the mire (Fig. 2) and periodic burning of the grassland is retarding its invasion by these shrubs. At its western end the mire borders beech forest along the boundary of Fiordland National Park (Fig. 1).

Manuka and bog pine are also characteristic of the mire where, along with *Dracophyllum oliveri,*

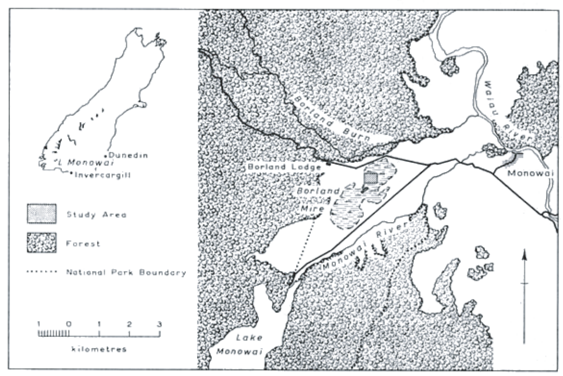

FIGURE 1. *Map showing location of Borland Mire and of the area studied. Adapted from NZMS* 1 : S158, *Monowai.*

they form a generally sparse woody cover to *c.* 1.5 m that increases towards the south-western end, where fires have been less frequent. The most recent fire, in the late 1950s, burnt the northern half and reduced its tall shrub cover. Domestic stock, both sheep and cattle, have lightly used a marginal strip up to 30 m wide. South Island fernbirds *(Bowdle ria punctata punctata)* are common throughout.

A brief plant ecological study of the northern half of the mire was made as part of a University Extension field school at Borland Lodge in January 1978 when much of the information presented here was obtained.

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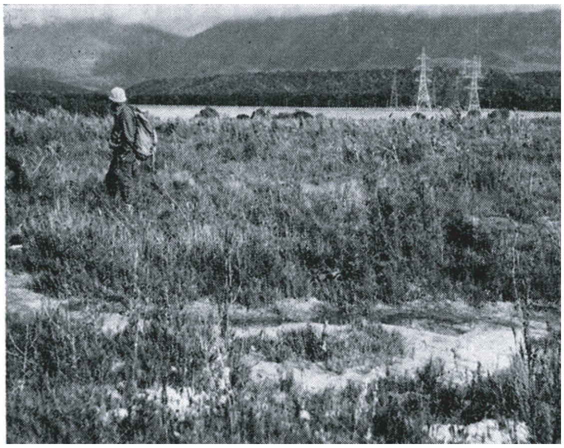


FIGURE 2. *View west from the study area near the centre of the mire showing a wet depression surrounded predominantly by* Sphagnum cristatum *(foreground). the narrow discontinuous woodland zone of* Dacrydium bidwillii *separating the mire from the modified grassland, and the forest of Fiordland National Park in the distance. October* 1978.

METHODS

Eight parallel transects, *c*. 20 m apart, were run from the western margin of the mire a distance of 450 m to beyond its centre (Fig. 1). Quadrats were laid out at 20 m intervals along these transects, beginning 10m in from the margin of the mire.

Cover values for shrubs (> 30 cm tall) were subjectively assessed in 2 x 2 m quadrats and the remaining cover, provided by a mixture of low shrubs and herbs, was assessed with a 0.5 x 0.5 m quadrat nested in the south-western corner of the larger one. Cover assessment in the small quadrat was assisted with a grid of 25 decimetre-square subquadrats. Species identification of the bryophytes and lichens among the eight work groups (one per transect) was facilitated by using folders containing small samples of the ten most common species.

A central line among the eight transects was profiled at the same 20 m intervals with a "Watts Autoset" level and surveyor's staff, pits were dug at each site to below the water table to measure its depth, and the thickness of peat was checked with a metal probe. At a later date (October 1978) peat samples from 10-15 cm depth were removed at the same 20 m intervals for determination of colour, pH, water content and organic matter content. Colour was checked against standard soil charts (Oyama and Takehara, 1970), pH was determined in a 1:1 (by volume) distilled water mixture, water content by oven-drying (105 °C for 48 hours), and organic content by igniting the oven-dried samples in a muffle furnace at 700 °C for two hours.

Community coefficients, both floristic and vegetational (Oosting, 1956), were assessed between each 20 m interval of the first 390 m of mire from the mean value for the eight quadrats at each interval. In addition, data for the 32 species of bryophytes, lichens and vascular plants recorded more than once among the 184 quadrats were subjected to classify-

