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Structure, Floristics and Species Richness of Plant Communities in Southeast Queensland

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ABSTRACT

The species richness of overstorey and understorey strata is examined in relation to the structure of fifteen plant communities (representative of rainforest, savanna, and heathy edaphic complexes) in southeast Queensland.

Community species richness (at the level of species or superorder) decreases along a humidity gradient from perhumid to subhumid zones in the subtropical climate. The lower values of community species richness in the *Nothofagus* forest parallel reduced canopy shoot growth in a cooler climate at higher altitudes. Of the twenty-four superorders present in the perhumid rainforest, only 10–12 persist in subhumid communities. Six of these superorders increase in importance in savanna ecosystems, seven in heathy ecosystems.

Species richness of overstorey is closely related to overstorey shoot-growth; the density of shading, resulting from overstorey canopy development, influences the species richness of the understorey.

Introduced species have invaded the gaps in rainforest (especially overstorey trees and vines) and savanna (especially in the ground stratum), but are rare in heathy ecosystems. Short-lived invaders have displaced perennial grasses and forbs in the savanna ecosystem; more seed is produced per unit area, resulting in a ground stratum richer in plant species.

INTRODUCTION

There is strong palaeo-ecological evidence which indicates that, for much of the Tertiary, Australia was some 5°C warmer than at present (Keast, 1981; Specht, 1988). Southern Australia, in particular, experienced a subtropical climate, with humid to perhumid ecosystems widespread across the continent (Specht and Dettmann, in press); from the mid-Miocene until today, frequent periods of aridity accompanied by a general cooling, have produced climatic sifting of the Early Tertiary subtropical ecosystems, resulting in the present-day sequence of ecosystems from perhumid to arid Australia.

The present-day vegetation in southeastern Queensland should provide some insights into the climatic sifting of community structure and species richness which may have occurred within the subtropical ecosystems of the Early Tertiary, in southern Australia (Herbert, 1950; Specht, 1958; Christophel and Greenwood, 1988).

In the subtropical region of southeast Queensland:

1. With decreasing temperature (associated with increasing altitude)
   (1) Perhumid closed-forests ('rainforests') grade from a notophyll vine forest to a microphyll fern forest.
2. With increasing aridity
   (1) Perhumid closed-forests grade from a notophyll vine forest/tall open-forest ('wet sclerophyll forest') to semi-evergreen microphyll vine forest to layered open-forest (dominated by brigalow, belah and bottle trees).
   (2) Savanna open-forests ('grassy open-forest') grade to savanna woodlands to grasslands on nutrient-rich soils.
   (3) Heathy open-forests ('dry sclerophyll forests') grade to heathy woodlands to heathlands on nutrient-poor soils.

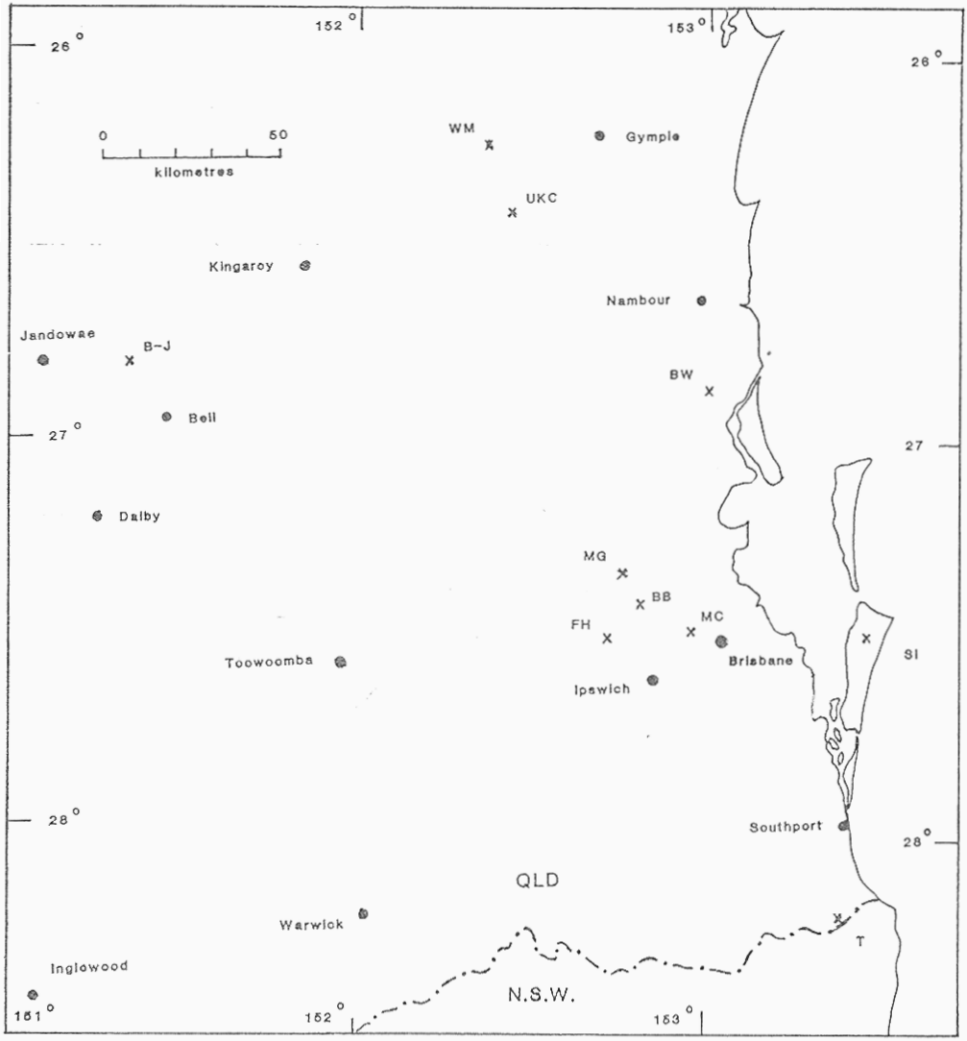

Fig. 1. Location of sampling sites in southeast Queensland.
BB Boombana; B-J Bell-Jandowae; BW Beerwah; FH Flinton Hill; MC Mt Coot-tha; MG Mt Glorious; SI Stradbroke Island; T Tullawallal; UKC Upper Kandanga Creek; WM Widgee Mountain.

(4) Intergrading savanna/heathy low open-forest occurs on serpentinite outcrops.

This study critically examines representative plant communities in subtropical southeastern Queensland, in order to show the major patterns of change in community structure and associated species richness, induced by these climatic gradients.

STUDY SITES

The following mature ecosystems (showing little evidence of disturbance by man) have been studied in detail in southeast Queensland (Fig. 1):

Rainforest edaphic complex (Soil Fertility Index > 0.75 — Specht, 1981)
- Microphyll fern forest (on krasnozem), Lamington N.P., Qld.
- Complex notophyll vine forest (on euchrozem), Mt Glorious, Qld.
- Semi-evergreen microphyll vine forest (on euchrozem), Flinton Hill, Qld.

Marginal rainforests (Soil Fertility Index > 0.75 — Specht, 1981)
- Tall layered open-forest (on red podzolic soil), Boombana N.P., Qld.
- Layered open-forest (on Quaternary alluvium), Bell-Jandowae, Qld
- Savanna edaphic complex (Soil Fertility Index 0.50–0.70 — Specht, 1981)
- Savanna open-forest (on podzolic lithosols–phyllites), Mt Coot-tha, Qld.
- Savanna open-forest/woodland (on grey soil of heavy texture), Bell–Jandowae, Qld.
- Savanna woodland (on black earth — basalt), Bell–Jandowae, Qld.

Heathy edaphic complex (Soil Fertility Index 0.10 — Specht, 1981)
- Heathy open-forest (on lateritic podzolic soils), Beerwah, Qld.
- Wet-heathland (on gleyed podzolic soil), Beerwah, Qld.
- Heathy open-forest (on podzolised sand of low hilly white sandhills), near Brown Lake, North Stradbroke Island, Qld.
- Dry-heathland (on "giant" podzols of high transgressive dunes), Mt Hardgrave, North Stradbroke Island, Qld.
- Heathy/savanna open-forest (lithosol–sandstone), Bell–Jandowae, Qld.

Serpentinite vegetation (Soil Fertility Index 0.30 — Specht, 1981)
- Savanna (+ *Xanthorrhoea*) low open-forest (on prairie soil — from serpentinite), Widgee Mountain, Qld, also Upper Kandanga Creek, Qld (Batianoff *et al.*, 1991).

FIELD OBSERVATIONS

For each study-site, the following observations were collated:

Foliage projective cover (FPC %) and *height* (m) of upper, mid and ground strata of mature plant communities, recorded during the season of minimal shoot growth (Specht and Specht, 1989c) — Percentage foliage interception in vertical, (needle-line) cross-wire sighting tubes was recorded at 50 cm intervals along randomly-located 50 m tapes.

Floristics — All plant species were collected within each plant community, identified by the authors, and checked by the staff of the Queensland Herbarium. Monthly visits over two to three years ensured that the majority of species was recorded in each list.

Species richness — number of vascular species contained in (or overlapping) nested quadrats of 1, 10, 100 and 1,000 m^2 in size, replicated within the study-site. The species (N)–area (A) relationship was expressed by the equation (Hopkins, 1955): $N = a \log A + b$

Life form spectrum — Proportion of the total vascular flora (in 1–2 hectares) recorded as trees (Raunkiaer's (1934) life-form mesophanerophyte), small trees/tall shrubs (microphanerophyte), low shrubs (nanophanerophyte), tree ferns, vines (lianes) or climbers, epiphytes (ferns and angiosperms), epiphytic parasites, ground stratum (ferns and angiosperms — chamaephytes, hemicryptophytes, geophytes, and therophytes).

Climatic data — collated from Australian Bureau of Meteorology handbooks, analysed by the Plant Community Simulation Program COMSIM (Specht, 1972, 1981) to derive the evaporative coefficient (k) for each study site.

Soil data — Soil profiles examined in the field, were related to Great Soil Groups (Stace *et al.*, 1968) with the assistance of Mr. C.H. Thompson of C.S.I.R.O. Division of Soils. Relevant chemical and physical analyses were extracted from published literature.

NUMERICAL ANALYSES

Correlation analyses

Statistical regression analyses determined the relationships between the evaporative coefficient (k) of each study site and (1) community species richness, (2) overstorey species richness, (3) the number of superorders per hectare, (4) the number of species per superorder, and (5) annual shoot-growth of overstorey *Eucalyptus* species.

At both Mt Hardgrave, North Stradbroke Island, and Bell–Jandowae, the statistical relationships between overstorey Foliage Projective Cover and species richness in adjacent micro-communities were established.

Clustering of sites

The sites were clustered on the basis of the number of species occurring in each of 29 plant groups: ferns, lycopods, cycads and conifers, together with 25 superorders of flowering plants, using the Canberra Metric as the measure of similarity, and clustering by the Group Average procedure (Clifford and Stephenson, 1975).

RESULTS

Detailed analyses of the structure, floristics, species-richness and the abiotic environment of each plant community are presented in Appendix I.

The study covers all major plant formations recorded in the subhumid to perhumid climates of southeastern Queensland (Specht *et al.*, 1974; Specht, in press), on three broad soil-nutrient groups — high, medium and very low. The relative growth of indicator species on unfertilized soil, compared with the growth on soil with optimal fertilizers, may be used as an index to express the nutrient status of the soil (Specht, 1981).

Rainforest edaphic complex — Soil Fertility Index greater than 0.75.

Savanna edaphic complex — Soil Fertility Index 0.50–0.70.

Heathy edaphic complex — Soil Fertility Index 0.10.

The vegetation developed on each edaphic complex may be recognised by distinctive structure (Fig. 2) and life form spectrum (Table 1).

1. Structure and life form spectrum

(a) Rainforest edaphic complex

The upper stratum of the rainforest edaphic complex is closed (FPC > 70%). Several intergrading strata are characteristic of this edaphic complex, each stratum becoming shorter in less humid environments (Mt Glorious to Flinton Hill to Bell–Jandowae) and as annual temperature decreases (*Nothofagus* forest, Lamington National Park). Meso- and micro- phanerophytes (31–53% of the total number of species) form the overstorey in the life-form spectrum, with an understorey of nanophanerophytes (10–23%), tree ferns (0–5%), and ferns and angiosperms (4–13%) forming a ground stratum. Lianes (19–23%) intertwine through the canopy, while epiphytes (5–10%) are common; parasitic mistletoes are rare (0–1%).

(b) Mareinal rainforests

At the edge of the rainforest where water becomes limiting, tall *Eucalyptus* trees (Boombana) overtop the perhumid rainforest elements, while *Allocasuarina luehmannii* overtops the subhumid rainforest elements at Bell–Jandowae.

Emergent mesophanerophytes (6–10% of the total number of species) overtop the rainforest micro-phanerophytes (25–31%), which form a complex mid-stratum, with lianes (14–20%) interlaced. An understorey of nanophanerophytes (16–22%) and ground stratum plants (24–25%) is present, with ground-ferns (but no tree ferns) being common in the wetter sites (Boombana).

(c) Savanna edaphic complex

The savanna edaphic complex on medium nutrient soils experiences more seasonal water stress than the rainforest edaphic complex. The upper stratum of *Eucalyptus* trees is open (FPC 35–50%), the mid-stratum is sparse, and a ground stratum of grasses and herbs gives the community the typical understorey of a savanna open-forest formation. As the climate becomes less humid (Mt Coot-tha to Bell–Jandowae), the tree stratum decreases in height and its canopy becomes more open, approaching that of the savanna woodland formation (Specht, 1970); the FPC of the savanna understorey becomes less dense — (FPC 51 and 73% on Mt Coot-tha, FPC 49 and 56% at Bell–Jandowae).

Mesophanerophytes (3–15% of the total number of species) form the overstorey in the life-form spectrum, with more tree species being found in the wetter sites (Mt Coot-tha).

Table 1 Species rich ess of major pl nt communities in southeast e nslai d, ubdi ided into life-form categories (Sampli g area 1 2 hectares).

Locality / Plant community	Trees (Mesophanerophytes)	Small trees or Tall shrubs (Microphanerophytes)	Tree ferns	Low shrubs (Nanophanerophytes)	Vines (Lianes) and climbers	Epiphytes			Ground stratum		Total
						Ferns	Angiosp.	Parasit s	Ferns	Angiosp.	
Lamington N.P.											
—*Nothofagus moorei* microphyll fern forest	9	10	3	14	12	3+		—	2+	6	62+
Mt Glorious closed-forest	68+1*	27+2		18+4	41+2	9		1	3	4+1*	178+10*
—complex notophyll vine forest											
Flinton Hill	102+1*		—	44+1	41+4	4	6	1	8	11+1*	217+7*
—semi-evergreen microphyll vine forest											
Boombana N.P.	9	36+4	—	32+4	29+2*	2	1	2	10	24+4*	145+14*
—tall layered open-forest											
Mt Coot-tha savanna open-forest											
—North-facing slope	12	9	—	—	4+1*	—	—	2	—	56+13*	83+14*
—South-facing slope	9	6	—	—	5+1*	—	—	—	4	57+12*	81+13*
Beerwah											
—heathy open-forest	5	8	—	43	4	—	—	3	3	41	107
—wet-heathland	(2)	—	—	30	1	—	—	2	3	61	97+(2)
North Stradbroke Island											
—heathy open-forest	3	2	—	27	—	—	—	4	3	42	81
—dry-heathland	—	6	—	29	2	—	—	2	3	33	75
Bell–Jandowae											
—belah layered open-forest	5	9+7+	—	8+1	7+1	—	—	2	—	13	51+3*
—*E. populnea* savanna woodland/ open-forest	3	10+1*	—	5	1	—	—	5	—	21+4*	45+5*
—*E. orgadophila* savanna woodland/open-forest	2	4	—	4	1	—	1	—	—	49+8*	61+8*
—*E. maculata* heathy/savanna open forest	3	4	—	8	—	—	—	—	2	17+1*	34+1*
Widgee Mountain											
—savanna (+ *Xanthorrhoea*) woodland	7	8	—	14+	5+1*	—	—	—	1	50	85+4*

* Introduced species, mostly on disturbed habitats.

\+ The mid-stratum of this community contains a mixture of m ll trees and a somewhat shorter yer of tall shrubs.

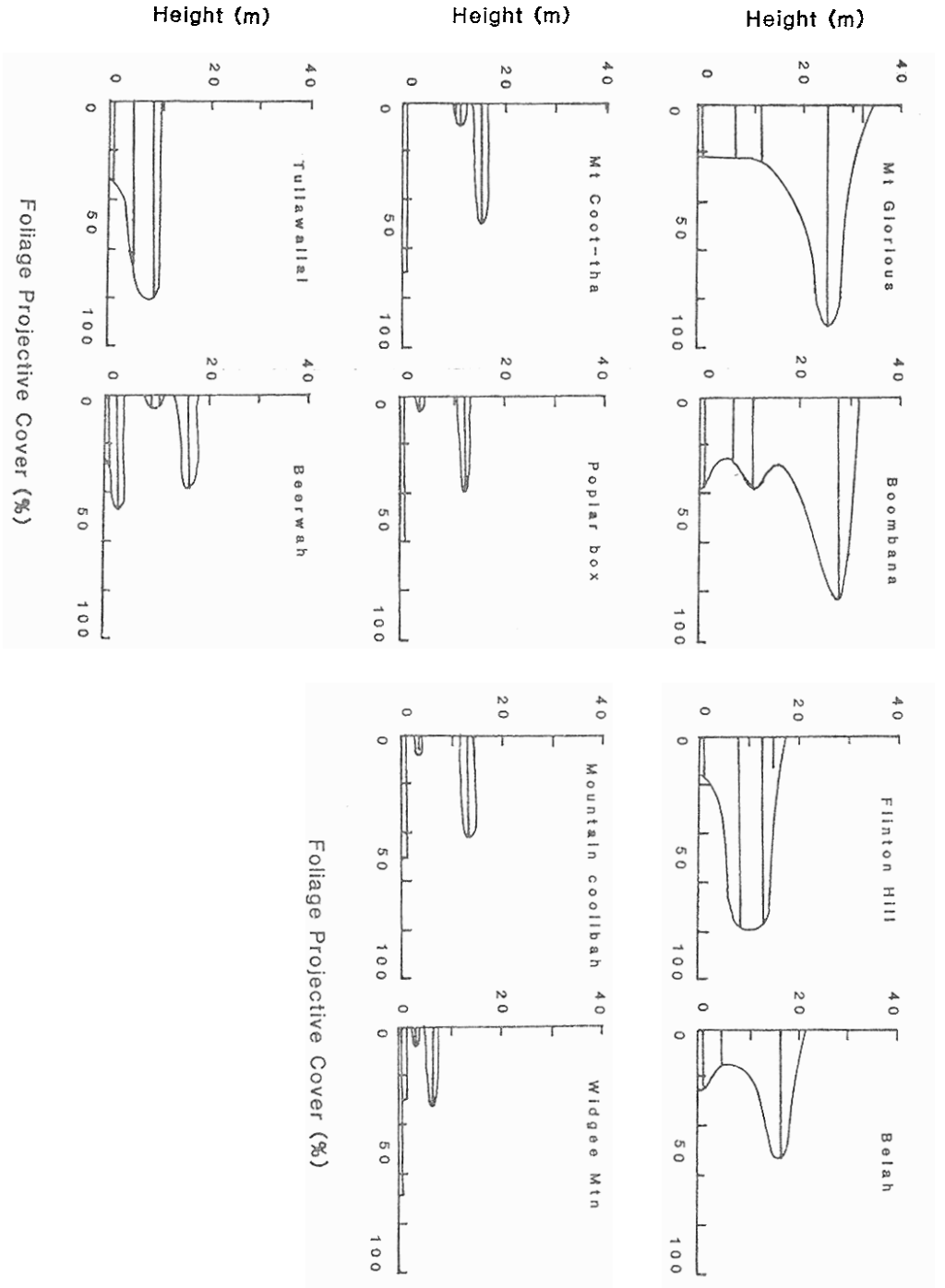

Fig. 2. Profile diagrams showing the distribution of Foliage Projective Cover with height of plant communities representative of the rainforest, savanna and heathy edaphic complexes in southeast Queensland.

