To Felicity (alias A. Beeston)
from
Keith McDougall

THE ALPINE VEGETATION OF THE BOGONG HIGH PLAINS

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The results of the vegetation survey described in this report have been used to compile detailed vegetation maps of the Bogong High Plains at scale 1:15 000. These will be published as 5 colour sheets by the Victoria Conservation Trust in conjunction with the Soil Conservation Authority.

The first sheet - "Rocky Valley" - will be published in December 1982 and the remainder will be printed during the following two years.

If organizations require detailed vegetation information for planning or management purposes before the maps are published, dye-line copies of the draft maps may be obtained from the Soil Conservation Authority, 378 Cotham Road, Kew, Vic. 3101, or from the Arthur Rylah Institute for Environmental Research, 123 Brown Street, Heidelberg, Vic. 3084. Note that it may be necessary to hand colour these dye-lines to make them usable.

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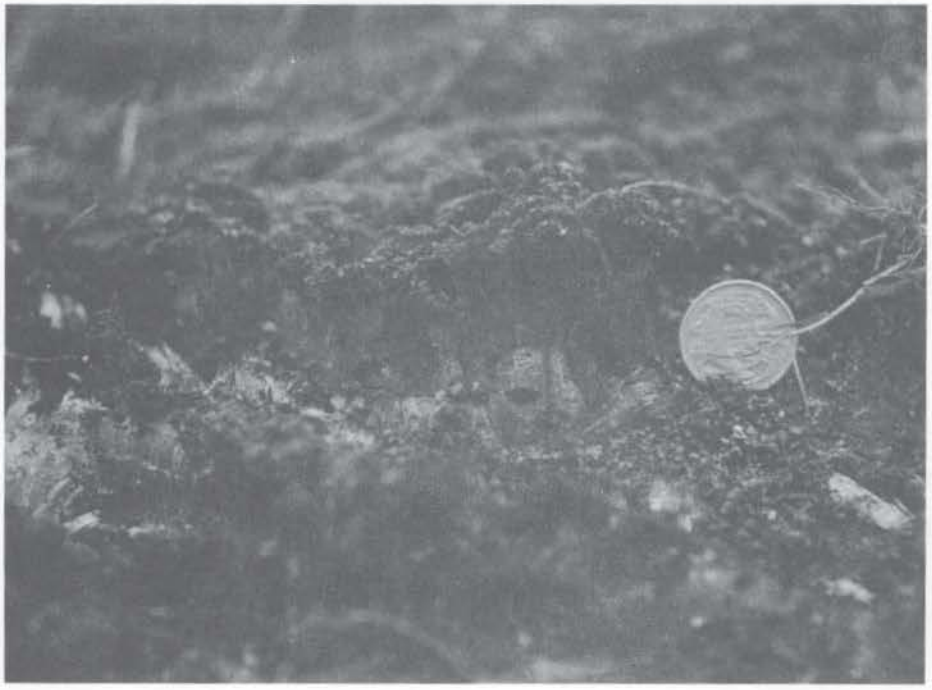
Vegetation mosaic, Spion Kopje Spur, looking eastwards to Mt. Nelse. Tussock grasslands (lightest tone) predominate on flat sites such as saddles, and beside bogs which occur only along drainage lines. Heathlands (mottled appearance) are present on most slopes. (Photo : S.C.A.)



Needle ice - the prime soil movement force. Soil particles are raised above the normal soil level and become susceptible to dispersal by wind once drying occurs. Needle ice does not occur where soil is covered by plants or their litter - see page 26. (Photo : Ken Rowe)

SUMMARY

The Bogong High Plains are a series of treeless plateaux and peaks covering an area of 120 km^2 in north-eastern Victoria. Their ecosystem is characterised by a harsh climate of consistent winter snowfall, high frost frequency and low year-round temperatures.

Land-use on the Bogong High Plains has undergone many changes in type and priority of importance since the decline of transient aboriginal use. Following pastoral settlement of surrounding lowlands, the area was used for summer stock grazing. Development has escalated over the past thirty years with the construction of the Kiewa Hydro-electricity Scheme and two ski villages. Grazing of cattle has continued.

Disruption of vegetation and soils through land-use is primarily a result of construction works, trampling by cattle and the smothering action of their faeces. Once the vegetation cover has been removed, frost in the form of needle ice is capable of lifting soil and small rocks. After the needle ice has melted, the uplifted soil is easily blown or washed away.

A vegetation survey of the Bogong High Plains was undertaken to provide (1) an unambiguous classification of plant communities, (2) an assessment of present vegetation condition in relation to disruptive land-use and (3) a foundation for the detection of future vegetation change. Twenty-three vegetation units were recognised. Heathlands are the most prominent feature of the Bogong High Plains vegetation constituting about two-thirds of the total area. Tussock grasslands and bogs make up most of the remainder. Bogs and diuturnal snowpatches are the types of vegetation most susceptible to disturbance. The Bogong High Plains vegetation is closely related to that of other mainland alpine regions. However, the Tasmanian alpine vegetation appears to be quite distinct.

The Bogong High Plains flora, almost two-thirds of which is restricted to high altitudes, has adaptive and generic parallels with alpine floras world-wide. A total of 325 species of vascular plant has been recorded on the Bogong High Plains including: 41 species of rare or restricted distribution, 47 introduced species and seven Victorian endemics.

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ACKNOWLEDGEMENTS

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INTRODUCTION

The Bogong High Plains of north-eastern Victoria are the largest of the State's alpine plateaux. They are defined, for the purposes of this report, as the treeless areas encompassed by the summits of Mt. Hotham, Mt. Feathertop, Mt. Bogong and Mt. Cope (Fig.1). They cover approximately 120 km^2, which represents two-thirds of Victoria's treeless alpine land. Apart from Mt. Feathertop, most of the alpine portions of the region are relatively flat or gently undulating, and range in elevation from about 1400 m at small plains on easterly spurs to 1986 m at Mt. Bogong. The Bogong High Plains grade steeply into surrounding forested river valleys.

The unique nature of the alpine vegetation, its use and/or disturbance by activities such as grazing, construction of the Kiewa Hydro-electricity Scheme and recreational facilities, and the harsh alpine environment have inspired various botanical studies of the area. These studies may be placed into four categories:

(1) Generalised classification surveys: usually undertaken as part of a larger study. Such surveys have been employed by Carr and Turner (1959a), Costin (1957, 1962) and Rowe (1967, 1972). The vegetation surveys of Costin and Rowe are extrapolations of the non-floristic classification of Costin (1954), for the Snowy Mountains of New South Wales.

(2) Localised and detailed classification surveys: such as that of McDougall (1978) for the Mt. Nelse area.

(3) Qualitative plant ecology and land studies: which investigate, largely by observation, the relationship between the vegetation and the natural and introduced environment. These include the pattern and process work of Carr (1962) and the land-use studies of Rowe (1967, 1972).

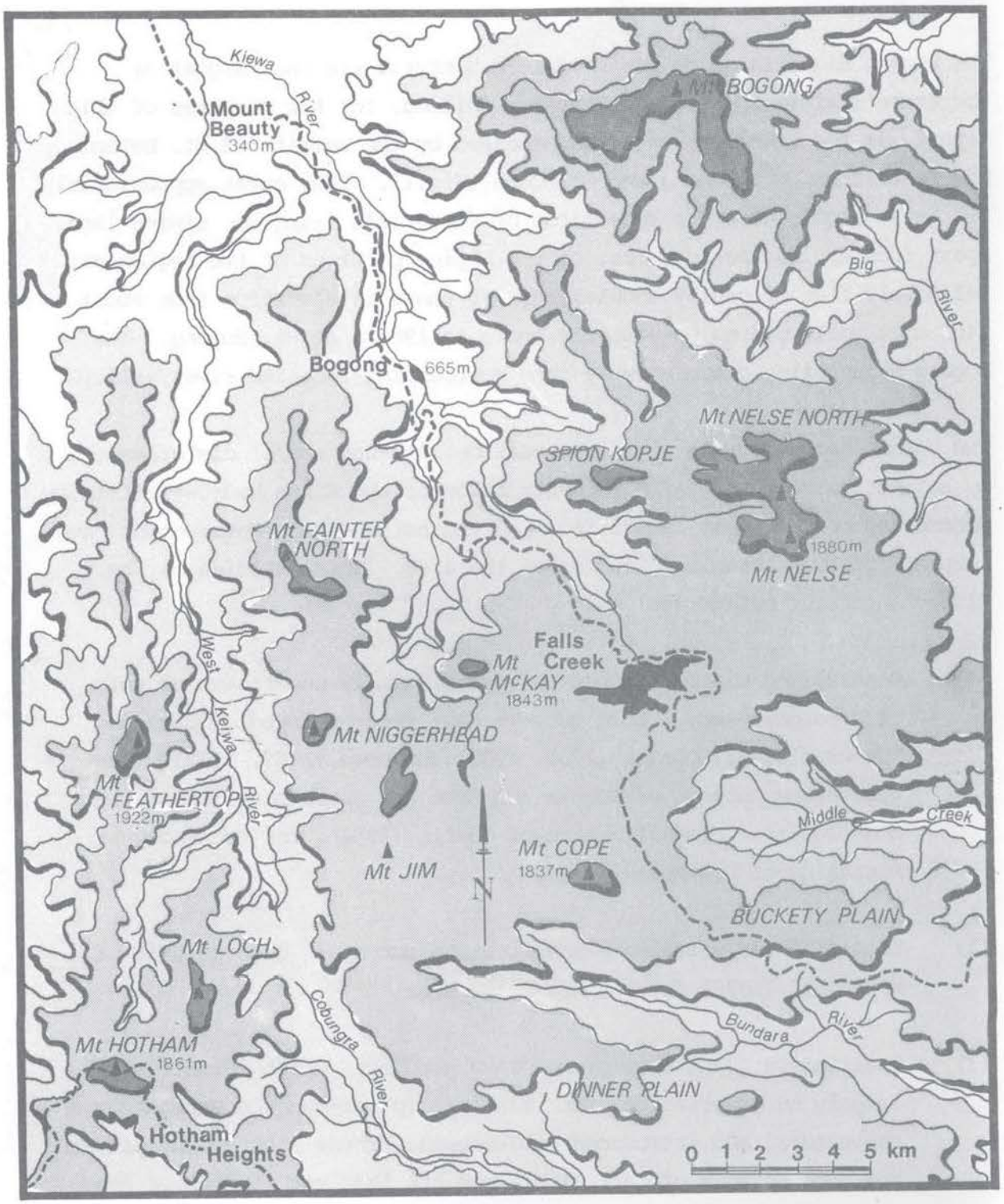


Fig. 1. Location of survey area

(4) Quantitative continuing studies involving the repetition of measurements over a period of time. Such on-going investigations have been performed by Carr and Turner (1959b) and Carr (1977) on small fenced areas of Pretty Valley and Rocky Valley to determine the effect of stock exclusion; the Soil Conservation Authority (Victoria: Soil Conservation Authority 1972) on Mt Hotham to measure the recovery of vegetation after total withdrawal of grazing pressure; and the Soil Conservation Authority (unpublished data) on various areas of the Bogong High Plains to discover the effects of fire, shrub slashing and continued grazing.

Investigations into the effects of grazing on alpine vegetation have been hindered by the absence of detailed historical records. The first aim of this project is to provide an extensive vegetation reconaissance of the Bogong High Plains for the year 1980, which should assist in the detection of future changes due to management practices. Such a survey is particularly applicable at present, since the region has recently been proclaimed a National Park with removal of grazing from some areas proposed.

The second aim of the project is to provide a classification for the Bogong High Plains vegetation which can be used unambiguously by all future users of the area. The absence of such a classification in the past has meant that extrapolations from other alpine areas have been used, or simple, generalised classifications constructed, making comparison of study areas difficult. The project will enable consistent vegetation descriptions to be made.

A detailed vegetation survey can greatly assist in an understanding of ecological relationships. Such an understanding enables predictions of vegetation response to environmental change and definition of ecological problems, which are particularly applicable where management decisions are involved. Such surveys also help locate areas of particular botanical significance.

A floristic method was chosen for this vegetation survey because it is reasonably objective and therefore repeatable. It has also been used in many other alpine areas of Australia: Chesterfield (1978) in the Glenmaggie Catchment, Hargreaves (1977) for Lake Mountain, Kirkpatrick and Harwood (1979) for Mt Bobs, McVean (1969) for the Snowy Mountains and Scott (1974) for Mt Buller.

The information produced by the survey has been used to prepare vegetation maps The practical and scientific importance of vegetation maps has been emphasized by Kuchler (1953, 1967), Mueller-Dombois and Ellenberg (1974) and Wimbush and Costin (1973).

PART 1

THE ALPINE ECOSYSTEM

A GLOBAL PERSPECTIVE

The alpine ecosystem is defined as the physical and biological environment which occurs on mountains, above the climatic upper limits of tree species. These limits are seldom sharp. The lower limits vary globally from about 300 m in subpolar regions to 3500 - 4000 m on tropical mountains. Such ecosystems occur in arctic areas, such as Lappland and Alaska, North and South America, Africa, Europe, Asia, Japan, South-East Asia and Australasia. Most regions, except within the Himalayas and Americas, are separated from each other by large expanses of lowlands (Billings, 1974).

The alpine environment is characterised by a harsh climate. All alpine areas receive a relatively high precipitation. This may be in the form of rain (the predominant form of precipitation on tropical mountains), hail, sleet or snow. The distribution of snow on non-tropical mountains is controlled by frequent, strong and turbulent winds. These produce deep and often permanent snow drifts on lee slopes. Air movement is also a controlling factor of temperature. Daytime maximum temperatures are usually lower on windswept ridges and night-time minima are lower in alpine valleys because of cold air drainage. Elevation naturally produces much lower temperatures in alpine zones than corresponding lowland areas but also permits higher intensities of solar radiation to reach the ground. Frost is common in all alpine environments. Severe frost may lead to the production of needle ice, which disrupts soil and may even fracture rocks. Needle ice is the prime factor in the downward flow of soil and debris on steep slopes called solifluction, a phenomenon of most alpine areas. In subpolar regions permafrost may also occur (Billings, 1974).

Alpine plants possess many adaptations which enable them to survive in areas of low temperature, where the soil may be heaved by frost action and the growing season is significantly shortened by a persisting snow cover. They survive by employing combinations of the following characteristics:

(1) Life form: plants are usually reduced in size so that their above ground parts can take advantage of higher temperatures and reduced wind speed, which prevail close to the ground surface (Bliss, 1962). The variety of life forms and even leaf shapes is small (Billings, 1974). The predominant life forms of alpine vascular plants are:

(a) Grass tussocks. These provide good temperature insulation, the centre of a tussock being considerably warmer than the external environment. Because of this insulation no frost heaving occurs beneath the tussock or nearby. Old tussock leaves die back but remain in place, acting as a mulch which protects the perennating buds lying at or near the soil surface. Tussocks also hold moisture, useful in times of periodic drought (Hedberg, 1964).

(b) Acaulescent rosettes. These herbaceous plants have an almost complete absence of aboveground stem. They are adapted to resist strain imposed on their water balance and can subsist on ice needle soils where a firm anchorage is essential for survival. (Hedberg, 1964).

(c) Cushion plants. Cushions are aggregates of acaulescent rosettes. They have a dense and often hard surface which provides insulation to growing parts. The cushion surface loses less heat than the soil at night (Hedberg, 1964 ; Hedberg and Hedberg, 1979).

(d) Dwarf shrubs. Shrubs tend to grow in dense mats or bushes of low stature, therefore creating their own insulated environment (Hedberg, 1964).

(2) Perenniality: almost all alpine plants are perennials. A growing season of unpredictable length and severity is not conducive to plants which rely on annual redevelopment from seed (Billings, 1974).

(3) Seed dormancy: most seeds are produced late in the snow-free season and don't germinate until the following snow-melt, if then. Alpine seeds germinate poorly at low temperatures or when the soil is dry, a safeguard against germination late in the season. Germination occurs soon after snow-melt when there is a considerable diurnal temperature fluctuation and much moisture (Billings, 1974). Some seeds require a chilling period, others must have a period of after-ripening, whilst most inherent dormancy is caused by seed coat inhibition. Not all alpine seeds display dormancy and it is believed that seed dormancy is related to the abundance and successional success of the dominant species of alpine flora (Amen, 1966).

(4) Seedling establishment: is rare and very slow, and it is often several years before a seedling is established. Much of the first year's growth goes into root development, insurance against drought death and frost upheaval (Billings and Mooney, 1968).

(5) Photosynthesis and respiration: occur at high rates for short periods when light and temperature are favourable. Optimum photosynthetic rates are at lower temperatures than for non-alpine plants and dark respiration is higher at all temperatures. Alpine species also have higher light-saturation values in photosynthesis (Billings and Mooney, 1968). Cushion plants in particular increase resistance to carbon dioxide, water vapour and heat fluxes, resulting in reduced water vapour losses and lower photosynthetic rates (Bliss, 1971).

(6) Xeromorphy: drought may occur during particularly dry summers to vegetation on shallow soils and also when available water is in a frozen state due to frost. At these times nutrient transport may be severely restricted. Many alpine plants have the following xeromorphic characteristics:

(a) leaf margins which are revolute to folded
(b) small leaf surfaces
(c) thick leathery leaves
(d) dense woolly indumentum on leaves

All of these characteristics serve to reduce transpiration and ease drought stress (Hedberg, 1964). A cover of short, soft hairs on leaves also protects tissue from intense cold and ultra-violet radiation and collects moisture (Hedberg, 1964; Tosco, 1974).

(7) Winter dormancy: alpine plants are capable of survival during winter under a snow pack, an essential characteristic. The onset of dormancy is triggered by photoperiod, low temperatures or drought. The dormant plant is extremely resistant to low temperatures. Controlled by mean temperature and in some cases photoperiod, dormancy is broken at about the same time as snow-melt or even before. At this time carbohydrates, stored during winter within the large underground root system, are used for the immediate growth of shoots and leaves (Billings, 1974; Billings and Mooney, 1968).

(8) Vegetative reproduction: by rhizome, stolon, bulb or layering (Billings and Mooney, 1968).

(9) Flowering: flower buds are preformed the season before flowering takes place in many alpine plants. This ensures rapid commencement of the reproductive cycle if conditions are favourable soon after snow-melt (Billings and Mooney, 1968). Many flowers are large and colourful, reflecting the importance of insect pollination (Tosco, 1974). This feature is atypical of Australasian alpine plants (Bliss, 1971).

(10) Seed production: dependent on temperatures during flowering and the latter half of the growing season (Billings and Mooney, 1968).

THE BOGONG HIGH PLAINS

Geology

Metamorphic rocks predominate on the High Plains. Gneiss extends from the mylonites of the West Kiewa Valley to Mt. Nelse and Mt. Bogong where it becomes transitional to schist. Unstable sedimentary slates are a feature of the area to the west of the West Kiewa River between Mt. Hotham and Mt. Feathertop. Several cappings of basalt exist, the most prominent being the gently sloping area surrounding Mt. Jim. This large basaltic plateau is bordered to the north (Mt. Niggerhead) and south (Dinner Plain Spur) by small areas of granodiorite, and falls away rapidly eastwards to the newer alluvium of the floor of Pretty Valley. Other basalt cappings occur at Mt. Higginbotham, Mt. Loch, Ruined Castle and Basalt Hill, all of which are flat topped. Roper Lookout, opposite Falls Creek Village, is a volcanic plug. Large gneissic granodiorite boulders are localised but prominent on Dam Site Hill (Beavis, 1962).

Geomorphology

The Bogong High Plains and surrounding mountains were formed by an uplift in the Late Pliocene. Unlike the mountains of the Kosciusko region and Tasmania, obvious features of Pleistocene glaciation are not present. Periglacial phenomena such as boulder streams have been described by Carr and Costin (1956) and Talent (1965).

Through periglacial weathering processes, most of the alpine parts of the Bogong High Plains have been relatively flattened, often passing steeply into the subalpine and montane zones. Mt. Feathertop is an exception, its razorback summit having steep slopes to the east and west. Numerous rock rivers composed of basalt occur in the vicinity of Mt. Jim, Basalt Hill and Mt. Higginbotham. Unstable scree occurs on the steep slopes of Mt. Bogong and is also associated with the slates of Mt. Hotham and Mt. Feathertop.

Soils

The soils of the Bogong High Plains are characteristically highly organic and acidic. They vary topographically from peats in impeded drainage lines to the alpine humus soils of well-drained sites. The profiles of the latter soil type often penetrate into a layer of decomposing rock. Acidity and organic matter content decrease gradually down the profile, which is undifferentiated and has a friable crumb structure. Floaters of varying sized rock are common throughout the profile (Costin *et al.*, 1952). Bog peats are principally formed by the accumulation and partial decomposition of the moss *Sphagnum* sp. The dead plant material is quite intact towards the top of the profile, near the growing surface, but more decomposed with increasing depth. Profile depths of alpine soils range from a few centimetres amongst rock outcrops to about one metre in some bogs.

Very little work has been directed towards the nutrient status of alpine soils and its consequent effect on plant distribution. Moore (1959) found no significant differences in chemical composition between adjacent stands dominated by *Poa* sp. and *Eucalyptus pauciflora*, but the relationship between soils and most alpine vegetation types remains unknown. The influence of rock type on soil composition has not been investigated. Plant species abundance and composition in areas underlain by basalt rock on the Bogong High Plains are often different to those of metamorphic areas. This may be due to soil characteristics.

Climate

The Australian alpine climate differs primarily from that of lowlands in its consistent winter snowfall, high frequency of frost and lower year-round temperatures.

Average annual precipitation recorded on the Bogong High Plains at Falls Creek (fig.2) is substantially higher than values at nearby lower altitude stations (Bogong, 1812mm; Mt. Beauty, 1280mm; Omeo, 651mm). Much of this falls as snow in the winter and early spring months.

Average temperatures follow a predictable sigmoid pattern with the lowest temperatures being recorded in winter (fig.2). Between May and October the average minimum is below 0°C, whilst extreme minimum temperature does not exceed freezing point in any month. There are very few winter days during which a subzero temperature is not achieved. The potential for ground frost is highest during April, May and October when minimum temperatures are often below zero and there is little or no snow cover.

The prevailing wind on the Bogong High Plains is from the north-western quarter (fig.3). Both fine and precipitant conditions may accompany this wind. Also prominent is the wind originating in the south-eastern quarter. Fog and mist are then common. Average wind speed is marginally greater in the winter/early spring period. Extreme average monthly wind speeds vary from almost calm (1 knot) to gale force (30+ knots). Average humidity peaks during winter months as does daily duration of cloud cover.

Flora

The alpine flora is composed largely of herbaceous dicots. Almost two-thirds of the plants are restricted to the alpine and subalpine zone, making the vegetation quite unique. The presence of *Eucalyptus pauciflora* marks the transition from the alpine to the subalpine region. Species occurring under *Eucalyptus pauciflora* near the boundary usually occur also in the open alpine areas, but the ameliorated climate under the tree layer often results in different species abundance.

	Temperature[1]						Precipitation[2]		
	AVERAGES		EXTREMES				SUBZERO		
	Average Maximum (°C)	Average Minimum (°C)	Av. max. monthly maximum (°C)	Av. min. monthly maximum (°C)	Av. max. monthly minimum (°C)	Av. min. monthly minimum (°C)	Av. days of maximum below zero	Av. days of minimum below zero	Average Rainfall (mm)
January	17.2	7.4	24.2	7.2	16.1	-1.9	0	2	105
February	16.1	6.4	23.8	6.4	14.3	-2.7	0	2	96
March	14.3	5.3	21.1	3.8	12.8	-3.1	0	4	117
April	8.6	1.8	16.0	-0.4	9.2	-5.3	1	10	192
May	5.5	-0.4	10.9	-1.0	4.3	-6.0	2	16	270
June	2.5	-2.3	8.0	-2.4	2.1	-6.6	6	26	245
July	0.6	-3.3	5.9	-3.2	0.6	-7.8	14	28	333
August	1.5	-3.0	6.7	-3.2	1.4	-7.3	10	27	337
September	4.3	-1.1	10.6	-2.3	4.3	-7.3	4	18	245
October	8.5	-0.8	15.2	0.6	8.6	-6.0	1	14	294
November	12.3	3.9	21.2	4.8	12.4	-4.1	0	5	200
December	15.8	6.0	23.8	5.9	14.8	-3.2	0	4	147
								Year	2555

1) Averages were compiled from 7 years of daily observations at Wilkinson's Lodge (Victoria: State Electricity Commission, unpublished data).

2) Averages were compiled from 24 years of daily observations at Falls Creek (Victoria: Land Conservation Council, 1977).

Fig. 2. Temperature and precipitation

	Wind[1]							Humidity[2]	Sunshine[2]
	DIRECTION (% of total observations)				SPEED (knots)				
	NW Quarter	SW Quarter	SE Quarter	NE Quarter	Average	Average monthly maximum	Average monthly minimum	Average humidity %	Average hours of sunshine
January	66	6	25	3	9	25	2	67.2	9.8
February	62	6	30	2	8	25	1	69.0	8.9
March	60	7	30	3	8	25	1	69.8	8.0
April	58	9	32	1	9	27	1	79.8	5.7
May	62	8	29	1	8	26	1	82.2	5.1
June	63	11	26	0	9	31	1	83.7	4.1
July	74	9	15	2	12	36	1	86.8	3.6
August	65	13	21	1	10	30	1	87.4	4.5
September	72	11	16	1	10	29	1	79.7	6.3
October	63	8	28	1	9	26	1	74.8	7.2
November	58	9	32	1	9	26	1	71.3	8.3
December	57	12	30	1	8	24	1	67.3	9.7

1) Wind direction and speed were compiled from 7 years of twice daily observations at Wilkinson's Lodge (Victoria: State Electricity Commission, unpublished data).

