

NATURAL VEGETATION AND SETTLEMENT AT MACQUARIE PASS, ILLAWARRA REGION, NEW SOUTH WALES

H. FALDING & J. S. BENSON*

(Accepted for publication 29.7.1983)

ABSTRACT

Fallding, H. & Benson, J. S. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, New South Wales, Australia 2000) 1985. Natural vegetation and settlement at Macquarie Pass, Illawarra region, New South Wales. Cunninghamia 1(3), 285-311. The plant communities of the Macquarie Pass area on the Illawarra escarpment, 100 km south of Sydney, are described and mapped; their distribution reflects geology, climate and topography. Open-forest, woodland, shrub communities and sedgeland occur on the plateau. The escarpment is characterized by closed-forest and tall open-forest; the foothills and coastal plain by drier open-forest and woodland communities. Four hundred and forty-one species are recorded. Comments are made on the rainforests of the Illawarra region and the effects of settlement on the vegetation of the escarpment and the coastal plain. The original extent of rainforest on the Illawarra is considered to be less than that often assumed.

INTRODUCTION

The subtropical rainforests and moist eucalypt forests of the Illawarra escarpment have interested botanists since Allan Cunningham in 1818 first entered "within the dark shades of a tropical forest, composed of very lofty timber of the red cedar [*Toona australis*], *Tristania albens* or Turpentine Tree [*Syncarpia glomulifera*]; large *Eucalypti*, of the species called Blue Gum, and many other trees . . . the whole being bound together with immense scandent and volubilous plants, that cannot fail to arrest the attention and admiration of the most indifferent observer" (quoted in Lee, 1925).

Botanical work in the Illawarra, a region extending from Bulli, 30 km north of Macquarie Pass, southward to the Shoalhaven River, includes that of Moore & Betche (1893), Hamilton (1914), Davis (1936, 1941a, b), Pidgeon (1940), Hume (1969), Strom (1977), Bywater (1978) and Fuller (1980). However, most of this work has been confined to the northern end, particularly around Bulli Pass and Mount Kiera. Little work has been done in the Macquarie Pass region or further south.

In this study the vegetation within and surrounding Macquarie Pass National Park is described and mapped. It embraces a transect of the Illawarra escarpment from exposed heath on the sandstone plateau through rainforest and moist eucalypt forest on the escarpment itself, to the drier open-forest and woodland on the coastal plain. This area was recognized for its natural and scenic beauty as early as 1882, when three reserves, about 200 ha in area, were set aside for the preservation of timber and recreation.

THE STUDY AREA

Macquarie Pass National Park (1064 ha) is about 100 km south of Sydney on the Illawarra escarpment, between the townships of Robertson (34° 35'S, 150° 36'E, 750 m alt.) on the Wingecarribee Tableland and Albion Park (34° 35'S, 150° 47'E,

* Present address: Resources Section, New South Wales National Parks and Wildlife Service, Kent Street, Sydney, New South Wales, Australia 2000.

10 m alt.) on the Illawarra coastal plain (see map in back pocket). It lies within the "horseshoe" of sandstone cliffs formed by the escarpment around the head of the basin drained by Macquarie Rivulet, one of the largest streams in the region (Figure 1). The Park is bounded to the north by Johnsons Ridge, which runs eastwards from the escarpment onto the coastal plain between Marshall Mount and Albion Park. The area is a small part of a more-or-less continuous band of natural vegetation stretching along the Illawarra escarpment. It is bounded on both the eastern and western sides by cleared land, at present used for dairying, potato cropping and beef production. The Illawarra Highway cuts through the middle of Macquarie Pass National Park, linking the agricultural lands of the coast and the highlands. The Park is also traversed by power lines. Most of the eastern part of Johnsons Ridge is privately owned farmland, with dairying and cropping on the river flats and grazing in the foothills of the escarpment and on clearings on the ridge itself. Some forest remains, mainly on the steeper slopes of the ridge, and it becomes quite extensive at higher altitudes. On the tableland, to the north and north-west of Macquarie Pass, are the Avon, Cordeaux and Nepean Dam catchments. These are virtually undisturbed bushland, and are managed by the Metropolitan Water Sewerage and Drainage Board (M.W.S.D.B.).

Geology, topography and soils

The geology of the study area is illustrated in Figure 2 and a cross-section through Macquarie Pass showing the relationships between geology, topography and vegetation is included on the map sheet (in back pocket). The geological nomenclature used throughout this paper is that of Bowman (1974). However, it should be noted that Carr (1983) has reclassified some of the strata.

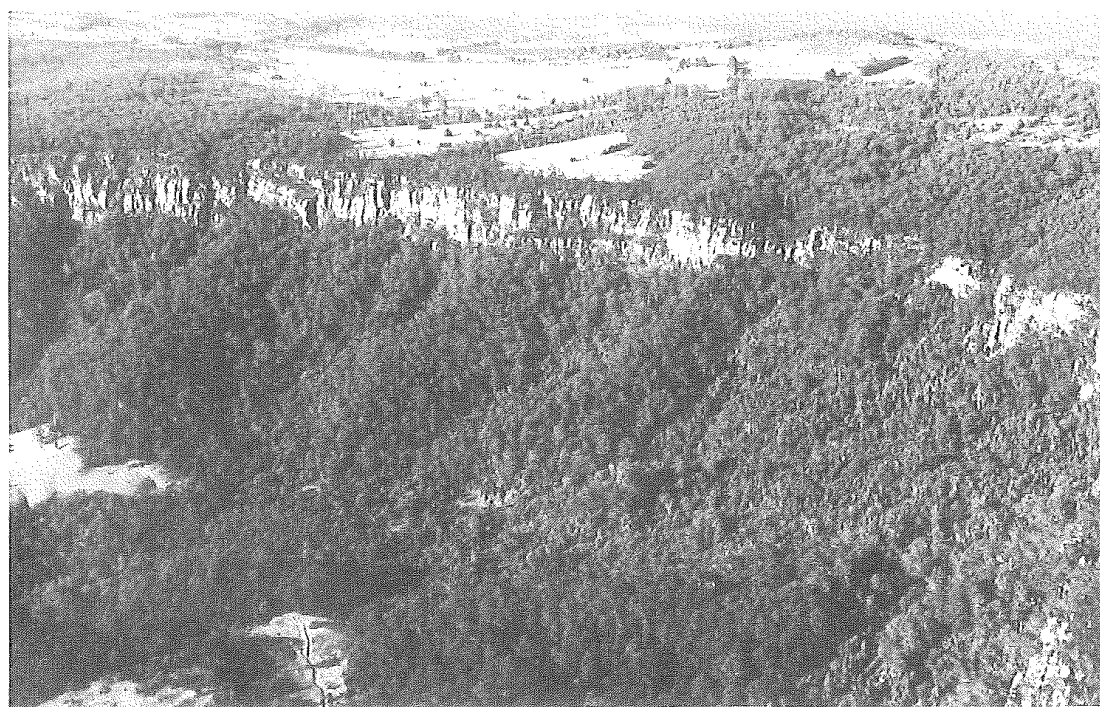


Figure 1. View over the southern half of Macquarie Pass National Park looking south-west over the upper part of Macquarie Rivulet, showing part of the horseshoe of sandstone cliffs, cleared areas on the Robertson Plateau, and part of two cleared areas on a latite bench. Rainforest can be seen in the gullies below the cliff-line and tall open-forest on the ridges. The vegetation remaining on the plateau is predominantly open-forest on Wianamatta Shale.