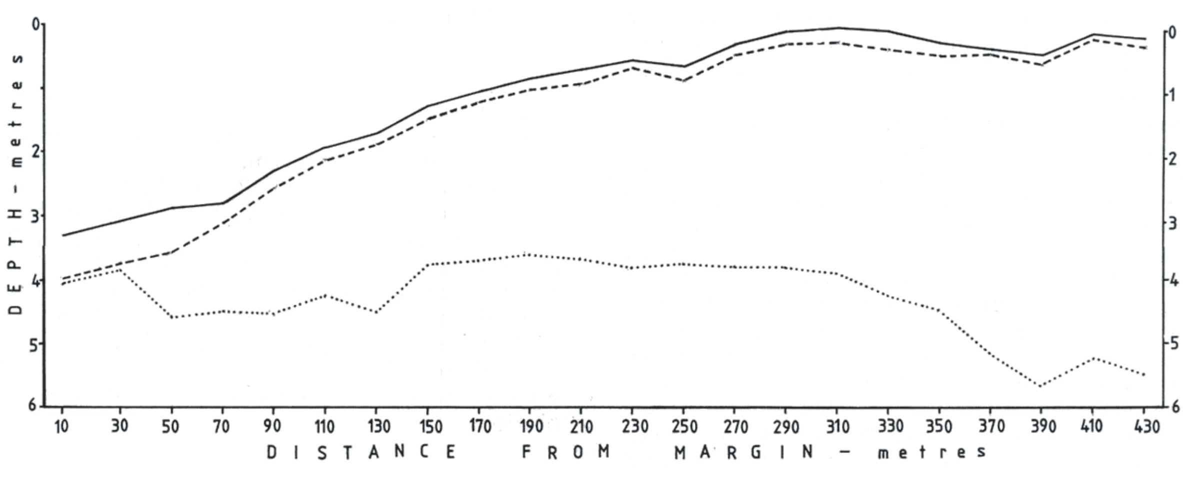


FIGURE 3. *Surface profile and peat depth of Borland Mire through the centre of the study area, including the position of the water table (dashed line) on 26 January 1978. The base of the peat is indicated by the dotted line.*

cation and ordination using the Golliwog computer programme (Wilson, unpublished). Since the order of the eight transects was not recorded in the field this placed some limitation on the amount of information which these analyses could provide.

A two-dimensional ordination was compiled for the 32 more abundant species, as well as for the 184 quadrats, using Principal Components Analysis, wh;le a Cluster Analysis, using the Canberra Distance Measure and Flexible Sorting Strategy (beta = -0.25), grouped the species according to their contribution to the vegetation (estimated per-centage cover value), and the quadrats according to their species composition. Details of these methods are given in Sneath and Sokal (1975). The normal classification was truncated at the eight-group If;vel to give eight communities or vegetation types. These have been named, for convenience, after some of the species important in them. The inverse classification was truncated at the seven-group level, to give seven groups of ecologically-related species.

RESULTS

The surveyed traverse of the mire surface and associated water table across 430 m of the transects from the outer edge indicates a gentle, increasing slope amounting to 3.3 m over the first 270 m, beyond which there are only minor irregularities Fig. 3). The water table depth decreased steadily from the outer edge (0.70 m) to the 90 m mark (0.19 m), beyond which there were only minor fluctuations (range 0.08-0.26 m; mean = 0.167 ±0.011 m) in its depth (Fig. 3). This probably represented a relatively low water table since it followed an unusually dry period with long periods of sunshine and virtually no rain falling in the previous eight days. Only the deepest depressions contained standing water at this time. Regular

TABLE 1 *Community coefficients on both floristic (upper right) and vegetational (lower left) bases for 20 sites on Borland Mire. Fiordl!lnd. Values are based on eight 0.25 m^2 quadrats for each site (see text for details).*

Dist. from edge (m)	10	30	50	70	90	110	130	150	170	190	210	230	250	270	290	310	330	350	370	390	Dist. from edge (m)
10		75	77	70	72	65	63	63	59	62	63	63	65	60	63	62	55	65	60	60	10
30	90		89	77	79	72	70	70	70	73	70	70	72	67	70	68	56	67	67	67	30
50	97	77		78	78	73	72	76	71	74	71	71	73	68	71	70	58	68	68	68	50
70	96	74	90		78	76	80	79	78	82	74	79	76	71	74	77	76	75	71	71	70
90	86	67	76	79		76	76	71	71	74	71	76	68	68	71	74	63	68	68	68	90
110	75	64	71	72	80		85	79	82	77	84	79	81	80	79	86	71	76	80	80	110
130	64	55	55	59	62	71		78	82	76	78	73	75	74	73	81	65	70	74	74	130
150	42	38	38	43	51	66	60		81	84	77	77	79	74	73	80	74	74	78	86	150
170	50	43	45	41	62	68	61	75		83	81	77	83	82	72	83	74	77	82	77	170
190	51	42	47	49	60	68	80	78	70		77	76	77	72	76	74	82	77	72	68	190
210	30	24	26	31	41	44	60	73	77	72		73	84	83	82	80	70	78	83	78	210
230	45	41	41	46	56	69	69	81	81	80	70		74	78	73	76	79	70	70	75	230
250	33	25	27	32	41	53	62	71	68	73	87	69		80	79	77	71	80	80	76	250
270	38	31	34	40	51	63	50	81	77	82	92	74	92		83	81	76	83	87	83	270
290	37	29	32	35	47	44	62	55	70	69	74	65	67	75		76	74	83	83	83	290
310	33	26	28	34	43	54	57	63	51	73	75	70	71	75	75		73	77	81	81	310
330	36	27	31	35	50	46	53	52	59	72	61	52	64	68	67	63		76	76	84	330
350	32	26	28	27	39	40	57	62	72	69	71	67	91	72	86	80	74		83	79	350
370	33	27	29	33	44	54	50	62	60	71	76	63	71	70	64	70	67	74		83	370
390	32	24	27	38	43	45	50	55	55	58	66	48	61	68	59	56	64	60	64		390

Floristic coefficients $K_{ab} = \frac{2C \times 100}{A + B}$

Where A= species at Site A;
B = species at Site B;
C = species in common

Vegetation coefficients $C_{ab} = \frac{2W \times 100}{A + B}$

Where A= total live plant cover at Site A;
B = total live plant cover at Site B;
W = sum of lowest of each pair of percentage cover vaues of species present at both sites.

probing of peat depths revealed a generally gradual reduction towards the perimeter of the mire from a central depression beyond the 300 m mark in which the depth of peat reaches 5 m (Fig. 3).

