FLORA IDENTIFICATION WORKSHOP

COURSE OUTLINE

Tuesday 25th August 1998

9.00- 9.15		Introduction and Course Outline
9.15- 9.30	A	The basics of good herbarium practice, how to collect specimens.
9.30- 10.30	B	Knowing the right terms to enable communication. Plant morphology, habit, leaves, flowers, fruits and seeds.
10.30- 10.45		Morning Tea
10.45- 12.30	C	What is taxonomy and systematics?. Classification, nomenclature, name formation and pronunciation.
12.30- 1.15		Lunch
1.15- 3.00	D	Florabase, electronic identification and information retrieval.
3.00- 3.15		Afternoon Tea
3.15- 4.30	E	Electronic keys and information for conservation and land management using “Wattles of the Kalannie Region” as an example. Bruce Maslin

Wednesday 26th August 1998

8. 30- 9.30	F	Introduction to basic flower, using keys. Monocotyledons and dicotyledons.
9.30-10.30.	G	Major dicotyledonous families, Myrtaceae, Proteaceae, Leguminoseae
10.30- 10.45		Morning Tea
10.45- 12.30	H	Identification using keys, other families.
12.30- 1.15		Lunch
1.15- 3.00	I	Identification, using the library and reference herbarium
3.00- 3.15		Afternoon Tea
3.15- 4.30		Identification.

Flora Identification Training

Location – Herbarium

Conducted by – Sue Patrick

Attendees (limited to 20 per session):

Dates - 25th and 26th August, 1998

Kelmscott
Region - David Mitchell, Ross Mead
Forest Management Branch – Abe van de Sande, Deanne Pember, Leigh Trevorrow, Mike Pez, John Meharry

Perth District – Steven King, Ken Borland

Mundaring District – Peter Batt, Alan Wright

Dwellingup District – Murray Love, Peter Gibson, Kris Narducci,

Como
Wildlife Branch –John Reilly
Wildlife Protection – Matt Warnock, Matt Dowling, Paul Connolly, Andrew Ando
Environmental Protection –Jude Allen

Nominations for the second course – 27th & 28th August

Region - Ralph Smith

Perth District – Lyndon Mutter, Roger Markham, Theresa Gepp

Mundaring District –Fred Hart, Isaac Lee

Dwellingup District - Grant Lamb, Taryn Linning

Marine & Coastal – Ian Gale

Como
Wildlfie Protection – Darren Graham, Kingsley Miller, Rick Dawson, Julie Gale
Environmental Protection – Norm Caporn
Wildlife Branch - Liesl Rohl

Wanneroo
Regional Parks –Stewart Harrison, Jason Puls, J Korb, Annabel Vowels

Moora – Paul Blechendyn

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Wednesday 26th August 1998 Friday 28th August

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3.15- 4.30	Identification.

Synopsis of the plant family Myrtaceae in Western Australia

Family
Myrtaceae

A large, primarily southern hemisphere plant family with over 3500 species in ca 150 genera. Within Australia are over 1300 in ca 70 genera.

Subfamily
Myrtoideae

Lillypilly.

Main development of Subfamily Myrtoidea is in South and Central America. Although 5 of the 6 alliances within Myrtoidea are represented in Australia, most of these are in eastern and northern tropical and subtropical areas.
4 genera occur in the Kimberley:

Myrtella (Myrtus alliance)
Syzygium (Acmena alliance)
Osbornia (Osbornia alliance)
Eugenia (Eugenia alliance)

Subfamily
Leptospermoideae

Mainly Australian; comprises 6 alliances, all of which occur in Australia. However, 2 of these, ***Backhousia*** and ***Eucalyptopsis***, do not occur in WA.

Mike Hislop
Identification Botanist,
Regional Herbaria Program

Alliance *

Subfamily
Leptospermoideae

- **Metrosideros**
- **Eucalyptus**
- **Leptospermum**
- **Chamaelaucium** ("camel awsion")

Metrosideros

Ca 12 genera with 2 represented in the Kimberley:

Lophostemon	*Xanthostemon*

Eucalyptus

3 genera with 2 widespread in WA:

Eucalyptus	*Corymbia*

Leptospermum

Ca 17 genera with 15 in WA:

Agonis	*Kunzea*
Angasomyrtus	*Lamarchea*
Beaufortia	*Leptospermum*
Callistemon	*Melaleuca*
Calothamnus	*Pericalymma*
Conothamnus	*Phymatocarpus*
Eremaea	*Regelia*
Homalospermum	

Chamaelaucium

More than 20 genera with 18 in WA:

Actinodium	*Homalocalyx*
Astartea	*Hypocalymma*
Baeckea	*Malleostemon*
Balaustion	*Micromyrtus*
Calytrix	*Pileanthus*
Chamaelaucium	*Rinzia*
Corynanthera	*Scholtzia*
Darwinia	*Thrytomene*
Euryomyrtus	*Verticordia*

* This synopsis does not include sub-alliances.
For more details refer to "Flowering Plants in Australia" by B.D. Morley and H.R. Toelken

Western Australian Genera within the Leptospermum Alliance

1) *Agonis* (DC.)Lindl.

11 named taxa with at least another 2 unnamed.
Confined to SW Australia, mostly in southern areas.

Major distinguishing features:

- Leaves alternate or in alternate bundles.
- Inflorescence of dense globular heads (except *A. grandiflora* which has 1-several flowers per inflorescence).
- Flowers sessile, 5-merous, usually white. Petals more or less persistent.
- Stamens free, not exceeding petals, either 10 and opposite petals and sepals or 20-30+, all or mostly opposite sepals.
- Anthers versatile.
- Ovary 3-celled, ovules 2-6 per cell.
- Fruit a 3-valved more or less woody capsule, which is usually shed annually after dehiscence.

Confusing genera:

A distinctive genus not usually confused with others.

Separated from *Kunzea* by its usually definite number of stamens, which are shorter than the petals, and from *Hypocalymma* by its alternate leaves.

Agonis grandiflora is an anomalous species which will probably be removed from the genus after future revision. (G.J. Keighery pers. comm.)

References:

Flora of the Perth Region – Marchant et al.
Forthcoming "Flora of the SW Forest Region" – J.R. Wheeler et al.
Blackall & Grieve Part IIIA – still quite useful

2) *Angasomyrtus* Trudgen & Keighery

1 species restricted to the edges of a few saline lakes north of Esperance.

Major distinguishing features:

- Leaves opposite.
- Inflorescence of solitary flowers in axils of leaf-like bracts.
- Flowers sessile, 5-merous.
- Stamens free, indefinite (usually 16-19) in 2 whorls, shorter than petals.
- Anthers versatile.
- Ovary 2-3(4)-celled, with 4 or 5 ovules per cell.
- Fruit a 2-3(4)-valved, more or less woody capsule, which is usually shed annually after dehiscence.

Confusing genera:

Closest to *Leptospermum*, *Pericalymma* and *Homalospermum* but differs in having opposite leaves and a specialised habitat.

References:

"*Angasomyrtus*, a new genus of Myrtaceae from West Australia" – M.E. Trudgen & G.J. Keighery, Nuytsia 4(3), 435-439 1983

3) *Beaufortia* R.Br.

20 named taxa and at least 1 unnamed.
Confined to SW Australia.

Major distinguishing features:

- Leaves opposite (except *B. sparsa*).
- Inflorescence a dense head or spike.
- Flowers sessile, 5-merous.
- Stamens usually indefinite, connate into 5 bundles.
- Anthers erect, basifixed, cells opening at the top by transverse slits.
- Ovary 3-celled, ovules 1 per cell.
- Fruit a 3-valved woody or subwoody capsule, long persistent. Seeds often with a terminal wing.

Confusing genera:

Closest to *Regelia*, which differs in having anthers opening by longitudinal slits and ovary with 4 ovules per cell.
Melaleuca and *Conothamnus* have versatile anthers and *Phymatocarpus* has alternate leaves.

References:

Flora of the Perth Region – Marchant et al.
Forthcoming "Flora of the SW Forest Region" – J.R. Wheeler et al.
Blackall & Grieve Part IIIA – still quite useful

4) *Callistemon* R.Br.

About 30 species in Australia, only 2 in SW Australia.

Major distinguishing features:

- Leaves alternate.
- Inflorescence a dense spike.
- Flowers sessile or slightly immersed in rhachis, 5-merous.
- Stamens indefinite, free or very shortly connate at the base into 5 bundles.
- Anthers versatile.
- Ovary 3 or 4-celled, ovules very numerous per cell.
- Fruit a 3 or 4-valved capsule, long persistent.

Confusing genera:

Very close to *Melaleuca*. The main distinguishing feature from that genus is the presence of stamens that are either free or very shortly united into 5 bundles. However, this separating character tends to break down as some species of *Melaleuca* also have stamens that are only very shortly connate at the base. It appears probable that L.A. Craven, who is currently revising the genus *Melaleuca*, will merge *Callistemon* into *Melaleuca*. (B.J. Lepschi pers. comm.)

References:

Flora of the Perth Region – Marchant et al.
Forthcoming "Flora of the SW Forest Region" – J.R. Wheeler et al.
Blackall & Grieve Part IIIA – still quite useful

5) *Calothamnus* Labill.

42 named taxa with at least another 5 unnamed.
Confined to SW Australia.

Major distinguishing features:

- Leaves usually crowded, scattered, terete in most species.
- Inflorescence of unilateral or cylindrical spikes or of scattered clusters, never terminal.
- Flowers sessile or more or less immersed in the rhachis, 4 or 5-merous.
- Stamens indefinite, connate into 4 or 5 bundles, which are characteristically long, at least 4 times longer than the petals.
- Anthers basifixed.
- Ovary 3-celled, ovules numerous.
- Fruit a 3-valved woody capsule, long persistent, often crowned by several thickened woody calyx lobes. The seeds are characteristically elongate, linear to oblong.

Confusing genera:
A distinctive genus not generally confused with others.
Lamarchia differs in having all stamens united in the basal half before separating into 5 bundles.
Eremaea has relatively shorter stamen bundles only about twice as long as the petals, compared with at least 4 times longer in *Calothamnus*. Additionally *Eremaea* has distinctly winged seeds.
Calothamnus is the only genus within the alliance which includes species with 4-merous floral parts.

References:

A Taxonomic Revision of the Genus *Calothamnus* Part 1, the 4-merous species – T.J. Hawkeswood – Nuytsia 6(1) 1987
Calothamnus, the 5-merous species – T.J. Hawkeswood – Australian Plants Vol. 16 No. 127
Flora of the Perth Region – Marchant et al.
Forthcoming "Flora of the SW Forest Region" – J.R. Wheeler et al.
Blackall & Grieve Part IIIA – of limited value

The genus is currently being revised for Flora of Australia by A.S. George.

6) *Conothamnus* Lindl.

A small genus of 3 species confined to SW Australia.

Major distinguishing features:

- Leaves opposite.
- Inflorescence a dense terminal head.
- Flowers sessile, 5-merous.
- Stamens indefinite, connate into 5 bundles.
- Anthers versatile.
- Ovary 3-celled with 1 ovule per cell.
- Fruit a 3-valved woody capsule, long persistent.

Confusing genera:

Close to *Melaleuca*, differing primarily in having only 1 ovule per cell.
Beaufortia and *Regelia* have erect, basifixed anthers.

References:

Flora of the Perth Region – Marchant et al.
Blackall & Grieve Part IIIA – taxonomy unchanged since publication

7) *Eremaea* Lindl.

24 taxa confined to SW Australia.

Major distinguishing features:

- Leaves scattered or crowded.
- Inflorescence of single flowers or small conflorescences of up to 9 flowers, axillary or subterminal.
- Flowers sessile, 5-merous, unusual within the *Leptospermum* alliance in that many species are orange flowered.
- Stamens indefinite, connate into 5 bundles.
- Anthers erect, basifixed, opening by longitudinal slits.
- Ovary 3-celled with numerous ovules per cell.
- Fruit a 3-valved woody capsule, long persistent. Capsule often lobed. Seeds very distinctive, strongly angular and winged along angles.

Confusing genera:

A distinctive genus, closest to *Beaufortia*, *Regelia* and *Calothamnus*.
It differs from *Beaufortia* in having scattered leaves and numerous ovules; from *Regelia* by its scattered leaves and few-flowered inflorescence and from *Calothamnus* in its relatively shorter stamen bundles, only about twice as long as the petals compared with at least 4 times longer in *Calothamnus*. May also be confused with *Melaleuca* but has basifixed anthers. It differs from all other genera by its distinctively shaped seeds.

References:

A revision of the genus *Eremaea* – Roger Hnatiuk – Nuytsia 9 (2) 1993.
Flora of the Perth Region – There have been taxonomic changes in this genus since publication.
Blackall & Grieve Part IIIA - don't bother.

8) *Homalospermum* Schauer

A single species confined to swamps in the wetter parts of SW Australia.

Major distinguishing features:

- Leaves alternate.
- Inflorescence of single axillary flowers in successive leaf axils.
- Flowers sessile/subsessile, 5-merous.
- Stamens versatile.
- Ovary 3-5(usually 4)-celled with numerous ovules per cell.
- Fruit a 3-5-valved woody capsule, persistent. Seeds flattened, peltate, winged.

Confusing genera:

Formerly included in *Leptospermum* and still readily confused with that genus. The defining characters separating the 2 genera can only be observed under the microscope.
Homalospermum has an ovary summit with radiating bands of hairs delimiting the cells, whereas in *Leptospermum* the ovary summit is glabrous, or with hairs not confined to radiating bands. In *Homalospermum* each anther has 2 thickened ridges on the back, on either side of the point of attachment of the filament; this is not found in *Leptospermum*. The ovules of *Homalospermum* are hemitropous and peltate: in *Leptospermum* they are anatropous and oblong. Additionally, the woody fruits of *Homalospermum* are persistent on the plant for several years, whereas those of WA *Leptospermum* species, (except the distinctive *L. spinescens* and, to a lesser extent, *L. confertum*) are shed at or soon after dehiscence.
May also be confused with *Pericalymma*, which was also included within *Leptospermum* until quite recently. However *Pericalymma* has leaves that grade into bracts below the inflorescence and only one seed developing per cell.

References:

Redefinitions and nomenclatural changes within the *Leptospermum* suballiance – J. Thompson – Telopea 2 (4) 1983

9) *Kunzea* Reichb.

Over 30 species across southern Australia with 27 taxa in SW Australia.

Major distinguishing features:

- Leaves alternate.
- Inflorescence usually a dense terminal head (although these may be relatively few-flowered in Kunzea section Zeanuk subsection Floridae).
- Flowers sessile, 5-merous.
- Stamens indefinite, free, in one or more whorls, longer than petals.
- Anthers versatile.
- Ovary 2-5-celled with (2)-numerous ovules per cell.
- Fruit a 2-5-valved , subwoody capsule, usually shed annually after dehiscence.

Confusing genera:

May be confused with *Melaleuca* but has free stamens and non-persisitent fruit. Distinguished from *Beaufortia* and *Regelia* by alternate leaves and versatile anthers and from *Leptospermum* by having stamens longer than the petals.
A considerable degree of hybridisation between species is suspected within this genus.

References:

A revision of the genus *Kunzea* 1. The West Australian section Zeanuk – H.R. Toelken – Journal of the Adelaide Botanical Gardens Vol. 17 1996 (This treats all WA species with the exception of *K. pulchella* and *K. baxteri*.)
Flora of the Perth Region – There have been taxonomic changes in the genus since publication.
Blackall & Grieve Part IIIA – of little value except for the distinction between *K. pulchella* and *K. baxteri*.

10) *Lamarchea* Gaudich.

3 taxa from the central west coast of WA and arid central areas of WA and NT.

Major distinguishing features:

- Leaves scattered.
- Inflorescence of solitary flowers scattered on older stems.
- Flowers sessile, 5-merous.
- Stamens indefinite, all connate in basal half into a tube, which is them divided into 5 separate bundles.
- Ovary 3-celled, ovules numerous.
- Fruit a 3-valved woody capsule, long persistent.

Confusing genera:

Only likely to be confused with Calothamnus, which has basifixed anthers and with the stamen bundles not all connate basally.

References:

A revision of the genus Lamarchea – A.S. George – Nuytsia Vol. 1 No. 3 1972
Blackall & Grieve Part IIIA – Taxonomy unchanged since publication.

11) ***Leptospermum*** Forster & G. Forster

About 80 Taxa mostly in eastern Australia but with 2 species in SE Asia and 1 in NZ. 15 in SW Australia including 1 naturalised and 1 in the Kimberley District.

Major distinguishing features:

- Leaves alternate.
- Inflorescence consists of one to several flowers on a short modified shoot terminated by a vegetative bud.
- Flowers subsessile to shortly pedicellate, 5-merous.
- Stamens indefinite, free in a single continuous whorl, shorter than petals.
- Anthers versatile.
- Ovary usually 3-5-celled with numerous ovules per cell.
- Fruit usually a 3-5-valved subwoody capsule. Within WA species, dehiscence occurs annually and the spent capsules are not long persistent on the plant; *L. spinescens* and *L. confertum* are exceptions in this regard.

Confusing genera:

May be confused with *Homalospermum* (see notes under that genus) or *Pericalymma*, which has leaves that grade into bracts below the inflorescence and only one seed developing per cell.

References:

A revision of the genus Leptospermum – J. Thompson – Telopea 3 (3) 1989 (Key is complex and difficult to use.)
Blackall & Grieve Part IIIA – Don't bother.

12) *Melaleuca* L.

About 230 species worldwide with 219 in Australia and 171 in WA. Reaches its greatest diversity in the SW corner of WA.

Major distinguishing features:

- Leaves opposite, alternate or scattered.
- Inflorescence a more or less globular heaad or spike or flowers irregularly clustered.
- Flowers sessile, 5-merous.
- Stamens usually indefinite, connate into 5 bundles.
- Anthers versatile.
- Ovary 3-celled, ovules few-numerous per cell.
- Fruit a 3-valved woody capsule, long persistent.

Confusing genera:

Differs from *Beaufortia*, *Phymatocarpus* and *Regelia* in having versatile anthers and usually numerous ovules. From *Eremaea* it differs again in its versatile anthers and usually numerous flowers per inflorescence.
Conothamnus is close but has only one ovule per cell while *Callistemon* and *Kunzea* have free stamens.

References:

A major revision by L.A. Craven & B.J. Lepschi is nearing completion. Some earlier work associated with this revision has been published:
Contributions to a revision of Melaleuca – the "M. fulgens complex" and the "M. laxiflora complex" – Australian Systematic Botany Vol. 3 (2) 1990
Contributions to a revision of Melaleuca – the "M. cuticularis complex" and the "M. lanceolata complex" – Australian Systematic Botany Vol. 1 (2) 1988

Other references:
New names & combinations for some Melaleuca species and subspecies from the SW of WA considered rare or threatened – F.C. Quinn, K.J. Cowley, B.A. Barlow K.R. Thiele – Nuytsia Vol. 8 (3)
Flora of Perth (The taxonomy still mostly current but changes pending)
Flora of the Kimberley
Blackall and Grieve Part IIIA – no longer very useful.

13) *Pericalymma* (Endl.)Endl.

5 taxa confined to wetter areas of SW Australia. Several have yet to be published.

Major distinguishing features:

- Leaves alternate.
- Inflorescence of one-few flowers on short modified shoots (usually with terminal bud aborted). Each flower subtended by a bract.
- Flowers subsessile or very shortly pedicellate, 5-merous.
- Stamens free, indefinite, in a single continuous whorl, shorter than the petals.
- Anthers versatile.
- Ovary 3-celled with several ovules per cell, peltately attached.
- Fruit a 3-valved subwoody capsule. Only one seed per cell develops from lowest ovule. Dehiscence occurs annually and spent capsules are not long persistent on the plant.

Confusing genera:

Can be confused with *Leptospermum* and *Homalospermum*. See comments under these genera for differences.
Differs from superficially similar members of the *Chamaelaucium* alliance by having alternate leaves and indefinite stamens in an uninterrupted whorl.

References:

Currently being revised by R.J. Cranfield.

Redefinitions and nomenclatural changes within the *Leptospermum* sub-alliance of Myrtaceae – J. Thompson – Telopea 2(4) 1983
Flora of the Perth Region.

14) *Phymatocarpus* F.Muell.

2 species from SW Australia.

Major distinguishing features:

- Leaves alternate.
- Inflorescence a dense globular head.
- Flowers sessile, 5-merous.
- Stamens definite or indefinite, connate into 5 bundles.
- Anthers erect, basifixed, opening near the base by transverse slits.
- Ovary 3-celled, ovules 2-4 per cell.
- Fruit a 3-valved woody capsule, long persistent.

Confusing genera:

Differs from *Melaleuca*, *Conothamnus* and *Kunzea* by its erect anthers.

From *Beaufortia* and *Regelia* it differs in having alternate leaves.

References:

Blackall & Grieve Part IIIA – Taxonomy unchanged since publication.

15) *Regelia* Schauer

6 taxa, 5 in SW Australia.

