# THE ENVIRONMENT

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### *Climate*

Rainfall and temperature records are available for the Chalet on Mt. Buffalo, however the climate over most of the Park had to be inferred.

### Precipitation

The Chalet records (Commonwealth Bureau of Meteorology 1956) (Table 1), provide an assessment of the climate on the eastern side of the plateau only. There are two reasons for not extending these data tot he whole of the plateau. First, the prevailing weather approaches from the west and north-west, and secondly, because of the elevated and exposed land mass of the western and north-western edge of the plateau, it may reasonably be expected that his area would receive higher precipitation than the eastern edge. Local knowledge tends to confirm that the western edge of the plateau receives more snow and more of the summer storms. There is a strong inverse correlation between elevation and temperature and this results in cooler conditions on the higher southern end of the plateau.

***Table 1. Average monthly and annual precipitation (in points at Mt. Buffalo Chalet (Commonwealth Bureau of Meteorology, 1956).***

| Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 291 | 401 | 440 | 521 | 716 | 914 | 959 | 929 | 722 | 759 | 515 | 421 | 7594 |

In accepting 75.9 inches as the average yearly precipitation for the eastern edge of the plateau, it seems reasonable to expect a somewhat higher precipitation on the western side, possibly up to 85 inches, with the greater increase occurring when the weather is predominantly from the west, that is, in the winter. The southern end may also receive up to about 85 inches.

The Parks extends part-way down the scarps of the mountain in the adjacent valleys of Yarrarabula Creek and the Buckland river, to elevations of about 1,200 feet to 1,500 feet.

Rainfall records for Myrtleford tot he north (34.4 inches), and Bright to the east (42.9 inches) indicate that the lower eastern side of the Park may have an average rainfall of about 40 inches, while Dondangadale to the south-west (47.4 inches) (from Central Planning authority 1949) indicates that at the lower western edge of the Park, average annual rainfall would be above 47 inches and possibly up to 60 inches or more. The eastern and southern ends, which both cross mountain ridges at about 3,500 feet to 4,000 feet, may be expected to be almost as wet as Chalet, say 70 inches.

Considerable local variation in total and seasonal precipitation can be expected because of the steep gorges and sharp changes of elevation and aspect.

Snow is a most important component of the total precipitation. However, there are no records available to indicate the general pattern of snowfall distribution throughout the year or throughout the Park.

Persistent snow generally occurs from about late May or early June, and snow suitable for skiing is usually gone by late October. Deeper snow accumulations may be expected on the western and southern sides of the plateau. As well as probably receiving more snow, the southern area is higher, and therefore snow persistence should be better.

Aspect and exposure are important factors influencing snow accumulation and persistence. Western and northern slopes receive less snow and it melts more rapidly so that persistence is less than n southern and eastern slopes.

The effect of obstructions such as hills, rocks and clumps of trees or breaks in the tree canopy, in creating turbulence and encouraging snow accumulation has been shown to be sustained by Costin *et. al* (1961) in the Snowy Mountains. This effect is readily observed on Mt. Buffalo in winter. Snow persistence is improved by the protection from warm winds and from solar radiation afforded by the tree canopy.

*Table 2. Average daily mean temperatures (°F) at Mt. Buffalo Chalet (Commonwealth Bureau of Meteorology, 1956).*

| Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59.3 | 58.9 | 54.8 | 46.7 | 42.0 | 36.4 | 34.6 | 36.0 | 40.3 | 45.3 | 51.1 | 56.0 | 46.8 |

## Temperature

Temperatures usually decrease with increasing elevation. The extremely steep slopes and great differences in elevation which occur I the Park make it impossible to give generally acceptable average temperature data. The Chalet figures (Table 2) may be fairly typical of the area at about 4,5000 feet; however the extensive areas of bare rock around the Chalet may result in more rapid heating and cooling of the air near the ground than would occur if the area were completely vegetated. Thus, it is possible that average daily maxima and minima at the Chalet may be rather extreme for this elevation, although they may balance out to produce a fairly typical average daily mean temperature.

Topography can influence temperatures by its effects on the drainage of cold air. The lack of tree vegetation on the relatively flat high-valley plains of the plateau may be, in part at least, attributed to the concentration of sold air in these areas of poor drainage (Costin 1962a).

The forest data in Table 3 is based on temperatures recorded in a meteorological screen 4 feet above the ground. A minimum screen temperature of 36°F indicates a light frost at ground level, and 32°F indicates a heavy frost on the ground. The average frost-free period is the number of days between the average date of the last minimum screen temperature of 36°F in spring or summer and the average date of the first minimum screen temperature of 36°F in the following late summer or autumn. At the Chalet, this period is 44 days, extending on the average, from December 15th to January 27th inclusive.

*Table 3. Frost Data for Mt. Buffalo Chalet (1930-39) (from Foley, 1945).*

| - | First 36°F | First 23°F | Last 32°F | Last 36°F |
|---|---|---|---|---|
| Average date of first or last occurrence in the year | Jan 28 | Mar 26 | Nov 25 | Dec 14 |
| Mean deviation from average (days) | 25 | 26 | 13 | 9 |
| First or last recorded occurrence in any year | Jan 3 | Jan 8 | Dec 23 | Dec 29 M |

Although the Chalet may be more prone to frosts than other better vegetated areas at that elevation, the higher-elevation country may be similarly or slightly more frosty and the high-valley plains would almost certainly be more frosty, but no records are available.

## Evaporation

Records of evaporation are not kept at the Chalet. Estimate of evaporation (E) and potential evapo-transpiration (pot. Et) can be made with Prescott's method, (E = 21 x 9 am saturation deficit), and a modification of the Thornthwaite formula (Leeper 1950). These are presented in Table 4.

*Table 4. Estimate of evaporation and transpiration in inches (Based on Chalet records)*

| Method | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E = 21 x SD | 4.7 | 4.4 | 3.4 | 2.1 | 1.7 | 1.1 | 0.8 | 1.1 | 1.5 | 2.2 | 3.0 | 3.6 | 29.6 |
| Thornthwaite's Pot. Et | 3.4 | 2.7 | 2.3 | 1.3 | 0.8 | 0.4 | 0.3 | 0.5 | 0.8 | 1.5 | 2.1 | 2.9 | 19.0 |
| Pot Et/E | 0.72 | 0.61 | 0.68 | 0.62 | 0.47 | 0.36 | 0.42 | 0.46 | 0.53 | 0.68 | 0.70 | 0.81 | 0.64 |

*E* is an estimate of evaporation from a free water surface.

*Pot. Et.* is an estimate of the total potential evaporation and transpiration loss from a fully vegetated area with soil moisture non-limiting. On average, Pot. Et is generally about 0.7 of E, but for Mt. Buffalo, there is a decrease in the ration in the colder months. A comparison with measured evaporation loss from snow on the Bogong High Plains (Car and Turner, 1959) indicates that E for June to September based on the Chalet saturation deficits, is rather high.

## Wind

Wind is an important ecological factor; however no wind records are available. It appears that most of the dessicating winds are from the north and west. This influences evaporation and transpiration on these aspects. Although evidence of wind erosion was not seen during the study, it is possible that it has played a part in maintaining the rocky prominences in a skeletal condition. The influence of wind direction in relation to barriers is important in determining snow-drift accumulation (Costin *et. al.* 1961). This factor should be considered if new skiing slopes are to be developed.

It may also be important in the establishment of vegetation on bare soil where freedom from snow during winter may lead to excessive dessication and frost heave.

## *Geology - Soil Parent Materials*[*]

The greater part of Mt. Buffalo is granite, but on the eastern side of the massif sedimentary rocks of Upper Ordovician age occur.

The granite is coarse grained and consists of "plentiful dark-looking quartz and white and pinkish feldspar with scattered flakes of black mica considerably smaller than feldspars, and rarer flakes of white mica". (Mahony in Dunn, 1908.)

No information is available on the sedimentary rocks o the Park, but Beavis (1962), in describing the rocks of the Kiewa area to the east, refers to an examination of the geology along the power-transmission line from Rose River to Bright, which crosses the ridge at the south-western corner of the Park. As the traverse shows no major structural or stratigraphic discontinuities (Beavis *op. Cit.* P. 353) the data for the Upper Ordovician sediments from the Kiewa area may be relevant. Beavis comments that near Bright, subgreywackes, (clayey sandstones) and quartzites become more important than shales. The chemical analyses of these rocks indicate that the sediments are rich in alumina and potash.

The greywackes are composed of angular to subangular grains of quartz, oligoclase, rare orthoclase and microcline. The coarse constitutes are set in a matrix of finer quartz, and sericite and chlorite, with occasional secondary calcite (Beavis *op cit* p.361).