Community coefficients for presence/absence (floristic) data were consistently high throughout (not less than 55%) but did reveal a gradual decrease in floristic affinity with increasing distance in either direction along the transect (Table 1). Coefficients based on the vegetation (cover values) showed a greater range (down to 24%), but again the pattern was generally one of decreasing association with distance from any position along the series of transects. No groupings are obvious, but in general the highest vegetation coefficients are among the plots in the outer 90 m of the transects, values here being generally above 70% and reaching 97% (Table 1). On a floristic basis, however, this group does not reveal abnormally high coefficients.

The major distinction shown by the normal classification (of the 184 quadrats) is between the first four communities *("Dacrydium* Community", etc.) on the one hand and the last four *("Leptospermum-Empodisma* Community", etc.) on the other. This is clearly a distinction between the communities of the bog edge and its centre (Fig. 4). There is some overlap, especially with occasional occurrences of some bog-edge communities towards the centre of the bog and one bog-centre community within the first 50 m. All the bog-centre communities, however, reach their maximum frequency of occurrence more than 150 m along the transects. One of them *("Cladonia alpestroides* Community") was recorded only beyond 250 m (Fig. 4).

In terms of species composition (Fig. 5), the four bog-edge communities have a generally greater cover of the two Group 1 species *(Dacrydium bidwillii* and *Cladia retipora),* whilst the four bog-centre communities have generally greater cover of Species Groups 2, 4, 6 and 7. Species Groups 3 and 5 show no such differentiation (Fig. 5). There is no species that can be cited as an infallible discriminator between the bog-edge and bog-centre communities. The nearest would be the mosses *Sphagnum cristatum* and *Eucamptodon inflatus,* of which one or other is present in but 20 % of the bog-edge community quadrats, but 84% of the bog-centre community quadrats.