2) Averages were compiled from 7 years of daily observations at Wilkinson's Lodge (Victoria: State Electricity Commission, unpublished data).

Fig. 3. Wind, humidity and sunshine

The tree-line is irregular and *Eucalyptus pauciflora* may reach altitudes well above the level of surrounding alpine vegetation, forming snow gum islands. Its upper limits are largely regulated by patterns of cold air accumulation. At about 1400m *Eucalyptus delegatensis* usually becomes dominant (figs.4,5). Many of the spurs which extend eastwards from the alpine zone are longer than those to the west. This results in large subalpine zones and gradual transitions to montane *E. delegatensis* forest. Small pockets of alpine vegetation may exist well below the upper alpine/subalpine boundary around the sources of creeks where cold air accumulates. The alpine/subalpine/montane boundaries of western spurs are usually very sharp.

Very little has been published about the cryptogam flora of the Bogong High Plains. Lichens and mosses are numerous and the former become most prominent at the highest altitudes. Fungi are rarely seen above the tree-line and then are usually only associated with the faeces of cattle. Puff balls are the most common of those occurring naturally.

The flora possess most of the adaptations and features of the generalised alpine flora outlined by Billings (1974). The major differences are the absence of true cushion plants and the pre-snow cover formation of overwintering flower buds in only a few species. These reflect the less severe climate of the Bogong High Plains when compared to most overseas alpine areas. Similarities in generic composition of alpine floras are evident (fig.6), highlighting the uniqueness of such vegetation.

The vegetation of the Bogong High Plains is described in more detail in Part 2 - The Vegetation Survey.

Fauna

The severe alpine climate and winter snow cover are also restrictive to faunal composition. Only *Burramys parvus*, the Mountain Pigmy Possum, is restricted to these high elevations. It has been found in the Bogong High Plains Region at Mt McKay, Mt Cope, Mt Loch, Mt Higginbotham and on Swindlers Spur.

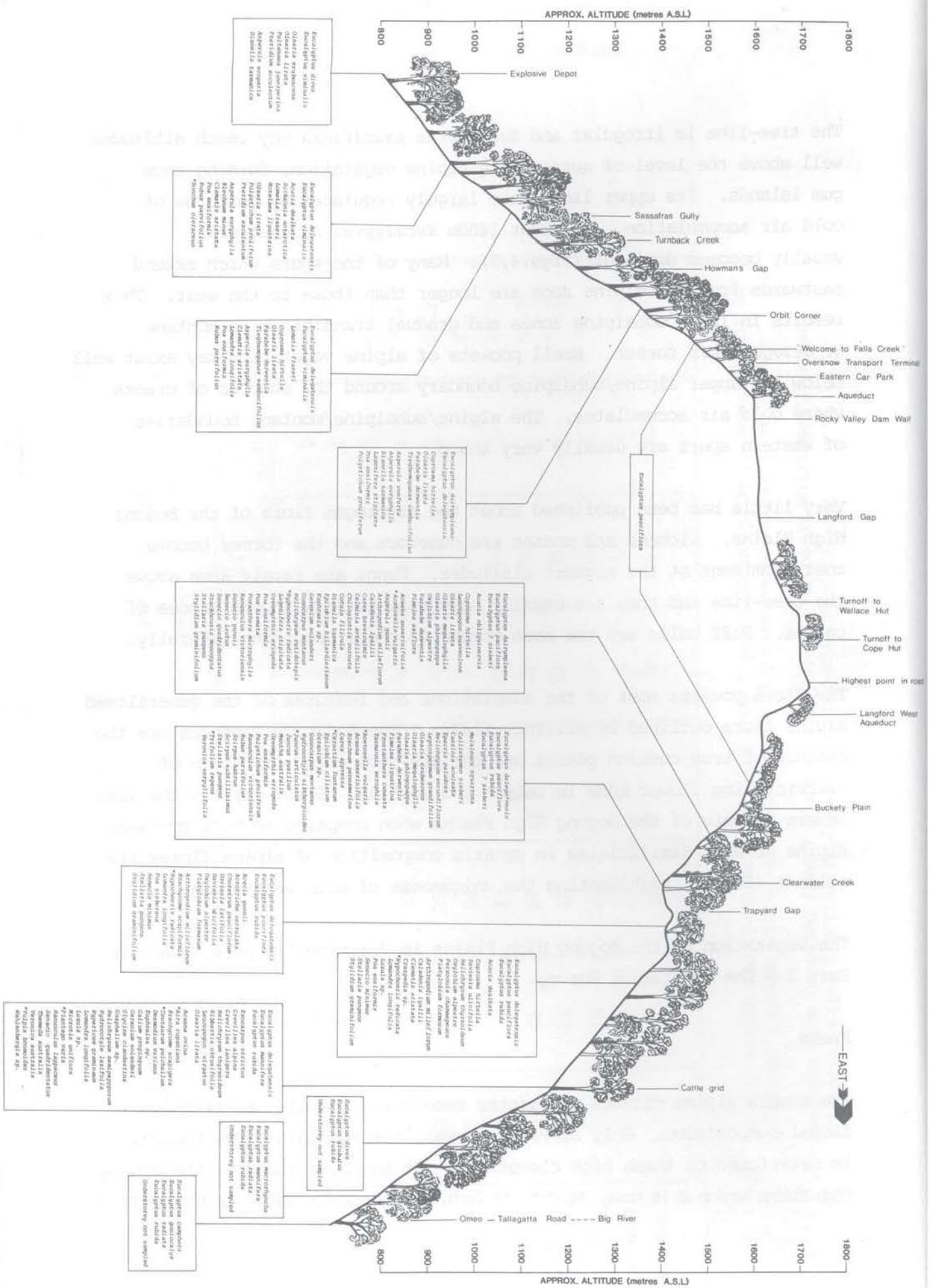


Fig. 4. Vegetation along Bogong High Plains Tourist Road

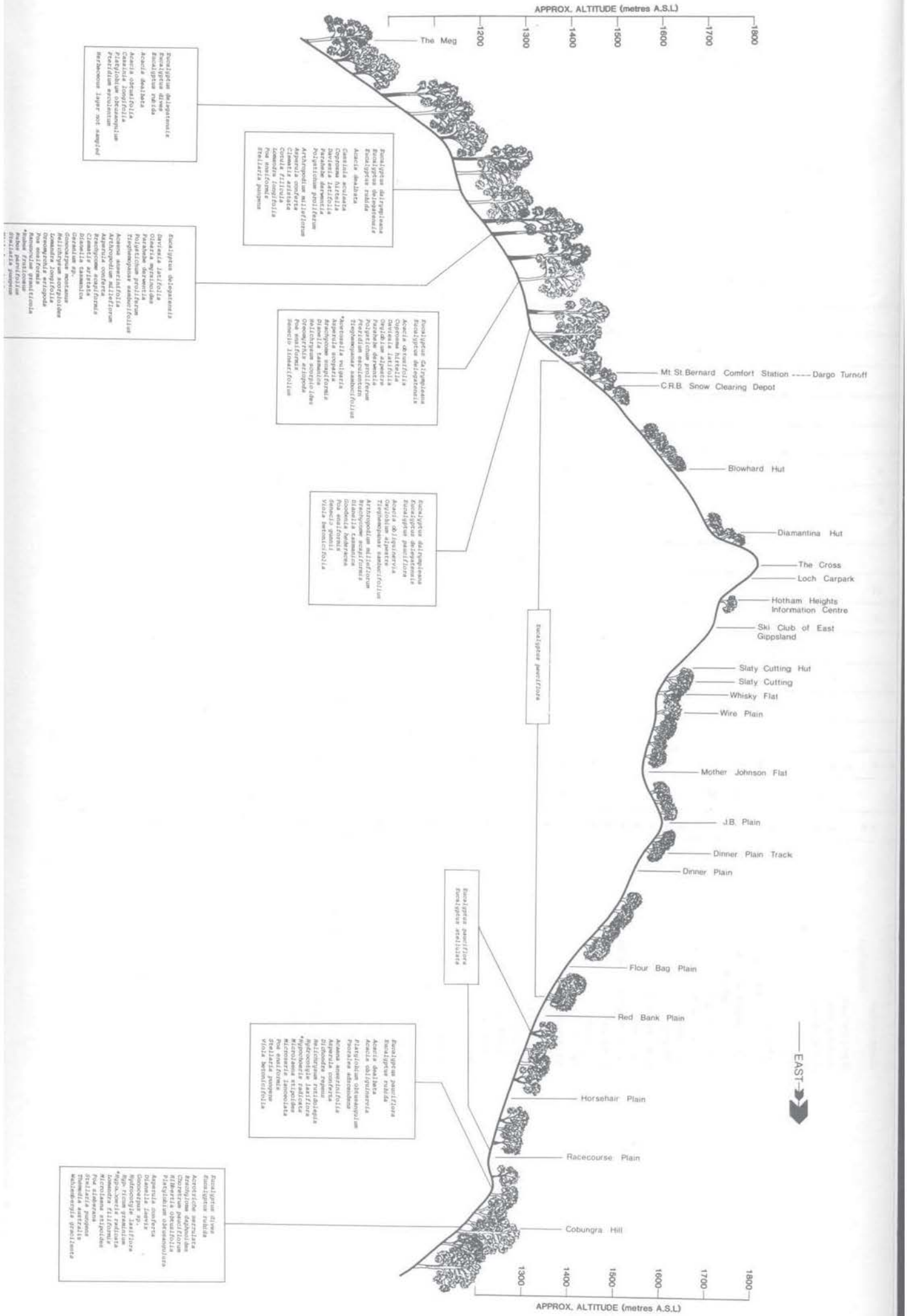


Fig. 5. Vegetation along Alpine Road

Its principal habitat is basalt rock rivers largely covered by *Podocarpus lawrencei*. The need for protection of this small marsupial of restricted distribution has been stressed by Gullan and Norris (1981). Other mammals occurring in the survey area include two species of *Antechinus* (Brown Antechinus and Swainson's Antechinus), *Rattus fuscipes* (Bush Rat) and *Mastacomys fuscus* (Broad-toothed Rat) (Victoria: Land Conservation Council, 1977). Echidnas (*Tachyglossus aculeatus*) were observed twice above tree-line during the survey and *Antechinus* have been found in one of the survival huts. There is a noticeable absence of macropods in alpine areas and they were observed only once, at Racecourse Plain (1300 m). Introduced mammals include hares (*Lepus europaeous*) and foxes (*Vulpes vulpes*). Introduced species are the most common part of the lowland fox diet (Coman, 1973), so they may assist in the control of hare numbers on the Bogong High Plains. Brumbies (*Equus caballus*) occasionally visit the basalt region south of Mt. Jim.

Reptiles are well represented by water skinks (*Sphenomorphus* spp.). White-lipped snakes (*Drysdalia coronoides*) are quite common and the alpine copperhead (*Austrelaps superbus*) was observed on the Razorback near Mt. Hotham.

Many birds frequent the area, the most conspicuous being ravens, prominent on basalt areas, pipits and birds of prey such as the nankeen kestrel, brown hawk and the wedge-tailed eagle which is common on Mt. Bogong. Emus, in groups of two to eight are occasionally seen between Mt. Jim and Mt. Nelse North.

The insect fauna is diverse, partly indicated by the fallout on snowpatches during snow-melt. Ants reach their peak of activity between snow-melt and February. Flies are also very conspicuous at this time. March flies were found to be most common on lower plains such as Wild Horse Valley and in the Mt. Hotham area. Wolf spiders (*Lycosa* sp.) and funnel-web spiders (*Atrax* sp.) are widespread. The normally placid spiders become quite agressive towards the end of the snow-free season. Swiftmoths (Hepialidae) and a casemoth (*Plutorectis caespitosae*) have been reported by Carr and Turner (1959a) for the area. The Bogong moth (*Agrotis infusa*) is abundant amongst the basalt boulders of block streams. These are migratory moths which inhabit the alpine area between November and April to aestivate away from the heat of the lowland summer (Common, 1954).

Numerous different types of grasshopper are abundant between December and March, including *Kosciuscola tristus* which shows a physiological colour change under the control of temperature (Key and Day, 1954), but their abundance seems to be seasonal.

Fire

Fire has not been a significant part of the Bogong High Plains ecosystem since at least 1939. No written records are known to exist of the extent and effect of the fires in that year or previously but evidence of their existence, at least in the forested subalpine zone, is still visible. For example, large areas of dead snow gums stand on the northern slopes of both Nelse and Nelse North Creeks. The age of several large trees in Rocky Valley, indicated by ring counts, does not exceed that of the 1939 fires, suggesting a possible regrowth origin for them. The presence of many large stands of *Podocarpus lawrencei*, a slow growing and long-lived shrub, on basalt rock rivers implies the absence of fire from much of that area for a long period of time.

2. The effect of fire on vegetation distribution is largely unknown. Good (1973) has described damage to bog peats by fire in New South Wales. The vegetation and peaty soils are destroyed and stream entrenchment follows.

Dominance of shrubs with tough coated seeds may be attributable to fire. *Hovea longifolia* only attains dominance in a few areas such as Mt. Fainter. *Oxylobium alpestre* and *Bossiaea foliosa* are common dominants of many subalpine woodlands.

A severe fire in the open alpine zone is likely to produce bare soil. However, the true susceptibility of vegetation to the influence of burning is difficult to assess because of the infrequency of fire.

Man

Man is a relatively recent component of the ecosystem. Long before European settlement of Australia, aborigines are known to have migrated

to alpine areas concurrently with the Bogong moth to feed on that insect (Massola, 1962). Permanent occupation is thought not to have occurred and their overall effect was probably minimal (Hancock, 1972).

Settlement of the lowland areas surrounding the Bogong High Plains inevitably led to the use of alpine land for grazing of stock after many pastures were burnt in the bushfires of early 1851. Much of the Bogong High Plains were pioneered by these first cattlemen. The inability of small selections to maintain sufficient stock through periods of drought encouraged many graziers to take up summer grazing leases in the latter half of the 19th Century. Cattle, sheep and horses were brought to the High Plains prior to 1945 but only cattle are now permitted to graze the land (Johnson, 1974).

Since the early part of the 20th Century, the potential of the high rainfall, upper Kiewa Valley for water retention and hydro-electricity generation has been recognised. However, the construction of dams and power stations was not realised until the late 1950's. The Kiewa Scheme functions primarily to supplement power output from the La Trobe Valley in periods of peak demand (Johnson, 1974). In recent years, maintenance of water quantity and quality has been given high priority in management decisions.

European man has replaced the aborigine as a regular visitor to the Bogong High Plains. Tourism and recreation are served in summer largely by numerous roads and tracks. In winter the villages of Falls Creek and Mt. Hotham are frequented by alpine skiers.

Herbivory

Large native herbivores are virtually absent from the alpine ecosystem. Cattle, hares, moths and grasshoppers are likely to be responsible for the major consumption of plant material.

Swiftmoths and casemoths have been reported to graze *Poa* spp. (Carr and Turner, 1959a). They are both inconspicuous herbivores, the larvae of swiftmoths feeding on the roots of *Poa* and those of casemoths occurring deep within the tussock. Their effect is thought to be minimal at present. Sizeable patches of dead *Poa*, described as symptoms of moth infestation by Carr and Turner (1959a) do occur, but are reasonably scarce. Population densities may be regulated by seasonal climatic characteristics. Although the Bogong moth is present in large numbers in a few areas, it does not feed on alpine vegetation during its summer aestivation (Common, 1954).

Grasshoppers have been extremely common on the Bogong High Plains for at least the past two snow-free seasons. Their numbers suggest that they could be highly significant herbivores. However, the grazing capability of these insects in the area is unknown at present. New Zealand alpine grasshoppers have been found to normally consume less than 2% of annual primary plant production (White, 1978). Although these grasshoppers are low-volume grazers, their feeding is selective for important ground cover species of low biomass (White, 1974).

The hare population and its role in grazing on the Bogong High Plains are unknown. In a New Zealand alpine grassland, hares were found to graze *Poa* tussocks from the top down but never established a short turf as rabbits do in lowland areas. After nibbling a few leaves the hares moved on to another tussock thus causing little damage. A population of eight hares in an area of 120 ha had little effect on vegetation (Flux, 1967). The snowshoe hares of northern America have a daily requirement of woody vegetation when the ground is snow covered (Pease *et al.*, 1979).

Cattle are present on the High Plains between mid-December and early April. They are likely to be the most important herbivores. A wide range of plants have been observed being eaten. These include *Poa* tussocks and even the shrubs *Grevillea australis* and *Asterolasia trymalioides*. The relative amounts of individual species in their diet are unknown at

present. The absolute dominance of *Poa* spp. in most vegetation types visited by cattle suggest that they might make up their dietary bulk even if unpalatable and non-digestible, as indicated by Costin (1970). All swards of *Poa* were at least partly grazed and some early in the season. Cattle often give the impression of being untidy eaters. The tussock tips are grazed and occasionally during this process, tillers are uprooted. These are either rejected by the cow, or more likely simply fall from its mouth, strewing the ground with numerous dead *Poa* leaves.

The response of Australian alpine plants to defoliation by herbivores has not been investigated. Morphological and physiological tolerances to grazing have been demonstrated in some arctic graminoids (Archer and Tieszen, 1980). The impact of grazing was reduced in these plants of relatively little supportive tissue by a reduction in root growth and subsequent re-allocation of nutrient reserves to rapid leaf production for the maintenance of required CO_2 uptake levels (Chapin, 1980).

[redacted] Although the partial removal of vegetation from inter-tussock spaces may slightly increase exposure of bare soil, the production of bare ground by cattle occurs principally through the smothering action of their faeces, and trampling. It became apparent during the current survey that faecal material could remain on the ground without decomposing for substantial periods of time. Faeces from at least the previous season were observed to be intact and thick in mid-December before the beginning of the grazing season. Removal of old, decaying faeces from *Poa* swards were found to produce neatly rounded patches of bare ground with sparse cover of dead and decaying *Poa* leaves. Germination beneath or on top of faeces seems to be uncommon and only a few species, such as **Acetosella vulgaris* and *Asperula gunnii*, have been observed growing through faeces in areas where they are almost completely degraded. Formation of a bare area occurs predominantly when faeces are

dropped on the edges of tussocks. The apparent lack of substantial bare ground and inter-tussock spaces amongst swards with large, robust tussocks (such as *Poa costiniana)* may relate to their resistance to smothering. Bare ground is abundant in some snowpatches where vegetation height does not exceed about 5 cm. Urine production by cattle is substantial but its effect on vegetation is more difficult to assess.

3. Production of bare ground by trampling is an important consequence of introduced herbivory. Repeated use of the same routes inevitably results in the removal of vegetative cover and production of a well defined track. A multiplicity of tracks usually occurs on steep slopes. *Sphagnum* is never present on tracks which traverse drainage lines.

The probability of recolonisation of bare ground by seed is dramatically reduced as a result of grazing by cattle and, to a lesser extent, insects. A reduction in seed crop is particularly significant on construction sites and ski slopes where vegetation is modified or totally removed. The attainment of a complete plant cover is unlikely in these areas if grazed.

4. The influence of grazing on species composition using fenced-unfenced comparative studies has been investigated for several vegetation types by Carr and Turner (1959b; Bogong High Plains) and Wimbush and Costin (1979a; Kosciusko). Prevention of grazing on the Bogong High Plains in a fenced area of Pretty Valley has resulted in an increased shrub cover (Carr and Turner, 1959b). Vegetation change may be incomplete here, possibly relying on the life cycles of the shrubs present which may be long. The reduction in grazing pressure has resulted in a decrease in bare soil in both the Pretty Valley and Kosciusko trials. Removal of stock from drainage areas in Rocky Valley (Carr, 1977) and the Kosciusko area (Wimbush and Costin, 1979b,c) often leads to the redevelopment of *Sphagnum* cover. The response here is much slower than in well-drained sites.

Recreation

Unlike many other areas, the Bogong High Plains, through their greater accessibility and winter snowfall, offer opportunities for year-round recreational activities.

In winter the predominant activity pursued by the visitor is skiing. Although some types of skiing require massive engineering developments in the form of villages and ski lifts, the direct effects of the skier on vegetation are likely to be minimal except at times of marginal snow cover.

During the snow-free season bushwalkers and sightseers are the most common users of the area. In an alpine area of Colorado trampling by walkers was not found to destroy vegetation unless it was intensive, or occurred in places of high soil moisture (Willard and Marr, 1970). Bare ground was also produced by the removal of rocks and the deposition of rubbish, such as cans, which killed the vegetation beneath them. Picking of wildflowers was noted to often involve complete plant removal and inevitably result in reduced seed crops. Some vegetation types, consisting of slow growing plants, are expected to take a minimum of 500 years to re-attain climax status after 25 years of visitor trampling (Scott-Williams, 1967).

The walkers of the Bogong High Plains keep primarily to tracks formed by cattle trampling. In areas where cattle no longer graze, such as the summit of Mt. Bogong, vegetation paucity on tracks is maintained by bushwalkers. Discarded rubbish is largely restricted to the vicinity of refuge huts and roadsides. The spread of introduced species may be occasionally attributable to bushwalkers. A well established apple tree is growing near a camp site on Twin Knobs near Mt. Feathertop. Although they may sometimes pick flowers, bushwalkers in their current numbers probably play a minor role in vegetation disturbance and bare soil production.

Trail bikes and horses are forms of recreational transport occasionally seen. The riders of the former have tended in the past to keep to roads and fire access tracks. However, the noise produced by this activity make it objectionable to most other users.

Engineering Developments

Major development has occurred only within the last forty years. Most has resulted from the construction of the Kiewa Hydro-electricity Scheme, such as roads, aqueducts, borrow pits, the Falls Creek Village and the Rocky Valley and Pretty Valley Reservoirs and surrounds. These construction schemes inevitably involve massive disturbances of soil. Production of bare soil is often substantial and usually requires the rapid establishment of introduced species to maintain vegetative cover. This may assist or instigate the spread of alien species. **Agrostis capillaris*, a commonly sown grass, is now a frequent member of many natural depression vegetations. Recolonisation by native species appears to be slow on sown sites. This is often impeded where adequate drainage is not provided, particularly where roads cross drainage lines.

Revegetation of grossly disturbed sites is rarely complete. Engineering developments inevitably lead to the production of some bare soil.

Needle Ice and Erosion

The phenomenon of needle ice formation in alpine soils has been widely reported overseas (e.g. Brink *et al.*, 1967, Canada; Hedberg, 1964, East Africa; Mitchell *et al.*, 1966, United States; Soons, 1967, New Zealand) and in Australia (Clothier and Condon, 1968). Ice needles form in areas of adequate soil moisture and exposure when atmospheric temperatures fall below $0^{o}C$. Needles of up to 5 cm in length have been observed in soils of the Bogong High Plains in early May. They give the soil a blistered appearance. This is caused by the upheaval of soil particles above the ice layer. Ice melt is followed by collapse of raised soil. Needles form perpendicular to the ground surface so that soil particles fall to positions lower than their original on all but flat slopes. The loosened soil of all needle ice areas becomes highly susceptible to erosion by wind and rain. Needle ice can be most damaging in snow patches which furnish a continuing supply of melt water in spring and early summer (Johnson and Billings, 1962). Heaving of suitably shaped stones may occur. If on thawing

the spaces beneath the stones become soil filled, they remain on the soil surface (Embleton and King, 1975). The scree slopes of Mt. Bogong and the rocky summit of Mt. Hotham may be attributable to this process. Needle ice formation inhibits the establishment of seedlings on bare soil by damaging developing root tissue or uprooting the entire plant (Brink *et al.*, 1967).

However, the intensity and frequency of needle ice activity are not sufficient to affect plant communities which form a complete ground cover due to the insulating influence of the vegetation and litter, as well as the binding effect of roots (Johnson and Billings, 1962).

Therefore, those factors which contribute to a decrease in vegetative cover above tree-line: faecal deposition, trampling by cattle and walkers, and engineering developments, lead to an inevitable loss of soil from the Bogong High Plains through the action of frost.

PART 2

THE VEGETATION SURVEY

SURVEY METHODOLOGY

The Braun-Blanquet Survey Approach

The survey method developed by Braun-Blanquet was chosen for the Bogong High Plains vegetation because it best suits the aims of such a primary reconnaissance. The method involves intensive sampling of recurring homogeneous combinations of plant species. It is a classification method which considers species presence and absence to be more important than variation in quantity (Mueller-Dombois and Ellenberg, 1974). Procedures which place most importance on dominants or structure often fail to reflect environmental parameters responsible for vegetation change, one of the prime objectives of this survey. This is particularly true in the alpine area where some species are capable of dominance in more than one habitat, and dominance may change over very small areas without appreciable change in environment.

Sampling Technique

The entire area containing open alpine vegetation was divided into squares of 1 km^2, based on the National Mapping grid system. Within each square three sample sites were selected. This was occasionally more in particularly varied vegetation and less within partly forested squares. A quadrat, the basic unit of vegetation sampling, of 4m x 5m was positioned at each sample site so that it was within a visually uniform vegetation. In a few stands of limited area, quadrats were necessarily smaller. Within each quadrat all vascular plant species were listed and given an estimate of cover-abundance according to a slightly modified Braun-Blanquet scale (fig.7).

fig.7 Cover-abundance scale used in sampling

Scale value	Cover-abundance
R	Solitary, cover negligible
+	Few individuals, cover <5%
1	Any number of individuals, cover <5%
2	" " " " , cover 5-20%
3	" " " " , cover 20-50%
4	" " " " , cover 50-75%
5	" " " " , cover 75-95%
6	" " " " , cover complete

Additional information gathered at most sites included slope, aspect, % shrub cover, % herb cover, soil depth, number of cattle faeces, % bare ground, shrub height and phenology of species present. A survey was also made of the area surrounding the quadrat. Any species found outside the quadrat but obviously a member of the sampled community was given a cover-abundance value of R. Altogether, 360 sites were sampled.