***Plate 2 – Exfoliation layers exposed by a road cutting. Exfoliation (scaling off of rock in layers) is an important form of weathering in granite.***

Dunn (1908) records that metamorphism of the sediments by the granite "… is traceable easterly for a quarter or a mile or more but on the western side of the range it extends to the Buffalo river, so that probably the granite mass extends westerly for a greater distance near the surface that on the eastern side. The production of secondary mica and a schistose character are the most salient features of this alteration…. Even close to the granite the sedimentary rocks do not appear to have been much indurated, nor do granite dykes appear to be common in the surrounding sedimentary beds."

The bulk of soil material is derived from the weathering of rock, organic matter generally making up the remainder. Alternating temperatures may be an important factor in the physical breakdown of rock in this environment, but the effects of water, and particularly the influence of ice in opening up the joining cracks will be dominant. The physical action of plant roots may also be important. These influences are described in some detail by Dunn.

As well as the breaking up of the granite mass along well-defined rectangular joint plains, exfoliation is also a widespread from of weathering. This consists of the scaling of relatively thin spheroid (convex) layers of granite from the surface of rock masses (plate 2).

The physical breakdown of the tock increases the surface area available for chemical weathering. The organic acids and carbon dioxide derived from the rotting vegetative material are important factors in the chemical weathering process. As quartz is the most resistant of the more common minerals occurring in granite, the resultant soil materials always has a high proportion of quartz sand. Soils derived from the fine-grained sedimentary rocks have a much lower proportion of sand-sized constituents.

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[*] Much of the information in this section is derived from a report on the geology of the area by E. J. Dunn (1908) which has been reproduced in booklet from by the Victorian Railways.

### *Geomorphology – Topography*

Granite massifs such as Mt. Buffalo, are formed by the intrusion of molten rock into the overlying solid rock. Solidification occurs at some great distance below the surface, so the present elevated nature of the mountain has resulted from the erosion of a considerable thickness of the less resistant sedimentary rocks.

The principal influence determining the present physiographic features of the mountain is the jointing if the granite. There are two sets of well developed vertical joints and an often imperfectly developed set of horizontal joints. The main vertical jointing has a bearing of 44° and the cross joints strike at about 317° producing an intersection angle of about 87° (Dunn 1908).

Where the joints are close together, the granite has decomposed without leaving conspicuous blocks, but where the joints are widely spaced great blocks and tors have been isolated. It seems that some joints do not open until after a block has been exposed and subjected to considerable weathering (Plate 25) (Dunn *op cit)*

The jointing pattern has also controlled the development of the streams on the plateau. Most of the main streams which cross the plateau parallel the major joint strike of about 44°. The effect is very noticeable in the fine rectangular drainage pattern between The Horn and Le Scouef Peak.

The Gorge, a notable feature of the eastern escarpment, has been formed by the development of a pair of intersecting vertical joints, presumably aided by the waters of Crystal Brook. The gorge of Buffalo Creek also appears to have developed in a set of north-easterly joints, although the extent of the entrenchment compared to other streams on the plateau suggests an even more severe weakening, possibly by faulting.

***Plate 3 – The Buffalo Plateau, seen to south between the Hump (left) and the Horn. Steep rocky slopes, hills and high-valley plains are shown.***

The term "plateau", applied to the tangle to low hilly ridges and occasional gently sloping valleys, may at first appear to be a misnomer, however the upper surface is in fact a mildly dissected plateau. (Plate 3). Projected sections on bearings 61° and 346° (magnetic) indicate that the plateau slopes to the north at about 100 feet per mile as far as the Buffalo Creek gorge. The North Buffalo plateau does not conform to this inclination. There is no obvious slope on section line 61°.

The lack of similar inclination on North Buffalo may indicate its separation from the main plateau by a fault, possibly along the Buffalo Creek gorge as suggested above.

The rolling plateau on the sedimentary rock at about 2,300 feet on the eastern side of the Park is a relic of a surface of low relief, formed during a prolonged period of stability when the base level of the regional drainage system was much higher than at present. It can be related to numerous small benches around the granite escarpment and to flat-topped spurs in the area.

The influence of topography on the macro and micro climate is fairly clear (discussed in climate section). The topography also affects soil development and the distribution of vegetation through its effect on climate factors and on the stability of the ground surface. Because it is a dominant factor in the distribution of soils and vegetation, and because it is fairly readily mapped from air photo interpretation, the topography has been used as the basis for the mapping of the area. The topographic units recognised are described below:

(i) Basins: valley bottoms with generally concave slopes up to about 25 per cent* steeper slopes may be included if they are short (less than about 2 chains), or is they are too small to separate at the scale used.

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* 25 per cent is a slope of 1 in 4 or 14°

(ii) Hills: generally mildly dissected plateau remnants or relatively broad surfaces (up to 20 to 30 chains wide), or narrower ridge tops. Slopes are mainly convex, up to 25 per cent, but may be steeper if only short (less than about 2 chains), or if they are too small to be separated at the scale used.

(iii) High valley plains: generally small, gently sloping valleys on the plateau at elevations above 4,000 feet. They are usually relatively narrow, less than 5 chains wide; their gentle gradients result in relatively poor drainage of cold air and groundwater.

(iv) Slopes and scarps: steep to precipitous slopes, in excess of 25 per cent, generally with much exposed rock on the granite.

## *Soils*

On the widespread granitic parent materials the range of soils formed is largely controlled by variations in effective climate. At the lower elevations, chemical weathering or rock to from clay minerals is an important process. At the upper most elevations however, production of clay minerals has apparently been limited by the prevailing low temperatures, and the accumulation of organic matter has been increased. Thus, on granite, the soils vary from relatively deeply weathers, clayey soils at low elevations to shallow organic soils at the upper elevations, and include large areas of very shallow and stony soils at all elevations.

The effects of restricted drainage rocks have not been imposed upon the altitudinal sequence and result in variations in the type of soil formed or in their distribution.
The soils on the sedimentary rocks have not been greatly influenced by the elevation controlled climatic sequence, because the upper elevations are not high enough for low temperatures to be effective in significantly reducing slay weathering or increasing organic matter accumulation. In the relatively small area of sedimentary rocks within the Park, situations with restricted drainage are not significant.

The soils of the lower elevations on both granite and sedimentary rocks have undergone mild evaluation[1] of both iron and clay. Those at higher elevations show no consistent downward movement of either iron or clay and in some there is a higher clay content at the surface.

The soil classification used in this study has been outlined elsewhere (Rowe 1967). Soils with an $A_2$ horizon paler than the horizons above or below may usually be shown to have suffered leaching or iron, and are considered to be podzolized. Three soil groups with this feature are described from the Park. There are, the amphipodzols in which the subsoil is reddish-brown friable clay, the cryptopodzols in which the bleaching is partly hidden by colouring derived from organic matter, and the leptopodzols in which podzilization is only weakly evident.

General descriptions of the more important soil groups are given in the following section, and detailed morphological descriptions and analytical data are presented in Appendix 1.

### (a) Soils on Sedimentary Rocks

The most common soils on the sedimentary rocks may be placed in either of two great soil groups. Red amphipodzols occur at the lower elevations, mainly in the basin of Eurobin Creek and other areas where slopes are moderate to gentle. On steeper slopes, and mainly at the higher elevations, cryptopodzols are the dominant soils. There is a gradual change in soil features from one group to the other so that it is not possible to delineate the boundary between the two groups.

(i) ***Red amphipodzols***: A typical profile consists of a dark greyish-brown loam at the surface, which becomes paler below about 1 in (2 cm) and extends to about 6 in (15 cm); a gradual increase in clay content is apparent in the field texture over the nest inch or so which merges into the reddish-brown light clay or clay loam of the B horizon. There is also a transition in colour between the A and B horizons. The $A_1$ horizon is usually moderately to strongly structured, with fine crumb or subangular blocky peds, but structure is usually less well developed in the $A_2$ horizon. The B horizon has a weak to moderate, fine subangular blocky structure and is somewhat compacted. Small chips of stone, and in places large rock fragments, are usually present in the B horizon, and they become more abundant with depth. The depth to unweathered *in situ* rock is usually about 3 ft (90 cm) to 4 ft (120 cm) on gently sloping sites, but is less on steeper slopes.

Variation from the typical profile is mainly in depth to rock and amount of rock in the profile. The thickness of the $A_1$ an $A_2$ horizons also varies. On moist sites, such as on sheltered aspects, the $A_1$ horizon may be 4 in (10 cm) or more deep and the $A_2$ horizon correspondingly thinner.

In the amphipodzols, clay usually makes up less than 20 per cent of the fine earth[2] in the a horizon and may ride to as high as 40 per cent in the lower part of the $B_1$ horizon, but often decreases towards the base of the profile. They acid soils with

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[1] Eluviation: under the influence of rainfall, the downward movement of material within the soil-may involve processes of solution and re-precipitation or movement of colloidal forms.