Major distinguishing features:

- Leaves opposite.
- Inflorescence a dense globular head or short spike.
- Flowers sessile, 5-merous.
- Stamens indefinite, connate into 5 bundles.
- Ovary 3-celled, ovules 4 per cell.
- Fruit a 3-valved woody capsule, long persistent. Seeds sometimes with terminal wings.

Confusing genera:

Closest to *Beaufortia*, which differs in having anthers opening at the top by transverse slits and by having only one ovule per cell.
Melaleuca and *Conothamnus* have versatile anthers and *Phymatocarpus* has alternate leaves.

References:

Flora of the Perth Region – Marchant et al.
Forthcoming "Flora of the SW Forest Region" – J.R. Wheeler et al.
Blackall & Grieve Part IIIA – still useful.

KEYS

Quick ID

Leaves opposite:	*Angasomyrtus, Beaufortia (except B. sparsa), Conothamnus, Melaleuca, Regelia.*
Leaves alternate or in alternate bundles or scattered:	*Agonis, Callistemon, Calothamnus, Eremaea, Homalospermum, Kunzea, Lamarchea, Leptospermum, Melaleuca, Pericalymma, Phymatocarpus.*
Inflorescence a dense head:	*Agonis, Beaufortia, Conothamnus, Kunzea, Melaleuca, Phymatocarpus, Regelia.*
Inflorescence a cylindrical spike	*Beaufortia, Callistemon, Calothamnus, Melaleuca, Regelia.*
Inflorescence of one to few flowers:	*Angasomyrtus, Calothamnus, Eremaea, Homalospermum, Kunzea, Lamarchea, Leptoospermum, Melaleuca, Pericalymma.*
Stamens connate into bundles, usually much longer than petals:	*Beaufortia, Calothamnus, Conothamnus, Eremaea, Lamarchea, Melaleuca, Phymatocarpus, Regelia.*
Stamens free to base, longer than petals:	*Callistemon, Kunzea.*
Stamens free to base, shorter than petals:	*Agonis, Angasomyrtus, Homalospermum, Leptospermum, Pericalymma.*
Anthers erect, basifixed:	*Beaufortia, Calothamnus, Eremaea, Phymatocarpus, Regelia.*
Anthers versatile:	*Agonis, Angasomyrtus, Callistemon, Conothamnus, Homalospermum, Kunzea, Lamarchea, Leptospermum, Melaleuca, Pericalymma.*

This character is of more use in the field than when working on dried material.

Fruits woody, long persistent, usually retaining seeds over several to many seasons:	*Beaufortia, Callistemon, Calothamnus, Conothamnus, Eremaea, Lamarchea, Melaleuca, Phymatocarpus, Regelia.* (*Homalospermum, Leptospermum spinescens* and *L. confertum* have persistent woody fruits but may shed seeds annually.)
Fruits subwoody or coriaceous, Seeds usually shed annually, Followed by the fruit itself:	*Agonis, Angasomyrtus, Kunzea, Leptospermum* (WA species only and excepting those species mentioned above), *Pericalymma.* (*Beaufortia* species sometimes have coriaceous rather than woody capsules, but these are retained over many seasons.)

Dichotomous Key

1. Stamens connate into bundles, longer than petals.

  2. Anthers erect, basifixed.

    3. Leaves opposite (alternate in *B. sparsa*).

      4. Anthers opening at the top by transverse slits; ovules one per cell. — 3 Beaufortia

      4: Anthers opening by longitudinal slits; ovules 4 per cell. — 15 Regelia

    3: Leaves alternate.

      5. Stamen bundles 4 or 5, >15 mm long, &/or at least 4 x longer than petals. — 5 Calothamnus

      5: Stamen bundles always 5, <12 mm long, usually about twice as long as petals.

        6. Anthers opening by longitudinal slits; seeds angular, winged along angles. — 7 Eremaea

6: Anthers opening near base by transverse slits; seeds not as above. 14 Phymatocarpus

2: Anthers versatile.

7. Leaves opposite.

8. Ovary with single ovule per cell. 6 Conothamnus

8: Ovary with few-numerous ovules per cell. 12 Melaleuca

7: Leaves alternate.

9. Stamens all united in a tube to at least the middle, then separating into 5 distinct bundles. 10 Lamarchea

9: Stamen bundles distinct to the base. 12 Melaleuca

1: Stamens free to the base.

10. Stamens longer than petals.

11. Inflorescence subterminal, cylindrical; capsules woody, long persistent. 4 Callistemon

11: Inflorescence terminal, compact, usually globular but sometimes few-flowered or shortly cylindrical; capsules subwoody, deciduous. 9 Kunzea - doesn't have woody capsule on plant.

10: Stamens shorter than petals.

12. Leaves opposite. 2 Angasomyrtus

12: Leaves alternate.

13. Flowers in dense globular head (except A. grandiflora, which has one-several flowers surrounded by conspicuous involucral bracts). 1 Agonis

13: Flowers not in globular head and without involucral bracts.

14. Leaves grading into bracts below the inflorescence; only one seed per cell, developed from lowest ovule. 13 Pericalymma

14: Leaves not grading into bracts; seeds not restricted to one per cell.

15. Ovary summit with radiating bands of hairs delimiting the cells; anther with 2 thickened ridges on the back on either side of the point of attachment of the filament; ovules hemitropous and peltate. 8 Homalospermum

15: Ovary summit glabrous or the hairs not confined to radiating bands; anthers without ridges; ovules anatropous and oblong. 11 Leptospermum

References:

Flowering Plants in Australia – B.D. Morley & H.R. Toelken – Rigby 1983
Flora of the Perth Region – N.G. Marchant et al. 1987
How to know WA Wildflowers Part IIIA W.E. Blackall & B.J. Grieve – 1980
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A revision of the genus Leptospermum – J. Thompson – Telopea 3 (3) 1989

Glossary

anatropous ovule	an ovule which is inverted and straight with the micropyle situated next to the funicle (see Fig. 1)
basifixed	(of anthers) attached at or by the base (see illustration) c.f. dorsifixed, versatile
conflorescence	an aggregation of several individual inflorescences
connate	fused to another organ of the same kind
coriaceoous	leathery
definite	with fixed number c.f. indefinite
dorsifixed	(of anthers) with filament attached to back of anther. Most versatile anthers are dorsifixed (see illustration).
hemitropous ovule	an ovule which is half inverted so that the funicle is attached near the middle with the micropyle at a right angle (see Fig. 2)
indefinite	numerous and often variable in number c.f. definite
rachis	the main axis of an inflorescence spike
versatile	(of anthers) swinging freely about point of attachment to filament c.f. basifixed

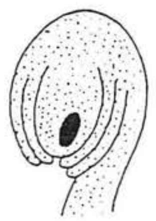


Fig. 1 anatropous ovule

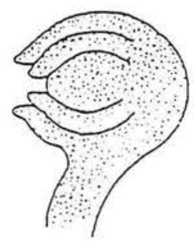
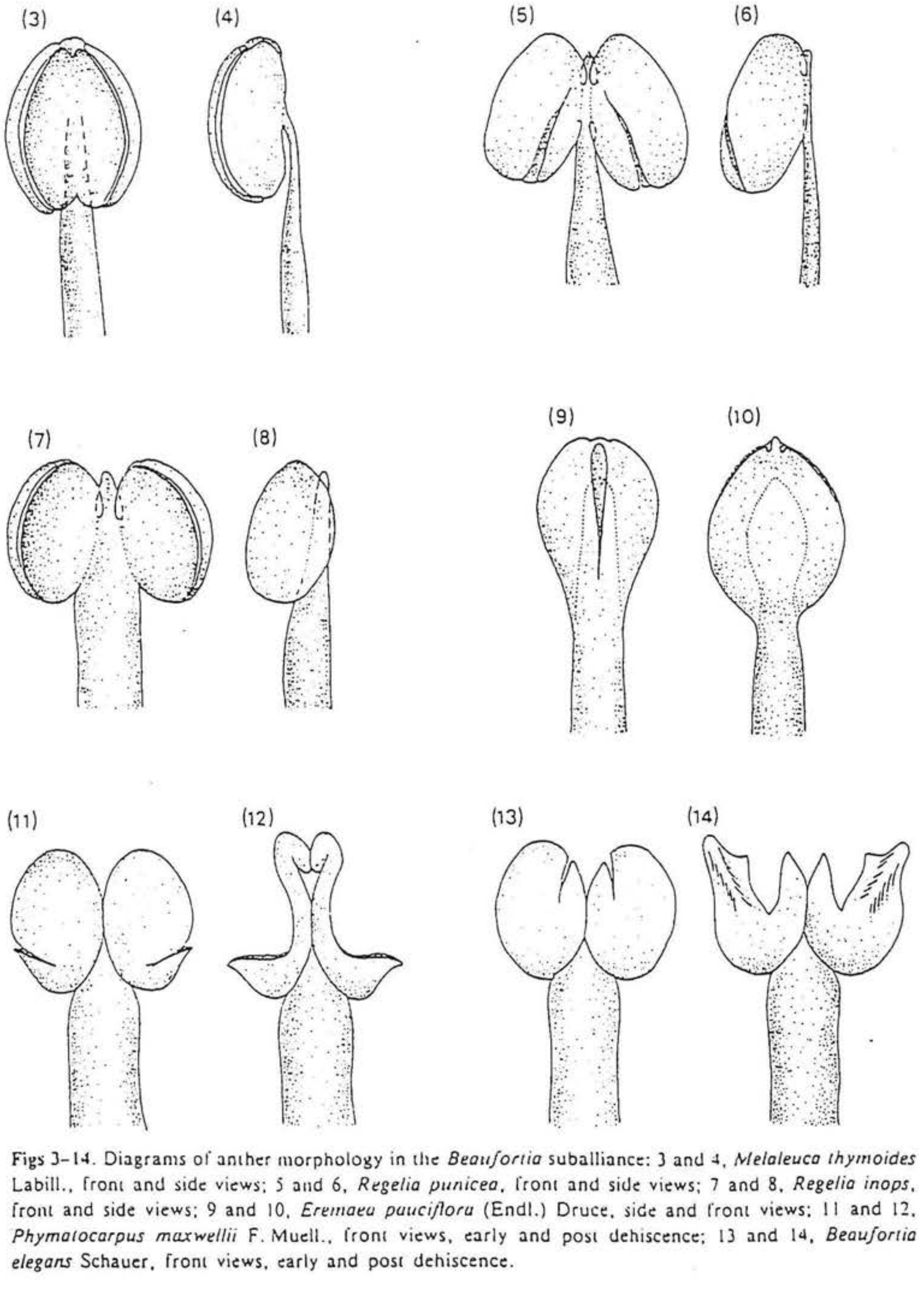


Fig. 2 Hemitropous ovule

Figures from Harris & Harris, Plant Identification Terminology: An Illustrated Glossary, Spring Lake Publishing, Utah, 1994

Anther Morphology Illustrations
From B.A. Barlow's paper on *Regelia punicea* in Brunonia, Vol. 9, No. 1 (1986)

to the filament/connective, so that the anthers are effectively basifixed; dehiscence by a longitudinal slit occurs only in the upper part of each sac. In anther morphology *R. ciliata* thus approaches *Eremaea* (Figs 9 and 10), in which the anther sacs and filament/connective are even more strongly integrated, and dehiscence is again longitudinal. In *Phymatocarpus* (Figs 11 and 12) and *Beaufortia* (Figs 13 and 14) the anther sacs are attached back-to-back, and dehisce transversely; the striking differences in pollen presentation are probably a simple consequence of the position of the line of dehiscence. In *Phymatocarpus* dehiscence is near the base, and the upper part of the anther wall is reverted, leaving the pollen presented in two pockets. In *Beaufortia*



Figs 3–14. Diagrams of anther morphology in the *Beaufortia* suballiance: 3 and 4, *Melaleuca thymoides* Labill., front and side views; 5 and 6, *Regelia punicea*, front and side views; 7 and 8, *Regelia inops*, front and side views; 9 and 10, *Eremaea pauciflora* (Endl.) Druce, side and front views; 11 and 12, *Phymatocarpus maxwellii* F. Muell., front views, early and post dehiscence; 13 and 14, *Beaufortia elegans* Schauer, front views, early and post dehiscence.

Family Myrtaceae Subfamily Leptospermoideae																
	Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Leaves	opposite															
	alternate, alternate bundles, scattered															
Inflorescence	dense head															
	cylindrical spike															
	one-few flowers															
Stamens	connate in bundles usually much longer than petals															
	free to base															
	longer than petals															
	shorter than petals															
Anthers	erect & basifixed															
	versatile															
Fruits	woody (it & seeds usually long persistent)															
	subwoody or coriaceous (it & seeds usually shed yearly)															

Synopsis of the plant family Epacridaceae in Western Australia

Family
Epacridaceae

A medium-sized predominantly Australian plant family with more than 450 species in over 30 genera.

Tribe
Richeeae

3 genera, 1 in WA
Sphenotoma

Tribe
Cosmelieae

7 genera, 2 in WA
Andersonia
Cosmelia

Tribe
Epacrideae

7 genera, 1 in WA
Lysinema

Tribe
Styphelieae

19 genera, 12 in WA
Acrotriche, Astroloma, Brachyloma, Coleanthera, Conostephium, Croninia, Leucopogon, Monotoca, Styphelia, Needhamiella, Oligarrhena, Trochocarpa

Mike Hislop
Identification Botanist,
Regional Herbaria Program

KEY TO TRIBES

1	Stems with annular leaf scars (*Sphenotoma*)	**Richeeae**
1	Stems without annular leaf scars	
2	Leaves sheathing, or if not sheathing, then with stamens free from corolla	**Cosmelieae**
2	Leaves not sheathing	
3	Style attenuated from the ovary; fruit indehiscent, usually a drupe	**Styphelieae**
3	Style inserted in a deep depression at apex of ovary; fruit a capsule	**Epacrideae**

(*Lysinema*)

KEY TO WA GENERA WITHIN COSMELIEAE

1	Stamens inserted on corolla tube	*Cosmelia*
1	Stamens free from corolla tube	*Andersonia*

KEY TO WA GENERA WITHIN STYPHELIEAE

1	Anthers completely exserted from the corolla tube	
2	Anthers free	*Styphelia*
2	Anthers connate or connivent	
3	Anthers connate in a cone around the style, filaments glabrous	*Coleanthera*
3	Anthers connivent or slightly cohering around the style, anthers and filaments enveloped in dense wool	*Astroloma stomarrhena*
1	Anthers wholly or partially enclosed in the corolla tube	
4	Corolla lobes broadly induplicate (rolled or folded inwards) in bud, hairs restricted to midline of corolla lobes	*Needhamiella*
4	Corolla lobes valvate or rarely imbricate in bud, and hairy or glabrous, not as above	
5	Corolla tube conical in upper part, or cylindrical for whole length, with very small erect, glabrous lobes; anthers prominently 2-lobed.	*Conostephium*
5	Corolla tube cylindrical or campanulate, lobes spreading or recurved; anthers entire (excluding *Croninia kingianus*)	
6	Corolla tube either with hairs or scales inside near the base or with hairy scales or tufts of reflexed hairs descending into the tube from the throat.	
7	Corolla lobes bearded; corolla tube with 5 tufts of hairs near the base (*Astroloma baxteri* is an exception with 5 deflexed fringed scales rather than tufts and with glabrous corolla lobes).	*Astroloma*
7	Corolla lobes glabrous; corolla tube with 5 hairy scales or tufts of reflexed hairs descending into the tube from the throat.	*Brachyloma*
6	Corolla tube glabrous below the throat (a few with hairs evenly distributed below the throat), may be glabrous or hairy on the corolla lobes and in the throat itself.	
8	Drupe 8-10-celled, separating into 8-10 pyrenes ("nutlets")	*Trochocarpa*
8	Drupe 5 or less-celled (except *Acrotriche* with 2-10 cells),	

9 COROLLA LOBES + THROAT ± GLABROUS ; OVARY 2 CELLED

10 Stamens 2; corolla lobes 4 *Oligarrhena*

10 Stamens 5; corolla lobes 5 *Monotoca*

9 Corolla lobes and often also throat hairy; ovary 2-10-celled

11 Corolla lobes with erect tufts of hair near apex and reflexed hairs in throat; ovary 2-10-celled; flowers greenish *Acrotriche*

11 Corolla lobes hairy, though sometimes only or mainly in the lower half; ovary 2-5-celled; flowers white, cream or red

12 Corolla 20-30 mm long *Astroloma*

12 Corolla < 15 mm long, usually white but sometimes cream or pink/red (*Leucopogon oxycedrus*, *L. rubicundus*; *L. strictus*)

13 Corolla usually < 10 mm long, but if more then flowers pendulous (excluding *Leucopogon strictus*) *Leucopogon*

13 Corolla 10-15 mm long, ± erect

14 Ovary and base of style hairy; anthers shortly 2-lobed *Croninia*

14 Ovary and style glabrous; anthers entire *Astroloma xerophyllum*

Ongoing taxonomic reassessment within Epacridaceae

Recent morphological and molecular studies of the plant family Epacridaceae as a whole and in particular the Tribe Styphelieae (A reassessment of relationships within Epacridaceae – J.M. Powell et al, Annals of Botany 77: 305-315, 1996; Relationships and generic concepts within Styphelieae – J.M. Powell et al, Aust. Systematic Botany 10, 15-29 1997) support a number of significant changes at the subfamily and generic levels.

The table of family relationships on page 1 is a summary of the new supra-generic concept as it affects WA genera. While morphological studies indicated that the tribes Richeeae, Cosmelieae and Styphelieae formed more or less natural groupings within the family, the tribe Epacrideae was less well defined. Further studies using an expanded morphological database will probably result in changes to the boundaries of Epacridaceae. Indeed the authors of a recently published paper (Archerieae: A new tribe in Epacridaceae – D.M. Crayn & C.J. Quinn, Aust. Syst. Botany 11, 1998) recognise a fifth tribe - Archerieae, previously embedded in Epacridaceae, with as many as another 3 to follow

Below is a summary of proposed changes at the generic level affecting WA taxa. Some of these changes are very well supported by the recent studies and will certainly be formalised; others are more tentative at this stage and await further study, particularly at the molecular level.

- The WA genus *Sphenotoma* may be combined with the eastern Australian *Dracophyllum*.

- Those WA taxa currently in the genus *Astroloma* may be recombined into 5 genera:
  - The majority of species (ie. those having 5 hair tufts or a continuous ring of hairs below the middle of the corolla tube, with hairy corolla lobes) would remain in *Astroloma*.
  - *Astroloma stomarrhena* may be combined with *Coleanthera* and *Styphelia* into a single genus, or be recognised as a monotypic genus.
  - *A. baxteri* and *A. xerophyllum* may also be recognised as 2 more monotypic genera.
  - *A. ciliatum* and *A. foliosum* would form another genus.

- WA *Leucopogon* species may be recombined into 4 genera:
  - The majority of species (ie. Those having sterile anther tips) would remain in *Leucopogon*.
    - WA examples include *L. australis*, *L. glabellus* and *L.verticillatus*. It is estimated that at least 50 of the 110 or so species within this group are currently unnamed.
    - Another group currently within *Leucopogon*, characterised by a cone-like gynoecium and narrow cylindrical fruit, would form another genus "*Gynoconus*". This will contain ca 18 species, half of which are currently unnamed. WA examples include *L. cymbiformis*, *L pogonocalyx* and *L. tamminensis*.
    - Those species characterised by long styles, twisted corolla hairs and without sterile anther tips form another large group "*Axonanthus*" with ca 80 species, many in WA, eg. *L. oxycedrus*, *L. conostephioides* and *L. hamulosus*.
    - A small group of 4 *Leucopogon* species (including the WA *L. rubicundus*) to be combined with the eastern Australian genus *Lissanthe*.

- Oligarrhena to be combined with Monotoca.

- At least 2 currently unnamed taxa within the tribe Styphelieae to form a new genus "*Pseudoactinia*".

WEST AUSTRALIAN GENERA WITHIN EPACRIDACEAE

1) *Acrotriche* R.Br.

Ca 14 species across southern & eastern Australia, with 5 in WA.

Major distinguishing features:

- Leaves non-sheathing; margins flat or revolute.
- Inflorescence a spike or irregular cluster.
- Flowers bracteate, bibracteolate; (4)5-merous; hypogynous disc present, annular.
- Calyx usually exceeded by corolla.
- Corolla valvate and tubular with tufts of hair at corolla lobe tips; throat closed by hairs; glabrous in tube below the throat; green or yellow-green.
- Stamens inserted in throat of corolla tube, becoming exserted or remaining included within the tube.
- Style attenuate from ovary.
- Ovary with 2-10 cells.
- Fruit a fleshy drupe.

Confusing genera:

With its greenish flowers and hairs confined to the apices of the corolla lobes and in the throat, *Acrotriche* is distinct from all other genera apart from *Trochocarpa*. The latter differs in having a drupe composed of 8-10 readily separable pyrenes ("nutlets").