Plant Identification

Plant identification was carried out in the field where possible. Species which could not be identified were collected for subsequent closer examination. The nomenclature of Willis (1970, 1972), with amendments by Todd (1979), was followed. Identification was impossible for the following species or genera when in a sterile state:

Agrostis parviflora, Agrostis venusta - listed as *Agrostis* spp.; *Epilobium* listed as *Epilobium* spp.; *Geranium* - listed as *Geranium* spp.; *Leucopogon hookeri, Leucopogon montanus* - listed as the more common *L. hookeri*; *Luzula* - listed as *Luzula* spp.; *Prasophyllum alpinum, Prasophyllum suttonii* - listed as *Prasophyllum* spp.; *Scirpus* - listed as *Scirpus* spp.

Euphrasia species have been aggregated due to the inadequacy of the key of Willis (1972). *Erigeron pappocroma* has been divided into the three forms of Costin *et al.* (1979). At least two forms of *Craspedia glauca* sp. agg. were recognised. They have been denoted *Craspedia* sp. A. and *Craspedia* sp. B, and possess the following differential characteristics:

Craspedia sp. A. - leaves oblanceolate to broadly oblanceolate, pale green to dark green in colour.

Craspedia sp. B. - leaves linear to lanceolate to narrowly oblanceolate, grey-green to silver-grey in colour.

This division of *Craspedia* does not correspond to that of Costin *et al.* (1979) although their *Craspedia* sp. A, thought to have been endemic to the Mt. Kosciusko area, has been collected from Pretty Valley (R.J. Adair - pers. comm.).

Data Analysis

Floristic information from the vegetation survey was stored on magnetic tape and manipulated using the Soil Conservation Authority's H.P. 9845B computer. Numerical classification programs, such as that of Ceska and Roemer (1971), were not available on the S.C.A. system so a taxonomic program, CANMAR, was used for the initial data sort. CANMAR was found to be inadequate because it produced groups with a high correlation to number of species within a quadrat. Therefore, most of the data analysis was performed by hand sorting coupled with the S.C.A. program, P2WAY, which enabled rapid rearrangement of data. The final product of the analysis is a two-way table, a plot of species with their cover-abundance value against the quadrats in which they occur. Groups of quadrats which contain similar species then define the vegetation groups or units.

BOGONG HIGH PLAINS VEGETATION UNITS

The Two-way Table and Unit Descriptions

The quadrats (horizontal axis) and species (vertical axis) of the two-way table (fig. 8) have been arranged such that quadrats with similar species composition are grouped together and species which are often found together in the field, occur together in the table. A block of cover-abundance values in the core of the table then indicates a group of recurring plant species. Combinations of these blocks are defined by the vertical lines, delineating groups of quadrats which are representative of the vegetation units. Although more than 270 species were recorded in the survey, most occurred in less than 5% of quadrats. For this reason the two-way table has been abridged to include only characteristic species and species with greater than 5% occurrence.

In the following definition and description of these units, placement into confusing, ill-defined or controversial categories has been avoided. Instead, the term unit, as used by Komarkova and Webber (1980), will be applied to any group of vegetatively similar quadrats. A well defined hierarchy is apparent in the two-way table so that units should be easily converted once a universal nomenclature system is accepted. A suggested common name has been designated for each unit, principally for cross-referencing. Apart from the terms snowpatch, bog and fen which are widely accepted and unambiguous, names have been based on structure and dominant characteristic species. Unit characteristics for which insufficient data has been collected are denoted by "ID". Species characteristic of a particular unit have been identified using the method of Gullan *et al.* (1979). Introduced species are indicated by an asterisk preceding the species name.

Figures 10-17 are included to represent structural patterns within units. Profile lengths are short because of scale requirements. Therefore, diagrams do not necessarily reflect the average species composition of units.

A summary of the characteristics of each vegetation unit is included (fig. 9).

XERIC ALPINE COMPLEX - HEATHLANDS

Two-way Table Unit 1 - *Podocarpus* heathland

		% Occurrence	Average cover
Characteristic species:	*Podocarpus lawrencei*	100	5
	Pimelea ligustrina	83	+

Area covered by unit (%of total)	:	< 1
Number of quadrats in unit	:	6
Average number of species/quadrat	:	5
Total number of species in unit	:	17
Total introduced species in unit	:	0
Average introduced species/quadrat	:	0
Average slope	:	10^{o}
Slope range	:	$2\text{-}20^{o}$
Aspect	:	All
Average cattle faeces/quadrat	:	0
Average bare ground cover/quadrat	:	0
Average soil depth to rock	:	negligible
Structure (after Specht, 1981)	:	Closed heathland
Average cover of shrub layer (%)	:	100
Height range of shrubs (cm)	:	30-100
Average cover of herb layer (%)	:	< 5

Unit characteristics: *Podocarpus lawrencei* is the characteristic and dominant feature of the unit. Although it occurs occasionally in other xeric heathland units, dominance is reached only on boulder-fields and rock rivers. These rock flows are mainly of basalt (although one granodiorite river was found at the Niggerheads) and occur wherever basalt forms the substrate. They range in area from about $100m^2$ to more than $1000m^2$ but *Podocarpus* rarely covers the entire field. Stands often comprise only a few individuals of *Podocarpus* which, apart from numerous lithophytic lichens, appear to be a primary coloniser of these barren habitats. The moss *Brachythecium paradoxum* is commonly found growing on the stems of *Podocarpus* which sometimes reach the proportions of *Eucalyptus pauciflora* trunks.

The diameter of most stems indicates that stands of this unit may be extremely old. Stems of 6cm diameter in the Kosciusko area have represented an age of more than 170 years (Costin *et al.*, 1979). Beneath the dense canopy, several cm of leaf litter accumulates (fig.10). Often amongst this debris are the remains of Bogong moths (*Agrotis infusa*). Similar vegetation types have been described for the Snowy Mountains (McVean, 1969) and Mt. Buller (Scott, 1974), although the Bogong High Plains unit is much less species rich.

Disturbance susceptibility: Gullan and Norris (1981) have already stressed the importance of this type of vegetation as a habitat for *Burramys parvus* in the Mt. Hotham area. Although trapping has been carried out in very few stands of *Podocarpus* heathland, they all appear to be potentially ideal habitats for native mammals. The unstable nature of the basalt rocks protects the vegetation from any damage by cattle. Removal of *Podocarpus* by fire or slashing would affectively destroy the unit since the shrub is extremely slow growing and may establish from seed only rarely. The presence of large *Podocarpus lawrencei* shrubs on most rock rivers of the basalt around Mt. Jim would seem to indicate the absence of fire from the region for many years. A seral relationship between *Podocarpus* heathland and unit 12 appears likely.

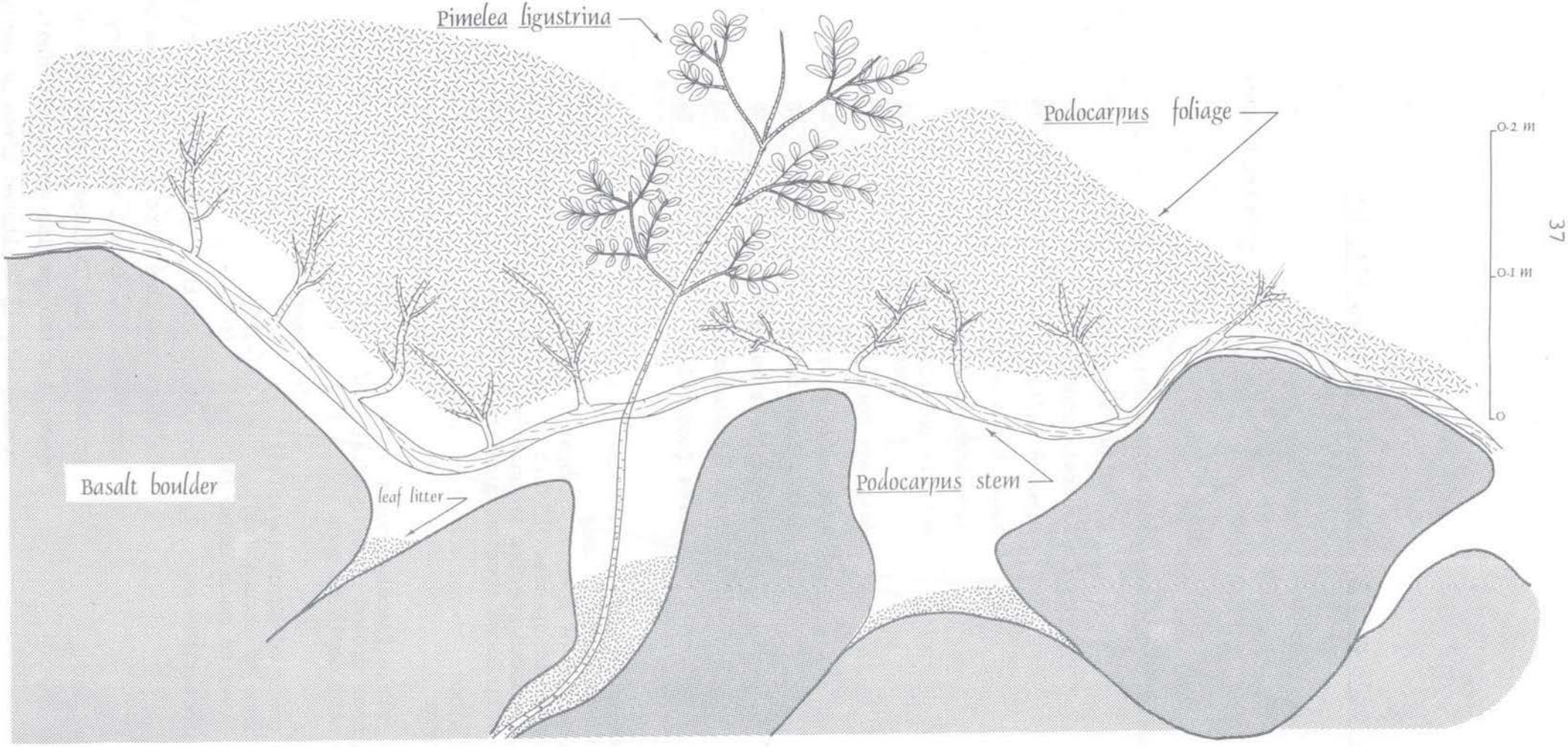


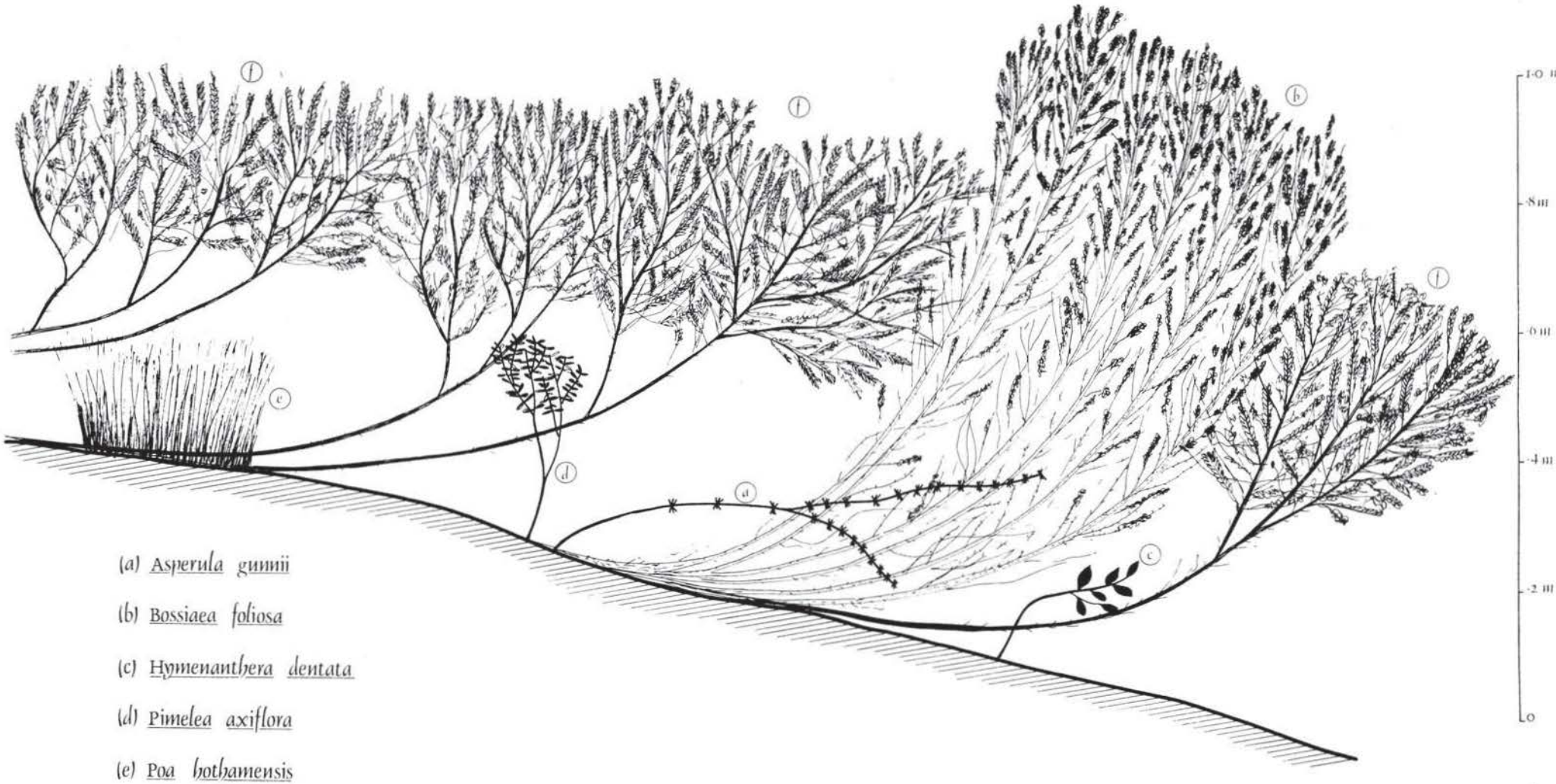
Fig. 10. Profile of *Podocarpus* heathland; Basalt Hill

Two-way Table Unit 2 - *Phebalium - Bossiaea* heathland

		% Occurrence	Average cover
Characteristic species:	*Poa hothamensis*	100	3
	Phebalium squamulosum	88	3
	Asperula gunnii	79	1
	Pimelea axiflora	79	1
	Viola betonicifolia	75	1
	Hymenanthera dentata	71	1
	Olearia phlogopappa var. *subrepanda*	71	1
	Bossiaea foliosa	67	3
	* *Acetosella vulgaris*	63	1
	Orites lancifolia	58	3
	Prostanthera cuneata	58	3
	Carex breviculmis	58	1
	Hovea longifolia	54	2

Area covered by unit (% of total)	: 20
Number of quadrats in unit	: 24
Average number of species/quadrat	: 17
Total number of species in unit	: 62
Total introduced species in unit	: 2
Average introduced species/quadrat	: 0.5
Average slope	: 17°
Slope range	: 8-32°
Aspect	: all
Average cattle faeces/quadrat	: 0.05
Average bare ground cover/quadrat	: R
Average soil depth to rock	: 0.27m
Structure	: Closed heathland
Average cover of shrub layer (%)	: 90
Height range of shrubs (cm)	:75-200
Average cover of herb layer (%)	: 50

Unit characteristics: The shrubs of this unit are always tall (usually 0.75-2m) and there are rarely spaces between them (fig.11), except where trampling has produced a well defined track. One or more of several shrub species may be dominant. The unit occurs only in sheltered sites of early snow-melt, particularly close to the tree-line.


(a) Asperula gunnii
(b) Bossiaea foliosa
(c) Hymenanthera dentata
(d) Pimelea axiflora
(e) Poa hothamensis
(f) Prostanthera cuneata
10 m
8 m
6 m
4 m
2 m
0

It also often extends well into the zone occupied by *Eucalyptus pauciflora*. The understorey of *Phebalium - Bossiaea* heathland is dominated by *Poa hothamensis* but is often very sparse. Similar vegetation has been described in the Snowy Mountains and on Mt. Buller.

Disturbance susceptibility: Cattle often traverse *Phebalium - Bossiaea* heathland but their presence is usually transitory. Although tracks result, caused by the trampling of the shrub layer, little or no erosion occurs. This is due to the shelter afforded by overhanging shrub branches against frost and wind. The formation of such tracks does, however, permit the establishment of opportunist species such as *Acaena anserinifolia* and **Acetosella vulgaris*. Removal of the shrub layer by slashing, as occurs in Falls Creek for slope grooming, often leaves large areas of soil bare. Soil loss is imminent with the removal of the upper stratum of *Phebalium - Bossiaea* heathland even though its sheltered habitat would tend to reduce the frequency and severity of frost and wind.

Two-way Table Unit 3A - Heathland/tussock grassland

		% Occurrence	Average cover
Characteristic species:	*Carex breviculmis*	100	1
	* *Acetosella vulgaris*	96	1
	Poa hothamensis	91	3
	Asperula gunnii	83	1
	Pimelea axiflora	83	1
	Grevillea australis	78	3
	Acaena anserinifolia	78	1
	Ranunculus victoriensis	78	1
	Scleranthus biflorus	78	1
	Oreomyrrhis eriopoda	78	+
	Viola betonicifolia	74	+
	Hymenanthera dentata	70	1
	Leucopogon hookeri	70	1
	Poa hiemata	65	2
	Brachycome decipiens	65	+
	Celmisia asteliifolia	61	2
	Microseris lanceolata	61	1
	Olearia phlogopappa var. *subrepanda*	57	1
	Prostanthera cuneata	52	3
	Asterolasia trymalioides	52	1
	Carex hebes	52	1

Area covered by unit (% of total)	: 20
Number of quadrats in unit	: 24
Average number of species/quadrat	: 26
Total number of species in unit	: 83
Total introduced species in unit	: 4
Average introduced species/quadrat	: 1.4
Average slope	: 10°
Slope range	: 0-28°
Aspect	: all
Average cattle faeces/quadrat	: 2.3

Average bare ground cover/quadrat	:	1
Average soil depth to rock	:	0.30m
Structure	:	Open heathland
Average cover of shrub layer (%)	:	60
Height range of shrubs (cm)	:	30-70
Average cover of herb layer (%)	:	70

Unit characteristics: The shrubs of this unit are short (0.3-0.7m) but not dwarf. Substantial gaps occur between adjacent shrubs and are usually occupied by *Poa hiemata* as well as many of the herbaceous species characteristic of unit 5B (*Poa hiemata* tussock grassland). The shrub understorey is similar to that of *Phebalium-Bossiaea* heathland, although usually more dense, so that this vegetation type may be seral. The unit is widespread on well-drained sites of greater exposure than those of *Phebalium-Bossiaea* heathland. Similar heathland/tussock grassland has been described for the Snowy Mountains (McVean, 1969) but is amalgamated with the Closed heathland of that region.

Disturbance susceptibility: Increased accessibility makes this unit more prone to cattle damage than *Phebalium-Bossiae* heathland. The high average cattle faeces/quadrat suggests frequent usage. Bare ground is not uncommon but substantial loss appears to be minimal, the bare area usually being on the same level as the bases of *Poa* tussocks and not showing wind-sorting of grav Some clearing of this unit has occurred in the Falls Creek ski development. Although more exposed than the cleared *Phebalium-Bossiaea* heathland stands of the ski slopes, much less soil is bare. However, some soil loss is likely on all but flat sites.

Two-way Table Unit 3B - *Hovea* basaltic heathland

		% Occurrence	Average cover
Characteristic species:	*Hovea longifolia*	100	3
	Poa costiniana	100	3
	Olearia phlogopappa var. *subrepanda*	100	2
	Acaena anserinifolia	100	1
	* *Acetosella vulgaris*	100	1
	Hymenanthera dentata	100	1
	Viola betonicifolia	100	1
	Epilobium billardierianum	100	1
	Poa hothamensis	86	2
	Asperula gunnii	86	1
	Carex breviculmis	86	1
	Microseris lanceolata	86	1
	Scleranthus biflorus	86	1
	Oreomyrrhis eriopoda	86	+
	Brachycome decipiens	71	+
	Plantago euryphylla	71	+
	Helichrysum rutidolepis	57	1
	* *Hypochoeris radicata*	57	1
	Pimelea axiflora	57	1
	* *Trifolium repens*	57	1
	Cotula filicula	57	+

Area covered by unit (% of total)	:	< 1
Number of quadrats in unit	:	7
Average number of species/quadrat	:	27
Total number of species in unit	:	54
Total introduced species in unit	:	3
Average introduced species/quadrat	:	3
Average slope	:	10^{o}
Slope range	:	$5-14^{o}$
Aspect	:	$200^{o}-310^{o}$
Average cattle faeces/quadrat	:	1.4
Average bare ground cover/quadrat	:	1
Average soil depth to rock	:	0.15m
Structure	:	Open heathland
Average cover of shrub layer (%)	:	50
Height range of shrubs (cm)	:	30-50
Average cover of herb layer (%)	:	80

Unit characteristics: *Hovea longifolia* is the dominant shrub of this unit. Unlike heathland/tussock grassland, the intershrub spaces are occupied by *Poa costiniana* or *Poa hothamensis*. This type of vegetation is relatively uncommon, being restricted to northern and western aspects of basaltic areas. Its occurrence is probably related to past burning. Directly comparable vegetation has not been previously described although similarities to heathlands of the Snowy Mountains and Mount Buller are apparent.

Disturbance susceptibility: Cattle have been frequently observed grazing in this unit, probably because of its open nature and the presence of *Poa hothamensis* in intershrub spaces. Some trampling of shrubs occurs. Bare soil surfaces are not depressed. A larger than normal number of introduced species is characteristic of this and other disturbed basaltic sites.

Two-way Table Unit 3C - *Grevillea* scree heathland

		% Occurrence	Average cover
Characteristic species:	*Carex breviculmis*	100	1
	Brachycome rigidula	96	1
	Poa hothamensis	92	2
	**Acetosella vulgaris*	92	1
	Grevillea australis	88	2
	**Hypochoeris radicata*	88	1
	Leucopogon hookeri	83	1
	Trisetum spicatum	83	+
	Celmisia asteliifolia	79	2
	Oreomyrrhis eriopoda	75	+
	Euphrasia spp.	58	+
	Microseris lanceolata	58	+
	Danthonia nudiflora	54	+
	Viola betonicifolia	54	+

Helichrysum rutidolepis	50	1
Olearia frostii	50	1
Pimelea axiflora	50	1

Area covered by unit (% of total)	:	10
Number of quadrats in unit	:	24
Average number of species/quadrat	:	24
Total number of species in unit	:	88
Total introduced species in unit	:	4
Average introduced species/quadrat	:	1.9
Average slope	:	24°
Slope range	:	2-38°
Aspect	:	all
Average cattle faeces/quadrat	:	0
Average bare ground cover/quadrat	:	2 (includes rock and scree)
Average soil depth to rock	:	0.10m
Structure	:	Open heathland
Average cover of shrub layer (%)	:	40
Height range of shrubs (cm)	:	30-80
Average cover of herb layer (%)	:	50

Unit characteristics: This unit occurs exclusively on loose rocky substrates (scree) at high altitudes. The dominant shrub is *Grevillea australis* and intershrub spaces are commonly occupied by *Celmisia asteliifolia*, *Brachycome rigidula* and **Hypochoeris radicata*. *Poa hothamensis* occurs only beneath shrubs. Stands contain a layer of small loose rock, much of which is usually unvegetated. Exposed soil is not common. The area encompassing Mt. Hotham, Mt. Blowhard and Mt. Feathertop together with the Mt. Bogong plateau contains most of the stands of this unit. In these areas *Grevillea* scree heathland replaces heathland/tussock grassland as the dominant heathland.

Disturbance susceptibility: Most of the areas where this vegetation occurs have been withdrawn from grazing. Loose rock, which has been lifted to the surface by frost heave, provides some protection to the once exposed soil. Plant development here will be extremely slow but with adequate protection from disturbance, a complete vegetative cover should be attainable.

Trampling or removal of rock debris, particularly from steep slopes, should be avoided.

Two-way Table Unit 4 - *Kunzea* heathland

		% Occurrence	Average cover
Characteristic species:	*Kunzea muelleri*	100	3
	Carex breviculmis	95	1
	Asperula gunnii	92	1
	Grevillea australis	89	2
	Celmisia asteliifolia	89	1
	Leucopogon hookeri	89	1
	Poa hiemata	84	3
	Craspedia sp. A	59	1
	Pimelea alpina	57	1
	Oreomyrrhis eriopoda	57	+
	Leptorhynchos squamatus	54	1
	Poa hothamensis	46	2

Area covered by unit (% of total)	:	5
Number of quadrats in unit	:	37
Average number of species/quadrat	:	20
Total number of species in unit	:	86
Total introduced species in unit	:	4
Average introduced species/quadrat	:	0.6
Average slope	:	6°
Slope range	:	1-9°
Aspect	:	all
Average cattle faeces/quadrat	:	0.5
Average bare ground cover/quadrat	:	1
Average soil depth to rock	:	0.18m
Structure	:	(Open or Closed) heathland
Average cover of shrub layer (%)	:	70
Height range of shrubs (cm)	:	15-50
Average cover of herb layer (%)	:	50

Unit characteristics: Occurring at a wide range of altitudes, the unit is characterised by the dominance and dwarf stature (<30 cm) of *Kunzea muelleri*. Stands are frequently species poor and rocky. *Kunzea* is a layering

shrub and often forms a dense cover to the exclusion of most other species. *Poa hiemata* grows between and amongst the shrubs. The shrub understorey is comprised largely of leaf litter and bare soil. *Kunzea* heathland includes the vegetation type of Costin (1957) called fjaeldmark. The fjaeldmark of overseas authors (eg. Komarkova and Webber, 1978) occurs on very exposed ridges where snow rarely accumulates, being blown by strong winds into leeward snowpatches. Cushion plants, lichens and much gravel are characteristic of such habitats. This type of habitat does not exist on the Bogong High Plains. The *Kunzea muelleri* association of McVean (1969) appears to be analogous to this unit.

