THE VEGETATION OF THE KOSCIUSKO PLATEAU.

Part i. The Plant Communities.

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(Plates x-xix and eight Text-figures.)

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Contents.

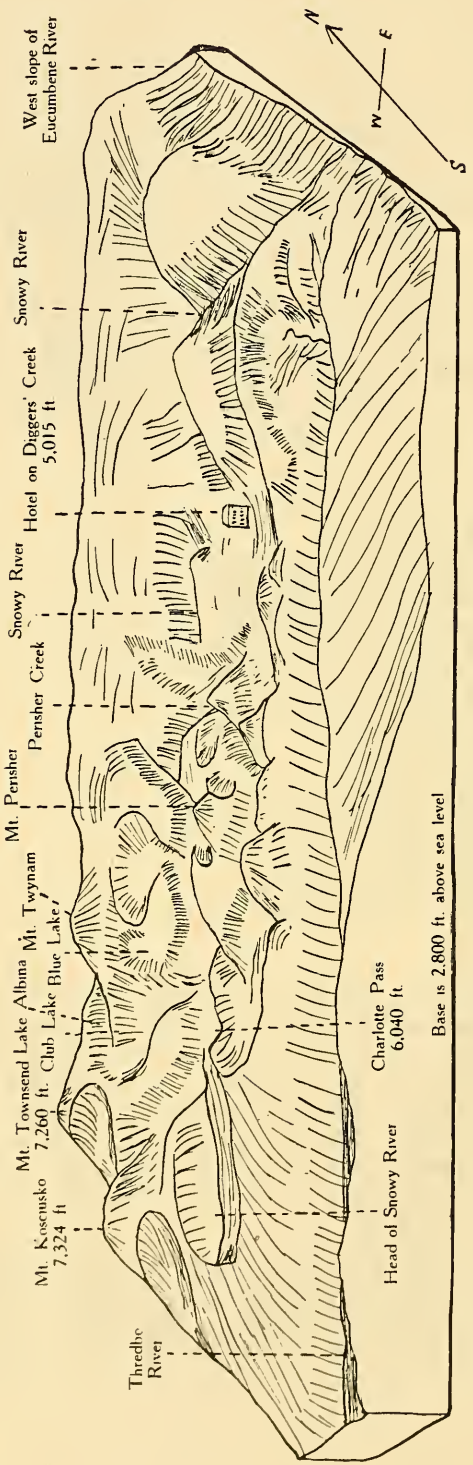
Introduction.

The Kosciusko Plateau, the plant ecology of which forms the subject of this paper, lies in the Snowy Range in the southern portion of New South Wales, and is the highest land surface on the Continent.[1] It is an elevated block about 20 miles long by 6 miles broad, rising gradually from east to west. At the junction of the Thredbo and Snowy Rivers, it is 3,000 feet above the sea. Mount Kosciusko at the other extreme (its westerly limit) is about 7,328 feet high. Only a few isolated points rise above 7,000 feet. A horse shoe-shaped area surrounding the Snowy head-waters exceeds 6,500 feet (contour map Plate x[2] and block diagram Text-fig. 1).

[1] The following description of the topography of the Kosciusko Plateau is taken from the paper "The Kosciusko Plateau," by G. Taylor, W. R. Browne and F. Jardine, published in the *Proc. Roy. Soc. N.S.W.*, 1925, pp. 200-205.

[2] The block, from which this map has been printed, has been kindly lent by the Royal Society of New South Wales, it having appeared in the Proceedings of that Society for 1925 as Plate i.

BLOCK DIAGRAM OF KOSCIUSKO PLATEAU.
(From the Geographical Laboratory by G. and D. Taylor, Sydney, 1925.)



Text-figure 1. The model is 30 miles from west to east.

"There is a very marked drop in the Plateau east of Perisher Creek, for practically all the high land (over 6,000 feet) lies to the west". . . "The 5,000 feet contour bounds the Plateau uplands around the lower Snowy River, which flows through a gorge which is largely below that level". "The drainage is arranged according to a very interesting plan. The main stream of the district is really the broad Eucumbene Valley in the extreme east. This is longer and 'older' than the Snowy Valley. The latter has cut back as a gorge into the uplifted plateau—probably along fault planes—as far back as Charlotte's Pass. Above this the valley is fairly wide and approaches maturity. Further west, the head-waters, above the road-ford, flow and meander through a flat senile valley. The Crackenback-Thredbo Valley is a profound gorge for most of its extent. . . . Besides these two parallel gorges of the Snowy and Crackenback, there is a third more or less continuous valley running between them. . . . It consists of a series of shallow basins linked by cols or gaps. . . . Each of these basins drains to the north by a creek leading into the Snowy River: This 'Road Valley' is about 1,000 feet above the two parallel river valleys. Its topography is probably in part due to bygone glacial erosion".

This region is the coldest portion of Australia, and for six months in the year the higher elevations are covered in snow. It thus offers features of special interest so far as the vegetation of Australia is concerned. The Plateau is an elevated land surface composed of gneissic granite, which ascends abruptly from the surrounding plains at about 3,000 feet above sea-level, to an altitude of 5,000 to 6,000 feet, from which level it rises more gradually until it culminates in various peaks ranging up to 7,328 feet. The lower slopes are steep and well drained, and are dissected by various defiles formed by erosion; the higher portion of the Plateau, however, above 5,000 feet, is traversed by long shallow valleys, whose flat bottoms form marshes by the slow draining away of the water from the melting snow of the higher peaks.

A consideration of the plant communities has led us to recognize three unit-areas in the region under discussion:

(1) The montane zone, from 3,000 to approximately 5,000 feet, comprising the lower slopes of the Plateau.

(2) The sub-alpine zone, from approximately 5,000 feet to the tree-line at 6,000 to 6,500 feet.

(3) The alpine zone, from the tree-line to the highest elevations.

The montane zone is entirely clad with sclerophyllous *Eucalyptus* forest, as is characteristically the case with the mountain regions of Eastern Australia. *Eucalyptus* forest also clothes the ridges and slopes in the sub-alpine zone; the boundary between the montane and sub-alpine zones, however, is also the position of the junction of the two main consociations of the forest. The lower portions of the slopes of the sub-alpine region, below the forest, are occupied by low-tussock grassland, which, admixed with mat herbage, is also the main formation of the alpine zone. A marsh vegetation occupies the shallow valley-bottoms throughout the sub-alpine and alpine regions. These three types of vegetation will be discussed in detail in the subsequent portion of the paper.

The lists of plants from this area, published by Maiden (1898-99) and Helms (1896-97) proved of great value to the writers in their identification work, but did not furnish an analysis of the communities of the plateau, which is attempted in this paper.

Meteorological Data.

The following information dealing with the distribution of snow falls throughout the season, the mean monthly humidity and the absolute maximum and minimum temperatures, has been kindly supplied to us by Mr. D. J. Mares, Divisional Meteorologist of the Commonwealth of Australia.

The greatest mean monthly humidity occurs during the winter months from about May to September, during which period considerable snow or rain falls, and heavy frosts are frequent.

The absolute maximum temperature so far recorded is 88° on the 9th November, 1919. The mean monthly humidity is lowest during the summer months.

The lowest absolute minimum temperature for any month occurred on the 15th August, 1920, and other very low temperatures during 1919 in the months July to September of the same and the following years, that is just subsequent to the devastating fires which swept over the plateau and destroyed great areas of the *Poa-Celmisia* and *Eucalyptus coriacea-E. Gunnii* associations, and the *E. stellulata* consociation. Perhaps the severity of the climate during such periods has been responsible for the tardy renaissance of the *Eucalyptus* forests and for the killing of areas near the highest portion of the tree-line.

Low temperatures and severe frosts during certain winters if followed by droughty conditions during the summers, retard the development of buds, and flowering and fruiting, and may temporarily destroy the more exposed parts of the *Poa* and *Eucalyptus* associations.

Commonwealth Meteorology.

Mt. Kosciusko.—Table I.

Mean Monthly Humidity 9 a.m. (14 years).

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
56%	60%	62%	65%	69%	79%	84%	79%	70%	60%	55%	58%

Absolute Maximum Temperature, 1911-24 (Fahrenheit).

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
84·0 30th 1912	85·0 15th 1919	77·0 5th 1924	71·0 4th 1911	67·0 2nd 1922	56·0 7th 1919 4th 1923	52·2 25th 1916	57·1 27th 1914	78·0 26th 1922	78·0 10th 1922 29th 1924	88·0 9th 1919	78·0 9th 10th 1918 1st 1924

Absolute Minimum Temperature, 1911-24.

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
21·0 27th 1919	24·9 5th 1917	19·8 24th 1917	15·0 27th 28th 1911	12·0 28th 1913	11·0 22nd 1917	7·0 16th 1919	6·8 15th 1920	14·0 8th 1919	16·0 22nd 1918	13·0 4th 1911	20·0 3rd 1924

MT. KOSCIUSKO.—TABLE II.

Days of Snow.

Jan. 1924	Feb. 1924	Mar. 1924	April 1924	May 1924	June 1924	July 1924	Aug. 1924	Sept. 1924	Oct. 1924	Nov. 1924	Dec. 1924
—*	1	—	2	2	3†	4	3‡	7	—	—	—

* Snow still abundant round summit of Mt. Kosciusko.
† Frosts more severe and sustained than for several years.
‡ Rarity remarkable. Frosts severe.

Jan. 1923	Feb. 1923	Mar. 1923	April 1923	May 1923	June 1923	July 1923	Aug. 1923	Sept. 1923	Oct. 1923	Nov. 1923	Dec. 1923
1	—	—	—	4	5	8*	2	5	1	—	—

* So much snow over such an extended area not seen since 1914.

Jan. 1922	Feb. 1922	Mar. 1922	April 1922	May 1922	June 1922	July 1922	Aug. 1922	Sept. 1922	Oct. 1922	Nov. 1922	Dec. 1922
—	—	1	1	2	11	6	11	6	4	—	—

Jan. 1921	Feb. 1921	Mar. 1921	April 1921	May 1921	June 1921	July 1921	Aug. 1921	Sept. 1921	Oct. 1921	Nov. 1921	Dec. 1921
—	—	—	—	2	3*	5†	9	1	2	—	—

* Season mild. Very little snow below 6,000 feet level.
† More rain than snow.

THE EUCALYPTUS FORESTS.

In the region under study there is only one association of *Eucalyptus* forest, namely, the *Eucalyptus coriacea-E. Gunnii* association, which extends from the foot of the Snowy Mountains on the edge of the Monaro Plains up to the tree-line.

It occurs also on the exposed wind-swept Monaro Plains themselves, from which the Snowy Mountains rise.

The following three consociations occur:

1. The *Eucalyptus coriacea* consociation, which is typical of the sub-alpine zone, and is found chiefly from about 4,500 feet to the tree-line between 6,100 and 6,500 feet, although it occurs also at lower altitudes.

2. The *Eucalyptus Gunnii* consociation which is found chiefly between 3,500 and 5,000 feet, and generally prefers the more sheltered slopes characteristic of the montane region.

3. The *Eucalyptus stellulata* consociation which occupies small areas between the altitudes of 4,000 and 5,000 feet.

THE EUCALYPTUS CORIACEA CONSOCIATION.

Habitat.

While the main adaptive feature of *Eucalyptus* forest is xerophily, the *Eucalyptus coriacea* consociation has fitted itself also for existence amid the

severities of a sub-alpine climate, and is the only forest which has ascended above an altitude of 5,000 feet in Australia. The same community occurs on the Monaro Plains, at an altitude of 2,700 to 4,000 feet, where it is exposed to bleak and desiccating winds from the west. *Eucalyptus coriacea* has also been recorded from other mountain tops in New South Wales, where it is found in similar habitats.

So far as the Snowy Mountains are concerned, the *Eucalyptus coriacea* consociation is found chiefly from about 4,500 to 5,000 feet up to 6,500 feet, which is the absolute limit of tree vegetation. It probably occurs, however, at a much lower altitude than 4,500 feet on the western slopes of the mountains owing to exposure to west and north-west winds. Above 5,000 feet the forest is confined to the upper and middle portions of the slopes of the hills, giving place below to grassland (Plate xi, figs. 1 and 2; Plate xii, fig. 3). All flat and gently sloping ground above this altitude is extremely damp, or even water-logged, owing to the drainage from the melting snow on the upper slopes, combined with the impervious nature of the granite substratum. The restricted distribution of the *Eucalyptus* forest which avoids all swampy areas is probably the result of the water-logging and consequent lack of aeration of the lower strata of the soil. Near the tree-line the forest is still further limited on account of the greater amount of snow, and the trees are confined to the drier ridges (Plate xvi, fig. 4).