2) *Andersonia* R.Br.

Ca 35 taxa, a number of which have yet to be formally named (pers. comm. K. Lemson) confined to SW Australia.

Major distinguishing features:

- Leaves usually sheathing, occasionally non-sheathing; margins flat.
- Inflorescence of solitary axillary flowers or clustered into heads.
- Flowers bracteate, bracteolate; 5-merous, hypogynous disc present, annular (lobed) or of separate scales.
- Calyx usually exceeding corolla or ± equalling corolla.
- Corolla valvate and tubular (tube cylindric or contracted above the ovary); tube and lobes variously hairy or rarely glabrous; white, pink, purple or blue.
- Stamens free from corolla tube; mostly included to slightly exserted from tube.
- Style from a depression at the top of the ovary.
- Ovary 5-celled.
- Fruit a capsule.

Confusing genera:

Generally quite distinct but may be confused with *Sphenotoma*, which has annular leaf scars and the throat of the corolla almost closed by longitudinal folds at the base of the lobes. Those species without sheathing leaf bases and with white flowers may be confused with *Lysinema* but the latter characteristically has imbricate bracts and bracteoles which grade into sepals.

This genus is being revised by K. Lemson and the work is close to completion.

3) *Astroloma* R.Br.

Between 25 & 35 taxa across southern Australia with 21 named and 6 unnamed in WA.

Major distinguishing features:

- Leaves non-sheathing; margins flat, concave or revolute.
- Inflorescence of solitary axillary flowers.
- Flowers bracteate, bracteolate; 5-merous; hypogynous disc present, annular (truncate or lobed).
- Calyx exceeded by corolla to ± equalling corolla.
- Corolla valvate and tubular (elongated and cylindric); lobes markedly shorter than tube, usually erect or spreading (but revolute in *A. stomarrhena*); lobes hairy (glabrous in *A. baxteri*); tube usually with 5 hair tufts or a ring of hairs towards the base (absent in *A. ciliatum* and *A. foliosum*, may be obscure or absent in *A. xerophyllum*),;red in most species but several have cream corollas and in *A. xerophyllum* they are white.
- Stamens inserted in throat of corolla tube; becoming exserted (prominently so in *A. stomarrhena*) or remaining included; filaments glabrous (hairy in *A. stomarrhena*), flattened or terete.
- Style attenuate from ovary.
- Ovary with 5 cells.
- Fruit a fleshy drupe.

Confusing genera:

May be confused with red/pink-flowered *Leucopogon* species but the latter lack hairs towards the base of the corolla tube and have usually shorter corollas (<12 mm).
A. ciliatum and *A. foliosum* also lack hairs towards the base of the tube but have flowers 20-30 mm long. The white-flowered *A. xerophyllum* may be confused with *Leucopogon* species but has large erect flowers 10-15 mm long with glabrous apices to the corolla lobes.
Brachyloma can be separated by its glabrous corolla lobes.

Currently being revised by A.J.G. Wilson.

4) *Brachyloma* Sonder

Ca 12 taxa in southern and eastern Australia with 5 named and 1 unnamed in WA.

Major distinguishing features:

- Leaves non-sheathing; flat or revolute.
- Inflorescence of solitary axillary flowers.
- Flowers bracteate or ebracteate, bibracteolate; 5-merous; hypogynous disc present, annular (lobed or toothed).
- Calyx exceeded by corolla.
- Corolla imbricate and tubular (tube short); lobes about the same length as tube, spreading; lobes glabrous; tube with tufts of hairs or ciliate scales reflexed in the throat, otherwise glabrous; pink or red (WA species).
- Stamens inserted in throat of corolla tube; included or partially exserted.
- Style attenuate from ovary.
- Ovary with 4-5 cells.
- Fruit a fleshy drupe.

Confusing genera:

Only likely to be confused with Astroloma, which has usually larger flowers and hairy corolla lobes (excluding *A. baxteri*).

5) *Coleanthera* Stschegl

Three taxa confined to south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; flat or concave.
- Inflorescence of solitary axillary flower or 2 or 3 together.
- Flowers bracteate, bibracteolate; 5-merous; hypogynous disc absent (or very obscure).
- Calyx exceeded by corolla.
- Corolla valvate and tubular (tube short), lobes long, usually longer than tube, distinctly revolute; lobes and throat hairy, glabrous below the throat; white or pink.
- Stamens inserted in throat of corolla tube; becoming exserted; filaments glabrous, long; anthers cohering above the middle in a cone.
- Style attenuate from ovary.
- Ovary with 5 cells.
- Fruit a fleshy or non-fleshy drupe.

Confusing genera:

With its prominently exserted stamens and revolute corolla lobes, *Coleanthera* is close to *Styphelia* but differs from that genus in having cohering anthers.

Astroloma stomarrhena is also similar but has hairy filaments.

6) *Conostephium* Benth

At least 7 named and 1 unnamed species restricted to south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; flat or revolute.
- Inflorescence of solitary axillary, usually pendulous flowers.
- Flowers bracteate, bracteolate (bracteoles appressed to sepals); 5-merous, hypogynous disc present or absent, when present of separate scales.
- Calyx exceeded by corolla, ± equalling corolla or with corolla scarcely exceeding calyx.
- Corolla valvate and long tubular, often conical in upper part; lobes much shorter than tube, erect; lobes glabrous, variously hairy in the throat and below; white and purple, red or pink.
- Stamens inserted half way down corolla tube or lower; anthers usually deeply divided into 2 lobes.
- Style attenuate from ovary.
- Ovary with 5 cells.
- Fruit a non-fleshy drupe.

Confusing Genera:

Its long tubular corolla, short erect lobes and completely included anthers make *Conostephium* a distinctive genus.

7) *Cosmelia* R.Br.

One species confined to far south-west Australia.

Major distinguishing features:

- Leaves sheathing; flat or concave.
- Inflorescence of solitary flowers, terminating axillary branchlets or with peduncles covered with leaf like bracts which pass gradually into sepals.
- Flowers bracteate, bracteolate; 5-merous; hypogynous disc present, annular.
- Calyx ± equalling corolla or scarcely exceeded by corolla.
- Corolla imbricate, tubular; lobes shorter than tube, glabrous throughout; purple to red.
- Stamens inserted in throat of corolla tube; remaining included in tube; filaments flattened.
- Style from a depression at the top of the ovary.
- Ovary with 5 cells.
- Fruit a capsule.

Confusing Genera:

Large purple-red flowers and sheathing leaves are a unique combination within W.A. Epacrids.

8) *Croninia* J. Powell

One species confined to south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; flat.
- Inflorescence of solitary, axillary flowers.
- Flowers bracteate, bracteolate; 5-merous; hypogynous disc present, annular.
- Calyx exceeded by corolla.
- Corolla valvate and tubular; lobes markedly shorter than tube, thick and fleshy, slightly spreading; lobes and tube hairy throughout; white.
- Stamens inserted in throat of corolla tube; scarcely exserted from tube; anthers bifurcate.
- Style from a depression at the top of the ovary, hairy.
- Ovary with 5 cells.
- Fruit a hairy, non-fleshy drupe.

Confusing Genera:

Formerly included in *Leucopogon* from which it differs in having the following character combination:

Large fleshy flowers (10-15 mm).
Bifurcate anthers.
Hairy ovary and hairy style from a depression at the top of the ovary.

9) *Leucopogon* R.Br.

As currently recognised comprises over 150 species mostly in southern and eastern Australia but also in parts of South East Asia and New Zealand. At least 110 named species and 16 unnamed in W.A.

Major distinguishing features:

- Leaves non-sheathing; flat, concave or revolute.
- Inflorescence of solitary, axillary flowers or in terminal or axillary spikes or racemes.
- Flowers bracteate, bibracteolate; 5-merous; hypogynous disc present or absent, when present of separate scales.
- Calyx length variable in relation to corolla.
- Corolla valvate and tubular (tube short to long), lobes vary from ± the same length as tube to much shorter than tube, spreading or reflexed; lobes and throat hairy, but usually glabrous below the throat.
- Stamens inserted in throat of corolla tube; becoming at least partially exserted or remaining included; filaments glabrous, terete; a large group of species (the true *Leucopogons* refer section "Taxonomic reassessment within *Epacridaceae*") have anther apices that are sterile tipped and so paler and often recurved.
- Style attenuate from ovary.
- Ovary with 5 cells.
- Fruit a fleshy or non-fleshy drupe.

Confusing Genera:

The small flowered species with sterile tipped anthers are usually quite distinctive. Those with longer tubular flowers may be mistaken for *Astroloma*, see "Confusing Genera" under that genus for differences.

Styphelia and *Coleanthera* have anthers fully exserted from tube and revolute corolla lobes. *Oligarrhena*, *Monotoca* and *Needhamiella* all have ± glabrous corolla lobes and *Acrotriche* has hairs confined to tips of the lobes.

See under *Croninia* for characters separating that genus.

10) ***Lysinema*** R.Br.

Five species restricted to south-west Australia. A number of infra-specific taxa may be recognised within *L. ciliatum*.

Major distinguishing features:

- Leaves non-sheathing; margins flat, or concave.
- Inflorescence of solitary, axillary flowers or aggregated in spikes or heads.
- Flowers bracteate, bracteolate; (4) 5-merous; hypogynous disc present, of separate scales.
- Calyx usually exceeded by corolla.
- Corolla valvate and tubular (tube cylindric); tube hairy or glabrous, lobes always glabrous; white or cream.
- Stamens free from corolla tube or adnate (slightly to corolla tube); becoming exserted or remaining included in the tube.
- Style from a depression at the top of the ovary.
- Ovary with 5 cells.
- Fruit a capsule.

Confusing Genera:

Quite distinct with its combination of non-sheathing leaves, glabrous corolla lobes and with characteristic, imbricate rows of bracts and bracteoles grading into sepals. The long corolla tube and style from a depression at the top of the ovary distinguish *Lysinema* from other genera with ± glabrous corolla lobes – *Needhamiella*, *Monotoca* and *Oligarrhena*.

11) *Monotoca* R. Br.

Ca 12 taxa across southern and eastern Australia with 4 in south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; margins flat or revolute.
- Inflorescence of solitary, axillary flowers or aggregated in spikes or racemes.
- Flowers bracteate, bibracteolate; (4) 5-merous; hypogynous disc present, annular (lobed or toothed).
- Calyx exceeded by corolla.
- Corolla valvate, campanulate; tube and lobes ± glabrous (except *M. tamariscina* which usually has relatively conspicuous hairs on the lobes); white or cream.
- Stamens inserted in throat of corolla; becoming exserted or remaining included.
- Style attenuate from the ovary.
- Ovary of 1-2 cells.
- Fruit a fleshy drupe.

Confusing Genera:

Most likely to be confused with *Oligarrhena* which always has 4-merous flowers with only 2 fertile stamens.

May also be confused with *Leucopogon* from which it can be separated by its glabrous or sparsely hairy corolla lobes.

Needhamiella differs in having inflexed tips to the corolla lobes and a usually reddish corolla tube and white lobes.

12) *Needhamiella* L. Watson

One species confined to south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; margins concave.
- Inflorescence of solitary, axillary flowers.
- Flowers bracteate, bibracteolate; 5-merous; hypogynous disc present, annular (cup shaped).
- Calyx exceeded by corolla.
- Corolla valvate (induplicate valvate), tubular (cylindric); lobes with inflexed tips and usually a few hairs in a central band; tube usually glabrous; tube usually reddish, lobes white.
- Stamens inserted below the middle of the tube; remaining included.
- Style attenuate from ovary.
- Ovary 2 celled.
- Fruit a non-fleshy drupe.

Confusing Genera:

Can be separated from *Acrotriche* and *Leucopogon* by having only sparsely hairy corolla lobes and stamens inserted below the middle of the tube.

The differences between *Needhamiella* and *Monotoca* are listed under the latter genus.

13) ***Oligarrhena*** R.Br.

One species confined to south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; margins flat.
- Inflorescence a spike.
- Flowers bracteate, bibracteolate; 4-merous; hypogynous disc present, of separate scales.
- Calyx exceeded by corolla.
- Corolla valvate, campanulate; tube and lobes glabrous; white or cream.
- Stamens 2 (unique in *Stypheliae*) sometimes also with 2 staminodes, inserted in throat of tube; remaining included.
- Style attenuate from ovary.
- Ovary of 2 cells.
- Fruit a fleshy/non fleshy drupe.

Confusing Genera:

Easily distinguished by its consistently 4-merous corolla with 2 fertile stamens.

14) ***Sphenotoma*** (R.Br.) Sweet

At least 7 taxa restricted to south-west Australia.

Major distinguishing features:

- Leaves sheathing; margins flat.
- Inflorescence a spike or head.
- Flowers bracteate, bracteolate; 5-merous; hypogynous disc present, annular or of separate scales.
- Calyx exceeded by corolla.
- Corolla imbricate, tubular (tube narrow, almost closed by longitudinal folds at base of the lobes); lobes markedly shorter than tube to about the same length, spreading; lobes and tube usually glabrous; white, sometimes yellow in throat.
- Stamens inserted in corolla tube; remaining included within the tube.
- Style from a depression at the top of the ovary.
- Ovary 5 celled.
- Fruit a capsule.

Confusing Genera:

The sheathing leaf bases separate *Sphenotoma* from all genera apart from *Cosmelia* and *Andersonia*.

The latter genus lacks the annular leaf scars and longitudinal folds at the base of the corolla lobes that are characteristic of *Sphenomtoma*. A further difference from *Andersonia* is the presence of free stamens in that genus.

Cosmelia has red-purple flowers unknown in *Sphenotoma*.

Currently being revised by Kristina Lemson.

15) ***Styphelia*** Smith

Ca 12 species across southern Australia with 6 in south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; margins flat, concave or revolute.
- Inflorescence of solitary, axillary flowers or 2-3 together.
- Flowers bracteate, bibracteolate; 5-merous; hypogynous disc present, annular or of 5 separate scales.
- Calyx exceeded by corolla, usually coloured.
- Corolla valvate and tubular (elongated and cylindric); lobes usually shorter than tube, distinctly revolute; lobes and throat hairy; glabrous below the throat (except for *S. hainesii* which has 5 tufts of hair near the base); white, cream or red.
- Stamens inserted in throat of corolla tube; becoming exserted, filaments glabrous, long.
- Style attenuate from ovary.
- Ovary 5 celled.
- Fruit a fleshy or non-fleshy drupe.

Confusing Genera:

Close to *Coleanthera* but without the cohering anthers.

The prominently exserted stamens and revolute corolla lobes also ally it with *Astroloma stomarrhena* but the latter can be distinguished by its very hairy filaments.

16) *Trochocarpa* R.Br.

Ca 6 species in southern and eastern Australia and South East Asia. One in south-west Australia.

Major distinguishing features:

- Leaves non-sheathing; flat or convex.
- Inflorescence a few flowered spike.
- Flowers bracteate, bibracteolate; 5-merous; hypogynous disc present, annular or of 5 separate scales.
- Calyx exceeded by corolla.
- Corolla valvate and tubular (cylindric) or campanulate; lobes usually shorter than tube; lobes and throat hairy (in W.A. species), glabrous below the throat.
- Stamens inserted in throat of the tube, becoming partially exserted from tube.
- Style attenuate from ovary.
- Ovary usually 10 celled.
- Fruit a fleshy drupe with the endocarp separating into distinct pyrenes (nutlets).

Confusing Genera:

The W.A. species *T. parviflora* is rarely collected and strongly resembles some species of *Acrotriche*. See note under that genus for distinctions.

GLOSSARY

Adnate	Fused to an organ of a different kind.
Annular	Forming a ring.
Attenuate	Tapering gradually.
Bifurcate	Divided into 2 branches.
Bract	A leaf like structure, different in form from the foliage leaves associated with an inflorescence or flower.
Bracteole	A bract like structure borne on pedicel or calyx of flower.
Campanulate	Bell shaped.
Capsule	A dehiscent fruit of two or more united carpels.
Connivent	Converging.
Disc	A nectariferous organ developed between the stamens and ovary.
Drupe	An indehiscent fruit with the seeds enclosed in a stony layer (endocarp) which is embedded in succulent tissue (mesocarp) surrounded by a thin outer layer (epicarp).
Gynoecium	All the carpels or pistils of a flower collectively.
Hypogynous	Borne below the ovary.
Imbricate	Overlapping.
Included	Not protruding beyond enclosing organ.
Induplicate	Margins overlapping and rolled inwards.
Revolute	With the margins rolled inwards on the lower surface.
Sheathing	Clasping or enveloping the stem.
Valvate	Meeting without overlapping.

AIDS TO IDENTIFICATION IN WA EPACRIDS

* Not all species within the genus exhibit this character
** Character not consistent on all flowers

Leaves sheathing	*Andersonia**, *Cosmelia*, *Sphenotoma*
Flowers in dense spikes or heads	*Andersonia**, *Leucopogon**, *Lysinema**, *Monotoca**, *Oligarrhena*, *Sphemotoma*
Flowers 4-merous	*Acrotriche***, *Lysinema***, *Monotoca***, *Oligarrhena*
Hypogynous disk absent or very obscure	*Coleanthera*, *Conostephium**
Calyx exceeding corolla or ± equalling corolla	*Andersonia**, *Astroloma**, *Conostephium**, *Cosmelia***, *Leucopogon**
Calyx prominently coloured	*Andersonia*, *Styphelia**
Corolla imbricate (not valvate)	*Brachyloma*, *Cosmelia*, *Sphenotoma*
Corolla tube much longer than lobes	*Andersonia**, *Astroloma*, *Conostephium*, *Cosmelia*, *Croninia*, *Leucopogon**, *Lysinema*, *Sphenotoma*, *Styphelia*
Corolla with ± glabrous lobes	*Andersonia**, *Astroloma** (*A. baxteri*), *Brachyloma*, *Conostephium*, *Cosmelia*, *Lysinema*, *Monotoca**, *Needhamiella***, *Oligarrhena*, *Sphenotoma*
Corolla with revolute lobes	*Coleanthera*, *Styphelia*, *Astroloma stomarrhena*, *Leucopogon** (usually recurved rather than revolute)
Corolla with hairs below the throat	*Andersonia**, *Astroloma**, *Conostephium**, *Croninia**, *Leucopogon** (few species), *Styphelia** (*S. hainesii*)
Corolla lobes with hairs confined to tips	*Acrotriche*, *Trochocarpa*
Corolla pink/red	*Andersonia**, *Astroloma**, *Brachyloma**, *Coleanthera**, *Conostephium**, *Cosmelia*, *Leucopogon**, *Needhamiella* (tube reddish), *Styphelia**
Stamens prominently exserted beyond tube	*Coleanthera*, *Styphelia*, *Astroloma stomarrhena*
Stamens inserted half-way down tube or lower	*Conostephium*, *Needhamiella*, *Sphenotoma**

Stamens free from tube	*Andersonia, Lysinema** (partly adnate)
Style from a depression at the top of the ovary	*Andersonia, Cosmelia, Croninia, Lysinema, Sphenotoma*
Ovary with > 5 cells	*Acrotriche, Trochocarpa*
Ovary with 1-2 cells	*Leucopogon**, *Monotoca, Oligarrhena, Needhamiella, Acrotriche**
Fruit a capsule	*Andersonia, Cosmelia, Lysinema, Sphenotoma*

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Blackall & Grieve IIIB – The only reference to the family in W.A. as a whole. Last revised in 1981. Variable in its usefulness, depending on genus. More or less reflects current taxonomy in the following genera: *Acrotriche, Coleanthera, Styphelia, Cosmelia, Needhamiella, Trochocarpa, Sphenotoma.*

Can still be used with caution for the remaining genera but be aware that a number of new taxa have been recognised, although at this stage, many of these have not been published.

K. Lemsom recognises numerous new species in *Andersonia*. These will be published in the near future.

Leucopogon presents special difficulties, not only are there numerous new names in the genus, both published and informal phrase names, but many species are enormously variable as currently circumscribed. There may be as many as 50 new species in *Leucopogon* (sens strict) according to J.M. Powell. (Relationships and generic concepts within Styphelieae. Australian Systematic Botany 10 (1997).)

Flora base "WA genera" – T.D. Macfarlane *et al.*

Flora of the Perth Region – Marchant *et al.* Still reflects current taxonomy.

Forthcoming "Flora of the SW Forest Region" – J.R. Wheeler *et al.*

A reassessment of relationships within Epacridaceae – J.M. Powell *et al.* Annals of Botany 77 (1996).

Relationships & generic concepts within Styphelieae – J.M. Powell *et al.* Australian Systematic Botany 10 (1997).

Croninia kingiana, a change in status for *Leucopogon kingianus* – J.M. Powell. Nuytsia 9(1) (1993).

A new species of *Conostephium* from S.W. Western Australia – P.G. van der Moezel. Nuytsia 6(1) (1986).

New species of *Leucopogon* and *Conostephium* from S.W. Aust. – Arne Strid. Willdenowia 161 (1986).