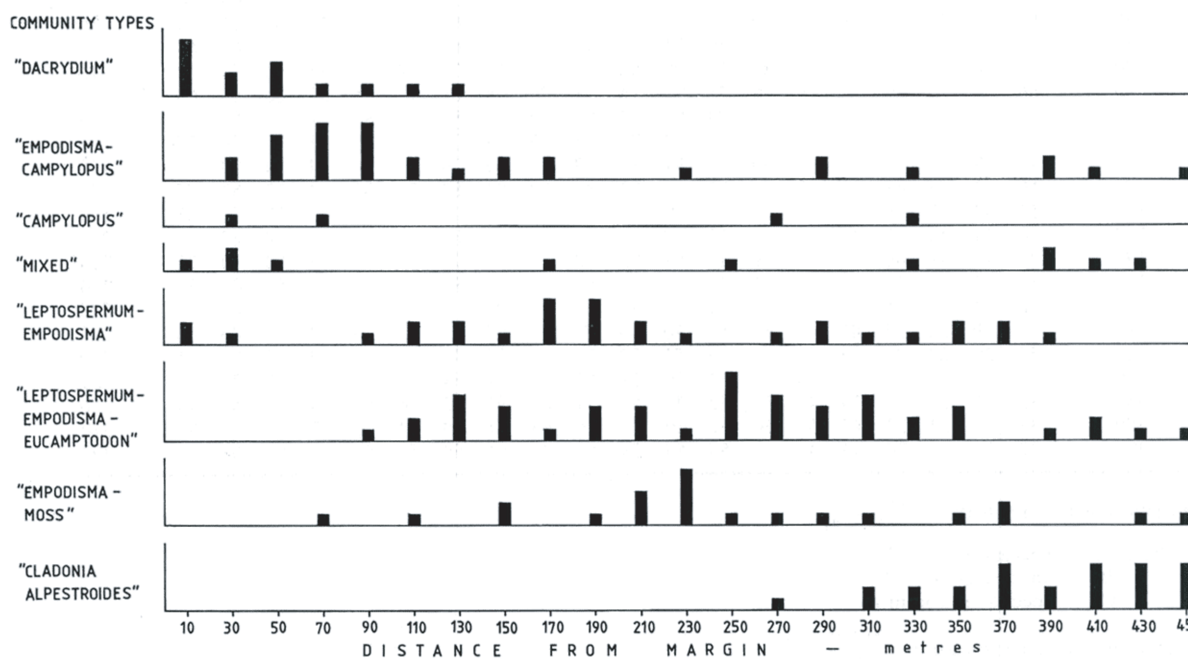
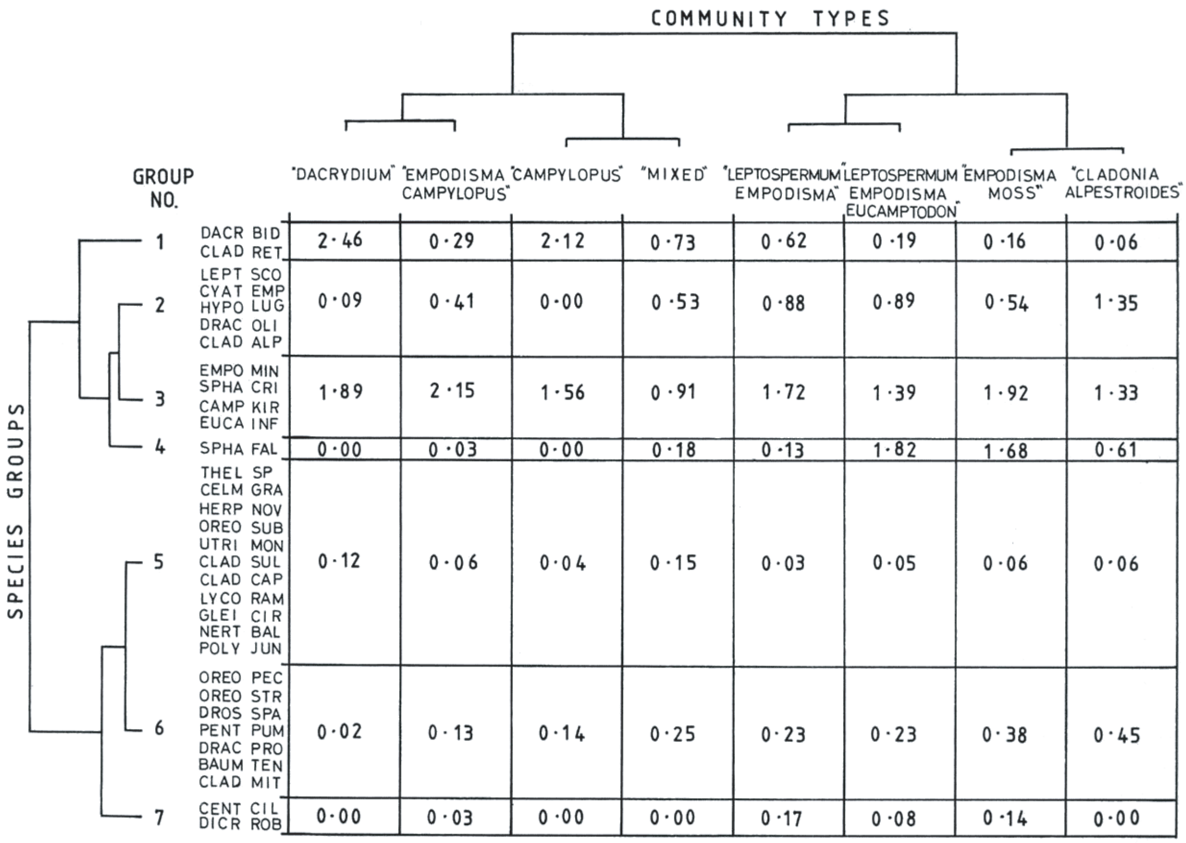


FIGURE 4. *Distribution of "community" types at the eight-group level, across the 450 m extent of the study area on Borland Mire. These communities were derived from a normal Cluster Analysis of the 184 quadrats using species cover data and have been named after their more important members.*



Group No.	Species	"Dacrydium"	"Empodisma Campylopus"	"Campylopus"	"Mixed"	"Leptospermum Empodisma"	"Leptospermum Empodisma Eucamptodon"	"Empodisma Moss"	"Cladonia alpestroides"
1	DACR BID, CLAD RET	2·46	0·29	2·12	0·73	0·62	0·19	0·16	0·06
2	LEPT SCO, CYAT EMP, HYPO LUG, DRAC OLI, CLAD ALP	0·09	0·41	0·00	0·53	0·88	0·89	0·54	1·35
3	EMPO MIN, SPHA CRI, CAMP KIR, EUCA INF	1·89	2·15	1·56	0·91	1·72	1·39	1·92	1·33
4	SPHA FAL	0·00	0·03	0·00	0·18	0·13	1·82	1·68	0·61
5	THEL SP, CELM GRA, HERP NOV, OREO SUB, UTRI MON, CLAD SUL, CLAD CAP, LYCO RAM, GLEI CIR, NERT BAL, POLY JUN	0·12	0·06	0·04	0·15	0·03	0·05	0·06	0·06
6	OREO PEC, OREO STR, DROS SPA, PENT PUM, DRAC PRO, BAUM TEN, CLAD MIT	0·02	0·13	0·14	0·25	0·23	0·23	0·38	0·45
7	CENT CIL, DICR ROB	0·00	0·03	0·00	0·00	0·17	0·08	0·14	0·00

FIGURE 5. *Nodal table showing "community" and species groups, and associated classification dendrograms, based on cover values for the 32 more abundant species in the 184 quadrats distributed across the 450 m extent of the study area on Borland Mire. Vertical columns show the eight "community" types recognised from a normal Cluster Analysis of the 184 quadrats (see Fig. 4) while horizontal lines separate the seven "species groups" among the 32 analysed. The numerical values indicate the relative contribution to cover provided by all species in each community. Binomia/s have been abbreviated-see Table 3 for complete names.*

Of the four bog-edge communities (Fig. 4), the "*Dacrydium* Community" is clearly the characteristic one of the bog edge, being most frequent along the outer margin of the transects and absent beyond 130 m. It is characterised by Species Group 1, together with a consistently high cover of *Empodisma minus,* and by the very occasional occurrence of only a few other species.