[2] Fine earth: This is that portion of the soil sample which, after grinding, will pass through a mm sieve. This is the fraction which is most reactive chemically and on which the chemical analyses are usually carried out change from soil to weathering rock, because weathering may extend some distance

reactions of about pH 5.0 to 5.5 throughout the profile. As with most of the soils under eucalypt forest in these areas, carbon/nitrogen ratios at the surface are about 20 or higher, and most of the nitrogen and organic carbon are in the surface inch or two. Phosphorous extracted with concentrated HCl is low. Potassium generally increases as clay content increases so that the subsoil usually has more HCl extractable potassium than the upper horizons. However, biological concentration at the surface can produce relatively high levels of exchangeable potassium there.

The biological concentration of cations and their apparent association with organic colloids in the surface soil generally result in there being more exchangeable calcium, and to a less extent magnesium, at the surface than elsewhere in the profile. This phenomenon increases the importance of the surface soil. Any processes which tend to accelerate the loss of the surface of the forest soils are detrimental and may result in loss of important quantities of plant nutrients.
There is less free ferric oxide in the A horizon than in the B horizon. This indicates that leaching or iron has occurred in the amphipodzols.

The capacity of the soil to store water which can be used by plants, has been determined by a study of undisturbed core samples. Water held between wilting point and field capacity is considered to be available to plants. A red amphipodzol 3 ft (90 cm) deep could retain about 5 in (13 cm) of water available for plant use.

(ii) ***Cryptopodzols***: (on sedimentary rocks) These soils have a dark, loamy organic $A_1$ horizon but a paler $A_2$ horizon is usually not apparent because the darkening caused by the surface organic matter extends into this horizon. There is a gradual increase in clay content through the $A_2$ horizon and the change to a clay loam or light clay $B_1$ horizon takes place over several inches. The texture of the B horizon is usually no heavier than a light clay, and colours are yellowish brown to reddish brown. The soil structure, which is strong, fine crumb in the a1 horizon, becomes coarser and more compacted in the $A_2$ horizon and is somewhat less well developed and subangular blocky in the B horizon. The B horizon is less compacted than in the amphipodzol group and macro porosity appears to the higher. Small chips of stone are common through the profile and larger stones become more abundant with depth. Although there is no clear

The main variations from the typical profile are in depth of weathering, stoniness, abundance or organic matter and depth of its influence.

Cryptopodzols have a slight increase in clay from the A horizon to the B horizon but generally have no more than about 40 per cent clay in the fine part of the profile. The carbon/nitrogen ratios of the surface soil are about 20 or higher and the organic carbon and nitrogen content decreases rapidly below the surface inch or two. As with most soils from the higher rainfall areas, they are low in HCl extractable phosphorous, although HCl extractable potassium is relatively high. The biological concentration of cations in the surfaces soil is more marked in these soils than in the amphipodzols although the cation exchange capacity remains fairly high down the profile.

The distribution of free ferric oxide in the profile indicates mild eluviation of iron from the $A_2$ horizon and its accumulation in the lower $B_1$ horizon.

The capacity of these soils to store water available for plant growth is a little better than for the amphipodzols because of their more porous B horizon; however, a greater proportion of stone and generally shallower depths would be adverse factors which could significantly reduce the available water capacity of may of these soils.

### (b) Soils on Granitic Parent Material

(i) ***Peats****:* The formation of peat soils is independent of the rock on which they occur. They are included in this section because, in this area, suitable conditions for their formation occur only on the granite.

Under the general term peats, are included three main groups – bog and fen peats, dry peats and humified peats.

The bog and fen peats consist mainly of the accumulated undecomposed and partly decomposed remains of the characteristic plants of the bogs and fens. They are usually found beneath thriving bog and fen vegetation and are related to the existence of a high water table and permanent wetness. Dry peats occur as shallow accumulations of plant material derived from heath vegetation on the extensive shelving rock around the escarpment of the mountain.

The humified peats are formed by decomposition of the true peats, as a result of their drying out. This may be caused by a long term climatic trend towards warmer and/or drier conditions as suggested by Costin (1954 p. 554), or by a local stream entrenchment which lowers the water table.

In the humified peat, the plant remains have become decomposed, and if humification has proceeded far enough, a fine crumb structure may have developed. They may then resemble deep alpine humus soils.

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down fissures in the rock, the general depth of predominantly weathered material is about 2 ft (60 cm) to 3 ft (90 cm). Soils are shallower on the steeper and drier slopes.

The bog and fen peat or humified peat usually rests on alluvial material, generally coarse granitic sand at depths of 2 ft (60 cm) or more. Dry peat is usually no more than about 12 in (31 cm) thick and rests on unweathered rock or a shallow layer of brown coarse sandy loam.

Peat is capable of retaining large quantities of water and this is an important physical property. Peat is very acid; reactions as low as pH 3.7 are reported by (Costin 1954 p 548), and from about 60 to 80 per cent by weight is organic matter.

In the humified peats, pH's of 5.0 or slightly less are typical. Because of the shrinkage of the peat as it becomes humified, the mineral constituents become more dominant and the content of organic matter declines to 20 per cent or less. Even so, they are still light and friable soils, and may be readily wind eroded if exposed to loosening by frost action.

Humified peats appear to be relatively common elsewhere. In the Monaro Region (Costin 1954 p 553) and on Mt Baw Baw (G. T Sibley pers comm) snow gums (*E. pauciflora*) may be found growing on humified peats. This suggests that in those areas humification occurred many years ago, probably prior to settlement, and may therefore be attributable to natural factors such as drier or warmer climate. However, no such situations have been seen on Mt. Buffalo, although they may well exist. This may mean that on the Buffalo Plateau these peats occurred where low temperatures or poor drainage prevent snow gum from growing. Humification may be completed with 10 to 15 years (Costin 1954 p 552), so that disturbance of the environment following settlement of the region could be the cause.

(ii) ***Alpine humus soils****:* the alpine humus soils are typically black or dark brown, well structured highly organic loams up to 2 ft (60 cm) deep, below which the mineral horizon exhibits little chemical weathering. The organic matter content may be up to 25 per cent in the surface 6 in (15 cm) but gradually decreases with depth. The acidity if high with reactions generally below pH5.0. The plant nutrients are concentrated in the surface few centimetres where some, at least, are apparently combined in organic complexes, and are not therefore readily available to plants. This may be an advantage because if they were more readily available, they may be leached beyond the plant roots. Base unsaturation is usually greater than 90 per cent. Throughout the profile, indicate that even the relatively abundant organic colloid in the surface is not very effective in retaining cation in this climate.

The structure of the organo-mineral horizon allows free penetration of roots and ready infiltration of water. Infiltration rates of about 1 in (2.5 cm)/30 min on dry, well vegetated soil and ¾ in (1.9 cm)/30 min on poorly vegetated souls have been recorded by Costin (1962b p 293). About 4 in (11 cm) to 5 in (14 cm) of water available to plants may be retained in the top 2 ft (60 cm) of an alpine humus soil.

Because of the high macro-porosity of alpine humus soils, water movement in unsaturated soil is poor (Costin *op cit* p 295). This means that soil around roots may dry to a wilting point even though nearby soil is still quite moist. The high macro porosity is however, of value in the rapid absorption of heavy rainfall and snow melt water.

Alpine humus soils are generally the moist widespread soils on well drainage areas at the elevations characteristic of the plateau. However, they are not as widespread as expected on most of the eastern and northern areas and appear to reach their best development towards the southern end of the plateau. This may be the result of the climatic gradient discussed in the climate section.

Alpine humus soils are the typical soils under grassland in the high valley plains. They occur also under the snow gum sub alpine woodland, mainly at the higher elevation in the south west.

(iii) ***Transitional alpine humus soils****:* On the plateau, many of the well drained areas in the east and north have minimal form of humus soil – the transitional alpine humus soil. These soils are commonly associated with mountain gum – snow gum woodland (*E. dalrympleana – E. pauciflora* association). The milder temperatures indicated by the presence of the mountain gum are possibly the reason for the lack of development of typical alpine humus soils.

These soils have a less well developed organo mineral A horizon than the alpine humus soils. However, a relatively well weathered mineral horizon occurs below the A horizon.

Transitional alpine humus soils occur in generally warmer situations than the alpine humus soils, where chemical weathering of the mineral horizon results in more clay formation. They form an intermediate group between the alpine humus soils and the acid brown earths, both morphologically and chemically.
Transitional alpine humus soils are most common under the mountain gum – snow gum woodlands (*E. dalrympleana – E. pauciflora* association) of the eastern part of the plateau.

(iv) ***Acid brown earths***: Acid brown earths are dominant soils in the upper montane and lower sub alpine areas.