Archerieae: A new tribe in Epacridaceae – D.M. Crayn & C.J. Quinn. Australian Systematic Botany 11(1) (1998).

LEGUMINOSAE

In this work the family Leguminosae is divided into three major subfamilies: the Papilionoideae, Caesalpinioideae, and Mimosoideae. Other botanists often regard these subfamilies as having full family status with the names Papilionaceae or Fabaceae, Caesalpiniaceae, and Mimosaceae. Whichever convention is accepted, the three related groups share the leguminous fruit character, but differ in floral characters as follows.

KEY TO SUBFAMILIES

1. Flowers regular in symmetry, calyx and corolla valvate in bud, stamens often more than 10 . . . . . . **Mimosoideae**
1. Flowers irregular in symmetry, perianth segments predominantly imbricate in bud, stamens 10 or less 2
2. Corolla caesalpinaceous, aestivation imbricate ascending, posterior petal innermost, petals typically 5 and distinct . . . . . . **Caesalpinioideae**
2. Corolla papilionaceous, aestivation imbricate descending, posterior petal outermost, 2 anterior petals often basally connate and forming a keel . . . . . . **Papilionoideae**

Subfamily MIMOSOIDEAE

KEY TO GENERA (by H. Toelken)

1. Fruits splitting longitudinally along one or two margins (sometimes only gradually) 2
1. Fruits not splitting or rarely breaking transversely into individual components 10
2. Stamens more than 10 3
2. Stamens 10 or less 7
3. Each flower with 5 or more carpels. WA, Q, New Guinea . . . . (Sometimes incl. in **Pithecellobium**) **Archidendron** F. Muell. (2 spp.)
3. Each flower with 1 carpel (ovary) 4
4. Stamens free, rarely slightly fused basally. All States, tropical and subtropical areas of the world . . . . **Acacia** Mill. (c. 660 spp.)
4. Stamens fused into a tube 5
5. Fruit twisted and valves usually coiled into spiral. Q, tropical America . . . . (= **Abarema** Pittier) **Pithecellobium** Mort. (21 spp.)
5. Fruit straight with valves straight or recurved but not coiled 6
6. Fruits elastically splitting and valves recurved; shrubs. Q, warm Asia, America . . . . ***Calliandra** Benth. (1 sp.)
6. Fruits gradually splitting with valves not recurved; usually trees. WA, NT, Q, warm Old World . . . . **Albizia** Durazz. (c. 10 spp.)
7. Anthers with hairs. NT, Q, pantropical but chiefly tropical America . . . . **Leucaena** Benth. (1 sp.)
7. Anthers without hairs 8
8. Trees; seeds with bright colours. Q, tropical Asia, Pacific . . . . **Adenanthera** L. (2 spp.)
8. Shrublets or aquatic herbs; seeds usually brown 9
9. Fruits short and broad; neuter flowers with petaloid staminodes. WA, NT, Q, SA, NSW, warm regions of world . . . . **Neptunia** Lour. (4 spp.)
9. Fruits linear; stamens in all flowers fertile. Q, mainly America ***Desmanthus** Willd. (1 sp.)
10. Stamens 10 or less 11
10. Stamens more than 10 14
11. Fruits splitting transversely into 1-seeded units; plants not spiny 12
11. Fruits indehiscent; plants usually spiny 13
12. Fruits to 3 cm long and covered with bristles; shrublets. NT, Q, mainly warm America but also Africa, Asia . . . . ***Mimosa** L. (2 spp.)
12. Fruits usually longer than 30 cm; woody climbers. NT, Q, warm regions of world . . . . **Entada** Adans. (1 sp.)
13. Branches usually with paired spines; all flowers on spike with same colour. WA, NT, Q, mainly warm America, tropical Africa, India . . . . ***Prosopis** L. (2 spp.)
13. Branches often with single spines; (short axillary branches) spikes with lower and upper flowers in different colours. WA, NT, Q, warm Africa to Australia . . . . **Dichrostachys** (DC.) Wight & Arn. (2 spp.)
14. Filaments free or almost so . . . . **Acacia** see 4
14. Filaments more or less fused into a tube 15
15. Fruits much constricted between seeds. WA, NT, Q, SE. Asia . . . . **Cathormion** Hassk. (1 sp.)
15. Fruits not or scarcely constricted between seeds 16
16. Fruits with a wall (septum) between seeds 17
16. Fruits without a wall between seeds 18
17. Fruit straight or almost so. Q, mainly tropical America but also tropical Africa . . . . ***Samanea** (Benth.) Merr. (1 sp.)
17. Fruit crescent to kidney-shaped. Q, mainly tropical America including W. Indies . . . . ***Enterolobium** Mart. (1 sp.)
18. Inflorescences borne on branches with leaves; leaves usually much branched . . . . **Albizia** see 6
18. Inflorescences borne on leafless older branches and stems; leaves with 1 or 2 pairs of branches (pinnae) . . . . **Zygia** R. Br. (1 sp.)

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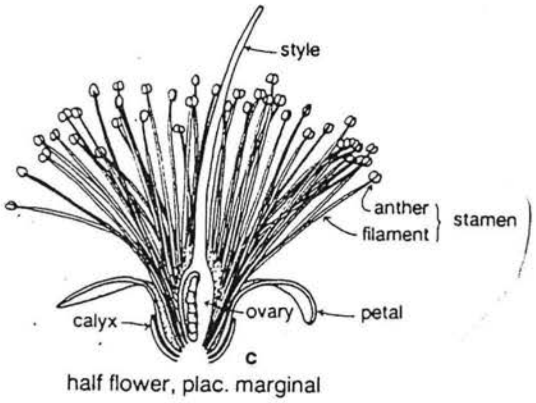
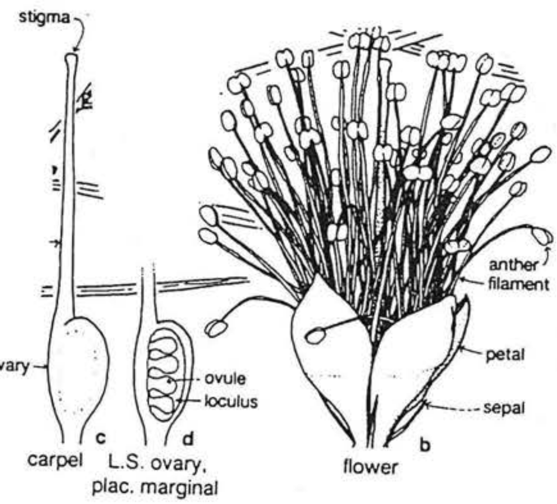


Acacia floribunda



Acacia iteaphylla

CAESALPINIOIDEAE

KEY TO GENERA

1. Leaves bipinnate ... 17
1. Leaves pinnate, digitate, unifoliate, or simple ... 2
2. Leaves imparipinnate, with terminal leaflet, or digitate unifoliate, or simple ... 3
2. Leaves paripinnate, without terminal leaflet, or in a few **Cassia** reduced to phyllodes ... 7
3. Fertile anthers 2, flowers few in short axillary racemes, style not flattened and petaloid. WA, Q ... **Labichea** Gaud.-Beaup. ex DC. (10 spp. end.)
3. Fertile anthers 3 or more ... 4
4. Fertile anthers 3, style flattened and petaloid. WA, NT, Q, SA, NSW ... **Petalostylis** R. Br. (3 spp. end.)
4. Fertile anthers 4 or more, flowers numerous, in racemes ... 5
5. Leaves unifoliate (cordate acuminate) membranous, pod valves thin. Q, NSW ... **Barklya** F. Muell. (1 sp. end.)
5. Leaves of several leaflets, coriaceous, pod woody ... 6
6. Petals absent, pod coriaceous, margin thickened. Q, pantropical ... **Crudia** Schreb. (1 sp.)
6. Petals 5 to 3, upper suture of pod broadly winged. Q, New Caledonia, Fiji ... **Storckiella** Seem. (c. 2 spp.)
7. Anthers opening by terminal pores or short slits, stamens 10 or fewer. All States except Tas; tropical and warm temperate regions ... **Cassia** L. (c. 52 spp.)
7. Anthers opening by longitudinal slits ... 8
8. Petals 1 or 3, remainder very reduced or absent ... 9
8. Petals 5 ... 10
9. Leaflet pairs 1 to 2; petals 1 (others minute); anthers 3 (some reduced to staminodes); pod compressed. Q, Madagascar, tropical Asia, Malaysia ... **Intsia** Thou. (1 sp.)
9. Leaflet pairs 10 to 20; petals 3 (2 reduced); anthers 3; pod turgid or oblong. WA, NT, Q?, widely cultivated in tropics ... **Tamarindus** L. (1 sp.)
10. Petals narrow linear; anthers 15 to 10; pod thick, turgid. Q, Malaysia to Fiji ... **Maniltoa** Scheffer (1 sp.)
10. Petals broader; anthers 10 or some reduced to staminodes ... 11
11. Leaflets 1 to 2 pairs ... 12
11. Leaflets numerous ... 15
12. Leaves bilobed ... 13
12. Leaves 1 to 2 pairs ... 14
13. Dioecious (separate male and female trees), stamens 10 in male flowers, or staminodes in female flowers, stigma thick, capitate, sessile on ovary. Q, tropical Africa, Indomalaysia ... **Piliostigma** Hochst. (1 sp.)
13. Bisexual, 1 stamen, style long, stigma capitate or small. Q, warm parts of the world ... ***Bauhinia** L. (1 sp.)
14. Leaflets 1 pair with digitate veins, pods flat mostly less than 15 cm long and less than 10 seeds. All States except Vic, Tas; India, Malaysia, New Guinea ... **Lysiphyllum** (Benth.) de Wit
14. Leaflets 1 to 2 pairs; pods wrinkled, one-seeded. Q, pantropical ... **Cynometra** L. (1 sp.)
15. Flowers greenish, small, subsessile, pods flat to more than 15 cm long, trunk often with stout branched spines (cult. and sparsely naturalised). NSW, tropical and subtropical regions ... ***Gleditsia** L. (1 sp.)
15. Flowers yellow, showy, pedicellate, pods rarely 15 cm long, trunks unarmed ... 16
16. Leaflets numerous less than 5 mm long, pods fusiform. WA, NT, Q, NSW, tropical America, S. Africa ... ***Parkinsonia** L. (1 sp.)
16. Leaflets 6 to 8, obcordate, more than 1 cm long, pods lanceolate, flattened. Q, Mexico, Central America, SW. Africa ... ***Haematoxylum** L. (1 sp.)
17. Style with broad peltate stigma, prickles absent, ovary sessile, pod indehiscent, not winged. NT, Q, pantropical ... **Peltophorum** (Vogel) Benth. (1 sp.)
17. Style with small or truncate stigma, branchlets often prickly ... 18
18. Flowers small, almost sessile in cylindrical spikes, greenish; stamens shortly exserted ... 19
18. Flowers larger, pedicellate, brightly coloured; stamens often long exserted ... 20
19. Leaflets few, to 5 cm broad; tree, unarmed. WA, NT, Q, Africa, tropical and E. Asia ... **Erythrophleum** Afz. ex G. Don (1 sp.)
19. Leaflets numerous (more than 16) rarely greater than 1 cm broad; tree often armed with large branched spines ... **Gleditsia** see 15
20. Leaflets rarely 5 mm long, leaf rachis flattened; pod few (1- to 4-) seeded, fusiform, unarmed, unwinged ... **Parkinsonia** see 16
20. Leaflets mostly more than 5 mm long, leaf rachis terete or grooved; pod flattened, may be winged or prickly. NT, Q, tropics and subtropics ... (incl. **Pterolobium** R. Br ex Wight & Arn., **Mezoneuron** Desf.) ... **Caesalpinia** L. (c. 4 spp.)

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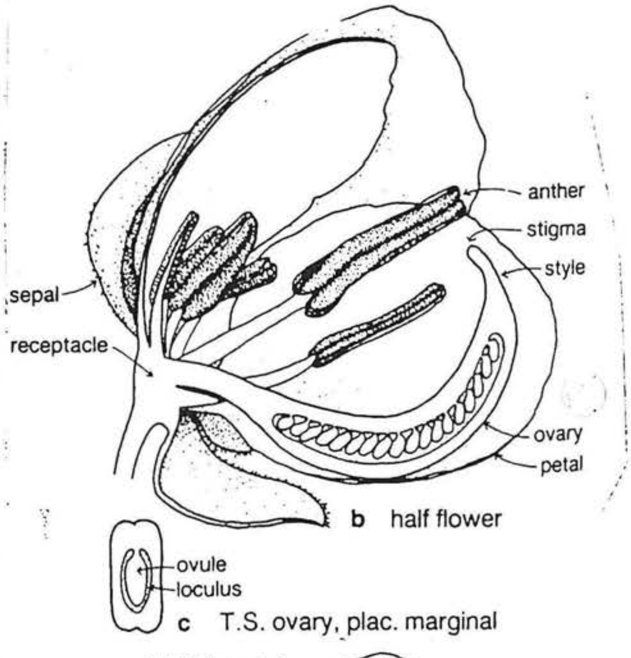
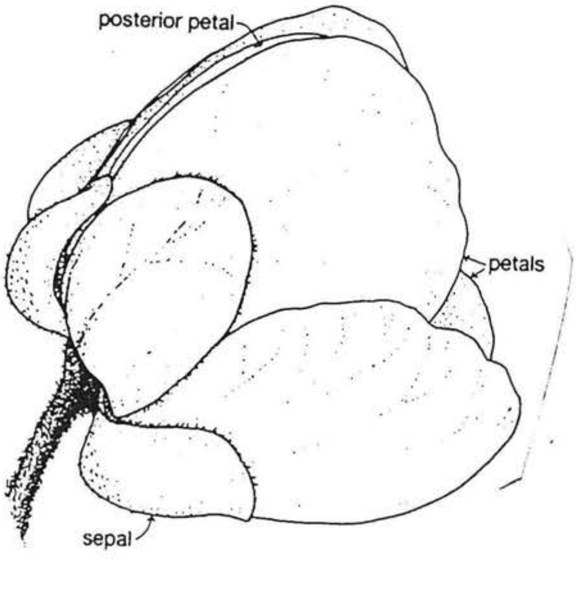


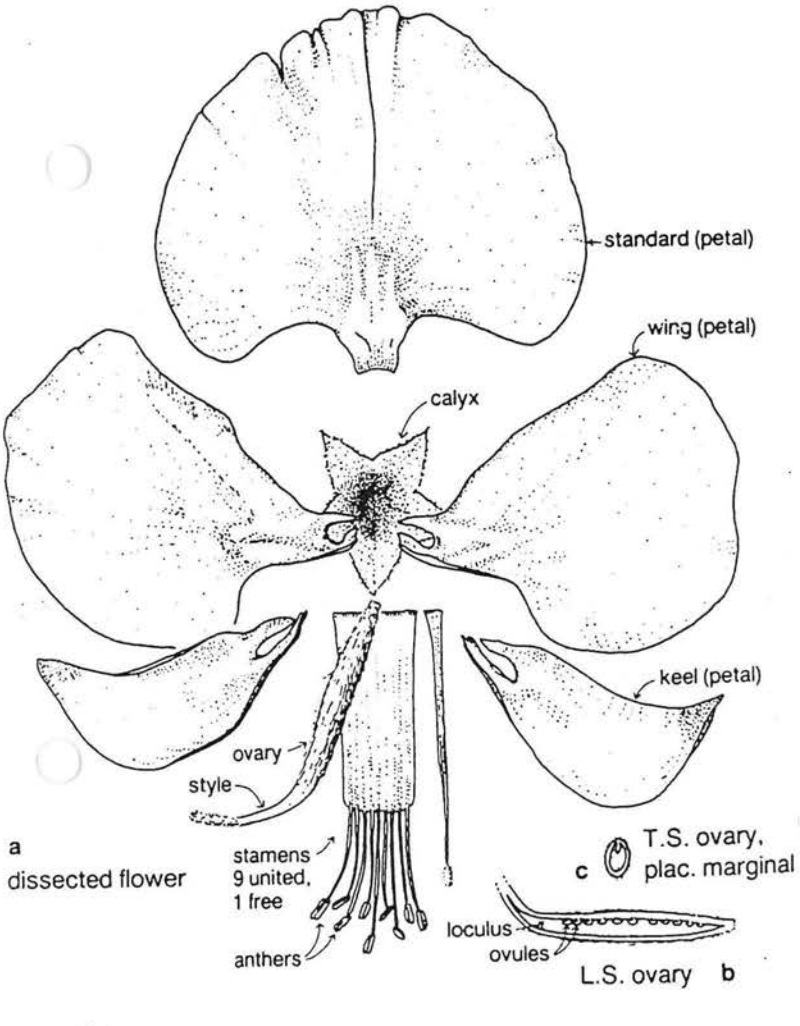
b half flower

c T.S. ovary, plac. marginal

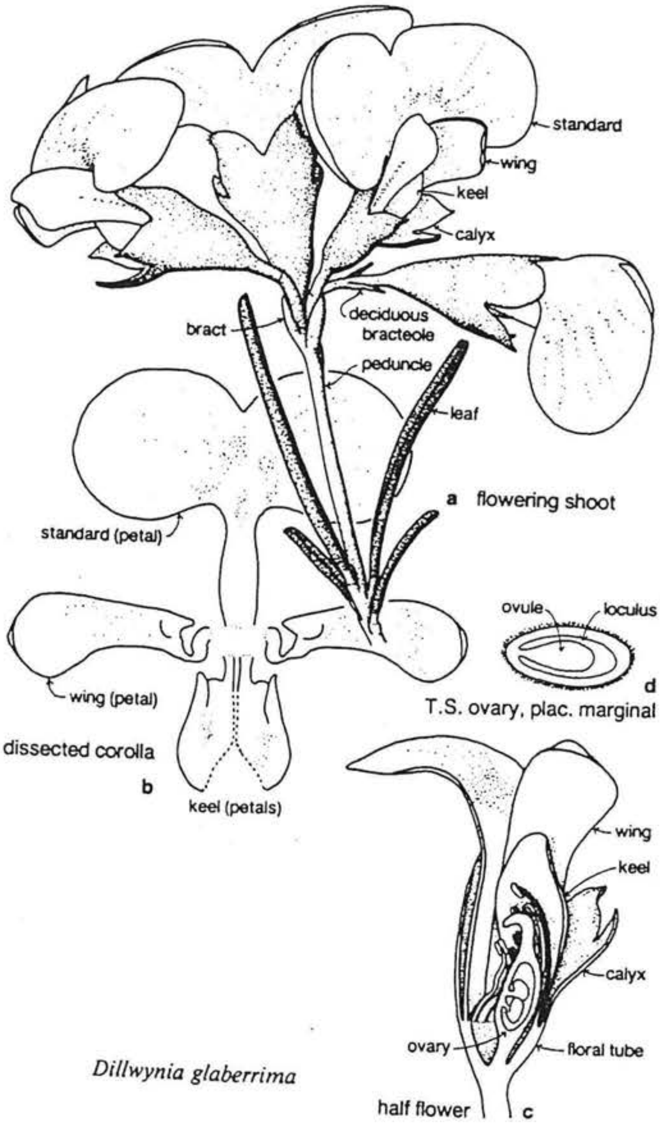


Key to Genera

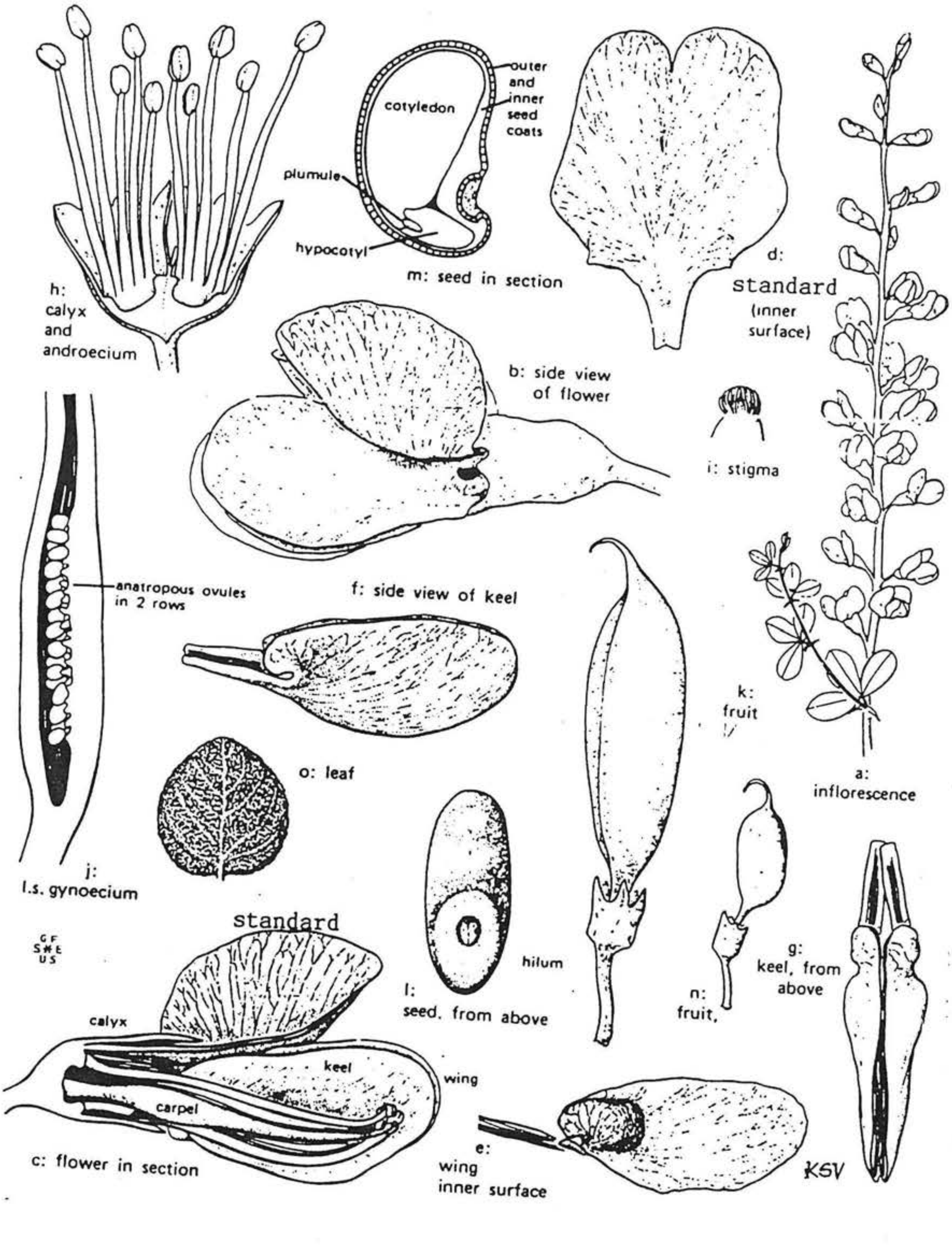
1. Leaves compound, comprised of 2 or more leaflets, rarely some leaves unifoliolate 4
1. All leaves of 1 leaflet, simple, reduced, or absent 2
2. Leaves absent or reduced to spines or scales .... GROUP 1
2. Leaves simple or unifoliolate 3
3. Leaves simple .... GROUP 2
3. Leaves unifoliolate, articulation or bend in petiole .... GROUP 3
4. Leaflets even in number, rhachis often ending in a bristle or tendril .... GROUP 4
4. Leaflets odd in number, rhachis ending in a leaflet, or character not obvious 5
5. Leaflets 5 or more, rarely some leaves trifoliolate .... GROUP 7
5. Leaflets 3 6
6. Leaves digitate, all 3 leaflet stalks equal .... GROUP 5
6. Leaves pinnate, central leaflet stalk longer than laterals .... GROUP 6