Disturbance susceptibility: *Kunzea muelleri* is readily damaged by trampling. Numerous cattle tracks traverse most stands. The removal of *Kunzea* by trampling results in the exposure of bare soil. In many places these bare soil tracks have become depressed as much as 10 cm below the vegetated surface. Regeneration of complete cover following removal of trampling pressure is likely, due to the layering nature of *Kunzea*. Continued trampling will ultimately result in widening of tracks and deterioration of the cover provided by the layer.

XERIC ALPINE COMPLEX - GRASSLANDS

Two-way Table Unit 5A - *Poa costiniana* tussock grassland

		% Occurrence	Average cover
Characteristic species:	*Poa costiniana*	100	4
	Ranunculus victoriensis	94	1
	Oreomyrrhis eriopoda	94	+
	**Acetosella vulgaris*	89	1

Carex breviculmis	89	1
Scleranthus biflorus	83	1
**Trifolium repens*	83	1
Poa hiemata	78	2
Colobanthus affinis	72	1
Microseris lanceolata	72	1
**Taraxacum officinale*	72	1
Asperula gunnii	72	+
Acaena anserinifolia	67	1
Plantago euryphylla	67	+
Cardamine sp.	61	1
Danthonia nudiflora	61	1
Brachycome decipiens	56	1
Cotula filicula	56	1
Celmisia asteliifolia	56	+

Area covered by unit (% of total)	:	5-10
Number of quadrats in unit	:	18
Average number of species/quadrat	:	28
Total number of species in unit	:	93
Total introduced species in unit	:	7
Average introduced species/quadrat	:	3.3
Average slope	:	4°
Slope range	:	0-16°
Aspect	:	all
Average cattle faeces/quadrat	:	3.4
Average bare ground cover/quadrat	:	1
Average soil depth to rock	:	ID
Structure	:	Closed tussock grassland
Average cover of shrub layer (%)	:	0
Height range of shrubs (cm)	:	-
Average cover of herb layer (%)	:	95

Unit characteristics: *Poa costiniana* is the dominant of this unit. Its tall tussock (15-25cm) is the prominent feature of most of the basaltic areas particularly surrounding Mt. Jim. Tussocks are crowded, prohibiting the attainment of substantial cover by other species. Shrubs are almost totally absent. Although bare ground is not common, most stands are interspersed by depressions which vary in size from a few m^2 to

about 100 m^2. These depressions have abrupt sides, may be 10-30 cm deep and contain vegetation unit 8A (*Pratia* depressions). A small depression and its adjoining *Poa costiniana* tussock grassland are shown in fig.12. The distribution of this grassland appears to be determined by the drainage patterns of basalt areas. Immediately after snow melt the unit is water saturated and water movement is lateral. The depressions fill with water and assist in its retention. Between mid-summer and late autumn, however, the area is extremely dry.

Disturbance susceptibility: *Poa costiniana* appears to be more resistant to compaction and destruction by cattle faeces than other species of *Poa* because of its greater leaf volume and more robust stature. Bare soil is generally uncommon. In areas of intense cattle activity, such as the cattle camp of Tawonga Gap, many tussocks of *Poa costiniana* have been removed and their replacement is unlikely with continued cattle use. Introduced species are again prominent in this basaltic unit although in some areas are largely absent from the sward. Brumbies have been observed occasionally on the basaltic rises to the south of Mt. Jim but their impact on *Poa costiniana* tussock grassland is unknown.

Two-way Table Unit 5B - *Poa hiemata* tussock grassland

		% Occurrence	Average cover
Characteristic species:	*Poa hiemata*	96	4
	Carex breviculmis	94	1
	Ranunculus victoriensis	88	1
	**Acetosella vulgaris*	86	1
	Scleranthus biflorus	80	1
	Oreomyrrhis eriopoda	76	+

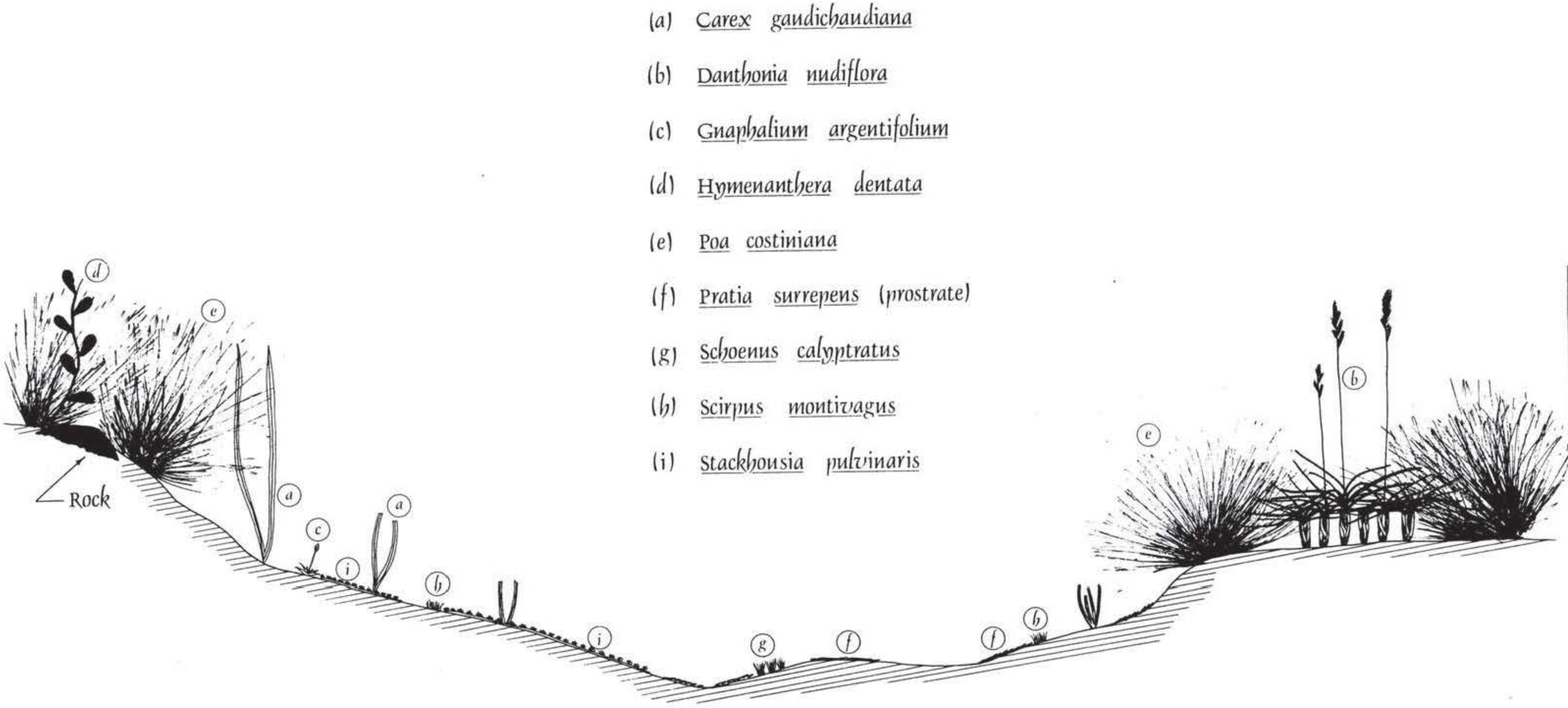


Fig. 12. Profile of *Poa costiniana* tussock grassland and *Pratia* depression; Mt. Jim

Danthonia nudiflora	74	1
Asperula gunnii	70	1
Brachycome decipiens	68	1
Microseris lanceolata	66	+
Senecio lautus	64	1
Trisetum spicatum	64	1
Pimelea alpina	60	1
Plantago euryphylla	60	1
Leptorhynchos squamatus	58	2
Celmisia asteliifolia	54	2
Ajuga australis	50	1
Craspedia sp. A.	50	1
Luzula modesta	50	1
Asterolasia trymalioides	46	1
Carex hebes	46	1
Poa costiniana	44	3
**Hypochoeris radicata*	42	+
Gnaphalium fordianum	36	1
Hymenanthera dentata	36	1

Area covered by unit (% of total)	10
Number of quadrats in unit	50
Average number of species/quadrat	24
Total number of species in unit	103
Total introduced species in unit	7
Average introduced species/quadrat	1.8
Average slope	4°
Slope range	0-11°
Aspect	all
Average cattle faeces/quadrat	3.7
Average bare ground cover/quadrat	1
Average soil depth to rock	0.31m
Structure	Tussock grassland
Average cover of shrub layer (%)	5
Height range of shrubs (cm)	20-50
Average cover of herb layer (%)	90

Unit characteristics: *Poa hiemata* tussock grassland is synonymous with the tall alpine herbfield of Costin (1954) and the *Poa - Celmisia* association of McVean (1969).

Stands are generally species rich and *Poa hiemata* is the usual dominant. Shrubs are sparse or absent. Substantial spaces occur between tussocks. These are often depressed and if not bare contain many forbs, particularly *Celmisia asteliifolia*, *Leptorhynchos squamatus* and *Senecio lautus* (fig.13). *Poa hiemata* tussock grassland is found on flat sites such as saddles, and also along some lower altitude cold air drainage valleys.

Disturbance susceptibility: The existence of *Poa hiemata* tussock grassland in exposed or frost prone cold air drainage sites makes it highly susceptible to disturbance. Cattle regularly frequent this type of vegetation. Areas of soil are left bare after decomposition of faecal deposits. The forces of needle ice, wind and rain continually remove soil until enough shelter is provided for seedling establishment. Deposition of more faeces re-activates the process, which ultimately means a continual loss of soil.

Two-way Table Unit 5C - Tussock grassland/mat heathland

		% Occurrence	Average cover
Characteristic species:	*Pentachondra pumila*	100	2
	Celmisia asteliifolia	93	1
	Danthonia nudiflora	93	1
	Oreomyrrhis eriopoda	93	1
	Poa fawcettiae	86	3
	Carex breviculmis	86	1
	Ranunculus victoriensis	86	1
	Plantago euryphylla	86	+
	Agropyron velutinum	79	1
	Asperula gunnii	79	1
	Brachycome decipiens	79	1
	Craspedia sp. A	79	1
	Pimelea alpina	79	1
	Poa hiemata	64	3

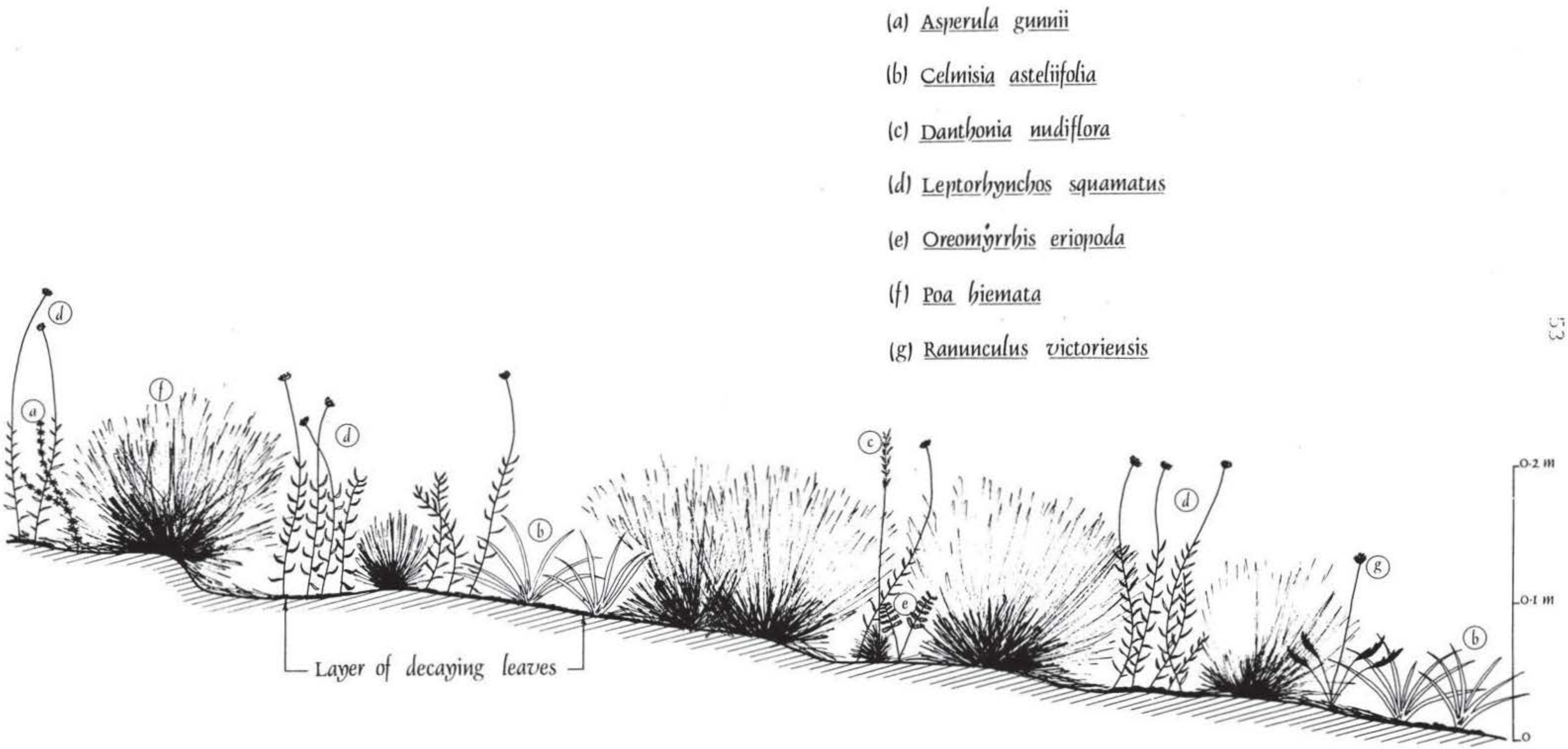


Fig. 13. Profile of *Poa hiemata* tussock grassland; Watchbed Valley

Gnaphalium fordianum	64	1
Scleranthus biflorus	64	1
Cardamine sp.	64	+
Asterolasia trymalioides	57	1
Luzula modesta	57	1
Ajuga australis	57	+
Scleranthus singuliflorus	50	1
Senecio lautus	50	1

Area covered by unit (% of total)	:	5
Number of quadrats in unit	:	14
Average number of species/quadrat	:	26
Total number of species in unit	:	72
Total introduced species in unit	:	3
Average introduced species/quadrat	:	0.6
Average slope	:	2^{o}
Slope range	:	$0-5^{o}$
Aspect	:	all
Average cattle faeces/quadrat	:	3
Average bare ground cover/quadrat	:	1
Average soil depth to rock	:	0.41m
Structure	:	Tussock grassland
Average cover of shrub layer (%)	:	20
Height range of shrubs (cm)	:	always prostrate
Average cover of herb layer (%)	:	80

Unit characteristics: Superficially, the vegetation of this unit appears to be the same as that of *Poa hiemata* tussock grasslands. The major difference is the presence of a prostrate mat of *Pentachondra pumila*. This mat is rarely continuous. The *Poa* tussocks which protrude from amongst the mat and the intershrub spaces are much shorter than their *Poa hiemata* tussock grassland counterparts. *Agropyron velutinum* is often associated with *Pentachondra*. The unit occurs extensively on the floor of Pretty Valley and amongst *Poa costiniana* tussock grassland to the north and south of Mt. Jim. A tussock grassland/mat heathland has not been previously described.

Disturbance susceptibility: This type of vegetation is frequented by cattle, particularly stands occurring on the sheltered floor of Pretty Valley. Destruction of *Pentachondra* mats does occur and at least some of this is attributable to smothering by faeces. Disruption of part or all of the carpet results in the exposure of bare soil. Areas of bare soil within the unit are only slightly depressed below the vegetated surface, so that further disturbances should not result in major soil loss. However, protection of *Pentachondra* mats is essential since these provide the only cover for some large areas of soil.

Two-way Table Unit 5D - Short turf snowpatch

		% Occurrence	Average cover
Characteristic species:	**Acetosella vulgaris*	100	2
	Carex hebes	100	2
	Viola betonicifolia	100	1
	Oreomyrrhis eriopoda	100	+
	Poa hothamensis	90	2
	**Hypochoeris radicata*	90	1
	Acaena anserinifolia	90	+
	Plantago euryphylla	90	+
	Danthonia nudiflora	80	2
	Scleranthus biflorus	70	+
	Celmisia asteliifolia	60	2
	Asperula gunnii	60	1
	Pimelea axiflora	60	+
	Ranunculus victoriensis	60	+

Area covered by unit (% of total)	: 1
Number of quadrats in unit	: 10
Average number of species/quadrat	: 21
Total number of species in unit	: 56
Total introduced species in unit	: 5
Average introduced species/quadrat	: 2.2
Average slope	: 15°
Slope range	: 7-22°
Aspect	:85-170°

Average cattle faeces/quadrat	:	2.3
Average bare ground cover/quadrat	:	2
Average soil depth to rock	:	0.25m
Structure	:	Grassland
Average cover of shrub layer (%)	:	5
Height range of shrubs (cm)	:	20-40
Average cover of herb layer (%)	:	90

Unit characteristics: Tussock forming *Poa*, characteristic of units 5A, 5B and 5C, is virtually absent from this unit which is found on moderate slopes of sheltered aspect. Snow remains on these sites one to two months longer than on adjoining units, usually 3A, 5B or 10. Plants are shorter in this habitat and rarely exceed 10 cm. Short turf snowpatch is equivalent to the grassland D of Carr and Turner (1959a) and undoubtedly has parallels with some of the snowpatches of the Snowy Mountains.

Disturbance susceptibility: The tips of plants such as *Carex hebes* and *Poa hothamensis* are normally the only parts consumed by cattle but because of their reduced stature in these small snowpatch sites, they are often grazed to almost ground level. *Agrostis parviflora*, although naturally short, suffers a similar fate due to its greater accessibility. Bare soil accounts for a considerable portion of the unit and with continued severe grazing and deposition of faeces is not likely to decrease. The exposed soils are surprisingly stable and soil loss is not always obvious. Part of this stability may be attributable to intact root material of mosses (*Polytrichum* spp.), the dead (or maybe dormant) above ground remains of which are scattered over many of the bare areas. However, massive soil loss has occurred from a few short turf snowpatches, such as on Mt. Fainter and the head of Cope Creek. The apparent stability of this unit may be only temporary.

Two-way Table Unit 6 - Diuturnal snowpatch

		%Occurrence	Average cover
Characteristic species:	**Acetosella vulgaris*	100	+
	Carex hebes	100	+
	Celmisia asteliifolia	85	3
	Poa fawcettiae	77	3
	Luzula acutifolia	54	2

Area covered by unit (% of total)	:	<1
Number of quadrats in unit	:	13
Average number of species/quadrat	:	9
Total number of species in unit	:	30
Total introduced species in unit	:	2
Average introduced species/quadrat	:	1.2
Average slope	:	20°
Slope range	:	10-29°
Aspect	:	90-180°
Average cattle faeces/quadrat	:	0.5
Average bare ground cover/quadrat	:	2
Average soil depth to rock	:	0.17m
Structure	:	Tussock grassland and Herbland
Average cover of shrub layer (%)	:	1
Height range of shrubs (cm)	:	<10 (but not prostrate)
Average cover of herb layer (%)	:	80

Unit characteristics: The unit is very restricted in distribution. It occurs only on large, concave, sheltered slopes at high altitude. Such sites exist only to the north of Mt. Nelse; on Spion Kopje spur, Mt. Bogong, Mt. Nelse North and Mt. Nelse itself. These summits and ridges are highly exposed and much winter snow is blown onto their sheltered slopes where it accumulates. Snow-melt is not complete until mid-summer. Very few species are capable of existing on these sites of the shortest growing season. The upper parts of the snow patches, where snow remains the longest, are dominated by *Celmisia asteliifolia* (fig.14).

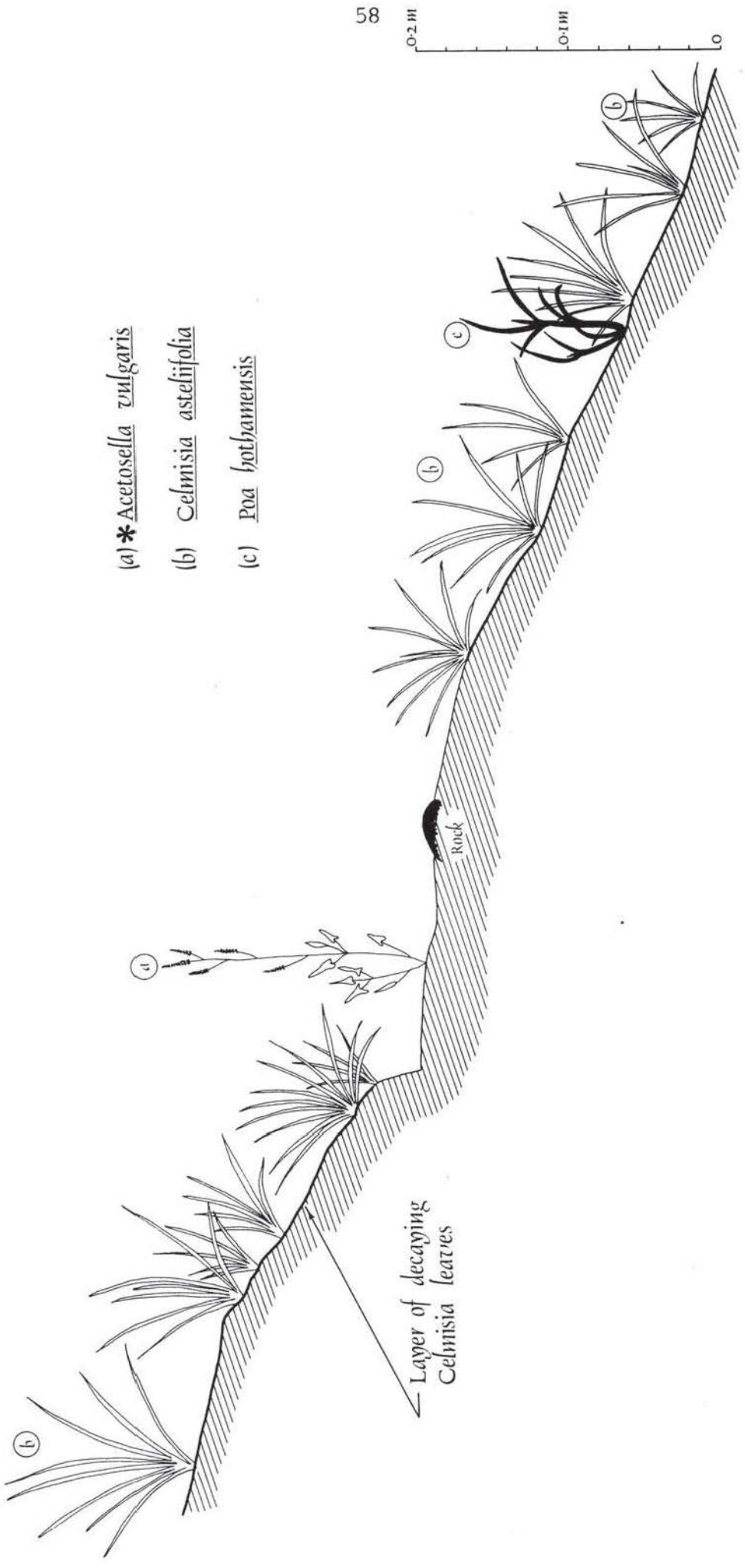


Fig. 14. Profile of vegetation from upper part of a diuturnal snowpatch; Mt. Nelse

Downslope, where soil is usually deeper, dominance is gradually attained by *Poa fawcettiae* (fig.15). Very few members of the dense stands of *Celmisia asteliifolia* flower in any one season. Reproduction in this environment is probably primarily vegetative.

Disturbance susceptibility: Bared soil is frequent within all diuturnal snowpatches. Soil loss is apparent and silt builds up on terraces and small depressions. The numerous cattle tracks traversing the snow patches which follow the fossil solifluction terraces have become severely entrenched. The walls of the tracks, particularly those along which water may flow because of altered topography, are up to 60 cm deep. Grazing mainly occurs in the *Poa* part of the snow-patch. Continued grazing of this section will ultimately lead to soil loss and replacement by species more characteristic of the upper *Celmisia* zone. Prolonged grazing, and particularly trampling, of this zone will inevitably result in the replacement of vegetation by rock, as is the case below the springs of the diuturnal snowpatch where only species capable of growing in shallow silt deposits exist. A dense, undisturbed carpet of *Celmisia asteliifolia* is capable of retaining the soil of the snowpatch even during snow-melt. A thick layer of dead leaves around each plant affectively provides protection to the surrounding soil. This unit, particularly prone to the actions of frost and flowing water, is one of the vegetation types most susceptible to disturbance by cattle or man.