Microphanerophytes (6–22%) form a scattered mid-stratum. Nanophanerophytes (0–11%) tend to occur more frequently (though still sparse) in the drier sites (Bell–Jandowae), while tree ferns are absent throughout. The herbaceous ground stratum is very rich (47–81%), plus herbaceous climbers (2–6%), with ferns rare except in wet micro-habitats. Epiphytes are almost absent, but parasitic mistletoes become prominent (11%) in drier habitats (*E. populnea* community at Bell–Jandowae).

(d) Heathy edaphic complex

The dearth of soil nutrients in nutrient-poor soils results in only a small decrease in stature and Foliage Projective Cover of the open-forests of the heathy edaphic complex compared with that of adjacent nutrient-rich soils (in the humid climates of Stradbroke Island and Beerwah). Instead of the savanna understorey of nutrient-rich soils, a heathy understorey develops on nutrient-poor soils, composed of several layers of sclerophyllous plants — sparse tall shrub layer 3–4 m, dense small shrub layer 2 m tall, and ground stratum of chamaephytes and sclerophyllous monocotyledons.

Only a few mesophanerophytes (5–8% of the total number of species) and microphanerophytes (3–7%) are found in this nutrient-poor plant community. Many nanophanerophytes (38–40%) form the shrubby stratum, while chamaephytes (16–19%), sclerophyllous monocotyledons (22–23%) and scrambling plants (3–4%) occur in the ground stratum. Occasional parasitic mistletoe are found in the trees, while the parasitic *Cassytha* may be common in the understorey.

As the landscape becomes seasonally-waterlogged, the few species of trees of the heathy open-forest fail to survive (Bolton, 1986), thus forming a wet-heathland (Beerwah), with *Banksia aemula* (a microphanerophyte) emergent in the ecotone area between open-forest and wet-heathland.

Similarly, trees fail to establish on the seasonally-droughted, deep sands on the summit of Mt Hardgrave, North Stradbroke Island (Clifford and Specht, 1979), thus producing a dry-heathland community.

In the absence of mesophanerophytes, sclerophyllous nanophanerophytes, chamaephytes and monocotyledons become more prominent in the life-form spectrum of heathland communities.

(e) Serpentinite vegetation

The vegetation on serpentinite soils (in the humid climate of Widgee Mountain) shows the influence of a high Mg:Ca ratio in the soil, associated with increased uptake of nickel. The deep-rooted, tree stratum is stunted and more open (FPC 34% upper stratum, 7% mid stratum), favouring the development of the understorey. Savanna grasses and forbs, as dense (FPC 68%) as that observed on the non-serpentinite soils of Mt Coot-tha, form a typical ground stratum, with many trunked grass trees (*Xanthorrhoea glauca*, FPC 16%) — and a few other sclerophyllous shrubs (FPC 4%) — prominent in the understorey. This vegetation appears to be transitional between the savanna and heathy edaphic complexes.

Mesophanerophytes (7% of the total number of species) and microphanerophytes (4%) form the overstorey of this serpentinite vegetation. Nanophanerophytes are generally scattered throughout the community, with many specimens of *Xanthorrhoea glauca* (often in dense stands) appearing as the parent-rock becomes more ultramafic. The herbaceous ground stratum (70%) is comprised of many species of herbs and grasses, typical of savanna communities.

2. Floristics and species-richness

Although the species–area relationship of each plant community was assessed in a series of nested quadrats up to 1,000 m^2 in area (Appendix I), the species-richness of the stand will depend on the age of the community after a fire or other 'natural' disturbance (Specht and Specht, 1989b). As the community ages after a disturbance, pioneer species will tend to decrease in importance and eventually to disappear. It is thus necessary to search for remnants of these pioneer species over a much larger area than 1,000 m^2; areas of 1–2 hectares of relatively uniform plant communities have been visited at monthly intervals (over two to three years) to ensure that the majority of the flora has been sampled. The total number of species recorded in the area is here termed *community species-richness*.

Community species-richness, of all edaphic complexes, increases exponentially (Fig. 3) from the subhumid sites (45 species when the evaporative coefficient k is 0.050) to the most humid sites (190 species when the evaporative coefficient k = 0.100). The warm-temperate *Nothofagus* closed-forest at Lamington National Park (with community species-richness of 62 species) is the only plant community which departs from the relationship (Fig. 3), established for subtropical vegetation. Species richness of these small, isolated pockets of warm-temperate vegetation is consistent with the values predicted by the reduced shoot-growth associated with cooler climates (Specht and Specht, in prep.).

Overstorey (meso- and micro-phanerophytes) species of the forest communities also show a linear increase in species-richness as the climate becomes more humid (Fig. 3). As an exception to this generalisation, overstorey species on low-nutrient soils are greatly reduced in number, also in Foliage Cover (Appendix Tables 6 and 7). Thus, as more solar radiation penetrates the overstorey of these heathy open-forests, understorey species increase both in Foliage Cover and number, but the total number of species in the community remains constant (Specht and Morgan, 1981).

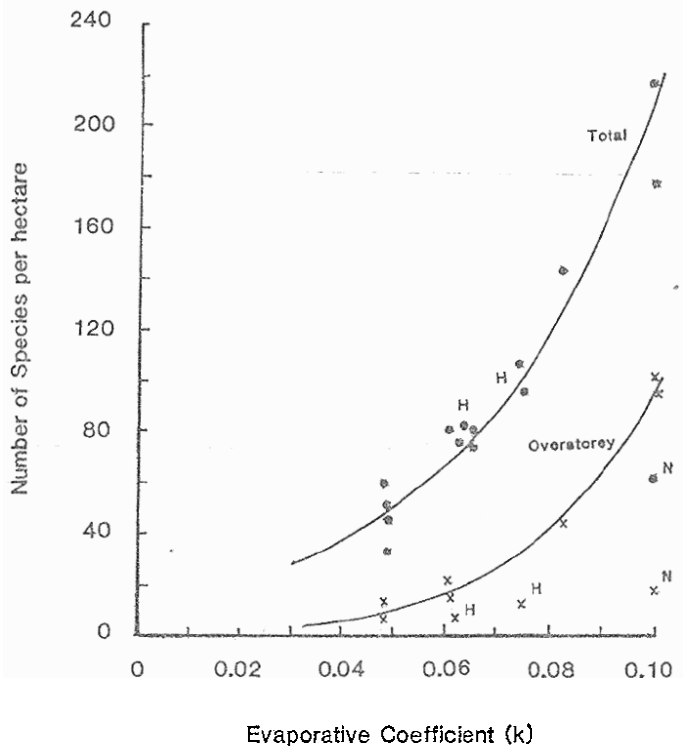

Fig. 3. Relationship between (1) community species richness, (2) overstorey species richness to the evaporative coefficient (k) in southeast Queensland.
(N = *Nothofagus* forest and H = heathy open-forest are not included in the analyses.)
ln(community species richness) = 2.54 + 28.10k (n = 14, r^2 = 0.91)
ln(overstorey species richness) = 0.01 + 46.50k (n = 7, r^2 = 0.93)

Within any macro-climate, micro-habitat factors (e.g. micro-distribution of rainfall, seasonal waterlogging, soil nutrient-status) may create adjacent plant communities with different overstorey foliage cover. Species-richness (per unit area) of these adjacent communities (of the same post-fire age) decreases as overstorey cover increases (Fig. 4), while overstorey species-richness increases.

When community species-richness (Appendix I) is examined as higher order taxa (Table 2), it would appear that almost all angiosperm superorders (Dahlgren, 1983) decrease in importance (or disappear) as the climate becomes less humid (Fig. 5). Twenty-two angiosperm superorders are present in the Mt Glorious rainforest (evaporative coefficient k = 0.100), while only 12 superorders persist in the subhumid climate at Bell-Jandowae (evaporative coefficient k = 0.050). Likewise, the ferns and conifers decrease in importance towards less humid habitats (Table 2).

There is also a decrease in species richness with decreasing temperatures for ferns and conifers as well as in angiosperm superorders. The lower species richness of *Nothofagus* forests as compared to rainforests is shown in Figures 3 and 5 where the values for warm-temperate *Nothofagus* forests fall below the linear regression lines.

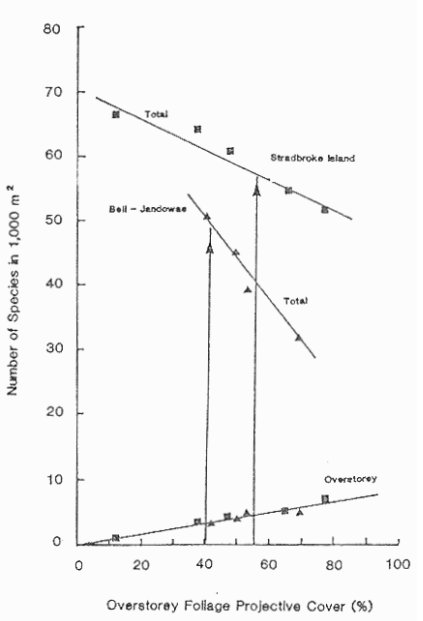

Fig. 4. The effect of overstorey foliage projective cover (FPC %) on species-richness (N, mean number of species in 1000 m^2) in adjacent micro-communities.
Mt Hardgrave, North Stradbroke Island (heathy communities — after Specht and Morgan 1981)
Total $N = 70.40 - 0.23$ FPC ($n = 5$, $r^2 = 0.93$)
Bell–Jandowae (savanna communities)
Total $N = 75.72 - 0.64$ FPC ($n = 4$, $r^2 = 0.99$)
The number of overstorey species (per 1000 m^2) found in both these suites of micro-communities is related linearly to the overstorey foliage cover:-
Overstorey $N = -0.19 + 0.083$ FPC ($n = 9$, $r^2 = 0.94$)
This equation is essentially the lower section of the exponential relationship, demonstrated for subtropical, climax plant communities in the macro-climatic gradient from arid to perhumid (Specht and Specht, 1989a).
The mean value of overstorey FPC in climax plant communities in each region (Specht, 1972, 1981) is shown by arrows.

Only a few of the angiosperm superorders show an increase in importance in less humid climates. In the heathy edaphic complex, the following superorders develop in species-richness:

Corniflorae (especially Epacridaceae)	5–10 spp.
Fabiflorae (especially Fabaceae)	7–18 spp.
Myrtiflorae (especially Myrtaceae)	5–13 spp.
Proteiflorae (Proteaceae)	6–16 spp.
Commeliniflorae (especially Cyperaceae, Restionaceae)	11–16 spp.
Liliiflorae (especially Iridaceae, Liliaceae, Xanthorrhoeaceae)	15–21 spp.

Theiflorae (*Drosera* spp.) is restricted to the heathy edaphic complex. In the savanna edaphic complex, the following angiosperm superorders develop in importance:

Asteriflorae (especially Asteraceae)	1–11 spp.
Fabiflorae (especially Fabaceae)	8–19 spp.
Commeliniflorae (especially Poaceae)	11–23 spp.

The Caryophylliflorae (Chenopodiaceae and Amaranthaceae) appear at the edge of semi-deciduous rainforests and in adjacent savanna ecosystems in less humid areas.

Table 2. Species richness of major plant communities in southeast Queensland. Species grouped into angiosperm superorders ferns lycopods and conifers.

	Nothofagus forest	Mt Glorious rainforest	Flinton Hill dry rainforest	Boombana tall open forest	Mt Cootha (north slope) open-forest	Mt Cootha (south slope) open-forest	Beerwah — heathy forest	Beerwah — wet-heathland	Strathbroke — heath	Strathbroke — heathy forest	Bell - *Casuarina* forest	Bell — *E. populnea* woodland	Bell — *E. orgadophila* woodland	Bell — *E. muralpia* forest	Widgee Mt woodland (serpentinite)	Upper Kandanga Ck woodland (serpentinite)
Araliiflorae	4	8	6	8	—	—	—	2	3	3	3	2	—	—	1	2
Asteriflorae	2	—	—	2	5	8	1	—	—	1	—	1	11	6	6	10
Caryophylliflorae	—	—	1	—	—	—	—	—	—	—	4	—	2	1	—	—
Corniflorae	6	8	1	3	1	—	5	6	8	10	—	—	—	1	1	1
Fabiflorae	—	4	6	17	19	18	18	7	8	7	3	8	11	9	10	10
Gentianiflorae	6	17	29	10	2	—	4	5	—	2	8	—	3	—	4	4
Lamiiflorae	1	3	10	3	5	6	—	1	—	—	4	1	2	—	5	3
Magnoliiflorae	7	21	6	4	2	1	2	2	2	2	—	—	—	—	—	1
Malviflorae	2	23	47	13	3	6	9	5	8	7	2	3	5	4	5	5
Myrtiflorae	4	8	7	12	11	8	13	10	9	5	—	2	1	3	5	5
Nymphaeiflorae	—	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—
Primuiflorae	1	6	9	2	1	—	—	—	—	—	—	—	—	—	—	—
Proteiflorae	3	2	1	—	1	—	16	8	6	6	—	—	—	1	2	1
Ranunculiflorae	—	4	3	3	—	—	—	—	—	—	—	—	—	—	—	—
Rosiflorae	3	4	3	5	1	2	1	1	1	1	2	—	—	—	2	2
Rutiflorae	1	22	36	11	1	1	3	5	3	3	6	3	4	1	2	2
Santaliflorae	—	8	14	10	2	2	2	1	—	1	8	8	—	—	2	1
Solaniflorae	1	2	1	3	—	1	—	—	—	2	4	2	2	1	1	—
Theiflorae	—	—	—	—	—	1	1	4	—	—	—	—	—	—	—	1
Violiflorae	1	3	5	2	1	1	—	—	—	—	3	1	1	—	1	1
Areciflorae	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ariflorae	—	2	1	1	—	1	—	—	—	—	—	—	—	—	—	—
Commeliniflorae	1	1	4	10	23	11	13	16	9	11	3	11	14	1	20	25
Liliiflorae	10	12	14	11	5	10	15	21	15	17	1	3	4	4	6	4
Zingiberiflorae	—	1	—	1	—	—	—	—	—	—	—	—	—	—	—	—
FERNS	8	15	12	12	—	4	3	1	3	3	—	—	—	2	1	2
LYCOPODS	—	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—
CYCADS	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	—
CONIFERS	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—

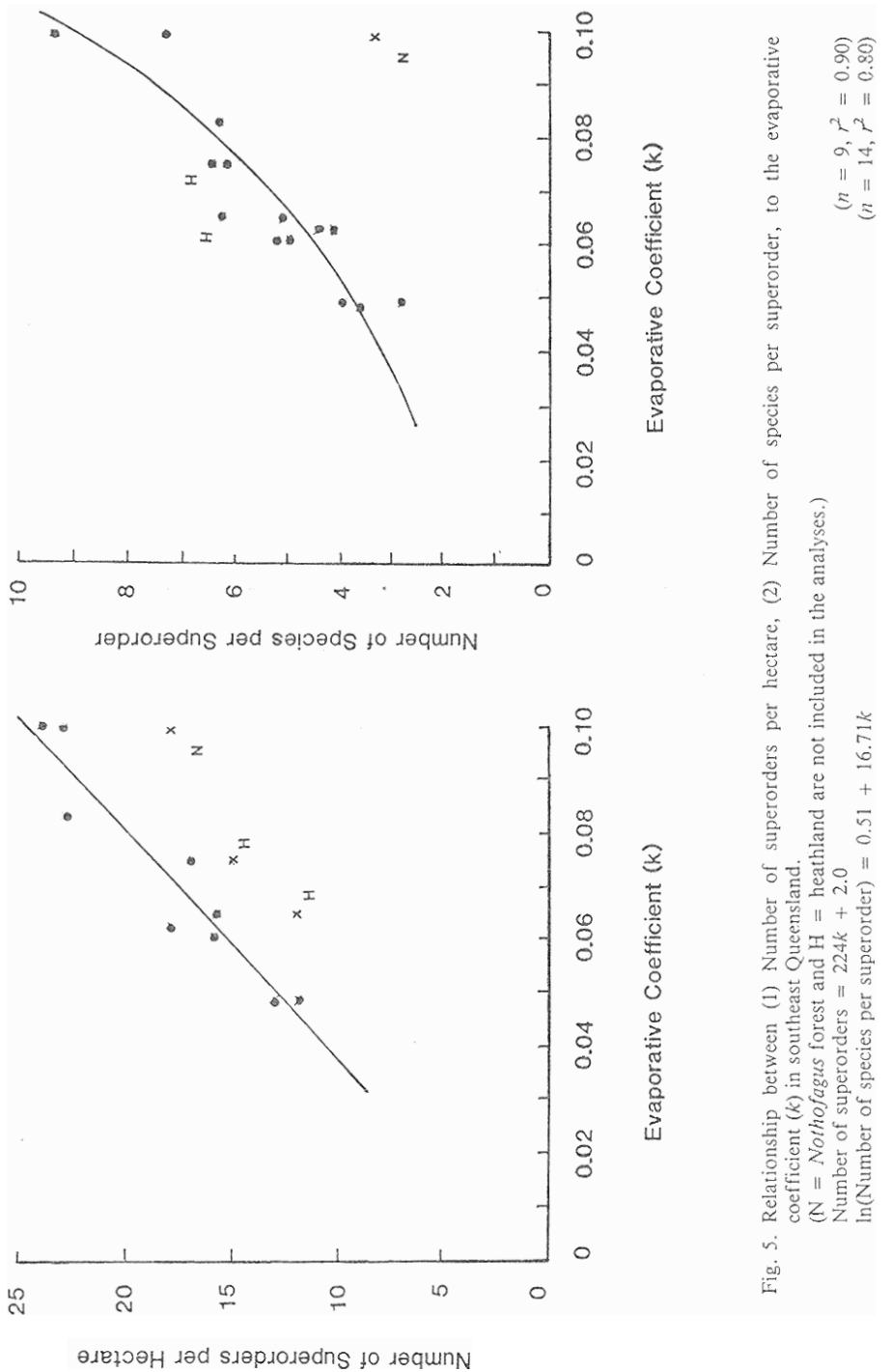

Fig. 5. Relationship between (1) Number of superorders per hectare, (2) Number of species per superorder, to the evaporative coefficient (k) in southeast Queensland.
(N = *Nothofagus* forest and H = heathland are not included in the analyses.)
Number of superorders = $224k + 2.0$ ($n = 9$, $r^2 = 0.90$)
ln(Number of species per superorder) = $0.51 + 16.71k$ ($n = 14$, $r^2 = 0.80$)

3. Introduced species

Introduced species have invaded gaps in both rainforest and savanna ecosystems, and are rare or absent in heathy ecosystems (Table 1). Overstorey trees and vines are frequent introductions in rainforest ecosystems, with a few ground stratum species. Introduced species have invaded gaps in the ground stratum of savanna ecosystems.

DISCUSSION

Community structure (Fig. 2) tends to increase in complexity along the humidity gradient from subhumid to perhumid climates in subtropical, southeast Queensland. Parallel to this, both community species-richness (total number of vascular species in 1–2 hectares) and higher order taxa increase in number along the same humidity gradient (Fig. 3, 5). It is only the warm-temperate *Nothofagus* closed-forest of Lamington National Park that shows lower values of species-richness (of vascular plants).

For forest communities growing on medium- to high-nutrient soils, the number of overstorey species (meso- and micro-phanerophytes) shows a similar increase along the humidity gradient (Fig. 3). However, few overstorey species are found in the warm-temperate *Nothofagus* closed-forest (see also cool-temperate *Nothofagus* closed-forests in Tasmania and Victoria (Specht and Specht, 1989a)) and in the heathy open-forests on low-nutrient soils. It has been demonstrated that the number of overstorey species in the stand is correlated with the vigour of annual shoot growth in the foliage canopy (Specht and Specht, 1989a). Along the humidity gradient from subhumid to perhumid, the annual shoot growth of *Eucalyptus* trees in southeast Queensland increases as shown in Fig. 6 (see also Specht and Specht, 1989c). Canopy growth of *Eucalyptus* trees in the heathy open-forest on low nutrient-soils is reduced in both foliage cover (Appendix Table 6) and shoot elongation (Fig. 6). Shoot growth (in length of shoots produced each year) of *Nothofagus* trees is markedly reduced by the lower temperatures experienced at that altitude (Fig. 6, Specht and Specht, 1989c). It thus appears that the correlation found between annual shoot growth and overstorey species-richness (Specht and Specht, 1989a) is maintained in a variety of forests on a range of soil fertility, growing along both humidity and temperature gradients, in southeast Queensland.