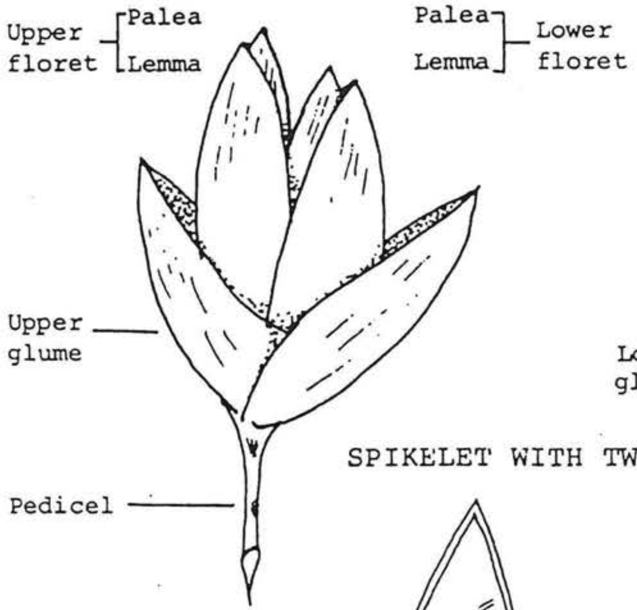


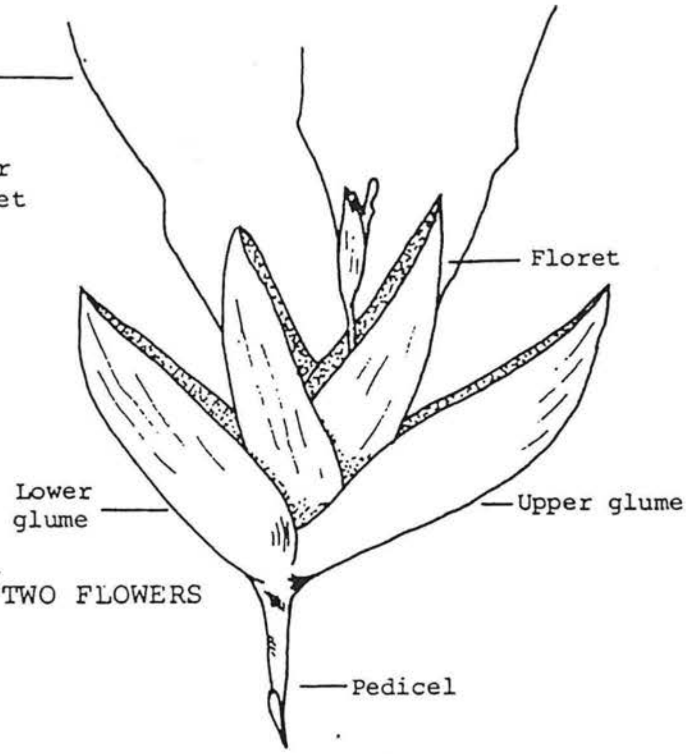
Lathyrus odoratus



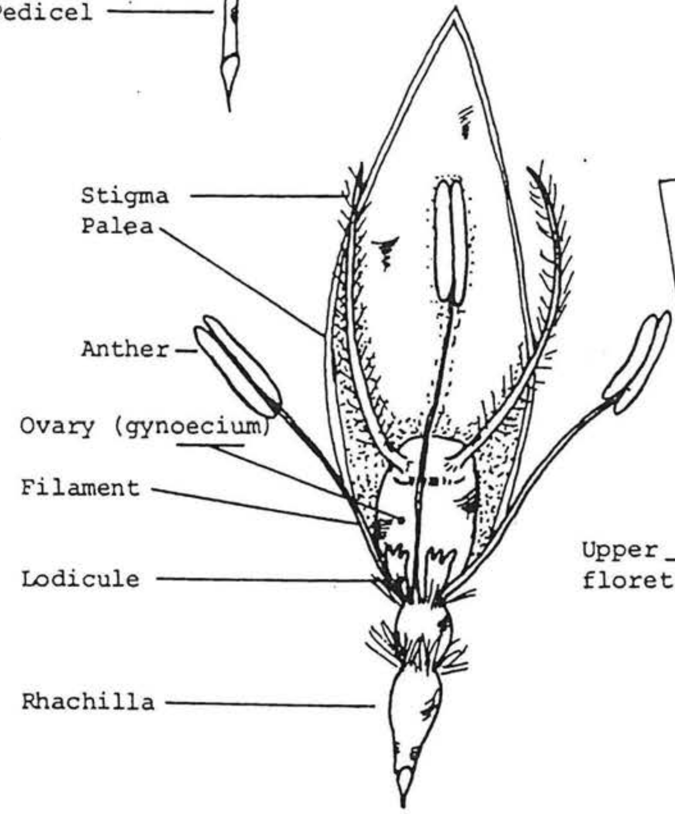
Dillwynia glaberrima


h:
calyx
and
androecium
cotyledon
outer
and
inner
seed
coats
plumule
hypocotyl
m: seed in section
d:
standard
(inner
surface)
b: side view
of flower
i: stigma
anatropous ovules
in 2 rows
f: side view of keel
k:
fruit
o: leaf
a:
inflorescence
j:
l.s. gynoecium
standard
hilum
l:
seed, from above
n:
fruit,
g:
keel, from
above
calyx
keel
wing
carpel
c: flower in section
e:
wing
inner surface
KSV

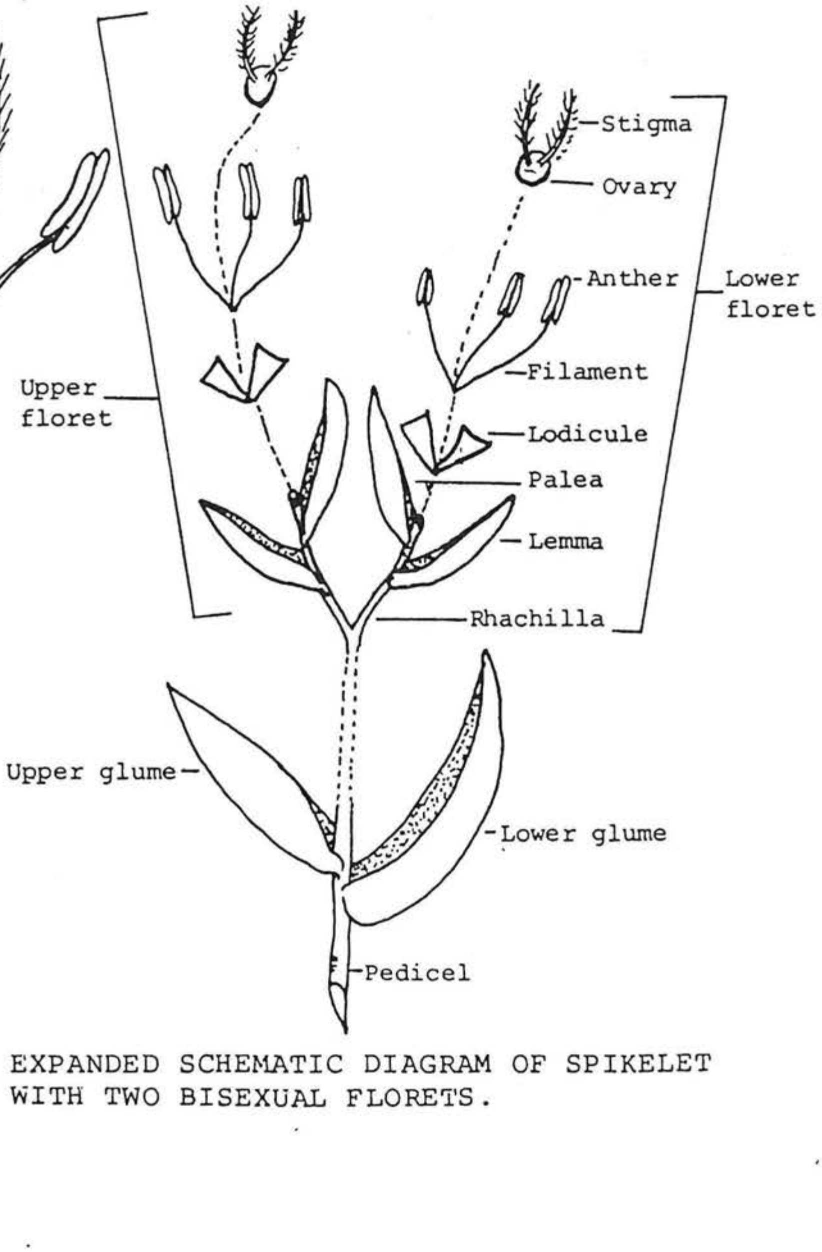




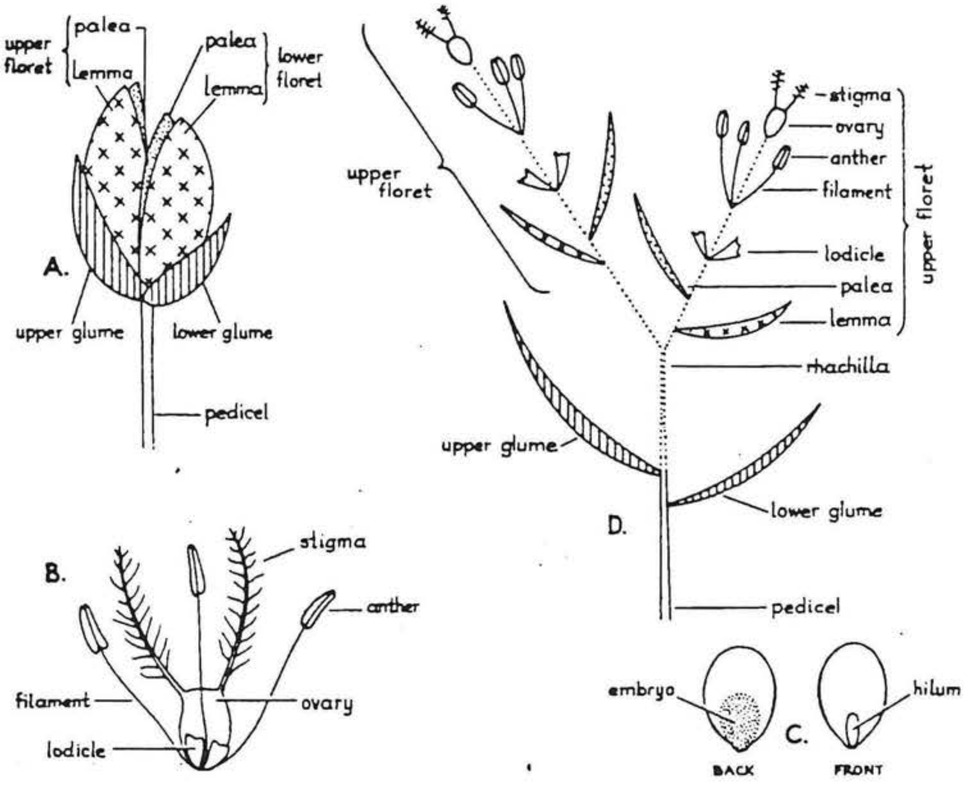
SPIKELET WITH TWO FLOWERS



FLOWER



EXPANDED SCHEMATIC DIAGRAM OF SPIKELET
WITH TWO BISEXUAL FLORETS.



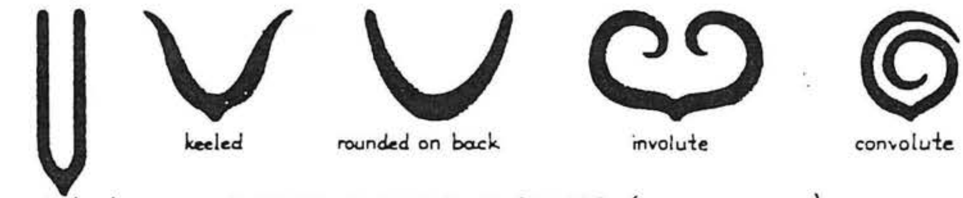
A. A spikelet with two florets.

B. A grass flower

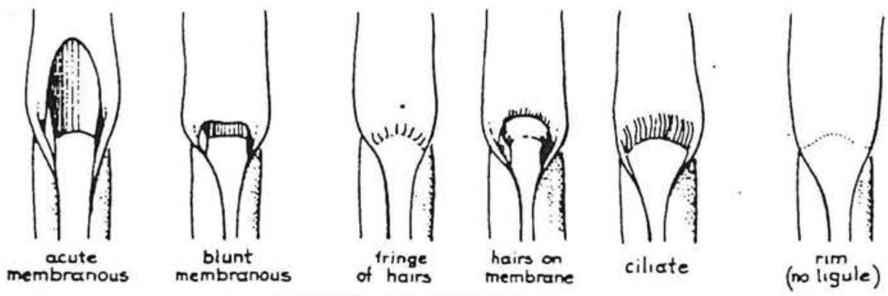
C. A grass fruit (grain)

D. An expanded schematic diagram of a spikelet with two bisexual florets.

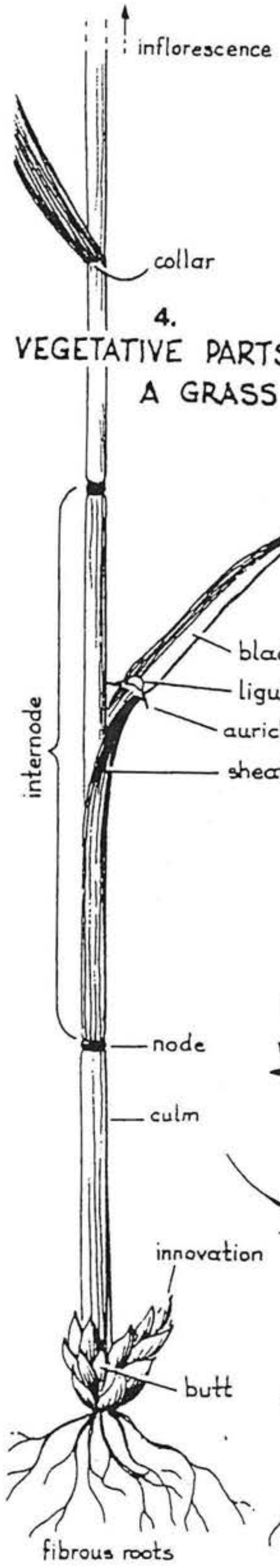
1. THE STRUCTURE OF A GRASS SPIKELET



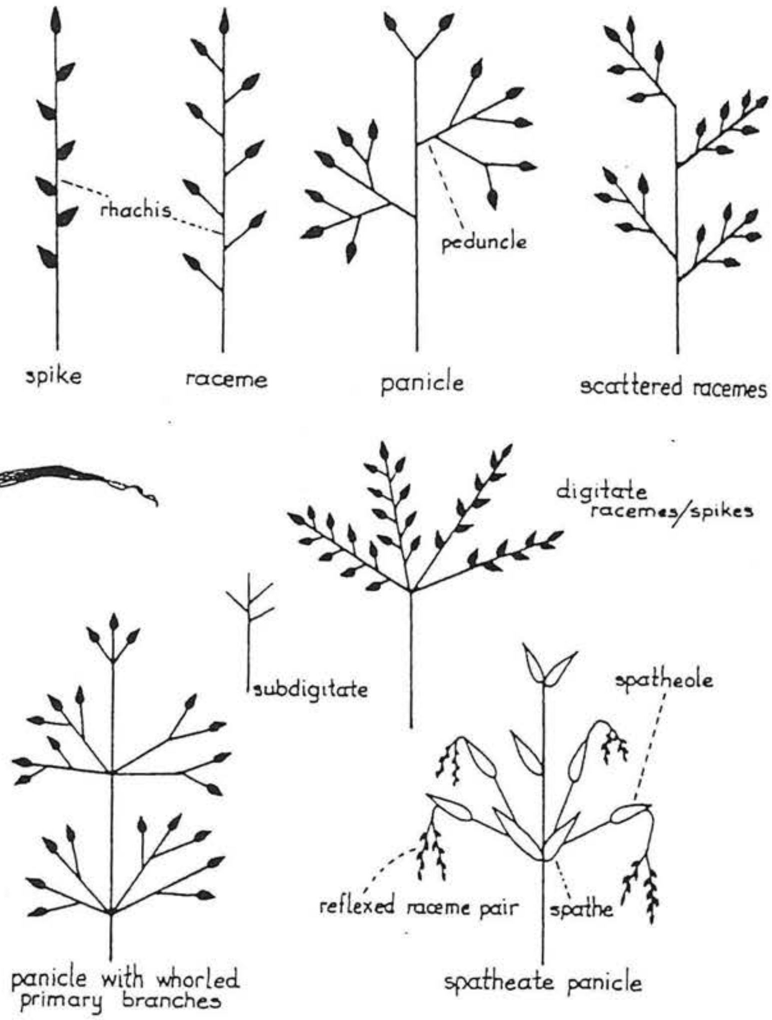
2. TYPES OF FOLDING OR ROLLING (*CROSS-SECTIONS*)