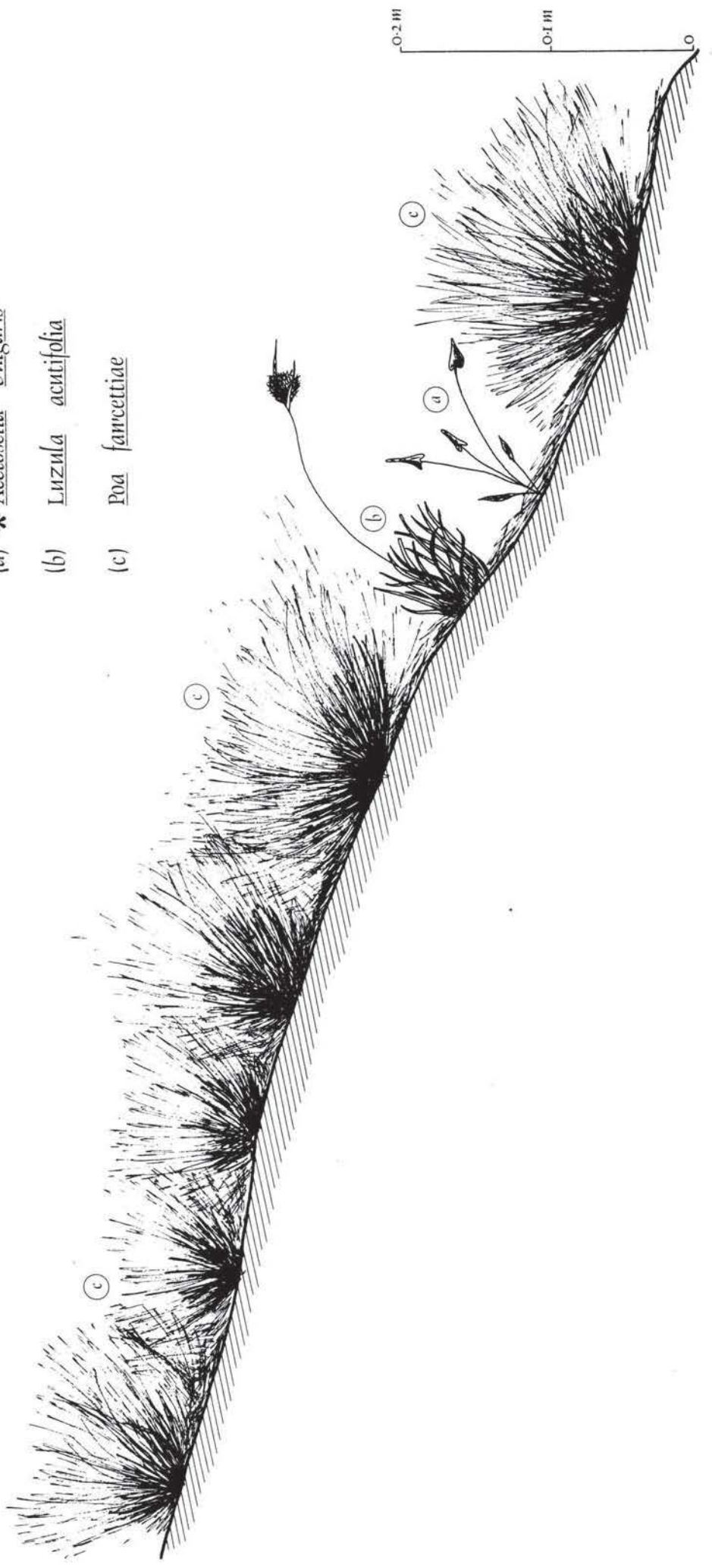


Fig. 15. Profile of vegetation from lower part of a diuturnal snowpatch: Mt. Nelse

MESIC-HYDRIC ALPINE COMPLEX -BOGS

Two-way Table Unit 7A - Bog

		% Occurrence	Average cover
Characteristic species:	*Empodisma minus*	100	4
	Richea continentis	97	3
	Poa costiniana	95	1
	Sphagnum sp.	86	4
	Baeckea gunniana	76	2
	Astelia alpina	73	2
	Carex gaudichaudiana	70	1
	Celmisia asteliifolia	70	+
	Epacris glacialis	65	2
	Erigeron pappocroma form A	62	1
	Oreobolus distichus	62	1
	Epacris paludosa	59	3
	Carpha nivicola	59	1
	Diplaspis hydrocotyle	43	1

Area covered by unit (% of total)	:	10
Number of quadrats in unit	:	37
Average number of species/quadrat	:	17
Total number of species in unit	:	95
Total introduced species in unit	:	6
Average introduced species/quadrat	:	0.2
Average slope	:	4°
Slope range	:	0-14°
Aspect	:	all
Average cattle faeces/quadrat	:	0.5
Average bare ground cover/quadrat	:	R
Average soil depth to rock	:	0.54m
Structure	:	Open heathland
Average cover of shrub layer (%)	:	60
Height range of shrubs (cm)	:	20-100
Average cover of herb layer (%)	:	70
Average cover of bryophyte layer (%)	:	50

Unit characteristics: Most of the drainage lines of moderate slope on the Bogong High Plains contain the vegetation of this unit. It is the bog or mossbed vegetation of most authors and is restricted to permanently wet sites. Most bog species do not occur in the drier sites of units 1-6 making the vegetation highly distinctive. Its structure is extremely complex. *Sphagnum* sp. often forms an extensive cushion mound or terrace absorbing and restricting water flow. Pools of varying size form within *Sphagnum* terraces. These are usually water filled and often contain substantial amounts of *Carex gaudichaudiana* (see unit 8B). Shrubs such as *Baeckea gunniana* and *Epacris paludosa* grow within and around the *Sphagnum*. The shrubs of the unit may be short and sparse (fig.16), or tall (to 1m) providing complete cover. *Callistemon sieberi* becomes prominent in the bogs of lower altitudes.

Disturbance susceptibility: Although cattle are often seen grazing in bogs, most damage is caused by trampling of *Sphagnum*. The *Sphagnum* part of the bog itself is rarely grazed but when the pools it contains dry out and vast amounts of *Carex gaudichaudiana* become accessible, severe trampling occurs. Hoof marks may remain in the cushion for long periods of time. Repeated trampling can lead to *Sphagnum* destruction, when moisture is limiting during dry summers, particularly at the bog edge. Removal of the *Sphagnum* layer results in more rapid water flow and ultimately stream entrenchment. *Sphagnum* is relatively slow growing so that widespread destruction is likely to be irreversible. This process seems to be at different stages in bogs on the Bogong High Plains. The siting of walking tracks through bogs should be avoided. The total absence of

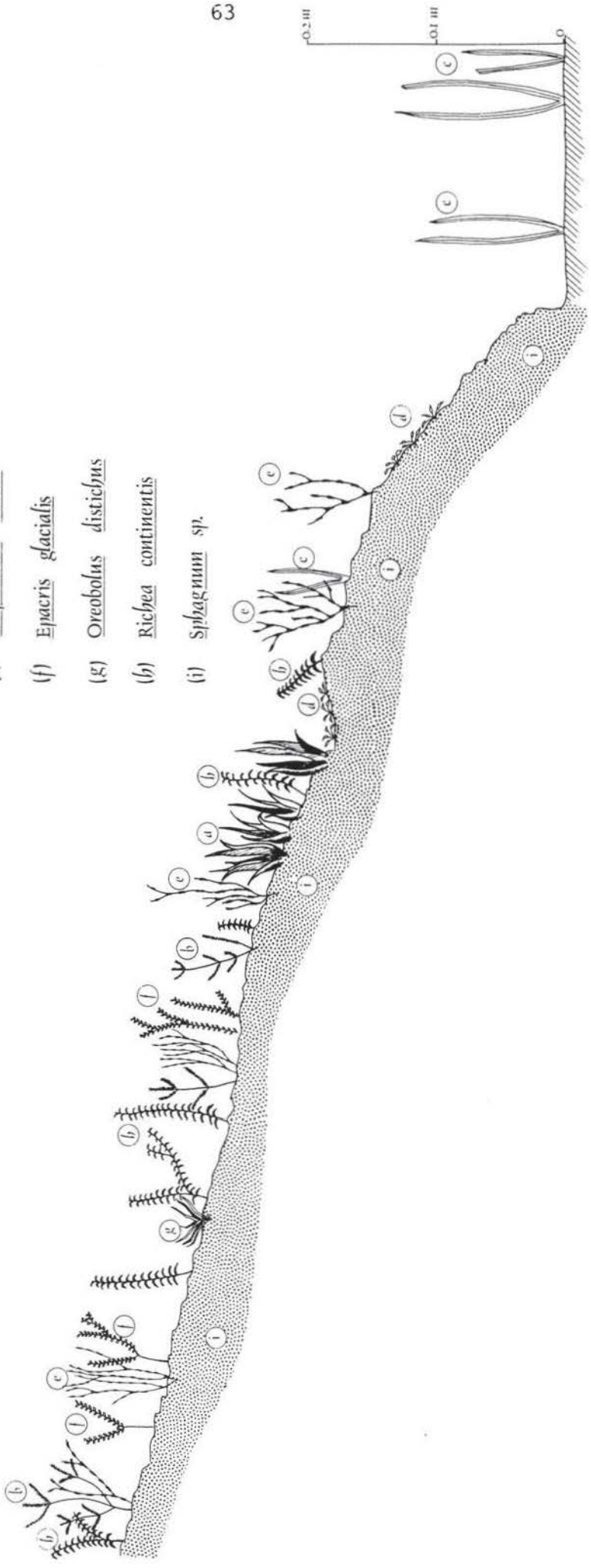


Fig. 16. Profile of a bog with short and sparse cover of shrubs; Watchbed Creek

Sphagnum from walking tracks through Watchbed Creek and Camp Creek and from cattle tracks on Dinner Plain demonstrates its intolerance to trampling. Bogs and diuturnal snowpatches (unit 6) are the most susceptible vegetation types to disturbance on the Bogong High Plains.

Two-way Table Unit 7B - *Epacris glacialis* heathland (relic bog)

		% Occurrence	Average cover
Characteristic species:	*Epacris glacialis*	100	5
	Empodisma minus	100	4
	Poa costiniana	100	2
	Carex breviculmis	100	1
	Ranunculus gunnianus	100	+
	Asperula gunnii	75	+
	Astelia alpina	75	+
	Gentianella diemensis	75	+
	Oreobolus distichus	75	+
	Stackhousia pulvinaris	75	+

Area covered by unit (% of total)	:	<5
Number of quadrats in unit	:	4
Average number of species/quadrat	:	19
Total number of species in unit	:	38
Total introduced species in unit	:	1
Average introduced species/quadrat	:	0.25
Average slope	:	1°
Slope range	:	0-1°
Aspect	:	all
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	R
Average soil depth to rock	:	0.42m
Structure	:	Closed heathland
Average cover of shrub layer (%)	:	80
Height range of shrubs (cm)	:	15-40
Average cover of herb layer (%)	:	60

Unit characteristics: Pretty Valley Creek, on the floor of Pretty Valley, is a deeply entrenched, fast flowing watercourse. The flat spaces between its many tributaries are intermittently wet and contain a mosaic of units 8A, 8B and 7B. Unit 7B occurs infrequently outside this valley. It is dominated by low growing shrubs of *Epacris glacialis*, which appear a purplish colour late in the growing season. The vegetation is similar to that of bogs. It differs primarily in the absence of *Sphagnum* sp. and is possibly a relic of bog vegetation. Small stands occur along the edges of some bogs, particularly those beside entrenched streams, and then merge imperceptibly with that unit.

Disturbance susceptibility: Very little bare soil occurs in the unit and it is unknown how frequently cattle use the areas. It is probably fairly stable.

MESIC-HYDRIC ALPINE COMPLEX - FENS

Two-way Table Unit 8A - *Pratia* depression

		% Occurrence	Average cover
Characteristic species:	*Pratia surrepens*	100	2
	Scirpus montivagus	92	1
	Carex gaudichaudiana	75	2
	Stackhousia pulvinaris	75	1
	Danthonia nudiflora	58	2

Area covered by unit (% of total)	:	<1
Number of quadrats in unit	:	12
Average number of species/quadrat	:	10
Total number of species in unit	:	48
Total introduced species in unit	:	4
Average introduced species/quadrat	:	0.6

Average slope	:	0^{o}
Slope range	:	-
Aspect	:	-
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	3
Average soil depth to rock	:	ID
Structure	:	Open sedgeland
Average cover of shrub layer (%)	:	0
Height range of shrubs (cm)	:	-
Average cover of herb layer (%)	:	40

Unit characteristics: This is the vegetation type of the depressions scattered throughout the *Poa costiniana* tussock grasslands on basalt. The depressions are usually rectangular to ovate and may be up to $100m^2$ in area. They have their longer axis oriented parallel to the contour of the slope. Vegetation rarely covers more than 70% of a depression (fig.12) and is submerged for at least one month after snow-melt. It is similar in appearance and composition to the pools in bogs (unit 8B) and may co-exist with them in large flat drainage areas such as Pretty Valley. Prostrate herbs and sedges dominate. The reason for the distribution of the depressions, and hence the unit, is not obvious. It occurs only rarely on metamorphic substrate in the Crow's Nest area of Spion Kopje, Buckety Plains and the head of Cope Creek. The phenomenon has been described for Snowy Mountains alpine areas and is suggested to relate to past activity of solifluction (McElroy, 1952).

Disturbance susceptibility: Although much soil is exposed, it is surprisingly stable and difficult to dislodge. This may be due to the presence of *Polytrichum* spp. which in other areas are often associated with firm, stable bare soils. Grazing of the leaf tips of *Carex gaudichaudiana* occurs but the effect of cattle is probably minimal. **Agrostis capillaris* is a common component of the unit as it is of water-logged disturbed sites.

Two-way Table Unit 8B - Fen (Bog pool)

		% Occurrence	Average cover
Characteristic species:	*Carex gaudichaudiana*	100	3
	Myriophyllum pedunculatum	100	1
	Ranunculus millanii	75	2
	Pratia surrepens	75	1

Area covered by unit (% of total)	:	1
Number of quadrats in unit	:	4
Average number of species/quadrat	:	6
Total number of species in unit	:	11
Total introduced species in unit	:	0
Average introduced species/quadrat	:	0
Average slope	:	0^{o}
Slope range	:	-
Aspect	:	-
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	ID
Average soil depth of rock	:	ID
Structure	:	Open sedgeland
Average cover of shrub layer (%)	:	0
Height range of shrubs (cm)	:	-
Average cover of herb layer (%)	:	25

Unit characteristics: The vegetation of this unit is characteristic of the pools which occur within bogs (unit 7A). Pools are also common within *Epacris glacialis* heathland on the floor of Pretty Valley. The cover provided by the species varies greatly and some pools are totally devoid of vegetation. Mosses often constitute a significant amount of cover. Pools are water filled for much of the growing season, so prostrate plants must be capable of surviving in an anaerobic environment. The pools of bog vegetation have not been considered as distinct vegetation types before, but they are in many ways analagous to fen vegetation described for the Snowy Mountains (McVean, 1969). They are considered a discrete, although variable unit on the Bogong High Plains where pools may cover areas of greater than $50m^2$.

Disturbance susceptibility: Towards the end of summer, free water disappears from many pools although they remain decidedly damp. They are then frequented by cattle which eat the tips of *Carex gaudichaudiana*. Much trampling of the moist, peaty soils occurs. This often leads to destruction of pool species. However, most disturbance is caused to the surrounding bog vegetation (unit 7A) in getting to and from the pools. Some pools which are devoid of vegetation are covered by a layer of thin rocks, possibly the result of a combination of the prolonged absence of a protecting vegetation and water cover, and frost action.

SUBALPINE COMPLEX

Two-way Table Unit 9 - Subalpine (exotic) grassland

		% Occurrence	Average cover
Characteristic species :	**Trifolium repens*	100	2
	Acaena agnipila	89	1
	Brachycome scapigera	78	1
	**Taraxacum officinale*	78	+
	Poa hiemata	67	3
	Danthonia penicillata	67	2
	**Acetosella vulgaris*	67	1
	Hypericum japonicum	67	1
	Velleia montana	67	1
	Aphanes australiana	67	+
	Plantago varia	67	+
	Carex gaudichaudiana	56	1
	Asperula gunnii	56	+
	**Cerastium fontanum*	56	+
	Cotula alpina	56	+
	Epilobium hirtigerum	56	+
	Ranunculus graniticola	56	+

Area covered by unit (% of total)	: < 5
Number of quadrats in unit	: 11
Average number of species/quadrat	: 29
Total number of species in unit	: 101
Total introduced species in unit	: 20
Average introduced species/quadrat	: 6.2
Average slope	: 5°
Slope range	: 1-8°
Aspect	: all
Average cattle faeces/quadrat	: ID
Average bare ground cover/quadrat	: ID
Average soil depth to rock	: ID
Structure	: Tussock grassland
Average cover of shrub layer (%)	: 5
Height range of shrubs (cm)	: 30-70
Average cover of herb layer (%)	: 90

Unit characteristics: This well-defined unit is perhaps not truly alpine. It contains very few alpine species and occurs only in small plains well below the continuous tree-line on the spurs running beside the Cobungra River to the north and south. Stands range in altitude from about 1200m to 1400m. Their structure is generally similar to that of *Poa hiemata* tussock grasslands and depressions containing prostrate herbaceous species are common. Snow is probably only present on the plains for relatively short periods during winter. They are bordered by *Eucalyptus stellulata* as well as *Eucalyptus pauciflora*.

Disturbance susceptibility: About half of the stands of this unit are on freehold land. Cattle graze on the lower of the plains for longer periods. All stands, and particularly those on freehold, contain large amounts of introduced species. At least one is dominated by **Festuca rubra*. Although the plains are heavily grazed, bare ground is minimal probably because of the less severe climate. There is a noticeable absence of bog vegetation (unit 7A) on most of the plains. Subalpine grasslands, excluding their tussock grasses, extend across drainage lines which are often entrenched. Tussocks of *Poa labillardieri*, which may be 1m tall and as much

wide, are occasionally dominant on small open areas relatively inaccessible to cattle. This grass may have been more widespread on lower plains before the inception of grazing. The vegetation of subalpine grasslands is less susceptible to damage in its present state than grasslands of the harsh climate above the tree-line.

UNITS OF RESTRICTED DISTRIBUTION

Two-way Table Unit 10 - *Caltha* herbland

		% Occurrence	Average cover
Characteristic species:	*Caltha introloba*	100	3
	Myriophyllum pedunculatum	100	2
	Carex gaudichaudiana	100	1
	Drosera arcturi	100	1
	Scirpus crassiusculus	100	1
	Deyeuxia parviseta	100	+
	Oreobolus pumilio	67	3
	Epacris glacialis	67	+

Area covered by unit (% of total)	:	< 1
Number of quadrats in unit	:	3
Average number of species/quadrat	:	13
Total number of species in unit	:	26
Total introduced species in unit	:	0
Average introduced species/quadrat	:	0
Average slope	:	1^{o}
Slope range	:	$0-3^{o}$
Aspect	:	all
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	ID
Average soil depth to rock	:	ID

Structure	:	Herbland/Sedgeland
Average cover of shrub layer (%)	:	<5
Height range of shrubs (cm)	:	10-20
Average cover of herb layer (%)	:	50

Unit characteristics: The distribution of this unit is very restricted. Occurring only in small areas below short turf snow-patches in Mt. Nelse Creek, head of Rocky Valley Creek and north of Mt. Cope, the dominants are *Caltha introloba* and cushions of *Oreobolus pumilio*. The flat, rocky sites are in a constant flow of water. *Oreobolus pumilio* forms robust cushions to 5cm high and 50cm wide. The cushions provide shelter for many minute plants such as *Drosera arcturi*, *Utricularia monanthos* and *Parantennaria uniceps*. The species of this unit occur more frequently in the Snowy Mountains where McVean (1969) has identified vegetation "associations" of both *Caltha* and *Oreobolus*.

Disturbance susceptibility: The *Oreobolus* cushions of the unit are particularly susceptible to trampling. *Oreobolus pumilio* and the species it shelters are extremely uncommon on the Bogong High Plains. Without adequate protection they may rapidly disappear from this area.

Two-way Table Unit 11 - *Celmisia sericophylla* herbland

		% Occurrence	Average cover
Characteristic species:	*Celmisia sericophylla*	100	4
	Scirpus aucklandicus	100	1
	Agrostis parviflora	80	1
	Carex gaudichaudiana	80	1
	Acaena anserinifolia	80	+
	Poa costiniana	60	1
	Caltha introloba	60	+

Luzula acutifolia	60	1
Richea continentis	60	1
Schoenus calyptratus	60	1

Area covered by unit (% of total)	:	< 1
Number of quadrats in unit	:	5
Average number of species/quadrat	:	21
Total number of species in unit	:	62
Total introduced species in unit	:	4
Average introduced species/quadrat	:	1
Average slope	:	ID (generally steep)
Slope range	:	ID
Aspect	:	all
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	ID
Average soil depth to rock	:	ID
Structure	:	Herbland
Average cover of shrub layer (%)	:	< 10
Height range of shrubs (cm)	:	10-30
Average cover of herb layer (%)	:	80

Unit characteristics : *Celmisia sericophylla* is the dominant of this unit (fig. 17). It is endemic to the Victorian high country and is virtually restricted to the Bogong High Plains. Therefore *Celmisia sericophylla* herbland is truly unique. It occurs mostly in the steep, rocky drainage lines below springs of diuturnal snowpatches.

Disturbance susceptibility: Although cattle tracks traverse most stands, the dense cover of *Celmisia sericophylla* appears to be fairly stable. Disturbance by sightseers of this highly attractive plant would seem to be its main threat. Some stands do, however, contain small quantities of plants rare to Victoria such as *Carpha alpina* and *Carex cephalotes*. Protection of this unique unit is essential.

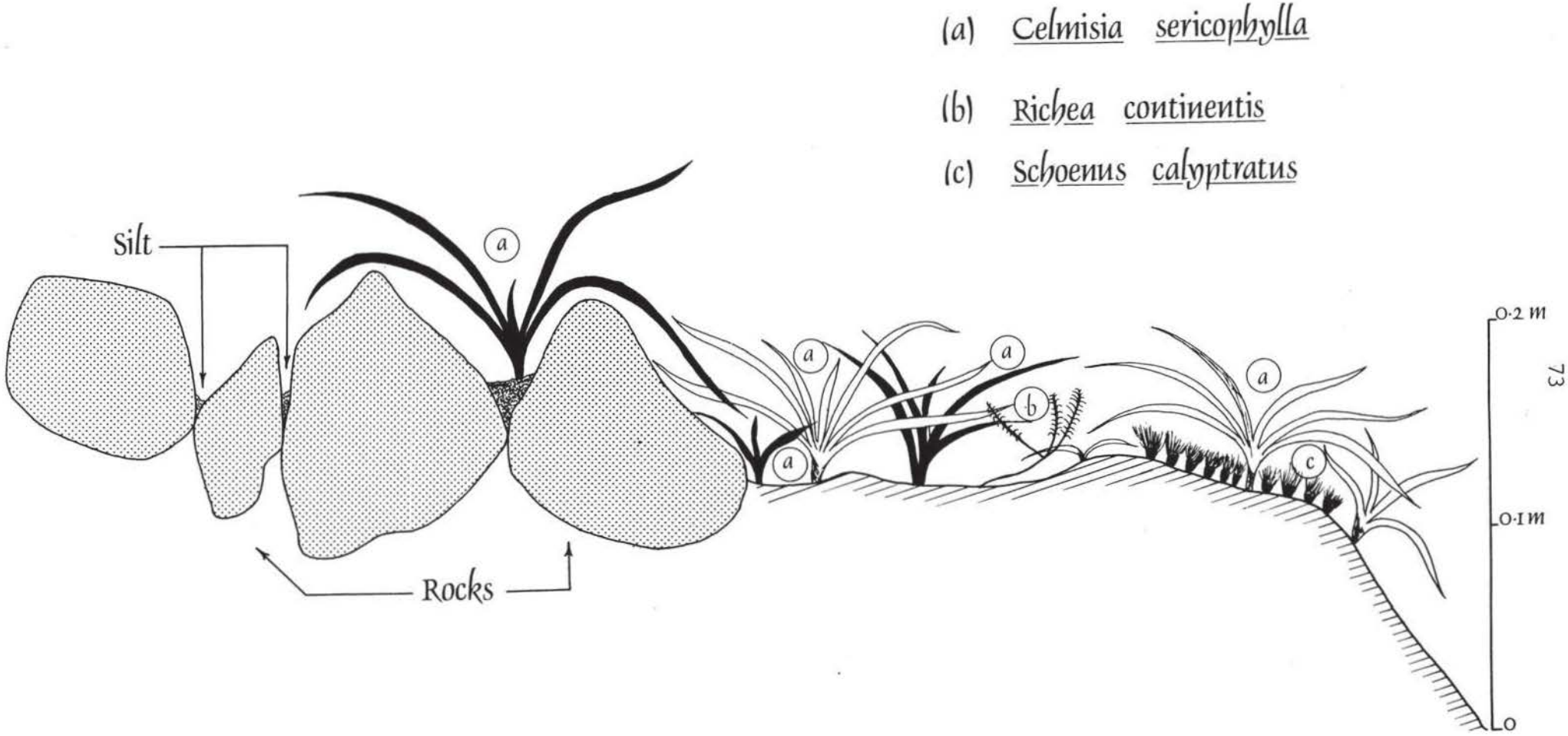


Fig. 17. Profile of *Celmisia sericophylla* herbland; Mt. Nelse

Two-way Table Unit 12 - *Carex appressa* sedgeland

		% Occurrence	Average cover
Characteristic species:	*Carex appressa*	100	3
	Acaena anserinifolia	88	2
	Poa helmsii	63	4
	**Trifolium repens*	63	2
	**Acetosella vulgaris*	63	1
	Poa costiniana	63	+
	**Taraxacum officinale*	63	+

Area covered by unit (% of total)	:	<1
Number of quadrats in unit	:	8
Average number of species/quadrat	:	15
Total number of species in unit	:	50
Total introduced species in unit	:	8
Average introduced species/quadrat	:	2.6
Average slope	:	ID (generally moderate)
Slope range	:	ID
Aspect	:	all
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	ID
Average soil depth to rock	:	ID
Structure	:	Tussock grassland/Sedgeland
Average cover of shrub layer (%)	:	0
Height range of shrubs (cm)	:	-
Average cover of herb layer (%)	:	95

Unit characteristics: Another of the units occurring predominantly on basalt is dominated by *Carex appressa* and/or *Poa helmsii*. The unit is very distinctive because the tussocks of these species are much bigger than those of related species in the surrounding grasslands. It occurs in narrow, well defined strips on moderate slopes. These strips are obviously related to drainage. They may also be old basalt boulder streams where sufficient soil build up has allowed establishment of species other than *Podocarpus lawrencei* (unit 1). The presence of partially exposed boulders in many stands is evidence for this. Where perennial water flow occurs, *Carex appressa* is the sole dominant. Species

occurring beneath the dense layer of living and dead *Carex* leaves are then commonly *Blechnum pennamarina, Hydrocotyle sibthorpioides* and **Trifolium repens*. Pronounced terracing occurs in these stands. On drier sites *Poa helmsii* is more common and stands are less species rich.