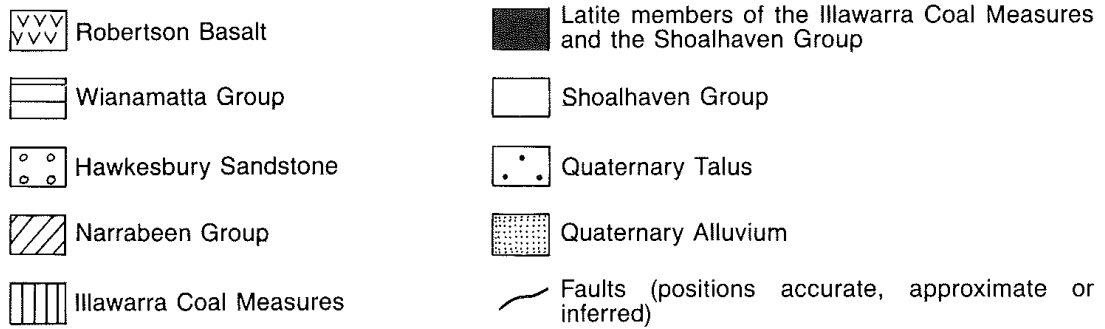
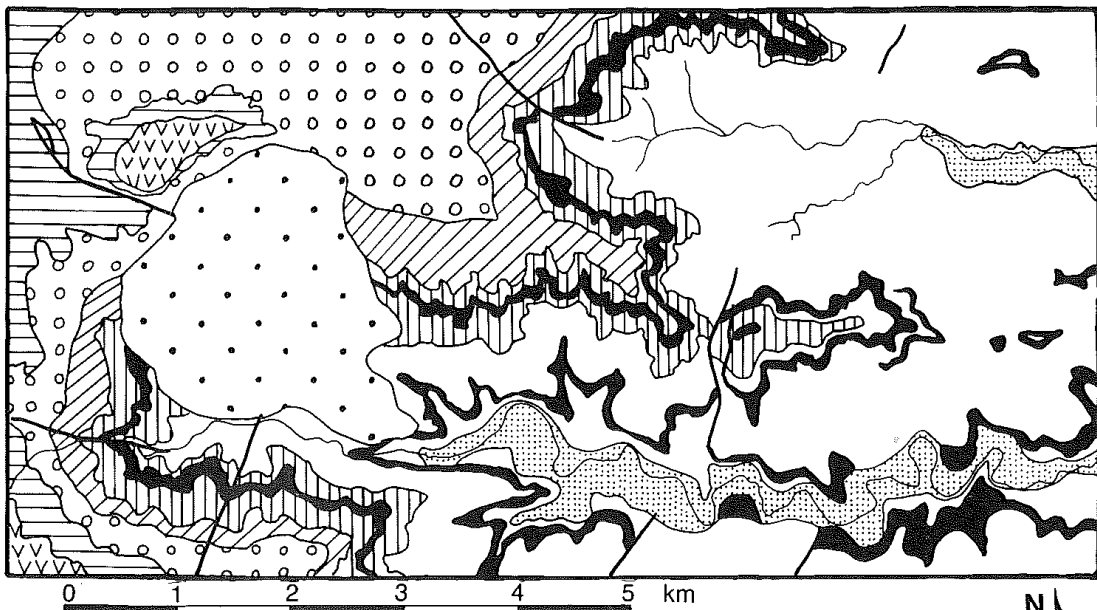
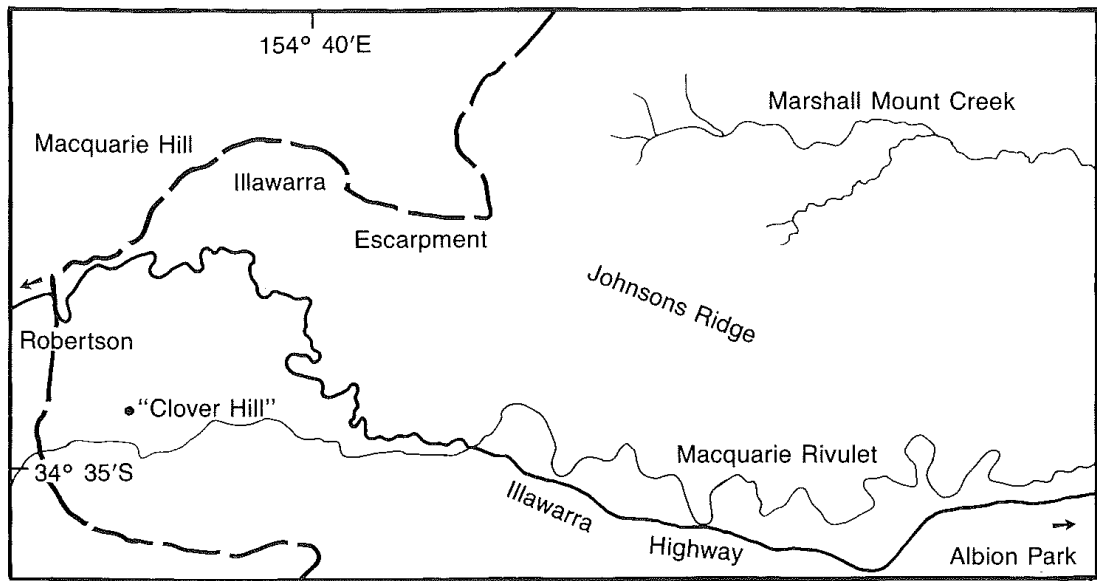


Figure 2. Major features and geology of the study area. Geology after Bowman (1974).

The uppermost rock unit is the Robertson Basalt (Tertiary age), outcropping at Macquarie Hill (Bowman, 1974). The Wianamatta Group (predominantly Triassic mudrock) lies below this, surrounding the outcropping basalt at Macquarie Hill, and also occurring extensively on the plateau to the south. The major part of the plateau and the cliffs dominating the escarpment are of Hawkesbury Sandstone (Triassic). The upper part of Johnsons Ridge is of Narrabeen Group units (sandstone and claystones) in the Clifton Sub-group. Below this, on the flanks of the ridge and the foothills of the escarpment generally, there are early Late Permian rocks of the Illawarra Coal Measures and the Shoalhaven Group, a number of latite members and the Budgong Sandstone.

Much of the head of the gully at Macquarie Pass consists of large and deep Quaternary talus deposits. The southern parts of the gully and Johnsons Ridge, however, are made up of sedimentary strata of the Narrabeen Group, Illawarra Coal Measures and the Shoalhaven Group.

A number of topographic units can be distinguished — plateau top, cliffs, escarpment slopes and benches, foothill spurs and gullies, and the coastal plain. Drainage patterns on the plateau and escarpment are dendritic, with local variations due to faulting or jointing. Where topography is gentle, streamflow is less definite and sometimes impeded. Johnsons Ridge is the watershed between the catchments of Macquarie Rivulet to the south and Marshall Mount Creek to the north. The Macquarie Rivulet, which originates on the Robertson Basalt on agricultural land, flows through Wianamatta Shale and Hawkesbury Sandstone before plunging over the cliff-line at Macquarie Falls.

Soil structure and composition are closely related to parent rock material and to topographic position. On the plateau, krasnozems are derived from the basalt outcrops; uniform to duplex soils develop from Wianamatta Shale and Hawkesbury Sandstone; podzols form in the shallow, sandy, swampy depressions. On the talus slopes the soils range in structure from uniform earthy sands at the top of the deposit, to yellow duplex soils in the lower parts. Soils on the escarpment are otherwise mainly a variety of duplex types that reflect differences in parent material.

Climate

The Illawarra experiences a mild climate with warm moist summers, cool winters and no marked dry season. In summer, the prevailing winds are from the south (SSW) or north-east and are often rain-bearing. In winter, dry winds come from the west or south-west. The escarpment causes uplift of air masses and consequent orographic rainfall and mists. Thus, rainfall on the edge of the plateau (for example, at Robertson, 1650 mm annually) is higher than that on the coastal plain (for example, at Albion Park, 1089 mm annually; Bureau of Meteorology, 1979). Macquarie Pass receives an annual rainfall of more than 1600 mm (from rainfall map by Young & Johnson, 1977). Funnelling associated with gorges and ravines can cause still higher local rainfalls on the upper slopes of the escarpment (Fuller, 1980). Temperatures in the region are affected by altitude and proximity to the sea. July mean minimum temperatures range from 3°C at Robertson to about 6°C at Albion Park; January mean maximum temperatures are about 25°C on both the coast and escarpment.

History of settlement

Other than the use of the Pass as a route between the highlands and the coast, there are no details of Aboriginal use in the area. The first Europeans to come to the region were the cedar-getters in the early 1800s. In 1821, one such man described the

vegetation of the region as being "except for small open patches, covered with timber and almost impenetrable". Others described the Macquarie Rivulet flats as being covered "with tall cabbage-tree palm [*Livistona australis*], ferns, cedar [*Toona australis*] and creeping vines" (Bayley, 1959). Harvesting of cedar continued for about 50 years, until the supply was exhausted.

Early land grants went to J.T. Hughes, C.T. Smith and Henry Osborne (about 1820). The landholders leased 30 to 40 acre (12 to 16 ha) blocks to immigrant settlers who agreed to clear the land in return for six years free rent. The large holdings were later subdivided (for example, Hughes' "Albion Park" in 1860, and the Marshall Mount Estate in 1890) into 40 and 60 acre (16 and 24 ha) blocks that were sold mainly to tenants. Such sales resulted in "... quick progress along the Macquarie. Timber was felled, properties fenced with hardwood and hut building proceeded as fast as the sawyers could cut hardwood into planks. A great quantity of firewood was despatched by rail for the Sydney market" (Bayley, 1959). Most of the area of Macquarie Pass National Park was divided into 40 and 60 acre portions that were surveyed during the period 1856 to 1906.

Hardwood logging and clearing probably first extended onto the escarpment in the 1840s and 1850s. The more fertile latite bands are likely to have been cleared first. After clearing, the land was generally cropped with wheat, corn or potatoes, and cattle were grazed. Butter, eggs, fowls and pigs were shipped to Sydney markets (Bayley, 1959). Wheat was grown in the area until 1860 when infestation by rust halted its cultivation. An idea of the degree of clearing can be gained from A. McFarland (1872) a travelling judge, who described the escarpment behind Lake Illawarra: "From the sea to the mountain — ay — far up the mountain sides, and occasionally to the very summits, pasture farms cover the face of the country; grass, grass, everywhere; on every flat, hill, and dale, in every nook and cranny. But, as a rule, the tillage or state of Agriculture is poor; but little corn or other grain is raised; there is a large supply of ugly 'stump' — redeemed in part by occasional clumps of cedars, and cabbage trees, belts of forest, and sylvan glades".