A typical profile consists of black or very dark brown loamy $A_1$ horizon, which has a strongly developed fine crumb to subangular blocky structure and extends to about 6 in (15 cm). The change to the $A_2$ horizon is clear to gradual. The $A_2$ horizon is dark greyish brown loam to clay loam with a weakly developed fine subangular blocky structure and friable consistence, although the coarse granitic quartz sand makes it feel harsh. The transition to the $B_1$ horizon is at about 12 in 930 cm) to 14 in (35 cm). A gradual decrease in organic colouring from the A to B horizon results in yellowish brown colours, and the texture becomes clay loam to light clay. The structure remains weak, fine subangular blocky until close to the weathering rock where it becomes apedal. Soils are commonly only 3 ft (90 cm) to 4 ft (120 cm) deep but weathering may extend much deeper. Shallower profiles are common. Boulders or floaters in the profile often restrict root penetration. Because of the coarse texture of the parent material, gritty textures predominate in the acid brown earths of the Mt. Buffalo area, and neither structure nor subsoil colours are as strongly developed as on finer textured parent materials elsewhere.

These are acid souls with reactions generally less than pH 5.5 and often below pH 5.0. Plant nutrients are concentrated in the surface few inches where they appear to be hold partly on the organic colloid in an exchangeable form, and partly combined in organic complexes where they would be of relatively limited availability to plants until broken down.

The acid brown earths on granitic parent material can retain up to 7 in (18 cm) of water available to plants in the top 3 ft (90 cm) and because they are often deeply weathered, may provide reserves up to 12 in (30 cm) to 14 in (36 cm) of water to plants with roots at depths of 5 ft 9150 cm) to 6 ft (180 cm).

(v) ***Cryptopodzols*** (on granite): The typical cryptopodzol profile on the sedimentary rocks has been described earlier. Cryptopodzols have a thin, dark organic A1 horizon, the colouring from which has partly obscured the mild bleaching of the A2 horizon, a slight increase in both clay content obscured the mild bleaching into the B1 horizon, and a decrease in both as the weathering rock is approached, usually at depths of 2 ft (60 cm) to 30 ft (90 cm).

The coarse grained parent material results in the granitic cryptopodzols having gritty textures. The structure is less developed in the $A_2$ horizon and B horizon and colours are paler brown than in the soils on the sedimentary rocks.

These souls possibly have higher available moisture capacities than the soils formed on the fine-textured rocks because of lower wilting points, while field capacities are similar.

Cryptopodzols, formed on granite, extend higher than is usual on the northern aspects of Mt. Buffalo. They occur up to elevations of about 3,800 feet where, on sedimentary rocks, acid brown earth would normally have been expected.

(vi) ***Leptopodzols***: The name leptopodzol is applies to a thinly or weakly podzolised soil. The most common occurrences of these soils are at lower elevations on the granitic parent materials, though limited areas of similar soils occur also on the lower slopes of the sedimentary rock area. They consist of deposits of granitic weathering products which have suffered mild leaching of clay and usually of iron, so that there is a pale A2 horizon and a more strongly coloured B horizon. The A1 horizon is only 1 in (2 cm) to 2 in (5 cm) deep and is darkened by the accumulation of organic matter. These souls lack structure and set hard when dry.

On steep slopes they are usually shallow souls but at the base of slopes where detritus accumulates, they may be 6 ft (180 cm) or more deep. In the deeper profiles the horizon of maximum iron and clay accumulation is usually at about 24 in (60 cm) to 30 in (75 cm), below which colours become more pale and the texture less clayey.

They may be relatively well supplied with plant nutrients, but poor moisture availability and the difficulty of root penetration in the massive soil are important limiting factors to plant growth. No soils of this group have been sampled in this study.

(vii) ***Lithosols***: Lithosols are possibly the most widespread soils on the plateau and on many of the steep slopes and scarps. They barely warrant consideration as soils because of the dominance of rock and gravelly material. However, the presence of some soil material enables a restricted range of plants to survive in these souls.

Because of the dominance of rock and coarse material, lithosols lack the capacity to retain moisture for plant growth; however, they are usually formed from unweathered or partly weathered rock and may therefore have relatively good nutrient status. The poor moisture status is the major limiting factor for plant growth.

### *Vegetation*

Articles describing the vegetation of the area have appeared in the “Victorian Naturalist” since the early days of the Park[3], and these provide a valuable record of the condition of the vegetation over a long period.

A small booklet, “Flower and Feather at Mt. Buffalo”, National Park: by H. C. E. Stewart, is one of the readily available publications, in which a number of the more interesting plants and birds are discussed.

In 1963 J. H. Willis carried out a survey of the flora of the Buffalo Plateau and compiled a check list of 300 native plants in the Park. He also reported 46 introduced species (unpublished reports to National Parks Authority, 1963).

The typical high mountain vegetation of Australia has been described by Costin (1957a). Although Mt. Buffalo lacks much of the higher sub alpine and alpine vegetation, the lower communities described by Costin are represented. These include the bog, fen and grassland communities, and the snow gum sub-alpine woodland. Several of the other communities appear to be related to communities described from the Monaro Region of New south Wales (Costin 1954).

The indigenous climax vegetation may be regarded as an indicator of the net effect of the environment. By studying the environment of that community it is possible to infer the environment of that community over a wider area.

To use this approach, it is necessary to be able to recognise the plant communities, and some form of classification is essential. The classification used in this study is based on that proposed by Beadle and Costin (1952). This involves recognition of differences in the structure, that is the form, spacing and arrangement of the individuals, and the different species combinations and dominance, termed the floristics.

While it is desirable to use the climax vegetation for classification, because other forms are transitory and need not be reliable indicators of the environment, this is not always possible because the activities of man, including burning and grazing, can cause changes which destroy the climax character. Insofar as it is possible, the climax vegetation is the basis of this study, but in some instances it has had to be inferred from persistent relics such as tree stumps, or by the extrapolation of knowledge of similar environments form other areas.
Some rare species or those not commonly associated with the communities described are considered separately.

The classification is set out in Table 5 and the descriptions of the communities follow.

***Table 5: Classification of vegetative communities.***

| | | |
|---|---|---|
| (a) Sclerophyll forest – | | |
| | (i) Wet sclerophyll forest .. | (i) Alpine ash forest (*E. delegatensis* association) |
| | | (ii) Peppermint-gum forest (*E. radiata – E. rubida – E. dives* alliance) |
| | | (iii) Mountain gum forest (*E. dalrympleana* association) |
| | (ii) Dry sclerophyll forest .. | Stringybark-peppermint forest (*E. macrorhyncha-E. dives* alliance) |
| (b) Woodland | | |
| | (i) Tall woodland .. | Mountain gum—snow gum woodland *(E. dalrympleana—E. pauciflora* association) |
| | (ii) Sub-alpine woodland .. | Snow gum woodlands *(E. pauciflora* association) |
| (c) Heath | | |
| | (i) Dry heaths on shallow soils | *(Leptospermum myrtifolium—Kunzea parvifolia* alliance) |
| | (ii) Hovea—Bossiaea heaths | *(Hovey longifolia—Bossiaea foliosa* alliance) |
| | (iii) Wet heaths of the high-valley plains | *(Baeckea gunniana—Epacris paludosa—Epacris breviflora* alliance) |
| (d) Grassland—Snow grass grassland (*Boa australis* association) | | |
| (e) Fen—Sedge fen (*Carex gaudichaudiana* association) | | |
| (f) Bog—Sphagnum moss bog (*Sphagnum cristatmn* association) | | |

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[3] e.g. Barnard, f. G. A and Sutton, C. S. - Amount the alpine flowers, V*ic Nat* Vol 20, May 1903: weindorfer, G. and others – The Buffalo Mountains camp out, *Vic Nat* Vol 20, Hodgson, L. L – On the Buffalo Plateau, *Vic Nat* Vol 44, Nov 1927: Stewart, H. C. E. – Flower and feather at Mt. Buffalo, *Vic. Nat.* Vol 55, 1939: Stewart, H. C. E – Botanical paradise or cattle run? *Vic Nat* Vol 59, June 1942

## *Vegetative Communities*

### **(a) Sclerophyll forest**

### **(1) Wet sclerophyll forest**

***(i) Alpine ash forest:*** This type of vegetation (Plate 4) occurs mainly between altitudes of 3,000 feet and 4,500 feet, and it extends beyond this range where topography produces favourable micro-climates; for example, on southern aspects with deep soils it may extend below 3,000 feet and on northern aspects where soils are deep, almost up to 5,000 feet (as in the head of Bunyip Creek).