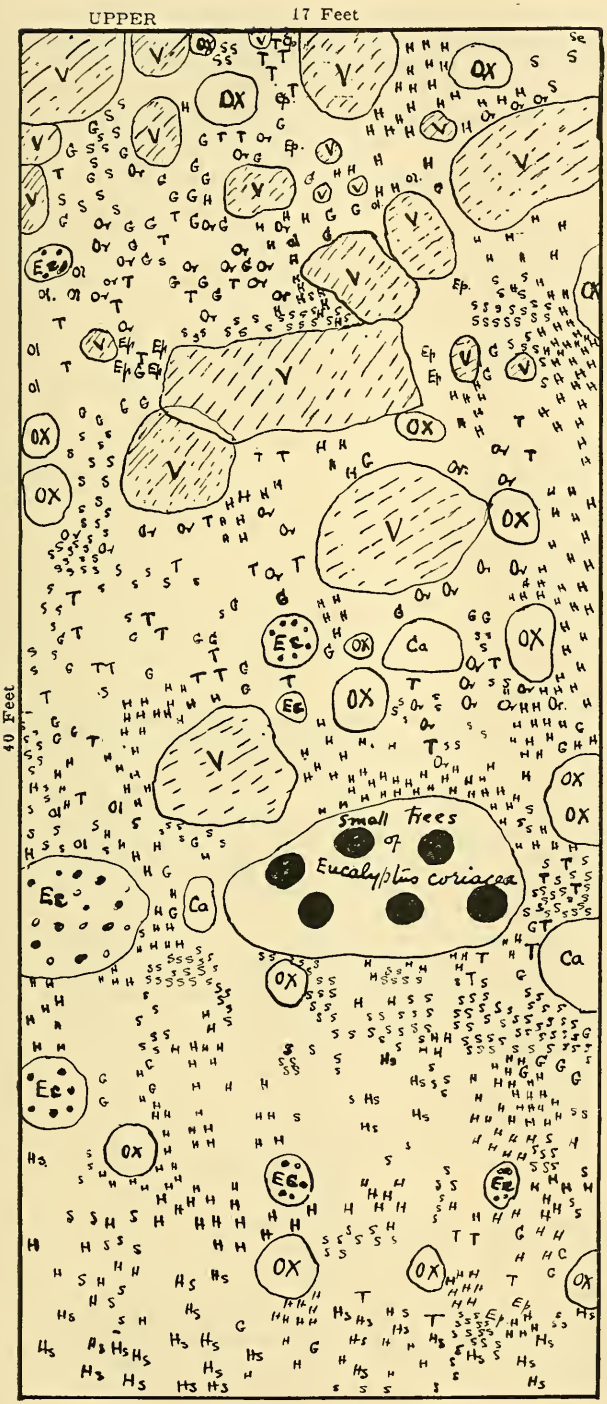
Structure and Physiognomy.

Eucalyptus coriacea is not only dominant, but is the only tree in the consociation at the higher altitudes; it has a distinctive appearance imparted by its smooth white bark, gnarled branches, excessively glaucous twigs, and thick coriaceous leaves. At an altitude of about 5,000 feet, in less exposed areas, *Eucalyptus coriacea* attains a height of about fifty feet and forms an extensive and fairly close forest (Plate xi, fig. 1); at higher altitudes, however, and on the hill-tops above 5,000 feet, the trees become stunted and the forest is more open (Plate xii, fig. 3); while near the tree-line they are rarely taller than twelve to fifteen feet, and often their gnarled branches and trunks are almost prostrate (Plate xvi, fig. 4). This condition is no doubt the result of the heavy snow-falls and frosts during several months of the year and the stimulation of excessive transpiration by strong winds, which are frequent at these altitudes.

While *Eucalyptus coriacea* forms a pure consociation at the higher altitudes, *E. stellulata* becomes frequent at 5,000 feet, as will be described subsequently. *E. Gunnii* is occasional at 5,000 feet, and also becomes abundant in Digger's Creek valley, where an extensive ecotone region exists between the *E. coriacea* and *E. Gunnii* consociations. *E. viminalis* is also occasional in this ecotone region; since, however, the lower strata are highly typical of the *E. Gunnii* consociation, neither this species nor *E. viminalis* can be considered typical of the *E. coriacea* forest.

Shrubs form a conspicuous element in the *Eucalyptus* forests of certain slopes, occurring in dense societies composed chiefly of a dominant species, or else scattered and mixed in composition. In more exposed areas, *e.g.*, on the top of the ridges, shrubs are absent, and the ground is occupied by *Poa caespitosa*, forming low tussocks, and by other grasses and herbaceous types, which also occupy the ground between the shrubs when they are so scattered as to permit of the development of lower strata.

Between 5,000 and 5,500 feet societies of *Oxylobium ellipticum* var. *alpinum* are common, containing as subordinates *Pimelea ligustrina*, *Drimys aromatica* var. *pedunculata*, *Cassinia aculeata*, *Olearia myrsinoides*, *Pimelea axiflora* and *Veronica Derwentia*.



Text-figure 2. Chart of an area in an open *Eucalyptus coriacea* forest (5,500 ft.).

This chart illustrates the vegetation on a typical slope. The lower end of this chart is within a few feet of a small creek traversing the hill-side.

As the water is approached certain types such as *Oreomyrrhis andicola* and *Veronica* disappear, while species of *Helichrysum* become more abundant.

Veronica is always abundant on the slopes of the water courses, while *Oxylobium ellipticum* prefers the drier hill-sides more remote from the streams.

V - *Veronica Derwentia.*

Ox - *Oxylobium ellipticum.*

S - *Stellarium pungens.*

H - *Helichrysum bracteatum.*

G - *Geranium dissectum.*

T - *Taraxacum* sp.

Or - *Oreomyrrhis andicola.*

Hs - *Helichrysum scorpioides.*

Ep - *Epilobium glabellum.*

Se - *Senecio pectinatus.*

Ol - *Olearia myrsinoides.*

Ec - *Eucalyptus coriacea*, seedlings.

Ca - *Cassinia aculeata.*

All space between symbols is occupied by *Poa caespitosa* forming a close grassy covering with occasional tussocks and withered patches. An attempt has been made to convey an impression of the relative proportion of the area that is occupied by each component.
Scale: 1 cm. = 2 feet.

The *Oxylobium* society is replaced by one dominated by *Callistemon Sieberi* in the little watercourses which frequently run down the slopes to the creeks and swampy areas invariably occupying the flat bottoms of the shallow valleys. This society is closely related to the *Callistemon Sieberi* consociation of the marsh vegetation, and contains a number of swamp-loving types not found elsewhere in the *Eucalyptus* forests.

Floristic Composition.

Shrub Stratum	
Callistemon Sieberi D.C.	d*
Cassinia aculeata R.Br.	f
Oxylobium ellipticum R.Br., var. *alpinum* Maiden and Betche	o-f
Drimys aromatica F.v.M., var. *pedunculata* Maiden	o
Panax sambucifolius Sieb.	r
Leptospermum lanigerum Sm.	lf
Ground Stratum	
Richea Gunnii For.	f
Acaena sanguisorba Vahl.	f
Anagallis arvensis Linn.	f
Epilobium glabellum Forst.	o
Rumex acetosella Linn.	o
Taraxacum dens-leonis Desf.	o
Stylidium graminifolium Swartz.	o
Linum marginale Cunn.	o
Blechnum penna-marina (Poir.) Kuhn	o
Galium umbrosum Sol.	o
Sphagnum societies	o
Prostanthera cuneata Benth.	r
Epacris paludosa R.Br.	lo

Veronica Derwentia also forms dense societies (Text-fig. 2), especially in more open areas, with *Olearia megalophylla* (f), *Drimys* (f), and *Oxylobium ellipticum* var. *alpinum* (o) (Plate xiii, fig. 2).

Above 5,500 feet these societies are not so frequent, their place being taken by *Prostanthera cuneata*, which forms abundant societies up to and beyond the tree-line (Plate xvi, fig. 4; Plate xix, fig. 2). *Phebalium ovatifolium* is a frequent subordinate in this society. Elsewhere the shrubs are mixed or absent, *Helichrysum baccharoides* and *H. rosmarinifolium* being conspicuous.

On the tops of the ridges, and between the shrubs where they are less dense, *Poa caespitosa*, with its many herbaceous subordinates, forms a close covering. At the foot of the slopes and at the tree-line this stratum-society passes out unchanged beyond the trees, and assumes the rank of an association, a feature which will be referred to again subsequently (Plate xii, fig. 3).

Floristic Composition.

Tree Stratum.	
Eucalyptus coriacea Cunn.	d
E. stellulata Sieb.	f (up to 5,000 ft.)—o (to 5,500 ft.)
E. Gunnii Hook.	o (to 5,000 ft.)
Tall-Shrub Stratum.	
Helichrysum rosmarinifolium Less.	f-c (above 5,500 ft.)
Drimys aromatica F.v.M. var. *pedunculata* Maiden	f-la
Cassinia aculeata R.Br.	f-la
Veronica Derwentia Littlej.	f-la

* In these lists, a = abundant, c = common, d = dominant, f = frequent, l = locally, o = occasional, r = rare, sd = subdominant, vr = very rare.

Tall-Shrub Stratum.	
Hovea longifolia R.Br.	f (5,500 ft. upwards)
Oxylobium ellipticum R.Br. var. *alpinum* Maiden and Betche	o-a (5,200-6,000 ft.)
Bossiaea foliosa Cunn.	o-la
Olearia myrsinoides F.v.M.	o-lc
Helichrysum baccharoides F.v.M.	o-lc
Olearia megalophylla F.v.M.	o-lf-lc
Pimelea ligustrina Labill. var. *hypericina* Benth.	o-f
Phebalium ovatifolium F.v.M.	o-f (above 5,600 ft.)
Pimelea axiflora F.v.M.	o
Rubus rosifolius Sm.	o
Orites lancifolia F.v.M.	o (near tree-line)
Grevillea australis R.Br.	o (at tree-line)
Hakea Macreana F.v.M.	r
Lissanthe montana R.Br.	r
Acacia alpina F.v.M.	r
Panax sambucifolius Sieb.	vr (below 5,100 ft.)
Prostanthera cuneata Benth.	vr (5,300 ft.)—a (6,000 ft.)
Leptospermum lanigerum Sm.	lf
Callistemon Sieberi D.C.	lf (5,000 ft.)
Low-Shrub Stratum.	
Hibbertia linearis R.Br. var. *obtusifolia* Benth.	o (below 5,000 ft.)
Ground Stratum.	
Poa caespitosa Forst.	a-lo
Taraxacum dens-leonis Desf.	f-a
Trifolium sp.	f-a
Rumex acetosella Linn.	f-la
Helichrysum scorpioides Labill.	f-c
Geranium dissectum Linn.	f
Ranunculus lappaceus Sm.	f
Plantago varia R.Br.	f
Senecio lautus Sol.	f
Wahlenbergia gracilis D.C.	f
Acaena sanguisorbae Vahl.	o-a
Stellaria pungens Brongn.	o-a
Brachycome scapiformis D.C.	o-a
Craspedia Richea Cass.	o-a
Podolepis longipedata Cunn.	o-la
Stylidium graminifolium Swartz.	o-f
Epilobium glabellum Forst.	o
Viola betonicifolia Sm.	o
Scaevola Hookeri F.v.M. societies.	o
Comesperma retusum Labill.	o (5,000 ft.)
Brachycome decipiens Hook.	o
Poranthera microphylla Brongn.	o
Polystichum aculeatum (L.) Schott.	o (under rocks)
Kunzea Muelleri Benth.	o
Celmisia longifolia Cass.	o-f (above 5,200 ft.)
Stellaria flaccida Hook.	o
Oreomyrrhis andicola Endl.	o
Euphrasia Brownii F.v.M.	o
Helichrysum bracteatum Willd.	o
Blechnum penna-marina (Poir.) Kuhn.	r
Galium umbrosum Sol.	r
Linum marginale Cunn.	r
Dianella tasmanica Hook.	r
Podocarpus alpina R.Br. societies	r (above 5,600 ft.)
Asplenium flabellifolium Cav.	vr (5,000 ft. downwards)
Chiloglottis Gunnii Lindl.	lc
Pterostylis mutica R.Br.	lf
Richea Gunnii For.	lo
Sphagnum societies	lo
Anagallis arvensis Linn.	lo (5,000 ft.)
Epacris paludosa R.Br.	lo

THE EUCALYPTUS GUNNII CONSOCIATION.

Passing into the sheltered gullies just below 5,000 feet, the *Eucalyptus coriacea* consociation gives place to the *E. Gunnii* consociation, very gradually in Digger's Creek valley, comparatively abruptly in other areas. *E. Gunnii* grows taller than *E. coriacea*, the trees averaging about seventy feet in height. For some distance into this consociation a number of shrubs characteristic of the *E. coriacea* forest persist, but a distinct and continuous change is noticeable as one descends the Plateau, new types appearing and former ones disappearing. *Poa caespitosa* tussocks are much less abundant; although they still form a carpet in certain areas where the soil is damper, a considerable amount of the ground is quite bare of grass or only sparsely covered (Plate xvi, fig. 3). In general this forest has a more xerophilous impress since many of the herbaceous types of the *E. coriacea* consociation are absent, the rich carpet of grass is less evident, and the shrubs have a more scraggy, sclerophyllous appearance; indeed the general physiognomy of the community resembles that of the *E. piperita* forest characteristic of the sandstone plateau at Mount Wilson.

The smaller rainfall which characterizes the lower altitudes of the mountains probably contributes to this feature of the *E. Gunnii* consociation, as also does a change in the topography. We are here below the level of the marshy flats and the continual streams of water from the melting snow; the water is concentrated in the deep gorges of the Snowy River and its tributaries, by means of which the gravitational water passes rapidly away, resulting in a general lowering of the soil moisture-content. Moreover this consociation dominates an area from which the snow disappears early on the approach of summer; there is therefore less soil moisture as compared with the higher zones, and the plant life is dependent directly upon the rainfall for its moisture requirements throughout the summer months. The extremely xerophilous structure of the plants inhabiting this zone indicates an approximation to the conditions which have stimulated the development of the highly xerophytic sclerophyllous forest on the Hawkesbury Sandstone habitat around Sydney.