Dairying increased in prominence after the 1840s with the development of refrigeration, and wheat production declined. There were three butter factories between the bottom of Macquarie Pass and Albion Park (Bob Dalhanty, pers. comm.). However, Bayley (1959) reports that "In the 1880s Shellharbour and Macquarie River settlers began moving to the Richmond River ...". During this century the local population and the dairy industry have declined greatly, some land has been abandoned to regrowth, and beef cattle grazing has become more important.

A well-worn bridle track existed down Macquarie Pass by 1878 and settlers were keen for a road to be constructed. In 1898 the Macquarie Pass road was opened. The road attracted many tourists in the 1920s and 30s and was sealed in 1932. Many ferns and wildflowers were picked during the 1920s. A.G. Hamilton (1914) mentions that the giant maidenhair fern *Adiantum affine* (*A. silvaticum*) "is gathered in quantities, tied in bundles and exported to Germany, where it is dyed with anilin green and re-exported to Australia for decorative purposes". Increasing areas of land were reserved for public recreation and the protection of native flora and fauna from 1882 to 1974 when Macquarie Pass National Park was dedicated.

Recent disturbances have come from power lines that were constructed in the late 1950s, and bisect the National Park with a band of cleared land; and a wildfire that swept much of the escarpment in 1968. The Macquarie Pass road (the Illawarra Highway) is carrying increasing volumes of traffic, but still retains its appeal to the tourist.

THE VEGETATION

Survey methods

Familiarity with the area was gained from field work in 1979 and a survey of the literature. Plant communities are defined in terms of structure (Specht, 1970) and floristics. Field sampling was either by ground traverse, where general species lists were compiled, or by sample sites where cover ratings for trees (using 40 m × 10 m quadrats) and cover-abundance ratings for understorey species (using 10 m × 10 m quadrats) were assessed, tree diameters measured, and slope, aspect, geology, geomorphology and any disturbance were recorded. Sample sites were not placed in communities 4a, 4b, 4c, 8 or 9, these being sampled only by ground traverses.

Aerial photography (New South Wales Department of Lands 1963, Kiama series about 1:44 000; New South Wales Department of Main Roads 1962, 1978 series, both about 1:10 000) was used to prepare a vegetation map at a scale of 1:10 000, which has been reduced to a scale of 1:25 000.

Description of plant communities

Ten plant communities were identified (see map in back pocket), ranging from closed-forest (rainforest) to sedgeland. Open-forest, woodland, shrub communities and sedgelands occur on the plateau. The escarpment is characterized by closed-forest and tall open-forest; and the foothills and coastal plain by drier open-forest communities.

Each plant community is described in terms of its structure, habitat and distribution, with the main species present. Variations in structure or species composition related to changes in geology, topography, drainage, aspect and fire are discussed. A species list for the area, and species records for each community, is given in Appendix I.

The communities described are arranged in sequence from the plateau to the coastal plain.

1. OPEN-FOREST: on Wianamatta Shale on plateau.
2. OPEN-SCRUB: on Wianamatta Shale on plateau.
3. LOW OPEN-FOREST to OPEN-FOREST: on Hawkesbury Sandstone on plateau.
4. OPEN-SCRUB, OPEN-HEATH and LOW SHRUBLAND: on Hawkesbury Sandstone on plateau.
5. SEDGELAND: on plateau.
6. CLOSED-FOREST: mixed warm-temperate/subtropical, warm-temperate, and warm-temperate/cool-temperate rainforests in gullies, sheltered places on escarpment.
7. TALL OPEN-FOREST to OPEN-FOREST: on escarpment.
8. OPEN-FOREST: with dry understorey on escarpment foothills.
9. WOODLAND to OPEN-FOREST: on coastal flats.
10. RIVERINE WOODLAND.

Community 1. OPEN-FOREST: on Wianamatta Shale on plateau

Distribution and habitat: restricted to outcropping Wianamatta Shale and therefore on only a small portion of the study area; generally lying between outcrops

of Robertson Basalt (mostly cleared) and Hawkesbury Sandstone (Communities 3, 4 and 5). It occurs more extensively west of the study area.

Structure and floristics: open-forest with trees 20 to 30 m high with a mid-dense foliage cover and a mid-dense to open understorey often dominated by the fern *Culcita dubia*. Main species include the trees *Eucalyptus fastigata*, *E. radiata* subsp. *radiata*, *E. obliqua*, *E. cypellocarpa* and *E. globoidea*; the shrubs *Pultenaea blakelyi*, *Leucopogon lanceolatus*, *Persoonia mollis* and *Platysace lanceolata*; climbers such as *Billardiera scandens* and *Hibbertia scandens*; the ferns *Culcita dubia* and *Pteridium esculentum*; and graminoids such as *Lomandra longifolia*, *Schoenus melanostachys* and *Gahnia* spp.

Comments: variations are largely related to soil type — those downslope from basaltic soils are richer in mafic minerals, while those closer to Hawkesbury Sandstone are influenced by siliceous minerals. Some species overlap into adjacent communities.

The vegetation of the Wianamatta Shale is discussed by Pidgeon (1941) and Phillips (1947). Phillips recognized two associations on the Wingecarribee Tableland: (a) *Eucalyptus radiata* and (b) *E. fastigata* — *E. viminalis* — *E. cypellocarpa*. Since Wianamatta Shale occurs in only a small part of the study area, and only two sites were sampled, it is difficult to draw any conclusions about eucalypt associations, or to dispute those recognized by Phillips. However, it is clear that the vegetation on Wianamatta Shale does differ significantly from that on basalt or Hawkesbury Sandstone in this district.

Community 2. OPEN SCRUB: on Wianamatta Shale on plateau

Distribution and habitat: restricted to gently sloping Wianamatta Shale on the fringes of the basalt outcrop at Macquarie Hill.

Structure and floristics: shrubs are dominant, up to 5 m high, with a dense foliage cover; some scattered trees up to 10 m high occur and the ground layer is dominated by graminoids. Main species recorded include the tree *Eucalyptus ovata*; the shrubs *Melaleuca linariifolia*, *Acacia longifolia*, *Pultenaea blakelyi* and *Leptospermum flavescens*; ferns such as *Blechnum cartilagineum* and *Pteridium esculentum*; and graminoids such as *Schoenus melanostachys* and *Lomandra longifolia*.

Community 3. LOW OPEN-FOREST to OPEN-FOREST: on Hawkesbury Sandstone on plateau

Distribution and habitat: on the Hawkesbury Sandstone plateau extending inland from the cliff edge; very restricted in Macquarie Pass National Park, but widespread within the M.S.W.D.B. catchment areas to the north.

Structure and floristics: low open-forest to open-forest with trees about 10 m high, a mid-dense foliage cover and a variable understorey of shrubs, ferns and graminoids. The main trees present include *Eucalyptus sieberi*, *E. smithii*, *E. piperita* subsp. *urceolaris*, *E. ligustrina* and *E. dendromorpha* (only at cliff edges). Shrubs are diverse, including *Leucopogon juniperinus*, *Epacris longifolia*, *Persoonia mollis*, *Leptospermum* spp., *Acacia obtusifolia*, *Banksia spinulosa* and *Pultenaea blakelyi*. The ferns *Culcita dubia*, *Pteridium esculentum* and *Gleichenia microphylla* occur, while *Sticherus lobatus* and *Blechnum* spp. were noted near creeks. Herbs include *Dampiera stricta* and *Gonocarpus tetragynus*, and the graminoids *Lomandra* spp., *Gahnia clarkei* and *Lepyrodia scariosa* are present.

Comments: considerable variation due to aspect, topographic position (gully, ridge or slope), soil type and proximity to the cliff edge occurs. Among the tree species, *E. sieberi* and *E. dendromorpha* are found close to the cliff edge. *E. smithii* grows in wet gullies, whilst *E. ligustrina* and *E. piperita* subsp. *urceolaris* occur in drier, well-drained places in the catchment areas. Similarly, the understorey varies, with an abundance of ferns along creek lines and scleromorphic species on the drier slopes and ridges.

The sandstone cliffs support a distinct and restricted vegetation, typified by such species as *Dracophyllum secundum*, *Dendrobium linguiforme*, *Grammitis billardieri*, *Eucryphia moorei*, *Bauera rubioides*, *Epacris longiflora*, *Gleichenia* spp. and *Todea barbara*.

Community 4a. OPEN-SCRUB: on Hawkesbury Sandstone on plateau

Distribution and habitat: occurring occasionally on sandy, organic soil in shallow depressions along drainage lines on the Hawkesbury Sandstone.

Structure and floristics: open-scrub with shrubs about 2 m high with mid-dense to dense cover; ground cover dense, dominated by sedges and ferns. The main species present include the shrubs *Melaleuca squarrosa*, *Leptospermum* spp., *Banksia ericifolia* and *Baeckea linearis*; the fern *Gleichenia microphylla*; and the monocotyledons *Lepyrodia scariosa*, *Empodisma minus* and *Lepidosperma laterale*.