The "*Empodisma - Campylopus* Community" reaches its maximum occurrence 50-90 m into the bog, with scattered occurrences further towards the centre. Here the cover of *Empodisma* often exceeds 70%, considerable cover of *Campylopus kirkii* is common, while all other species are relatively rare.

The "*Campylopus* Community" is found scattered across the bog and is characterised by the unique combination of considerable amounts of *Campy/opus kirkii* with the almost complete absence of *Empodisma* and the compiete absence of Group 2 species. **In** some cases there is also a unique combination of considerable cover of both *Campylopus kirkii* and *Dacrydium bidwillii.*

The "mixed Community" is something of a dustbin group, such as a space-dilating sorting strategy in Cluster Analysis is likely to produce. The fairly common occurrence of *Baumea tenax* and the relative rarity of species in Group 3 can be noted but neither is consistent. The "mixed Community" is found scattered across the bog.

The four bog-centre communities also differ in their distribution along the transects. Thf' "*Leptospermum-Empodisma* Community" is most common 170-190 m along the transect, just as the "*Empodisma-Campylopus* Community" becomes rare, although it is not dissimilar from that community in its species composition. One difference of note is the increase in the mean cover of Species Group 6, composed mostly of species characteristic of wet habitats (Fig. 5).

The "*Leptospermum - Empodisma - Eucamptodon* Community" reaches its peak of frequency 250 m along the transect. The most notable difference from the last community is the almost uniform occurrence of one or other of the three mosses, *Sphagnum cristatum,* S. *falmtulum* or *Eucamptodon inflatus,* again a feature that would be expected of the vegetation towards the wetter centre of the bog.

Distribution of the "*Empodisma-moss* Community" is generally similar to the one previously described, differing chiefly in its considerably smaller cover of *Leptospermum scoparium* and *Cyathodes empetrifolia,* and a greater cover of the Group 3 and 4 mosses *(Sphagnum cristatum, Campylopus, Eucamptodon;* and *Sphagnum falcatulum),* and the Group 6 species, especially but locally, *Oreobolus pectinatus*. This is probably a community of the lowest-lying wettest areas.

The "*Cladonia alpestroides* Community" characterises the centre of the bog, not being found until the 260 m point along the transects. It actually shows an increase of all Group 2 species but particularly *Cladonia alpestroides,* which reaches 60 % cover and is of constant occurrence here. This is accompanied by a reduction in cover provided by *Sphagnum fa!catulum*. The Group 6 species, which are mostly obligate bog plants, reach their maximum importance in this community (Fig. 5).

The inverse classification, which sorts the species according to their distribution, shows the main distinction as being between Groups 1 to 4 on the one hand, and Groups 5 to 7 on the other (Fig. 5). The first assemblage seems to comprise mainly the more common species. Group I species reach their greatest cover at the edge of the bog, Group 2 species further in, with the "*Leptospermum-Empodisma*", the "*Leptospermum – Empodisma-Eucamptodon*", and the "*Cladonia alpestroides*" communities, while Group 3 species are relatively important throughout the sequence. Group 4, consisting of only *Sphagnum falcatulum,* is absent from three communities and is characteristic of those that predominate away from the margin of the mire. Group 5, in general, contains the less common species. These appear to be fairly uniformly distributed through the mire while Group 6 species generally increase in importance towards the centre. Group 7 could be a chance grouping of two species which show no distinct pattern (Fig. 5).

A plot of the scores based on species cover values for each of the quadrats on the first principal component against the distance of the quadrat along the transect, shows a definite but loose correlation (Flg. 6). This is seen also in the ordination of the species (Fig. 7). Species with relatively high negative correlations on the first principal component, *Cladia retipora* and *Dacrydium bidwillii,* are those of the edge of the mire while species with positive correlations include those typical of its centre *(Cladonia alpestroides, Drosera spathulata, Baumea ten ax),* but also some of intermediate distribution *(Leptospermum scoparium, Hypogymnion lugubris)*. The second axis resolves this to some extent, placing those species characteristic of the wettest depressions towards the centre of the mire, at the top of the diagram *(Drosera spathulata, Dracophyllum prostratum, Baumea, Thelymitra, Sphagnum falcatulum)*. The first two components together, accounted for 14% of the variation. Subsequent axes were not interpretable ecologically.

Values for pH, colour, water content, organic matter content, and ash content of the peat samples, collected (10-15 cm depth) at regular intervals across the mire in October 1978, show gradations in all these factors from the margin up to about the 90 m position, but with little variation beyond (Table 2). The water content, being generally very high, has been given both in terms of field weights and the more conventional oven-dry weights.