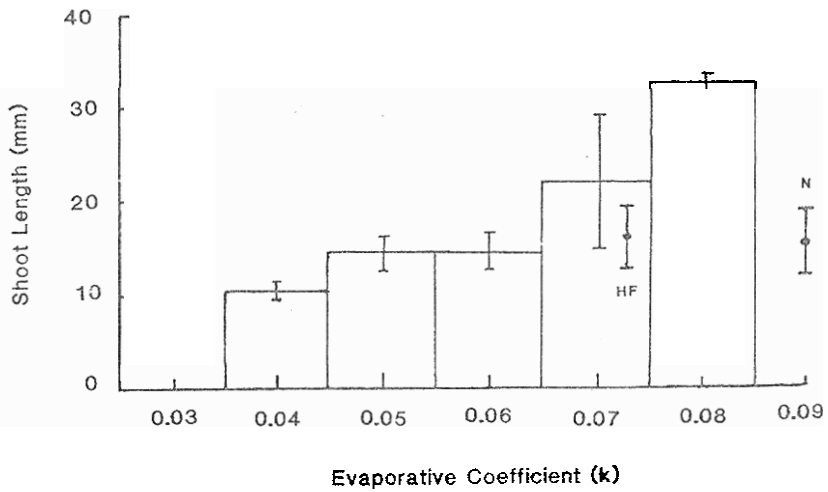

Fig. 6. Relationship between mean annual shoot-growth (± standard deviation) of overstorey *Eucalyptus* species to the evaporative coefficient (*k*) in southeast Queensland (after Specht and Specht, 1989c).
(N = *Nothofagus* forest, HF = heathy open-forest.)

Understorey species-richness is influenced by overstorey foliage cover (Specht and Morgan, 1981; Specht and Specht, 1989b, Fig. 4). The reduced Foliage Projective Cover of the heathy open-forest (Fig. 2) will allow species-richness of the understorey to increase so that total community species-richness reaches the equilibrium value shown in Fig. 3.

The expected value for total community species-richness (for warm-temperate vegetation) has not been attained by vascular species (ferns and angiosperms) in the small, isolated pockets of *Nothofagus* forest in the Border Ranges. It is in this microphyll fern-forest that species of ferns and cryptogams increase greatly in number. If the abundant cryptogam flora of epiphytic and ground species is also included with the vascular plants (as in the study of the heathland flora of Britain — Hopkins 1955), the total community species richness may approach that expected in this perhumid, warm-temperate climate (Specht and Specht, in prep.).

The marked influence of the humidity gradient (evaporative coefficient *k*) on species-richness, especially in sifting higher level taxa (Fig. 5) appears to determine the broad relationships shown by Cluster Analysis (Fig. 7), where the following groups have been recognised:–

1. Lamington N.P. *Nothofagus* forest — 17 angiosperm superorders
2. Mt Glorious rainforest
   Boombana rainforest
   (with *Eucalyptus* emergents)
   Flinton Hill dry rainforest — 21–22 angiosperm superorders
3. Mt Coot-tha savanna forest
   Widgee Mt. savanna forest
   (with *Xanthorrhoea*)
   Kandanga Creek savanna forest
   (with *Xanthorrhoea*) — 15–17 angiosperm superorders
4. Beerwah heathy ecosystems
   Stradbroke Island heathy ecosystems — 14–15 angiosperm superorders
5. Bell–Jandowae savanna woodlands
   Bell–Jandowae rainforest
   (with *Allocasuarina* emergents) — 12–13 angiosperm superorders

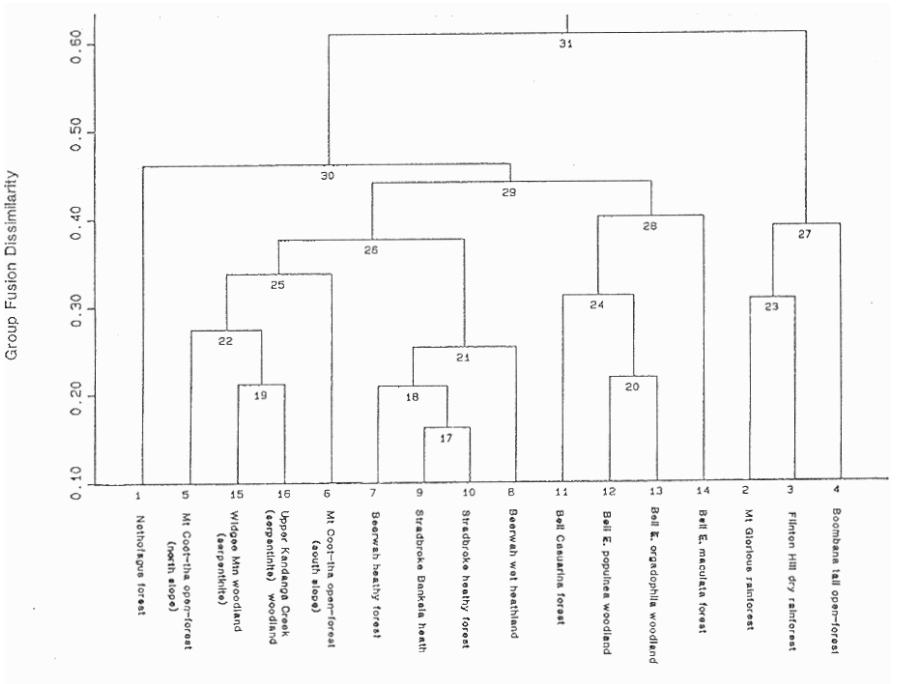

Fig. 7. Dendogram resulting from clustering 16 plant communities in southeast Queensland on the basis of the number of species occurring in each of 29 plant groups. These were the ferns, lycopods, cycads and conifers together with 25 superorders as defined by Dahlgren (1983). Similarity measure employed — Canberra Metric; clustering by Group Average (Clifford and Stephenson, 1975). [Analysis due to Dr C.J. Andrews.]

The separation of the subtropical rainforest group (No. 2) from all other groups early in the Cluster Analysis (Fig. 7) is a result of the large number (21–22) of superorders surviving in perhumid sites of the lowland to upland altitudes (0–800 m) of southeast Queensland. The number of superorders (17), surviving in the *Nothofagus* forest (Group No. 1) is correlated with reduced shoot growth in the foliage canopy as air temperature decreases with altitude (Specht and Specht, 1989c; Specht and Yates, 1990; Specht and Specht, in prep.). As drought increases in the gradient from humid to subhumid climates, the number of superorders progressively decreases (from 15–17 in savanna open-forest — Group No. 3 — to 12–13 in savanna woodland — Group No. 5). The 14–15 superorders recorded in heathy ecosystems on nutrient-poor soils of the humid coastal lowlands is less than the 15–17 superorders found in the savanna open-forests on nutrient-rich soils.

CONCLUSIONS

The structure of plant communities is determined by environmental factors — humidity (evaporative coefficient *k*), rainfall, temperature and soil nutrition. These factors all influence the plant communities of southeast Queensland, in particular the annual shoot growth of overstorey species (Fig. 6).

Community species richness (the total number of vascular species recorded in 1–2 hectares) is closely correlated with the evaporative coefficient (*k*). This relationship applies for all communities studied in southeast Queensland (both at the level of species and higher level taxa). [In the warm-temperate *Nothofagus* forest, cryptogams appear to replace vascular species in the total count — an hypothesis which needs to be tested.]

Overstorey species richness (the number of meso- and micro-phanerophytes recorded in 1–2 hectares) of forests in southeast Queensland is correlated with the evaporative coefficient (*k*), except in the warm-temperate *Nothofagus* forest and in the heathy open-forests. In these latter communities, cooler temperatures and low soil nutrients, respectively, affect annual shoot growth (Specht and Specht, 1989c; Specht and Yates, 1990; Specht and Specht, in prep.). Micro-habitat variation in a macro-climate also produces a series of micro-communities with different overstorey foliage cover and annual shoot growth, correlated with overstorey species richness (Fig. 4). Species richness of the overstorey of all plant communities can be correlated with annual shoot growth of that community (Specht and Specht, 1989a).

Community species richness — the sum of overstorey and understorey species richness — appears to be a constant for any particular evaporative macro-climate (evaporative coefficient *k*), increasing exponentially from subhumid to perhumid climates in southeast Queensland. Understorey species richness is determined by the radiant energy transmitted through the overstorey canopy. Reduction in overstorey cover induced by micro-habitat factors, such as seasonal waterlogging, soil nutrient-poverty, etc., leads to increased species richness of the understorey in that macro-climate.

Disturbance, by man and his grazing animals, of the largely perennial understorey of native Australian plant communities has led to the invasion of many short-lived plants, in which a large percentage of photosynthesis is utilized in the production of seed. The species richness of this exotic ground stratum increases dramatically (Specht *et al.*, 1990).

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APPENDIX

Table 1. Species richness and structure of microphyll fern forests in Lamington National Park, Queensland (Compiled by R.L. Specht 1987).

Location: Tullawallal, Lamington National Park, Queensland (28°13'S, 153°11'E, 935 m)

Nearest climate station:
Binna Burra Guest House (28°12'S, 153°11'E, 780 m)
Annual precipitation 1678 mm; rain days 125
Green Mountains (28°14'S, 153°08'E, 924 m)
Annual precipitation 1661 mm; rain days 126
Mean annual temperature 15.6° (est.)
Evaporative coefficient (*k*) 0.100

Geology: Miocene basalt

Soils: Krasnozems (Gn 4.31) — brown friable porous earths with brown subsoils of rough-faced peds. Surface soils are loamy and darkened by organic material, grade directly into the subsoil without any observable A2 horizon. Acid reaction trend through the profile.

Chemical and physical analyses (Darling Downs example — Stace *et al.*, 1968)

Depth 0–10 cm, pH 6.1, C 14%, N 0.46%, P 0.08%, Avail. P 14 p.p.m.
Coarse sand 7%, Fine sand 30%, Silt 26%, Clay 25%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 44, Ca 8.1, Mg 6.6, K 0.2, Na 0.6

Vegetation references: McDonald and Whiteman, 1979; McDonald and Thomas, 1981.

Vegetation analysis:

Age since last fire: very rare

Vegetation structure: Microphyll fern forest (submontane, warm temperate closed-forest)

Species composition	*F.P.C. (%)*
Upper stratum (10 m)	
Nothofagus moorei	68
Tristaniopsis collina	13
	81
Mid stratum (5–6 m → 8 m)	
Ceratopetalum apetalum	41
Trochocarpa laurina	9
Nothofagus moorei	7
Miscellaneous (4 spp.)	6
	63
Small shrub stratum (1–2 m)	
Psychotria simmondsiana var. *exigua*	2
Ground stratum (< 60 cm)	
Blechnum cartilagineum	23
Dianella caerulea	3
Lomandra spicata	1
Miscellaneous (4 spp.)	4
	31
Bare ground	69

Species richness:
$N = 10.61 \log A + 5.36 \quad (r^2 = 0.90, n = 7)$

Species recorded by W.J.F. McDonald and W.G. Whiteman (1979) in *Nothofagus moorei* closed-forests in Lamington National Park, Queensland.

TREES

Atherospermataceae
Doryphora sassafras Endl.
Elaeocarpaceae
Sloanea australis (Benth.) F. Muell.
Fagaceae
Nothofagus moorei (F. Muell.) Krasser
Lauraceae
Cryptocarya foveolata C.T. White & Francis
Myrtaceae
Acmena smithii (Poiret) Merr. & Perry
Syzygium crebrinerve (C.T. White) L.A.S. Johnson
S. oleosum (F. Muell.) B. Hyland
Tristaniopsis laurina (Smith) P.G. Wilson & Waterhouse
Proteaceae
Orites excelsa R.Br.

SMALL TREES/TALL SHRUBS

Cunoniaceae
Callicoma serratifolia Andr.
Epacridaceae
Trochocarpa laurina (R.Br. ex Rudge) R.Br.
Escalloniaceae
Cuttsia viburnea F. Muell.
Polyosma cunninghamii Benn.
Quintinia sieberi A.DC.
Q. verdonii F. Muell.
Pittosporaceae
Pittosporum undulatum Vent.
Proteaceae
Lomatia arborescens Fraser & Vickery
Oreocallis pinnata (Maiden & Betche) Sleumer
Sapindaceae
Sarcopteryx stipata (F. Muell.) Radlk.

LOW SHRUBS

Agavaceae
Cordyline stricta (Sims) Endl
Apocynaceae
Alyxia ruscifolia R.Br.
Arecaceae
Linospadix monostachya (Mart.) H. Wendl.
Asteraceae
Helichrysum vagans C.T. White
Olearia elliptica DC.
Cyatheaceae
Cyathea australis (R.Br.) Domin
Dicksoniaceae
Dicksonia antarctica Labill
D. youngiae C. Moore
Epacridaceae
Leucopogon lanceolatus (Smith) R.Br.
Monimiaceae
Hedycaria augustifolia Cunn.
Wilkiea huegeliana (Tul.) A.DC.
Myrsinaceae
Rapanea howittiana (F. Muell.) Mez
Pittosporaceae
Pittosporum oreillyanum C.T. White
Rubiaceae
Psychotria simmondsiana F.M. Bailey
Randia benthamiana F. Muell.
Solanaceae
Solanum inaequilaterum Domin
Winteraceae
Tasmannia insipida R.Br. ex DC.

VINES

Apocynaceae
Melodinus acutiflorus F. Muell.
Parsonsia induplicata F. Muell.
P. ventricosa F. Muell
Araliaceae
Cephalaralia cephalobotrys (F. Muell.) Harms
Aristolochiaceae
Aristolochia deltantha F. Muell. var. *laheyana* F.M. Bailey
Flacourtiaceae
Streptothamnus beckleri F. Muell.
Monimiaceae
Palmeria scandens F. Muell.
Philesiaceae
Eustrephus latifolius R.Br.
Rosaceae
Rubus moorei F. Muell.
Smilacaceae
Ripogonum discolor F. Muell
R. fawcettianum F. Muell. ex Benth
Smilax australis R.Br.

EPIPHYTES

Gesneraceae
Fieldia australis Cunn.
Hymenophyllaceae
Hymenophyllum spp.
Polyphylebium venosum (R.Br.) Copel.
Orchidaceae
Dendrobium falcorostrum R.D. Fitzg.
Papillilabium beckleri (F. Muell. ex Benth.) Dockrill
Polypodiaceae
Microsorium diversifolium (Willd.) Copel.

GROUND STRATUM — FERNS

Aspidiaceae
Lastreopsis spp.
Blechnaceae
Blechnum wattsii Tindale

GROUND STRATUM — ANGIOSPERMS

Apiaceae
Hydrocotyle pedicellosa F. Muell
Cyperaceae
Cyperus disjunctus C.B. Clarke
Liliaceae
Dianella caerulea Sims
Drymophila moorei Baker
Urticaceae
Elatostema stipitatum Wedd.
Xanthorrhoeaceae
Lomandra spicata A. Lee

Table 2. Species richness and structure of complex notophyll vine-forest at Mt Glorious, Queensland (Compiled by E.E. Hegarty 1984–86).

Location: Mt Glorious, Queensland (27°20′S, 152°46′E, 640 m)

Nearest climate station:
Mt Glorious (27°20′S, 152°46′E, 640 m)
Annual precipitation 1785 mm; rain days 139
Mean annual temperature 17.1° C
Evaporative coefficient (k) 0.083 (open-forest) → 0.100 (closed-forest)

Geology: Miocene basalt

Soil: Euchrozem (Gn 3.12) — Red friable earths with marked development of shiny smooth-faced peds in the B horizon. Surface soils are loamy and darkened by organic matter, grade directly into the subsoil without any observable A2 horizon development. Neutral reaction trend through the profile.

Chemical and physical analysis (Darling Downs example, Stace *et al.*, 1968)

Depth 0–13 cm, pH 6.6, C 5.6%, N 0.23%, P 0.34%
Coarse sand 2%, Fine sand 18%, Silt 32%, Clay 45%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Ca 17, Mg 8.4, K 0.6, Na 0.3

Vegetation references: Hegarty, 1988; Young, 1982, 1985.

Vegetation analysis:

Age since last fire: unknown (very rare)

Vegetation structure: Complex notophyll vine-forest (closed-forest)

Species composition	*Leaf Area Index*
Upper stratum — trees (25–35 m)	
Gap trees	
Olea paniculata	0.23
Gap → late-age trees	
Acmena brachyandra	0.07
Pseudoweinmannia lachnocarpa	0.23
Sloanea woollsii	1.75
Late-age trees	
Argyrodendron actinophyllum	1.03
Argyrodendron trifoliolatum	0.72
Beilschmiedia obtusifolia	0.32
Syzygium corynanthum	0.50
Mid stratum — trees (10–15 m)	
Gap → late-age trees	
Pennantia cunninghamii	0.13
Late-age trees	
Niemevera chartacea	?
Upper stratum — lianes	
Gap lianes	
Cayratia eurynema	0.09
Cissus antarctica	0.16
Legnephora moorei	0.03
Tetrastigma nitens	0.03
Gap → late-age lianes	
Malaisia scandens	0.19
Parsonsia fulva	0.19
Rauwenhoffia leichhardtii	0.19
Middle-age lianes	
Calamus muelleri	
Late-age lianes	
Melodinus australis	0.27
Palmeria scandens	0.04
Piper novae-hollandiae	0.28
	Frequency (ha^{-1})
Small shrub stratum (1–4 m)	
Austromyrtus inophloia	(19 + 81)*
Capparis arborea	(16 + 24)
Citriobatus pauciflorus	(9 + 75)
Eupomatia laurina	(83 + 162)
Rapanea subsessilis	(15 + 45)
Tasmannia insipida	(4 + 9)
Wilkiea macrophylla	(286 + 530)
Regrowth (1–4 m) of upper stratum	
Actephila lindleyi	(580 + 1393)
Polyosma cunninghamii	(25 + 9)

* Number > 2m + Number < 2m

Species richness:

$N = 76.90 \log A - 155.64 \quad (r^2 = 0.99, n = 4)$

Species recorded by E.E. Hegarty (1988) in complex notophyll vine-forest (closed-forest) at Mt Glorious, Queensland.

Indicates an introduced species.