Community 4b. OPEN-HEATH: on Hawkesbury Sandstone on plateau

Distribution and habitat: one patch only in the study area, in an extensive shallow depression on the plateau, with poorly drained organic sandy soils.

Structure and floristics: open-heath with shrubs to 2 m high, with mid-dense foliage cover; the ground layer is dominated by graminoids. The main species present



Figure 3. Sedgeland fringed with *Banksia robur* and *Melaleuca linariifolia*. Open-forest with *Eucalyptus piperita* (Community 3) can be seen in the background.

include the shrubs *Banksia ericifolia*, *Hakea teretifolia*, *Eucalyptus stricta*, *Leptospermum attenuatum* and *Banksia paludosa*; *B. robur*, *Sprengelia sprengelioides* and the graminoids *Empodisma minus*, *Sowerbaea juncea* and *Gymnoschoenus sphaerocephalus* occur in moister situations.

Comments: this community occurs on drier sites than Community 4a. The moister sites form a continuum with sedgeland. The mallee, *Eucalyptus stricta*, occurs in somewhat drier, better drained situations.

Community 4c. LOW SHRUBLAND: on Hawkesbury Sandstone on plateau

Distribution and habitat: only one occurrence of this community in the study area; it occupies a very exposed site with shallow, poorly drained soils, adjacent to the cliff edge on Hawkesbury Sandstone.

Structure and floristics: dominated by shrubs about 0.5 m high; taller shrubs and mallee (*Eucalyptus stricta*), 2 to 3 m high, occur as occasional clumps with sparse foliage cover. The main species present are the low shrubs *Petrophile sessilis*, *Isopogon anemonifolius*, *Leptospermum squarrosum* var. *rotundifolium*, *Banksia paludosa* and *Allocasuarina nana*; and as tall shrubs, *Eucalyptus stricta*, *Leptospermum attenuatum*, *Acacia obtusifolia*, *Banksia ericifolia* and *Hakea dactyloides*. Other species recorded include *Patersonia sericea*, *Lepyrodia scariosa*, *Leptocarpus tenax*, *Mitrasacme polymorpha* and *Hemigenia purpurea*.

Community 5. SEDGELAND: on plateau

Distribution and habitat: situated on the Hawkesbury Sandstone plateau in shallow depressions with swampy organic soils. Present also in the M.W.S.D.B. catchment areas to the north and on the plateau further to the south, for example at Barren Grounds Nature Reserve (south-east of Robertson).

Structure and floristics: dominated by graminoids, particularly the families Cyperaceae and Restionaceae; shrubs, when present, are scattered and less than 2 m high (Figure 3). Shrubs recorded include *Banksia robur*, *Melaleuca linariifolia*, *Pultenaea linophylla* and *Leptospermum* sp. A. (*L.* sp. aff. *scoparium*). The graminoids *Empodisma minus*, *Lepyrodia anarthria*, *Leptocarpus tenax*, *Lepidosperma laterale* and *Xanthorrhoea resinosa* are common, and herbs such as *Drosera spathulata* and *Goodenia dimorpha* var. *angustifolia* occur with the pteridophyte *Selaginella uliginosa*.

Comment: variation occurs due to differences in drainage and fire history.

Community 6. CLOSED-FOREST: rainforest on escarpment

Recently, Bywater (1978) and Floyd (1981) have classified the types of rainforest on the Illawarra. Bywater (using Webb's (1968) classification) recognized two distinct types:

(a) Mixed notophyll vine-fern forest occurring at altitudes of 150 to 450 m above mean sea level on escarpment benches. These forests receive 1500 to 1600 mm average annual rainfall, with additional moisture from frequent mists, and are on soils derived from Hawkesbury Sandstone, Narrabeen Group talus and Illawarra Coal Measures with relatively low phosphate levels.

(b) Complex notophyll vine forest at lower altitudes (85 to 120 m). The rainfall is much lower, averaging about 1200 mm annually. Soils are derived from latites and soil phosphate levels are markedly higher than on the sedimentary material.

Floyd divides Illawarra rainforests into two types:

- a. Predominantly subtropical
 - (i) dry/subtropical (= Bywater's complex notophyll vine forest)
 - (ii) subtropical
- b. Predominantly temperate
 - (i) warm-temperate with some subtropical (= Bywater's mixed notophyll vine-fern forest)
 - (ii) warm-temperate
 - (iii) warm-temperate/cool-temperate.

A mixture of rainforest types occurs at Macquarie Pass. Warm-temperate rainforest is the most widespread type. Subtropical rainforest elements occur with the warm-temperate rainforest only on the fertile soils of the Minnamurra latite bench and in low altitude gully bottoms; much of this has been cleared but remnants still occur. Cool-temperate rainforest elements are found at higher altitudes in the Pass. Although the rainforest at Macquarie Pass has been mapped as one unit, the variations are described below:

a. *Mixed warm-temperate/subtropical rainforest*

Distribution and habitat: subtropical rainforest elements occur on soils derived from latite, on benches on the escarpment (themselves formed from latite bands within the Illawarra Coal Measures) and in low altitude gully bottoms. This vegetation type is uncommon now because of extensive clearance of the benches, for example at "Clover Hill".

Structure and floristics: closed-forest with 10 to 30 m high trees and occasional emergents; foliage cover dense. The open understorey consists of ferns, vines, scattered shrubs, mosses and lichens. The main trees present include *Doryphora sassafras*, *Ceratopetalum apetalum*, *Livistona australis*, *Pennantia cunninghamii*, *Cryptocarya glaucescens* and *Toona australis*. *Citriobatus pauciflorus* and *Hymenanchera dentata* occur as shrubs, with the tree-ferns *Cyathea australis* and *C. leichhartiana*. The vines *Palmeria scandens*, *Cissus hypoglauca*, *Parsonsia straminea*, *Marsdenia* spp. and the climbing fern *Arthropteris tenella* are present. *Lastreopsis microsora* and *Doodia aspera* dominate the ground layer.

b. *Warm-temperate rainforest*

Distribution and habitat: found in gullies, along creek lines and in other sheltered areas protected by the escarpment cliffs; predominantly on sandstone talus slopes or on sandstones of the Illawarra Coal Measures. The soils are generally of texture-contrast type.

Structure and floristics: structure is similar to the subtropical rainforest described above, but the trees are often shorter. Main tree species are *Ceratopetalum apetalum*, *Doryphora sassafras*, *Cryptocarya glaucescens*, *Acmena smithii*, *Polyosma cunninghamii*, *Abarema sapindoides* and *Dendrocnide excelsa*. Shrubs such as *Tasmania insipida*, *Eupomatia laurina* and *Clerodendrum tomentosum*, and vines such as *Malaisia scandens* and *Marsdenia rostrata* were recorded. The ferns *Dicksonia antarctica*, *Cyathea australis* and *Lastreopsis acuminata* are present in the understorey with species such as *Gymnostachys anceps* and *Australina pusilla*.

c. *Mixed warm-temperate/cool-temperate rainforest*

Distribution and habitat: cool-temperate rainforest elements are found just below the cliff-line at Macquarie Pass. This type of vegetation was once much more extensive on the basaltic Robertson Plateau (Phillips, 1947), but now only small patches remain; the largest of these is Robertson Nature Reserve (4.5 ha at 750 m altitude).

Structure and floristics: rainforest with trees 10 to 20 m high but sometimes dwarfed in more exposed situations. Foliage cover is dense. Many ferns and a number of vines are present, but there are no epiphytes. Species recorded include the trees *Doryphora sassafras*, *Quintinia sieberi*, *Ceratopetalum apetalum*, *Rapanea howittiana*, *Polyosma cunninghamii* and *Eucryphia moorei* (the last at the top of Macquarie Pass, but not at Robertson Nature Reserve); the shrubs *Hymenanthera dentata*, *Tasmannia insipida*, *Citriobatus pauciflorus* and *Notelaea venosa*; and the vines *Eustrephus latifolius*, *Smilax australis* and *Marsdenia rostrata*. Ferns such as *Dicksonia antarctica*, *Lastreopsis microsora* and *Pyrrosia rupestris*, and the herbs *Gymnostachys anceps* and *Urtica incisa* are also present.