Disturbance susceptibility: Cattle graze and trample this type of vegetation Bare soil is rare, except in wet areas where hooves may penetrate to depths of more than 10cm. The soils and vegetation of this unit appear to be resistant to disturbance.

Two-way Table Unit 13 - *Poa hothamensis* (rocky) grassland

		% Occurrence	Average cover
Characteristic species:	*Poa hothamensis*	100	1
	**Acetosella vulgaris*	80	1
	Crassula sieberana	80	+
	Epilobium billardierianum	80	+
	Neopaxia australasica	80	+
	Brachycome rigidula	60	1
	Danthonia alpicola	60	1
	Scleranthus diander	60	1
	Agrostis parviflora	60	+
	Agrostis venusta	60	+
	Brachycome nivalis	60	+

Area covered by unit (% of total)	:	<1
Number of quadrats in unit	:	5
Average number of species/quadrat	:	13
Total number of species in unit	:	27
Total introduced species in unit	:	4
Average introduced species/quadrat	:	1.4
Average slope	:	ID
Slope range	:	ID
Aspect	:	all
Average cattle faeces/quadrat	:	ID

Average bare ground cover/quadrat	:	ID
Average soil depth to rock	:	negligible
Structure	:	Open herbland
Average cover of shrub layer (%)	:	0
Height range of shrubs (cm)	:	-
Average cover of herb layer (%)	:	25

Unit characteristics: This unit is best developed on rocky basaltic outcrops but is also occasionally found on those of metamorphic origin. The combination of plants making up the unit is quite unique although variable. The habitat is one of exposure, unstable rocky substrate and minimal soil. Examples of this environment are Roper Lookout and Ruined Castle. Plant cover is sparse over the basalt boulders and columns.

Disturbance susceptibility: Most stands are inaccessible to cattle because of their steep, unstable locality. Substantial damage may result from trampling or rock movement caused by sightseers who climb the outcrops for improved views.

Two-way Table Unit 14 - *Epacris microphylla* heathland

		% Occurrence	Average cover
Characteristic species:	*Epacris microphylla*	100	3
	Carex breviculmis	100	1
	Ewartia nubigena	100	1
	Luzula acutifolia	100	1
	Hypericum japonicum	100	1
	Poa fawcettiae	67	3
	**Acetosella vulgaris*	67	1
	Deyeuxia monticola	67	1
	Poa hothamensis	67	1
	Celmisia asteliifolia	67	+

Area covered by unit (% of total)	:	<1
Number of quadrats in unit	:	3
Average number of species/quadrat	:	15
Total number of species in unit	:	24
Total introduced species in unit	:	4
Average introduced species/quadrat	:	1.67
Average slope	:	1°
Slope range	:	0-4°
Aspect	:	all
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	ID
Average soil depth to rock	:	ID
Structure	:	Open heathland
Average cover of shrub layer (%)	:	25
Height range of shrubs (cm)	:	10-30
Average cover of herb layer (%)	:	40

Unit characteristics: This combination of species occurs only on the flat top of Basalt Hill. The site is highly exposed and has much bare soil and protruding basalt rock. It also possesses a unique lichen flora (R. Filson, National Herbarium of Victoria - pers. comm.). The vegetation of the unit is characteristically dwarf.

Disturbance susceptibility: The vascular flora of this unit appears to be resistant to disturbance by grazing and trampling. However, damage could potentially occur to the lichen flora through removal of rocks or entire plants by sightseers. Substantial invasion by **Agrostis capillaris* has occurred at the top of the quarry on the northern side of Basalt Hill where vehicles have been used to transport rock. The quarry itself is now rarely used.

UNDERSAMPLED UNITS

Two-way Table Unit 15 - *Poa fawcettiae* tussock grassland

		% Occurrence	Average cover
Characteristic species:	*Poa fawcettiae*	100	4
	Carex breviculmis	100	1

Empodisma minus	67	2
Danthonia nudiflora	67	1
Carex hebes	67	+

Area covered by unit (% of total)	:	<1
Number of quadrats in unit	:	6
Average number of species/quadrat	:	11
Total number of species in unit	:	28
Total introduced species in unit	:	2
Average introduced species/quadrat	:	0.5
Average slope	:	2°
Slope range	:	0-3°
Aspect	:	all
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	R
Average soil depth to rock	:	ID
Structure	:	Closed tussock grassland
Average cover of shrub layer (%)	:	0
Height range of shrubs (cm)	:	-
Average cover of herb layer (%)	:	100

Unit characteristics: A variable unit of often small stands, it is characterised by a short dense sward of *Poa fawcettiae*. Bare ground is rare and stands are species poor. They occur amongst other grasslands and beside drainage lines, where drainage is apparently impeded. *Empodisma minus* is a common component.

Disturbance susceptibility: The unit appears to be highly resistant to grazing and trampling. The closed tussock sward provides adequate protection to the soil.

Two-way Table Unit 16 - *Hovea* heathland

		% Occurrence	Average cover
Characteristic species:	*Hovea longifolia*	100	5
	Asperula gunnii	100	2
	Poa hothamensis	100	2
	**Acetosella vulgaris*	100	1
	Carex hebes	100	1

Area covered by unit (% of total)	:	<1
Number of quadrats in unit	:	2
Average number of species/quadrat	:	11
Total number of species in unit	:	16
Total introduced species in unit	:	2
Average introduced species/quadrat	:	1.5
Average slope	:	ID (gentle)
Slope range	:	ID
Aspect	:	SE-NE
Average cattle faeces/quadrat	:	ID
Average bare ground cover/quadrat	:	ID
Average soil depth to rock	:	ID
Structure	:	Closed heathland
Average cover of shrub layer (%)	:	80
Height range of shrubs (cm)	:	30-50
Average cover of herb layer (%)	:	50

Unit characteristics: Insufficient quadrats have been sampled to enable classification of this as a distinct vegetation type. The two samples were taken on Mt. Feathertop, south of Twin Knobs, and on Mt. Fainter. Both sites have easterly aspects and are species poor. *Poa hothamensis* occurs predominantly in the spaces between shrubs unlike the other heathlands of the Bogong High Plains. *Hovea longifolia* is the dominant and only shrub of the two stands. A relationship with past severe burning seems possible.

Disturbance susceptibility: The Mt. Fainter stand is traversed by numerous cattle tracks, many of which are severely eroded. *Poa hothamensis* is readily accessible and *Hovea* shrubs are low and easily trampled. Further substantial soil losses are inevitable in this type of vegetation on Mt. Fainter with continued grazing.

OTHER VEGETATION GROUPS

(1) Mechanically disturbed sites:

Six quadrats were sampled in revegetated disturbed areas such as disused building sites. They have been listed in figure 23 as two-way table unit 17. However, because of the varying seed mixtures used for

revegetation and the range of habitats, from water-logged to well-drained, in which they occur, truly characteristic species may be misleading. The sites are characterised by large numbers of introduced species, usually with high cover. **Agrostis capillaris* is the most common of these. Total vegetative cover varies from site to site and soil loss is often evident. Succession by native vegetation is slow. *Bossiaea foliosa* is the most common recoloniser of well-drained stands.

(2) Fernland:

McVean (1969) describes an "association" for the Snowy Mountains sometimes dominated by the fern *Blechnum pennamarina*. A stand of similar vegetation occurs on the lower south-eastern slope of Basalt Hill, and nowhere else on the Bogong High Plains. It is about $40m^2$ in area and bounded on its southern and eastern sides by *Podocarpus lawrencei*. Cattle are unlikely to disturb the fernland since it lies on smaller than usual, unstable basalt rocks. *Acaena anserinifolia* is common amongst the *Blechnum*. Another fern, *Polystichum proliferum* attains its maximum size and frequency in the vicinity.

(3) Closed *Ewartia* heathland:

On the flat slope south of the basalt capping of Basalt Hill is an extensive mat of *Ewartia nubigena*. *Ewartia* dominated vegetation has been described by McVean (1969). The mat formed by this subshrub is rarely more than $1m^2$ but at the base of Basalt Hill is at least $10m^2$.

(4) *Plantago glacialis* - *Oreomyrrhis pulvinifica* herbland:

Mats of *Plantago glacialis* and *Oreomyrrhis pulvinifica* cover small areas (generally less than $5m^2$) along drainage lines of the Mt. Nelse snowpatch and New Species Gully. Much larger stands of similar vegetation have been described for the snowpatches of the Snowy Mountains by Costin (1954) and McVean (1969). The rarity of this vegetation on the Bogong High Plains (and in Victoria) may reflect increased competition from other species due to a shorter duration of snow cover in snowpatches. Alternatively, grazing, trampling and subsequent soil loss from

snowpatches may have contributed to reduction in cover of perhaps once more extensive stands.

Key to the Bogong High Plains Vegetation Units

A key (fig.18) has been developed for the field identification of the units described above. Because the vegetation analysis was very detailed and minor botanical differences were noted, a strictly floristic key was not feasible. Characteristics of structure, dominance and habitat have necessarily been included.

The Two-way Table Units and Other Australian Alpine Vegetation

Floristic relationships are evident between many units of the Bogong High Plains. These give a continuum appearance to the two-way table, particularly between units 1 to 6. The characteristic species which compose these units are extremely similar to those of associations 1,2,3,4,6, and 8 of McVean (1969) for the Snowy Mountains, and can be successfully amalgamated to form a complex of vegetation of well-drained sites (xeric). Similar integration can be attained for the mesic to hydric sites of bogs and fens, thus producing two main vegetation complexes for Australian mainland alpine sites. The alpine vegetation described by Scott (1974) for Mt. Buller also fits into these categories, as do many of the units of Hargreaves (1977, Lake Mountain) and Chesterfield (1978, Glenmaggie Catchment). However, the cushion bogs and heathlands of the Tasmanian alpine environment (eg. Kirkpatrick and Harwood, 1980) appear to be quite distinctive.

The subalpine grasslands (unit 9) do not relate to previously described alpine vegetations, or even to other Victorian lower altitude grasslands such as Snowy and Howitt Plains (P. Gullan, National Herbarium of Victoria - pers. comm.). This possibly reflects mainly a high degree of disturbance on what are primarily freehold lands.

fig. 18. Key to two-way table units

TWT = Two Way Table

1. Shrubs forming > 30% of stand (excluding *Pentachondra pumila*) 2
   Not as above 10
2. At least two of the following present - *Richea continentis*, *Empodisma minus*, *Baeckea gunniana*, *Epacris paludosa*, *Epacris glacialis* 11
   Not as above 3
3. *Podocarpus lawrencei* dominant, < 10 species/stand, on boulder-streams ..... TWT Unit 1
   Not as above 4
4. One or more of the following as dominants - *Bossiaea foliosa*, *Prostanthera cuneata*, *Phebalium squamulosum*, *Orites lancifolia* 5
   Not as above 6
5. At least four of the following present - *Poa hiemata*, *Danthonia nudiflora*, *Trisetum spicatum*, *Microseris lanceolata*, *Oreomyrrhis eriopoda*, *Ranunculus victoriensis*, *Scleranthus biflorus*, *Plantago euryphylla*, *Brachycome decipiens* ..... TWT Unit 3A
   Not as above ..... TWT Unit 2
6. *Kunzea muelleri* dominant ..... TWT Unit 4
   Not as above 7
7. *Hovea longifolia* dominant and intershrub spaces occupied by *Poa costiniana* or *Poa hothamensis* 8
   Not as above 9
8. *Olearia phlogopappa* var. *subrepanda*, *Hymenanthera dentata* and *Epilobium billardierianum* present ..... TWT Unit 3B
   Not as above ..... TWT Unit 16
9. At least two of the following present - **Hypochoeris radicata*, *Euphrasia* spp., *Brachycome rigidula*. On unstable rocky substrate ..... TWT Unit 3C
   Not as above ..... TWT Unit 3A
10. *Sphagnum* sp. common 11
    Not as above 12
11. At least two of the following present - *Richea continentis*, *Sphagnum* sp., *Baeckea gunniana*, *Carpha nivicola*, *Epacris paludosa*, *Erigeron pappocroma* form A ..... TWT Unit 7A
    Not as above ..... TWT Unit 7B
12. At least three of the following present - *Brachycome scapigera*, *Plantago varia*, *Danthonia penicillata*, *Acaena agnipila*, *Epilobium hirtigerum* ..... TWT Unit 9
    Not as above 13
13. At least three of the following present - **Agrostis capillaris*, **Trifolium repens*, **Hypochoeris radicata*, **Dactylis glomerata*, **Trifolium dubium*, **Cerastium glomeratum*, **Lolium perenne* ..... TWT Unit 17
    Not as above 14
14. *Poa costiniana* dominant and at least three of the following present - **Trifolium repens*, **Taraxacum officinale*, *Cardamine* sp., *Colobanthus affinis*, *Cotula filicula* ..... TWT Unit 5A
    Not as above 15
15. *Pentachondra pumila* present and common, *Poa fawcettiae* usually dominant ..... TWT Unit 5C
    Not as above 16
16. At least four of the following present - *Poa hiemata*, *Danthonia nudiflora*, *Trisetum spicatum*, *Microseris lanceolata*, *Oreomyrrhis eriopoda*, *Ranunculus victoriensis*, *Scleranthus biflorus*, *Plantago euryphylla*, *Brachycome decipiens* 17
    Not as above 20

17. *Empodisma minus* present .....TWT Unit 15
    Not as above 18
18. *Poa helmsii* dominant .....TWT Unit 12
    Not as above 19
19. At least three of the following present - *Viola betonicifolia, Pimelea axiflora, Poa hothamensis, Acaena anserinifolia*. Sheltered sites .....TWT Unit 5D
    Not as above .....TWT Unit 5B
20. *Celmisia asteliifolia* and/or *Poa fawcettiae* dominant. Very sheltered sites .....TWT Unit 6
    Not as above 21
21. *Celmisia sericophylla* dominant .....TWT Unit 11
    Not as above 22
22. At least four of the following present - *Caltha introloba, Drosera arcturi, Oreobolus pumilio, Scirpus crassiusculus, Deyeuxia parviseta* .....TWT Unit 10
    Not as above 23
23. *Carex appressa* and/or *Poa helmsii* dominant.....TWT Unit 12
    Not as above 24
24. At least three of the following present - *Crassula sieberana, Neopaxia australasica, Brachycome nivalis, Epilobium billardierianum, Danthonia alpicola, Scleranthus diander* .....TWT Unit 13
    Not as above 25
25. At least three of the following present - *Ewartia nubigena, Deyeuxia monticola, Epacris microphylla, Hypericum japonicum* .....TWT Unit 14
    Not as above 26
26. At least three of the following present - *Carex gaudichaudiana, Scirpus montivagus, Stackhousia pulvinarus, Pratia surrepens* .....TWT Unit 8A
    Not as above 27
27. *Myriophyllum pedunculatum* and *Carex gaudichaudiana* present .....TWT Unit 8B
    Not as above 28
28. At least three of the following present - *Carex hebes, Carex breviculmis, Empodisma minus, Poa fawcettiae* .....TWT Unit 15
    Not as above .....Unclassified

BOGONG HIGH PLAINS FLORA

Origin

Billings (1974) has suggested that most alpine floras originated during the late Tertiary and Pleistocene through migration and evolution. The newly uplifted mountains selected those members of other floras which were adapted or could adapt to the much lower temperatures of these environments. Part of the Australian alpine flora has resulted from long distance dispersal of plants which had become established on the tropical mountains of Asia (Raven, 1973). Evolutionary radiation has produced many species which are endemic to the Australian alpine region, even though their genera are present on many alpine mountains in other parts of the world; particularly New Guinea and New Zealand (Costin, 1967). The Bogong High Plains and other alpine areas of Australia contain a significant component of lowland species. This indicates either a high degree of tolerance to low temperatures and phenotypic plasticity by these species, or a less severe climate for the Australian Alps.

Composition

Almost two-thirds of the native species which occur on the Bogong High Plains are confined, altitudinally, to alpine or subalpine areas (fig. 19). Most are indigenous to Australia but less than 10 are Victorian endemics. Forty-one species are considered to have rare or restricted distribution (fig. 20). A total of 47 introduced species, other than those planted in gardens of the ski resorts, were recorded during the survey (fig. 21). Most of these are restricted to mechanically disturbed areas such as road verges and disused construction sites. Very few species attain a high

fig. 19 Altitudinal restriction of Bogong High Plains plant species

	Species altitudinally restricted to alpine/ subalpine area (% of total species)	Species of widespread distribution (% of total species)
Ferns and conifers	3.3	2.3
Monocotyledons : grasses	9.4	4.7
: other	14.6	7.0
Dicotyledons	33.3	25.4
Total	60.6	39.4

cover or wide distribution on natural sites. The most commonly encountered introduced plants were **Acetosella vulgaris*, **Hypochoeris radicata*, **Taraxacum officinale* and **Trifolium repens*. There are a high incidence and cover of introduced species in sites of two-way table unit 9 vegetation, suggesting a greater degree of disturbance than normal. Altogether, about 325 species of vascular plant have been recorded on the Bogong High Plains.

Phenology

Flowering on the Bogong High Plains occurs throughout much of the growing season, unlike that of many overseas alpine regions where it rapidly follows snow-melt. This relates principally to the longer Australian snow-free period of 5-8 months.

Many shrubs are amongst the first to flower, soon after snow-melt. This is achieved by the formation of well developed overwintering buds during the previous growing season. Shrubs observed to display this phenomenon include *Asterolasia trymalioides*, *Bossiaea foliosa*, *Callistemon sieberi*, *Epacris paludosa*, *Grevillea australis*, *Hakea microcarpa*, *Hovea longifolia*,

fig.20 Rare, restricted and/or endangered species (Beauglehole, 1981; Willis, 1978)

Species		Location (Willis, 1978; this survey; National Herbarium of Victoria) and Notes
Abrotanella nivigena	*	Near Spion Kopje
Agrostis australiensis		Rocky Valley; possibly overlooked because of similarity to *A. parviflora*
Agrostis meionectes		Depressions north of Mt. Jim
Brachycome obovata	*	Buckety Plains
Brachycome tenuiscapa	*	Pretty Valley
Caesia alpina	*	Mt. Cope, Middle and Wildhorse Ck.
Carex cephalotes		Mt. Hotham, Mt. Bogong, Mt. Nelse
Carex echinata		Mt. Fainter, Basalt Hill
Carex paupera	*	Mt. Hotham;? Bogong High Plains Endemic
Carpha alpina	*	Mt. Hotham, Mt. Nelse
Celmisia sericophylla		Mt. Hotham - Mt. Bogong ; Endemic to the Victorian high country.
Chiloglottis trapeziformis		Buckety Plains, Northern Dinner Plain
Deyeuxia affinis	*	Cope Creek
Deyeuxia parviseta		See TWT Unit 10
Drapetes tasmanica	*	Mt. Jim (R.J. Adair - pers. comm.)
Epilobium tasmanicum		Mt. Nelse
Erythranthera australis		See TWT Unit 10
Gnaphalium nitidulum		Throughout Bogong High Plains
Grammitis armstrongii	*	Mt. Hotham, Mt. Bogong; possibly overlooked
Hierochloe redolens var. *submutica*	*	Head of Middle Creek
Juncus antarcticus		Pretty Valley, Mt. Nelse
Leucopogon montanus		Mt. Nelse, Mt. Bogong, Mt. Loch; possibly overlooked because of similarity to *L. hookeri* when in a sterile state.

Leucopogon pilifer		Northern Dinner Plain; Victorian endemic
Lycopodium scariosum		Near Roper's Hut
Oreobolus pumilio		See TWT Unit 10
Oreomyrrhis argentea		Wild Horse Ck., Pretty Valley, Buckety Plains
Oreomyrrhis brevipes	*	Basalt Hill, Mt. Nelse
Oreomyrrhis pulvinifica		Mt. Nelse, New Species Gully
Parantennaria uniceps	*	See TWT Unit 10
Pelargonium helmsii	*	Basalt Hill, Nelse North Creek, Mt. Bogong
Pimelea biflora		Buckety Plains, Pretty Valley
Plantago glacialis		Near Cope Hut, Mt. Nelse
Poa saxicola	*	Buckety Plains
Pterostylis mutica		Mt. Hotham
Ranunculus muelleri		Often in basaltic areas
Schizeilema fragoseum		Mt. Bogong, Mt. Nelse
Scirpus gunnii	*	Location unknown
Taraxacum aristum	*	Mt. Jim
Uncinia sp.	*	Mt. Spion Kopje
Utricularia monanthos		See TWT Unit 10
Westringia senifolia		Razorback (southern end)

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* considered to be extremely rare (i.e. very few stands or individuals known to exist)

Fig.21 Introduced species

(showing percentage of quadrats in which species occurs and average cover in parentheses)

Species	Natural alpine sites	Two-way table unit 9 sites	Mechanically disturbed sites
Acetosella vulgaris	60 (1)	60 (1)	100 (1)
Achillea millefolorum			17 (2)
Agrostis capillaris	3 (1)		100 (3)
Agrostis stolonifera	1 (+)		
Alchemilla xanthochlora	1 (2)		
Anthoxanthum odoratum	observed	10 (+)	33 (1)
Bromus hordaceus			33 (1)
Cerastium fontanum	2 (+)	60 (+)	33 (+)
Cerastium glomeratum	9 (+)	20 (+)	50 (+)
Chenopodium album			17 (+)
Cirsium vulgare		10 (+)	17 (+)
Cytisus scoparius			observed
Dactylis glomerata		10 (+)	33 (1)
Epilobium ciliatum			33 (+)
Festuca arundinacea		10 (+)	
Festuca rubra		20 (3)	
Holcus lanatus		10 (+)	17 (+)
Hordeum leporinum			17 (+)
Hypericum perforatum			observed
Hypochoeris radicata	28 (1)	30 (+)	100 (1)
Juncus articulatus			33 (1)
Juncus effusus			observed
Juncus tenuis			observed
Lolium perenne		10 (+)	33 (1)
Lotus corniculatus	1 (4)		
Lupinus ?perenne			17 (R)
Malus x-domestica	observed		17 (+)
Melilotus alba			observed
Mimulus moschatus	1 (+)	30 (+)	
Phleum pratense			observed
Plantago lanceolata			17 (+)
Poa annua		10 (+)	17 (1)
Poa pratensis		30 (2)	
Polygonum aviculare			observed
Polygonum persicaria			observed
Ranunculus repens	observed		
Rosa rubiginosa			observed
Rubus fruticosus sp.. agg.			observed
Rumex crispus	observed		
Spergularia rubra			17 (+)
Taraxacum officinale	10 (1)	70 (1)	17 (1)
Trifolium dubium		40 (1)	50 (+)
Trifolium repens	10 (1)	100 (2)	100 (2)
Verbascum virgatum		10 (+)	17 (+)
Veronica arvensis	1 (+)		
Viola tricolor		10 (+)	
Vulpia bromoides		10 (+)	
	16	20	35

Leucopogon hookeri, *Orites lancifolia*, *Pimelea axiflora* and *Phebalium squamulosum*. *Caltha introloba* also forms such buds and often flowers before the snow cover above it has completely melted. Conversely, *Gentianella diemensis* doesn't begin flowering until March and some plants may still bear flowers in early May. Some species exhibit irregular flowering, particularly those of the Asteraceae, and a few, such as **Acetosella vulgaris*, may flower over long periods. Inflorescence initiation may be delayed at higher altitudes.

All flowers are relatively small and most are white or yellow, unlike the alpine plants of non-Australasian mountains which are usually large and of a wide variety of colours. White flowers are unattractive to insects whereas yellow floral parts are the most visited (Bliss, 1971). This reflects the potential importance of modes of pollination other than insect on the Bogong High Plains, such as wind or self pollination.

The generalised anthesis of some of the more common species for the 1979/80 season is shown in fig.22.