Floristic Composition.

Tree Stratum.	
Eucalyptus Gunnii Hook.	d
E. viminalis Labill.	o-c
E. coriacea Cunn.	o-f
E. stellulata Sieb.	o
E. amygdalina Labill. var. *nitida* Benth.	r-o
Low-Tree Stratum.	
Acacia rubida Cunn.	o
Shrub Stratum.	
Oxylobium ellipticum R.Br. var. *alpinum* Maiden and Betche	f-la
Bossiaea foliosa Cunn.	f-la
Daviesia ulicina Sm.	f
Leptospermum stellatum Cav.	o-c
Cassinia aculeata R.Br.	o-f
Baeckea Gunniana Schau.	o-f
Grevillea lanigera Cunn.	o
Lomatia longifolia R.Br.	o
Acacia penninervis Sieb.	o
Rubus parvifolius Linn.	o
Panax sambucifolius Sieb.	o
Daviesia corymbosa Sm.	r

Low-Shrub Stratum.	
Discaria australis Hook.	o
Grass Stratum.	
Poa caespitosa Forst.	c-o
Wahlenbergia gracilis D.C.	f-c
Stellaria pungens Brongn.	f-c
Taraxacum dens-leonis Desf.	f-c
Hibbertia linearis R.Br. var. *obtusifolia* Benth.	f-c
Helichrysum semipapposum D.C.	f-c
Geranium dissectum Linn.	f-la
Rumex acetosella Linn.	f
Brachycome scapiformis D.C.	f
Plantago varia R.Br.	f
Epilobium glabellum Forst.	f
Trifolium sp.	f
Velleya paradoxa R.Br.	f
Acaena sanguisorbae Vahl.	f
Prunella vulgaris D.C.	o-la
Xerotes longifolia R.Br.	o-f
Pimelea glauca R.Br.	o-f
Arthropodium paniculatum R.Br.	o
Persoonia chamaepeuce Lhotsky	o
Stylidium graminifolium Swartz.	o
Galium umbrosum Sol.	o
Lotus australis Andr.	o
Lotus corniculatus Linn.	o
Helichrysum scorpioides Labill.	o
Pterostylis coccinea Fitzg.	vr
Bulbine bulbosa Haw.	vr
Erythraea australis R.Br.	la

THE EUCALYPTUS CORIACEA—E. GUNNII ECOTONE AND THE E. STELLULATA CONSOCIATION.

As has been mentioned earlier, the slopes of Digger's Creek valley (4,000-5,000 feet) are clothed by a forest which represents an ecotone between the *E. coriacea* and *E. Gunnii* consociations. The continuity of this ecotone is interrupted by the occasional presence of a pure consociation of *E. stellulata*. Where Digger's Creek valley joins the main gorge of the Snowy River (at about 4,000 feet) the ecotone gives place gradually to the *E. Gunnii* consociation. One may suppose that in this region the conditions are intermediate between the exposed habitat yet damp soil occupied by the *E. coriacea* forest on the one hand, and the drier, yet more sheltered environment normally occupied by *E. Gunnii*. The valley is sheltered, and the sides are steep; yet the soil in many parts has still much of the dampness characteristic of the higher altitudes.

We have not up to the present been able to discover definitely the factors leading to the interruption of the ecotone by occasional consociations of *E. stellulata*, but it is possible that a slightly greater degree of exposure may be the key to its presence; nor did we observe any difference in the floristic composition of the two communities.

Floristic Composition.

	Ecotone.	*E. stellulata.*
Tree Stratum.		
Eucalyptus coriacea Cunn.	d	o
E. Gunnii Hook.	a-f	—
E. viminalis Labill.	o	—
E. stellulata Sieb.	o	d
Small-Tree Stratum.		
Acacia neriifolia Cunn.	o in societies	

Shrub Stratum.		
Veronica Derwentia Littlej.	f-a	
Epacris sp.	f	
Pimelea axiflora F.v.M.	f	
Oxylobium ellipticum R.Br. var. *alpinum* Maiden and Betche	f	
Bossiaea foliosa Cunn.	f	
Hymenanthera dentata R.Br.	o-f	
Olearia megalophylla F.v.M.	o	
Hovea longifolia R.Br.	o	
Olearia myrsinoides F.v.M.	o	
Drimys aromatica F.v.M. var. *pedunculata* Maiden	o	
Pimelea ligustrina Labill. var. *hypericina* Benth.	o	
Panax sambucifolius Sieb.	o	
Daviesia ulicina Sm.	o	
Acacia decurrens Willd.	o	
Lomatia longifolia R.Br.	o	
Acacia penninervis Sieb.	o	
Persoonia chamaepeuce Lhotsky	o	
Hibbertia linearis R.Br. var. *obtusifolia* Benth.	o	
Acacia siculiformis Cunn.	o	
Leptospermum stellatum Cav.	o	(in drainage channels)
Leptospermum lanigerum Sm.	o	
Callistemon Sieberi D.C.	o	
Hakea Macreana F.v.M.	o	
Rubus parvifolius Linn.	r-o	
Low-Shrub Stratum.		
Helichrysum semipapposum D.C.	o	
Cassinia aculeata R.Br.	o	
Ground Stratum.		
Stellaria pungens Brongn.	a	
Poa caespitosa Forst.	a	
Acaena sanguisorbae Vahl.	c	
Geranium dissectum Linn.	c	
Trifolium sp.	c	
Wahlenbergia gracilis D.C.	c	
Taraxacum dens-leonis Desf.	f-c	
Galium umbrosum Sol.	f	
Rumex acetosella Linn.	f	
Brachycome scapiformis D.C.	f	
Plantago varia R.Br.	f	
Viola betonicifolia Sm.	f	
Velleya paradoxa R.Br.	f	
Velleya montana Hook.	f	
Helichrysum bracteatum Willd	la-o	
Prunella vulgaris D.C.	o	(below 4,650 ft.)
Podolepis longipedata Cunn.	o	
Oreomyrrhis andicola Endl.	o	
Linum marginale Cunn.	o	
Craspedia Richea Cass.	o	
Stylidium graminifolium Swartz.	o	
Hypericum japonicum Thunb.	o	
Lotus australis Andr.	o	(below 4,400 ft.)
Goodenia hederacea Sm.	o	(below 4,100 ft.)
Poranthera microphylla Brongn.	o	
Xerotes longifolia R.Br.	o	
Helichrysum scorpioides Labill.	o	
Asplenium flabellifolium Cav.	r	(under rocks)
Exocarpus nana Hook.	r	
Arthropodium paniculatum R.Br.	r	
Pterostylis acuminata R.Br.	r	
Dianella sp.	r	
Gastrodia sesamoides R.Br.	vr	

Ground Stratum.		
Stackhousia monogyna Lindl. ?	lf	
Lotus corniculatus Linn.	lf-la	(in damp places)
Epilobium glabellum Forst.	lf-lc	
Juncus pallidus R.Br.	lo	
Lotus australis Andr.	o	

THE LEPTOSPERMUM SHRUB SOCIETY.

Along the banks of the rivers occupying the beds of the valleys whose slopes are clad by the *Eucalyptus Gunnii* consociation or by the *E. coriacea-E. Gunnii* ecotone, occurs a society of shrubs about five to seven feet in height. In the upper part of the ecotone at about 4,600 feet *Leptospermum lanigerum* is the dominant, while, as the beginning of the *E. Gunnii* consociation is approached, *Leptospermum stellatum* becomes co-dominant. (Plate xiv, fig. 2).

The majority of the components of this society appear to be species requiring a moderate degree of shelter and soil-moisture. It is interesting to note also that *Kunzea Muelleri* and *Hakea microcarpa* here attain a height of four to five feet, whereas above the 5,000 feet altitude *Kunzea* is only about six inches high, and *Hakea* one foot. In many cases this society is so dense as to be almost impenetrable and, during periods of flooding of the river, is practically submerged.

Floristic Composition.

Shrub Stratum, 4,650 ft.	
Leptospermum lanigerum Sm.	c-d
Callistemon Sieberi D.C.	f
Daviesia corymbosa Sm.	f
Leptospermum stellatum Cav.	f-d
Cassinia aculeata R.Br.	o
Hakea Macreana F.v.M.	o
Kunzea Muelleri Benth.	o
Hakea microcarpa R.Br.	o
Correa Lawrenciana Hook.	o
Lomatia longifolia R.Br.	r
Ground Stratum.	
Juncus pusillus Buch.	c
Hypolaena lateriflora Benth.	f
Epilobium glabellum Forst.	o
Lotus australis Andr.	o
Lotus corniculatus Linn.	o
Drosera peltata Sm.	o
Oreomyrrhis andicola Endl.	o
Stylidium graminifolium Swartz.	o
Hypericum Japonicum Thunb.	o
Utricularia dichotoma Labill. var. *uniflora* Benth.	r
Juncus pallidus R.Br.	f-a
Creeper.	
Glycine clandestina Wendl.	o

REGENERATION OF THE EUCALYPTUS FORESTS AFTER FIRE.

On account of the high rainfall and general dampness of the ground, bush fires are by no means so prevalent on the Kosciusko Plateau above an altitude of 5,000 feet as in other more arid regions of the State; and at the time of study (1924 and 1925) none had occurred since 1919 in the area under review. The fire which took place in the latter year, however, swept over large areas of the *Eucalyptus coriacea* consociation between 5,000 and 5,500 feet, as well as through a small consociation of *E. stellulata*.

It appears that the *Eucalyptus coriacea* consociation by no means possesses the power of speedy renascence which characterizes *Eucalyptus* forests in other regions. Whereas most *Eucalyptus* forests would have recovered from the fire before the lapse of six years, here we found renascence to be tardy, and sometimes not even to have started. Neither *E. coriacea* nor *E. stellulata* appear readily to produce adventitious shoots from the stem, renascence taking place rather from the root-stock; thus most of the regenerating *E. coriacea* forest showed young shoots rising from the ground surrounding the old dead trunk, and only a few feet high (Plate xviii, fig. 1).

In the more exposed areas no renascence was evident, and it seems that here the severity of the climatic conditions has prevented it. In these areas the dead trees are standing while the normal lower strata of the forest and especially the *Poa* stratum have re-developed. It is likely that regeneration of the forest will be slow, as it will now be chiefly dependent upon migration, followed by a precarious ecesis (Plate xi, fig. 2).

The *Eucalyptus stellulata* consociation regenerates more rapidly, perhaps because of the lower altitude and the consequently greater shelter of its environment; in this case a mass of shrub-like growth surrounded the base of the old trunks, so dense as to cover the ground almost completely.

The regeneration of the lower strata was more advanced, and the burnt areas did not appear to differ appreciably in these strata from those which were unburnt, except that very dense shrub-societies had arisen in places. Where renascence of the trees is slow dense societies of *Veronica Derwentia*, accompanied by *Olearia megalophylla* (f), *Drimys* (f), and *Oxylobium ellipticum* var. *alpinum* (o), are generally characteristic features (Plate xiii, fig. 2). The rapid recovery of these types is no doubt due to their resistant subterranean root-stocks or rhizomes. The *Eucalyptus Gunnii* consociation is subject to more frequent burns and is more akin in its reaction, to the *Eucalyptus piperita* Forest at Mount Wilson.

FACTORS CAUSING OR MODIFYING THE TIMBER-LINE.

In certain more exposed areas on the summits of the hills and on the higher slopes, the tree-trunks in the *Eucalyptus coriacea* consociation appear to have been killed by severe climatic conditions rather than by fire; for although regeneration is taking place as usual from the base of the stem, there is no indication of fire on the trunks, and moreover, these conditions are found only in exposed areas. An analogous phenomenon is seen at altitudes of 6,500 feet, where the stunted *Eucalyptus* forest has migrated during favourable seasons above the normal level of the timber-line, and subsequently, possibly as the result of an unusually severe season, has been entirely destroyed (Plate xvi, fig. 1).

These observations lead us to consider the factors which are effective in controlling the tree-line in this region. Rhydberg (1914) has enumerated some of those which he considered to be important in the case of the Rocky Mountains, and it is of interest to note their significance in the case of the vegetation of the Kosciusko Plateau. The chief of these factors described by Rhydberg are as follows: (1) low temperature during the growing season; (2) shortness of the growing season; (3) late frosts; (4) strong winds; (5) deep snow; (6) form of precipitation; (7) large mountain masses; (8) physiographical barriers.

The timber-line on the Kosciusko Plateau varies from 6,100 feet in exposed habitats to 6,500 feet in sheltered habitats. At these altitudes the forest thins out and the trees are represented by low gnarled and stunted shrubby individuals; the zone, however, between the absolute tree-line (where arboreal species disappear

entirely) and the relative tree-line (where the arboreal species just cease to form forest) is comparatively narrow. Exposure to desiccating westerly and north-westerly winds, very cold in winter and hot in summer, determines the points where the forest suddenly merges into isolated stunted individuals. In other alpine regions of the earth coniferous forests frequently exist above the angiospermic forest, but at Kosciusko the highest arboreal community is that composed of *Eucalyptus coriacea*.