Community 7. TALL OPEN-FOREST to OPEN-FOREST: on escarpment

Distribution and habitat: community 7 occurs in a more-or-less continuous band below the cliff-line on the upper slopes of the Illawarra escarpment (about 550 m altitude), and on ridges and in sheltered valleys down to about 250 m and 80 m altitude respectively (Figure 4). It is usually in association with closed-forest, which occupies the more sheltered positions. Soils vary with parent material, but generally tend to be duplex in structure. Floristic associations are described below; these are associated with different geological substrates.

a. *Sandstone talus*

At lower altitudes *Eucalyptus muelleriana* and *Syncarpia glomulifera* are dominant. *Eucalyptus smithii* and *E. fastigata* become increasingly important above 150 m altitude and are the major tree species on the upper slopes of the escarpment. Other tall tree species present are *E. botryoides-saligna* intergrade, *E. quadrangulata* and *E. sieberi*. Other species occurring throughout include the small trees *Acacia binervata* and *Cryptocarya glaucescens*; the shrubs *Rhodamnia rubescens*, *Acmena smithii*, *Persoonia linearis*, *Clerodendrum tomentosum*, *Synoum glandulosum*, *Elaeocarpus reticulatus* and *Zieria smithii*; the climbers *Morinda jasminoides*, *Marsdenia rostrata*, *Tylophora barbata*, *Stephania japonica* and *Smilax* spp.; and the ferns *Culcita dubia*, *Doodia aspera* and *Blechnum cartilagineum*.

b. *Narrabeen Group Sediments (primarily on Johnsons Ridge)*

(i) *Coal Cliff Sandstone*

The main trees include *Eucalyptus muelleriana*, *E. smithii*, *E. quadrangulata* and *Allocasuarina torulosa*. The understorey is dominated by shrubs such as *Oxylobium ilicifolium*.

(ii) *Wombarra Claystone*

The tree species recorded are the same as for the Coal Cliff Sandstone. *Goodenia ovata* dominates the understorey; other species present include *Pimelea ligustrina*, *Olearia argophylla*, *Senecio velleioides*, *Cynoglossum australe*, *Logania albiflora*, *Cassinia aureonitens*, *Acacia binervata* and *Tylophora barbata*.

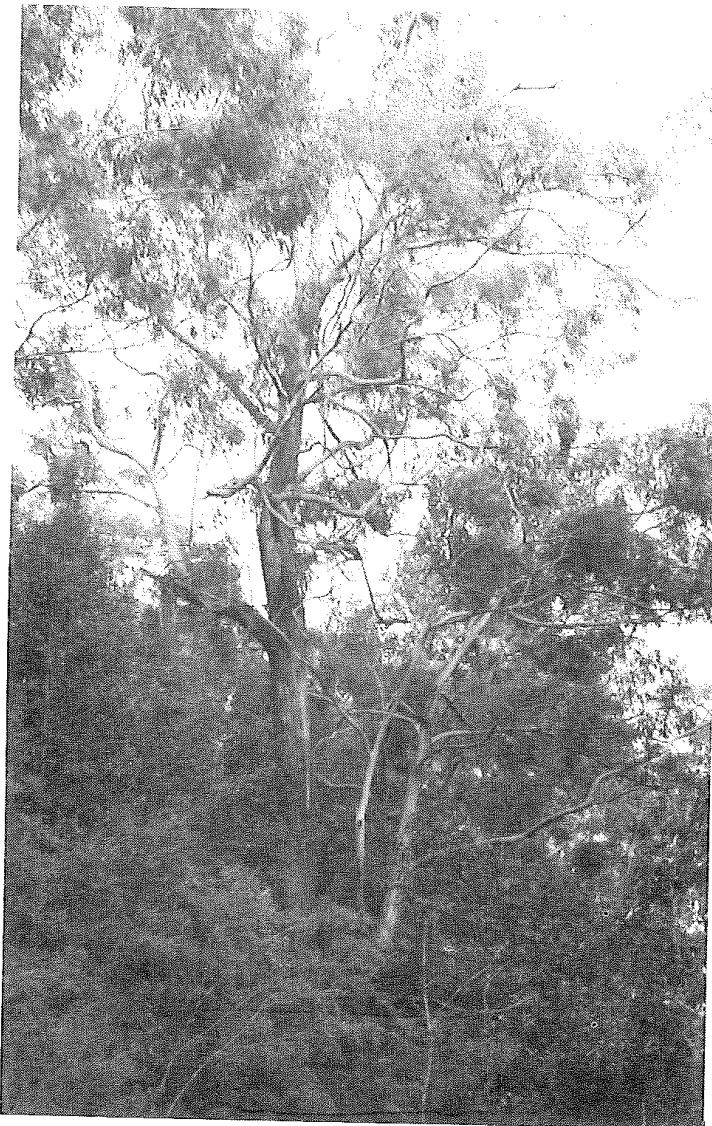


Figure 4. *Eucalyptus smithii* on talus on the escarpment in Community 7.

(iii) Colo Vale Sandstone

The main tree species include *Eucalyptus sieberi*, *E. smithii*, *E. quadrangulata*, *E. muelleriana* and *E. piperita* subsp. *urceolaris*. The understorey near the cliff-line is moist, including species such as *Backhousia myrtifolia*, *Acacia binervata*, *Clerodendrum tomentosum*, *Rapanea variabilis*, *Pittosporum undulatum*, *Elaeocarpus reticulatus*, *Synoum glandulosum* and *Tristaniopsis collina*. Understorey species on a dry knoll on Johnsons Ridge include *Persoonia pinifolia*, *Oxylobium ilicifolium*, *Lomandra longifolia*, *Cyathochaeta diandra*, *Amperea xiphoclada*, *Comesperma ericinum*, *Smilax glycyphylla* and *Pteridium esculentum*.

Comments: logging and clearing in the past have had significant effects on this community. A large part of the forest, on the talus particularly, shows signs of disturbance. Evidence of regeneration is provided by dense growth of saplings, especially *Syncarpia glomulifera* and *Doryphora sassafras*, resulting in a variety of more-or-less even-age stands of some tree species. The understorey does not appear to vary greatly except in places of recent disturbance.

Community 8. OPEN-FOREST: with dry understorey on escarpment foothills

Distribution and habitat: occurring on the foothills of the escarpment and sometimes extending onto the coastal plain, where rainfall is lower than close to the escarpment; on various geological formations, usually Permian volcanic sandstones and latites. Much of this community has been disturbed or cleared for grazing.

Structure and floristics: open-forest of trees, 10 to 20 m high with mid-dense foliage cover and a dry understorey of shrubs, herbs and monocotyledons. The main trees present are *Eucalyptus tereticornis* and *E. globoidea*, with *E. botryoides-saligna* intergrade along the moister gullies. The shrubs *Breynia oblongifolia*, *Acacia* spp. and *Indigofera australis* are present as well as the climbers *Kennedia rubicunda* and *Geitonoplesium cymosum*.

Community 9. WOODLAND to OPEN-FOREST: on coastal flats

Distribution and habitat: this community occupies Permian sediments (Budgong Sandstone and Berry Siltstone) on the undulating coastal plain. Formerly it would have been widespread north of Albion Park, but now only remnants occur.

Structure and floristics: woodland to open-forest with trees 10 to 30 m tall, with foliage cover ranging from sparse to mid-dense. The understorey is generally open and dominated by grasses. The main tree species on the drier rises are *Eucalyptus longifolia*, *E. eugenioides*, *Angophora floribunda* and *Melaleuca decora*, whilst in depressions and near creeks *E. amplifolia*, *Melaleuca styphelioides* and *Casuarina glauca* occur. Scattered shrubs such as *Acacia mearnsii*, *A. falcata*, *Dodonaea viscosa*, *Olearia viscidula*, *Daviesia ulicifolia* and *Hakea dactyloides* are recorded, with the monocotyledons *Dichelachne micrantha*, *Entolasia stricta*, *Imperata cylindrica*, *Dianella caerulea* and *Laxmannia gracilis*.

Comments: the largest remaining area of this community in the region is near Yallah (north-east of Albion Park). It is divided in two by transmission lines, and has also been used for grazing. This is the only known locality of the orchid *Pterostylis serifolia*. Most remnants of this community will have been grazed, burnt and selectively logged, so the understorey species composition may have been considerably altered.

Community 10. RIVERINE WOODLAND

Distribution and habitat: occurring on the banks of the Macquarie Rivulet on alluvial soils.

Structure and floristics: woodland with trees 10 to 25 m high with open foliage cover. The main species present are *Casuarina cunninghamiana* and *Erythrina* × *sykesii* (Coral Tree), an introduced species.

Comments: this community is generally very disturbed in the study area. Weeds from adjacent farming land are prevalent. Fuller (1980), in a study of the northern Illawarra, noted the presence of *Casuarina cunninghamiana* on Marshall Mount Creek; other creeks further north on the coastal plain, where rainfall is higher, apparently had rainforest species on their banks, while those further south, for example Minnamurra River, have *Casuarina cunninghamiana*. *Casuarina glauca* occurs on stream banks closer to the coast.

DISCUSSION

There have been a number of studies of the Illawarra vegetation, mostly of a general nature. Hamilton (1914) divided the vegetation into four main types:

- beach and sand dune flora
- open forest on the coastal plain and foothills of the escarpment
- subtropical jungle in gullies and seaward slopes of the mountain range
- sandstone association on the top of the range.

This division agrees well with the broad conclusions of this study, although the beach and sand dune flora do not occur in the study area.