TREES

Alangiaceae
Alangium villosum (Blume) Wangerin subsp *polyosmoides* (F. Muell.) Bloemb.
Anacardiaceae
Euroschinus falcata Hook. f. var. *falcata*
Rhodosphaera rhodanthema (F. Muell. ex Benth.)
Araliaceae
Polyscias elegans (C. Moore & F. Muell.) Harms
P. murrayi (F. Muell.) Harms
Arecaceae
Archontophoenix cunninghamiana (H. Wendl.) H. Wendl. & Drude
Atherospermataceae
Daphnandra micrantha (Tul.) Benth
Cunoniaceae
Caldcluvia paniculosa (F. Muell.) Hoogland
Pseudoweinmannia lachnocarpa (F. Muell.) Engl
Ebenaceae
Diospyros pentamera (Woolls & F. Muell.) F. Muell.
Elaeocarpaceae
Elaeocarpus grandis F. Muell.
E. kirtonii F. Muell. ex F.M. Bailey
E. obovatus G. Don
Sloanea woollsii F. Muell.
Euphorbiaceae
Baloghia lucida Endl.
Flacourtiaceae
Scolopia braunii (Klotzsch) Sleumer
Icacinaceae
Citronella moorei (F. Muell. ex Benth.) R.A. Howard
Pennantia cunninghamii Miers
Lauraceae
Beilschmiedia elliptica C.T. White & Francis
B. obtusifolia (F. Muell. ex Meissner) F. Muell.
Cinnamomum oliveri F.M. Bailey
Cryptocarya erythroxylon Maiden & Betche
C. glaucescens R.Br.
C. obovata R.Br.
C. triplinervis R.Br.
Cryptocarya sp. 1 (*C.* sp. aff. *C. cunninghamii*)
Endiandra discolor Benth.
E. muelleri Meissner
Litsea leefeana (F. Muell.) Merr.
L. reticulata (Meissner) F. Muell.
Meliaceae
Dysoxylum fraseranum (Andr. Juss.) Benth.
D. rufum (A. Rich.) Benth.
Melia azedarach L. var. *australasica* (Adr. Juss.) C.DC
Synoum glandulosum (Smith) Adr. Juss
Toona australis (F. Muell.) Harms
Mimosaceae
Acacia melanoxylon R.Br. ex Aiton
Moraceae
Ficus fraseri Miq.
F. obliqua Forster f. var. *obliqua*
F. watkinsiana F.M. Bailey
Streblus pendulinus (Endl.) F. Muell.
Myrtaceae
Acmena brachyandra (Maiden & Betche) Merr. & Perry
Austromyrtus acmenoides (F. Muell.) Burret
Eucalyptus saligna Smith
Lophostemon confertus (R.Br.) P.G. Wilson & Waterhouse
Syzygium corynanthum (F. Muell.) L.A.S. Johnson
S. crebrinerve (C.T. White) L.A.S. Johnson
Oleaceae
Olea paniculata R.Br.
Pittosporaceae
Hymenosporum flavum (Hook.) F. Muell.
Pittosporum rhombifolium Cunn. ex Hook.
P. undulatum Vent.
Podocarpaceae
Podocarpus elatus R.Br. ex Endl.
Proteaceae
Helicia glabriflora F. Muell.
Stenocarpus sinuatus Endl.
Sapindaceae
Alectryon subcinereus (A. Gray) Radlk.
Diploglottis cunninghamii (Hook.) Hook. f.
Elattostachys nervosa (F. Muell.) Radlk
F. xylocarpa (Cunn. ex F. Muell.) Radlk.
Guioa semiglauca (F. Muell.) Radlk
Jagera pseudorhus (A. Rich.) Radlk.
Mischocarpus pyriformis (F. Muell.) Radlk.
Sapotaceae
Niemeyera chartacea (F.M. Bailey) C.T. White
Simaroubaceae
Guilfoylia monostylis (Benth.) F. Muell.
Sterculiaceae
Argyrodendron actinophyllum (F.M. Bailey) Edlin
A. trifoliolatum F. Muell.
Brachychiton discolor F. Muell
Ulmaceae
**Celtis sinensis* Pers.
Urticaceae
Dendrocnide excelsa (Wedd.) Chew
D. photinophylla (Kunth) Chew
Verbenaceae
Gmelina leichhardtii (F. Muell.) Benth.

SMALL TREES/TALL SHRUBS

Caesalpiniaceae
**Cassia floribunda* Cav.
Capparaceae
Capparis arborea (F. Muell.) Maiden
Caprifoliaceae
Sambucus australasica (Lindl.) Fritschy
Celastraceae
Denhamia celastroides (F. Muell.) Jessup
Ebenaceae
Diospyros australis (R.Br.) Hiern
Epacridaceae
Trochocarpa laurina R.Br. (at edge of rainforest and tall open-forest)
Escalloniaceae
Polyosma cunninghamii Benn.
Euphorbiaceae
Actephila lindleyi (Steudel) Airy Shaw
Claoxylon australe Baillon

Omalanthus populifolius Graham
Lauraceae
Neolitsea australiensis Kosterm.
N. dealbata (R.Br.) Merr.
Meliaceae
Pseudocarapa nitidula (Benth.) Merr. & Perry
Mimosaceae
Parachidendron pruinosum (Cunn. ex Benth.) Nielsen
Moniaceae
Wilkiea macrophylla (Cunn.) A. DC.
Myrsinaceae
Rapanea subsessilis (F. Muell.) Mez
Myrtaceae
Austromyrtus inophloia (J.F. Bailey & C.T. White) Burret
Rhodamnia argentea Benth
Rubiaceae
Canthium odoratum (G. Forster) Seem
Psychotria loniceroides Sieber ex DC.
Rutaceae
Acronychia pubescens (F.M. Bailey) C.T. White
Bauerella simplicifolia (Endl.) T. Hartley
Euodia micrococca F. Muell.
Medicosma cunninghamii (Hook.) Hook. f.
Sapindaceae
Mischocarpus lachnocarpus (F. Muell.) Radlk.
Sarcopteryx stipata (F. Muell.) Radlk.
Solanaceae
Duboisia myoporoides R.Br.
**Solanum mauritianum* Scop.
Symplocaceae
Symplocos thwaitesii F. Muell.

TREE FERNS
Cyatheaceae
Alsophila australis R.Br.
Sphaeropteris australis (Presl) Tryon
S. cooperi (Hook. ex F. Muell.) Tryon

LOW SHRUBS
Agavaceae
Cordyline petiolaris Domin
C. rubra Otto & A. Dietr.
Apocynaceae
Ervatamia angustisepala (Benth.) Domin
Eupomatiaceae
Eupomatia bennettii F. Muell.
E. laurina R.Br.
Myrsinaceae
Rapanea subsessilis F. Muell.
Pittosporaceae
Citriobatus pauciflorus Cunn. ex Ettingsch.
Pittosporum revolutum Aiton ex Dryander
Rosaceae
Rubus moluccanus L. (sometimes scandent)
R. parvifolius L.
Rubiaceae
Hodgkinsonia ovatiflora F. Muell.
Randia chartacea (F. Muell.) F. Muell.
Sambucaceae
Sambucus australasica (Lindl.) Fritsch
Solanaceae
**Cestrum fasciculatum* Schlect.
Solanum aviculare G. Forster
**S. hispidum* Pers.
S. discolor R.Br.
**S. nigrum* L.
Ulmaceae
Trema aspera (Brongn.) Blume
Verbenaceae
Clerodendrum floribundum R.Br.
**Lantana camara* L. (sometimes scandent)
Winteraceae
Tasmannia insipida R.Br. ex DC.

VINES
Annonaceae
Rauwenhoffia leichhardtii (F. Muell.) Diels
Apocynaceae
Melodinus acutiflorus F. Muell.
M. australis (F. Muell.) Pierre
Parsonsia fulva S.T. Blake
P. latifolia (Benth.) S.T. Blake
P. lilacina F. Muell.
P. straminea (R.Br.) F. Muell.
P. velutina R.Br.
P. ventricosa F. Muell.
Araliaceae
Cephalaralia cephalobotrys (F. Muell.) Harms
Araceae
Pothos longipes Schott
Arecaceae
Calamus muelleri H. Wendl.
Asclepiadaceae
Marsdenia rostrata R.Br.
Bignoniaceae
Pandorea pandorana (Andr.) van Steenis
Caesalpiniaceae
Caesalpinia scortechinii (F. Muell.) Hattink
Cucurbitaceae
Nothoalsomitra suberosa (F.M. Bailey) Telford
Dilleniaceae
Hibbertia scandens (Willd.) Gilg
Dioscoreaceae
Dioscorea transversa R.Br.
Fabaceae
Derris involuta (Sprague) Sprague
Flagellariaceae
Flagellaria indica L.
Menispermaceae
Legnephora moorei (F. Muell.) Miers
Sarcopetalum harveyanum F. Muell.
Monimiaceae
Palmeria scandens F. Muell.
Moraceae
Cudrania cochinchinensis (Lour.) Kudo & Masamune
Malaisia scandens (Lour.) Planchon
Myrsinaceae
Embelia australiana (F. Muell.) Mez
Passifloraceae
**Passiflora edulis* Sims
P. herbertiana Ker-Gawl
**P. subpeltata* Ort.
Philesiaceae
Geitonoplesium cymosum (R.Br.) Cunn. ex Hook.
Piperaceae
Piper novae-hollandiae Miq.
Ranunculaceae
Clematis glycinoides DC. var. *glycinoides*

C. glycinoides DC. var. *submutica* Benth
Rubiaceae
Morinda jasminoides Cunn. ex Hook.
Smilacaceae
Ripogonum album R.Br.
R. elseyanum F. Muell.
Smilax australis R.Br.
Vitaceae
Cayratia clematidea (F. Muell.) Domin
C. eurynema B.L. Burtt
Cissus antarctica Vent.
C. hypoglauca A. Gray
C. sterculiifolia (F. Muell. ex Benth.) Planchon
Tetrastigma nitens (F. Muell.) Planchon

EPIPHYTES
Aspleniaceae
Asplenium australasicum (J. Smith) Hook.
Davalliaceae
Davallia pyxidata Cav.
Hymenophyllaceae
Gonocormus saxifragoides (Presl.) v.d. Bosch
Macroglena caudata (Brack.) Copel.
Nephrolepidaceae
Arthropteris tenella (Forster f.) J. Sm. ex Hook. f.
Orchidaceae
Bulbophyllum aurantiacum F. Muell
Dendrobium gracilicaule F. Muell.
D. teretifolium R.Br.
D. speciosum Smith
Sarchochilus falcatus R.Br.
Polypodiaceae
Microsorum scandens (Forst. f.) Tindale
Platycerium bifurcatum (Cav.) C. Chr.
P. superbum G.J. Jones & Hennipman
Pyrrosia rupestris (R. Br.) Ching

PARASITIC EPIPHYTES
Loranthaceae
Amylotheca dictyophleba (F. Muell.) van Tieghem

GROUND STRATUM — FERNS
Aspidiaceae
Lastreopsis marginans (F. Muell.) D.A. Smith & Tindale
L. smithiana Tindale
Sinopteridaceae
Pellaea paradoxa (R.Br.) Hook.

GROUND STRATUM — ANGIOSPERMS
Araceae
Alocasia macrorrhiza (L.) G. Don
Asteraceae
**Bidens pilosa* L.
Urticaceae
Elatostema reticulatum Wedd. (in water courses)
Urtica incisa Poiret
Zingiberaceae
Alpinia caerulea (R.Br.) Benth.

Table 3. Species richness and structure of semi-evergreen microphyll vine forest at Flinton Hill, Queensland (Compiled by P.I. Forster and R.L. Specht 1987).

Location: Flinton Hill (Worlds End Pocket), near Pine Mountain, Queensland (27°31'S, 152°45'E, 135 m)

Nearest climate station:
Pine Mountain–Viewmount (27°33'S, 152°44' E, 232 m)
Annual precipitation 893 mm; rain days 75
Mean annual temperature 19.8°C (est.)
Evaporative coefficient (k) 0.062 (open-forest) → 0.100 (closed-forest)

Geology: Chert (probably with bands of shale) in Neranleigh–Fernvale Beds (Devonian–Carboniferous)

Soils: Euchrozem (Gn 3.12) — Red friable earths with marked development of shiny smooth-faced peds in the B horizon. Surface soils are loamy and darkened by organic matter, grade directly into the subsoil without any observable A2 horizon development. Neutral reaction trend through the profile.

Chemical and physical analysis (Neumann's Lookout example, Smith *et al.*, 1985)

Depth 0–22 cm, pH 6.8, T.S.S. 0.06%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Ca 23.8, Mg 7.4, K 0.6, Na 0.3

Vegetation references: Bostock *et al.*, In press.

Vegetation analysis:

Age since last fire: unknown (very rare)

Vegetation structure: Semi-evergreen microphyll vine forest (low closed-forest) + emergent *Araucaria*

Species composition	*F.P.C. (%)*
Emergent upper stratum (15 m)	
Araucaria cunninghamii	13
Upper stratum (12–14 m)	
Alectryon connatus	12
Atalaya salicifolia	11
Bursaria incana	14
Dendrocnide photinophylla	11
Miscellaneous (12 spp.)	30
Mid stratum (6–10 m)	
Acalypha eremorum	17
Alchornea ilicifolia	24
Canthium microphyllum	13
Planchonella myrsinoides	6
Miscellaneous (6 spp.)	16
	76
Ground stratum (< 50 cm)	
Rivina humilis (introd.)	9
Ancistrachne uncinulatum	2
Canthium microphyllum	
Solanum stelligerum	trace
Miscellaneous (2 spp.)	1
	13
Bare ground	87

Species richness:
$N = 26.86 \log A - 12.77 \quad (r^2 = 0.96, n = 8)$

Species recorded in the semi-evergreen microphyll vine forest (with emergent *Araucaria cunninghamii*) at Flinton Hill (World End Pocket), near Pine Mountain, Queensland by L.H. Bird.

* Indicates an introduced species.

TREES

Alangiaceae
- *Alangium villosum* (Blume) Wangerin subsp. *tomentosum* (F. Muell.) Bloemb.

Anacardiaceae
- *Euroschinus falcata* Hook. f.
- *Rhodosphaera rhodanthema* (F. Muell. ex Benth.) Engl.

Apocynaceae
- *Alstonia constricta* F. Muell.

Araliaceae
- *Polyscias elegans* (C. Moore & F. Muell.) Harms

Araucariaceae
- *Araucaria cunninghamii* Aiton ex D. Don (emergent tree)

Cactaceae
- **Opuntia tomentosa* Salm-Dyck

Capparaceae
- *Capparis arborea* (F. Muell.) Maiden

Casuarinaceae
- *Allocasuarina littoralis* (Salisb.) L.A.S. Johnson
- *Casuarina cunninghamiana* Miq.

Celastraceae
- *Cassine australis* (Vent.) Kuntze
- *Denhamia pittosporoides F. Muell.*
- *Maytenus bilocularis* (F. Muell.) Loes.
- *M. disperma* (F. Muell.) Loes.
- *Siphonodon australis* Benth.

Ebenaceae
- *Diospyros fasciculosa* (F. Muell.) F. Muell.
- *D. geminata* R.Br.

Ehretiaceae
- *Ehretia membranifolia* R.Br.

Elaeocarpaceae
- *Elaeocarpus obovatus* G. Don

Euphorbiaceae
- *Alchornea ilicifolia* (J. Smith) Muell. Arg.
- *Baloghia inophylla* (G. Forster) P. Green
- *Bridelia exaltata* F. Muell.
- *B. leichhardtii* Baillon ex Muell. Arg.
- *Claoxylon australe* Baillon
- *C. australe* Baillon (hairy form)
- *Cleistanthus cunninghamii* (Muell. Arg.) Muell. Arg.
- *Drypetes australasica* (Muell. Arg.) Pax & Hoffman
- *Excoecaria dallachyana* (Baillon) Benth.
- *Glochidion ferdinandi* (Muell. Arg.) F.M. Bailey
- *Mallotus claoxyloides* (F. Muell.) Muell. Arg.
- *M. discolor* (F. Muell.) F. Muell. ex Benth.
- *M. philippensis* (Lam.) Muell. Arg.

Fabaceae
- *Castanospermum australe* Cunn. & C. Fraser ex Hook.
- *Erythrina* sp. (Pine Mt.)

Gyrostemonaceae
- *Codonocarpus attenuatus* (Hook.) H. Walter

Hernandiaceae
- *Hernandia bivalvis* Benth

Lauraceae
- *Cryptocarya triplinervis* R.Br.

Loganiaceae
- *Strychnos axillaris* Colebr.

Meliaceae
- *Dysoxylum rufum* (A. Rich.) Benth.
- *Melia azedarach* L. var. *australasica* (Andr. Juss.) C.DC.
- *Owenia venosa* F. Muell.
- *Toona australis* (F. Muell.) Harms

Mimosaceae
- *Parachidendron pruinosum* (Benth.) Nielsen

Moraceae
- *Ficus coronata* Spin
- *F. fraseri* Miq.
- *F. macrophylla* Desf.
- *F. obliqua* Forster f.
- *F. opposita* Miq.
- *F. platypoda* (Miq.) Cunn. ex Miq.
- *F. virens Aiton* ex Dryander var. *sublanceolata* (Miq.) Corner
- *Streblus pendulinus* (Endl.) F. Muell.

Myrtaceae
- *Acmena brachyandra* (Maiden & Betche) Merr. & Perry
- *Austromyrtus bidwillii* (Benth.) Burret
- *Choricarpia subargentea* (C.T. White) L.A.S. Johnson
- *Rhodamnia dumicola* Guymer & Jessup
- *Syzygium australe* (Wendl. ex Link) B. Hyland
- *Waterhousia floribunda* (F. Muell.) B. Hyland

Oleaceae
- *Notelaea longifolia* Vent.
- *N. microcarpa* R.Br.

Pittosporaceae
- *Bursaria incana* Lindl.
- *Pittosporum rhombifolium* Cunn. ex Hook.

Proteaceae
- *Grevillea robusta* Cunn. ex R.Br.

Rhamnaceae
- *Alphitonia excelsa* (Cunn. ex Fenzl) Reisseck ex Benth.

Rutaceae
- *Acronychia laevis* J.R. & G. Forster
- *A. pauciflora* C.T. White
- *Bouchardatia neurococca* (F. Muell.) Baillon
- *Flindersia australis* R.Br.
- *F. collina* F.M. Bailey
- *F. xanthoxyla* (Cunn. ex Hook.) Domin
- *Geijera salicifolia* Schott var. *latifolia* (Lindl.) Domin
- *Pentaceras australe* (F. Muell.) Hook. f . ex Benth.
- *Sarcomelicope simplicifolia* (Endl.) T. Hartley
- *Zanthoxylum brachyacanthum* F. Muell.

Santalaceae
- *Exocarpos latifolius* R.Br.

Sapindaceae
- *Alectryon connatus* (F. Muell.) Radlk.
- *A. diversifolius* (F. Muell.) S. Reyn.
- *A. subcinereus* (A. Gray) Radlk.
- *A. subdentatus* (F. Muell. ex Benth.) Radlk.
- *A. tomentosus* (F. Muell.) Radlk.
- *Arytera divaricata* F. Muell.
- *A. foveolata* F. Muell.

Atalaya salicifolia (A.DC.) Blume
Cupaniopsis parvifolia (F. M. Bailey) L.A.S. Johnson
Elattostachys xylocarpa (Cunn. ex. F. Muell.) Radlk.
Guioa semiglauca (F. Muell.) Radlk.
Harpullia hillii F. Muell.
H. pendula Planchon ex F. Muell.
Mischocarpus anodontus (F. Muell.) Radlk.
Toechima tenax (Benth.) Radlk.
Sapotaceae
Amorphospermum antilogum F. Muell.
Planchonella cotinifolia (A.DC.) Dubard
P. myrsinoides (Cunn. ex Benth.) S.T. Blake
P. pohlmaniana (F. Muell.) Pierre ex Dubard
Simaroubaceae
Ailanthus triphysa (Dennst.) Alston
Sterculiaceae
Argyrodendron trifoliolatum F. Muell.
Brachychiton discolor F. Muell.
B. populneus Schott & Endl. R.Br.
Commersonia fraxinea (L.) Merr.
Sterculia quadrifida R.Br.
Ulmaceae
Aphananthe philippinensis Planchon
Celtis paniculata (Endl.) Planchon
Trema aspera (Brongn.) Blume
Urticaceae
Dendrocnide photinophylla (Kunth) Chew
Verbenaceae
Premna lignum-vitae (Cunn. ex Schauer) Pieper

SHRUBS
Agavaceae
Cordyline petiolaris (Domin) Pedley
C. rubra Otto & A. Dietr.
Apocynaceae
Alyxia magnifolia F.M. Bailey
A. ruscifolia R.Br.
Carissa ovata R.Br.
Ervatamia angustisepala (Benth.) Domin
Caesalpiniaceae
Cassia tomentella (Benth.) Domin
Chloanthaceae
Spartothamnella juncea (Cunn. ex Walp.) Briq.
Ebenaceae
Diospyros australis (R.Br.) Hiern
Euphorbiaceae
Acalypha capillipes F. Muell.
A. eremorum Muell. Arg.
Breynia oblongifolia Muell. Arg.
Croton insularis Baillon
C. phebalioides Muell. Arg.
C. stigmatosus F. Muell.
Phyllanthus albiflorus F. Muell. ex Muell. Arg.
Flacourtiaceae
Casearia multinervosa C.T. White & Sleumer ex Sleumer
Lauraceae
Cryptocarya sp. aff. *bidwillii* Meissner
C. laevigata Blume var. *bowiei* (Hook.) Kosterm
C. microneura Meissner
Linaceae
Erythroxylum australe F. Muell
Malvaceae
Abutilon auritum (Wall. ex Link) Sweet
A. oxycarpum (F. Muell.) F. Muell. ex Benth.
Hibiscus heterophyllus Vent.
Meliaceae
Turraea brownii C.DC.
Myrsinaceae
Rapanea variabilis (R.Br.) Mez
Myrtaceae
Decaspermum humile (G. Don) A.J. Scott
Pittosporaceae
Citriobatus linearis (F.M. Bailey) C.T. White
C. pauciflorus Cunn. ex Ettingsh.
Pittosporum revolutum Aiton ex Dryander
Plumbaginaceae
Plumbago zeylanica L.
Rubiaceae
Canthium coprosmoides F. Muell.
C. microphyllum F. Muell.
C. odoratum (G. Forster) Seem
Diplospora cameronii C.T. White
Hodgkinsonia ovatiflora F. Muell.
Ixora beckleri Benth.
Pavetta australiensis Bremek.
Psychotria daphnoides Cunn. ex Hook.
Rutaceae
Microcitrus australis (Planchon) Swingle
Micromelum minutum (Forster f.) Wight & Arn
Thymelaeaceae
Wikstroemia indica (L.) C.A. Meyer
Verbenaceae
Clerodendrum floribundum R.Br.
C. tomentosum R.Br.
**Lantana camara* L.