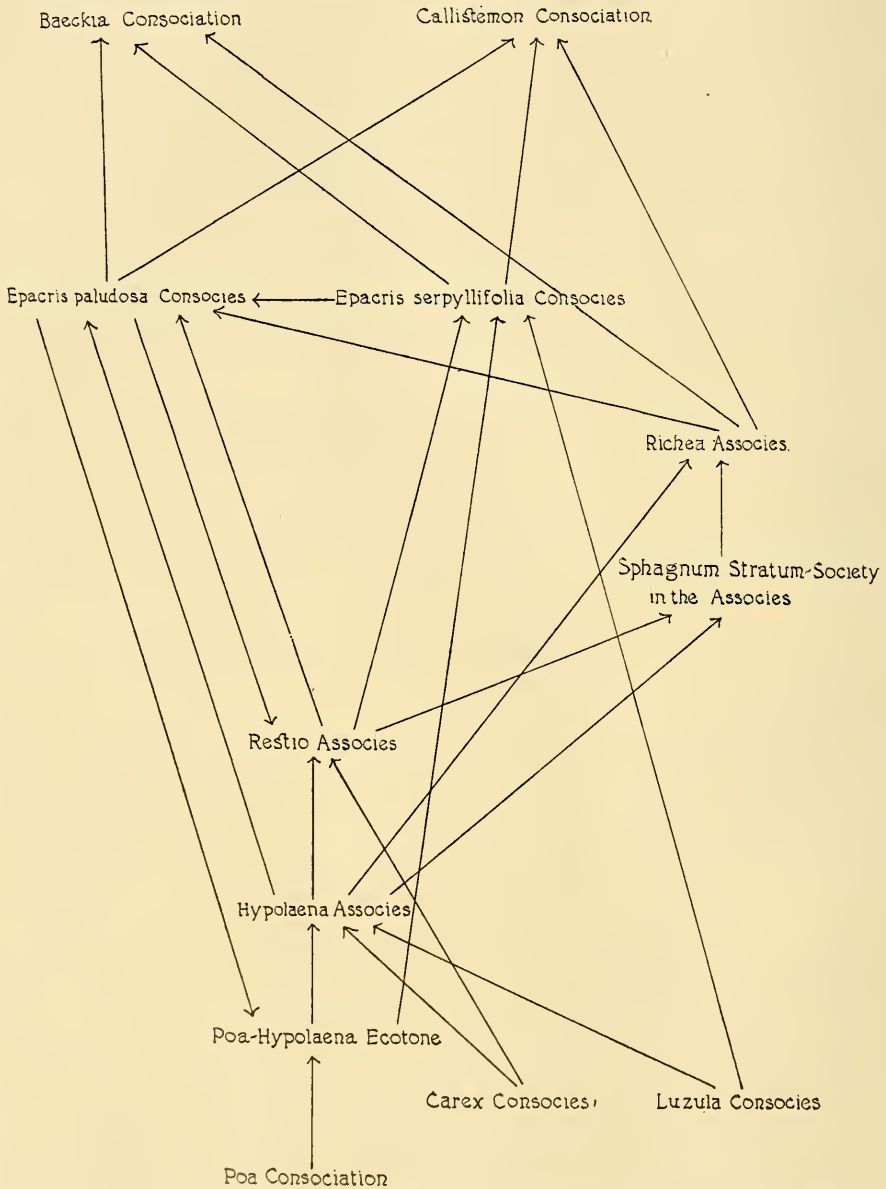
Competition is of considerable importance in connection with the effect of the various climatic factors on the tree-line; the transition zone is undoubtedly a scene of constant struggle between the grassland and the scanty forest. In good seasons seeds of *Eucalyptus coriacea* germinate and develop in the true grassland areas, and if they survive, the grassland community becomes reduced to the status of a subordinate stratum. No doubt this tree after difficult ecesis tends to carry the forest upwards in this manner, but unfavourable seasons, when snow lies late in summer as it occasionally does, and late frosts followed by a dry summer, cause many of the trees to die down, perhaps for good, or perhaps till renascence sets in; the grassland types then for the time resume their dominance, probably to be subordinated again and again during long periods of slow oscillation. Throughout the whole of this district, the higher forest tracts show abundant evidence of the struggle against the grassland types.

The lowering of the temperature during the growing season (from November to March), the first of Rhydberg's factors, has an intermittent effect which probably influences ecesis of the forest trees in their own or the grassland zone. The shortness of the season, however, is more important in the Kosciusko district; but both factors are closely related, for the prevalence of a low temperature during the growing season as the result of late snow-falls or frosts, must inevitably curtail the season for growth. Late snows are common in this area; in some years very heavy falls take place in September, and lie long, water-logging the soil in certain places and delaying the germination and growth not only of herbaceous but also of arboreal types. In such seasons the small alpine and sub-alpine herbs are several weeks later in flowering as compared with other seasons which have no late snow-falls.

Strong wind in winter, especially during frosty periods, appears to be the most important factor affecting the higher forest on the Snowy Mountains. Along the upper limit of the forest, and where it passes into isolated groves or individuals, the trees show the effect of wind by their gnarled, stunted, irregular, often prostrate habit, and their frequently unilateral growth (Plate xix, fig. 2). This peculiar and characteristic growth-form is probably due as much to the desiccating effect of wind, by increasing transpiration from the youngest parts, as to its mechanical action. This wind action prohibits the forest development above 6,100 feet on exposed slopes and peaks, while on the leeward slopes, as has previously been mentioned, the forest ascends to approximately 6,500 feet. The valley-heads and erosion channels on the leeward side, however, are devoid of the forest which occurs on the slopes, as has been described; this is no doubt due to the persistence of the deep snow drifts in such positions, and the smothering of the root-systems while the aerial organs are exposed to strong insolation and high transpiration. This feature has been observed also by Rhydberg in the Rocky Mountains.

The significance of the amount of rainfall during the growing season is by no means certain. On account of the high rainfall and low temperatures generally associated with montane zones—to which the Snowy Mountains are no exception—trees normally occurring in such habitats are usually found to have relatively high

moisture requirements and low temperature requirements (Pearson, 1920); and it is noteworthy that the *Eucalyptus coriacea* forest maintains its optimum development between about 4,500 and 5,600 feet, which is the zone of greatest rainfall. Yet at the same time, although it may be that *E. coriacea* has low temperature requirements, and that this factor causes it to replace the *E. Gunnii* forest at



Text-figure 3. Illustrating the succession in the shallow valleys above 5,000 feet. *Baeckia* should be spelt *Baeckea*.

4,500 feet, its occurrence in exposed habitats near Goulburn, near Clarence, and on the Monaro Plains, regions with a rainfall probably often bordering on 20 inches per annum during some months of the year, suggests that it is an extreme xerophyte, more especially as the soil in these regions is dry and generally of low moisture-retaining power. It is improbable that *E. Gunnii* or *E. stellulata* have lower moisture requirements, while our observations on *E. viminalis* in other localities seem to indicate that this has a moisture requirement somewhat higher than most species of *Eucalyptus*. So far as the upper limit of the distribution of *Eucalyptus coriacea* is concerned, however, it may be that the rainfall is of importance, since it is to be expected that in the alpine region the effective rainfall is low during the summer, the precipitation being mainly of the nature of light showers which, while sufficing for the grassland vegetation, do not penetrate deep enough to reach the roots of trees.

The Marsh Vegetation.

In the flat, water-logged floors of the shallow valleys above an altitude of 5,000 feet, the *Poa* association, which occupies the lower portions of the slopes, gives place to reed- and bush-swamp. This vegetation is exceedingly complex in structure, comprising a large number of communities, all of which seem to be in successional relation. The causes of this succession appear to be somewhat obscure, and require detailed investigation. We have endeavoured in the present paper, however, to characterize the communities and to indicate, to the extent of our observations, the main lines along which succession seems to take place. No doubt the amount, nature and distribution of the precipitation from year to year and factors which modify the drainage system temporarily or permanently, influence this vegetation materially.

The accompanying diagram (Text-fig. 3) will help to elucidate the remarks which are made upon succession in the following detailed consideration of the communities of this habitat.

Our present investigations indicate that there is little material physiognomic or floristic variation in the communities of the marsh vegetation throughout the extent of their range, from 5,000 to about 6,500 feet, with the exception of the *Richea* and *Restio* associes, which extend in a modified form to 7,000 feet.

The Poa-Hypolaena Ecotone.

Where the *Poa* association of the lower parts of the slopes encroaches upon the damp soil of the valley bottom it forms an ecotone in which it is mixed with *Hypolaena lateriflora*, the dominant of the community which seems to be one of the early stages in the development of the swamp flora. *Hypolaena* is a reed-like plant about six inches in height, and grows densely between the tussocks of *Poa*.

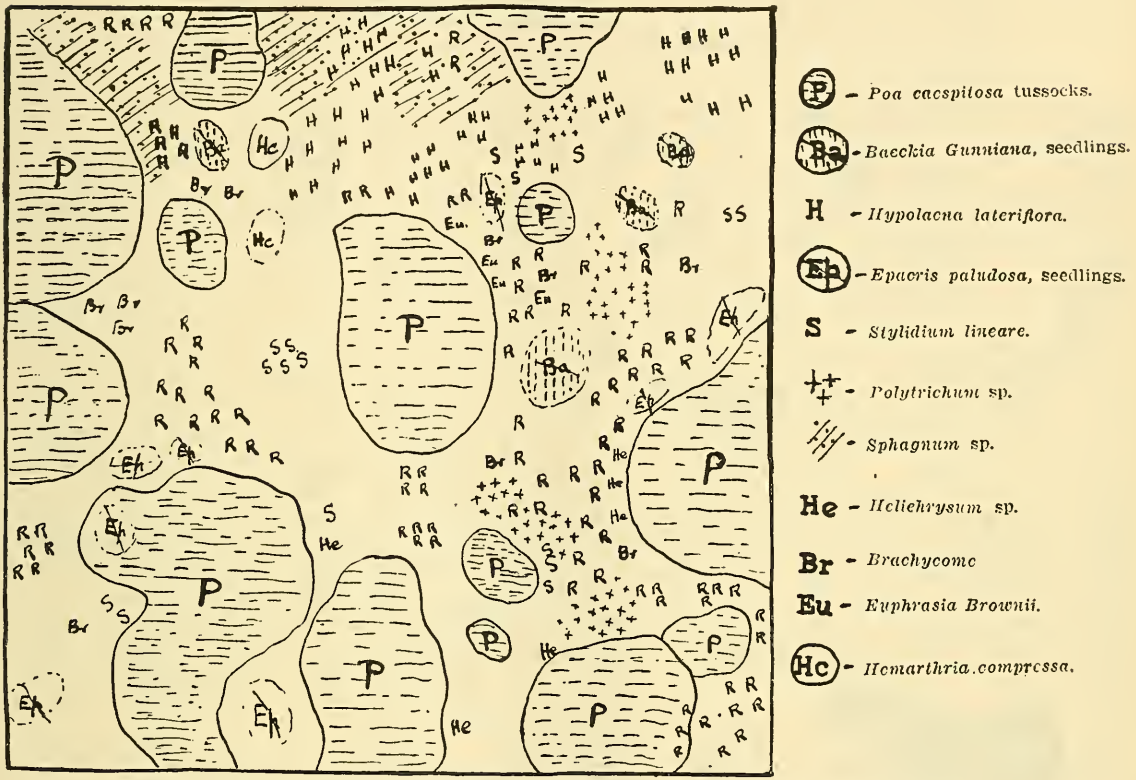
Reference to the accompanying statement of the floristic composition shows that a large number of the subordinates of the *Poa* consociation are absent from the ecotone; these are apparently more suited to the drier soil, although in the case of *Stellaria pungens*, which favours the damp erosion channels higher up the slopes, it is possible that lack of drainage is an inhibiting factor. It will also be observed that, in the case of a number of the components of the *Poa* consociation, the frequency decreases on passing into the ecotone, which represents the limit of their range; and in the same manner in this region first appear a number of the subordinates of the *Hypolaena* associes, such as *Oreomyrrhis andicola*. Certain types occurring in the *Poa* consociation, *e.g. Prasophyllum fuscum*, appear to find a more favourable habitat in the ecotone, and their frequency increases. The

Poa — *Poa caespitosa* tussocks.
H — *Hypolaena lateriflora.*
L — *Lotus australis.*
Lc — *Luzula campestris.*
R — *Richea Gunnii.*
D — *Drosera peltata.*
— *Polytrichum* sp.
Hc — *Hemarthria compressa.*
Cs — *Callistemon Sieberi.*
Eu — *Euphrasia Brownii.*
Cr — *Comesperma retusum.*
Es — *Epacris serpyllifolia.*
CR — *Craspedia Richei.*
O — *Olearia* sp.
— *Restio australis.*
Br — *Brachycome* sp.
B — *Baeckia.*
S — *Stylidium lineare.*
— *Sphagnum* sp.

Text-figure 4. Quadrat 4 sq. metres of the *Poa-Hypolaena* ecotone, nearest the marsh communities. The spaces between the tussocks of *Poa caespitosa* are either bare, or occupied by typically moisture-loving types, *e.g. Hypolaena, Drosera, Polytrichum, Richea* and *Luzula.*

Correct spelling should be *Craspedia Richea* and *Baeckea.*

tussocks of *Poa* are less continuous in the ecotone than in the *Poa* consociation, the drainage channels between them which are occupied by *Hypolaena* and the subordinates, being much wider (Text-figs. 4, 5).