Sites of Botanical Significance

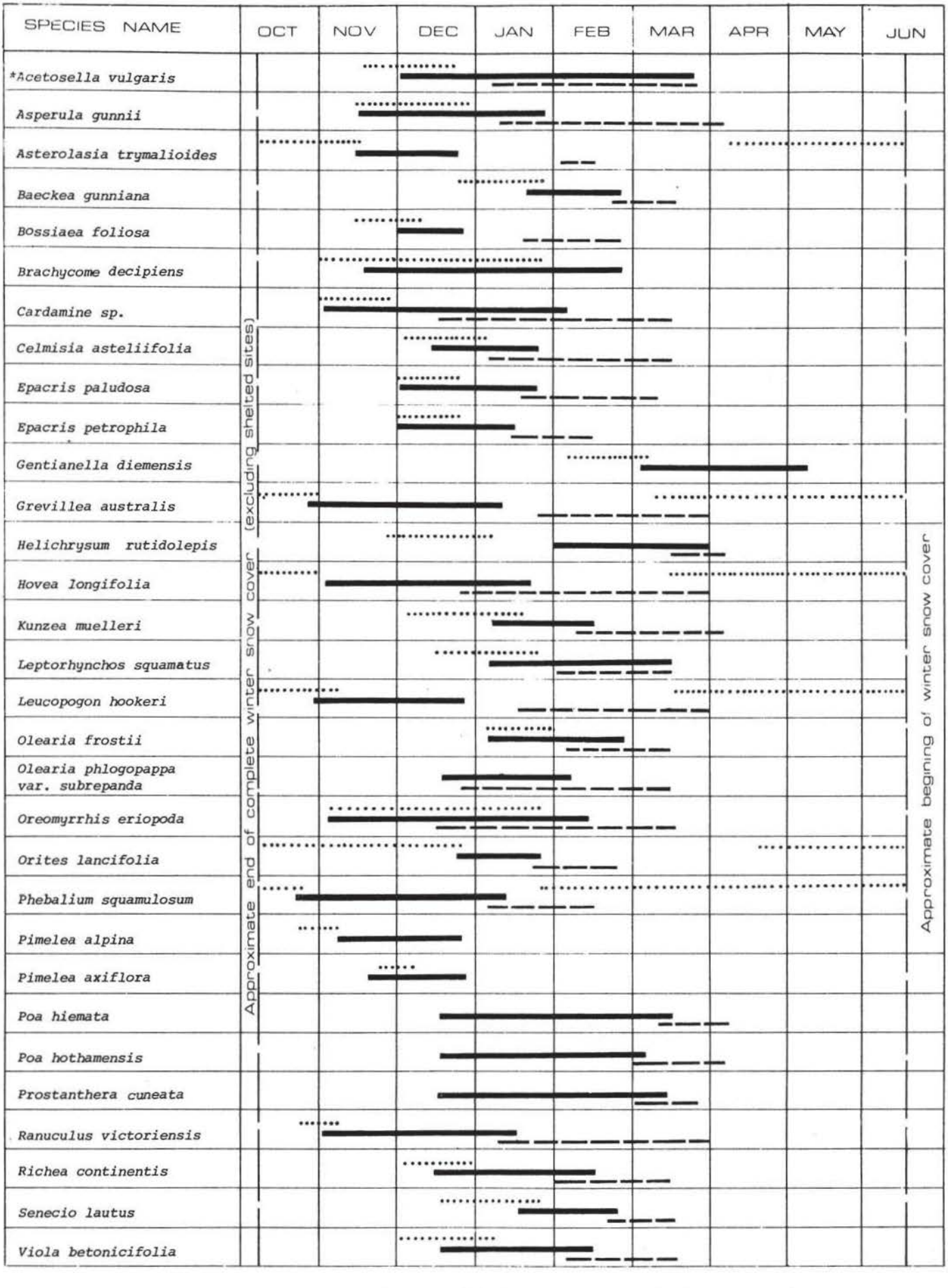
Three sites are prominent in having a highly significant species composition:

(1) New Species Gully (head of Middle Ck., 1 km NNE of Mt. Cope).

The following rare and restricted plants are found within a very small area:

Carpha alpina
Deyeuxia parviseta
Drosera arcturi
Hierochloe redolens var. *submutica*
Oreobolus pumilio
Oreomyrrhis pulvinifica
Parantennaria uniceps
Plantago glacialis
Utricularia monanthos

Fig. 22. Phenology of some Bogong High Plains species



The most intact and extensive cushions of *Oreobolus pumilio* occur in this site. It is currently enclosed by a fence erected by the Soil Conservation Authority.

(2) Mt. Nelse Snowpatch

The following rare and restricted plants occur in the Mt. Nelse snowpatch, principally in drainage lines.

Carex cephalotes
Carpha alpina
Celmisia sericophylla
Deyeuxia parviseta
Epilobium tasmanicum
Oreomyrrhis pulvinifica
Plantago glacialis

The snowpatch is one of the largest in Victoria and contains extensive stands of *Celmisia sericophylla*. It is currently grazed, although this is due to be phased out by 1991.

(3) Basalt Hill and surrounds

The vegetation of Basalt Hill gives the impression of being discordant with that of the remainder of the Bogong High Plains. It has the following characteristics:

- a unique lichen flora including several rare species (R. Filson, National Herbarium of Victoria - pers. comm.),
- a population of the rare herb *Oreomyrrhis brevipes*,
- the largest single patch of *Ewartia nubigena* found on the Bogong High Plains,
- a large, dense population of *Agropyron scabrum*,
- a large, dense population of *Blechnum pennamarina*,
- substantial patches of *Polystichum proliferum*, the members of which attain larger than normal stature,
- a substantial population of *Rubus parvifolius*, uncommon above the tree-line and not found elsewhere on the Bogong High Plains,

- several plants of *Rumex brownii* which is also uncommon at high altitudes and not found elsewhere on the Bogong High Plains.

The area also has geomorphological significance. An extensive, flat boulder-field occurs on the south-eastern side of Basalt Hill. All other basalt rock accumulations on the Bogong High Plains are on moderate to steep slopes.

The northern end of Basalt Hill has been quarried. Most of the features described above occur on the western and east to south-eastern slopes. Disturbance from the quarry in the past has probably been minimal but care will need to be exercised to prevent future damage to this significant area. The entire area is currently grazed.

Species Distribution

The distribution of all species recorded during the survey is shown in fig. 23. The percentage occurrence and average cover (in parentheses) for each of the two-way table units in which they occur are shown in the core of the table. Species recorded by others have been included and given the symbol (R). Those which have been located during field work but do not occur in quadrats are indicated by (O). Photographs may be found of many species in Costin *et al.* (1979)- (c) and Willis *et al.* (1975) - (w).

NUMBER OF QUADRATS	6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS	1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																								COMMENTS
PTERIDOPHYTA																									
ASPIDIACEAE																									
Polystichum proliferum	Broad Shield-fern (c)	17 (+)	4 (+)	4 (R)		4 (+)		6 (+)			10 (1)								20 (+)							Locally common on eastern slopes of Basalt Hill.
ASPLENIACEAE																									
Asplenium flabellifolium (O)	Necklace Fern (c)																								
ATHYRIACEAE																									
Cystopteris filixfragilis (R)	Bristle Bladder-fern																								
BLECHNACEAE																									
Blechnum fluviatile (R)	Ray Water-fern																								
Blechnum pennamarina	Alpine Water-fern												3 (+)						20 (+)	38 (1)						Locally abundant amongst basalt boulders on eastern slope of Basalt Hill.
GLEICHENIACEAE																									
Gleichenia dicarpa (R)	Pouched Coral-fern																								
GRAMMITIDACEAE																									
Grammitis armstrongii (R)	Alpine Finger-fern (c)																								
HYMENOPHYLLACEAE																									
Hymenophyllum peltatum (R)	Alpine Filmy-fern																								
LYCOPODIACEAE																									
Lycopodium australianum	Fir Clubmoss (c:as *Huperzia selago)*												8 (1)												
Lycopodium fastigiatum	Mountain Clubmoss (c)		8 (3)				3 (R)						22 (1)												
Lycopodium scariosum	Spreading Clubmoss												8 (+)												

Fig. 23. Species distribution

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
OPHIOGLOSSACEAE																										
Ophioglossum lusitanicum	Austral Adder's-tongue							6 (1)																		
SPERMATOPHYTA																										
GYMNOSPERMAE																										
PODOCARPACEAE																										
Podocarpus lawrencei	Mountain Plum Pine (c)	100 (5)	8 (2)	4 (1)			3 (1)																			
ANGIOSPERMAE																										
(A) MONOCOTYLEDONEAE																										
CYPERACEAE																										
Carex appressa	Tall Sedge				14 (1)			11 (1)					5 (2)				33 (+)		20 (1)	100 (3)					33 (1)	
Carex archeri (R)	Sedge																									
Carex blakei	Sedge								2 (+)										20 (1)						17 (+)	
Carex breviculmis	Sedge (c)	17 (+)	58 (1)	100 (1)	86 (1)	100 (1)	95 (1)	89 (1)	94 (1)	86 (1)	50 (+)	31 (+)	11 (+)	100 (1)	25 (+)		44 (1)			13 (1)	40 (1)	100 (1)	100 (1)	50 (+)	33 (1)	
Carex cephalotes	Sedge (c)																		20 (+)							Rare - found in Nelse snowpatch drainage lines
Carex curta	Sedge (c)												3 (+)						20 (1)						33 (+)	
Carex echinata	Star Sedge												3 (1)				11 (+)									
Carex gaudichaudiana	Sedge (c)							33 (1)		7 (+)	10 (1)		70 (1)	25 (+)	75 (2)	100 (3)	56 (2)	100 (1)	80 (1)						50 (1)	
Carex hebes	Sedge (c)		25 (+)	54 (1)	43 (1)	29 (1)	5 (1)	44 (1)	46 (1)	21 (1)	100 (2)	100 (1)					44 (1)		20 (1)	13 (+)			67 (+)	100 (1)		
Carex inversa (o)																										
Carex jackiana	Sedge (c)							6 (+)					5 (1)	25 (+)	17 (+)				20 (+)	13 (1)						

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Carex paupera (R)	Sedge																									
Carex raleighii (R)	Sedge																									
Carpha alpina	Small Flower-rush (c)																		20 (1)							Observed on eastern slopes of Mt. Nelse and in New Species Gully
Carpha nivicola	Broad-leaf Flower-rush (c)												59 (1)			25 (+)		33 (+)	40 (+)						17 (+)	
Eleocharis gracilis	Slender Spike-rush														8 (+)											
Oreobolus distichus	Fan Tuft-rush (c)												62 (1)	75 (+)	8 (+)			33 (+)								
Oreobolus pumilio	Alpine Tuft-rush (c)												3 (+)					67 (3)								
Schoenus calyptratus	Alpine Bog-rush (c)						3 (1)			7 (2)			5 (+)	25 (+)	42 (1)				60 (+)						17 (+)	
Schoenus maschalinus (R)	Leafy Bog-rush																									
Scirpus aucklandicus	Club-rush (c)										10 (+)		14 (+)						100 (1)							
Scirpus crassiusculus	Alpine Club-rush (c)															25 (+)		100 (1)								
Scirpus fluitans	Floating Club-rush														8 (1)											
Scirpus gunnii (R)	Club-rush																									
Scirpus habrus	Club-rush (c)												5 (+)													
Scirpus montivagus	Club-rush (c)			4 (+)				6 (+)		7 (+)					92 (1)		11 (1)								33 (+)	
Scirpus subtilissimus	Salaisoi (c)																		20 (1)							
Uncinia flaccida (O)	Mountain Hook-sedge																									Recorded below tree-line on Mt. Bogong (near Cleve Cole Hut) and on disturbed ground in Pretty Valley. Possibly overlooked due to its superficial similarity to *Carex* spp.

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Unicinia sp. (o)	Hook-sedge																									
JUNCACEAE																										
Juncus antarcticus	Cushion Rush (c)												3 (+)					33 (+)	40 (+)							
**Juncus articulatus*	Jointed Rush																								33 (1)	
Juncus australis (o)	Austral Rush																									
Juncus bufonius (o)	Toad Rush																									
**Juncus effusus (o)*	Soft Rush																									
Juncus falcatus	Sickle-leaf Rush (c)														8 (+)		11 (1)		20 (+)							
Juncus sandwithii (O)	Alpine Joint-leaf Rush																									
**Juncus tenuis (O)*	Slender Rush																									
Luzula acutifolia	Woodrush (c)			13 (1)		13 (1)	11 (2)			14 (2)	20 (2)	54 (2)			25 (1)				60 (+)			100 (1)		50 (R)		
Luzula alpestris	Woodrush (c)						3 (+)		2 (2)						17 (2)										17 (+)	
Luzula atrata subsp. acutifolia (o)	Woodrush																									
Luzula flaccida (o)	Woodrush																									
Luzula modesta	Woodrush (c:as L.atrata)			13 (1)	29 (+)	4 (+)	38 (1)	44 (1)	50 (1)	57 (1)		8 (1)	22 (+)		8 (1)		33 (1)		20 (+)				17 (+)		17 (+)	
Luzula novaecambriae	Woodrush		4 (1)		14 (1)	29 (1)	5 (1)		2 (+)		10 (+)						11 (1)	33 (+)	20 (+)						17 (+)	
LILIACEAE																										
Arthropodium milleflorum	Pale Vanilla-lily							6 (+)																		Rare above treeline
Astelia alpina	Silver Astelia (c)												73 (2)	75 (1)					20 (+)							

NAME	COMMON NAME	6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	COMMENTS
NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
Bulbine bulbosa (O)	Bulbine Lily (w)																									Common on some slashed ski slopes and drainage lines of Falls Creek
Caesia alpina	Alpine Grass-lily								2 (2)						8 (1)											
Dianella tasmanica (O)	Tasman Flax-lily (c,w)																									Rare above tree-line
Herpolirion novaezelandiae	Sky Lily (c,w)			4 (+)					2 (+)					25 (+)												
ORCHIDACEAE																										
Caladenia lyallii	Mountain Caladenia (c)					4 (R)							3 (+)													Uncommon above tree-line
Chiloglottis trapeziformis	Dainty Bird-orchid												3 (+)													
Diuris pedunculata	Golden Moths																44 (+)									
Eriochilus cucullatus (O)	Parson's Bands (w)																									
Gastrodia sesamoides (R)	Cinnamon Bells																									
Prasophyllum alpinum	Alpine Leek-orchid (c)			4 (R)			5 (+)		4 (+)	14 (1)		8 (+)	3 (+)		8 (1)		22 (+)		20 (+)							
Prasophyllum suttonii	Mauve Leek-orchid (c)					4 (R)	3 (+)												20 (+)							
Pterostylis cycnocephala	Swan Greenhood								2 (+)	7 (+)																
Pterostylis mutica (o)	Midget Greenhood																									
Thelymitra venosa	Veined Sun-orchid												5 (1)													

NUMBER OF QUADRATS	6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS	1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																								COMMENTS
POACEAE																									
Agropyron scabrum	Common Wheat-grass				14 (+)				2 (R)								22 (+)				20 (+)					Locally common on northern and western slopes of Basalt Hill
Agropyron velutinum	Mountain Wheat-grass (c)							11 (1)	18 (+)	79 (1)			3 (1)	25 (+)											
Agrostis aemula (R)	Blown-grass																								
Agrostis australiensis (R)	Bent																								
**Agrostis capillaris*	Brown-top Bent								2 (+)		10 (+)			25 (+)	33 (2)						33 (3)			100 (3)	
Agrostis meionectes	Bent (c)														8 (R)										
Agrostis muellerana	Bent (c)										20 (1)	23 (+)						20 (+)							
Agrostis parviflora	Bent (c)								2 (+)		20 (2)		3 (+)		25 (1)		11 (+)	33 (+)	80 (1)		60 (+)	33 (+)			
**Agrostis stolonifera*	Creeping Bent												3 (+)						20 (+)						
Agrostis venusta	Bent				14 (+)	17 (1)		11 (+)	10 (1)	29 (1)	30 (1)				8 (1)			33 (+)			60 (1)	67 (1)		50 (1)	
**Anthoxanthum odoratum*	Sweet Vernal-grass																11 (+)							33 (1)	
**Bromus hordaceus*	Soft Brome																							33 (1)	
**Dactylis glomerata*	Cocksfoot																11 (+)							33 (2)	
Danthonia alpicola	Crag Wallaby-grass (c)					17 (1)	5 (+)														60 (1)				
Danthonia laevis	Wallaby-grass																11 (+)								
Danthonia nivicola	Snow Wallaby-grass (c)												24 (1)		8 (+)			33 (+)	20 (+)						

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Danthonia nudiflora	Alpine Wallaby-grass (c)			33 (1)	43 (+)	54 (+)	16 (1)	61 (1)	74 (1)	93 (1)	80 (2)	23 (1)		25 (+)	58 (2)			33 (+)					67 (2)		17 (+)	
Danthonia penicillata	Slender Wallaby-grass				13 (+)												89 (2)									
Deschampsia caespitosa	Tufted Hair-grass (c)																	33 (+)								Observed once in the upper part of Cope Creek
Deyeuxia brachyathera	Bent-grass							6 (+)	2 (+)		10 (+)				17 (1)				40 (+)							
Deyeuxia carinata (R)	Bent-grass (c)																									
Deyeuxia crassiuscula	Bent-grass (c)		4 (1)			4 (+)	14 (+)		2 (R)	7 (+)													17 (+)			
Deyeuxia frigida (R)	Bent-grass																									
Deyeuxia monticola	Bent-grass					25 (1)	19 (+)		2 (R)												20 (+)	67 (1)				
Deyeuxia parviseta	Bent-grass																	100 (+)	40 (+)							
Erythranthera australis	(c)																	33 (+)								
**Festuca arundinacea*	Tall Fescue																11 (+)									
**Festuca rubra*	Red Fescue																22 (3)									
Hierochloe redolens (O) var. submutica	Sweet Holy Grass (c)																									Recorded once at head of Middle Creek, just south of Cope Hut.
**Holcus lanatus*	Yorkshire Fog																11 (+)								17 (+)	
**Hordeum leporinum*	Common Barley-grass																								33 (1)	
**Lolium perenne*	Perennial Rye-grass																11 (+)								33 (1)	
**Phleum pratense (O)*	Timothy Grass																									
**Poa annua*	Annual Meadow-grass																11 (+)								17 (1)	

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Poa costiniana	Snow-grass (c)	17 (+)	4 (+)	38 (1)	100 (3)	4 (2)	5 (1)	100 (4)	44 (3)	21 (2)			95 (1)	100 (2)	25 (1)	25 (1)		33 (+)	60 (1)	63 (1)			33 (3)			
Poa fawcettiae	Horny Grass (c)			21 (1)		8 (2)	30 (2)	11 (1)	26 (3)	86 (3)	40 (3)	77 (3)	3 (1)					33 (+)				67 (4)	100 (4)			
Poa helmsii	Broad-leafed Snow-grass							17 (1)			10 (+)									63 (4)						
Poa hiemata	Soft Snow-grass (c)	17 (+)	4 (3)	63 (2)	14 (+)	46 (2)	84 (3)	78 (2)	96 (4)	64 (3)	40 (1)		5 (2)	25 (1)	8 (+)		78 (3)			13 (2)		33 (1)	50 (3)		83 (1)	
Poa hothamensis	Ledge Grass	50 (1)	100 (3)	92 (3)	86 (2)	92 (2)	46 (2)	33 (2)	16 (1)	14 (2)	90 (2)	38 (1)	5 (+)	25 (+)			11 (1)		20 (+)	13 (+)	100 (1)	67 (2)	17 (+)	100 (2)	83 (1)	
Poa labillardieri	Tussock-grass																22 (+)									
Poa phillipsiana	Snow-grass								2 (5)																	Recorded near Johnston's Hut
**Poa pratensis*	English Meadow-grass																33 (2)									
Poa saxicola	Rock Poa (c)								2 (+)																	
Stipa nivicola	Alpine Spear-grass								2 (1)																	Possibly overlooked because of superficial similarity to other tussocks. Common on northern slopes of Mt. Cope
Themeda australis	Kangaroo Grass (w)																11 (+)									
Trisetum spicatum	Bristle-grass (c)		4 (+)	46 (+)	43 (1)	83 (1)	27 (+)	44 (+)	64 (1)	43 (1)	40 (1)	8 (+)							20 (+)			33 (1)	17 (+)			
**Vulpia bromoides*	Squirrel-tail Fescue																11 (+)								17 (+)	
RESTIONACEAE																										
Empodisma minus	Spreading Rope-rush (c)							11 (1)	6 (2)	29 (2)			100 (4)	100 (4)	17 (2)		11 (2)		20 (+)				67 (2)		17 (1)	
Restio australis	Mountain Cord-rush												19 (1)		17 (2)		11 (2)									

NUMBER OF QUADRATS	6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS	1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																								COMMENTS
(B) DICOTYLEDONEAE																									
APIACEAE																									
Aciphylla glacialis	Snow Aciphyll (c,w)		4 (R)	8 (1)		13 (1)	5 (+)	6 (+)	4 (+)	14 (+)	10 (2)								20 (+)				17 (+)			
Aciphylla simplicifolia	Mountain Aciphyll (c)												3 (+)												Often conspicuous only when flowering. Recorded on Northern Dinner Plain (near McNamara's Hut) and on the eastern *Poa* dominated slopes of Mt. Cope
Diplaspis hydrocotyle	Stiff Dislaspis (c)												43 (1)					33 (+)							
Hydrocotyle algida (R)	Mountain Pennywort																								
Hydrocotyle sibthorpioides	Shining Pennywort							6 (+)					5 (1)		8 (+)		33 (2)			38 (1)					17 (+)	
Oreomyrrhis argentea	Silver Carraway								6 (2)	7 (+)															Locally common in Wild Horse Creek valley and Buckety Plains
Oreomyrrhis brevipes	Branched Carraway (c)																				20 (1)				Rare. Recorded only on basaltic outcrop, western slope of Basalt Hill.
Oreomyrrhis ciliata	Fringed Carraway (c)							11 (+)					16 (+)				44 (1)		20 (+)	25 (+)					50 (+)	
Oreomyrrhis eriopoda	Australian Carraway (c)		25 (+)	79 (+)	86 (+)	75 (+)	57 (+)	94 (+)	76 (+)	93 (+)	100 (+)	15 (+)	8 (1)	25 (+)			44 (1)			25 (+)			17 (+)	50 (+)		
Oreomyrrhis pulvinifica	Cushion Carraway (c)																	20 (1)							Reasonably common only in drainage lines of Nelse snowpatch and New Species Gully
Schizeilema fragoseum	Alpine Pennywort (c)							6 (+)					3 (1)												
Trachymene humilis	Alpine Trachymene			4 (1)					6 (1)	7 (+)	20 (1)			50 (1)											
ASTERACEAE																									
Abrotanella nivigena (O)	Snow-wort																								

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
*Achillea millefolium	Milfoil (Yarrow)																								17 (2)	Abundant at Rocky Valley Reservoir observations and information point
Brachycome decipiens	Field Daisy		21 (1)	63 (+)	71 (+)	4 (R)	3 (+)	56 (1)	68 (1)	79 (1)			3 (1)		8 (+)		22 (+)			25 (+)					33 (+)	
Brachycome nivalis var. alpina	Daisy (c)						3 (1)												20 (+)							
Brachycome nivalis var. nivalis	Snow Daisy (c)		4 (+)	4 (1)		38 (1)	22 (+)		2 (+)			8 (R)									60 (+)					
Brachycome obovata	Baw Baw Daisy								4 (1)																	Located only at Buckety Plains
Brachycome rigidula	Leafy Daisy (w)		4 (+)	8 (2)		96 (1)	8 (+)	6 (+)													60 (+)					
Brachycome scapiformis	Coarse Daisy		38 (+)	17 (1)	14 (+)	33 (+)	41 (+)	28 (+)	6 (+)				5 (1)				11 (+)						17 (1)		17 (+)	
Brachycome scapigera	Tufted Daisy (c)									7 (1)							78 (1)									
Brachycome tenuiscapa	Mountain Daisy (c)									7 (+)																
Celmisia asteliifolia	Silver Daisy (c,w)		46 (1)	63 (2)	29 (+)	79 (2)	89 (1)	56 (+)	54 (2)	93 (1)	60 (2)	85 (3)	70 (1)	75 (+)									67 (+)	50 (1)		33 (+)	
Celmisia sericophylla	Silky Daisy																	33 (+)	100 (4)							
*Cirsium vulgare	Spear Thistle																11 (+)								17 (+)	
Cotula alpina	Alpine Cotula							6 (+)	2 (1)		10 (+)		3 (+)		8 (+)		56 (1)								17 (+)	
Cotula filicula	Mountain Cotula		29 (+)	46 (+)	57 (1)	4 (+)	8 (+)	56 (1)	30 (1)	21 (R)	40 (1)	8 (+)	3 (+)						20 (+)					50 (+)	33 (+)	
Craspedia sp. A	Billy-buttons		33 (1)	54 (1)		54 (+)	59 (1)	33 (1)	50 (1)	79 (1)	20 (+)		11 (+)	50 (+)			22 (+)				40 (+)	33 (+)				
Craspedia sp. B	Billy-buttons		13 (1)	8 (+)	14 (+)	13 (1)	8 (+)	22 (1)	16 (+)	21 (1)	20 (+)	8 (+)	14 (+)	25 (+)			33 (1)			38 (1)			17 (R)			