Davis (1936, 1941a, b) studied the Bulli district (where the Illawarra escarpment curves eastward to the sea) and described the vegetation of the plateau, the slopes and the coastal plain in considerable detail. He found that, on the slopes of the escarpment in drier locations where "brush" (rainforest) did not occur, *Eucalyptus pilularis* was dominant, commonly associated with *E. paniculata* and *Syncarpia glomulifera*. Although *Syncarpia* is common at Macquarie Pass, neither of the eucalypt species occurs there. In similar positions at Macquarie Pass, *E. muelleriana*, *E. fastigata* and *E. smithii* are the dominants. The understorey appears to be similar in both places. The differences between the two areas are most likely due to the warmer temperatures, proximity to the sea and lower annual rainfall at Bulli (1400 to 1500 mm). Davis found "brush" in sheltered positions immediately below the scarp, in gullies on the lower slopes, and on soils derived from Chocolate Shale. Similarly, in our study, rainforest on the plateau on Narrabeen and Hawkesbury Sandstone was found to occur in very sheltered positions and was floristically poorer than that on the coast.

Rainforests on the Illawarra

Many people associate the Illawarra region with rainforest. Indeed, the scenic attraction of Macquarie Pass is largely based on the rainforest and moist eucalypt forest. This had led to an exaggeration of the importance of rainforests in the region and some debate over the years concerning its original extent. Early descriptions of the vegetation of the Illawarra frequently refer to "brush", which is often interpreted as referring to rainforest, although it seems likely that this word was used for any moist dense forest. For example, Maiden (1914) discusses "brush" in the County of Cumberland and lists *Syncarpia glomulifera* (Turpentine) amongst the common canopy species. *Syncarpia glomulifera* is not a species typical of rainforest, although it is often an emergent or associated with a moist understorey dominated by mesophyllous (or rainforest-type) shrubs ("wet sclerophyll forest"). At Macquarie Pass, *Syncarpia* and *Eucalyptus* spp. are the dominant canopy species of the tall open-forest.

Pidgeon (1937) gives a brief account of the Illawarra rainforest, saying that it is a remnant of forest that "once covered the slopes and valleys of the Illawarra from Bulli to Berry". She based this on the widespread distribution of *Livistona australis*. Davis (1936) had already singled out this species as being the most abundant and characteristic of the "brush" at Bulli. This species is frequently found in rainforest, but may also occur in other forest types, for example open eucalypt forest near Otford, north of Bulli, or swamp forests. Hence the remnant individuals on the Illawarra do not necessarily indicate the previous existence of rainforest. *Livistona australis* is extremely fire-resistant (A. Floyd, pers. comm.) and this may account for

its common survival in cleared areas; or it may have been retained for its ornamental value.

It seems, then, that the theories of extensive rainforest on the Illawarra (such as in Pidgeon, 1937; Baur, 1957; Strom, 1977) at the time of European settlement are probably overestimations. However, it is very likely that there were extensive forests with moist understories ("wet sclerophyll forests") in which *Livistonia australis* was common. As Floyd (1981) states, "Rainforest in the Illawarra was originally restricted to areas of deep moderately fertile soil with high and reliable rainfall. Protection from wildfire and desiccating and cold winds was also required".

Clearing of rainforest has been extensive on the coastal lowlands, the Robertson Plateau and the benches of the escarpment. Few stands of Floyd's lowland "dry/subtropical" rainforest remain on the Illawarra. The best known example is at Whispering Gallery between Albion Park and Jamberoo. It is in a steep gully on latite and both subtropical and dry rainforest species occur; it is on freehold land and so not adequately protected. Subtropical rainforest is well represented at Minnamurra Falls. Some small pockets can be found on the escarpment, for example on Macquarie Rivulet near Clover Falls. Warm-temperate/subtropical rainforest is well represented at Macquarie Pass. Elements of warm-temperate/cool-temperate rainforest are found at the highest altitudes at Macquarie Pass just below the cliffs. However, on the Robertson Plateau where it was once extensive, only Robertson Nature Reserve and a few smaller refuges remain. (Often these small refuges are dominated by *Acacia melanoxylon*, which may be regrowth after disturbance.)

Macquarie Pass National Park contains 190 hectares of rainforest (National Parks & Wildlife Service of New South Wales, 1979); it is therefore regionally important in rainforest conservation, particularly of warm-temperate rainforest.

Disturbance and regeneration

Most of Macquarie Pass was divided into 40 and 60 acre (16 and 24 ha) portions between 1856 and 1906. Investigation of the surveyors' site descriptions gives some information on the dominant tree species in the area, but very little indication on the density of species (Table 1). The area was generally described as "heavily timbered

TABLE 1
Species mentioned in surveys at Macquarie Pass between 1856 and 1888

Surveyors' nomenclature*	Probable botanical name in this area
Ash	<i>Eucalyptus ?smithii</i>
Blackbutt	<i>Eucalyptus pilularis</i> [†] (possibly <i>E. smithii</i>)
Blackwattle	<i>Acacia mearnsii</i> [†] , <i>Callicoma serratifolia</i> or <i>Acacia binervata</i>
Box	<i>Eucalyptus</i> spp. (possibly <i>E. quadrangulata</i>)
Brushwood(s)	Mesophyllous tree and shrub species
Cabbage Tree	<i>Livistonia australis</i>
Corkwood	<i>Duboisia myoporoides</i> or <i>Endiandra sieberi</i>
Featherwood	<i>Polyosma cunninghamii</i>
Leatherjacket	<i>Ceratopetalum apetalum</i>
Lilly Pilly	<i>Acmena smithii</i>
Messmate	<i>Eucalyptus fastigata</i> or <i>E. obliqua</i> [†]
Sycamore	Uncertain, possibly <i>Cryptocarya</i> sp.
Tea Tree	<i>Leptospermum</i> spp. or <i>Melaleuca</i> spp.
Turpentine	<i>Syncarpia glomulifera</i>
Wattle	<i>Acacia ?binervata</i> or synonym for blackwattle

* On portion plan, New South Wales Department of Lands

† Species does not occur on the escarpment at Macquarie Pass

turpentine, stringybark, wattle etc". The dominant canopy species appear to be almost identical with those present in the forest today, and the understorey in the eucalypt forest was moist and mesophyllous — for example, "Chiefly messmate [probably *Eucalyptus fastigata*] and brushwood". Only two portion descriptions indicate a rainforest community — one of these is located in an area just below the escarpment and is still warm-temperate rainforest today; the other, at "Clover Hill", is on a latite band that supported subtropical rainforest and is now cleared.

With the decline in the dairy industry and the reduction in population density at the end of the last century, some cleared areas were neglected and regeneration of native forests began. The regeneration has taken place during this century, and probably mainly in the last 40 to 50 years (Bob Dalhanty, pers. comm.). The similarity of these forests to the original vegetation is uncertain in terms of structure and species importance. It does seem, however, that most of the original canopy species still occur.

Evidence for disturbance in tall open-forest includes old (logging) tracks, sites of huts, frequent sawn stumps, piles of rocks, dense growth of young trees in virtually single-age stands (especially *Syncarpia glomulifera* and *Cryptocarya* spp.) (Table 2), very few trees with basal diameters similar to or greater than those of the remaining stumps, and a very simple understorey (Figure 5). Within the closed-forest, old logging tracks, stumps of trees such as *Toona australis*, few large old trees, the coppicing of several species, the frequent occurrence of common colonizing species such as *Acacia binervata*, *Euodia micrococca*, *Dendrocnide excelsa* and *Polyscias murrayi*, often as quite large trees, and substantial areas of forest with many vines (indicating an open canopy at one time) (A. Floyd, pers. comm.) all indicate disturbance over a considerable time.

Hamilton (1914) mentions several introduced species common on the Illawarra at that time. "Introduced plants do not get much hold in virgin brush, but wherever it is disturbed, there are certain noxious plants which make headway. The worst of these are — [the exotic] *Phytolacca octandra*, *Lantana camara* and *Rubus fruticosus*." He mentions a few other species to be common in the brush near settlements — the peach (**Prunus persica*), rough-skinned lemon (**Citrus jambiri*), Cape gooseberry (**Physalis peruviana*) and passionfruit (**Passiflora edulis*).

TABLE 2
Size distributions of selected tree species

Species	Forest type*	No. of individuals with dbh		Total no. individuals
		< 10 cm	10-15 cm	
<i>Cryptocarya glaucescens</i>	TOF	9	2	11
	TOF	19	0	19
	TOF	27	9	37
	TOF	13	8	23
<i>Doryphora sassafras</i>	CF	10	5	25
	CF	9	13	29
<i>Syncarpia glomulifera</i>	TOF	31	12	49
	TOF	20	8	34
<i>Ceratopetalum apetalum</i>	CF	13	10	23

* TOF: Tall open-forest; CF: Closed-forest



Figure 5. Evidence for disturbance in tall open-forest — sawn logs and stumps, dense growth of young trees (*Eucalyptus smithii*, *E. fastigata* and *Syncarpia glomulifera*), very few large trees and a very simple understorey.