Examination of the mire beyond the study area did not add to the 36 species recorded there, cryptogams of minor importance excluded, but this did reveal a much greater coverage of shrubs, particularly *Leptospermum* and *Dracophyllum oliveri* to *c*. 1.2 m tall, over the south-western half of the mire (Fig. 8). Here fire apparently has been absent at kast since 1933, despite several attempts to burn the man uk a, according to a local runholder (Mr M. O'Brien, *pers. comm.)*.

An isolated clump of manuka *C*. 3 m tall appears to have been protected from fire by an extended, narrow, permanently wet depression along its northern side. The living bushes of *Leptospermum* are much more sparsely colonised by the lichen *Hypogymnion lugubris* than are the bushes killed by fire elsewhere. The southern half of the mire appears to be more uniform in its ground cover than is the

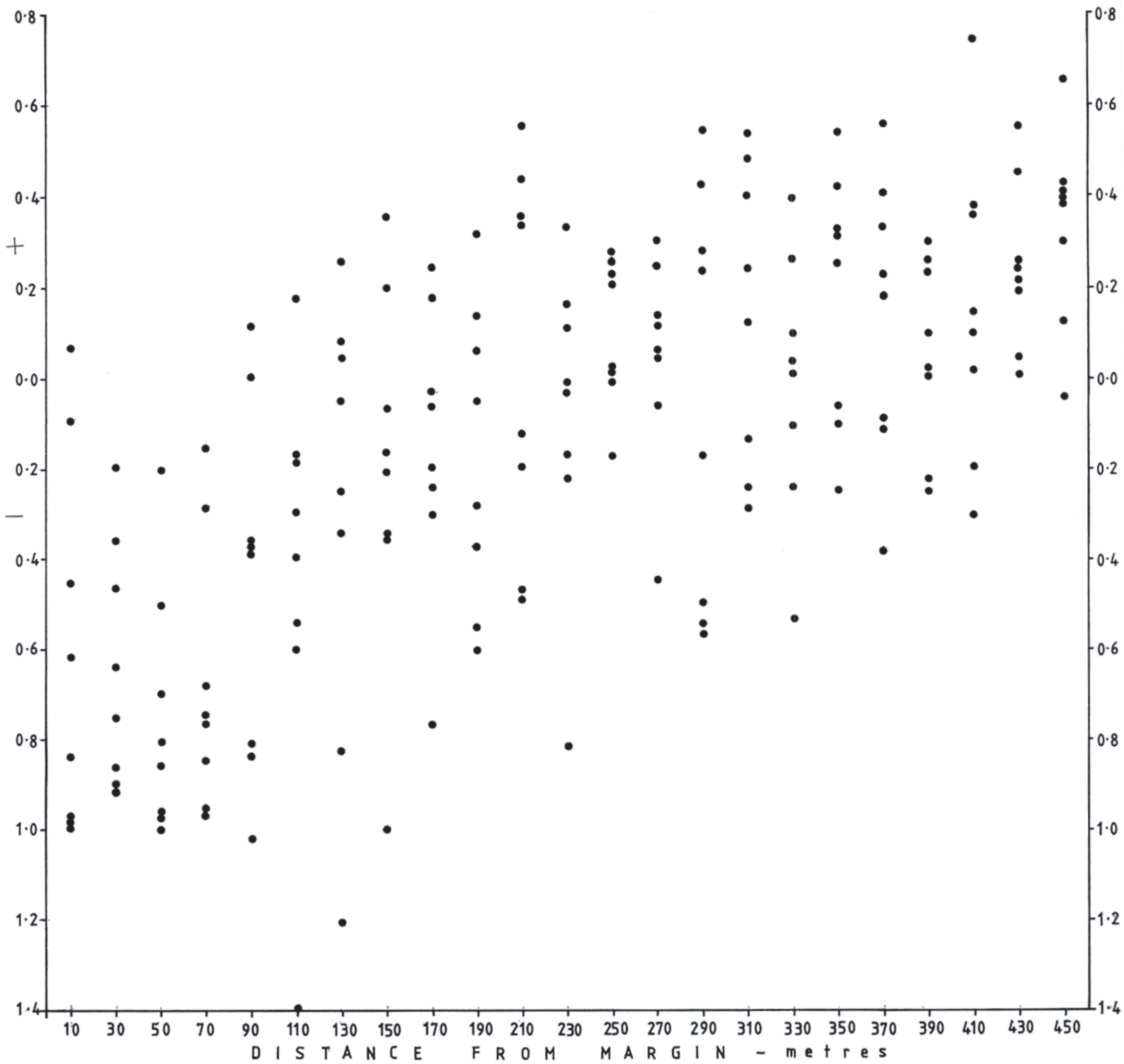


FIGURE 6. *The scores of the 184 quadrats on the first of the Principal Components analyses, plotted against distance tram the margin of the mire.*

northern half where the study was made, with *Empodisma minus, Cyathodes empetritolia* and *Eucamptodon inflatus* widespread, and wet depres-Sions relatively few. Although the southern half Was not profiled it appears to be raised above the surrounding area of outwash gravels like the study area in the northern half. A probing of its peat depth revealed a similar pattern in the two halves-a 700 m line across the centre of the southern half from the north-western to south-eastern sides showed a generally steady increase 450 m from the north-western margin.