NAME	COMMON NAME	1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	COMMENTS
NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS																										
Craspedia sp. (o)	Billy-button																									Formerly thought to be N.S.W. endemic
Erigeron pappocroma form A	Violet Fleabane						3 (1)						62 (1)						20 (+)						17 (+)	
Erigeron pappocroma form B	Violet Fleabane (c)		4 (+)	25 (1)	14 (+)	21 (+)	38 (1)	28 (1)	14 (1)	36 (1)	10 (1)	23 (+)	3 (R)	25 (1)	17 (+)							33 (+)	17 (+)			
Erigeron pappocroma form C	Violet Fleabane			25 (1)	14 (+)		24 (1)	11 (1)	26 (1)	29 (1)																
Ewartia nubigena	Silver Ewartia (c,w)			8 (1)		4 (+)	16 (1)			36 (1)		31 (1)									20 (1)	100 (1)				
Gnaphalium argentifolium	Silver Cudweed (c)							11 (+)	4 (+)	14 (1)	10 (+)	31 (+)			33 (+)		44 (1)		20 (+)							
Gnaphalium fordianum	Cudweed (c)		17 (+)	17 (+)			19 (+)	33 (+)	36 (1)	64 (1)	50 (1)	8 (R).	8 (1)	50 (+)			22 (+)		20 (+)			33 (+)			17 (+)	
Gnaphalium nitidulum	Shining Cudweed (c)			4 (+)			5 (+)	6 (+)	10 (+)	14 (1)	10 (+)	15 (+)			17 (1)											
Gnaphalium sp.	Cudweed												27 (+)	50 (+)	8 (+)		11 (+)			13 (+)						
Gnaphalium traversii (R)	Mat Cudweed																									
Gnaphalium umbricola (O)	Cliff Cudweed (c)																									Observed once on rocky outcrop of upper Quartz Ridge, Mt. Bogong.
Helichrysum acuminatum	Orange Everlasting			13 (1)		13 (1)	14 (+)		16 (1)								22 (+)									
Helichrysum alpinum	Alpine Everlasting		17 (1)			4 (1)	19 (1)		2 (1)																17 (+)	
Helichrysum hookeri	Scaly Everlasting (Kerosene Bush)						8 (1)		4 (+)	7 (+)			3 (+)												17 (1)	
Helichrysum rutidolepis	Pale Everlasting		21 (1)	29 (+)	57 (+)	50 (+)	3 (1)	6 (+)	2 (1)								11 (+)			13 (+)						
Helichrysum scorpioides	Button Everlasting					4 (+)																		50 (1)		
Helichrysum secundiflorum	Cascade Everlasting		4 (1)			8 (+)																				

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Helichrysum semipapposum	Clustered Everlasting					17 (1)																				
Helipterum albicans subsp. albicans	Sunray					13 (+)																				
Helipterum albicans subsp. alpinum	Alpine Sunray (c)					4 (+)	5 (1)																			
Helipterum anthemoides	Chamomile Sunray (c)					29 (2)																				
**Hypochoeris radicata*	Cat's-ear			25 (+)	57 (1)	88 (1)	27 (+)	28 (+)	42 (+)	21 (+)	90 (1)	15 (R)	8 (+)				22 (+)		40 (+)		40 (+)	33 (+)		50 (+)	100 (1)	
Lagenifera stipitata	Common Lagenifera		13 (+)	8 (+)			5 (R)	6 (+)	2 (+)				3 (+)													
Leptorhynchos squamatus	Scaly Buttons			8 (1)		21 (1)	54 (1)	28 (1)	58 (2)	36 (2)			8 (1)				33 (1)		20 (+)	13 (R)		33 (R)			17 (+)	
Microseris scapigera	Yam-daisy		21 (+)	58 (1)	86 (1)	58 (+)	35 (1)	72 (1)	66 (+)	43 (1)	50 (1)	38 (+)	8 (1)		8 (+)		11 (1)					33 (+)				
Olearia algida	Mountain Daisy-bush (c)			4 (+)				6 (1)	6 (1)	7 (1)															17 (+)	
Olearia frostii	Bogong Daisy-bush (w)		46 (+)	38 (+)		50 (1)	41 (1)	6 (+)	12 (+)			50 (1)		3 (+)											33 (+)	
Olearia phlogopappa var. flavescens	(c)	50 (1)	8 (1)	4 (+)		13 (+)	3 (+)	6 (+)						3 (+)												
Olearia phlogopappa var. subrepanda	Dusty Daisy-bush (c)		71 (1)	58 (1)	100 (1)	13 (1)	14 (1)	6 (+)	14 (1)																33 (+)	
Parantennaria uniceps (O)	Parantennaria (c)																									
Podolepis robusta	Alpine Podolepis (c,w)			4 (2)		4 (+)		6 (+)	4 (1)																	
Senecio gunnii	Mountain Fireweed (c)			13 (+)		21 (+)		6 (+)			10 (+)														17 (1)	
Senecio lautus	Variable Groundsel (c,w)		4 (+)	27 (+)	43 (+)	8 (+)	38 (+)	50 (1)	64 (1)	50 (1)	10 (+)						33 (+)						50 (R)		33 (+)	

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Senecio pectinatus	Alpine Groundsel (c,w)						8 (R)												20 (+)		20 (+)					
Senecio quadridentatus (O)	Cotton Fireweed																									
Solenogyne gunnii	Solengyne																11 (1)									
Taraxacum aristum (R)	Austral Dandelion																									
**Taraxacum officinale*	Dandelion			17 (+)	43 (1)	4 (R)	3 (R)	72 (1)	4 (+)						8 (+)		78 (1)			57 (1)	20 (+)	33 (+)			17 (1)	
BORAGINACEAE																										
**Myosotis discolor*	Yellow and Blue Forget-me-not																33 (+)									
BRASSICACEAE																										
Cardamine sp.	Bitter-cress		13 (+)	38 (+)	43 (+)	13 (+)	16 (+)	61 (1)	34 (+)	64 (+)							11 (+)			29 (+)	20 (+)					
CAMPANULACEAE																										
Wahlenbergia ceracea	Waxy Bluebell (c)					4 (+)													20 (+)							
Wahlenbergia gloriosa	Royal Bluebell (c,w)					8 (+)	3 (1)												20 (+)							
Wahlenbergia quadrifida	Sprawling Bluebell																11 (+)									
CARYOPHYLLACEAE																										
**Cerastium fontanum*	Mouse-ear Chickweed				14 (+)			11 (+)	2 (+)		10 (+)						67 (+)			13 (+)	20 (+)				33 (+)	
**Cerastium glomeratum*	Common Mouse-ear Chickweed		4 (+)	4 (+)	43 (1)	4 (+)	5 (+)	33 (+)	20 (+)	14 (+)			3 (+)				22 (+)		20 (+)	13 (+)			17 (R)		50 (+)	
Colobanthus affinis	Alpine Colobanth (c,w)			4 (2)		4 (+)		72 (1)	20 (+)	21 (1)	20 (+)				8 (+)				20 (+)	13 (+)					17 (+)	

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Scleranthus biflorus	Twin-flower Knawel (c,w)		13 (+)	75 (1)	86 (1)	29 (+)	22 (+)	83 (1)	80 (1)	64 (1)	70 (1)		3 (R)	25 (+)	8 (+)		44 (1)			13 (1)			17 (+)		50 (+)	
Scleranthus diander	Tufted Knawel					13 (1)															60 (1)					
Scleranthus singuliflorus	Mossy Knawel (c)			13 (+)	29 (+)	25 (+)	16 (+)	22 (+)	26 (+)	50 (1)			3 (+)	25 (R)									33 (1)			
**Spergularia rubra*	Red Sand-spurrey																								17 (+)	
Stellaria multiflora	Rayless Starwort (c)																				40 (+)					
Stellaria palustris	Swamp Starwort																22 (+)									
Stellaria pungens	Prickly Starwort		13 (1)	33 (1)	29 (+)	38 (+)	3 (+)	22 (+)	12 (+)		10 (1)									38 (1)				50 (+)	17 (+)	
CHENOPODIACEAE																										
**Chenopodium album*	Fat Hen																								17 (+)	Uncommon and found only on disturbed sites near Falls Creek village
CONVOLVULACEAE																										
Dichondra repens	Kidney-weed (w)														8 (2)		33 (2)			25 (+)						
CRASSULACEAE																										
Crassula sieberana	Sieber Crassula (c)					13 (+)															80 (1)	33 (+)				
DROSERACEAE																										
Drosera arcturi	Alpine Sundew (c,w)												5 (R)					100 (1)	20 (+)							

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
ELATINACEAE																										
Elatine gratioloides (O)	Waterwort																									Locally common on saturated soils around Rocky Valley Reservoir
EPACRIDACEAE																										
Epacris glacialis	Heath (c)												65 (2)	100 (5)	8 (4)			67 (+)	20 (+)						17 (1)	
Epacris microphylla	Coral Heath (c)					4 (+)	24 (2)	6 (1)	6 (2)	21 (1)			5 (2)				11 (2)					100 (3)			33 (1)	
Epacris paludosa	Swamp Heath (c,w)												59 (3)					33 (+)	40 (1)	29 (1)					17 (+)	
Leucopogon gelidus	Drooping Beard-heath																									At treeline, near Cleve Cole Hut, Mt. Bogong
Leucopogon hookeri	Mountain Beard-heath (w)	17 (+)	33 (1)	67 (1)	14 (+)	83 (1)	89 (1)	28 (1)	30 (1)	29 (1)	10 (+)	15 (+)													17 (+)	
Leucopogon montanus (O)	Snow Beard-heath																									Impossible to distinguish from *L. hookeri* vegetatively
Leucopogon pilifer	Thready Beard-heath												5 (1)													
Pentachondra pumila	Carpet Heath (c,w)						3 (+)	17 (2)		100 (2)				25 (1)												
Richea continentis	Candle Heath (c,w)												97 (3)						60 (1)						33 (+)	
EUPHORBIACEAE																										
Poranthera microphylla	Small Poranthera (w)			4 (1)	14 (+)		5 (+)	6 (+)	18 (1)	14 (+)							11 (+)									

NUMBER OF QUADRATS	6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS	1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																								COMMENTS
FABACEAE																									
Bossiaea foliosa	Leafy Bossiaea (w)		67 (3)	4 (2)	14 (+)	4 (+)	3 (3)	6 (1)																67 (1)	
**Cytisus scoparius (O)*	English Broom																								Extremely common in Falls Creek Village
Hovea longifolia	Rusty-pods (c,w)		54 (2)	46 (3)	100 (3)	17 (3)	19 (1)	39 (1)	26 (1)	7 (+)			3 (1)											100 (5)		
**Lotus corniculatus*	Bird's-foot Trefoil																		13 (3)					17 (+)	
**Lupinus perennis*	Lupin																							17 (R)	Grown in Falls Creek gardens and rarely escaping to surrounding area within resort
**Melilotus alba (O)*	Bokhara Clover																								
Oxylobium alpestre	Alpine Oxylobium (c,w)		4 (2)			17 (2)	14 (1)						5 (+)											17 (+)	
Oxylobium ellipticum	Common Oxylobium (c)		4 (1)			4 (+)			2 (+)	7 (+)			3 (+)												
Pultenaea fasciculata (O)	Alpine Bush-pea																								Not uncommon at Buckety Plain
**Trifolium dubium*	Suckling Clover															44 (1)								33 (+)	
**Trifolium repens*	White Clover				57 (1)			83 (1)	12 (+)		10 (+)		5 (+)		8 (+)		100 (2)			57 (2)				100 (2)	
GENTIANACEAE																									
Gentianella diemensis	Mountain Gentian (c,w)			4 (+)		4 (1)	8 (+)		4 (+)	7 (R)			24 (+)	75 (1)	8 (1)			20 (+)							
GERANIACEAE																									
Geranium antrorsum	Rosetted Crane's-bill (c)		4 (R)		14 (+)				2 (+)	7 (+)						33 (1)									
Geranium potentilloides	Cinquefoil (c)		4 (+)	8 (1)		4 (+)	5 (+)	11 (+)	4 (+)										25 (+)	14 (+)					

NUMBER OF QUADRATS	6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS	1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																								COMMENTS
Geranium sessiliflorum	Alpine Crane's-bill						3 (R)									22 (2)									
GOODENIACEAE																									
Goodenia hederacea	Ivy Goodenia (c,w)		13 (2)	4 (1)		25 (+)	11 (1)																	17 (+)	
Scaevola hookeri (O)	Creeping Fan-flower (w)																								Common along abandoned tracks
Velleia montana	Mountain Velleia													8 (1)		67 (1)			13 (3)						
HALORAGACEAE																									
Gonocarpus micranthus	Creeping Raspwort (c)								2 (1)		10 (+)		11 (+)	25 (R)	17 (1)	25 (+)	22 (+)		20 (+)						
Gonocarpus montanus	Mat Raspwort (c)	17 (1)	4 (+)	21 (+)	29 (+)	25 (1)	5 (+)	11 (+)	2 (+)		10 (+)									25 (+)				17 (+)	
Myriophyllum pedunculatum	Mat Water-milfoil (c)													8 (1)	100 (1)		100 (2)								
Myriophyllum propinquum (O)	Common Water-milfoil																								Growing in permanently wet depressions in Pretty Valley
HYPERICACEAE																									
Hypericum japonicum	Matted St.John's Wort							11 (1)	2 (+)				3 (+)		8 (1)		67 (1)		20 (+)	25 (+)		100 (+)			
**Hypericum perforatum (O)*	St. John's Wort																								Uncommon above tree-line but found in disturbed site near Ruined Castle
LAMIACEAE																									
Ajuga australis	Austral Bugle (w)			17 (1)	43 (+)	8 (1)	5 (+)	39 (1)	50 (1)	57 (+)	10 (+)		3 (+)		8 (+)		22 (+)			13 (+)	20 (+)	33 (+)				

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Prostanthera cuneata	Alpine Mint-bush (c,w)		58 (3)	50 (3)	14 (+)	4 (1)	5 (1)				10 (+)		5 (+)													
Westringia senifolia (O)	Alpine Westringia (w)																									Uncommon above tree-line but frequent at southern end of Razorback
LENTIBULARIACEAE																										
Utricularia monanthos	Tasmanian Bladderwort																	33 (+)								
LINACEAE																										
Linum marginale	Native Flax (w)												3 (+)				11 (+)									
LOBELIACEAE																										
Pratia surrepens	Mud Pratia (c,w)												14 (1)	25 (+)	100 (2)	75 (1)										
LOGANIACEAE																										
Mitrasacme montana (O)	Mountain Mitrewort																									
MIMOSEAE																										
Acacia alpina	Alpine Wattle (w)					8 (2)																				Uncommon above tree-line but most frequent in Hotham-Loch-Razorback area
MYRTACEAE																										
Baeckea gunniana	Alpine Beackea (c,w)	17 (+)		4 (+)				6 (+)					76 (2)	25 (2)			11 (+)		40 (+)	13 (1)						

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Callistemon sieberi	Alpine Bottlebrush												16 (1)													Occurs predominantly in lower altitude drainage lines
Kunzea muelleri	Yellow Kunzea (c)			4 (3)		4 (1)	100 (3)		6 (1)	7 (+)																
ONAGRACEAE																										
Epilobium billardierianum	Robust Willow-herb	17 (+)	4 (1)	4 (1)	100 (1)			6 (+)			10 (+)		3 (+)				22 (+)			13 (1)	80 (+)					
**Epilobium ciliatum*	Glandular Willow-herb																								50 (1)	
Epilobium curtisiae	Bald-seeded Willow-herb																11 (+)									
Epilobium gunnianum	Gunn's Willow-herb (c)	17 (1)						6 (+)					3 (+)			25 (1)			20 (1)	25 (2)					50 (+)	
Epilobium hirtigerum	Hairy Willow-herb																67 (1)									
Epilobium sarmentaceum	Mountain Willow-herb (c)			4 (+)		4 (+)													20 (+)							
Epilobium tasmanicum (O)	Snow Willow-herb (c)																									Rare. Located once in snow-patch area of Mt. Nelse
OXALIDACEAE																										
Oxalis corniculata	Yellow Wood-sorrel (w)							6 (+)									33 (1)									
PLANTAGINACEAE																										
Plantago alpestris (R)	Plantain (c)																									
Plantago euryphylla	Plantain (c)		4 (+)	46 (+)	71 (+)	4 (+)	19 (+)	67 (+)	60 (+)	86 (+)	90 (+)		3 (+)	25 (+)	8 (+)				20 (+)							17 (+)	

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Plantago glacialis (O)	Plantain (c)																									
**Plantago lanceolata*	Ribwort																								17 (+)	
Plantago varia	Variable Plantain																67 (+)									
POLYGALACEAE																										
Comesperma retusum (O)	Mountain Milkwort (w)																									Found once at northern Dinner Plain near McNamara's Hut
POLYGONACEAE																										
**Acetosella vulgaris*	Sheep Sorrel		63 (1)	96 (1)	100 (1)	92 (1)	32 (1)	89 (1)	86 (1)	36 (+)	100 (2)	100 (+)	5 (+)	25 (+)	42 (+)		67 (1)		20 (+)	63 (1)	80 (1)	67 (1)	50 (1)	100 (1)	100 (1)	
**Polygonum aviculare (O)*	Prostrate Knotweed																									
**Polygonum persicaria (O)*	Persicaria																									
Rumex brownii	Slender Dock																			13 (+)						Recorded once from eastern slope of Basalt Hill near tree-line
**Rumex crispus (O)*	Curled Dock																									Observed growing on the headwaters of the Diamantina River below Alpine Road
PORTULACEAE																										
Neopaxia australasica	White Purslane (c,w)											23 (1)							20 (+)		80 (+)					

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
PROTEACEAE																										
Grevillea alpina (O)	Cat's Claws (w)																									Isolated occurrence near Johnston's Hut
Grevillea australis	Alpine Grevillea (c)		46 (2)	75 (3)	29 (1)	88 (2)	89 (2)	17 (1)	34 (1)	7 (+)	20 (1)	8 (+)	5 (1)									20 (+)				50 (1)	
Grevillea victoriae (O)	Royal Grevillea (c,w)																									Prominant below tree-line but occasionally in closed heathland stands above tree-line
Hakea microcarpa	Small-fruit Hakea																11 (+)									
Orites lancifolia	Alpine Orites (c,w)	17 (2)	58 (3)	29 (3)		8 (1)	24 (2)		2 (1)																17 (+)	
RANUNCULACEAE																										
Caltha introloba	Alpine Marsh-marigold (c)																	100 (3)	60 (1)							
Ranunculus collinus (R)	Strawberry Buttercup (w)																									
Ranunculus eichleranus	Eichler's Buttercup			4 (+)		33 (+)		6 (+)	8 (1)		20 (+)	8 (+)														
Ranunculus graniticola	Granite Buttercup (c)								2 (+)						8 (+)	25 (+)	67 (+)									
Ranunculus gunnianus	Gunn's Alpine Buttercup (c)												22 (+)	100 (+)												
Ranunculus millanii	Dwarf Buttercup (c,w)														25 (3)	75 (2)										
Ranunculus muelleri	Felted Buttercup (c)				43 (+)		8 (+)	6 (+)	6 (1)	7 (1)			8 (1)	25 (+)	8 (+)									17 (+)		
Ranunculus pimpinellifolius	Bog Buttercup												3 (+)				44 (1)			13 (+)					17 (+)	

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
**Ranunculus repens (O)*	Creeping Buttercup																									Locally common along head-waters of Diamantina River below Alpine Road
Ranunculus victoriensis	Victorian Buttercup		8 (+)	75 (1)	29 (+)	13 (+)	38 (+)	94 (1)	88 (1)	86 (1)	60 (+)	8 (R)	5 (+)		8 (1)		22 (+)			50 (1)			33 (+)		83 (+)	
ROSACEAE																										
Acaena agnipila	Hairy Sheep's Burr							11 (1)									89 (1)									
Acaena anserinifolia	Bidgee-widgee (c,w)	17 (1)	46 (1)	79 (1)	100 (1)	42 (1)	3 (+)	67 (1)	26 (+)		90 (1)	8 (+)	16 (+)	25 (+)			11 (+)		80 (1)	88 (2)	40 (+)			50 (1)	83 (1)	
**Alchemilla xanthochlora*	Lady's Mantle (c)																			25 (2)						Locally common on south-eastern side of Tawonga Gap
Aphanes australiana	Australian Piert																67 (1)									
**Malus X-domestica*	Domestic Apple																								17 (+)	Ocassionally found above tree-line along roadsides and at campsites such as Twin Knobs on the Razorback
**Rosa rubiginosa (O)*	Sweet Briar																									
**Rubus fruticosus*	Blackberry																									Rare above tree-line; common at Bogong Jack Saddle
Rubus parvifolius	Small-leaf Bramble (w)																			13 (2)						Locally common on verge of boulder field, eastern slope of Basalt Hill
RUBIACEAE																										
Asperula conferta	Common Woodruff																22 (+)									

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
Asperula gunnii	Mountain Woodruff (c)		79 (1)	83 (1)	86 (1)	46 (1)	92 (1)	72 (+)	70 (1)	79 (1)	60 (1)		46 (1)	75 (+)	17 (+)		56 (1)			25 (2)			17 (1)	100 (2)	33 (1)	
Asperula pusilla	Alpine Woodruff (c)			8 (1)	29 (+)			28 (1)	4 (1)		10 (+)						22 (+)			25 (1)						
Coprosma nivalis	Snow Coprosma	17 (3)					3 (1)	6 (+)																		
Nertera depressa	Matted Nertera (c)												11 (1)						20 (+)							
RUTACEAE																										
Asterolasia trymaliodes	Alpine Star-bush		8 (+)	50 (1)		38 (2)	38 (1)	33 (1)	46 (1)	57 (1)	10 (R)										20 (+)					
Boronia algida (O)	Alpine Boronia (w)																									
Phebalium phylicifolium (O)	Alpine Phebalium																									Uncommon above tree-line
Phebalium squamulosum var. alpinum	Phebalium		88 (3)	46 (2)		17 (2)	16 (1)	6 (+)	10 (1)				3 (+)												17 (+)	
SANTALACEAE																										
Exocarpus nanus	Alpine Ballart (c,w)			4 (+)			11 (1)	6 (1)	6 (+)				5 (+)													
SCROPHULARIACEAE																										
Euphrasia spp.	Eyebright		8 (1)	4 (+)		58 (+)	19 (+)			7 (R)							11 (+)									
**Mimulus moschatus*	Musk Monkey-flower												3 (+)							13 (1)						
Parahebe derwentia (O)	Derwent Speedwell (w)																									Most common along roadsides

NUMBER OF QUADRATS		6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS		1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																									COMMENTS
*Verbascum virgatum	Twiggy Mullein																11 (+)								17 (+)	
*Veronica arvensis	Wall Speedwell							11 (1)																		
Veronica gracilis	Slender Speedwell (w)																22 (+)									
Veronica nivea (o)	Milfoil Speedwell																									
Veronica serpyllifolia	Thyme Speedwell (c)				29 (+)			33 (1)						25 (+)	17 (1)		33 (1)			13 (+)					33 (+)	
STACKHOUSIACEAE																										
Stackhousia monogyna	Creamy Stackhousia (w)			4 (+)			3 (1)		2 (+)						8 (1)											
Stackhousia pulvinaris	Alpine Stackhousia (c,w)						8 (+)		4 (+)				3 (+)	75 (1)	67 (1)											
STYLIDIACEAE																										
Stylidium graminifolium	Grass Trigger-plant (c,w)		17 (1)			13 (1)	8 (1)						11 (1)				11 (1)								17 (+)	
THYMELAEACEAE																										
Drapetes tasmanicus (O)	(c)																									Rare. Recorded only in *Poa costiniana* grassland near Mt. Jim
Pimelea alpina	Alpine Rice-flower (c)		4 (+)	33 (+)		21 (1)	57 (1)	39 (1)	60 (1)	79 (1)	20 (2)	8 (+)	16 (+)	50 (+)										50 (R)	17 (+)	
Pimelea axiflora var. alpina	Bootlace Bush (c,w)		79 (1)	83 (1)	57 (1)	50 (1)	14 (+)	17 (1)	16 (1)		60 (1)		3 (+)												33 (+)	
Pimelea biflora	Matted Rice-flower								2 (2)	14 (+)																
Pimelea ligustrina	Tall Rice-flower (c)	83 (+)	4 (1)	4 (+)			3 (+)						3 (+)												17 (+)	

NUMBER OF QUADRATS	6	24	24	7	24	37	18	50	14	10	13	37	4	12	4	9	3	5	8	5	3	6	2	6	
TWO-WAY TABLE UNITS	1	2	3A	3B	3C	4	5A	5B	5C	5D	6	7A	7B	8A	8B	9	10	11	12	13	14	15	16	17	
NAME	COMMON NAME																								COMMENTS
Pimelea linifolia	Slender Rice-flower												3 (+)												
VIOLACEAE																									
Hymenanthera dentata	Tree Violet (c,w)		71 (1)	71 (1)	100 (1)	42 (+)	14 (1)	33 (+)	36 (1)	29 (+)	10 (+)	8 (+)					22 (+)			50 (1)						
Viola betonicifolia	Showy Violet (c,w)		75 (1)	75 (+)	100 (1)	54 (1)	30 (1)	50 (+)	20 (1)	21 (+)	100 (1)	15 (+)	8 (+)		25 (1)		22 (+)		40 (+)	38 (1)	20 (+)	33 (+)	33 (1)	50 (+)	
Viola sieberana	Tiny Violet												3 (+)		8 (1)										
**Viola tricolor*	Wild Pansy																11 (+)								
WINTERACEAE																									
Tasmannia xerophila	Alpine Pepper (c,w)	17 (1)											3 (+)												

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