At Macquarie Pass, weeds are restricted mainly to sites of recent disturbance, and associated with edges of clearings and roadsides. The main weed infestations are at the lower altitudes. Here, the most abundant weed species are the exotics **Lantana camara*, **Rubus* spp., **Pennisetum clandestinum*, **Sida rhombifolia*, **Tradescantia albiflora* and **Senecio mikanioides*. *Lantana* is the biggest problem, growing more densely and extensively at the edges of clearings than along the roadsides; it appears to grow only at lower altitudes, generally not above about 300 m. Large areas dominated by *Lantana* are shown on the map (inside back cover). Higher on the escarpment slopes at Macquarie Pass, weed infestations are not as extensive. Other disturbed areas, mainly at roadsides, are colonized by native species and some introduced weed species. The most common colonizing species are *Urtica incisa*, **Ageratina adenophora*, **A. riparia*, *Senecio linarifolia*, *Lastreopsis decomposita* and **Rubus* spp. **Ligustrum sinense* is the most common weed in the warm-temperate/cool-temperate rainforest at Robertson Nature Reserve.

CONCLUSIONS

The vegetation pattern seen in the Macquarie Pass area represents a broad west-to-east transect through the plant communities from the plateau to the coastal plain on the Illawarra. The diversity of the plant communities strongly reflects patterns in geology, climate and topography.

The settlement history of the area has had lasting effects on the vegetation of the coastal plain and escarpment. The more arable areas have been cleared, but regeneration of cleared and logged sites has occurred, especially on the escarpment. Evidence of past disturbance can be found in these forests.

Only remnants of some communities can be found on the coastal plain and they are not protected. The vegetation conserved in Macquarie Pass National Park is representative of the escarpment slopes (moist eucalypt-dominated open-forest) and of rainforest.

ACKNOWLEDGMENTS

We wish to thank R.G. Coveny and the staff of the National Herbarium of New South Wales for help with the identification of plant specimens; and D.H. Benson, J.M. Powell and M.D. Fox for encouragement, comment and advice during the preparation of this manuscript. We also thank Bob Dalhanty and Alex Floyd for useful and enjoyable discussions.

REFERENCES

- Baur, G.N. (1957). Nature and distribution of rain-forest in New South Wales. *Austral. J. Bot.* **5**, 190-222.
- Bayley, W.A. (1959). *Green meadows*. Centenary history of the Shellharbour Municipality, New South Wales. Shellharbour Municipal Council, Albion Park.
- Bowman, H.N. (1974). *Geology of the Wollongong, Kiama and Robertson 1:50 000 sheets*. Geological Survey of New South Wales. Government Printer, Sydney.
- Bureau of Meteorology (1979). *Climatic survey: Sydney region 5 New South Wales*. Australian Government Publishing Service, Canberra.
- Bywater, J. (1978). Distribution and ecology of rainforest vegetation and fauna in the Illawarra. Unpublished Honours Thesis, Department of Geography, University of Wollongong.
- Carr, B.F. (1983). A reappraisal of the stratigraphy of the upper Shoalhaven Group and lower Illawarra Coal Measures, southern Sydney Basin, New South Wales. *Proc. Linn. Soc. N.S.W.* **106**, 287-297.
- Davis, C. (1936). Plant ecology of the Bulli District. Part I. *Proc. Linn. Soc. N.S.W.* **61**, 285-297.
- Davis, C. (1941a). Plant ecology of the Bulli District. Part II. *Proc. Linn. Soc. N.S.W.* **66**, 1-19.
- Davis, C. (1941b). Plant ecology of the Bulli District. Part III. *Proc. Linn. Soc. N.S.W.* **66**, 20-32.
- Floyd, A.G. (1981). Rainforests of the Illawarra Region. Unpublished report, National Parks & Wildlife Service of New South Wales, Sydney.
- Fuller, L. (1980). *Wollongong's native trees*. Weston & Co., Kiama.
- Hamilton, A.G. (1914). Flora of the South Coast. In *Handbook for New South Wales*, pp. 386-406. British Association for the Advancement of Science, Sydney.
- Hume, J.M. (1969). Plant geography of the Illawarra Region. *Geogr. Bull.* **1(5)**, 33-39.
- Jacobs, S.W.L. & Pickard, J. (1981). *Plants of New South Wales*. Government Printer, Sydney.
- Lee, I. (1925). *Early explorers in Australia*. Methuen, London.
- McFarland, A. (1872). *Illawarra and Monaro: Districts of New South Wales*. William Maddock, Sydney.
- Maiden, J.H. (1914). Sketch of the botany of the County of Cumberland. In *Handbook for New South Wales*, pp. 367-385. British Association for the Advancement of Science, Sydney.

- Moore, C. & Betche, E. (1893). *Flora of New South Wales*. Government Printer, Sydney.
- National Parks & Wildlife Service of New South Wales (1979). *Background paper on rainforest policy*. Government Printer, Sydney.
- Phillips, M.E. (1947). The vegetation of the Wianamatta Shale and associated soil types. Unpublished M.Sc. Thesis, Department of Botany, University of Sydney.
- Pidgeon, I. (1937). The ecology of the Central Coastal area of New South Wales. I. The environment and general features of the vegetation. *Proc. Linn. Soc. N.S.W.* **62**, 315–340.
- Pidgeon, I. (1940). The ecology of the Central Coastal area of New South Wales. III. Types of primary succession. *Proc. Linn. Soc. N.S.W.* **65**, 221–224.
- Pidgeon, I. (1941). The ecology of the Central Coastal area of New South Wales. IV. Forest types on soils from Hawkesbury Sandstone and Wianamatta Shale. *Proc. Linn. Soc. N.S.W.* **66**, 113–137.
- Pryor, L. & Johnson, L.A.S. (1971). *A classification of the eucalypts*. Australian National University Press, Canberra.
- Specht, R.L. (1970). Vegetation. In *The Australian Environment* (Ed. G.W. Leeper), pp. 44–67. Ed. 4. CSIRO & Melbourne University Press, Melbourne.
- Strom, A. (1977). On the Illawarra. In *Rainforests* (Ed. W. Goldstein), pp. 13–22. National Parks & Wildlife Service, Sydney.
- Webb, L.J. (1968). Environmental relationships of the structural types of Australian rain forest vegetation. *Ecology* **49**, 296–311.
- Young, R.W. & Johnson, A.R.M. (1977). The physical setting: environmental hazards and urban planning. In *Urban Illawarra* (Ed. R. Robinson). Sorrett, Melbourne. [Cited in Bywater, 1978.]

APPENDIX 1

Species list for Macquarie Pass district

This list is arranged alphabetically in families and genera within the following divisions: Pteridophytes, Angiosperms — Dicotyledons, and Angiosperms — Monocotyledons. Exotic species are marked with an asterisk. Names are those currently recognized at the National Herbarium of New South Wales (Jacobs & Pickard, 1981, except where subsequent revisions or nomenclatural changes have occurred). Pryor & Johnson (1971) codes are used with eucalypt names.

List of plant community names and numbers

1. OPEN-FOREST: on Wianamatta Shale on plateau.
2. OPEN-SCRUB: on Wianamatta Shale on plateau.
3. LOW OPEN-FOREST to OPEN-FOREST: on Hawkesbury Sandstone on plateau.
4. OPEN-SCRUB, OPEN-HEATH and LOW SHRUBLAND: on Hawkesbury Sandstone on plateau.
5. SEDGELAND: on plateau.
6. CLOSED-FOREST: mixed warm-temperate/subtropical, warm-temperate, and warm-temperate/cool-temperate rainforests in gullies, sheltered places on escarpment.
7. TALL OPEN-FOREST to OPEN-FOREST: on escarpment.
8. OPEN-FOREST: with dry understorey on escarpment foothills.
9. WOODLAND to OPEN-FOREST: on coastal flats.
10. RIVERINE WOODLAND.

Species	Community number		
PTERIDOPHYTES			
ADIANTACEAE			
<i>Adiantum formosum</i>		6	7 9
<i>A. hispidulum</i>		6	
<i>Cheilanthes tenuifolia</i>		6	7 9
<i>Pellaea falcata</i>		6	9
ASPIDIACEAE			
<i>Lastreopsis acuminata</i>		6	
<i>L. decomposita</i>			9
<i>L. microsora</i>		6	
ASPLENIACEAE			
<i>Asplenium australasicum</i>		6	
<i>A. flabellifolium</i>		6	7
BLECHNACEAE			
<i>Blechnum ambiguum</i>			3
<i>B. cartilagineum</i>	1	2	3 6 7
<i>B. nudum</i>	1		3
<i>B. patersonii</i>			3 6
<i>B. wattsii</i>			3
<i>Doodia aspera</i>			6 7 9
CYATHEACEAE			
<i>Cyathea australis</i>	1	3	6 7
<i>C. leichhardtiana</i>			6
<i>Dicksonia antarctica</i>			6
<i>Culcita dubia</i>	1	3	7 9
DAVALLIACEAE			
<i>Arthropteris tenella</i>			6
<i>Davallia pyxidata</i>			6
DENNSTAEDTIACEAE			
<i>Histiopteris incisa</i>			3
<i>Hypolepis muelleri</i>			6
<i>H. punctata</i>			6
<i>Pteridium esculentum</i>	1	2 3	7 9
GLEICHENIACEAE			
<i>Gleichenia dicarpa</i>			3 4
<i>G. microphylla</i>			3 4
<i>Sticherus lobatus</i>	1	3	7
GRAMMITIDACEAE			
<i>Grammitis billardieri</i>			3
HYMENOPHYLLACEAE			
<i>Hymenophyllum cupressiforme</i>			6
LINDSAEACEAE			
<i>Lindsaea linearis</i>			3 4
<i>L. microphylla</i>			7
LYCOPODIACEAE			
<i>Lycopodium</i> sp.			3
OSMUNDACEAE			
<i>Todea barbara</i>			3 6
POLYPODIACEAE			
<i>Microsorium scandens</i>			6
<i>Pyrosia rupestris</i>			3 6
PTERIDACEAE			
<i>Pteris umbrosa</i>			6
SELAGINELLACEAE			
<i>Selaginella uliginosa</i>			7
SCHIZAEACEAE			
<i>Schizaea bifida</i>			3
SINOPTERIDACEAE			
<i>Pellaea falcata</i> var. <i>falcata</i>			6
ANGIOSPERMS — DICOTYLEDONS			
ACANTHACEAE			
<i>Pseuderanthemum variable</i>			7 10
ANACARDIACEAE			
<i>Euroschinus falcata</i>			3