VINES
Annonaceae
Rauwenhoffia leichhardtii (F. Muell.) Diels
Apocynaceae
Parsonsia lanceolata R.Br.
P. latifolia (Benth.) S.T. Blake
P. leichhardtii F. Muell.
P. lenticellata C.T. White
P. rotata Maiden & Betche
P. straminea (R.Br.) F. Muell.
Asclepiadaceae
Cynanchum bowmanii S.T. Blake
Gymnema dunnii (Maiden & Betche) P. Forster
Hoya australis R.Br. ex Traill
Sarcostemma australe R.Br.
Secamone elliptica R.Br.
Bignoniaceae
Pandorea jasminoides (Lindl.) R. Schum.
P. pandorana (Andr.) van Steenis
Capparaceae
Capparis sarmentosa Cunn. ex Benth
Celastraceae
Celastrus subspicata Hook.
Hippocratea barbata (F. Muell.)
Cucurbitaceae
Diplocyclos palmatus (L.) C. Jeffrey
Cunoniaceae
Aphanopetalum resinosum Endl
Dioscoreaceae
Dioscorea transversa R.Br.
Euphorbiaceae

Tragia novaehollandiae Muell. Arg
Fabaceae
Austrosteenisia blackii (F. Muell.) Gees.
Derris involuta (Sprague) Sprague
Flagellariaceae
Flagellaria indica L.
Menispermaceae
Legnephora moorei (F. Muell.) Miers
Pleogyne australis Benth.
Tinospora smilacina Benth.
Moraceae
Cudrania cochinchinensis (Lour.) Kudo & Masamune
Malaisia scandens (Lour.) Planchon
Myrsinaceae
Embelia australiana (F. Muell.) Mez
Oleaceae
Jasminum didymum G. Forster subsp *racemosum* (F. Muell.) P.S. Green
J. simplicifolium G. Forster subsp. *australiense* P.S. Green
Passifloraceae
**Passiflora foetida* L.
**P. suberosa* L.
**P. subpeltata* Ort.
Philesiaceae
Eustrephus latifolius R.Br.
Geitonoplesium cymosum (R.Br.) Cunn. ex Hook.
Sapindaceae
**Cardiospermum grandiflorum* Sweet
Smilacaceae
Ripogonum brevifolium Conran & Clifford
Smilax australis R.Br.
Vitaceae
Cayratia acris (F. Muell.) Domin
C. clematidea (F. Muell.) Domin
Cissus antarctica Vent.
C. opaca F. Muell.
Tetrastigma nitens (F. Muell.) Planchon

EPIPHYTES
Orchidaceae
Dendrobium gracilicaule F. Muell.
D. speciosum Sm.
E. teretifolium R.Br.
E. tetragonum Cunn
Rhinerrhiza divitiflora (F. Muell. ex Benth.) Rupp
Sarcochilus dilatatus F. Muell.
Polypodiaceae
Drynaria rigidula (Sw.) Bedd.
Platycerium bifurcatum (Cav.) C. Chr.
P. superbum G.J. Joncheere & Hennipman
Pyrrosia rupestris (R.Br.) Ching

PARASITIC EPIPHYTES
Viscaceae
Notothixos incanus (Hook.) Oliver

GROUND STRATUM — FERNS
Adiantaceae
Adiantum aethiopicum L.
A. hispidulum Sw.
Aspleniaceae
Asplenium attenuatum R.Br.
A. australasicum (J. Sm.) Hook.
Sinopteridaceae
Doryopteris concolor (Langsd. & Fisch.) Kuhn
Pellaea falcata (R.Br.) Feé var. *nana* Hook.
P. paradoxa (R.Br.) Hook.
Thelypteridaceae
Christella dentata (Forsk.) Brownsey & Jermy

GROUND STRATUM — ANGIOSPERMS
Acanthaceae
Calophenoides hygrophiloides (F. Muell.) R. Barker
Pseuderanthemum tenellum (Benth.) Domin
P. variabile (R.Br.) Radlk. ex Lindau
Amaryllidaceae
Proiphys cunninghamii (Aiton ex Lindley) Mabb.
Araceae
Gymnostachys anceps R.Br.
Chenopodiaceae
Rhagodia nutans R.Br.
Commelinaceae
Commelina cyanea R.Br.
Lamiaceae
Plectranthus parviflorus Willd
Peperomiaceae
Peperomia leptostachyo Hook. & Arn.
Phytolaccaceae
**Rivina humilis* L
Poaceae
Ancistrachne uncinulata (R.Br.) S.T. Blake
Stipa ramosissima (Trin.) Trin.

Table 4. Species richness and structure of tall layered open-forest near Boombana National Park, Queensland (Compiled by E.E. Hegarty and R.L. Specht 1987).

Location: State Forest 1355, near Boombana N.P., Queensland (27°24'S, 152°47'E, c. 500 m)

Nearest climate station:
Mt Nebo (27°24'S, 152°47'E, c. 450 m)
Annual precipitation 1415 mm, rain days 100
Mt Glorious 27°20'S, 152°46'E, 640 m)
Annual precipitation 1785 mm; rain days 139;
Mean annual temperature 17.1°C;
Evaporative coefficient (k) 0.083 (open-forest) → 0.100 (closed-forest)

Geology: Hornfels

Soils: Red podzolic soils (Dr 2.61) — hard-setting surface soils, unbleached A2 horizon, red clayey subsoils whole coloured, acid reaction trend through profile.

Chemical and physical analyses (Samford example, Stace *et al.*, 1968)

Depth 0–15 cm, pH 5.7, C 3.7%, N 0.11%, P 0.02%
Coarse sand 42%, Fine sand 40%, Silt 4%, Clay 9%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 9, Ca 0.9, Mg 0.6, K 0.3, Na 0.1

Vegetation references: Beckmann *et al.*, 1987; Hegarty, 1980; Young, 1982, 1985.

Vegetation analysis:

Age since last fire: 10 years

Vegetation structure: Tall layered open-forest ("Wet sclerophyll forest")

Species composition	*F.P.C. (%)*
Upper stratum (27–30 m)	
Eucalyptus microcorys	59
E. propinqua	18
E. drepanophylla	6
	83
Mid stratum (12 m)	
E. microcorys	20
E. intermedia	8
E. propinqua	5
E. acmenoides	1
Lophostemon confertus	4
	38
Mid stratum (8 m)	
Cryptocarya glaucescens	12
Polyscias elegans	3
Rhodamnia rubescens	2
Guioa semiglauca	2
Euroschinus falcata	1
	20
Mid stratum-lianes (8 m)	
Cissus antarctica	2
Smilax australis	2
Ground stratum (<1 m)	
Doodia aspera	13
Oplismenus aemulus	7
Poa labillardieri	5
Alpinia caerulea	2
Lomandra longifolia	2
Miscellaneous (10 spp.)	
	36
Bare ground	64

Species richness:
$N = 26.33 \log A + 5.44$ ($r^2 = 0.97$, $n = 16$)

Species recorded by E.E. Hegarty (1980) in tall layered open-forest (wet sclerophyll forest) in State Forest 1355, near Boombana N.P., Queensland.

* Indicates an introduced species.

TREES

Casuarinaceae
- *Allocasuarina torulosa* (Aiton ex Dryander) L.A.S. Johnson

Myrtaceae
- *Eucalyptus acmenoides* Schauer
- *E. drepanophylla* F. Muell. ex Benth.
- *E. intermedia* R.T. Baker
- *E. microcorys* F. Muell.
- *E. propinqua* Deane & Maiden var. *propinqua*
- *E. punctata* DC. var. *didyma* R.T. Baker & H.G. Smith
- *E. saligna* Smith
- *Lophostemon confertus* (R.Br.) P.G. Wilson & Waterhouse

SMALL TREES/TALL SHRUBS

Anacardiaceae
- *Euroschinus falcata* Hook. f.

Araliaceae
- *Polyscias elegans* (C. Moore & F. Muell.) Harms

Caesalpiniaceae
- **Cassia coluteoides* Colladon
- **C. floribunda* Cav.

Celastraceae
- *Denhamia celastroides* (F. Muell.) Jessup

Ehretiaceae
- *Ehretia acuminata* R.Br

Elaeocarpaceae
- *Elaeocarpus obovatus* G. Don

Epacridaceae
- *Trochocarpa laurina* (R.Br. ex Rudge) R.Br.

Euphorbiaceae
- *Alchornea ilicifolia* (John Smith) Muell. Arg.
- *Drypetes australasica* (Muell. Arg.) Pax & Hoffman
- *Mallotus claoxyloides* (F. Muell.) Muell. Arg.
- *M. philippensis* (Lam.) Muell. Arg.
- *Omalanthus populifolius* Graham

Lauraceae
- *Neolitsea dealbata* (R.Br.) Merr
- *Cryptocarya glaucescens* R.Br.

Meliaceae
- *Synoum glandulosum* (Smith) Adr. Juss.

Mimosaceae
- *Acacia aulacocarpa* Cunn. ex Benth.
- *A. concurrens* Pedley
- *A. fimbriata* Cunn. ex G. Don
- *A. irrorata* Sieber ex Sprengel
- *A. maidenii* F. Muell.
- *A. melanoxylon* R.Br. ex Aiton

Myrtaceae
- *Callistemon salignus* (Smith) DC.
- *Decaspermum humile* (G. Don) A.J. Scott
- *Rhodamnia rubescens* (Benth.) Miq.
- *Rhodomyrtus psidioides* (G. Don) Benth.

Oleaceae
- *Notelaea longifolia* Vent. forma *glabra* P.S. Green

Pittosporaceae
- *Pittosporum undulatum* Vent.

Rhamnaceae
- *Alphitonia excelsa* (Cunn. ex Fenzl.) Reisseck ex Benth.

Rubiaceae
- *Psychotria loniceroides* Sieber ex DC

Rutaceae
- *Acronychia pauciflora* C.T. White

Sapindaceae
- *Arytera distylis* (F. Muell. ex Benth.) Radlk
- *Cupaniopsis parvifolia* (F.M. Bailey) L.A.S. Johnson
- *Guioa semiglauca* (F. Muell.) Radlk.
- *Jagera pseudorhus* (A. Rich.) Radlk.
- *Mischocarpus pyriformis* Radlk.

Solanaceae
- *Duboisia myoporoides* R.Br.
- **Solanum hispidum* Pers.
- **S. mauritianum* Scop.

Verbenaceae
- *Clerodendrum floribundum* R.Br.

LOW SHRUBS

Agavaceae
- *Cordyline petiolaris* Domin
- *C. rubra* Otto & A. Dietr.

Apocynaceae
- *Carissa ovata* R.Br.
- *Ervatamia angustisepala* Domin

Araceae
- *Gymnostachys anceps* R.Br.

Araliaceae
- *Astrotricha floccosa* DC.

Asclepiadaceae
- **Gomphocarpus fruticosus* (L.) R.Br.

Asteraceae
- **Eupatorium riparium* Regel
- *Helichrysum diosmifolium* (Vent.) Sweet

Celastraceae
- *Cassine australis* (Vent.) Kuntze
- *Maytenus silvestris* N. Lander & L.A.S. Johnson

Epacridaceae
- *Acrotriche aggregata* R.Br.
- *Leucopogon juniperinus* R.Br.

Euphorbiaceae
- *Acalypha nemorum* F. Muell.
- *Breynia oblongifolia* Muell.Arg.

Eupomatiaceae
- *Eupomatia bennettii* F. Muell.
- *E. laurina* R.Br.

Fabaceae
- *Hovea acutifolia* Cunn. ex G. Don
- *Indigofera australis* Willd. var. *australis*

Malvaceae
- *Hibiscus heterophyllus* Vent.

Mimosaceae
- *Acacia longissima* H. Wendl.

Myoporaceae
- *Myoporum montanum* R.Br. (occasional)

Myrsinaceae
- *Rapanea variabilis* (R.Br.) Mez

Pittosporaceae
- *Citriobatus pauciflorus* Cunn. ex Ettingsh.
- *Pittosporum revolutum* Aiton ex Dryander

Rosaceae
- *Rubus moluccanus* L.

R. rosifolius Smith
Rubiaceae
Psychotria daphnoides Cunn. ex Hook.
Rutaceae
Zieria smithii Benth. sens. lat.
Solanaceae
Solanum densivestitum F. Muell. ex Benth
**S. nigrum* L.
Thymelaeaceae
Pimelea latifolia R.Br. subsp. *altior* (F. Muell.) Threlfall var. *altior*
Wikstroemia indica (L.) C.A. Meyer
Ulmaceae
Trema aspera (Brongn.) Blume
Verbenaceae
**Lantana camara* L. (sometimes scandent)
Zamiaceae
Macrozamia lucida L. Johnson

Apocynaceae
Parsonsia rotata Maiden & Betche
P. straminea (R.Br.) F. Muell.
P. ventricosa F. Muell.
Araliaceae
Cephalaralia cephalobotrys (F. Muell.) Harms
Bignoniaceae
**Macfadyena unguis-cati* (L.) Gentry
Cucurbitaceae
Diplocyclos palmatus (L.) C. Jeffrey
Zehneria cunninghamii F. Muell.
Cunoniaceae
Aphanopetalum resinosum Endl.
Dioscoreaceae
Dioscorea transversa R.Br.
Fabaceae
Derris involuta (Sprague) Sprague
Desmodium rhytidophyllum F. Muell. ex Benth.
Glycine clandestina Wendl.
G tabacina (Labill.) Benth.
G. tomentella Hayata
Hardenbergia violacea (Schneev.) Stearn
Kennedia rubicunda (Schneev.) Vent.
Kunstleria blackii (F. Muell.) Polhill
Menispermaceae
Sarcopetalum harveyanum F. Muell.
Stephania japonica (Thunb.) Miers var. *discolor* (Blume) Forman
Myrsinaceae
Embelia australiana (F. Muell.) Mez
Passifloraceae
**Passiflora subpeltata* Ort.
Philesiaceae
Eustrephus latifolius R.Br.
Geitonoplesium cymosum (R.Br.) Cunn. ex Hook
Pittosporaceae
Billardiera scandens Smith
Ranunculaceae
Clematis glycinoides DC.
Smilacaceae
Smilax australis R.Br
Vitaceae
Cayratia clematidea (F. Muell.) Domin
Cissus antarctica Vent.
C. hypoglauca A. Gray
C. opaca F. Muell.
Tetrastigma nitens (F. Muell.) Planchon

EPIPHYTES
Orchidaceae
Dendrobium aemulum R.Br.
Polypodiaceae
Pyrrosia confluens (R.Br.) Ching
P. rupestris (R.Br.) Ching

PARASITIC EPIPHYTES
Loranthaceae
Amyema miquelii (Lehm. ex Miq.) van Tieghem
Amylotheca dictyophleba (F. Muell.) van Tieghem

GROUND STRATUM — FERNS
Adiantaceae
Adiantum aethiopicum L.
A. hispidulum Swartz
Aspidiaceae
Lastreopsis decomposita (R.Br.) Tindale
Blechnaceae
Blechnum cartilagineum Swartz
Doodia aspera R.Br.
D. caudata (Cav.) R.Br.
Dennstaedtiaceae
Pteridium esculentum (Forster f.) Cockayne
Dicksoniaceae
Culcita dubia (R.Br.) Maxon
Polypodiaceae
Drynaria rigidula (Swartz) Bedd.
Sinopteridaceae
Pellaea paradoxa (R.Br.) Hook.

GROUND STRATUM — ANGIOSPERMS
Acanthaceae
Pseuderanthemum variabile (R.Br.) Radlk. ex Lindau
Asteraceae
**Ageratum houstonianum* Miller
**Crassocephalum crepidioides* (Benth.) S. Moore
Commelinaceae
Commelina cyanea R.Br.
Cyperaceae
Cyperus tetraphyllus R.Br.
Gahnia aspera R.Br.
Lepidosperma laterale R.Br.
Geraniaceae
Geranium homeanum Turcz.
Goodeniaceae
Goodenia rotundifolia R.Br.
Hydrocotylaceae
Hydrocotyle pedicellosa F. Muell.
Liliaceae
Dianella caerulea Sims
Proiphys cunninghamii (Lindl.) Mabberley
Lobeliaceae
Pratia purpurascens (R.Br.) E. Wimmer
Orchidaceae
Pterostylis nutans R.Br.
Oxalidaceae
Oxalis corniculata L.
Peperomiaceae
Peperomia leptostachya Hook. & Arn.
Phytolaccaceae
**Phytolacca octandra* L.
Poaceae

Entolasia marginata (R.Br.) Hughes
Oplismenus aemulus (R.Br.) Roemer & Schultes
O. hirtellus (L.) Beauv. subsp. *imbecillis* (R.Br.) U. Scholz
Ottochloa gracillima C.E. Hubbard
Poa labillardieri Steudel
Themeda triandra Forsskal
Primulaceae
**Anagallis arvensis* L.
Rosaceae
Rubus parvifolius L.
Rubiaceae
Galium migrans Ehrendorfer & McGillivray
Xanthorrhoeaceae
Lomandra longifolia Labill.
Zingiberaceae
Alpinia caerulea (R.Br.) Benth.

Table 5. Species richness and structure of savanna open-forest at Mt Coot-tha, Queensland (Compiled by R.I. Grundy and R.L. Specht 1987).

Location: Mt Coot-tha, Queensland (27°29′S, 152°57′E, 232 m)

Nearest climate station:
Toowong (27°30′S, 153°00′E, 9 m)
Annual precipitation 1102 mm; rain days 90
Mt Coot-tha (27°29′S, 152°57′E, 232 m)
Annual precipitation 1200 mm (est.)
Mean annual temperature 19.5°C (est.)
Evaporative coefficient (*k*) 0.061 (est.)

Geology: Bunya phyllites

Soils: *Lithosols* (Um 4.11) — Shallow uniform-textured loamy soil, with an unbleached A2 horizon underlain directly by weathered phyllite.

Podzolic lithosols (Dr 2.11) — Soils with contrasting (duplex) texture profiles with red clayey subsoils, below seasonally hard-setting surface soils. Acid reaction trend through the profile.