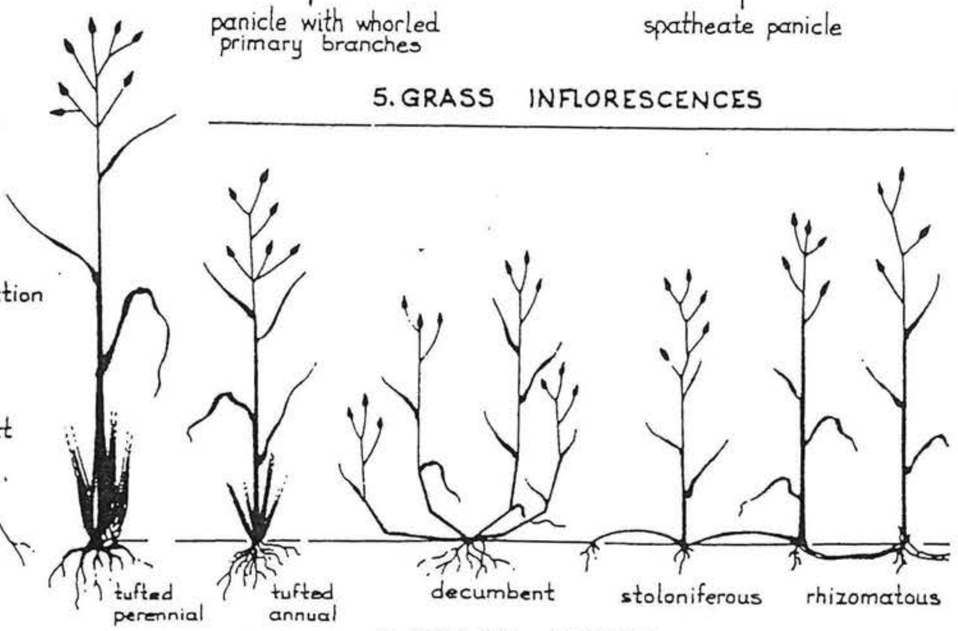
3. TYPES OF LIGULES



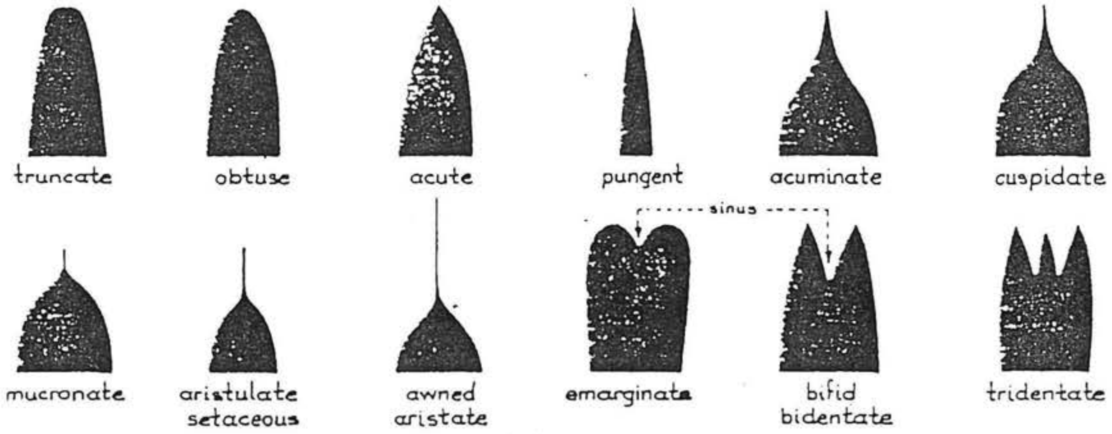
4.
VEGETATIVE PARTS OF A GRASS



5. GRASS INFLORESCENCES

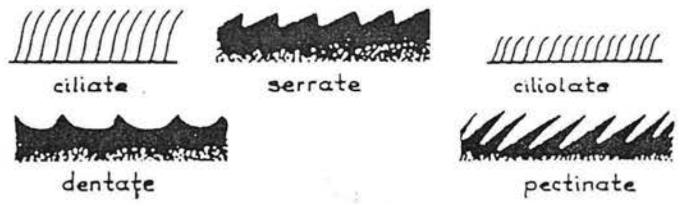


6. GRASS HABITS

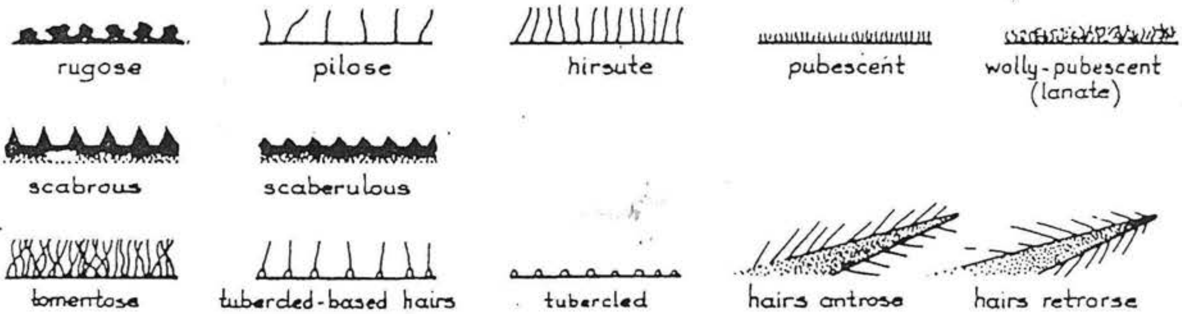


7. APICES

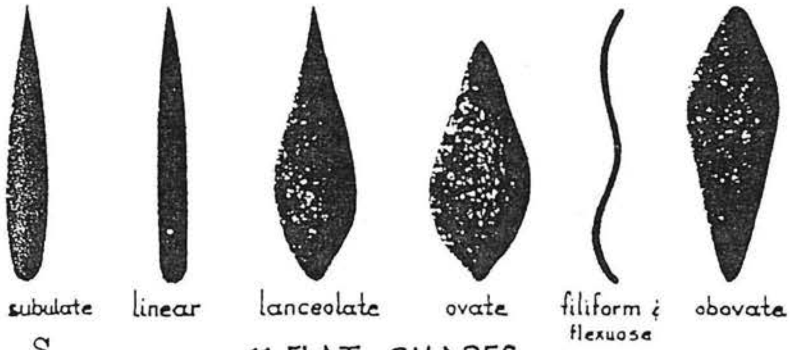
8. BASES of LEAF BLADES



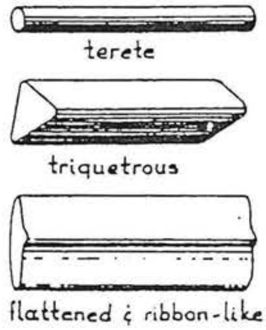
9. MARGINS



10. INDUMENTUM AND SURFACE TYPES



11. FLAT SHAPES



12. SOLID SHAPES

CLASSIFICATION OF W.A. PROTEACEAE

GENUS	SUBTRIBE	TRIBE	SUBFAMILY
Persoonia	Persooniinae	Persoonieae	Persoonioideae
Acidonia	Persooniinae	Persoonieae	Persoonioideae
Pycnonia	Persooniinae	Persoonieae	Persoonioideae
Stirlingia	Stirlingiinae	Conospermeae	Proteoideae
Isopogon	Petrophilinae	Conospermeae	Proteoideae
Petrophile	Petrophilinae	Conospermeae	Proteoideae
Conospermum	Conosperminae	Conospermeae	Proteoideae
Synaphaea	Conosperminae	Conospermeae	Proteoideae
Franklandia	Franklandiinae	Franklandiaeae	Proteoideae
Adenanthos	Adenanthinae	Franklandiaeae	Proteoideae
Strangea	Stenocarpinae	Embothrieae	Grevilleoideae
Stenocarpus	Stenocarpinae	Embothrieae	Grevilleoideae
Grevillea		Grevilleeae	Grevilleoideae
Hakea		Grevilleeae	Grevilleoideae
lomelum	Helicieae	Helicieae	Grevilleoideae
Lambertia	Lambertiinae	Macadamiieae	Grevilleoideae
Banksia	Banksiinae	Banksieae	Grevilleoideae
Dryandra	Banksiinae	Banksieae	Grevilleoideae

PROTEACEAE protea family, banksias, grevilleas, hakeas

Most of the 75 genera in the Proteaceae are found in the Southern Hemisphere: 45 occur in Australia and the remainder are mainly South African or South American. In spite of superficial morphological similarities, the Australian and South African genera are not closely related and none is common to both regions. The family is a very old one and the distribution patterns are thought to have existed before the separation of the southern land masses. There is great diversity of form within the Proteaceae, but its floral structure is distinctive. The family name is derived from the South African genus *Protea*, often grown in Australia as an ornamental.

The name of the type genus of the family, *Protea*, is derived from that of the Greek sea-god Proteus, who could assume various shapes. Originally the name was given to a few species now placed in another South African genus, *Leucadendron*, and thus referred to diversity within that group alone. The name became established for the genus to which it is now applied and much later the family Proteaceae was based upon it in the usual way a family name is based upon that of its type genus. Hence the frequent claim that the name Proteaceae was given because of the great range of forms within the family is not correct. Indeed the degree of diversity shown by Proteaceae is matched in a number of other substantial families.

Figures 1 and 2 display the most likely phylogeny as we now see it and summarize the classification into genera, subtribes, tribes and subfamilies. Comparison with figs 2 and 3 of our earlier account (J & B, 1963) will reveal a number of changes, which can be discussed only briefly here.

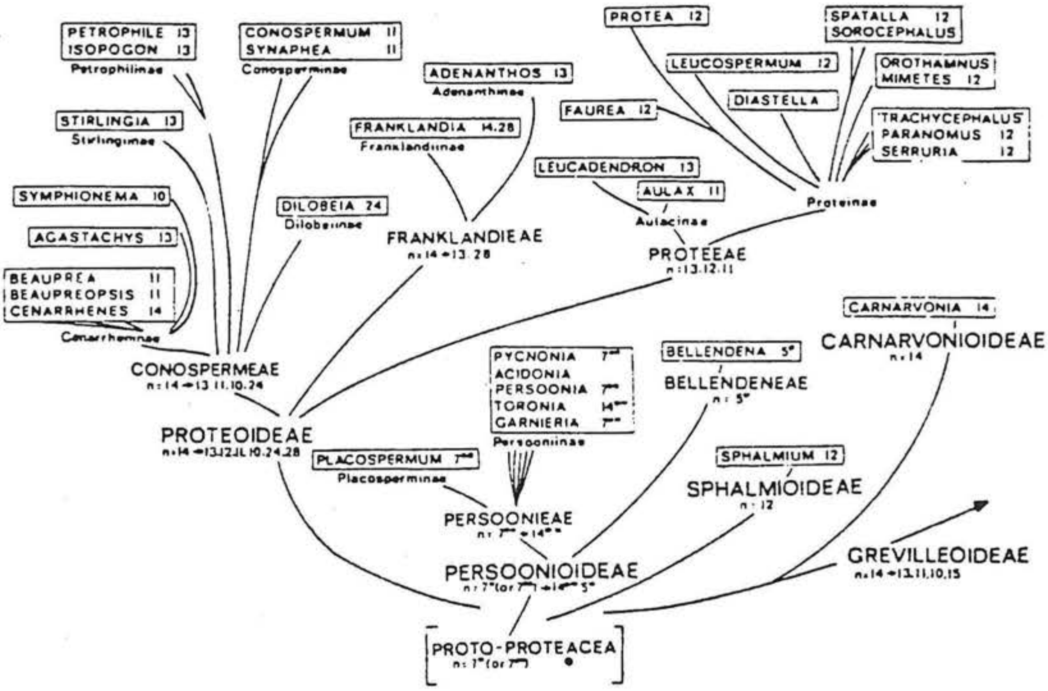


Figure 1. Inferred phylogenetic relationships in the Proteaceae and classificatory scheme of the family, excluding details of the Grevilleoideae. Haploid chromosome numbers are included; moderately and very large chromosomes are indicated by one or two asterisks respectively.

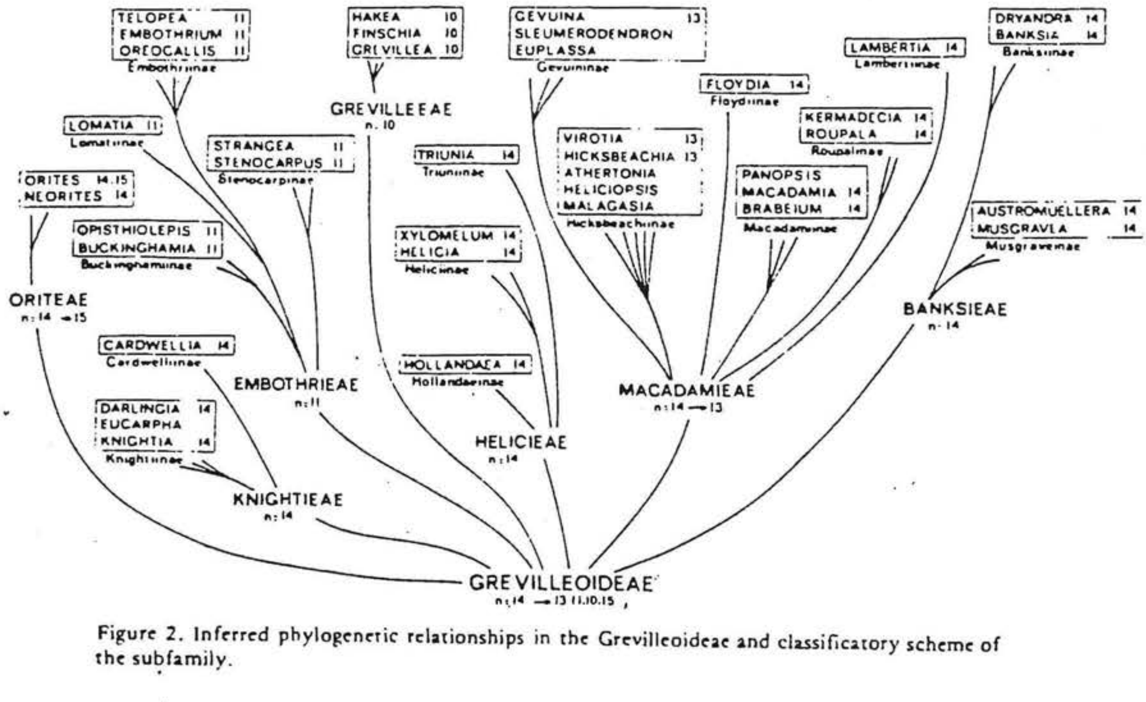


Figure 2. Inferred phylogenetic relationships in the Grevilleoideae and classificatory scheme of the subfamily.

PROTEACEAE

Key to Subfamilies

1. Flowers not in regular pairs. Fruit indehiscent (often a drupe or very small nut) or if a follicle then flowers in racemes or irregularly branched inflorescences 2
1. Flowers usually in pairs in the axil of a common bract (individual floral bracts often also present). Fruit a follicle or less commonly indehiscent and large-seeded. (If flowers not paired then flowers in dense heads, clusters, or single-flowered inflorescences and fruit a follicle) . . . . **Grevilleoideae**
2. Fruit usually indehiscent and 1-seeded, or rarely a follicle with many transverse seeds. Flowers regular or irregular. Hypogynous glands present or absent. Mostly sclerophyllous shrubs or small trees, rarely rainforest trees 3
2. Fruit a follicle, ovules and seeds 2, seeds longitudinally orientated. Flowers regular, glands absent. Rainforest trees 4
3. Fruit a drupe, or rarely a follicle, or if flattened and membranous then floral bracts absent. If fruit a drupe then leaves entire . . . . **Persoonioideae**
3. Fruit dry and indehiscent (usually a small nut or achene) or rarely a drupe. Floral bracts present. If fruit a drupe then leaves toothed or divided . . . . **Proteoideae**
4. Adult leaves entire, pre-adult leaves pinnatifid. Flowers in racemes. Seeds pendulous from a false dissepiment (formed from the funicles) which separates the seeds . **Sphalmioideae**
4. Leaves digitately divided, the divisions pinnately divided. Flowers in irregularly branched inflorescences. No dissepiment between the seeds . . . . **Carnarvonioideae**

The **Persoonioideae** are Australian except for two monotypic genera, *Garnieria* (New Caledonia) and *Toronia* (New Zealand). The largest genus, *Persoonia* or geebung, has its greatest development in eastern Australia.

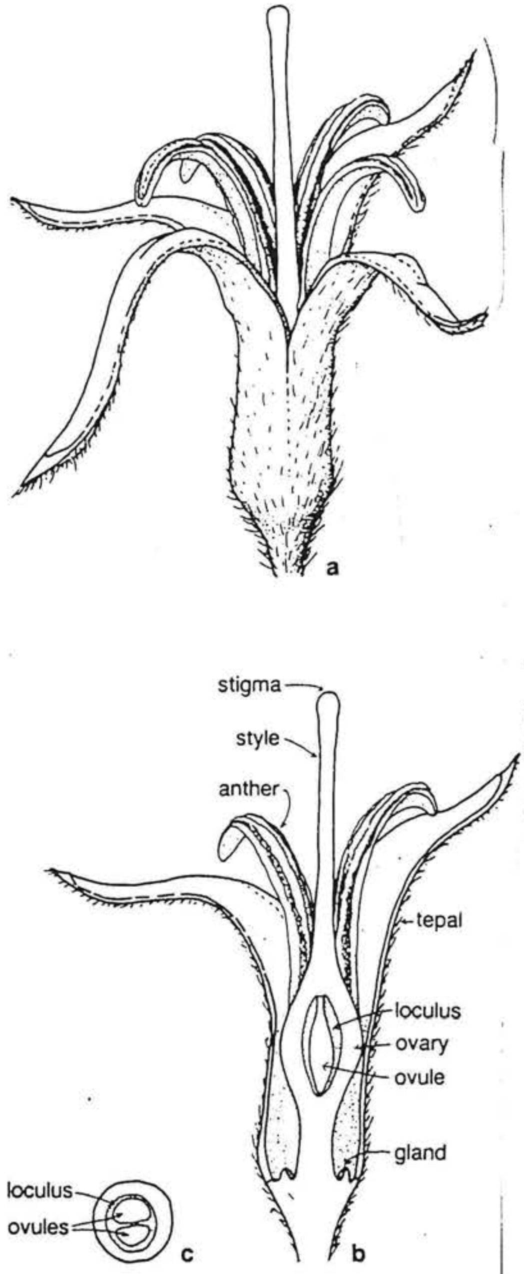
Key to Persoonioideae

1. Fruit membranous, compressed. Flowers in bractless racemes. Filaments free from tepals. Hypogynous glands absent. Low shrub. Leaves often toothed at the end. Tas . . . . (Tribe **Bellendeneae**) **Bellendena** R. Br. (1 sp. end.)
1. Fruit not membranous nor strongly compressed. Flowers in axils of leaves or bracts. Filaments adnate to the tepals for part of their length. Hypogynous glands present. Habit various. Leaves entire or coarsely lobed. . . . . (Tribe **Persoonieae**) 2
2. Fruit a follicle with numerous seeds. Only the adaxial stamen fertile, with 3 staminodes. Rainforest trees. Pre-adult leaves lobed, adult leaves entire. NE. Q . . . . (Subtribe **Placosperminae**) **Placospermum** C. T. White & Francis (1 sp. end.)
2. Fruit a drupe. All stamens fertile. Mostly sclerophyllous shrubs or small trees. All leaves entire . . . . (Subtribe **Persooniinae**) 3
3. Style elongated beyond anthers, straight in flowering stage 4
3. Style short and thick, incurved at end; the stigma held in a cavity of the adaxial tepal. SW. and N. WA, N. NT, N. Q . . . . **Pycnonia** L. A. S. Johnson & B. G. Briggs (7 spp. end.)
4. Connective not produced beyond anther loculi. Leaves not prominently 3-veined. SW. WA, SE. Q, S. SA, E. NSW, Vic, Tas . . . . **Persoonia** J. E. Sm. (42 spp. end.)
4. Connective produced beyond anther loculi. Leaves usually with 2 lateral longitudinal veins about as prominent as the mid-vein. SW. WA . . . . **Acidonia** L. A. S. Johnson & B. G. Briggs (13 spp. end.)

Most of the **Proteoideae** are sclerophyllous shrubs of infertile soils. Of the three tribes, one (Franklandieae) is exclusively Australian; another (Proteeae) is African with 12 or 13 genera and about 400 species. The tribe Conospermeae consists of three endemic Australian subtribes, together with the monotypic Dilobeiinae in Madagascar, and the Cenarrheninae which is an assemblage of three relict genera in Australia and two (*Beauprea* and *Beaupreopsis*) in New Caledonia.

Key to Proteoideae

1. Hypogynous glands present, scale-like or forming a ring. Leaves with glandular cavities. . . . . (Tribe **Franklandieae**) 9
1. Hypogynous glands absent or if present (**Cenarrhenes**) then short and thick. Leaf glands absent. . . . . (Tribe **Conospermeae**) 2
2. Anthers all developed, fully 4-locular. Perianth regular 3
2. One anther and 2 half-anthers abortive, the loculi of adjacent anthers coherent in bud, each half-anther apparently 1-locular due to breaking down of the septum. Perianth strongly or (less often) weakly zygomorphic. . . . . (Subtribe **Conosperminae**) 8
3. Fruit a small nut, usually markedly hairy. Flowers in globular or cone-like heads or short spikes 6
3. Fruit hairless or almost so. Flowers in spikes or racemes, not in globular or cone-like heads. . . . . (Subtribe **Cenarrheninae**) 4



T.S. ovary, plac. apical   half flower

Persoonia juniperina (prickly geebung)

4. Fruit a drupe. Anthers with a long terminal awn. Floral glands present. Leaves simple, toothed. Tas .... **Cenarrhenes** Labill. (1 sp. end.)