MELIACEAE					
<i>Melia azedarach</i> var. <i>australasica</i>				7
<i>Synoum glandulosum</i>	1			6 7
<i>Toona australis</i>				6
MENISPERMACEAE					
<i>Legnephora moorei</i>				6
<i>Sarcopetalum harveyanum</i>				6 7
<i>Stephania japonica</i> var. <i>discolor</i>				6 7
MONIMIACEAE					
<i>Doryphora sassafras</i>				6 7
<i>Hedycarya angustifolia</i>				6 7
<i>Palmeria scandens</i>	3			6 7
MORACEAE					
<i>Ficus coronata</i>				6
<i>F. obliqua</i>				6
<i>Maclura cochinchinensis</i>				6
<i>Malaisia scandens</i>				6
<i>Streblus brunonianus</i>				6
MYOPORACEAE					
<i>Myoporum acuminatum</i>				7
MYRSINACEAE					
<i>Rapanea howittiana</i>				6 7
<i>R. variabilis</i>				6 7
MYRTACEAE					
<i>Acmena smithii</i>				6 7
<i>Angophora floribunda</i>				9
<i>Backhousia myrtifolia</i>				7
<i>Baekea diosmifolia</i>		4		
<i>B. linearis</i>		4		
<i>Callistemon citrinus</i>		4		
<i>Eucalyptus amplifolia</i> SNEEA				9
<i>E. bosistoana</i> SUNCA				9
<i>E. botryoides-saligna</i> SECAD-SECAC (intergrading population)				7 8
<i>E. cypellocarpa</i> SPIFE	1			
<i>E. dendromorpha</i> MAKID		3		
<i>E. eugenioides</i> MAHEA				8 9
<i>E. fastigata</i> MAKCB	1	3		7
<i>E. globoidea</i> MAHEF	1			8
<i>E. gummifera</i> CAFUF		3		
<i>E. ligustrina</i> MAHEQ		3		
<i>E. longifolia</i> SECGA				9
<i>E. mannifera</i> SPECH		3		
<i>E. muelleriana</i> MAHAA				7
<i>E. obliqua</i> MAKAA	1			
<i>E. ovata</i> SPEAB		2		
<i>E. piperita</i> ssp. <i>urceolaris</i> MATHAC		3		
<i>E. quadrangulata</i> SPIHA				6 7
<i>E. radiata</i> ssp. <i>radiata</i> MATELA	1			
<i>S. sieberi</i> MAKID	1	3		
<i>E. smithii</i> SPIKE		3		7
<i>E. stricta</i> MAKIG			4	
<i>E. tereticornis</i> SNEEB			4	
<i>Kunzea ?cambagei</i>			4	
<i>Leptospermum attenuatum</i>		3	4 5	7
<i>L. flavescens</i> (large form)	2	3		
<i>L. junperinum</i> sens. str.			4	
<i>L. scoparium</i> var. <i>rotundifolium</i>		3	4	
<i>L. squarrosus</i>	2	3	4 5	
<i>L. sp. A</i>	2	3	5	
<i>Melaleuca decora</i>				9
<i>M. linariifolia</i>	2		5	
<i>M. squarrosa</i>	2	4		
<i>M. styphelioides</i>				9
<i>Rhodammia rubescens</i>				7 9
<i>Syncarpia glomulifera</i>				7
<i>Tristaniopsis laurina</i>				6 7
<i>T. collina</i>	1	3		7
OLEACEAE					
* <i>Ligustrum lucidum</i>				6
* <i>L. sinense</i>				6
<i>Notelaea longifolia</i>				6 7
<i>N. venosa</i>				6 7

SANTALACEAE			
<i>Exocarpos cupressiformis</i>	3	7
<i>Leptomeria acida</i>		7 9
<i>Santalum obtusifolium</i>		
SAPINDACEAE			
<i>Alectryon subcinereus</i>		6 8
<i>Diploglottis australis</i>		7
<i>Dodonaea viscosa</i>	6	7 8 9
<i>Guioa semiglauc</i>	6	
SCROPHULARIACEAE			
<i>Veronica plebeia</i>		7
SOLANACEAE			
<i>Duboisia myoporoides</i>		7
<i>Solanum prinophyllum</i>	6	7
<i>S. pungetium</i>		7
STERCULIACEAE			
<i>Brachychiton populneum</i>		8
<i>Commersonia fraseri</i>	6	7
<i>Lasiopetalum latifolium</i>		7
STYLIDIACEAE			
<i>Stylidium laricifolium</i>	2	3 7
<i>S. lineare</i>		
THYMELIACEAE			
<i>Pimelea ligustrina</i>		6 7
<i>P. linifolia</i>	1	
URTICACEAE			
<i>Australina pusilla</i>		6
<i>Dendrocnide excelsa</i>		6 7
<i>Elatostema reticulatum</i>		6
<i>Urtica incisa</i>		6 7
VERBENACEAE			
<i>Clerodendrum tomentosum</i>		6 7
* <i>Lantana camara</i>		7
* <i>Verbena bonariensis</i>		
VIOLACEAE			
<i>Hymenanchera dentata</i>	2	6 7
<i>Viola hederacea</i>		
<i>V. sieberiana</i>	3	
VITACEAE			
<i>Cissus hypoglauc</i>		6 7
WINTERACEAE			
<i>Tasmannia insipida</i>		6 7
ANGIOSPERMS — MONOCOTYLEDONS			
ANTHERICACEAE (LILIACEAE)			
<i>Caesia vittata</i>		9
<i>Laxmannia gracilis</i>		9
<i>Sowerbaea juncea</i>	4	
<i>Thysanotus tuberosus</i>	4	
ARECACEAE			
<i>Livistona australis</i>		6 7
ARACEAE			
<i>Gymnostachys anceps</i>		6 7
<i>Alocasia macrorrhizos</i>		7
CANNACEAE			
* <i>Canna indica</i>		7
COLCHICACEAE (LILIACEAE)			
<i>Schelhammera undulata</i>		7
COMMELINACEAE			
<i>Pollia crispata</i>		6
* <i>Tradescantia albiflora</i>		7
CYPERACEAE			
<i>Caustis flexuosa</i>	3	
<i>C. pentandra</i>		4
<i>Chorizandra sphaerocephala</i>		5
<i>Cyathochaeta diandra</i>	3	7
* <i>Cyperus eragrostis</i>		6 7
<i>Gahnia aspera</i>		6
<i>G. clarkei</i>	3	

<i>G. sieberana</i>	1	3			9
<i>Gymnoschoenus sphaerocephalus</i>			4	5	
<i>Lepidosperma flexuosum</i>		3	4		
<i>L. laterale</i>		3	4	5	7 9
<i>Schoenus melanostachys</i>	1	2	3	4	
DIANELLACEAE (LILIACEAE)						
<i>Dianella caerulea</i>		3		7	9
<i>D. laevis</i>					9
<i>D. revoluta</i>		3			
HAEMODORACEAE						
<i>Haemodorum corymbosum</i>		3			
IRIDACEAE						
<i>Libertia paniculata</i>		3			
<i>Patersonia glabrata</i>		3			
<i>P. sericea</i>		3	4		
JUNCACEAE						
<i>Juncus continuus</i>	1	3			
<i>J. sp. D₁</i>		3			
<i>J. planifolius</i>		3	4		9
<i>J. subsecundus</i>		3			
LOMANDRACEAE						
<i>Lomandra filiformis</i> ssp. <i>filiformis</i>		3	4		
<i>L. glauca</i>		3	4		
<i>L. longifolia</i>	1	2	3	6	7
ORCHIDACEAE						
<i>Acianthus</i> sp.		3			
<i>Cymbidium suave</i>				7	
<i>Dendrobium linguiforme</i>		3			
<i>D. speciosum</i>				6	
<i>Liparis reflexa</i>					8
<i>Pterostylis longifolia</i>				7	
<i>P. nutans</i>				7	