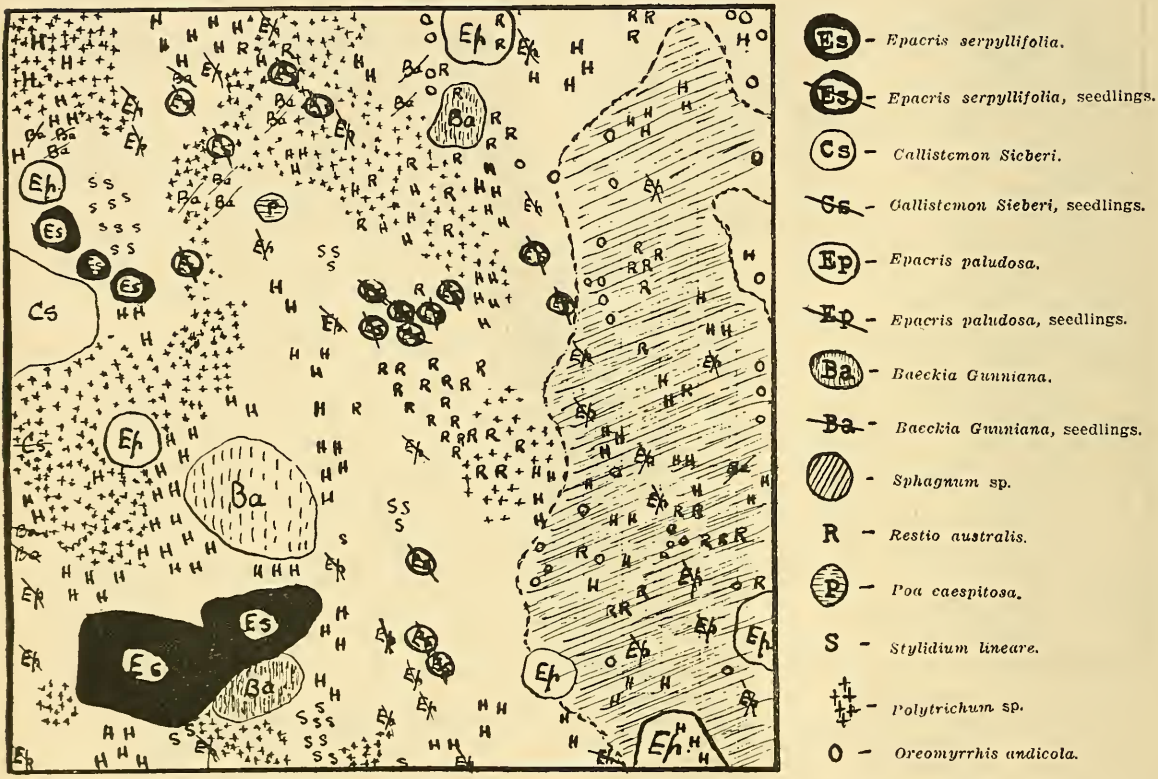
Text-figure 5. Quadrat of the *Poa* ecotone 1 m. square. The spaces between the *Poa* tussocks are drainage channels. The presence of *Restio, Hypolaena, Epacris* and *Baeckea* suggests the developmental nature of the community, while in addition the mosses represent types not present in the *Poa* consociation. The *Restio* associes (R) is developing somewhat precociously on the right at the bottom.

Generally speaking this ecotone occupies the transitional habitat between that of the *Poa* and that of the *Hypolaena* community. It may arise also, however, as a result of a definite succession; local alterations in the drainage frequently lead to increase in the soil-moisture-content of areas occupied by *Poa*, leading to invasion by *Hypolaena*; as a consequence the same mixed community is found as occurs in the ecotone, although here it possesses rather the character of a *mictium* (Clements, 1916, p. 140).

THE HYPOLAENA ASSOCIES. (Text-fig. 6.)

As the water-table reaches the surface of the soil, on passing from the *Poa-Hypolaena* ecotone towards the centre of the marsh, the *Poa* disappears, yielding the dominance to *Hypolaena*. This species forms a kind of uniform basal

stratum throughout all the communities of the marsh; and where it is not intermingled with taller types it constitutes a distinct community. All stages of abundance of these taller types may be found, especially in the case of *Restio australis*; sometimes their distribution is so open that they rank merely as subordinates in the *Hypolaena* associes although taller than the dominant, from which condition they pass to being dominants themselves when in more close formation.



Text-figure 6. Quadrat 1 m. square of the *Hypolaena* associes, showing development of the *Restio* in the centre. A typical *Sphagnum* patch is seen on the right, while the numerous *Epacris* seedlings indicate that further development is taking place.

Observations seem to indicate that *Restio* appears in flat areas where the content of gravitational water is higher than it is normally in the *Hypolaena* associes, and becomes more prolific with increased water supply. We suggest, therefore, that the accumulation of water in parts, owing to the defective drainage from the great quantities of melting snow on flat ground such as the valley bottoms, causes *Restio* to spring up among the *Hypolaena* and to form a new community.

Isolated societies of *Sphagnum* occur in the *Hypolaena* associes; in these the normal subordinates of the associes, except *Oreomyrrhis andicola*, are often less abundant, and occasionally *Hypolaena* alone remains. In some of the larger

Sphagnum societies numerous seedlings of the epacrid *Richea Gunnii* appear, and, since this type when found mature is usually growing in a dense cushion on old *Sphagnum* beds, it is thought probable that the establishment of *Sphagnum* in the *Hypolaena* associes paves the way for the development of a new community dominated by *Richea*.

In somewhat drier areas than that in which the above succession takes place, the *Hypolaena* associes contains numbers of seedlings, often exceedingly small, of *Epacris serpyllifolia* or of *E. paludosa*. There is no doubt but that this is evidence of another succession taking place from *Hypolaena* to the *Epacris* associes; and it is this evidence in particular, which clearly establishes the seral nature of the *Hypolaena* associes. In the earlier stages of the developing *Epacris* associes, *E. serpyllifolia* seems often more abundant, with only occasional seedlings of *E. paludosa*, although more rarely a pure developing consocies of the latter is found; in the older stages, however, only the *E. paludosa* consocies was seen, although there is every reason to believe that the *Hypolaena* associes must be capable of giving rise to both the *Epacris* communities. It must be added at the same time that there is undoubted evidence in places that the *Epacris serpyllifolia* consocies gives place to the *E. paludosa* consocies, the dominant of the later community being a larger shrub; and it certainly seems in many cases that a telescoping of this succession takes place in the developing *Epacris* associes, so that the originally abundant seedlings of *E. serpyllifolia* subsequently give place to an invasion of seedlings of *E. paludosa*, which is perhaps a more vigorous type. A more probable explanation is that *E. serpyllifolia* is better adapted to establish itself first in the *Hypolaena* and that *E. paludosa* has to await further changes in the conditions before it can colonize the habitat, after which it readily assumes dominance on account of its larger size.

It thus appears that the *Hypolaena* associes is a synthetic seral community, which, collaterally with habitat changes in different directions, develops along various lines.

THE RESTIO ASSOCIES.

Restio australis, which we have already referred to as dominating a community developing in all probability from the *Hypolaena* associes, is a restiaceous plant from one foot to eighteen inches high, growing densely and often occupying large areas (Plate xii, fig. 2). The subordinates of the *Restio* associes will be seen from the accompanying table to be much the same as in the *Hypolaena* associes, and *Hypolaena* itself forms an almost constantly present lower stratum. *Restio*, however, occurs often with no subordinates as a pure society in little flat water-holes so characteristic of the sub-alpine and montane marshy areas.

Sphagnum societies are occasional, in which communities most subordinates except *Hypolaena* are absent; and judging by analogy with the previously recorded observations in the *Hypolaena* associes, it is possible that these societies may lead to the development of the *Richea* associes.

Seedlings of *Epacris serpyllifolia* and *E. paludosa* are abundant in places, so that there appears reason to believe that when these have attained maturity the *Restio* associes will have developed to a further stage in the sere dominated by *Epacris*.

A large area of the *Restio* associes was observed where dead white gnarled stems of *Epacris* indicated that this plant had previously made fair headway and subsequently died out. Apparently its disappearance was followed by the estab-

lishment of the previous stage of the sere, *viz.*, the *Restio* associes, suggesting that a reversal of the changes in the habitat was the factor leading to the destruction of the *Epacris*.

THE RICHEA ASSOCIES.

Richea Gunnii is a megaphyllous, unbranched or sparsely branched epacrid, growing in dense clumps, usually on old *Sphagnum* beds (Plate xiii, fig. 1). The habit of *Sphagnum* of forming mounds is well known, and *Richea* appears to find its most favourable environment on these, sending long shoots upwards through the *Sphagnum*; by this means the clumps of *Richea* reach a height of two or three feet, although the normal height of the plant under ordinary conditions is usually only about one foot.

Richea grows so densely and in such a sodden substratum, that it ordinarily has few subordinates. It seems, however, to consolidate the *Sphagnum* beds, and, as the water in the soil gradually finds drainage channels by which to pass away, other types are able to come in. The first to appear is *Restio*, after which comes *Hypolaena*, suggestive of reversion of the sere owing to reversion of the habitat changes. *Hypolaena* grows up through the *Richea* on long attenuated stalks, in order to reach air and light, so that, although the plant is normally only about six inches high this ecad attains a length of two or three feet. Where the drainage and consolidation has proceeded further, *Baeckea Gunniana* gains entrance, as also less frequently does *Callistemon Sieberi*. This seems to suggest a possibility of *Richea* giving place to the *Baeckea-Callistemon* association, which is the climax stage in the succession taking place in the swamp flora. Probably one may explain in the same way the rather curious local presence among the *Richea* of *Oxylobium ellipticum* var. *alpinum*, a type which usually inhabits much drier places in the *Eucalyptus* forests.

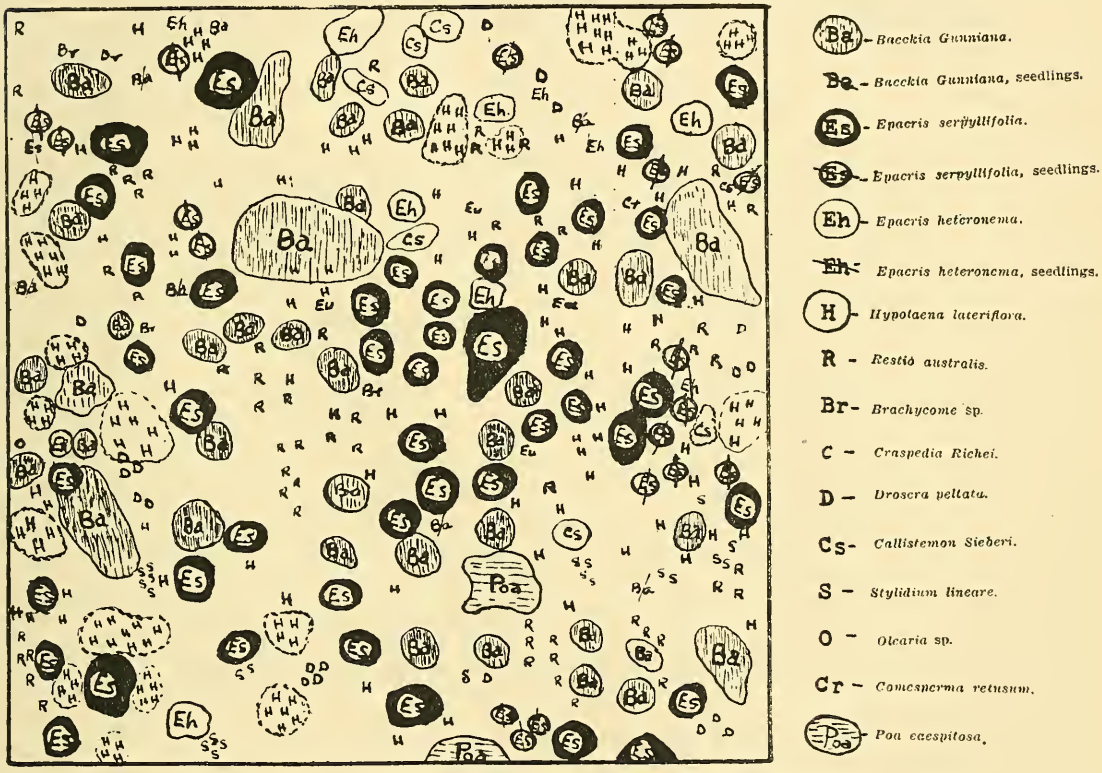
Epacris paludosa also is present in some of the dying clumps of *Richea*, which suggests succession from *Richea* to the *Epacris* associes; this is rendered more probable by the fact that *Epacris* is usually an intermediate stage in the development of the *Baeckea-Callistemon* association.

The distribution of *Richea* between 5,000 and 5,500 feet is much more restricted than that of the communities previously described, nor do the clumps often occupy very extensive areas. From 5,500 to near 7,000 feet (the upward limit of its range), however, the *Richea* associes gradually becomes more frequent and widespread, until it eventually occupies extensive areas of the valley floors where the habitat is sufficiently wet. Its structure in the alpine regions will be referred to again subsequently.

THE EPACRIS ASSOCIES. (Text-fig. 7).