TABLE 2. *Values for pH, colour, water content, organic content and ash content of peat samples collected from 10-15 cm depth at fixed intervals from the north-western margin of Borland Mire, Fiordland. October* 9, *1978.*

Dist. from margin (m)	pH	Colour Notation	Colour Name	Water Content % Field Wt	Water Content %O.D. Wt	Organic Matter %O.D. Wt	Ash Content %O.D. Wt
10	3.5	5YR 2/2	Brownish black	80.0	400	91.9	8.1
30	3.8	5YR 3/3	Dark reddish brown	84.8	586	93.4	6.6
50	3.5	5YR 3/3	Dark reddish brown	85.4	557	94.4	5.6
70	3.5	5YR 3/3	Dark reddish brown	88.4	764	94.5	5.5
90	3.8	5YR 4/6	Reddish brown	91.9	1141	95.7	4.3
110	3.9	5YR 4/8	Reddish brown	90.5	950	98.0	2.0
130	3.7	5YR 4/6	Reddish brown	93.5	1438	96.9	3.1
150	3.8	5YR 4/8	Reddish brown	89.7	869	98.6	1.4
170	3.7	5YR 4/8	Reddish brown	92.7	1279	97.2	2.8
190	3.9	5YR 5/8	Bright reddish brown	93.3	1390	96.7	3.3
210	4.0	5YR 5/8	Bright reddish brown	94.0	1559	97.1	2.9
230	3.8	5YR 5/8	Bright reddish brown	93.7	1501	97.2	2.8
250	3.8	5YR 4/8	Reddish brown	93.5	1436	96.2	3.8
270	3.8	5YR 5/8	Bright reddish brown	93.7	1486	-	-
290	3.9	5YR 4/8	Reddish brown	89.8	881	98.2	1.8
310	3.7	5YR 4/6	Reddish brown	93.2	1366	96.9	3.1
330	3.8	5YR 4/8	Reddish brown	91.9	1133	98.4	1.6
350	3.7	5YR 5/8	Bright reddish brown	94.4	1689	96.9	3.1
370	3.9	5YR 5/8	Bright reddish brown	93.9	1531	95.8	4.2
390	3.8	5YR 4/8	Reddish brown	90.5	958	97.9	2.1
410	3.8	5YR 4/6	Reddish brown	89.2	827	96.8	3.2
430	3.8	5YR 4/8	Reddish brown	93.6	1457	96.1	3.9
450	3.6	5YR 4/8	Reddish brown	93.6	1470	96.3	3.7

DISCUSSION AND CONCLUSIONS

A weak, diffuse zonation pattern of flora and vegetation has been revealed by a range of numerical analyses of data from parallel transects extending 430 m into Borland Mire. Among a limited flora of 24 vascular species (one exotic) and 12 of the more abundant cryptogams (6 lichens and 6 mosses), the most obvious pattern is a change in floristic composition about 90 m from the margin. Here two communities that predominate in the outer zone (called "*Dacrydium*" and "*Empodisma-Campylopus*" communities on the basis of their more distinctive components) decline in importance, while three others *("Leptospermum-Empodisma", "Leptospermum-Empodisma-Eucamptodon"* and *"Empodisma*-moss") assume increasing significance. This transition is marked by changes in most of the few environmental parameters measured: slope; water table depth; depth, colour, water content, organic matter content and ash content of the peat; and probably is related to one or more of these. The flattish centre of the mire, which begins about 270 m from the margin, is characterised by another community *("Cladonia alpestroides")* joining the other three to form mosaics, related probably to micro-topography through affecting water table depth, although the method of sampling was too coarse to establish its basis. Two m:nor but widespread communities were also recognised at the eight-group level of a normal classification.

Some of the more widely tolerant species occurred in most of the eight communities, e.g., *Cladia retipora, Campy lop us kirkii, Empodisma minus* (all 8), *Leptospermum scoparium, Dacrydium bidwi!lii, Pentachondra pumila, Sphagnum cristatum, Cyathodes empetrifolia* (7), whereas others, mostly minor ones, were much more restricted in their distributions -*Centrolepis ciliata* and *Oreobolus pectinatus* (3), *Dracophyllum prostratum* (plus some hybrids with *D. oliveri)* and *Baumea tenax* (4). Species importance in terms of cover usually varied considerably among the eight communities. An inverse classification sorted the 32 more important species into seven groups according to their distribution. A two-dimensional ordination separated along its first axis those species most important towards the edge of the mire *(Cladia retipora, Dacrydium bidwillii, Empodisma minus)* and of the remainder those

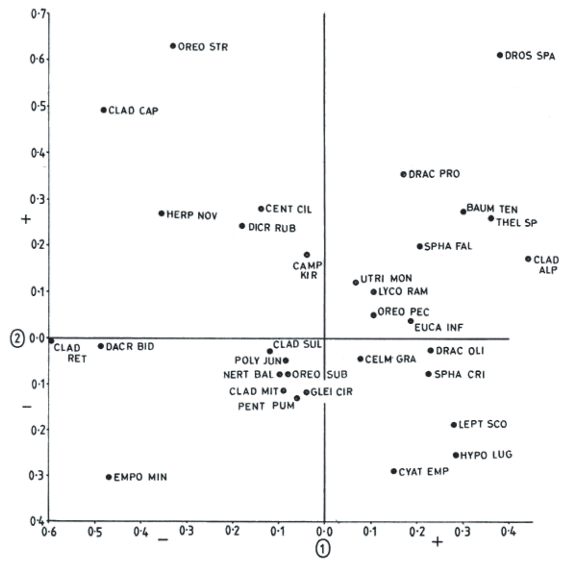


FIGURE 7. *Two-dimensional ordination of the 32 more important species in the study area of Borland Mire, based on a normal Principal Components Analysis. Binomials have been abbreviated-see Table 3 for complete names.*