4. Fruit dry. Anthers without long awns. Floral glands absent. Leaves entire or much divided 5

5. Fruit 3-angled with 2 broad lateral wings and 1 narrow dorsal wing. Tall shrubs with entire leaves. Tas .... **Agastachys** R. Br. (1 sp. end.)

5. Fruit a small smooth nut. Subshrubs with divided leaves. E. NSW .... **Symphionema** R. Br. (2 spp. end.)

6. Flowers in small heads or short spikes. Floral bracts small. Loculi of adjacent anthers applied face to face. Style not modified below the stigma. Subshrubs or low shrubs; leaves divided, mostly arising near the base. SW. WA .... (Subtribe **Stirlingiinae**). **Stirlingia** Endl. (5 spp. end.)

6. Flowers in dense cone-like spikes or heads with imbricate scale-like floral bracts. Loculi of adjacent anthers not closely appressed. Style thickened below the stigma, forming a pollen-presenter, often with a brush of hairs. Low to tall shrubs, leaves undivided to variously divided. .... (Subtribe **Petrophilinae**) 7

7. Cone scales firmly adhering to the rachis and opening to release the flattened nuts. SW. WA, SE. Q, S. SA, E. NSW .... **Petrophile** R. A. Salisb. (c. 42 spp. end.)

7. Cone scales falling with the fruits. Nuts not strongly compressed. SW. WA, SE. Q, SE. SA, E. NSW, S. Vic, Tas .... **Isopogon** R. Br. (c. 35 spp. end.)

8. Leaves divided. Flowers more or less yellow. Upper anther abortive. Nut ovoid or oblong. SW. WA, S. SA .... **Synaphea** R. Br. (c. 10 spp. end.)

8. Leaves entire. Flowers white, bluish, or pinkish. Lower anther abortive. Nut turbinate. SW. WA, SE. Q, SE. SA, E. NSW, S. Vic, Tas ...... **Conospermum** J. E. Sm. (c. 38 spp. end.)

9. Perianth fused for much of its length with the filaments and hypogynous glands to form a slender tube. Margins of free parts of tepals incurved. Flowers several in the raceme. Leaves appearing dichotomously divided, central lobe not developed. SW. WA .... (Subtribe **Franklandiinae**). **Franklandia** R. Br. (2 spp. end.)

9. Perianth not as above. Glands fused with perianth only at the base. Margins of free parts of tepals not incurved. Flowers solitary within a group of imbricate bracts. Leaves entire or toothed, or if divided then the central lobe more or less developed. SW. WA, S. SA, W. Vic .... (Subtribe **Adenanthinae**) **Adenanthos** Labill. (31 spp. end.)

The **Sphalmioideae** and **Carnarvonioideae** are relict groups, consisting of trees of rainforests in north-east Queensland. The first is monotypic, **Sphalmium** B. Briggs, B. Hyland & L. Johnson; the second consists of two species of **Carnarvonia** F. Muell. Both have similarities to the Grevilleoideae in the follicles and wood anatomy but differ (among other characters) in the lack of flower pairs. Distinctive specialisations are the false septum (formed from funicles) between the seeds of *Sphalmium* and the digitate-pinnate leaf division in *Carnarvonia*.

All the seven tribes of the **Grevilleoideae** are represented in Australia and only one subtribe, Roupalinae, from tropical America and New Caledonia has no Australian members. Of the 41 genera, 18 are confined to Australia, four occur only in America, and two are African. Several genera are common to Australia and other parts of the west Pacific–Malesia–southern Asian region and seven genera occur in this region but outside Australia. *Orites*, *Lomatia*, and *Oreocallis* are common to Australia and America. Most remarkable is the presence of three very closely related genera, *Macadamia*, *Panopsis*, and *Brabeium*, respectively in Australasia, South America, and South Africa.

Several genera are prominent in Australia's sclerophyllous heaths and woodlands, notably *Grevillea*, *Hakea*, *Banksia*, and *Dryandra*; the first two of these have also diversified in the semi-arid inland. The majority of the genera, but not most of the species, are restricted to rainforests.

Key to Grevilleoideae

1. Flowers regular and straight. Lacking both peduncles (common stalks) of flower pairs and bracts of individual flowers. Style not or scarcely thickened, i.e. without a definite pollen-presenter. Hypogynous glands 4, free. Fruit a follicle with winged seeds. Leaves alternate. Bracts of flower pairs broad and concave but often falling early .... (Tribe **Oriteae**) 2

1. Differing in one or more of the above characters 3

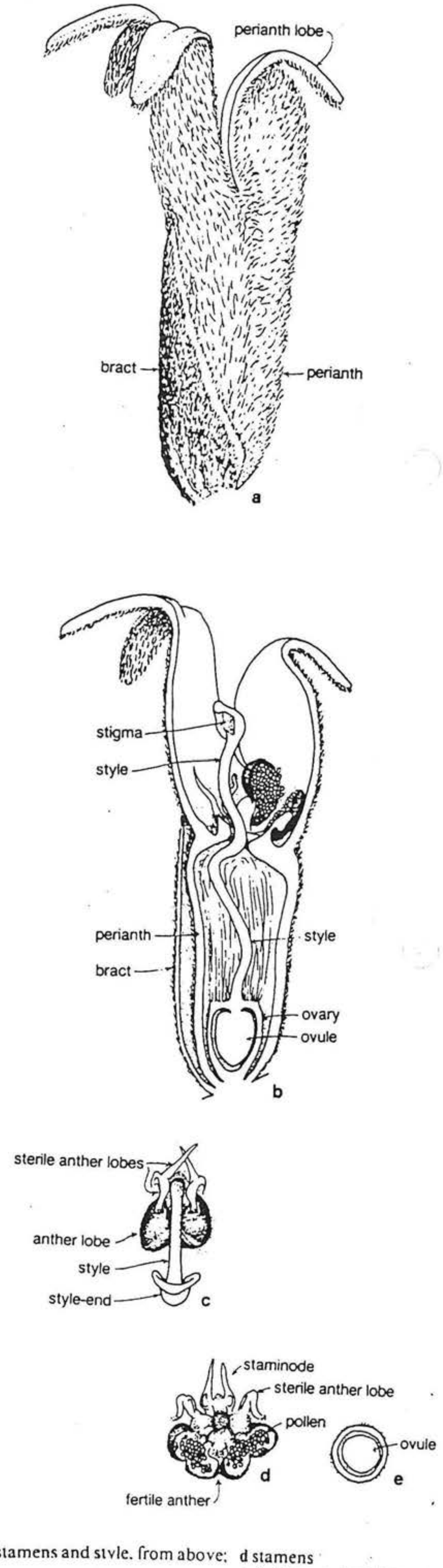
2. Ovules and seeds numerous. Rainforest trees. NE. Q ..... **Neorites** L. S. Sm. (1 sp. end.)

2. Ovules and seeds 2. Rainforest trees or sclerophyllous shrubs. E. Q, E. NSW, E. Vic, Tas, S. America .... **Orites** R. Br. (6 spp. end.)

3. Ovules usually 4 or more, or if 2 (**Strangea**) then the seed solitary with an outer wing enveloping the inner wing. Fruit a follicle, seeds winged 4

3. Ovules usually 2, or if numerous (**Hollandaea**) the seeds thick and wingless. Fruit a follicle or indehiscent 12

4. Hypogynous glands 2 or 3 or fused into an incomplete ring (the fourth gland present but small in some **Lomatia** spp.) .... (Tribe **Embothrieae**) 6



c stamens and style, from above; d stamens dehisced, from above;
Conospermum mitchellii (Victorian smoke-bush)

4. Hypogynous glands 4, unfused . . . . (Tribe **Knightieae**) 5

5. Adult leaves simple (pre-adult leaves lobed). Pollen-presenter swollen but not oblique. NE. Q . . . . (Subtribe **Knightiinae**) **Darlingia** F. Muell. (2 spp. end.)

5. Adult leaves pinnate. Pollen-presenter strongly oblique. NE. Q . . . . (Subtribe **Cardwelliinae**) **Cardwellia** F. Muell. (1 sp. end.)

6. Flowers in inflorescences with more or less elongated rachis (sometimes in heads with an involucre). Seed wings simple 8

6. Flowers in clusters without an elongated rachis (sometimes arranged like the spokes of a wheel or reduced to a single flower). Seeds with an outer wing folded around the inner wing . . . . (Subtribe **Stenocarpinae**) 7

7. Ovules and seeds numerous. Trees of rainforest or moist monsoon forest. N. WA, N. NT, E. Q, E. NSW, New Guinea, New Caledonia . . . . **Stenocarpus** R. Br. (c. 2 spp. end., 2 spp. native)

7. Ovules 2, seed 1. Sclerophyllous shrubs. SW. WA, SE. Q, NE. NSW . . . . **Strangea** Meissn. (3 spp. end.)

8. Suture of ovary opposite junction of 2 tepals (plane of zygomorphy passing between 2 tepals) 10

8. Suture of ovary (and plane of zygomorphy) bisecting a tepal . . . . (Subtribe **Buckinghamiinae**) 9

9. Flower pairs with short common stalks. Ovules and seeds many. NE. Q . . . . **Opisthiolepis** L. S. Sm. (1 sp. end.)

9. Pedicels of individual flowers arising directly from rachis. Ovules and seeds 4. NE. Q . . . . **Buckinghamia** F. Muell. (1 sp. end.)

10. Flowers white or cream, in raceme-like inflorescences. Vascular strand (raphe) forming margin of seed wing. E. Q, E. NSW, S. and E. Vic, Tas, S. America . . . . (Subtribe **Lomatiinae**) **Lomatia** R. Br. (8 spp. end.)

10. Flowers normally pink or red; inflorescences condensed or head-like. Vascular strand running through seed wing . . . . (Subtribe **Embothriinae**) 11

11. Inflorescence shortly raceme-like but not capitate, lacking a conspicuous involucre. E. Q, NE. NSW, New Guinea, S. America . . . . **Oreocallis** R. Br. (2 spp. end.)

11. Inflorescence more or less capitate with conspicuous involucre. E. NSW, SE. Vic, Tas . . . . **Telopea** R. Br. (3 or 4 spp. end.)

12. Peduncles and floral bracts absent. Ovary suture and plane of zygomorphy bisecting a tepal. Flowers usually strongly zygomorphic. Pollen-presenter well developed. Ovules attached well below the top of the ovary. Hairs (sometimes indumentum sparse or almost absent) 2-branched or appearing to be attached near the middle . (Tribe **Grevilleeae**) 13

12. One or more characters not as above 14

13. Pericarp of follicle thin or if thick then without woody secondary thickening formed by a cambium. Seeds winged all around or occasionally wingless. Leaves almost always with upper and lower surfaces different. Flowers almost always in definite pairs. All States, New Guinea, New Caledonia, Celebes . . . . . . **Grevillea** R. Br. (c. 250 spp. end., 2 spp. native)

13. Pericarp woody with secondary thickening formed by a cambium. Seeds winged, usually at one end. Surfaces of leaves similar or leaves centric (terete, not grooved). Inflorescences often condensed and then the flowers not regularly or obviously paired. All States . . . . **Hakea** Schrad. (c. 125 spp. end.)

14. Hypogynous glands thin, elongated, not fused (not readily seen in **Dryandra**). Fruit a follicle, never horned, if thick and woody then the seeds separated by a plate-like false dissepiment. Seeds more or less flattened, winged. Pollen grains curved-ellipsoid . . . . (Tribe **Banksieae**) 25

14. Hypogynous glands unfused or more or less united, variously shaped, very rarely absent. Fruit usually indehiscent with 1 thick wingless seed (or rarely a follicle with many wingless seeds, or a thick and woody or horned follicle with 2 winged seeds). Seeds never separated by a plate-like false dissepiment. Pollen grains 3-angled 15

15. Ovules pendulous, attached near top of ovary, more or less orthotropous. Leaves simple or divided . . . . (Tribe **Macadamieae**) 19

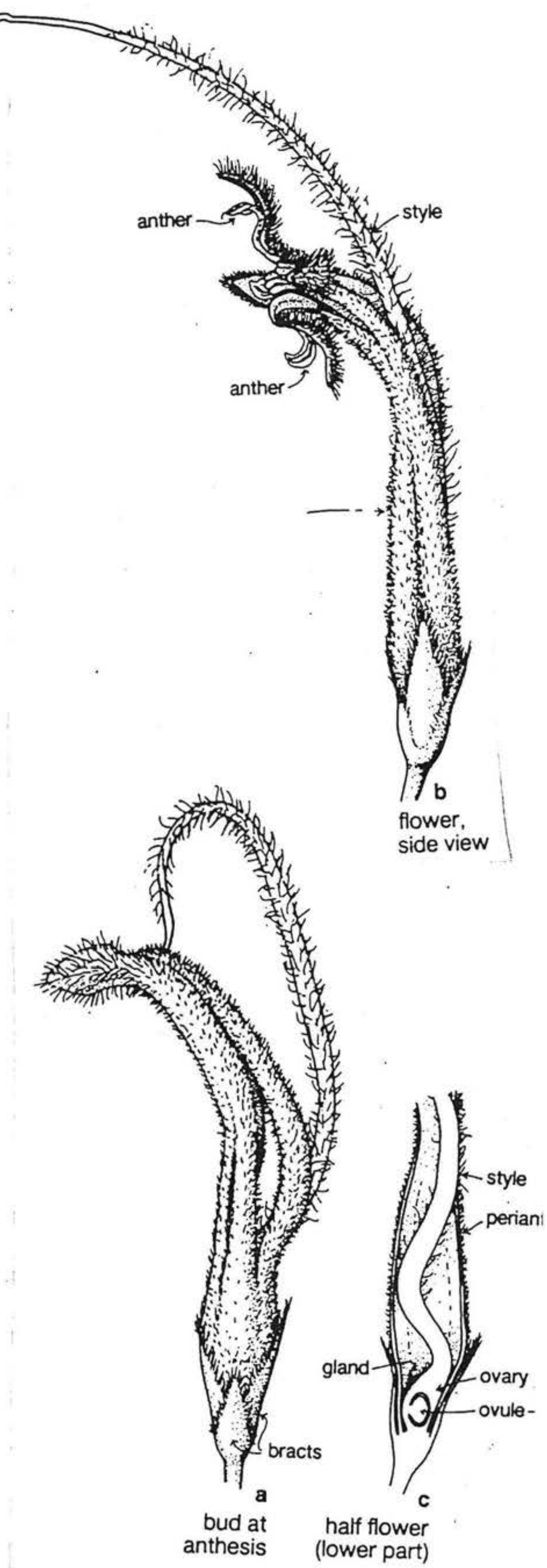
15. Ovules attached on the side or near the base of ovary, hemitropous or anatropous. Leaves all simple . . . . (Tribe **Helicieae**) 16

16. Ovules and seeds numerous. Fruit a follicle. NE. Q . . . . (Subtribe **Hollandaeinae**) **Hollandaea** F. Muell. (1 sp. end.)

16. Ovules 2, seeds usually 1. Fruit indehiscent and usually 1-seeded or a large woody follicle with 2 seeds 17

17. Flowers zygomorphic with 3 tepals coherent and 1 tepal free. Fruit indehiscent and fleshy. Leaves whorled. E. Q, NE. NSW . . . . (Subtribe **Triuniinae**) **Triunia** L. A. S. Johnson & B. G. Briggs (3 spp. end.)

17. Flowers regular. Fruit indehiscent or dehiscent. Leaves alternate or opposite . . . . (Subtribe **Heliciinae**) 18



Adenanthos terminalis (gland flower)

18. Rainforest trees or shrubs. Fruit indehiscent. Seed usually 1, thick, not winged. Leaves alternate. N. NT, E. Q, E. NSW, New Guinea, Malesia, E. and SE. Asia .... **Helicia** Lour. (6 spp. end.)

18. Sclerophyllous trees or shrubs. Fruit a large woody follicle. Seeds 2, flattened, with a terminal wing. Leaves opposite. SW. WA, E. Q, E. NSW .... **Xylomelum** J. E. Sm. (5 spp. end.)

19. Pre-adult leaves more or less divided, adult leaves simple or divided. Common stalk of flower pair usually present, if more or less absent (**Hicksbeachia**) then the adult leaves divided. Fruit fleshy, indehiscent 20

19. All leaves simple. Common stalk of flower pair absent or rarely (**Floydia**) present. Fruit dehiscent or indehiscent 23

20. Flowers zygomorphic, curved. Hypogynous glands 2. NE. Q, New Guinea .... (Subtribe **Gevuininae**) **Bleasdalea** F. Muell. (1 sp. end.)

20. Flowers regular, straight. Hypogynous glands 4 or more or less fused into a complete ring. .... (Subtribe **Hicksbeachiinae**) 21

21. Adult leaves deeply pinnatisect. Common stalks of flower pairs very short or more or less absent. Fruit red. E. Q, NE. NSW .... **Hicksbeachia** F. Muell. (1 or 2 spp. end.)

21. Adult leaves simple. Common stalks of flower pairs present. Fruit not brightly coloured 22

22. Inflorescences terminating leafy branchlets. Tepals of open flowers not strongly spirally twisted. Fruit black. NE. Q ..... **Athertonia** L. A. S. Johnson & B. G. Briggs (1 sp. end.)

22. Inflorescences axillary. Tepals of open flowers spirally twisted. Fruit unknown in Australian spp. **Macadamia heyana** is tentatively referred (without fruit) to this chiefly New Caledonian genus. It belongs in this affinity (Johnson and Briggs 1975) but no combination exists for it under **Virotia**. NE. Q, New Caledonia .... **Virotia** L. A. S. Johnson & B. G. Briggs (1 sp. end.)

23. Peduncles of flower pairs developed. Leaves alternate. Fruit indehiscent with a single large seed. Rainforest trees. SE. Q, NE. NSW .... (Subtribe **Floydiinae**) **Floydia** L. A. S. Johnson & B. G. Briggs (1 sp. end.)

23. Peduncles of flower pairs absent. Leaves usually opposite or whorled. Fruit indehiscent or tardily dehiscent or a follicle 24

24. Flowers in heads of 7 flowers or reduced to a single flower, red or yellow. Inflorescence with an involucre. Fruit a follicle. Seeds narrowly winged all around. Sclerophyllous shrubs. SW. WA, E. NSW .... (Subtribe **Lambertiinae**) **Lambertia** J. E. Sm. (9 spp. end.)

24. Flowers in elongated inflorescences, not red or yellow. Fruit indehiscent or tardily dehiscent. Seed thick, not winged. Rainforest trees. E. Q, NE. NSW and Celebes .... (Subtribe **Macadamiinae**) **Macadamia** F. Muell. (c. 6 spp. end.)

25. Inflorescence cone-like or head-like. Common stalks of flower pairs absent. Hypogynous glands 4 or perhaps sometimes absent. Seeds separated by a false single or double dissepiment. Sclerophyllous trees or shrubs .... (Subtribe **Banksiinae**) 27

25. Inflorescence raceme-like. Common stalks of flower pairs present. Hypogynous glands 3. No false dissepiment between the seeds. Rainforest trees ... (Subtribe **Musgraveinae**) 26

26. Leaves pinnate, leaflets with sub-parallel venation. Pedicels of individual flowers distinctly developed. NE. Q .... **Austromuellera** C. T. White (1 sp. end.)

26. Adult leaves simple, entire. Pedicels very short or absent. NE. Q .... **Musgravea** F. Muell. (2 spp. end.)

27. Flowers in ovoid or cylindrical cone-like inflorescences, without a prominent involucre. Follicles usually transversely orientated. SW. and N. WA, N. NT, E. Q, S. SA, E. NSW, W. and S. Vic, Tas, New Guinea .... **Banksia** L.f. (c. 71 spp. end., 1 sp. native)

27. Flowers in heads surrounded by an involucre. Follicles usually vertically orientated. SW. WA .... **Dryandra** R. Br. (c. 55 spp. end.)