Reference has already been made to the presence of *Epacris* seedlings in the *Poa-Hypolaena* ecotone and in the *Restio*, *Hypolaena* and *Richea* associes, which appear to develop into a community having *Epacris* as dominant. So far, the communities we have been considering have been distributed in zones of increasing content of gravitational water in the soil; *Epacris*, however, occurs in drier soils more akin to that of the habitat of the *Poa-Hypolaena* ecotone and the *Hypolaena* associes. The *Epacris* associes may be a natural development of these two communities in an unchanging habitat; and, indeed, every stage may be observed between these two communities with only a few plants of *Epacris* scattered here and there (Plate xvii, fig. 1), to where it is abundant with only a

subordinate stratum of either *Poa* with a little *Hypolaena* or *Hypolaena* with a little *Poa* (Plate xv, fig. 2; Plate xvi, fig. 2). Consequently the transitional area between the *Poa* consociation and the marsh may be occupied in places by a *Poa-Epacris* ecotone rather than by a *Poa-Hypolaena* ecotone. The *Epacris* associes also appears to follow the *Restio* and *Richea* associes coincident with the drainage of the excess of gravitational water from the soil which takes place eventually as the result of the gradual formation of erosion channels. In this case *Poa* is not present, but later it is possible that *Poa* enters the habitat and becomes as abundant as if the *Epacris* had directly succeeded the *Poa-Hypolaena* ecotone.



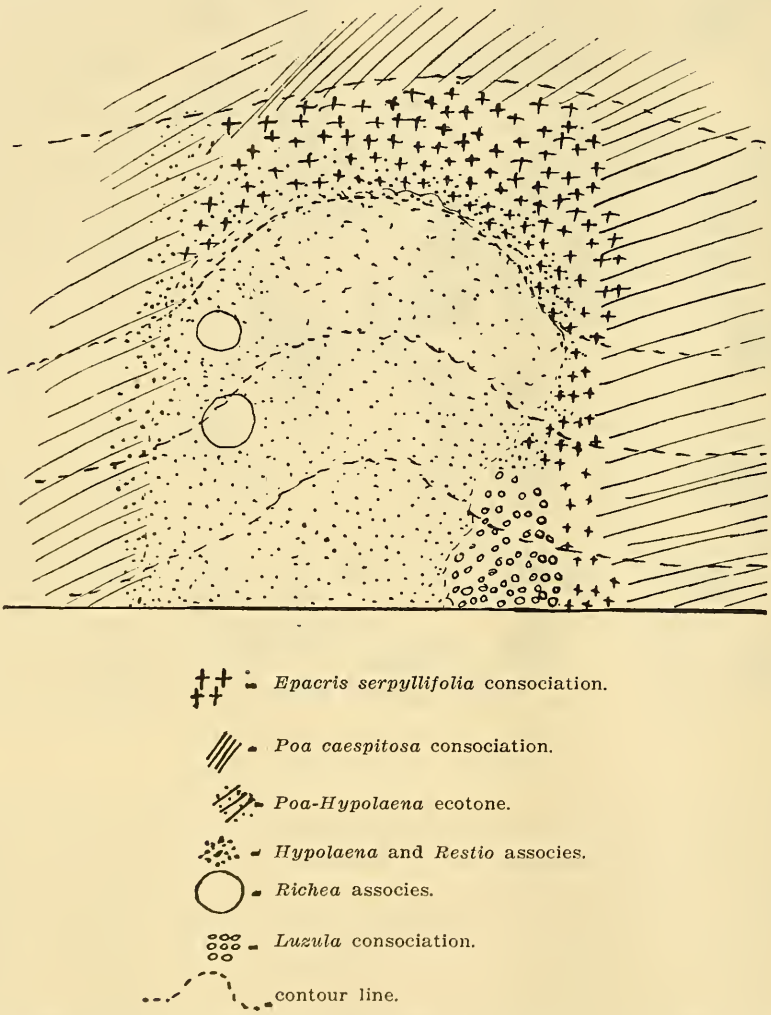
Text-figure 7. Quadrat, 1 m. square of the *Epacris serpyllifolia* consocies in process of developing into the *Baeckea* consocies.

In certain drier parts of the swamp the *Poa* consociation was observed merging into the ecotone, which in parts had apparently developed directly to *Restio* with the omission of the pure *Hypolaena* stage, *Poa* still being present in the *Restio* associes. In places the latter was developing into the *Epacris serpyllifolia* consocies, with scattered plants of the dominant between which *Poa* was abundant. This seems to be a telescoping of the sere owing to drier edaphic conditions.

Destruction of the *Epacris paludosa* consocies and its replacement by the *Poa-Hypolaena* mictium was observed in several places, where the habitat was littered with the dead gnarled and knotted stems (Plate xv, fig. 1). This destruction may

have been caused by snow lying long on the ground and killing out the *Epacris*. The latter would then naturally be replaced by the *Poa-Hypolaena* community which, as has been mentioned above, is akin in its habitat requirements.

As has already been mentioned, two consocies occur, dominated respectively by *E. serpyllifolia* and *E. paludosa*. The former seems to appear first and often subsequently to give place to the latter, but in large areas *E. paludosa* is absent and the *E. serpyllifolia* consocies develops directly to the *Baeckea-Callistemon* association, which usually follows the *Epacris* associes as the next and final stage of the sere. Evidence of this interrelationship between these communities is seen in the presence among the *Epacris* of locally abundant seedlings of both *Baeckea* and *Callistemon*. Occasionally in the *Epacris* associes occur single mature plants



Text-figure 8. Diagrammatic Chart (not to scale) of a portion of the marsh vegetation.

of *Callistemon Sieberi* and *Hakea microcarpa*, shrubs about three feet high which stand conspicuously above the dwarf *Epacris* (Plate xvi, fig. 2).

The *Epacris* associes is one of the most widespread communities in the marsh between 5,000 and 5,500 feet, and in many cases, indeed, may possibly be a sub-climax. Above 5,500 feet, however, it gradually gives place to the extensive *Richea* associes which apparently is more suited to the sub-alpine environment. Text-figure 8 shows the interrelationship of the communities described in detail in the preceding pages.

THE BAECKEA-CALLISTEMON ASSOCIATION.

This association appears to be the climax stage in the development of the marsh vegetation, but rather curiously it is very restricted in its distribution, and it is only here and there that conditions appear to permit the existence of the dominants.

The association is present sometimes as a zone round the edge of the marsh in a manner suggesting the occurrence of the *Epacris* associes, but only where the ground has a well-marked slope; at other times it colonizes the margins of channels of water running rapidly through the marsh. These facts of distribution suggest that the association requires a more aerated soil than normally constitutes the marsh; and this conclusion is supported by the similarity between the *Callistemon* consociation of the association under discussion and the *Callistemon* society which inhabits water-courses in the *Eucalyptus* forest higher up the slope (Plate xii, fig. 1).

The dominants occur separately as consociations, the *Baeckea* consociation being the more abundant and containing *Callistemon Sieberi* and *Hakea microcarpa* as subordinates.

The number of species in this association is small, since the closeness of the shrubs prevents the occurrence of lower strata and necessitates the display of all foliage at one level; *Richea*, *Hypolaena* and *Restio* are present in the *Baeckea* consociation growing up on long attenuated stalks through the mass of knotty branches of the *Baeckea*, in the manner described for *Hypolaena* in the *Richea* associes. The light ecad of *Hypolaena* in this community attains a height of three feet, six times the normal height of the plant.

The destruction of *Epacris* by severe conditions with consequent return to the *Poa-Hypolaena* stage of the sere has already been described. A similar case was observed of the destruction of the aerial shoots of *Callistemon* in a consociation of that type, leaving the characteristic white stems standing erect throughout the area. After the ground had been so bared, the *Hypolaena* associes had appeared, and in parts had developed to the *Restio* associes, although not so far as the *Epacris* associes, *E. serpyllifolia* being only occasional. In the meantime a fundamental difference between the epacrid and the myrtaceous type had asserted itself. All our observations indicate that members of the Epacridaceae have generally no means of renascence after destruction of the aerial shoots as is characteristic of the Myrtaceae and many other families represented in *Eucalyptus* forests; therefore, while regeneration of the *Epacris* associes has to await the comparatively slow process of migration and ecesis, *Callistemon*, before even the *Restio* stage had fully asserted itself, had commenced active renascence everywhere by the production of adventitious shoots from the base of the stem, which no doubt would rapidly grow up and restore the original structure of the community, while the *Restio* and *Hypolaena* would be stamped out (Plate xiv, fig. 1). It is interesting to note that *Baeckea* which was apparently occasional in the original

community, had survived destruction, suggesting that *Baeckea* is a more vigorous type; a conclusion supported by its greater abundance at higher altitudes in the *Poa-Celmisia* association.

THE LUZULA-CAREX ASSOCIES.

In flat shallow pools of water occur two closely related consocies dominated respectively by the sedge-like *Luzula campestris* and *Carex Gaudichaudiana*.

The *Luzula* consocies occurs not only in the marsh vegetation, but also in little flat hollows or natural drains in the *Poa* consociation or in flat areas of the *Callistemon Sieberi* society in the *Eucalyptus coriacea* consociation.

The *Luzula-Carex* association does not appear to form a stage in the complex sere already described, although it passes into it in several ways, as is about to be mentioned. The floristic composition is also considerably different from that of the various stages in that sere, since there are present a number of amphibious or semi-aquatic types such as three species of *Ranunculus*, *Utricularia*, and even the definitely hygrophytic *Chara* or *Nitella*.

In one example of the *Luzula* consocies *Oreomyrrhis andicola* was observed to be equally abundant with *Luzula*. Since the leaves of that rosette-type form a lower stratum than the *Luzula* we have termed it arbitrarily a sub-dominant; at the same time when *Oreomyrrhis* is in flower or fruit, its pedicel is equally as tall as the haulm of *Luzula*, so that during a large period of its existence it is co-dominant. The community in which this observation was made was a less wet habitat than is normally occupied by the *Luzula* consocies; and it is possible that *Oreomyrrhis* has gained entrance to the community on this account. Increasing drainage of the habitat in one part has resulted in the establishment of numerous seedlings of *Epacris serpyllifolia*, indicating that the community is able to develop into the *E. serpyllifolia* consocies and so link up with the main sere of the marsh vegetation.

Another instance of this is exemplified by the presence of *Restio* in parts of both the *Carex* and *Luzula* consocies, which of course on account of its larger size soon becomes dominant, forming the typical *Restio* associes. Occasionally *Hypolaena* is also locally abundant in the *Carex* consocies so that development to the *Hypolaena* associes may possibly take place concomitant with consolidation of the substratum and ablation of the surface water.

These various lines of possible succession are illustrated in Text-fig. 3.

Floristic Composition.

	L.	C.
Reed Stratum.		
Restio australis R.Br.	lf	lc
Epilobium glabellum Forst.	r	—
Grass Stratum.		
Luzula campestris D.C.	d	f-c
Carex Gaudichaudiana Kunth.	lf	d
Hypolaena lateriflora Benth.	—	la
Rumex acetosella Linn.	r	—
Poa caespitosa Forst.	lf	—
Plantago varia R.Br.	lf	—
Brachycome sp.	lf	—
Oreomyrrhis andicola Endl.	lsd	—
Ground Stratum.		
Ranunculus Millani F.v.M.	a	o-a
Utricularia dichotoma Labill. var. *uniflora* Benth.	—	la
Chara sp. or *Nitella* sp.	—	la
Velleya montana Hook.	lf	—
Epacris serpyllifolia Labill. (seedlings)	lc	—
Moss societies (chiefly *Sphagnum* and *Polytrichum*)	o	—

Species.	*Poa* consociation.	*Poa-Restio* ecotone.	*Restio* associes.	*Hypolaena* associes.	*Richea* associes.	*Epacris* associes.	*Callistemon* consociation.	*Baeckea* consociation.
Shrub Stratum.								
Baeckea Gunniana Schau.	—	‡	—	‡	*	*	f-lc	d
Callistemon Sieberi D.C.	—	—	lo	—	—	societies lf	d	o-c
Cassinia aculeata R.Br.	o-lc	—	—	—	—	—	—	—
Hakea microcarpa R.Br.	o	‡	‡	—	—	societies lf	—	o
Helichrysum baccharoides F.v.M.	o	‡	—	—	—	*	f	—
Phebalium ovatifolium F.v.M. ..	r	—	—	—	—	—	—	—
Dwarf-Shrub Stratum.								
Callistemon Sieberi D.C. young plants	—	—	†	—	—	lf	†	†
Baeckea Gunniana Schau. young plants	—	‡	—	‡	lf	la	†	†
Comesperma retusum Labill.	r	o	o	o	—	o	—	—
Epacris paludosa R.Br.	—	—	§	§	lf	d-o	r	o-f
Epacris serpyllifolia R.Br.	—	§	§	o §	—	o-d	o	o-f
Eucalyptus coriacea Cunn. seedlings	—	—	—	—	—	r	—	—
Helichrysum baccharoides F.v.M. young plants	†	‡	—	—	—	lf	†	—
Restio australis R.Br.	—	lf-la	lo-lf	d	o-a	a	c	o-c
Linum marginale Cunn.	r	o-c	—	—	—	—	—	—
Oxylobium ellipticum R.Br. var. *alpinum* Maiden and Betche..	r	‡	—	—	la at 5,000 ft.	—	—	—
Podolepis longipedata Cunn. ...	o in societies	—	—	—	—	—	—	—
Hypolaena lateriflora Benth. attenuated ecad	—	‡	‡	‡	la	‡	a	la
Richea Gunnii Hook.	—	—	‡	—	d	la over 6,000 ft.	r	lf-la
Herb Stratum.								
Aciphylla glacialis F.v.M.	—	—	r above 5,500 ft.	r above 5,700 ft.	r above 5,700 ft.	—	—	—
Baeckea Gunniana Schau. seedlings	—	o	—	lf	*	*	†	†
Brachycome decipiens Hook. ..	o-f	—	—	—	—	—	—	—
Brachycome scapiformis D.C. ..	f-a	—	—	—	—	—	—	—
Brachycome scapigera D.C.	o	o-f	—	—	—	o	—	—
Celmisia longifolia Cass.	f above 5,700 ft.	—	—	—	o-f above 5,700 ft.	r above 5,700 ft.	—	—
Craspedia Richea Cass.	f	o-c	o	o	r	o	—	—
Diuris pedunculata R.Br.	—	o at 5,500 ft.	—	—	—	—	—	—
Epilobium glabellum Forst.	o	o	o-f	o-c	—	—	—	—
Euphrasia Brownii F.v.M.	f	o	r	r	—	—	—	—
Euphrasia antarctica Benth. ...	—	r at 5,800 ft.	—	—	—	—	—	—
Hakea microcarpa R.Br. seedlings	†	r	r	—	—	†	—	†
Helichrysum baccharoides F.v.M. seedlings	†	r	—	—	—	*	†	—
Helichrysum bracteatum Willd.	o	—	—	—	—	—	—	—
Helichrysum rutidolepis D.C.	f	—	—	—	—	—	—	—
Helichrysum scorpioides Labill.	f-lc	f	o	—	—	—	—	—
Hovea longifolia R.Br.	o	—	—	—	—	—	—	—

* See dwarf-shrub stratum. ‡ See herb stratum.