Chemical and physical analyses (Koppi, 1981; Beckmann *et al.*, 1987)
Depth 0–5 cm, pH 5.2, C 5.6%
Coarse sand 40%, Fine sand 23%, Silt 19%, Clay 13%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 27.0, Ca 0.18, Mg 1.7, K 0.6, Na 0.1

Vegetation references: Beckmann *et al.*, 1987; Young, 1982, 1985

Vegetation analysis:

Age since last ground fire: 1 year

Vegetation structure: Savanna open-forest (North-facing slope)	
Species composition	*F.P.C. (%)*
Upper stratum (18 m)	
Eucalyptus drepanophylla	20
E. maculata	11
E. umbra	6
E. propinqua	5
E. tereticornis	5
	47
Mid stratum — tall (12 m)	
Allocasuarina littoralis	5
Ground stratum (<60 cm)	
Themeda triandra	65
Glycine clandestina	3
Lomandra longifolia	3
Desmodium rhytidophyllum	2
	73
Bare ground	27

Species richness:
$N = 20.14 \log A + 2.56$ ($r^2 = 0.96$, $n = 17$)

Vegetation structure: Savanna open-forest (South-facing slope)	
Species composition	*F.P.C. (%)*
Upper stratum (18 m)	
Eucalyptus crebra	8
E. maculata	8
E. microcorys	12
E. propinqua	
E. trachyphloia	
Lophostemon confertus	
	58
Mid stratum (12 m)	
Allocasuarina littoralis	2
Ground stratum (<60 cm)	
Themeda triandra	46
Miscellaneous	5
	51
Bare ground	49

Species richness:
$N = 21.69 \log A + 6.78$ ($r^2 = 0.96$, $n = 17$)

Species recorded by R.I. Grundy in *Eucalyptus crebra-E. maculata-E. macrocorys* savanna open-forest at Mt Coot-tha, Queensland.

(N) indicates north-facing slope; (S) indicates south-facing slope; no annotation indicates that the species is found on both aspects.

* Indicates an introduced species.

UPPER STRATUM (18 m)
Casuarinaceae
Allocasuarina littoralis (Salisb.) L.A.S. Johnson
Myrtaceae
Eucalyptus acmenoides Schauer (N)
E. crebra F. Muell.
E. intermedia R.T. Baker
E. maculata Hook.
E. microcorys F. Muell.
E. propinqua Deane & Maiden
E. tereticornis Smith
E. tessellaris F. Muell. (N)
E. trachyphloia F. Muell.
E. umbra R.T. Baker subsp. *carnea* (R.T. Baker) L.A.S. Johnson (N)
Lophostemon confertus (R.Br.) P.G. Wilson & Waterhouse

MID STRATUM (4–12 m)
Euphorbiaceae
Breynia oblongifolia Muell. Arg.
Mimosaceae
Acacia concurrens Pedley
A. fimbriata Cunn. ex G. Don
A. leiocalyx Domin (N)
A. maidenii F. Muell.
Myrsinaceae
Rapanea variabilis (R.Br.) Mez (N)
Proteaceae
Persoonia sericea Cunn. ex R.Br. (N)
Rhamnaceae
Alphitonia excelsa (Cunn. ex Fenzl) Reisseck ex Benth.
Thymelaeaceae
Wikstroemia indica (L.) C.A. Meyer

VINES
Aristolochiaceae
Aristolochia sp. aff. *A. pubera* R.Br
Fabaceae
Abrus precatorius L. (N)
Passifloraceae
**Passiflora suberosa* L.
Philesiaceae
Eustrephus latifolius R.Br.
Smilacaceae
Smilax australis R.Br. (S)
Vitaceae
Cayratia clematidea (F. Muell.) Domin
Cissus opaca F. Muell. (S)

PARASITIC EPIPHYTES
Lauraceae
Cassytha filiformis L. (N)
Loranthaceae
Amyema miquelii (Lehm. ex Miq.) van Tieghem (N)

GROUND STRATUM — FERNS
Adiantaceae
Adiantum aethiopicum L. (S)
A. hispidulum Sw. (S)
Blechnaceae
Doodia media R.Br. (S)
Dennstaedtiaceae
Pteridium esculentum (Forster f.) Cockayne (S)

GROUND STRATUM — ANGIOSPERMS
Acanthaceae
Justicia procumbens L.
Ruellia australis R.Br.
Araceae
Gymnostachys anceps R.Br. (S)
Asteraceae
**Ageratum houstonianum* Miller
**Bidens pilosa* L.
Brachyscome microcarpa F. Muell.
Calotis dentex R.Br.
Centratherum punctatum Cass. subsp. *australianum* Kirkman
**Cirsium vulgare* (Savi) Ten.
Glossogyne tenuifolia (Labill.) Cass.
**Hypochoeris* sp.
Senecio quadridentatus Labill. (S)
Sigesbeckia orientalis L. (S)
**Sonchus oleraceus* L
**Tagetes minuta* L.
Vernonia cinerea (L.) Less.
Caesalpiniaceae
Cassia mimosoides L
Clusiaceae
Hypericum gramineum Forster f. (S)
Commelinaceae
Commelina cyanea R.Br.
Convolvulaceae
Dichondra repens J.R. & G. Forster (S)
Cyperaceae
Carex breviculmis R.Br.
Cyperus cyperoides (L.) Kuntze (N)
C. enervis R.Br.
C. fulvus R.Br. (N)
C. gracilis R.Br.
C. laevis R.Br. (N)
Fimbristylis dichotoma (L.) Vahl (N)
F. ovata (N. Burman) Kern (N)
Scleria mackaviensis Boeck.
Epacridaceae
Acrotriche aggregata R.Br. (N)
Euphorbiaceae
Euphorbia vachelli Hook. & Arn. (S)
Phyllanthus virgatus Forster f. (S)
Poranthera microphylla Brongn. (S)
Fabaceae
**Crotalaria lanceolata* E. Meyer
**C. medicaginea* Lam.
C. montana Roth
**C. pallida* Aiton (N)
Desmodium brachypodum A. Gray (S)
D. heterocarpon (Willd.) DC.
D. rhytidophyllum F. Muell. ex Benth.
D. varians Endl.
Galactia tenuiflora (Willd.) Wight & Arn.
Glycine clandestina Wendl.

Hardenbergia violacea (Schneev.) Stearn
Indigofera hirsuta L.
Kennedia rubicunda (Schneev.) Vent.
Lespedeza juncea (Linn. f.) Pers. (S)
Swainsona brachycarpa Benth.
Tephrosia filipes Benth. (N)
Vigna vexillata (L.) A. Rich var. *youngiana* F.M. Bailey (S)
Zornia dyctiocarpa DC. (N)

Goodeniaceae
Goodenia rotundifolia R.Br. (N)

Lamiaceae
Ajuga australis R.Br.
Anisomeles malabarica (L.) R.Br. ex Sims
Plectranthus parviflorus Willd. (S)
Teucrium argutum R.Br. var. *argutum* (S)

Liliaceae
Dianella caerulea Sims
Iphigenia indica Kunth. (N)
Thysanotus tuberosus R.Br. (S)

Lobeliaceae
Lobelia purpurascens R.Br. (S)

Myoporaceae
Myporum debile (Andr.) R.Br. (N)

Orchidaceae
Dipodium punctatum (Smith) R.Br. (S)
Pterostylis nutans R.Br. (S)
P. obtusa R.Br. (S)

Oxalidaceae
Oxalis corniculata L.

Poaceae
Aristida queenslandica Henrard (N)
Bothriochloa decipiens (Hackel) C.E. Hubbard (N)
**Brachiaria decumbens* Stapf
Capillipedium spicigerum S.T. Blake
Chrysopogon sylvaticus C.E. Hubbard (N)
Cymbopogon refractus (R.Br.) A. Camus (N)
Digitaria breviglumis (Domin) Henrard (N)
Entolasia stricta (R.Br.) Hughes (N)
Heteropogon contortus (L.) Beauv. ex R. & S. (N)
Imperata cylindrica (L.) Beauv. var. *major* (Nees) C.E. Hubbard
Oplismenus aemulus (R.Br.) R. & S.
O. hirtellus (L.) Beauv. subsp. *imbecillis* (R.Br.) Y. Scholz (S)
Panicum effusum R.Br. (N)
**P. maximum* Jacq. var. *trichoglume* Eyles ex Robyns (N)
Paspalidium distans (Trin.) Hughes (N)
**Paspalum urvillei* Steudel
Poa labillardieri Steudel (S)
**Rhyncheletrum repens* (Willd.) C.E. Hubbard
Themeda triandra Forsskal

Rosaceae
Rubus parvifolius L. (S)

Rubiaceae
Spermococe multicaulis Benth. (N)

Violaceae
Hybanthus enneaspermus (L.) F. Muell.

Xanthorrhoeaceae
Lomandra confertifolia (Bailey) Fahn
L. filiformis (Thunb.) Britten (S)
L. multiflora (R.Br.) Britten

Table 6. Species richness and structure of a heathy open-forest and a wet-heathland at Beerwah, Queensland (Compiled by M.P. Bolton and R.L. Specht 1987).

Location: Beerwah Scientific Area No. 1, Queensland (26°51'S, 153°00'E, c. 15 m)

Nearest climate station: **Beerwah Forest Station (26°51'S, 153°00'E)**
Annual precipitation 1666 mm; rain days 129
Mean annual temperature 20.5°C
Evaporative coefficient (*k*) 0.075 (open-forest) → 0.100 (closed-forest)

Geology: Quaternary sands

Soils: *Heathy open-forest* Lateritic podzolic soil (Dy 5.41) — Soils with contrasting (duplex) texture profiles, with sandy surface soils (not seasonally hard-setting) over mottled yellow clayey subsoils. Acid reaction trend through the profile.

Chemical and physical analyses (Hubble, 1954)

Depth 0–5 cm, pH 5.3, C 1.1%, N 0.036%, Avail. P 2 ppm
Coarse sand 39%, Fine sand 47%, Silt 8%, Clay 6%

Wet-heathland Gleyed podzolic soil (Dy 3.41) — Soils with contrasting (duplex) textured profiles, with seasonally hard-setting surface sandy loams over mottled yellow clayey subsoils. Acid reaction trend through the profile.

Chemical and physical analyses (Hubble, 1954)

Depth 0–10 cm, pH 5.6, C 1.3%, N 0.03%, P 26ppm, Avail. P 3 ppm
Coarse sand 56%, Fine sand 34%, Silt 6%, Clay 2%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 1.5, Ca 0.4, Mg 0.4, K ?, Na 0.1

Vegetation references: Bolton 1986

Vegetation analysis:

Age since last ground fire: 6 years

Vegetation structure: Heathy open-forest

Species composition	*F.P.C.(%)*
Upper stratum (16–18 m)	
Eucalyptus signata	27
E. intermedia	11
	38
Upper stratum — regrowth (8–10 m)	
E. signata	1
E. intermedia	1
	2
Mid stratum — tall (2–3 m)	
Leptospermum attenuatum	2
	2
Mid stratum — low (1 m)	
Xanthorrhoea johnsonii	16
Banksia oblongifolia	11
Daviesia umbellulata	7
Pultenaea myrtoides	6
Miscellaneous (8 spp.)	7
	47
Ground stratum (<30 cm)	
Hibbertia vestita	12
Schoenus sp.	9
Miscellaneous (5 spp.)	9
	30
Bare ground	31

Species richness:
$N = 14.74 \log A + 9.57$
($r^2 = 0.94$, $n = 16$)

Age since last fire: 12 years

Vegetation structure: Wet-heathland
(+ scattered small trees of *Banksia aemula*)

Species composition	*F.P.C.(%)*
Emergent (4–6 m) (at open-forest/heathland ecotone)	
Banksia aemula —	
Upper stratum (2 m)	
Hakea sp. aff. *H. gibbosa*	42
	42
Mid stratum (1 m)	
Xanthorrhoea media	13
Melaleuca sieberi	8
Melaleuca nodosa	trace
Banksia oblongifolia	4
Banksia robur	
Miscellaneous (7 spp.)	
Ground stratum (<50 cm)	
Schoenus spp.	
Empodisma minus	
Hibbertia vestita	
Miscellaneous (5 spp.)	
Bare ground	

Species richness:
$N = 14.45 \log A + 10.23$
($r^2 = 0.97$, $n = 15$)

Species recorded by M.P. Bolton (1986), based on collections of D.I. Bevege (1971), in the Beerwah Scientific Area No. 1, Queensland, in the following three plant communities:

A. *Eucalyptus* heathy open-forest
B. *Banksia aemula* heathy woodland
C. Wet heathland

× Indicates the presence of that species in the community.

	Plant Communities		
	A	*B*	*C*
TREES			
Myrtaceae			
Angophora woodsiana F.M. Bail.	..		
Eucalyptus conglomerata Maiden & Blakely	rare	—	—
E. gummifera (Soland. ex Gaertn.) Hochr.	rare	—	—
E. intermedia R.T. Baker	×	×	—
E. microcorys F. Muell.	rare	—	—
E. nigra R.T. Baker	rare	—	—
E. pilularis Sm.	rare	—	—
E. resinifera Sm.	rare	—	—
E. robusta Sm.	rare	—	rare
E. signata F. Muell.	×	×	—
E. trachyphloia F. Muell.	rare	—	—
E. umbra R.T. Baker ssp. *carnea* (R.T. Baker) L.A.S. Johnson	×	—	—
Lophostemon confertus (R.Br.) P.G. Wilson & J.T. Waterhouse	×	—	—
L. suaveolens (Soland. ex Gaertn.) P.G. Wilson & J.T. Waterhouse	rare	—	—
Melaleuca quinquenervia (Cav.) S.T. Blake	—	—	rare
Syncarpia glomulifera (Sm.) Nied.	rare	—	—
TALL SHRUBS			
Casuarinaceae			
Allocasuarina littoralis (Salisb.) L.A.S. Johnson			
Euphorbiaceae			
Glochidion ferdinandi (Muell. Arg.) F.M. Bail.			
Mimosaceae			
Acacia complanata Cunn. ex Benth.			
A. concurrens Pedley			
Myrtaceae			
Leptospermum attenuatum Sm.			
Proteaceae			
Banksia aemula R.Br.	×	×	—
B. integrifolia L.f.	×	—	—
Xylomelum sp. 1	×	×	—
Rhamnaceae			
Alphitonia excelsa (Cunn. ex Fenzl) Reiss. ex Benth.			
LOW SHRUBS			
Epacridaceae			
Acrotriche aggregata R.Br.	×	—	—
Monotoca scoparia (Sm.) R.Br.	×	×	×
Sprengelia sprengelioides (R.Br.) Druce	—	—	×
Euphorbiaceae			
Petalostigma triloculare Muell. Arg.	×	—	—
Ricinocarpos pinifolius Desf.	—	×	×
Fabaceae			
Aotus lanigera Cunn. ex Benth.	×	×	—
Daviesia umbellulata Sm.	×	×	—
Dillwynia floribunda Sm.	—	×	—
D. retorta (Wendl.) Druce	—	×	×
Phyllota phylicoides (Sieb. ex DC.) Benth.	×	×	—
Pultenaea myrtoides Cunn. ex Benth.	×	—	×
P. paleacea Willd.	×	×	—
P. petiolaris Cunn. ex Benth.	×	—	×
P. villosa Willd.	×	×	×
Viminaria juncea (Schrad.) Hoffm.	×	—	—
Melastomataceae			
Melastoma affine D. Don			

Mimosaceae			
Acacia hubbardiana Pedley	×	—	—
A. myrtifolia Sm.	×	—	—
A. suaveolens Sm.	×	—	×
A. ulicifolia Salisb.	×	×	—
Myrtaceae			
Austromyrtus dulcis (C.T. White) L.S. Smith	×	—	—
Baeckea linearis C.T. White	—	×	—
B. stenophylla F. Muell.	—	×	×
B. virgata (Forst. & Forst. f.) Andr.	×	×	—
Callistemon pachyphyllus Cheel	—	—	✓
Leptospermum flavescens Sm. (including *L. lanigerum* (Aiton) Sm.)	×	×	×
L. liversidgei R.T. Baker & H.G. Sm.	—	—	×
L. speciosum Schauer	—	—	×
Melaleuca bracteata F. Muell.	×	—	—
M. nodosa (Gaertn.) Sm.	×	—	×
M. sieberi Schauer	×	—	×
M. thymifolia Sm.	×	—	×
Olaceae			
Olax retusa F. Muell. ex Benth.			
Oleaceae			
Notelaea ovata R.Br.			
Proteaceae			
Banksia oblongifolia Cav. var. *minor* (Maiden & Camfield) Conran & Clifford			
B. oblongifolia Cav. var. *oblongifolia*	—	×	×
B. robur Cav.	—	—	×
B. spinulosa Sm. var. *collina* (R.Br.) George	×	—	—
Conospermum taxifolium Sm.	×	—	×
Grevillea linearifolia (Cav.) Druce	×	—	—
Hakea florulenta Meissn.	×	—	—
Hakea sp. 2	×	—	×
Lomatia silaifolia (Sm.) R.Br.	×	—	—
Persoonia cornifolia Cunn. ex R.Br	×	×	—
P. linearis Andr.	×	—	—
P. tenuifolia R.Br.	×	×	×
P. virgata R.Br.	×	×	—
Petrophila shirleyae F.M. Bail.	×	×	×
Strangea linearis Meissn.	×	×	×
Rutaceae			
Boronia falcifolia Cunn. ex Lindl.	—	×	×
B. parviflora Smith	—	—	×
B. rosmarinifolia Cunn.	×	—	—
Eriostemon myoporoides DC. subsp. *queenslandicus* (C.T. White) P.G Wilson	×	—	×
Zieria laxiflora (Benth.) Domin	×	—	—
Sapindaceae			
Dodonaea triquetra Andr.			
Tremandraceae			
Tetratheca thymifolia Sm.			
Xanthorrhoeaceae			
Xanthorrhoea johnsonii A.T. Lee	×	—	—
X. media R.Br.	—	—	×
X. resinosa Pers. subsp. *fulva* A.T. Lee	×	—	—
VINES			
Apocynaceae			
Parsonsia straminea (R.Br.) F. Muell.			
Fabaceae			
Hardenbergia violacea (Schneev.) Stearn			
Philesiaceae			
Eustrephus latifolius R.Br.			
Geitonoplesium cymosum (R.Br.) Cunn. ex Hook.			
Pittosporaceae			
Billardiera scandens Sm			

GROUND STRATUM — FERNS/FERN ALLIES			
Dennstaedtiaceae			
Pteridium esculentum (Forst. f.) Cockayne	×	×	—
Gleicheniaceae			
Gleichenia rupestris R.Br.	—	—	
Lycopodiaceae			
Lycopodium cernuum L.	—	—	
Schizaeaceae			
Schizaea bifida Willd	×	×	—
S. dichotoma (L.) Sm.	×	×	—
Selaginellaceae			
Selaginella uliginosa (Labill.) Spring			
GROUND STRATUM — ANGIOSPERMS			
Asteraceae			
Podolepis neglecta G.L. Davis			
Baueraceae			
Bauera capitata Ser. ex DC.	?	—	×
Burmanniaceae			
Burmannia disticha L.	—	—	
Cyperaceae			
Baumea teretifolia (R.Br.) Palla	—	—	×
Caustis blakei Kukenth. ex S.T. Blake	×	—	—
C. flexuosa R.Br.	×	—	—
C. recurvata Spreng	×	×	—
Cyathochaeta diandra (R.Br.) Nees	—	—	—
Gahnia aspera (R.Br.) Spreng.	—	—	
Lepidosperma laterale R.Br.	×	×	×
Ptilanthelium deustum (R.Br.) Kukenth.	×	—	×
Schoenus brevifolius R.Br.	×	×	×
S. paludosus (R.Br.) Poir.	—	—	×
Dilleniaceae			
Hibbertia acicularis (Labill.) F. Muell.	×	—	—
H. linearis R.Br. ex DC.	×	—	—
H. salicifolia (DC.) F. Muell.	—	—	×
H. stricta (DC.) R.Br. ex F. Muell. sens. lat	×	—	—
H. vestita Cunn. ex Benth.	×	—	×
Droseraceae			
Drosera binata Labill.	—	—	×
D. peltata Thunb. sens. lat.	×	—	×
D. pygmaea DC.	—	—	×
D. spatulata Labill.	—	—	×
Epacridaceae			
Epacris microphylla R.Br.	—	—	
E. pulchella Cav.	×	×	×
Leucopogon lanceolatus (Sm.) R.Br.	×	—	—
L. virgatus (Labill.) R.Br.	—	×	×
Lissanthe strigosa (Sm.) R.Br.	×	—	—
Euphorbiaceae			
Poranthera microphylla Brongn.	×	×	—
Pseudanthus orientalis (Baill.) F. Muell.	×	×	×
Fabaceae			
Chorizema parviflorum Benth.	×	—	—
Gompholobium pinnatum Sm.	×	—	×
C. virgatum Sieb. ex DC.	×	—	—
Mirbelia rubiifolia (Andr.) G. Don	—	×	×
Goodeniaceae			
Dampiera stricta (Sm.) R.Br.	×	—	×
Goodenia rotundifolia R.Br.	—	—	
G. stelligera R.Br.	×	—	×
Velleia spathulata R.Br.	—	—	×
Haemodoraceae			
Haemodorum tenuifolium Cunn. ex Benth			
Haloragaceae			
Gonocarpus micranthus Thunb			