***Plate 4 - Wet sclerophyll forest of alpine ash.***

On the better sites, alpine ash *(E. delegatensis)* occurs in pure stands with shrubs such as hickory wattle *(Acacia obliquinervia),* hop bitter-pea *(Daviesia latifolia),* alpine Oxylobium *(Oxylobium alpestre)* and elderberry panax *(Tieghemopanax sambucifolius)* either scattered or dense. The fine stand in the Buffalo Creek saddle below Anderson's Peak has practically no shrub layer, only occasional shrubs of rough Coprosma *(Coprosma hirtella)* and mountain beard-heath *(Leucopogon hookeri),* with a range of herbs including pale vanilla-lily *(Arthropodium milleflorum)* and Tasman flax-lily *(Dianella tasmanica)* and ferns, (mainly *Blechnum procerum)* as the ground flora. The lack of fire-blackened bark on all but a few over-mature trees seems to indicate a long period free of severe fires. The lack of shrubs and the dominance of herbaceous ground cover is considered to be nearer the climax form than the common shrubby condition which may be a fire disclimax.

As site conditions become marginal for alpine ash other tree species enter the community. At the lower or warmer end of its range, broad-leaf peppermint (*E. dives),* Bogong gum *(E. chapmaniana),* candlebark gum *(E. rubida)* and narrow-leaf peppermint *(E. radiata)* may occur in varying proportions. At the cooler end of the range on drier sites, mountain gum *(E. dalrympleana)* and sometimes snow gum *(E. pauciflora)* (in the subordinate tree stratum) occur with alpine ash.

Because of the need for low temperatures prior to commencement of germination to release the seeds from a primary dormancy (Grose 1961), the natural occurrence of alpine ash is restricted to those situations where snow lies for short periods during winter. Seedling establishment is greatly enhanced by bare soil and even more favourable conditions are provided by an ash bed (Grose *op. cit.).* The even-aged character of most pure alpine ash stands is attributed to the creation of suitable seed-bed conditions by fire, which kills the very fire-sensitive mature trees.

The annual precipitation ranges from around 40 inches to over 60 inches. The association attains its best form on deep, well drained soils where soil moisture is never limiting.

Alpine ash may be found growing in narrow crevices in the rocks on Mt. Buffalo, however many such situations are marginal, as demonstrated by the death of many young trees growing in these sites during the dry summer of 1964-65.

Because of the relatively narrow ecological amplitude of alpine ash, this community is a useful indicator of the environment. Variations in the subordinate strata may indicate small differences in environment but fire is a most important factor in modifying this part of the association. Variations in the form of the trees and in stand density, and the occurrence of other tree species are better indicators of deviations from the maximal growth conditions.

(ii) ***Peppermint—gum forest****:* This community is most widespread at the intermediate elevations on the soils derived from sedimentary rock, but it also occurs on granitic soils.

Narrow-leaf peppermint *(E. radiata),* the most abundant species, occurs with manna gum *(E. viminalis)* in the lower parts of the Park where soils are relatively deep, and on sheltered aspects or in moist gullies.

Candlebark gum *(E. rubida) is* never a numerically dominant species although it has a wide range and occurs throughout the Park associated with almost all vegetative communities up to the snow line.

Generally, broad-leaf peppermint *(E. dives)* achieves dominance in the stringybark—peppermint forest but it is also a common member of the peppermint—gum forest.

Bogong gum *(E. chapmaniana)* occurs throughout the range of this community within the Park. Towards the higher elevations it becomes more common and is often found with broad-leaf peppermint on the drier sites.

The shrub stratum is generally well developed in this community. Hickory wattle *(Acacia obliquinervia),* hop bitter-pea *(Daviesia latifolia),* common Cassinia *(Cassinia aculeata)* and handsome flat-pea *(Platylobium formosum)* are the most common shrubs. Lomatia *(Lomatia myricoides),* shiny Cassinia *(Cassinia longifolia)* and cherry ballart *(Exocarpus cupressiformis)* are common but not usually dominant species. Tussock grass *(Poa australis) is* the most abundant ground flora species. Prickly starwort *(Stetlaria pungens),* Austral bracken *(Pteridium esculentum)* and Derwent speedwell *(Veronica derwentia)* are other common ground-flora species (Plate 5).

***Plate 5 - Wet sclerophyll forest of narrow-leaf peppermint and manna gum with dense Austral bracken understorey on the lower plateau formed on the sedimentary rocks.***

In moist gullies and on sheltered aspects, blackwood *(Acacia melanoxylon)* and Victorian Christmas bush *(Prostanthera lasianthos)* also occur. Musk daisy-bush *(0learia argophylla)* occurs as a wet-gully shrub with a ferny ground flora.

The rather specialised vegetation of the banks of permanent streams below about 3,000 feet altitude, has been included with the peppermint gum forest alliance. The trees are usually narrow-leaf peppermint and manna gum in well drained sites, with mountain swamp gum *(E. camphora)* in the wetter sites. Tall shrubs of blackwood, Victorian Christmas bush and burgan *(Leptospermum phylicoides)* occur on the better-drained areas and woolly tea-tree *(L. lanigerum)* occurs on wet sites with ferns. King fern *(Todea barbara) is* also common along the banks of Eurobin Creek.

The peppermint gum forest occurs on well drained soils (except for the mountain swamp gum component) where rainfall of more than about 40 inches per annum ensures good soil-moisture availability throughout most of the year. Its range in the Park extends from the lowest elevations up to about 3,000 feet where it gives way to the alpine ash forest.

Where shallow soils, steeper slopes, or exposed aspects or combinations of these factors produce drier conditions, it is replaced by stringybark—peppermint forest.

The distribution of these two communities forms a complex mosaic as changing aspect alters the micro-environment. The Porepunkah Road between Eurobin Creek and Eurobin Point traverses a continual alternation between the two communities from northern to southern aspects.

Although the environmental conditions governing the distribution of the peppermint—gum forest are not as well understood as those for the alpine ash forest, a fairly well-defined environment is apparent. The considerable ecological amplitude of candlebark gum and to a lesser degree broad-leaf peppermint, makes the boundary between adjacent communities rather indeterminate in some localities.

The sequence of increasing dryness or deteriorating growth conditions is indicated by the species sequence, manna gum, narrow-leaf peppermint, candlebark gum, Bogong gum, broad-leaf peppermint. A similar sequence of shrub species could probably be made but the effects of fire may produce misleading alterations in the species composition of the shrub stratum.

(iii) ***Mountain gum forest****:* Two species usually associated with mountain gum *(E. dalrympleana)* singly, or more rarely together, are broad-leaf peppermint *(E. dives)* and snow gum *(E. pauciflora).* Usually, broad-leaf peppermint occurs at the warm or lower end of the range and snow gum at the cooler end. The shrub stratum usually contains hickory wattle *(A. obliquinervia)* on warmer sites and mountain beard-heath *(Leucopogon hookeri),* alpine Oxylobium *(Oxilobium alpestre)* and leafy Bossiaea *(Bossiaea foliosa)* on cooler sites. The ground flora is dominated by tussock grass *(Poa australis)* with herbs such as the pale vanilla-lily *(Arthropodium milleflorum)* and common fringe-lily *(Thysanotus tuberosus).* The association usually occurs within the same altitudinal range as the alpine ash forest *(E. delegatensis* association) where it occupies the drier or more exposed sites and shallower soils. Mountain gum appears to have an upper altitudinal limit of about 4,500 feet. Above this elevation snow gum becomes dominant in pure stands. The transition from wet sclerophyll forest of mountain gum to the tall woodland and subsequently to sub-alpine woodland and wet mallee of snow gum is gradual and difficult to define and to map.

Although occurring within the normal elevation range of alpine ash, the mountain gum forest is confined to those sites which are marginal for that species. This may result from a decreased availability of soil moisture in summer. However, it is also possible that mountain gum is able to regenerate without the dormancy-breaking conditions required by alpine ash (Grose 1961) and may thus have a competitive advantage on those sites where warmer conditions occur early in the spring. The warmth-induced or dryness-induced secondary dormancy (Grose *op. cit.)* of alpine ash seeds may limit its occurrence on sites on which mountain gum succeeds. Thus the mountain gum forests occur on sites where snow does not persist for long into spring, and where warmer temperatures and more rapid drying out of surface soil occur earlier in spring than on alpine ash sites.

The upper limit of the association is probably temperature controlled but the mechanism is not known.

### (2) Dry sclerophyll forest

***Stringybark peppermint forest****:* Although this community is not a typical dry sclerophyll forest, sensu Beadle and Costin (1952), it is useful to recognise it as a drier type of vegetation than that of the communities in the wet sclerophyll forest group.

The dominant species, red stringybark *(E. macrorhyncha)* and broad-leaf peppermint *(E. dives),* form a forest of rather open density and probably no more than 50 feet to 60 feet high (Plate 6). Long-leaf box *(E. goniocalyx :* syn. *E. elaeophora)* is often present, usually as a much branched tree of poor form. Other tree species which often occur in this alliance are candlebark gum *(E. rubida),* manna gum *(E. viminalis),* and narrow-leaf peppermint *(E. radiata)* which occasionally overlap from the adjacent wet forests.