† See shrub stratum. § See ground stratum.

FLORISTIC COMPOSITION OF THE MAIN COMMUNITIES OF THE MARSH VEGETATION.—*Continued.*

Species.	*Poa* consociation.	*Poa-Restio* ecotone.	*Restio* associes.	*Hypolaena* associes.	*Richea* associes.	*Epacris* associes.	*Callistemon* consociation.	*Baeckea* consociation.
Herb Stratum.—*Continued.*								
Hymenanthera dentata R.Br. young plants	—	—	—	—	—	vr	—	—
Kunzea Muelleri Benth.	o-f	vr	vr	—	—	r	—	—
Leptorrhynchos squamatus Less.	c	o	o	r	—	—	—	—
Carex Gaudichaudiana Kunth..	—	—	lo-lf	—	—	—	—	—
Luzula campestris D.C.	—	—	lo-lc	—	—	—	—	—
Oreomyrrhis andicola Endl.	—	o-f	o	f-c	—	o	—	—
Oxylobium ellipticum R.Br. var. *alpinum* Maiden and Betche	*	o at 5,600 ft.	—	—	*	—	—	—
Plantago varia R.Br.	o	f	—	—	—	o	—	—
Poa caespitosa Forst.	d	d	o-lf	la	—	o-la	lf	lf
Prasophyllum fuscum R.Br.	o	o-f	—	—	—	—	—	—
Prasophyllum fuscum R.Br. var. *alpinum* Benth.	o	o	—	—	—	—	—	—
Prasophyllum patens R.Br.	r	r	—	—	—	—	—	—
Pterostylis mutica R.Br.	r-lo	—	—	—	—	—	—	—
Pultenaea fasciculata Benth.	o	lf	—	—	—	o-f	—	—
Ranunculus lappaceus Sm.	r-f	o	o	—	—	—	—	—
Hypolaena lateriflora Benth.	—	sd	d	a	*	a	*	*
Richea Gunnii Hook. seedlings in *Sphagnum* societies	—	—	lc	—	*	*	—	*
Rumex acetosella Linn.	la	—	—	—	—	—	—	—
Senecio lautus Sol.	f	—	—	—	—	—	—	—
Stellaria pungens Brongn.	o-a	—	—	—	—	—	—	—
Stylidium graminifolium Swartz.	o	o-c	o-f	o	—	f	—	—
Taraxacum dens-leonis Desf.	f-a	—	—	—	—	—	—	—
Thelymitra venosa R.Br.	—	—	vr	—	—	—	—	—
Trifolium sp.	o at 5,000 ft.	—	—	—	—	—	—	—
Wahlenbergia gracilis D.C.	o-c	o-f	f	f	—	—	—	—
Ground Stratum.								
Acaena sanguisorbae Vahl.	a	—	—	—	—	—	—	—
Asperula oligantha F.v.M.	o	—	—	—	—	—	—	—
Chiloglottis Gunnii Lindl.	lf	—	—	—	—	—	—	—
Drosera peltata Sm.	—	—	—	o	—	o	—	—
Drosera Arcturi Hook.	—	—	r above 5,500 ft.	r above 5,500 ft.	—	—	—	—
Epacris serpyllifolia Labill. seedlings	—	lf	f-a	lf-la	—	*	*	*
Epacris paludosa R.Br. seedlings	—	—	f-a	lo-lf	*	*	*	*
Galium umbrosum Sol.	o	—	—	—	—	—	—	—
Geranium dissectum Linn.	o	—	—	—	—	—	—	—
Lycoperdon sp.	o	—	—	—	—	—	—	—
Lycopodium clavatum R.Br.	—	—	o-f	vr	—	r	—	—
Poranthera microphylla Brongn.	o	—	—	—	—	—	—	—
Ranunculus sp.	—	—	la	la	—	—	—	—
Sphagnum societies	—	r	f	o	o	—	—	—
Scaevola Hookeri F.v.M.	o	—	—	—	—	—	—	—
Utricularia dichotoma Labill. var. *uniflora* Benth.	—	—	la	—	—	—	—	—
Viola betonicifolia Sm.	o	—	—	—	—	—	—	—
Moss societies (*Sphagnum*, *Polytrichum*, etc.)	—	o	f	f	—	f	—	—
Hypericum japonicum Thunb.	—	—	la	—	—	—	—	—

* See dwarf-shrub stratum.
† See shrub stratum.
‡ See herb stratum.
§ See ground stratum.

The Alpine Vegetation.

THE POA-CELMISIA ASSOCIATION.

Above the tree-line in the neighbourhood of 6,000 to 6,500 feet, the open. stunted *Eucalyptus* forest gives place to a vegetation composed mainly of low-tussock grassland and herbs. This vegetation has a characteristically alpine physiognomy, and forms a low dense covering over the treeless peaks which reach an altitude of over 7,000 feet. Two consociations are found, the one being dominated by *Poa caespitosa*, and forming a typical low-tussock grassland community. This is in reality the same community as occurs below the *Eucalyptus* forest on the slopes of the sub-alpine region, and as forms the ground stratum of the forest itself. The composition of the subordinates, however, differs somewhat, as will be seen by comparing the statement of the floristic composition at the end of this section of the paper, with that of the ground stratum of the *Eucalyptus coriacea* consociation and with that of the *Poa* consociation of the sub-alpine region given with that of the marsh vegetation. The other consociation is dominated by a creeping rosette composite, *Celmisia longifolia*, which forms a dense felt-like growth. The *Poa* gives a rich olive-green to the hills in the distance; *Celmisia*, however, with its glaucous leaves, thick white tomentum and numerous inflorescences, appears in the distance as large bluish-white patches scattered over the hillsides; this feature is illustrated in Plate xviii, figs. 2 and 3.

The subordinates of these two communities, as will be seen from the accompanying statement of the floristic composition, are largely composed of the same species, although it appears that the more delicate mesophytic types favour rather the *Celmisia* consociation. The majority of the species conform to characteristic alpine life-forms, as will also be seen from the statement of the floristic composition. Apart from the tussock grass represented by *Poa* and the mat grass represented by *Hemarthria compressa*, the dominant life-form is the rosette herb, intermixed with a smaller proportion of cushion herbs. Shrubs are only occasional and tend to be confined to the shelter of granite boulders; they exhibit a marked degree of nanism, being either prostrate or in the form of low cushions, usually occurring flattened close against the rock surfaces, in order to avoid the effects of the strong winds (Plate xix, fig. 1). Among these shrubs may be mentioned *Grevillea australis*, *Podocarpus alpina*, and the fern *Polystichum aculeatum*.

The extreme shortness of the vegetative season at these high altitudes results in every species flowering at the same period; consequently there is a wealth of floral production unmatched in other regions of the State, more especially as the flowers are mostly large and brightly coloured (Plate xix, fig. 3).

A certain amount of competition and overlapping takes place between the *Poa* and *Celmisia* consociations, and often the two types are co-dominant. In damper parts of the slopes and valley-bottoms in both consociations occurs the dwarfed and prostrate *Epacris petrophila*, which in parts becomes dominant, thus forming a new consociation retaining the typical subordinates of the *Poa* and *Celmisia* communities. The *Richea Gunnii* associes occurs also in the swampy areas, where it is the main community, as has been mentioned earlier; this species is also sometimes locally abundant in the *Celmisia* consociation. The *Epacris* associes of the marsh vegetation, however, does not occur, and it appears that the *Richea* associes forms the climax at these high altitudes. The *Hypolaena* associes is found pure in one or two marshes, and this develops directly into the *Richea* associes, which then contains *Hypolaena* in abundance. The *Epacris*

petrophila consociation occurs associated with the *Richea* consociation in these marshes but does not appear to be developmentally related. In water-courses below the melting snow-drifts a *Ranunculus rivularis* society occurs with a number of semi-aquatic subordinates, including *Caltha introloba* which is confined to altitudes bordering on 7,000 feet.

On many drier areas *Celmisia* and *Poa* occur practically alone, since it appears that the subordinates are the less hardy and more mesophytic types.

During nine months of the year the alpine region is covered in snow which in places frequently lies as drifts throughout the summer. The effect of this on the vegetation is naturally very pronounced. All the herbaceous types die down when the snow comes, but perennate from season to season by subterranean organs of propagation. Thus an area from which the snow has just been melted is seen to be covered with the withered remains of vegetation; and later appear the young shoots of *Poa*, etc. In some areas where snow has remained continuously for several years these withered remains have very largely disappeared, and no doubt the perennating organs are here entirely killed out, so that a new migration will have to take place. These occasional patches are the only areas of granite soil which, in summer-time, are not clothed with a dense carpet of vegetation. Contrary to this feature of the lifehistory of the herbaceous plants, the shrubs are able to withstand the effects of the snow covering, without even losing their leaves, since no periodically deciduous species occur in the New South Wales flora. At the same time the shrubs are often killed during severe seasons, as is evinced by the bleached, gnarled and thick woody stems which are often to be seen.

The *Poa* and *Celmisia* consociations occur also on a large area of slate in the alpine region, where they possess practically the same features. A number of smaller differences in floristic composition appear to exist, as will be seen from the accompanying lists; but we have no definite record of any plant being confined to the consociation on the slate, nor have we definite record of any species not occurring on the slate. It is probable, however, that further work may modify this statement, since our observations on the composition of the slate flora are incomplete.

In the alpine region numerous very typical structural and growth features are exhibited by the herbaceous and shrubby plants. The habit of the shrubs varies with exposure to wind. In the most exposed situations where the desiccating effect of wind is predominant and retards normal elongation of the aerial shoots, nanism, or stunted, dwarfed and distorted growth results. The larger shrubs such as *Phebalium ovatifolium*, *Orites lancifolia*, *Prostanthera cuneata*, *Podocarpus alpina* and *Grevillea australis* assume a close, dense, caespitose habit, which favours reduction of transpiration and natural protection from wind-action. Forms like *Pimelea alpina*, *Lissanthe montana*, and *Kunzea Muelleri* frequently assume a typical espalier habit, prostrate and straggling, and raising their growing tips only a few inches above the level of the soil or protective rock.

Several mat-forming herbs occur in the alpine zone, being generally very dwarfed forms which cling closely to the surface of the soil. The most important of the plants in this category are *Stackhousia pulvinaris*, *Raoulia catipes*, and *Epilobium confertifolium*.

The rosette leaf habit is represented in a number of types, as will be seen from the accompanying statement of the floristic composition. The majority of these plants are characterized by deep tap roots.

Sclerophylly is a characteristic feature of the shrubs, while many types, both shrubby and herbaceous, have extensive and dense coverings of silky or woolly

Floristic Composition.
Poa-Celmisia Association.