FIGURE 8. *View south-west from near the southern end of Borland Mire showing relatively dense scrub, chiefly* Leptospermum scoparium *and* Dracophyllum oliveri, *with a narrow zone of* Dacrydium bidwillii *woodland adjoining the beech forest of Fiordland National Park. White patches in the foreground are of the lichen* Cladia retipora. *October 1978.*

characteristic of the permanently saturated conditions of the central depressions *(Sphagnum falcatulum, Drosera spathulata, Thelymitra* sp., *Oreobolus strictus, Baumea ten ax, Dracophyllum prostratum)* were largely separated from the more widely tolerant species *(Empodisma, Cyathodes empetrifolia, Leptospermum scoparium)* on the second axis.

Since Burrows and Dobson (1972) do not give a full floristic list for the mires of the Manapouri-Te Anau lowlands, some 20-55 km to the north of Borland Mire, also in the lee of the Fiordland mountains, no detailed comparison between the two floras is possible. Of the 36 species of lichens, bryophytes and vascular plants recorded from the Borland Mire (Table 3), halt are listed for the Manapouri- Te Anau mires (Burrows and Dobson, 1972) and *Campylopus kirkii* could be among the *Campylopus* spp. listed by Burrows and Dobson. The much greater floristic diversity of the Manapouri-Te Anau mires reflects the greater variety of wetlands than is represented in this study, but nevertheless it is surprising that several of the species recorded for the Borland Mire (e.g., *Nertera balfouriana, Pernettya macrostigma, Lycopodium ramulosum, Oreostylidium subulatum, Dracophyllum prostratum, Celmisia gracilenta* and *Thelymitra* sp.), were not recorded from the nearby Manapouri-Te Anau mires. There are relatively few species shared with lowland bog of the West Cape District of Fiordland (Wardle, Mark and Baylis, 1973), with a pakihi in South Westland (Mark and Smith, 1974), or with subalpine mires from Canterbury (Dobson, 1975).

Inflated bark that characterises the lower stems and roots of *Leptospermum scoparium* on such sites (Wardle, *et al.,* 1973; Mark and Smith, 1974; Mark, Johnson and Wilson, 1978) was also prominent in the larger bushes on Borland Mire, although a prostrate form that is common among the erect shrubs in the wetter areas did not have obviously inflated bark.

With an agreement in principle by the Lands and Survey Department, Invercargill, to reserve the entire Borland Mire, burning may become less frequent in future, in which case this study could Provide a useful basis for following future changes.

TABLE 3. *Flora of the Borland Mire, Fiordland. Species are arranged systematically with a value for the percentage of 0.25m2 quadrats (out of 184) in which the species was present in this study (%P). Species common to the Manapouri-Te Anau mires (* = from Burrows and Dobson, 1972; A = "more or less common on acid raised mire"-Burrows and Dobson, pers. comm.) are also indicated (M-TeA). Authorities are given only for names that are not included in current floras.*

LICHENS	%P	M-TeA
Cladia retipora	29.9	A
C. *sullivanii*	1.6	*
Clalonia alpestroides	34.2	
C. *capitata*	4.9	
C. *mitis*	2.7	A
Hypogymnion lugubris	40.8	A
BR YOPHYTES		
Campylopus kirkii	47.8	A
Dicranoloma billardieri	2.7	A
Eucamptodon inflatus	36.4	*
Polytrichum commune	2.1	A
Sphagnum cristatum	40.8	*
S. *falcatulum*	23.4	*
PTERIDOPHYTES		
Gleichenia circinata	4.3	*
Lycopodium ramulosum	2.7	A
CONIFERS		
Dacrydium bidwillii	20.1	*
DICOTYLEDONS		
Celmisia gracilenta	4.9	A
Cyathodes empetrifolia	63.6	*
Dracophyllum oliveri	33.7	*
D. *prostratum*	7.1	A
Drosera spathulata	39.1	*
Gonocarpus micranthus Thunb.	0.5	A
Leptospermum scoparium	54.3	*
Nertera balfouriana	2.7	A
Oreostylidium subulatum	1.1	A (rare)
Pentachondra pumila	34.8	*
Pernettya macrostigma	0.5	
Rumex acetosella	0.5	
Utricularia monanthos	1.1	*
MONOCOTYLEDONS		
Baumea tenax	14.7	*
Carex coriacea	0.5	*
Centrolepis ciliata	1.6	*
Empodisma minus (Hook. f.) Johnson et Cutler	89.1	*
H erpolirion novae-zelandiae	9.2	
Oreobolus pectinatus	6.0	*
O. strictus	31.5	*
Thelymitra sp.	21.7	A

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