The shrub stratum is usually sparse and is characterised by common Cassinia *(Cassinia aculeata)* and sometimes burgan *(Leptospermum phylicoides)* with occasional hop bitter-pea *(Daviesia latifolia).* Ground cover is predominantly litter, although Austral bracken *(Pteridium esculentum)* often forms a closed stand on sites with deeper soils. The presence of burgan may indicate the occurrence of a seasonally excessively wet sub-soil.

This community occurs on the dry northerly and westerly aspects of the steep slopes of the sedimentary rock areas. On southerly aspects and on less steep slopes, the peppermint—gum forest is dominant. The annual rainfall is in excess of 40 inches so that the occurrence of this dry form of vegetation is an expression of site dryness caused by aspect and slope, and probably also involves relatively low soil-moisture availability because of the shallowness of the soils.

***Plate 6 - Dry sclerophyll forest of red stringybark and broad-leaf peppermint with sparse Austral bracken understorey***

## (b) Woodland

### (l) Tall woodland

***Mountain gum—snow gum woodland:*** The tall woodland form of this community is similar to the wet sclerophyll forest form, but the dominants are not as tall and have crown depths about equal to the bole length. This community often consists of scattered mountain gum *(E. dalrympleana)* trees up to 60 feet tall, with a subordinate stratum of mallee-form snow gum *(E. pauciflora)* (Plate 7). In the climax condition, these would probably be woodland-form trees also, but not as tall as the mountain gum trees (Plate 8). The common shrubs associated with this vegetation are alpine Oxylobium *(Oxylobium alpestre),* gorse bitter-pea *(Daviesia ulicifolia)* and leafy Bossiaea *(Bossiaea foliosa).* Snow grass *(Poa australis) is* usually abundant, and with herbs and litter, forms a continuous ground cover. It occurs at higher elevations than the wet sclerophyll forest form and generally grades into sub-alpine woodland of snow gum.

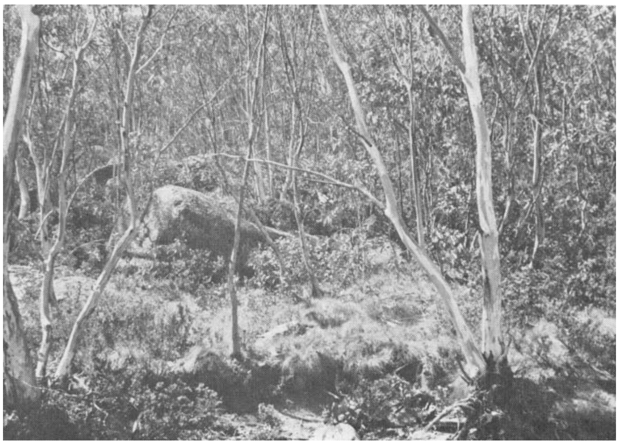

***Plate 7 - Snow gum in a tall scrub formation with snow grass sward and scattered shrubs.***

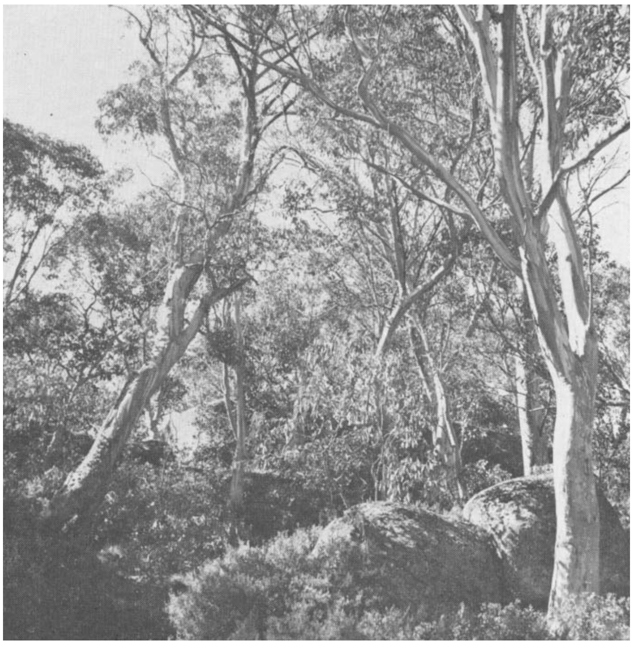

***Plate 8 - Snow gum trees—part of the tall woodland of mountain gum and snow gum.***

The conditions controlling the occurrence of the mountain gum-snow gum tall woodland are probably similar to those for the mountain gum forest. The shorter trees may be simply a result of a shorter growing period produced by the lower temperatures at the upper end of the mountain gum range, or by soil-moisture deficiency in the summer or autumn.

In general, its occurrence reflects poorer growth conditions than those prevailing in the wet sclerophyll forest community, and possibly both temperature and soil moisture are limiting factors.

### (2) Sub-alpine woodland

***Snow gum woodland:*** The climax form of the snow gum *(E. pauciflora)* woodland has to be largely inferred. Over practically the whole plateau, the dominant form of snow gum is a multi-stemmed mallee, varying in height from about 6 feet to 25 feet (Plate 9). Occasionally the dead trunk of the parent tree can be seen, but more usually all that remains is a short stump in the centre of the mallee clump. Even on the north-western slopes of The Horn, a very exposed situation, there is evidence that the previous dominants were single-stemmed or at most several-stemmed trees with diameters of eight inches or more. Presumably the present condition has been produced by fire.

The present shrub-choked condition of much of the snow gum woodland may also have been induced by fires. The most abundant shrub species are the legumes, hickory wattle *(Acacia obliquinervia),* alpine wattle *(Acacia alpina),* alpine Oxylobium *(Oxylobium alpestre),* gorse bitter-pea *(Daviesia ulicifolia)* and to a lesser extent leafy Bossiaea *(Bossiaea foliosa).* Other common species include box Micrantheum *(Micrantheum hexandrum),* alpine pepper *(Drimys xerophila)* and shrubby Platysace *(Platysace lanceolata).*

***Plate 9. Thicket of snow gum—many stems arise from a central rootstock. The parent tree was probably killed by fire. This form may be termed wet mallee.***

A species endemic to the Mt. Buffalo plateau is the Buffalo Sallee *(E. mitchelliana).* This occurs in the snow gum woodland in the lower part of its range, predominantly in the very rocky areas, such as around the Chalet. It has a superficial resemblance to black sallee *(E. stellulata),* and may be a derivative of that species which is also recorded from the Park. The Buffalo sallee occurs with snow gum on the eastern side of the plateau and on the slopes of Mt. McLeod. It may be more extensive but seems to be absent from the higher elevation and wetter country both to the south and west. Several specimens near Bent's Lookout have a characteristic sub-alpine woodland form but elsewhere it occurs as a spindly mallee.

The snow gum woodland occurs on most of the country above 4,500 feet altitude. It appears to be excluded from the high-valley plains by excessive subsoil wetness and possibly low temperatures (Costin 1954).

Vegetative communities containing snow gum occur elsewhere in north-eastern Victoria where rainfall ranges from 30 inches to over 80 inches per annum, and where winter snow persists for less than one to as many as four months. Snow gums are found in some places in north-eastern Victoria where snow rarely falls. The wide range in precipitation tolerance indicates that other factors must be exerting control over its distribution. Costin (1954) lists the following as determining distribution of the community in the Monaro region: exposure to wind, duration of the winter snow cover, low temperatures during the growing season and imperfect soil aeration or drainage.

The duration of winter snow and low temperatures during the growing season seem most likely to be the important factors controlling the distribution of the snow gum woodland and the adjacent vegetative communities in this area. As Costin *(op. cit.)* points out, snow gum is excluded from the alpine ash (*E. delegatensis)* areas by the superior competition of that species, not by unfavourable environment.

The limitation of occurrence of snow gum in the high-valley plains is probably largely due to imperfect soil drainage in these gently sloping valleys as suggested by Costin *(op. cit.).* However, because of the topographic configuration, accumulation of cold air in these valleys must also be an important limiting factor for the establishment of woody plants.

***Plate 10. Dry heath on shelving rock—a number of species occur in this community, some are myrtle tea-tree, violet Kunzea, lemon bottle-brush, Buffalo sallow wattle and common fringe-myrtle. The scattered trees are brittle gum.***

### (c) Heath

(i) ***Dry heaths on shallow soils****:* Myrtle tea-tree *(Leptospermum myrtifolium),* violet Kunzea *(Kunzea parrifolia),* lemon bottle-brush *(Callistemon pallielis),* Buffalo sallow wattle *(Acacia phlebophylla),* common fringe-myrtle *(Calytrix tetragona)* and shrubby Platysace *(Platysace lanceolata)* are the most common species in this vegetative community. Occasional small trees of brittle gum *(E. mannifera)* occur with this alliance. It appears to be closely related to the *Casuarina nana—Leptospermum lanigerum* alliance of Costin (1954). The main occurrences of this vegetation are on the steep rocky faces of the scarps at mid-elevations, where it occurs in rock crevices and in the shallow soil formed from rock detritus.