Species.	Life-form.	Granite.		Slate.	
		Poa consociation.	*Celmisia* consociation.	*Poa* consociation.	*Celmisia* consociation.
Acaena sanguisorbae Vahl.	Creeping mat herb	la	—	la	—
Aciphylla glacialis F.v.M.	Rosette herb	f	f	o	o
Astelia alpina R.Br.	Rosette herb	—	o	—	—
Brachycome cardiocarpa F.v.M. var. *alpina*	Rosette herb	o	o	o	o-f
Brachycome scapiformis D.C.	Rosette herb	f	f	—	—
Barbarea vulgaris R.Br. ..	Low erect herb ...	—	o	o	o
Carex breviculmis R.Br. ...	Sedge	o	o	—	—
Celmisia longifolia Cass. ..	Creeping rosette herb	lf	d	lf	d
Claytonia australasica Hook.	Mat herb	—	o-lc	—	o-a
Craspedia Richea Cass.	Rosette herb	f	o	o	o
Craspedia Richea Cass. var. *alpina* Benth.	Rosette herb	o	f	o	o
Drapetes Tasmanica Hook.	Prostrate shrub ...	o	o	—	—
Epacris petrophila Hook. ..	Prostrate shrub ...	la	lo-la	—	—
Euphrasia Brownii, F.v.M.	Low erect herb	la	f	o	f
Galium umbrosum Sol. ..	Low herb	o up to 6,700 ft.	—	—	—
Grevillea australis R.Br. ..	Caespitose or prostrate shrub	o	—	o	r
Helipterum incanum D.C...	Creeping rosette herb	—	o-c	—	o
Hemarthria compressa R.Br.	Low grass	c	lf	—	—
Hymenanthera dentata R.Br.	Espalier shrub	vr	—	—	—
Kunzea Muelleri Benth. ..	Espalier shrub	vr	—	—	—
Lissanthe montana R.Br. ..	Espalier shrub	o	o	—	—
Lycoperdon sp.	Puff-ball	—	o	—	—
Lycopodium clavatum R.Br.	Decumbent herb ..	vr	vr	—	r
Myosotis australis R.Br.	Herb	—	r	—	—
Olearia floribunda Benth. ..	Espalier shrub ...	r	—	r	—
Oreomyrrhis andicola Endl.	Rosette herb	o	—	—	—
Oreomyrrhis pulvinifica F.v.M.	Rosette herb	r	—	—	—
Orites lancifolia F.v.M. ...	Caespitose shrub ..	vr	—	—	—
Pimelea alpina F.v.M.	Espalier shrub	o	o-lc	o	—
Pimelea axiflora F.v.M. var. *alpina* F.v.M.	Espalier shrub	o	o	o	—
Phebalium ovatifolium F.v.M.	Caespitose shrub ..	o-lc	—	—	—
Poa caespitosa Forst.	Low-tussock grass	d	o-a	d	o-a
Podocarpus alpina R.Br. ..	Caespitose shrub ..	o	—	—	—
Polystichum aculeatum (L.) Schott.	Fern	r	—	—	—
Polytrichum sp.	Moss	—	la	—	—
Pentachondra pumila R.Br.	Espalier shrub	o	—	—	—
Prostanthera cuneata Benth.	Caespitose shrub ..	r	—	r	—
Ranunculus anemoneus F.v.M.	Rosette herb	—	o	—	—
Ranunculus dissectifolius F.v.M.	Rosette herb	—	o-lf	—	—
Ranunculus Gunnianus Hook.	Creeping rosette herb	o	o	—	—
Ranunculus Muelleri Benth.	Rosette herb	—	o-lf	—	—
Azorella dichopetala Benth.	Rosette herb	f	f	—	—
Ranunculus sp.	Rosette herb	—	—	la	—
Raoulia catipes Hook.	Mat herb	o	f	—	o
Richea Gunnii Hook.	Low caespitose shrub	—	la	—	—
Senecio pectinatus D.C. ..	Erect herb	r	—	o	—
Stackhousia pulvinaris F.v.M.	Mat herb	lo	lo	—	—
Taraxacum dens-leonis Desf.	Rosette herb	o-c	o	c-a	o
Viola betonicifolia Sm. ...	Creeping rosette herb	vr	—	vr	—
Danthonia robusta F.v.M...	Tufted grass	o-lc	—	—	—
Epilobium confertifolium ..	Mat herb	—	o	—	o
Coprosma Nertera F.v.M...	Espalier shrub	o	—	—	—
Lycopodium Selago, Linn...		r	—	—	—

hairs on their inflorescences, leaves and young shoots. Examples of this class are *Celmisia longifolia*, *Helipterum incanum*, *Podolepis longipedata*, *Craspedia Richea* var. *alpina*, *Raoulia catipes*, *Oreomyrrhis andicola* and *Ranunculus Muelleri*. The relation of hairiness of alpine and sub-alpine plants to protection against intense insolation, and consequent excessive transpiration and inhibition of growth, is so well known that it needs no discussion here.

Epacris petrophila Consociation.	
Epacris petrophila Hook.	d
Celmisia longifolia Cass.	f-c
Richea Gunnii Hook.	la
Craspedia Richea Cass.	o-f
Richea Associes.	
Richea Gunnii Hook.	d
Restio australis R.Br.	la
Sphagnum sp.	o
Ranunculus rivularis Society.	
Herb Stratum.	
Ranunculus Gunnianus Hook.	
Brachycome cardiocarpa F.v.M. var. *alpina*	f
Ground Stratum.	
Ranunculus rivularis Banks and Sol.	d
Caltha introloba F.v.M.	a
Drosera Arcturi Hook.	o
Sphagnum sp.	o

THE EPACRIS PETROPHILA CONSOCIATION.

The summits of certain of the peaks in the slate region of the Plateau represent an extremely barren habitat: the ground is composed of the upturned edges of the strata of slate, and there is practically no soil. The conditions seem too severe for the grassland which tends to accumulate the raw humus of a moisture retaining soil, and a few of the hardy species form an open community which has the characteristic physiognomy of fell-field or alpine rocky desert (Plate xvii, fig. 2). None of the individuals are more than three or four inches in height, and they are scattered intermittently over the rocky ground. The available moisture is less than elsewhere, hence the plants are mostly xerophytes, especially the dominant, *Epacris petrophila*. It is curious in this connection that this species should have been characteristic of the damper slopes in the *Poa-Celmisia* association.

Although the majority of the components of the community were found in the *Poa-Celmisia* association, the great difference in physiognomy marks it out as a distinct association, distinct even from the consociation of the *Poa-Celmisia* association having the same dominant.

A remarkable feature is the sudden replacement of the *Epacris petrophila* association by the *Poa* consociation on passing to a more sheltered habitat over the brow of the hill, the ecotone region being only a few yards in breadth.

Floristic Composition.	
Epacris petrophila Hook.	d
Colobanthus subulatus Hook.	f
Carex breviculmis R.Br.	f
Azorella dichopetala Benth.	o
Azorella cuneifolia F.v.M.	o
Poa caespitosa Forst.	o
Brachycome sp.	o
Euphrasia Brownii F.v.M. very small form	r
Lichens	f

Summary.

The paper comprises an account of the plant communities of the Kosciusko Plateau.

Three regions are recognized on the plateau, *viz.*, the alpine, sub-alpine and montane zones.

The montane zone and the slopes of the ridges in the sub-alpine zone are occupied by *Eucalyptus* forests, the former mainly by a *Eucalyptus Gunnii* consociation, the latter by a *Eucalyptus coriacea* consociation.

Accounts are given of the structure and adaptations of these forests, including certain features of regeneration, and of the factors controlling the timber-line at the upper limit of the sub-alpine zone.

The flat bottoms of the shallow valleys of the alpine and sub-alpine regions are occupied by a marsh vegetation comprising reed-swamp and dwarf-shrub heath. The interrelationships of a number of seral communities in this habitat are discussed at some length.

The alpine zone, extending from the upper limit of arboreal vegetation to the summit of the plateau, is occupied mainly by a *Poa-Celmisia* association. The *Poa* consociation forms a low-tussock grassland community, and occurs also in the sub-alpine zone between the *Eucalyptus* forest on the slopes and the marsh vegetation in the valley bottoms; the *Celmisia* consociation forms a mat-herb community and is confined to the alpine region.

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EXPLANATION OF PLATES X-XIX.

Plate x.

Map of Kosciusko Plateau (20 miles by 6 miles), where the elevations are represented by form-lines or approximate contours.

Plate xi.

1. Slope of a shallow valley at about 5,100 feet. The *Eucalyptus coriacea* consociation, with its characteristic shrubs, is seen in the rear. The typical life-form of the dominant is well illustrated in the comparatively large tree on the left. The *Poa* consociation is present on the slopes on the right and left, while the marsh vegetation occupies the level ground where water collects. The low dark heath-like portion is the *Epacris* association, while the *Hypolaena* associes and such communities constitute the remaining portion of the marsh vegetation.

2. A shallow valley at about 5,500 feet, showing destruction of *Eucalyptus coriacea* by severe climatic conditions. The lower stature of the trees at this altitude compared with those of the previous photograph is evident. The replacement of the forest by the *Poa* consociation on the lower parts of the slopes is shown; the marsh vegetation is

sparingly developed, as the drainage is comparatively good in this instance, but darker patches of it are seen in the middle distance. The occurrence of isolated trees on small raised drier hummocks in the *Poa* consociation is a conspicuous feature.

Plate xii.

1. View at 5,200 feet, showing the *Eucalyptus coriacea* consociation in the background, and the *Callistemon* consociation in the foreground.
2. The *Restio* associes in gently undulating country at 5,500 feet. The *Poa* and *Eucalyptus coriacea* consociations are seen on the higher ground in the distance.
3. A shallow valley at 5,600 feet showing the *Eucalyptus coriacea* forest on the ridge and the *Poa* consociation in the foreground. The lower stature of the trees than in Plate xi, fig. 1, is again evident. The tussock-like nature of *Poa caespitosa* is more noticeable at this higher altitude on account of the greater abundance of drainage water. This is particularly seen in the foreground.

Plate xiii.

1. A granite boulder in a marsh at 6,000 feet, showing *Baeckea Gunniana* flattened against it, in order to obtain protection from wind. *Richea Gunnii* is seen in the right foreground.
2. A society of *Veronica Derwentia* in a portion of the *Eucalyptus coriacea* consociation at 5,500 feet, which has been killed by fire. *Poa* is seen to occupy the ground between the plants of *Veronica*.

Plate xiv.

1. A regenerating plant of *Callistemon Sieberi*, whose aerial portion has previously been killed by severe climatic conditions.
2. The Snowy River at 4,000 feet, showing the *Eucalyptus Gunnii* consociation clothing the slope in the background, and the *Leptospermum* society lining the river bank. The difference in the topography from the higher altitude, as well as the denser forest is evident. The bare nature of the forest floor in the *E. Gunnii* consociation is seen on the right.

Plate xv.

1. In the middle distance is seen the *Epacris paludosa* consocies in flower. The foreground was originally occupied by this type, which has, however, died out, as is evident by the dead branches, and has been replaced by the *Poa-Hypolaena* mictium. The *Eucalyptus coriacea* is well developed in the background. Altitude 5,100 feet.
2. Another view of the *Epacris paludosa* consocies in flower, passing through the *Poa-Hypolaena* mictium which reaches as far as the foot of the white tree on the right and then merges into the *Poa* stratum society of the forest.

Plate xvi.

1. A view in the alpine region at 6,700 feet. The white patches on the steep slope on the left are dead trunks of a low forest of *Eucalyptus coriacea*, which has migrated upwards and subsequently been killed by severe seasons. In the foreground is seen the *Celmisia* consociation, the dominant being admixed with *Poa*. The distant ranges are in Victoria.
2. The *Epacris paludosa* consocies, 5,100 feet. A bush of *Hakea microcarpa* is seen in the background.
3. A view in the *Eucalyptus Gunnii* consociation, 4,000 feet, showing the tall trees and the ground almost devoid of vegetation.
4. A shallow valley at 5,800 feet. The *Eucalyptus coriacea* consociation is seen to be here very stunted and confined to the ridges between the erosion-channels running down the slope. Between the patches of forest are dense societies of *Prostanthera cuneata* which extend down over the *Poa* consociation on the lower part of the slope. On the floor of the valley in the creek bed occur the *Restio* and *Hypolaena* associes.

Plate xvii.

1. The *Poa-Hypolaena* ecotone developing into the *Epacris* associes. Plants of *Epacris paludosa* are scattered through the *Poa*. A plant of *Callistemon Sieberi* is seen in the foreground.

2. Summit of a ridge in the slate area at the summit of the Plateau, occupied by the *Epacris petrophila* consociation. The area is seen to have the characteristic physiognomy of fell-field, the plants being scattered openly among the projecting edges of the folded slate strata.

Plate xviii.

1. A portion of the *Eucalyptus coriacea* consociation at 5,200 feet, in which the trunks of the trees have been killed by fire. Regeneration is seen to be taking place from the rootstocks.

2. The *Poa-Celmisia* association above 7,000 feet. The *Celmisia,* in flower, is seen to alternate with the much more sombre-coloured *Poa* consociation. The characteristic patchwork effect of the alternation of these two communities is seen on the distant hills.

3. A view of the alpine region from Mount Kosciusko, 7,328 feet. The patchwork effect of the *Poa* and *Celmisia* consociations is again seen covering the distant hills.

Plate xix.

1. *Podocarpus alpina* in the shelter of a granite boulder, 7,000 feet. Under the rock on the right is the habitat of *Polystichum aculeatum,* the only fern occurring in the alpine region.

2. Scene at 6,000 feet showing a few isolated, gnarled and stunted trees of *Eucalyptus coriacea* in the foreground, surrounded by a dense society of *Prostanthera cuneata* mixed with *Phebalium ovatifolium.* Forest clothes the lower ridges on the left, but the others are practically above the tree-line. Water is seen lying in a marsh on the flat ground to the left.

3. The *Celmisia* consociation at 7,000 feet, with dense societies of *Euphrasia Brownii,* all the plants being in flower.

[The following names on the text-figures, submitted incorrectly, were not noticed until the blocks had been made. Text-fig. 2, *Stellaria*; Text-fig. 3, *Baeckea*; Text-fig. 4, *Baeckea* and *Craspedia Richea*; Text-fig. 5, *Baeckea* and R = *Restio australis*; Text-fig. 6, *Baeckea*; Text-fig. 7, *Baeckea* and *Craspedia Richea.*—ED.]