Iridaceae			
Patersonia fragilis (Labill.) Aschers & Graebner	—		
P. glabrata R.Br.	×		
P. sericea R.Br. ex Ker-Gawl.	×		
Lentibulariaceae			
Utricularia lateriflora R.Br.			
Liliaceae			
Blandfordia grandiflora R.Br	—	—	
Burchardia umbellata R.Br.	—	—	
Caesia vittata R.Br.	—	—	
Dianella caerulea Sims	×	—	
Laxmannia gracilis R.Br.	×	×	
Sowerbaea juncea Sm.	—	—	
Thysanotus tuberosus R.Br.	—	×	
Tricoryne elatior R.Br.	×	—	
Orchidaceae			
Caladenia carnea R.Br	×	—	
Calochilis campestris R.Br.	×	—	
Geodorum densiflorum (Lamk.) Schlechter	×	—	
Glossodia minor R.Br.	—	—	
Prasophyllum sp.	×	×	
Thelymitra ixioides Sw.	—	—	
T. pauciflora R.Br.	—	×	
Philydraceae			
Philydrum lanuginosum Banks & Soland. ex Gaertn			
Poaceae			
Aristida intricata S.T. Blake	×	—	×
Cymbopogon refractus (R.Br.) A. Camus	×	—	—
Entolasia stricta (R.Br.) Hughes	×	—	×
Eriachne glabrata (Maiden) W. Hartley	×	×	—
Imperata cylindrica (L.) Beauv. var *major* (Nees) C.E. Hubbard	×	—	×
Themeda triandra Forsskal	×	—	—
Polygalaceae			
Comesperma retusum Labill.			
C. volubile Labill .			
Restionaceae			
Empodisma minus (Hook. f.) L. Johnson & Cutler	—	—	
Lepyrodia scariosa R.Br.	×	×	
Restio complanatus R.Br.	—	—	
R. pallens R.Br.	—	—	
Spigeliaceae			
Mitrasacme alsinoides R.Br.			
Stackhousiaceae			
Stackhousia viminea Sm.			
Stylidiaceae			
Stylidium debile F. Muell.			
Thymelaeaceae			
Pimelea linifolia Sm.			
Xanthorrhoeaceae			
Lomandra laxa (R.Br.) A.T. Lee	×		
L. multiflora (R.Br.) Britten	×		
Xyridaceae			
Xyris juncea R.Br.			
X. operculata Labill.			
PARASITIC EPIPHYTES			
Cassythaceae			
Cassytha filiformis L.	×		
Cassytha glabella R.Br.	×		
Loranthaceae			
*Amyema miquelii** (Lehm. ex Miq.) van Tieghem			

Table 7. Species richness and structure of a dry-heathland and a heathy open-forest on North Stradbroke Island (Compiled by R.L. Specht and H.T. Clifford 1988).

Nearest climate station:
Dunwich (27°31′S, 153°25′E, 20m)
Annual precipitation 1, 603 mm, raindays 104
Mean annual temperature 20.5°C
Evaporative coefficient (*k*) 0.065

Geology: Quaternary sands
Mt Hardgrave: high transgressive dunes
Brown Lake: low hilly, white sandhills

Soils: Deep podzolised sands (Uc 2.2) — "giant" podzols, with organic B horizons below depths as great as 12–20 m (Thompson, 1975).

Chemical and physical analyses (Thompson and Jehne, 1988; Westman and Rogers, 1977)
Depth 0–10 cm, pH 5.1, C 0.8%, N 0.18%, P 0.001%, K 0.007%, Ca 0.02%
Coarse sand 44%, Fine sand 55%, Silt/Clay 1%

Vegetation references: Clifford and Specht, 1979; Connor and Clifford, 1972; Specht, 1979; Specht and Morgan, 1981; Specht *et al.*, 1984

Vegetation analysis:

Location:
Mt Hardgrave
(27°30′ S, 158°27 E, 219 m)

Age since last fire: 15 years

Vegetation structure:
Dry-heathland (with emergent *Banksia aemula*)

Species composition	*F.P.C.(%)*
Shrub stratum (1–2 m)	
Banksia aemula	11
Baeckea linearis	4
Leptospermum flavescens	3
	18
Low shrub stratum (< 1 m)	
Woollsia pungens	16
Bossiaea heterophylla	8
Boronia safrolifera	3
Miscellaneous	4
	31
Ground stratum (< 30 cm)	
Coleocarya gracilis	34
Caustis recurvata	8
Miscellaneous	2
	44
Bare ground	7

Species richness:
$N = 12.74 \log A + 14.15$
($r^2 = 0.99$, $n = 7$)

Location:
Brown Lake
(27°30′S, 158°26′E, 65 m)

Age since last fire: 9 years

Vegetation structure:
Heathy open-forest

Species composition	*F.P.C.(%)*
Tree stratum (13 m)	
Eucalyptus signata	43
Small tree/tall shrub stratum (4–8 m)	
Banksia aemula	17
Allocasuarina littoralis	8
Leptospermun attenuatum	7
Monotoca scoparia	4
	36
Grass tree stratum (2 m)	
Xanthorrhoea johnsonii	11
Low shrub stratum (< 1 m)	
Pteridium esculentum	4
Woollsii pungens	3
Miscellaneous	5
	12
Ground stratum (< 30 cm)	
Coleocarya gracilis	28
Caustis recurvata	3
	31
Bare ground	46

Species richness:
$N = 12.84 \log A + 12.46$
($r^2 = 0.96$, $n = 7$)

Species recorded by H.T. Clifford and R.L. Specht on North Stradbroke Island, Queensland in the following two plant communities:

A. Dry-heathland, with emergent *Banksia aemula* and mallee *Eucalyptus* spp. on Mt Hardgrave (Clifford and Specht, 1979; Specht, 1979)

B. *Eucalyptus* heathy open-forest near Brown Lake (Connor and Clifford, 1972; Clifford and Specht, 1979; Specht *et al.*, 1984).

	Plant Communities	
	A	*B*
TREES		
Casuarinaceae		
Allocasuarina littoralis (Salisb.) L.A.S. Johnson		
Myrtaceae		
Angophora woodsiana F.M. Bailey	—	×
Eucalyptus signata F. Muell.	—	×
SMALL TREES/TALL SHRUBS		
Casuarinaceae		
Allocasuarina torulosa (Aiton ex Dryander) L.A.S. Johnson	×	—
Epacridaceae		
Monotoca scoparia (Smith) R.Br.	—	×
Myrtaceae		
Eucalyptus intermedia R.T. Baker	×	—
E. planchoniana F. Muell .	×	—
E. signata F. Muell.	×	—
Lophostemon confertus (R.Br.) P.G. Wilson & Waterhouse	×	—
Proteaceae		
Eanksia aemula R.Br.		
LOW SHRUBS		
Dilleniaceae		
Hibbertia linearis R.Br. ex DC.	×	×
Elaeocarpaceae		
Elaeocarpus reticulatus Smith	×	—
Epacridaceae		
Acrotriche aggregata R.Br.	—	×
Brachyloma daphnoides (Smith) Benth	×	×
Epacris pulchella Cav.	×	×
Leucopogon ericoides (Smith) R.Br.	—	×
L. margarodes R.Br.	×	—
Monotoca scoparia (Smith) R.Br.	×	—
Styphelia viridis Antr.	×	×
Woollsia pungens (Cav.) F. Muell.	×	×
Euphorbiaceae		
Ricinocarpos pinifolius Desf.		
Fabaceae		
Dillwynia retorta (Wendl.) Druce var. *retorta*	×	×
Phyllota phylicoides (Sieber ex DC.) Benth.	×	×
Mimosaceae		
Acacia baueri Benth.	—	×
A. suaveolens Smith	×	×
A. ulicifolia Salisb.	×	×
Myrtaceae		
Austromyrtus dulcis (C.T. White) L.S. Smith	×	—
Baeckea linearis C.T. White	×	×
Homoranthus virgatus Cunn. ex Schauer	×	×
Leptospermum attenuatum Smith	×	×
L. flavescens Smith sens. lat.	×	—
Olacaceae		
Olax retusa F. Muell. ex Benth.		
Proteaceae		
Conospermum taxifolium Smith	×	×
Persoonia cornifolia Cunn. ex R.Br.	—	×
P. linearis Andr.	×	—
P. virgata R.Br.	—	×
Petrophila canescens Cunn. ex R.Br	×	—
P. shirleyae F.M. Bail.	×	×

Strangea linearis Meissn		
Rutaceae		
Boronia falcifolia Cunn. ex Lindl.		×
B. rosmarinifolia Cunn.	×	×
B. safrolifera Cheel	×	
Zieria laxiflora (Benth.) Domin	×	
Tremandraceae		
Tetratheca thymifolia Smith		
Xanthorrhoeaceae		
Xanthorrhoea johnsonii A.T. Lee		
X. macronema F. Muell. ex Benth.		
VINES		
Fabaceae		
Hardenbergia violacea (Schneev.) Stearn	×	
Smilacaceae		
Smilax australis R.Br.	×	
PARASITIC EPIPHYTES		
Lauraceae		
Cassytha glabella R.Br.		
C. pubescens R.Br.		
Loranthaceae		
Amyema penduium (Sieber ex Sprengel) van Tieghem		
Muellerina celastroides (Sieber ex J.A. & J.H. Schultes) van Tieghem		
GROUND STRATUM — FERNS		
Dennstaedtiaceae		
Pteridium esculentum (Forst.f.) Cockayne		
Schizaeaceae		
Schizaea bifida Willd.		
S. dichotoma (L.) Sm.		
GROUND STRATUM — ANGIOSPERMS		
Apiaceae		
Platysace ericoides (Sieber ex DC.) C. Norman	×	×
Xanthosia pilosa Rudge	×	×
Asteraceae		
Vernonia cinerea (L.) Less.		
Cyperaceae		
Caustis blakei Kukenth. ex S.T. Blake	×	
C. recurvata Spreng.	×	
Lepidosperma laterale R.Br.	×	
Schoenus brevifolius R.Br.		
S. ericetorum R.Br. var. *ornithopodioides*		
Trachystylis stradbrokensis (Domin) Kukenth.		×
Dilleniaceae		
Hibbertia acicularis (Labill.) F. Muell.		×
H. vestita Cunn. ex Benth.		—
Epacridaceae		
Leucopogon leptospermoides R.Br.	×	
L. virgatus (Labill.) R.Br.	×	
Melichrus procumbens (Cav.) Druce		
Euphorbiaceae		
Amperea xiphoclada (Sieber ex Sprengel) Druce	×	×
Poranthera microphylla Brongn.	×	×
Pseudanthus orientalis (Baill.) F. Muell.	×	×
Fabaceae		
Bossiaea heterophylla Vent.	×	×
Gompholobium pinnatum Smith	×	×
Jacksonia stackhousii F. Muell.	×	—
Goodeniaceae		
Dampiera stricta (Smith) R.Br.		
Iridaceae		
Patersonia glabrata R.Br.	×	—
P. sericea R.Br. ex Ker-Gawl.	×	×
Liliaceae		
Caesia vittata R.Br.		

Dianella caerulea Sims	×	×
Laxmannia gracilis R.Br.	×	×
Sowerbaea juncea Sm.	—	×
Thysanotus tuberosus R.Br.	×	×
Tricoryne elatior R.Br.	×	×
Orchidaceae		
Caladenia alba R.Br.	—	×
C. carnea R.Br.	—	×
Caleana major R.Br.	—	×
Dipodium punctatum (Smith) R.Br	—	×
Prasophyllum sp.	×	×
Thelymitra ixioides Sw.	×	×
Poaceae		
Aristida calycina R.Br.	—	×
Entolasia stricta (R.Br.) Hughes	×	×
Eriachne insularis Domin	—	×
Imperata cylindrica (L.) Beauv. var. *major* (Nees) C.E. Hubbard	—	×
Panicum simile Domin	×	×
Themeda triandra Forsskal	×	×
Restionaceae		
Coleocarya gracilis S.T. Blake	×	×
Hypolaena fastigiata R.Br.	×	×
Rubiaceae		
Pomax umbellata (Gaertn.) Solander ex A. Rich	—	×
Thymelaeaceae		
Pimelea linifolia Smith	×	×
Xanthorrhoeaceae		
Lomandra elongata (Benth.) Ewart	×	×
L. filiformis (Thunb.) Britten	×	×
L. longifolia Labill.	×	—
L. multiflora (R.Br.) Britten	×	×

Table 8. Species richness and structure of four plant communities in State Forest 98, between Bell and Jandowae, Queensland (Compiled by R.L. Specht and A. Specht 1987).

Location: State Forest 98 (Mahen), Bell–Jandowae, Queensland (26°48′S, 151°19′E, c. 420 m)

Nearest climate station:
Bell (26°56′S, 151°27′E, 480 m)
Annual precipitation 665 mm; rain days 59
Jandowae (26°48′S, 151°06′E, 357 m)
Annual precipitation 670 mm; rain days 62
Dalby (27°11′S, 151°16′E, 342 m)
Annual precipitation 673 mm; rain days 71
Mean annual temperature 19.0°C
Evaporative coefficient (*k*) 0.049

A. *Allocasuarina luehmannii* layered open-forest

Quaternary alluvium, derived from Miocene basalts.

Moderately deep grey clays/"Northern red-brown earths" (Dr 2.13) — Deep to moderately deep soils with dark reddish brown to dark brown loams overlying reddish-brown medium to heavy clays.

Chemical and physical analyses (Vandersee, 1984)

Depth 0–5 cm, pH 6.8, T.S.S. 710 ppm, Cl 30 ppm
Coarse sand 23%, Fine sand 14%, Silt 15%, Clay 16%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 34, Na 0.3, K 2.3

Species composition	*F.P.C. (%)*
Upper stratum (16–17 m)	
Allocasuarina luehmannii	50*
Acacia harpophylla	1
	51
Mid stratum (4–5 m)	
Cassine australis var. *angustifolius*	9
Geijera parviflora	2
Pandorea pandorana (liane)	1
	12
Ground stratum (< 1 m)	
Aristida caput-medusae	6
Carissa ovata	4
Bothriochloa decipiens	3
Maireana microphylla	2
Spartothamnella juncea	2
Miscellaneous (5 spp.)	5
	22
Bare ground	78

*F.P.C. value (62%) of "filmy" foliage of *Allocasuarina* corrected for light transmission between cladodes.

Species richness:
$N = 12.97 \log A + 5.45 \quad (r^2 = 0.97, n = 6)$

B. *Eucalyptus populnea* savanna woodland/open-forest

Quaternary alluvium, derived from Miocene basalt.

Grey soils of heavy texture (Ug 5.24, Ug 5.4) — Deep soils, with a thin brownish grey sandy light clay surface, overlying grey to dark greyish brown clays. Calcium carbonate occurs at depth.

Chemical and physical analyses (Vandersee, 1984)

Depth 0–10 cm, pH 6.5, C 4.1%, N 0.10%, P 0.03%, Avail. P 26 p.p.m.
Coarse sand 14%, Fine sand 29%, Silt 19%, Clay 34%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 21, Ca 9.5, Mg 8.3, K 0.7, Na 0.6

Species composition	*F.P.C. (%)*
Upper stratum (14 m)	
Eucalyptus populnea	38
Mid stratum (4–5 m)	
Geijera parviflora	2
Acacia excelsa	1
	3
Ground stratum (< 30 cm)	
Aristida calycina	22
Cymbopogon refractus	19
Bothriochloa decipiens	7
Miscellaneous (6 spp.)	8
	56
Bare ground	44
Species richness:	
$N = 10.76 \log A + 6.47$ ($r^2 = 0.96$, $n = 6$)	

C. *Eucalyptus orgadophila* savanna woodland/open-forest

Miocene basalt, forming broad rounded hilltops.

Stony, self-mulching black earths (Ug 5.12, Ug 5.13) - Moderately deep (30–60 cm) soils with very dark brown to very dark greyish brown clays over decomposing basalt. Calcium carbonate may be present.

Chemical and physical analyses (Vandersee, 1984)

Soil depth 0–10 cm., pH 6.9, C 6.0%, N 0.23%, P 0.05%, Avail. P 16 p.p.m.
Coarse sand 7%, Fine sand 29%, Silt 18%, Clay 40%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 38, Ca 24, Mg 10 , K 1. 3, Na 1. 2

Species composition	*F.P.C.(%)*
Upper stratum (14 m)	
Eucalyptus orgadophila	36
Eucalyptus polycarpa (only on basalt hilltop)	5
	41
Mid stratum (2–4 m)	
Dodonaea viscosa var. *angustifolia*	2
Pimelea linifolia	1
	3
Ground stratum (< 30 cm)	
Aristida benthamii	20
Themeda triandra	12
Dianella revoluta	10
Miscellaneous (4 spp.)	7
	49
Bare ground	51
Species richness:	
$N = 14.37 \log A + 6.72$ ($r^2 = 0.99$, $n = 6$)	

D. *Eucalyptus maculata* heathy/savanna open-forest

Jurassic sandstone

Very shallow, grey to dark grey, stony, coarse-texture sands to sandy loams (lithosols Uc 2.1) over decomposing sandstone on flat topped slope 5–10%.

Chemical and physical analyses (not available).

Species composition	*F.P.C.(%)*
Upper stratum (20–22 m)	
Eucalyptus maculata	60
Eucalyptus drepanophylla	9
	69
Mid stratum (2–4 m)	
Jacksonia scoparia	
Hovea longifolia	
Ground stratum (< 30 cm)	
Aristida ramosa	
Themeda triandra	3
Lomandra longifolia	2
Dianella revoluta	
Melichrus urceolatus	
	16
Bare ground	85
Species richness:	
$N = 10.54 \log A + 0.40 \quad (r^2 = 0.91, n = 6)$	

Species recorded by R.L. and A. Specht in State Forest 98 (Mahen), Bell–Jandowae, Queensland in the following four plant communities —

A. *Allocasuarina luehmannii* layered open-forest
B. *Eucalyptus populnea* savanna woodland/open-forest
C. *E. orgadophila* savanna woodland/open-forest
D. *E. maculata–E.* drepanophylla heathy/savanna open-forest

× indicates the presence of that species in the community.
* indicates an introduced species.