The dependence of this community on periodic rain to maintain soil moisture is demonstrated by the death of many of the shrubs during the dry summer of 1964-65. The high run-off from the extensive bare rock in these areas probably results in a greater availability of soil moisture in the crevices than would be expected on areas with complete soil cover.

The relatively favourable crevice sites apparently act as foci for vegetation establishment and soil development. The shrubs trap debris washed off the rocks above, and in places, areas of soil up to about 12 inches deep may be found resting on shelving rock and stabilized by the shrubs. The stability of the soils and vegetation on these harsh sites is dependent on the availability of crevice anchorages. The destruction of some such crevices when the main road was constructed has resulted in the erosion of some of the shallow soils and the exposure of bare rock.

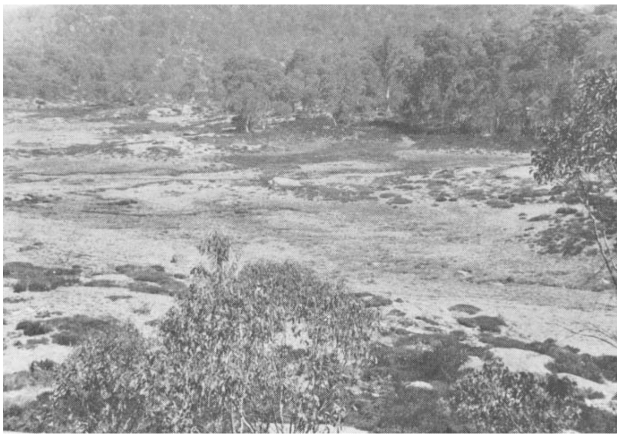

***Plate 11. Hospice Plain—a high-valley plain with the characteristic vegetation pattern. The forest in the right mid-distance is alpine ash, and to the left (centre) is mountain gum—snow gum woodland.***

***Plate 12. Rosy heath-myrtle forms a dense mat at the base of rock outcrops. The other procumbent shrub is alpine grevillea.***

This community may be considered as an advanced stage in a lithosere. The continued accumulation of soil material which results in the development of deeper soils favours species with a higher moisture requirement. These generally grow more rapidly and produce more complete cover than do the shrubs and so ultimately exclude the shrub community.

The later stages in the sere may be represented by those areas of sclerophyll forest adjacent to the bare rock faces. The deep rooting of woody perennials in rock crevices is probably essential for the stability of the soils of these areas also.

(ii) ***Hovea—Bossiaea heaths****:* This vegetation occurs most generally as a narrow strip of low shrubs, 12 inches to 18 inches tall, between the snow gum *(E. pauciflora)* woodlands and the grasslands of the high-valley plains (Plate 11). Rusty pods *(Hovea longifolia) is* dominant on the grassland side of the community and leafy Bossiaea *(B. foliosa)* adjacent to the woodland, into which it may continue to form a closed shrub stratum, though it is more usually replaced by alpine Oxylobium *(O. alpestre),* alpine wattle *(Acacia alpina)* and other shrubs.

Rusty pods and leafy Bossiaea are clearly more tolerant of the poorer soil aeration and/or lower temperatures which characterise the high-valley plains than is snow gum, and judging from their distribution rusty pods is more tolerant than leafy Bossiaea. However, leafy Bossiaea has a wider ecological amplitude than the other species.

On drier and shallower soils, and particularly those lacking the organic-matter-rich A-horizon typical of the soils of the high-valley plains, yellow Kunzea *(Kunzea muelleri),* alpine Grevillea *(Grevillea australis)* and box Micrantheum *(Micrantheum hexandrum)* occur, often with leafy Bossiaea. Snow grass *(Poa australis)* forms a more or less continuous sward beneath both associations of this alliance.

Ivy Goodenia *(G. hederacae) is* often an early coloniser of bare soil in these areas.

Where rock outcrops within this community, shrubs such as alpine grevillea and alpine wattle may be procumbent on the rock. In these situations rosy heath-myrtle *(Baeckea ramosissima)* often forms a mat at the soil-rock junction (Plate 12).

(iii) ***Wet heaths of the high-valley plains****:* The most common shrub species in this community are alpine Baeckea *(Baeckea gunniana)* and short-flower heath *(Epacris breviflora)* with occasional swamp heath *(Epacris paludosa)* (Plate 13). It occurs on wetter parts of the high-valley plains and may have snow grass *(Poa australis)* or spreading rope-rush *(Calorophus lateriflorus)* and candle heath *(Richea continentis)* as ground flora species, the latter is the wetter form.

*Plate 13. Dense wet heath of alpine Baeckea and short-flower heath in the Long Plain at the head of Lake Catani.*

*Plate 14. The high-valley plain vegetation sequence at Lake Catani. Heath in the foreground, grassland beyond and fen at the Lake edge.*

There are indications that the vegetation may not be climax. For example, the mixture of alpine Baeckea and candle heath, and the lack of Sphagnum moss seem to indicate a bog community which is drying out. In some such areas, snow grass also occurs with spreading rope-rush (Plate 15).

Costin (1954 p. 256), in discussing the bog communities of the Monaro Region of New South Wales, comments that—" The initial vegetative changes produced by drier bog conditions involve invasion by less hygrophilous species, especially such as [4]*Calostrophus lateriflorus* and *Poa caespitosa,* and an increase in the abundance of shrubs ".

The soils of this vegetation are often humified peats which tend to confirm that the site was once occupied by bog but has dried out. This may be the result of disturbances caused by man but may also be because of a reduction in moisture availability caused by climatic change over an extended period.

### (d) Grassland

***Snow grass grassland****:* The snow grass (*Poa australis)* grass lands consist of a closed sward of closely associated but discrete tussocks with abundant, overlapping leaves. Herbs other than grass (forbs) make up a small proportion of the species composition of the grassland, none occurring in other than occasional numbers. Billy buttons *(Craspedia glauca)* and mountain gentian *(Gentianella diemensis)* are two conspicuous forbs. Shrubs, mainly of the Hovea-Bossiaea heath, frequently occur scattered through the grassland and form a narrow strip between the grassland and the sub-alpine woodlands on the slopes (Plate 14). This community is restricted to the high-valley plains.

The condition of most of the grasslands seems to be climax or near climax. Costin (1957) reported on the condition of the Buffalo Plateau in 1955 and stated that in places, the tussocks were open with much bare ground between them, and in many places the tussocks had been destroyed altogether. The cessation of grazing following this report has removed one of the major causes of deterioration of the grasslands and apparently allowed some recovery of this community.

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[4] Spreading rope-rush and snow grass respectively.

### (e) Fen

***Sedge fen**:* This is a vegetative community in which the plants grow in water or permanently saturated soil, but from which hummock forming mosses are absent. It is a common form of vegetation along all of the perennial drainage lines which have a relatively flat gradient. Most of the fens of the Buffalo Plateau are dominated by sedge *(Carex gaudichaudiana).* A notable extension of the fen vegetation has occurred around the high-water level of Lake Catani, an artificial lake on the plateau (Plate 14). In this fen tall spike-rush *(Eleocharis sphacelata)* is dominant in the permanently inundated edge of the lake, and sedge attains dominance in the permanently wet soil at the edge of the water.
Fen gives way to grassland where improved soil drainage occurs, often through an ecotone in which spreading rope-rush *(Calorophus lateriflorus)* occurs. Small bogs of Sphagnum moss *(Sphagnum cristatum)* are usually associated with the fens in the drainage lines and the wet heath community occurs extensively, possibly as an invader as the water-table becomes lowered by stream entrenchment.

### (f) Bog

*Sphagnum moss bog:* Sphagnum moss *(Sphagnum cristatum) is* the dominant species in this form of vegetation. Sedge *(Carex gaudichaudiana)* also occurs in quantity. Some of the other species are candle heath *(Richea continentis),* swamp heath *(Epacris paludosa)* and alpine Baeckea *(Baeckea gunniana).* Costin (1954) recognises valley bogs and raised bogs in the Kosciusko area. Although both sub-forms may have been represented on the Buffalo Plateau, the only apparently vigorous bogs are raised bogs, where the hummock-hollow phases are well developed. There may have been valley bog in the drainage lines of the Kowan Plain, Skeleton Gully and other similar high-valley plains, but those areas examined have a degenerate form of Sphagnum moss bog which appears generally to have been brought about by a lowering of the water-table. Stream entrenchment, which has occurred on all of the streams examined, appears to be the cause. The bogs have been invaded by spreading rope-rush *(Calorophus lateriflorus)* and even snow grass *(Poa australis).* These invasions indicate successive stages in drying out (Costin 1954, p. 256) (Plate 15).

One of the most heathy raised bogs seen in the high-valley plains in the Park occurs in the lowest small plain on the Bunyip Creek. The bog in the adjacent plain is also in better-than-average condition. Cattle rarely grazed the lower area and only occasionally frequented the upper one (E. Higgins pers. comm.). The association between soundness of bog and lack of grazing seems to be well illustrated here, and it seems logical to blame the grazing for the poor condition of the bogs or their almost total elimination from grazed high-valley plains.

Another healthy bog occupies the drainage line just to the north-east of the main road crossing of Crystal Brook near the turn to the Chalet. Bog vegetation seems to thrive in situations such as this, where entrenchment is prevented by the rockiness of the drainage line.

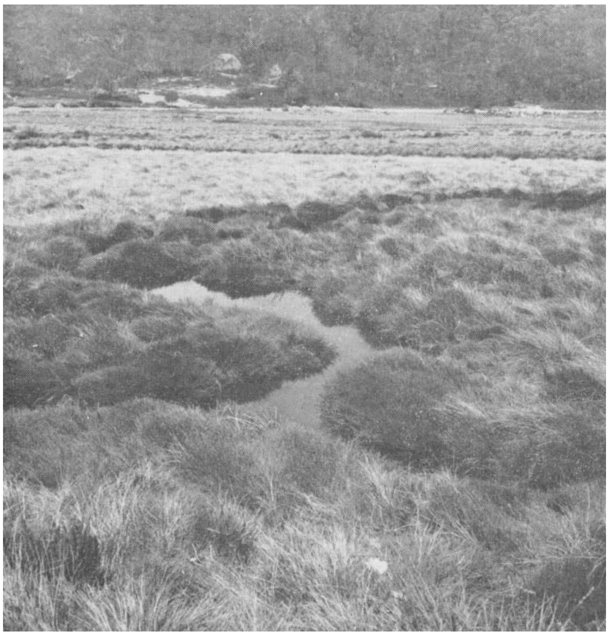

***Plate 15. The darker vegetation is mainly spreading rope-rush. There are a few small hummocks of sphagnum moss. It may once have been a bog but is now invaded by non-hydromorphic species such as snow grass. It may be regarded as a degenerate bog.***

### (i) Species of special interest

A number of plant species found within the Park are of special interest because they are rare or endemic. Some of these are discussed below.

Mountain plum pine *(Podocarpus lawrencei) is* of special interest because it is the only member of the genus indigenous to Victoria and is one of the few indigenous conifers. It is restricted to the sub-alpine and upper montane tracts in Victoria, Tasmania and southern New South Wales where, although it occurs over a wide range, it is not common. Low shrubby specimens of this species may be found in the ravine below Lake Catani and on the southern slopes of the Horn. A healthy tall-shrub specimen occurs in the lowest plain on Bunyip Creek.

The rare monkey mint-bush *(Prostanthera walteri)* was first discovered near the Crystal Brook gorge (Barnard and Sutton, 1903) and was more recently recorded by Stewart (1939) as " fringing the road to Lake Catani " and being present at the Horn and on the eastern slopes of Mt. McLeod on North Buffalo. This shrub has been recorded in Victoria only from Mt. Buffalo and a few localities in East Gippsland.

Buffalo sallee *(Eucalyptus mitchelliana) is* endemic to the Park. It is fairly common on the eastern side of the plateau and on Mt. McLeod.

Fern-leaf Baeckea *(Baeckea crenatilolia)* is a rare species endemic to Mt. Buffalo, recorded in 1903 from the track to the Reservoir and another un-named location at 3,800 feet. Its present distribution is not known.

Alpine spear grass *(Stipa niricola) is* a rare grass which in Victoria is recorded only from Mt. Buffalo and the Bogong High Plains (Willis 1962, p. 188).

*Hakea lissosperma* occurs on North Buffalo and to the west of the main plateau. This is another species with a relatively restricted distribution within the State and is worthy of preservation.

### *Fauna*

McEvey (1962) states that little thoroughly authenticated work has been done on the ecology of birds and mammals, particularly the latter, of the Victorian high plains areas. Most of the published information on birds has been based on Mt. Buffalo. In reference to fish, amphibians and reptiles of the Victorian high plains in general, Littlejohn (1962) also points out that little is known. He suggests that information relating to the Monaro region of New South Wales may be useful. The author's knowledge of the fauna of the Park is very limited, but some comment can be made.

Rabbits are probably the most important introduced animals in the Park. They appear to be present in considerable numbers, and are considered by some (R. M. Rollason pers. comm.) to be a major disturbing agency in the environment because they are heavy grazers and even dig out tussocks and other palatable herbs to eat the roots. Their presence is very undesirable, particularly on the plateau where they damage the grasslands and are probably responsible for much damage to re-vegetation works which involve palatable species. Unseasonable conditions, particularly early and/or prolonged snow cover, may exercise some measure of control over rabbits on the plateau.

Wombats are relatively abundant in the Park and ample evidence of their presence may be seen on the plateau. They excavate large tunnels where the soil is deep enough to permit. They appear to have favourite grazing areas, usually adjacent to permanent water. Such relatively small areas are usually grazed heavily and subjected to sporadic digging or scratching.

Several insects are worthy of comment. On the Bogong High Plains, casemoth *(Plutorectis caespitosae)* larvae feed near the bases of snow grass tussocks and at times kill large patches of grassland (Carr and Turner 1959). Swift moths *(Hepialidae—species* not determined) also cause death of patches of grassland on the Bogong High Plains. A small patch of dead snow grass tussock, seen during the field work in Skeleton Gully on the Buffalo Plateau appeared to be of the type damaged by the swift moth larvae (Carr and Turner *op. cit.).* Although the elevations of the grasslands on Mt. Buffalo are slightly lower than those of the Bogong High Plains, it is reasonable to expect that similar destructive insects would also be found in the Park.

Another insect which is of interest is the Bogong moth *(Agrotis inflisa)* which occurs in large numbers in rock crevices such as those at The Horn and The Cathedral. Although the larvae are cut-worms and serious pests in the lowlands, they do not appear to cause damage in the alpine grasslands (Carr and Turner *op. cit.).* If they do not live their life cycle in the mountains, their presence in such large numbers at certain times of the year is very strange. Massola (1962) mentions that the passing of the aborigines, who must have exerted some control over the number of these edible moths, could have resulted in plagues ; however increasing numbers of crows (Australian raven) *(Corvus coronoides),* which also feed on the moths, may compensate for the absence of aborigines.

A plague population of the leaf-eating phasmatid *(Didynuria violescens)* developed in the peppermint—gum forest on the eastern side of the Park in 1962-63. About 530 acres was aerially sprayed with a malathion insecticide in February 1963, and a 90 per cent kill was claimed (Newman 1964). There has been no further plague development of this insect in the Park. Readshaw (1965) lists as important predators of phasmatids the pied currawong *(Strepera graculina),* red wattle-bird *(Anthochaera carunculata),* black-backed magpie *(Gymnorhina tibicen)* and the Australian raven. The grey currawong *(Strepera versicolor)* and the laughing kookaburra *(Dacelo gigas)* are also thought to exert some control on the phasmatid. All these are important regulators of other potentially damaging insects and are recorded from the Park (Stewart 1939).

The birds of Mt. Buffalo have been subjected to fairly close observation since white man first became interested in the area, and probably more is known of this branch of the fauna than any other. H. C. E. Stewart has been responsible for most of the published information (see bibliography in McEvey 1962). A check list of the more common birds of the area is available in "Flower and Feather at Mt. Buffalo National Park" (Victorian Railways print of an article by H. C. E. Stewart). Included in this list are brief notes which often give some indication of the birds' place in the ecosystem. Some have been discussed above. The yellow-tailed black cockatoo *(Calyptorhynchus firnereus)* extracts wood-boring larvae from infested trees and dead wood; the superb lyrebird *(Menura novae-hollandiae) is* an active scratcher and may assist the rapid re-cycling of plant nutrients through the incorporation of forest litter in the mineral soil.

A report of a field outing by the Royal Australasian Ornithologists Union (Wheeler 1966), which included a day visit to Mt. Buffalo, lists a number of birds sighted in the area, and their common habitat.

Most, if not all the birds, could be found to have an ecologically important role. However, in general, little appears to be known of their life cycles and what part they play in maintaining a stable ecosystem. Zoology, ecology, park management and even tourism could be well served by concentration of the efforts of zoologists on an area such as the Mt. Buffalo National Park.