	Plant Community			
	A	*B*	*C*	*D*
TREES (14–17 m)				
Anacardiaceae				
Euroschinus falcata Hook.f.	×	—	—	—
Casuarinaceae				
Allocasuarina luehmannii (R.T. Baker) L.A.S. Johnson	×	—	—	—
Casuarina cristata Miq.	×	—	—	—
Mimosaceae				
Acacia harpophylla F. Muell. ex Benth	×	—	—	—
A. pustula Maiden & Blakely	—	×	—	—
A. salicina Lindl.	—	×	—	—
Myrtaceae				
Angophora costata (Gaertn.) J. Britten	—	—	—	×
Eucalyptus drepanophylla F. Muell. ex Benth	—	—	—	×
E. maculata Hook.	—	—	—	×
E. orgadophila Maiden & Blakely	—	—	×	—
E. polycarpa F. Muell.	—	—	rare	—
E. populnea F. Muell.	—	×	—	—
Sterculiaceae				
Brachychiton rupestris (Mitchell ex Lindl.) K. Schum.	×	—	—	—
TALL SHRUBS/SMALL TREES (4–5 m)				
Apocynaceae				
Alstonia constricta F. Muell.				
Cactaceae				
**Opuntia tomentosa* Salm-Dyck	×	×	—	—
Capparaceae				
Apophyllum anomalum F. Muell.	×	—	—	—
Capparis canescens Banks ex DC.	×	—	—	—
C. mitchellii Lindl.	×	×	—	—
Celastraceae				
Cassine australis (Vent.) Kuntze var. *angustifolius* (Benth.) Jessup	×	×	—	—

Denhamia pittosporoides F. Muell.				
Maytenus bilocularis (F. Muell.) Loes.				
Ehretiaceae				
Ehretia membranifolia R.Br.				
Euphorbiaceae				
Petalostigma pubescens Domin				
Meliaceae				
Owenia venosa F. Muell.				
Mimosaceae				
Acacia excelsa Benth.	—	×	—	—
A. fimbriata Cunn. ex G. Don	—	—	—	×
A. implexa Benth.	—	×	—	—
A. leiocalyx Domin	—	×	×	×
A. neriifolia Benth.	—	×	×	—
Oleaceae				
Notelaea microcarpa R.Br.				
Pittosporaceae				
Bursaria incana Lindl.		—	—	—
Pittosporum phylliraeoides DC		×	—	—
Proteaceae				
Grevillea striata R.Br.				
Rhamnaceae				
Alphitonia excelsa (Cunn. ex Fenzl.) Reisseck ex Benth				
Rubiaceae				
Canthium buxifolium Benth	×			
C. vaciniifolium F. Muell.	×			
Rutaceae				
Geijera parviflora Lindl				
Santalaceae				
Santalum lanceolatum R.Br.				
Sapindaceae				
Atalaya salicifolia (A.DC.) Blume	×	—	—	—
Cupaniopsis parvifolia (F.M. Bailey) L.A.S. Johnson	×	—	—	—
Sapotaceae				
Planchonella cotinifolia (A.DC.) Dubard				
LOW SHRUBS (2-3 m)				
Apocynaceae				
Carissa ovata R.Br.	×	—	—	—
Asteraceae				
Cassinia laevis R.Br.	—	—	—	×
Olearia canescens (Benth.) Hutch	—	—	—	×
O. elliptica DC.	—	—	×	—
Caesalpiniaceae				
**Cassia barclayana* Sweet	×	—	—	—
C. coronilloides Benth.	×	—	—	×
C. nemophila Cunn. ex Vogel var. *zygophylla* (Benth.) Benth.				
Chenopodiaceae				
Rhagodia parabolica R.Br.				
Euphorbiaceae				
Acalypha eremorum Muell. Arg.	×	—	—	—
Fabaceae				
Daviesia genistifolia Cunn. ex Benth.	—	—	—	×
Hovea longifolia R.Br. ex Aiton	—	—	—	×
Jacksonia scoparia R.Br.	—	—	—	×
Malvaceae				
Sida subspicata F. Muell. ex Benth.				
Mimosaceae				
Acacia decora Reichenb.	—	—	—	×
A. muelleriana Maiden & R.T. Baker	×	—	—	×
Pittosporaceae				
Citriobatus linearis (F.M. Bailey) C.T. White	×	×	—	—
C. spinescens (F. Muell.) Druce	×	—	—	—

Sapindaceae				
Alectryon diversifolius (F. Muell.) S. Reynolds	×	×	×	
Dodonaea stenophylla F. Muell.	—	—	—	
D. tenuifolia Lindl.	—	×	×	
D. viscosa (L.) Jacq. var. *angustifolia* (L.f.) Benth.	—	—	×	
CLIMBING PLANTS				
Apocynaceae				
Parsonsia lanceolata R.Br.				
Asclepiadaceae				
**Araujia hortorum* Fourn.	×	—	—	
Sarcostemma australe R.Br.	×	—	—	
Secamone elliptica R.Br.	×	—	—	
Bignoniaceae				
Pandorea pandorana (Andr.) van Steenis	×	—	—	
Fabaceae				
Rhynchosia minima (L.) DC. var. *australis* (Benth.) C. Moore	—	—	×	
Oleaceae				
Jasminum didymum G. Forster subsp. *racemosum* (F. Muell.) P.S. Green	×	—	—	
Vitaceae				
Cayratia clematidea (F. Muell.) Domin	×	—	—	
Cissus opaca F. Muell.	×	×	—	
EPIPHYTES				
Orchidaceae				
Cymbidium canaliculatum R.Br.	—	—	×	
PARASITIC EPIPHYTES				
Loranthaceae				
Amyema cambagei† (Blakely) Danser	×	—	—	
A. congener§ (Sieber ex J.A. & J.H. Schultes) van Tieghem	—	×	—	
A. miquelii§ (Lehm. ex Miq.) van Tieghem	—	×	—	
A. quandang‡ (Lindl.) van Tieghem	×	—	—	
Dendrophthoe glabrescens§ (Blakely) Barlow	—	×	—	
Viscaceae				
Nothothixos subaureus# Oliver	—	×	—	
Viscum articulatum# N.L. Burm.	—	×	—	
GROUND STRATUM (< 1 m)				
Acanthaceae				
Justicia procumbens L.				
Amaranthaceae				
**Amaranthus viridus* L.	—	—	×	
Nyssanthes erecta R.Br.	—	—	×	
Apiaceae				
**Apium leptophyllum* (Pers.) F. Muell				
Asteraceae				
Calotis dentex R.Br.	—	—	×	×
C. lappulacea Benth.	—	—	×	—
C. scabiosifolia Sonder & F. Muell.	—	—	×	—
**Centaurea melitensis* L.	—	—	×	—
Glossogyne tenuifolia (Labill.) Cass.	—	—	×	—
Helichrysum bracteatum (Vent.) Andr.	—	—	—	×
H. ramosissimum Hook.	—	—	×	—
Helipterum anthemoides (Sieber ex Sprengel) DC.	—	—	—	×
Pterocaulon redolens (Willd.) F. Vill.	—	—	—	×
Sigesbeckia orientalis L.	—	—	×	—
Vernonia cinerea (L.) Less.	—	—	×	—
Vittadinia cuneata DC. var. *hirsuta* N.T. Burbidge	—	—	×	—
**Zinnia peruviana* (L.) L.	—	—	—	×
Brassicaceae				
Lepidium africanum (N. Burman) DC.	—	—	×	

† On *Allocasuarina luehmannii*;
‡ On *Acacia harpophylla*;
§ On *Eucalyptus populnea*;
# On *Amyema congener*

Campanulaceae				
Wahlenbergia gracilis (G. Forster) Schrader				
Chenopodiaceae				
Atriplex muelleri Benth.	×	—	—	—
Enchylaena tomentosa R.Br.	×	—	—	—
Maireana decalvans (Gandoger) P.G. Wilson	—	—	—	×
Rhagodia nutans R.Br.	×	—	—	—
Chloanthaceae				
Spartothamnella juncea (Cunn. ex Walp.) Briq.				
Convolvulaceae				
Dichondra repens J.R. & G. Forster				
Evolvulus alsinoides (L.) L.				
var. *decumbens* (R.Br.) van Ooststr.				
Cyperaceae				
Cyperus clarus S.T. Blake				
C. dietrichiae Boeck.				
var. *brevibracteatus* (Domin) Kukenthal	—	—	×	—
C. rigidellus (Benth.) J.M. Black	—	—	×	—
Dilleniaceae				
Hibbertia obtusifolia DC.				
Epacridaceae				
Melichrus urceolatus R.Br.				
Euphorbiaceae				
Euphorbia drummondii Boiss.	—	—	×	—
Poranthera microphylla Brogn	—	—	—	×
Fabaceae				
Crotalaria mitchellii Benth.	—	—	×	—
Desmodium brachypodum A. Gray	—	—	×	—
**D. tortuosum* (Swartz) DC.	—	—	×	—
D. trichostachyum Benth.	—	—	×	—
Glycine tabacina (Labill.) Benth.	—	×	×	—
Hardenbergia violacea (Schneev.) Stearn	—	—	—	×
Indigofera brevidens Benth.	—	—	—	×
I. linnaei Ali	—	—	×	—
Lespedeza juncea (L.f.) Pers. subsp. *sericea* (Thunb.) Steen	—	—	×	—
Lotus australis Andr.	—	—	×	—
Neptunia gracilis Benth.	—	—	×	—
Pycnospora lutescens (Poiret) Schindler	—	—	×	—
Swainsona galegifolia (Andr.) R.Br.	—	—	×	—
Gentianaceae				
**Centaurium erythraea* Rafn.				
Goodeniaceae				
Goodenia delicata Carolin ms				
Juncaceae				
Juncus subsecundus Wakefield				
Lamiaceae				
Plectranthus parviflorus Willd.				
Liliaceae				
Dianella revoluta R.Br.	—	×	×	×
Laxmannia gracilis R.Br.	—	×	×	×
Lobeliaceae (Campanulaceae)				
Pratia concolor (R.Br.) Druce				
Malvaceae				
Abutilon malvifolium (Benth.) J.M. Black	—	—	×	—
Hibiscus sturtii Hook.	—	—	—	×
**Malvastrum americanum* (L.) Torrey	—	—	×	—
Sida corrugata Lindl.	—	×	—	×

Myoporaceae				
Myoporum debile (Andr.) R.Br.				
Nyctaginaceae				
Boerhavia dominii Meikle & Hewson				
Philesiaceae				
Eustrephus latifolius R.Br.				
Plantaginaceae				
Plantago debilis R.Br.				
Poaceae				
Aristida benthamii Henrard	—	×	—	—
A. calycina R.Br.	—	×	—	—
A. caput-medusae Domin	×	—	—	—
A. leptopoda Benth.	—	—	×	—
A. queenslandica Henrard var. *dissimilis* (S.T. Blake) B. Simon	—	—	×	—
A. ramosa R.Br. *var. speciosa* Henrard	—	—	—	×
Alloteropsis semialata (R.Br.) Hitchc.	—	—	×	—
Bothriochloa bladhii (Retz.) S.T. Blake	—	—	×	—
B. decipiens (Hackel) C.E. Hubbard	×	—	—	—
B. ewartiana (Domin) C.E. Hubbard	—	×	—	—
**Chloris gayana* Kunth	—	×	—	—
Cymbopogon refractus (R.Br.) A. Camus	—	×	×	—
Dichanthium affine (R.Br.) A. Camus	—	—	×	—
Digitaria brownii (R. & S.) Hughes	—	—	×	—
D. divaricatissima (R.Br.) Hughes	—	×	×	—
Enneapogon sp.	—	—	×	—
Eriochloa crebra S.T. Blake	—	×	×	—
E. pseudoacrotricha (Stapf ex Thell.) J.M. Black	—	×	—	—
Heteropogon contortus (L.) Beauv. ex R. & S.	—	—	×	—
Panicum effusum R.Br. var. effusum	—	×	—	×
P. queenslandicum Domin	—	×	—	—
Paspalidium rarum (R.Br.) Hughes	—	×	—	—
**Paspalum dilatatum* Poiret	—	×	—	—
Sorghum leiocladum (Hackel) C.E. Hubbard	—	—	×	—
Sporobolus creber De Nardi	—	×	×	—
**Sporobolus jacquemontii* Kunth	—	×	—	—
Stipa ramosissima (Trin.) Trin.	×	—	—	—
Themeda triandra Forsskal	—	—	×	—
Rubiaceae				
Asperula conferta J.D. Hook. var. conferta				
Sinopteridaceae				
Cheilanthes distans (R.Br.) Matt.				
C. sieberi Kuntze				
Solanaceae				
Solanum nemophilum F. Muell	×	×	×	×
S. semiarmatum F. Muell.	×	—	—	—
S. parvifolium R.Br.	×	—	—	—
Thymelaeaceae				
Pimelea curviflora R.Br. ssp. *gracilis* (R.Br.) Threlfall	—	—	×	—
P. linifolia Smith	—	×	×	—
Verbenaceae				
**Verbena officinalis* L	—	×	×	—
**V. tenuisecta* Briq.	—	×	×	—
Xanthorrhoeaceae				
Lomandra confertifolia (Bailey) Fahn subsp. *pallida* A. Lee	—	—	—	×
L. leucocephala (R.Br.) Ewart	—	—	—	×
L. longifolia Labill.	—	—	×	×
Zygophyllaceae				
Tribulus terrestris L.				

Table 9. Species richness and structure of savanna (+ *Xanthorrhoea*) open-forest at Widgee Mountain, Queensland (Compiled by M. Arianoutsou and R.L. Specht, 1987).

Location: Widgee Mountain, Queensland (26°15'S, 152°22'E, 659 m)

Nearest climate station:
Glastonbury (26°13'S, 152°31'E, 79 m)
Annual precipitation 1,179 mm; rain days 95
Kilkivan (26°05'S, 152°15E', 141 m)
Annual precipitation 875 mm; rain days 75
Mean annual temperature 20.2°C (est.)
Evaporative coefficient (k) > 0.063 (open-forest) -→ 0.100 (closed-forest)

Geology: Serpentinite (Palethorpe, 1968)

Soils: ***Lithosols (Uf 6.21)*** — very dark grey-brown loams and clay loams overlying serpentinite at 5–20 cm.

Prairie soils (Gn 3.42) — very dark brown/dark reddish brown, well- structured clay loams increasing to light and medium clays with depth, overlying serpentinite at 45–75 cm.

Chemical and physical analyses (Thompson, 1969)

Depth 0–10 cm, pH 6.6, C 5.8%, N 0.365%, Avail. P 10ppm
Coarse sand 11%, Fine sand 13%, Silt 20%, Clay 45%
Cation Exch. Cap. (m equiv. per 100 g oven-dry soil)
Total 53.6, Ca 4.7, Mg 37, K 0.3, Na 0.3
Exploratory analyses (Thompson, 1969) of the serpentinite soils show very low phosphorus and calcium status, high magnesium saturation with low potassium level. Chromium and nickel do not seem sufficiently high to cause concern.

Vegetation references: Batianoff *et al.*, 1991.

Vegetation analysis:

Age since last ground fire: more than 3 years

Vegetation structure: Low open-forest (savanna + *Xanthorrhoea*)

Species composition	*F.P.C.(%)*
Upper stratum (7–8 m)	
Eucalyptus acmenoides	21
E. punctata var. *longirostrata*	7
E. intermedia	4
Angophora subvelutina	2
	34
Mid stratum–tall (4–6 m)	
Allocasuarina littoralis	6
Banksia integrifolia var. *compar*	1
	7
Mid stratum–low (1–2 m)	
Xanthorrhoea glauca (1.5–2.0 m)	16
Jacksonia scoparia	2
Hakea florulenta	
Macrozamia miquelii	
	20
Ground stratum (30 cm)	
Themeda triandra	67
Dianella caerulea	1
	68
Bare ground	32

Species recorded by M. Arianoutsou, R.D. Reeves and R.L. Specht in low open-forest (savanna + Xanthorrhoea) at Widgee Mountain, Queensland.

TREES (7-8 m)
Myrtaceae
Angophora subvelutina F. Muell.
Eucalyptus acmenoides Schauer
Eucalyptus crebra F. Muell.
Eucalyptus erythrophloia Blakely
Eucalyptus intermedia R.T. Baker
Eucalyptus melanophloia F. Muell.
Eucalyptus punctata DC. var. *longirostrata* Blakely
Eucalyptus tereticornis Smith
Lophostemon confertus (R.Br.) P.G. Wilson & Waterhouse

TALL SHRUBS/SMALL TREES (4-6 m)
Casuarinaceae
Allocasuarina littoralis (Salisb.) L.A.S. Johnson
Mimosaceae
Acacia aulacocarpa Cunn. ex Benth.
Acacia implexa Benth.
Acacia irrorata Sieber ex Sprengel
Acacia maidenii F. Muell.
Pittosporaceae
Citriobatus spinescens (F. Muell.) Druce
Proteaceae
Banksia integrifolia L.f. var. *compar* (R.Br.) F.M. Bailey
Santalaceae
Exocarpos cupressiformis Labill

LOW SHRUBS (1-2 m)
Araliaceae
Astrotricha floccosa DC.
Asclepiadaceae
**Asclepias curassavica* L.
**Gomphocarpus physocarpus* E. Meyer
Asteraceae
**Baccharis halimifolia* L
Dilleniaceae
Hibbertia linearis R.Br. ex DC.
Euphorbiaceae
Breynia oblongifolia Muell. Arg.
Phyllanthus gasstroemii Muell. Arg.
Fabaceae
Bossiaea heterophylla Vent.
Cajanus reticulatus (Dryander) F. Muell
Daviesia genistifolia Cunn. ex Benth.
Jacksonia scoparia R.Br.
Lamiaceae.
Plectranthus parviflorus Willd.
Westringia eremicola Cunn. ex Benth.
Proteaceae
Hakea florulenta Meissn.
Rubiaceae
Psychotria daphnoides Cunn. ex Hook. var *daphnoides*
Xanthorrhoeaceae
Xanthorrhoea glauca Bedford
Zamiaceae
Macrozamia miquelii (F. Muell.) A.DC

CLIMBING PLANTS
Convolvulaceae
**Convolvulus arvensis* L
Fabaceae
Glycine clandestina Wendl
Hardenbergia violacea (Schneev.) Stearn
Philesiaceae
Eustrephus latifolius R.Br
Rosaceae
Rubus parvifolius L.
Vitaceae
Cissus opaca F. Muell.

GROUND STRATUM (30 cm)
Acanthaceae
Pseuderanthemum variabile (R.Br.) Radlk. ex Lindau
Asteraceae
Bidens bipinnata L.
Vernonia cinerea (L.) Less.
Wedelia spilanthoides F. Muell.
Campanulaceae
Wahlenbergia communis Carolin
Wahlenbergia gracilis (G. Forster) Schrader
Commelinaceae
Commelina lanceolata R.Br.
Cyperaceae
Carex breviculmis R.Br.
Cyperus cyperoides (L.) Kuntze
Fimbristylis dichotoma (L.) Vahl
Fimbristylis ovata (N. Burman) Kern
Gahnia aspera (R.Br.) Spreng.
Lepidosperma laterale R.Br.
Lepidosperma lineare R.Br.
Scleria mackaviensis Boeck.
Euphorbiaceae
Phyllanthus virgatus Forster f.
Poranthera microphylla Brongn.
Fabaceae
Crotalaria montana Roth
Desmodium rhytidophyllum F. Muell. ex Benth
Desmodium triflorum (L.) DC.
Goodeniaceae
Goodenia rotundifolia R.Br.
Velleia paradoxa R.Br.
Lamiaceae
Ajuga australis R.Br.
Anisomeles malabarica (L.) R.Br. ex Sims
Liliaceae
Dianella caerulea Sims var. *vannata* R. Henderson
Tricoryne elatior R.Br.
Lobeliaceae
Lobelia purpurascens R.Br.
Orchidaceae
Dipodium variegatum M. Clements & D. Jones
Diuris chrysantha D. Jones & M. Clements
Poaceae
Alloteropsis semialata (R.Br.) Hitchc.
Cymbopogon refractus (R.Br.) A. Camus
Dichanthium sericeum (R.Br.) A. Camus subsp. *sericeum*
Echinopogon nutans C.E. Hubbard
Entolasia stricta (R.Br.) Hughes
Eragrostis sororia Domin
Eremochloa bimaculata Hackel
Imperata cylindrica (L.) Beauv. var. *major* (Nees) C.E. Hubbard
Oplismenus aemulus (R.Br.) R. & S.

Panicum effusum R.Br. var. *effusum*
Sorghum leiocladum (Hackel) C.E. Hubbard
Themeda triandra Forsskal
Polygalaceae
Polygala japonica Houtt.
Polygala linariifolia Willd.
Polypodiaceae
Drynaria rigidula (Sw.) Bedd.
Rubiaceae
Spermacoce multicaulis Benth.
Scrophulariaceae
Limnophila sp.
Stylidiaceae
Stylidium graminifolium Swartz ex Willd
Violaceae
Hybanthus enneaspermus (L.) F. Muell.
Viola betonicifolia Smith
Xanthorrhoeaceae
Lomandra filiformis (Thunb.) Britten
Lomandra longifolia Labill.