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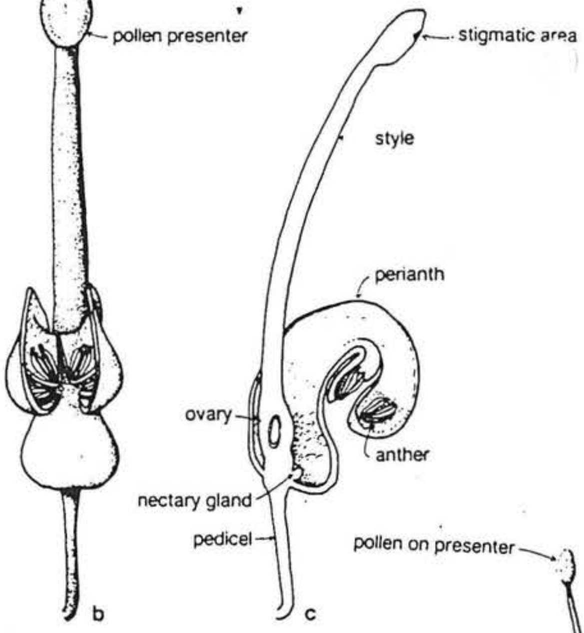


flower, front view   half flower

Grevillea rosmarinifolia (rosemary grevillea)

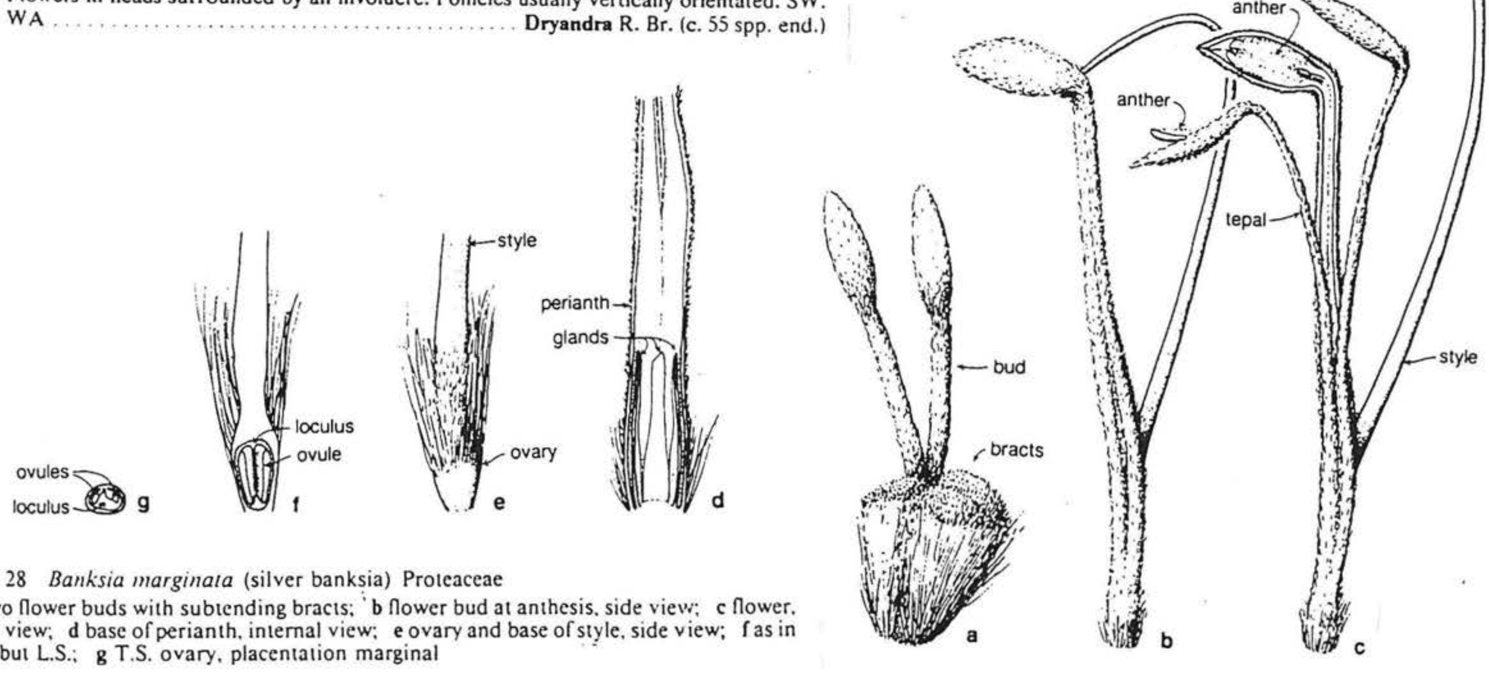
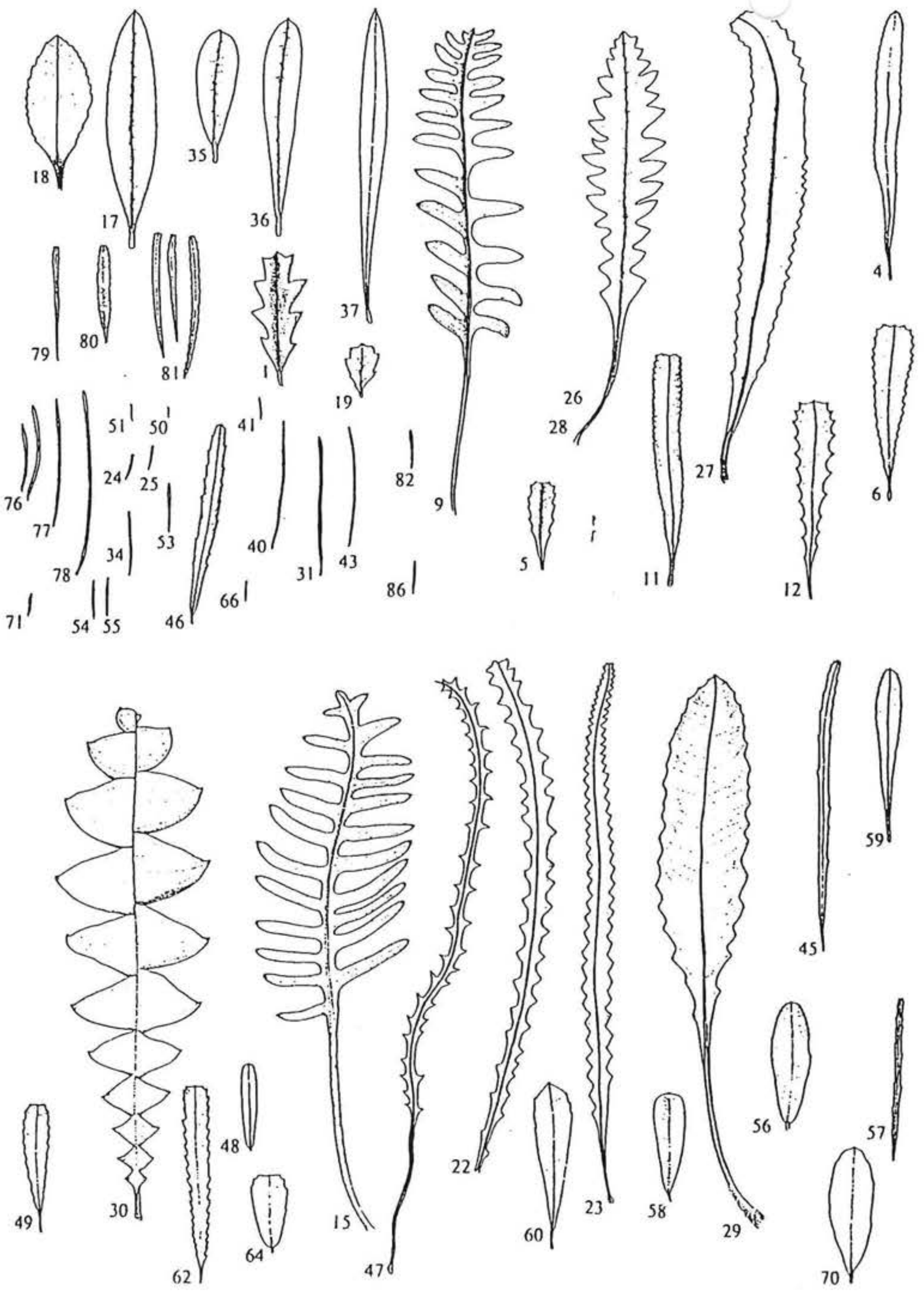
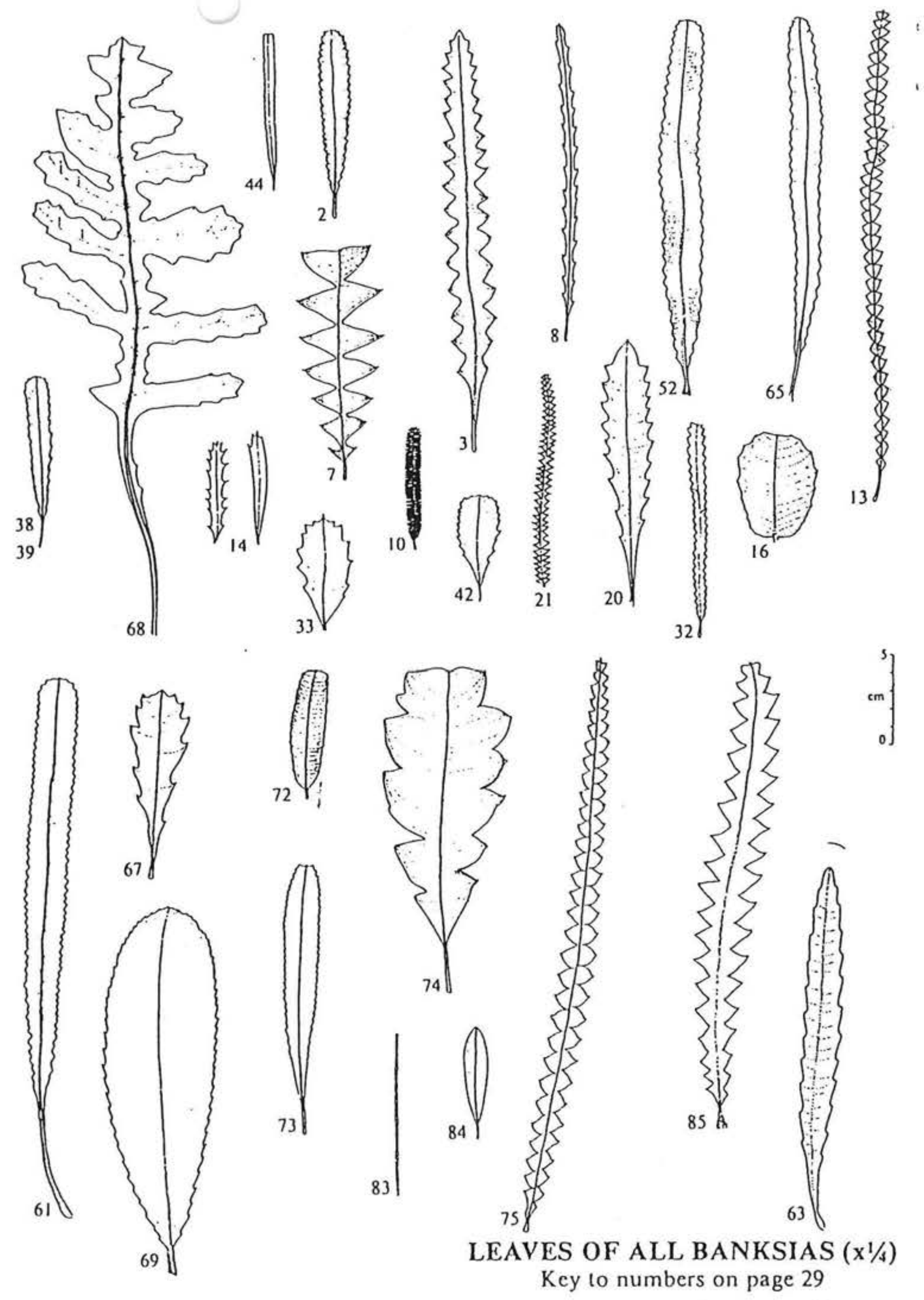


Fig. 28 *Banksia marginata* (silver banksia) Proteaceae
a two flower buds with subtending bracts; **b** flower bud at anthesis, side view; **c** flower, side view; **d** base of perianth, internal view; **e** ovary and base of style, side view; **f** as in (e), but L.S.; **g** T.S. ovary, placentation marginal





LEAVES OF ALL BANKSIAS (x¼)

Key to numbers on page 29

Key to the Banksia leaf drawings on pages 30 and 31

1. *aculeata*
2. *aemula*
3. *ashbyi*
4. *attenuata*
5. *audax*
6. *baueri*
7. *baxteri*
8. *benthamiana*
9. *blechnifolia*
10. *brownii*
11. *burdettii*
12. *caleyi*
13. *candolleana*
14. *canei*
15. *chamaephyton*
16. *coccinea*
17. *conferta* var. *conferta*
18. var. *penicillata*
19. *cuneata*
20. *dentata*
21. *dryandroides*
22. *elderana*
23. *elegans*
24. *ericifolia* var. *ericifolia*
25. var. *macrantha*
26. *gardneri* var. *gardneri*
27. var. *brevidentata*
28. var. *hiemalis*
29. *goodii*
30. *grandis*
31. *grossa*
32. *hookeriana*
33. *ilicifolia*
34. *incana*
35. *integrifolia* var. *integrifolia*
36. var. *compar*
37. var. *aquilonia*
38. *laevigata* subsp. *laevigata*
39. subsp. *fuscolutea*
40. *lanata*
41. *laricina*
42. *lemanniana*
43. *leptophylla*
44. *lindleyana*
45. *littoralis* var. *littoralis*
46. var. *seminuda*
47. *lullfitzii*
48. *marginata*
49. *media*
50. *meisneri* var. *meisneri*
51. var. *ascendens*
52. *menziesii*
53. *micrantha*
54. *nutans* var. *nutans*
55. var. *cernuella*
56. *oblongifolia*
57. *occidentalis*
58. *oreophila*
59. *orna.*
60. *paludosa*
61. *petiolaris*
62. *pilostylis*
63. *plagiocarpa*
64. *praemorsa*
65. *prionotes*
66. *pulchella*
67. *quercifolia*
68. *repens*
69. *robur*
70. *saxicola*
71. *scabrella*
72. *sceptrum*
73. *serrata*
74. *solandri*
75. *speciosa*
76. *sphaerocarpa* var. *sphaerocarpa*
77. var. *caesia*
78. var. *dolichostyla*
79. *spinulosa* var. *spinulosa*
80. var. *collina*
81. var. *cunninghamii*
82. *telmatiaea*
83. *tricuspis*
84. *verticillata*
85. *victoriae*
86. *violacea*

(4) The treatment of the **Eucalyptus** alliance adopted here will be unfamiliar, in that the traditional *Eucalyptus* and *Angophora* are replaced by 9 genera, of which 4 have not yet been formally named as genera. These 9 groups correspond with the subgenera designated within *Eucalyptus* by Pryor and Johnson (1971) and Johnson (1976) and are considered to be of equal rank with the already generally recognised *Angophora*.

The traditional generic concepts in this alliance cannot be logically maintained. *Angophora* with free petals has been regarded as distinct from *Eucalyptus* which has a calyptra or operculum (cap) on the flower bud and no conspicuous petals. However, that calyptra is sometimes formed from petals and sometimes from calyx lobes; or there may be two caps, one formed from each type of structure. As the calyptras are not formed in the same way, they cannot be considered as equivalent (homologous) structures in different groups of '*Eucalyptus*'.

If *Angophora* is distinguished because it lacks a calyptra it is equally appropriate to distinguish the types of eucalypts that have calyptras that have evolved separately from different structures in the flowers. An alternative treatment, uniting *Angophora* with *Eucalyptus*, would obscure basic differences in flower structure equivalent to those recognised elsewhere in different genera, and considerable differences in geographic and adaptive patterns.

The necessary formal changes in names have yet to be published; meanwhile, most species can only be referred to by their traditional names in *Eucalyptus*, but it should be realised that *Angophora* is considered to be more closely allied to groups traditionally placed within *Eucalyptus* than these are to some other eucalypts.

The generic groups are difficult to separate in Keys because many of the important structures are small or only seen at particular stages of growth. However, each is characterised by a distinctive assemblage of a considerable number of features. Even when divided in this way, some of the genera are large. *Eucalyptus* in the strict sense has about 100 species and *Symphyomyrtus* about 300. Where reference is made to all or several genera of the alliance the common name 'eucalypts' is still appropriate.

Bark types and anthers have commonly been used to characterise species groups within the eucalypts but there are many discrepancies between these groups and the relationships deduced from more broadly based studies which are embodied in the generic Key. For example *E. sideroxylon*, *E. melliodora*, and *E. leucoxylon* are closely related members of *Symphyomyrtus* but have ironbark-, box-, and gum-type barks respectively.

The following are among the common names widely applied to groups of eucalypts, although these are sometimes differently applied in different areas: *Angophora* apples; '*Blakella*' ghost gums; '*Corymbia*' bloodwoods, spotted gums; *Symphyomyrtus* gums, boxes, ironbarks, red mahoganies, many mallees; *Eucalyptus* ('Monocalyptus') stringybarks, white mahoganies, peppermints, scribbly gums, snow gums, ashes.

Most eucalypts are trees but some are mallees with several or many stems from a broad underground woody base (lignotuber). Eucalypts include some of the world's tallest tree species: *E. regnans* is only surpassed by *Sequoia*, the redwood, of western North America. They include also small mallees, sometimes scarcely 0·5 m tall; but the latter are still the tallest plants in the sites in which they occur, growing in low heaths and shrublands, never forming an understorey among taller plants. They extend to the lowland tropics with a few species reaching New Guinea, the Lesser Sunda Islands, the Moluccas, and southern Philippines. At another ecological extreme they form the treeline in the Australian Alps and Tasmanian mountains. Several features suggest that this alliance, although perhaps rather closely allied to the *Eucalyptopsis* alliance, is otherwise a very isolated group. It shows much evidence of relatively recent diversification but retains certain primitive features.

KEY TO SUB-ALLIANCES AND GENERA OF EUCALYPTUS ALLIANCE

1. Ovules hemitropous or campylotropous. Perianth of 2 whorls, at least in young bud: calyx lobes and petals unfused, *or* calyx lobes unfused but corolla forming a calyptra (operculum), *or* calyx lobes and corolla each forming a calyptra though sometimes the inner calyptra adhering to the outer. Seeds various, very seldom D-shaped 2

1. Ovules anatropous. Perianth usually of 1 whorl: corolla usually absent: calyx united to form a single calyptra (operculum), or rarely calyx lobes unfused or becoming separate and the corolla forming a calyptra. Seeds more or less D-shaped. (**Eucalyptus** sub-alliance) . 7

2. Oil ducts absent from the pith, oil glands present or absent. Calyx and corolla either each forming a calyptra *or* rarely largely fused to form a single calyptra *or* calyx lobes unfused but corolla forming a calyptra; never with *both* calyx lobes and petals unfused. Anthers various, from versatile to basifixed (attached at base to the filament and sometimes at an oblique angle to the filament); dehiscence various, from parallel slits to terminal pores. Adult leaves with lateral veins parallel to the mid-vein and fairly close, or variously reticulate and oblique. Bristle glands absent. (**Symphyomyrtus** sub-alliance) 5

2. Oil ducts as well as oil glands almost always present in the pith of branchlets. Calyx and corolla either each forming a calyptra *or* both with unfused segments *or* petals closely adhering to the inner surface of the calycine calyptra. Anthers always versatile and opening by parallel slits. Adult leaves usually with the lateral veins very close, straight and parallel, spreading at a wide angle from the mid-rib. Stiff multicellular bristles containing an oil gland usually present (at least on seedlings or young plants). (**Angophora** sub-alliance) 3

3. Calyx lobes and petals free, neither shedding as a calyptra. Leaves opposite. Fruit usually ribbed, not very thickly woody, the rim with more or less persistent, projecting calyx lobes. E. Q. N. and E. NSW, SE. Vic . . . . **Angophora** Cav. (7 spp. end.)

3. Calyx always forming a calyptra (sometimes shed in very early bud). Corolla usually forming a calyptra or occasionally the petals closely adherent to the calycine calyptra. Fruit usually smooth, rarely ribbed (in 1 sp. of genus 'C') and then very thick and woody; fruit rim without calyx lobes 4

4. Fruit chartaceous (not or scarcely woody). Outer (calycine) calyptra shedding in young bud. Inflorescences always lateral. N. and inland WA, NT, Q, N. NSW, New Guinea . . . . genus '**B**' ('**Blakella**') (7 spp. end., 2 native)

4. Fruit woody. Outer (calycine) calyptra shedding early or persisting until opening of flowers. Inflorescences terminal or lateral. WA, NT, Q, N. SA, N. and E. NSW, SE. Vic, New Guinea . . . . genus 'C' ('**Corymbia**') (c. 35 spp. end., 1 native)

5. Calyx lobes free, at the rim of the perigynium, persisting as teeth in the open flowers though sometimes very small, *or* with a calyptra of fused calyx and corolla crowned at apex by very small tips of the calyx lobes. Anthers versatile, opening by parallel slits. Juvenile foliage and stems almost always with tufts of blunt-tipped radiating hairs over oil glands. WA, NT, N. and E. Q, N. SA, NE. NSW . . . . **Eudesmia** R. Br. (15 spp. end.)

5. Calyx united into a calyptra separate from the corolline calyptra (although occasionally both falling together when flowers open), *or* calyx lobes rarely more or less separate and shedding before the opening of the flower, *or* carried up on the expanding corolline calyptra. Anthers versatile or basifixed, opening variously. Hairs usually entirely absent, rarely clusters of very short papillae present over oil glands on juvenile parts 6

6. Inflorescences axillary or if terminating leafy branches then the main shoot not ending in a flower. Calyx usually forming a calyptra, rarely the lobes separate. Anthers various. All States, Malesia (Lesser Sunda Islands), New Guinea . . . . **Symphyomyrtus** Schau. (c. 300 spp. end., 3 native)

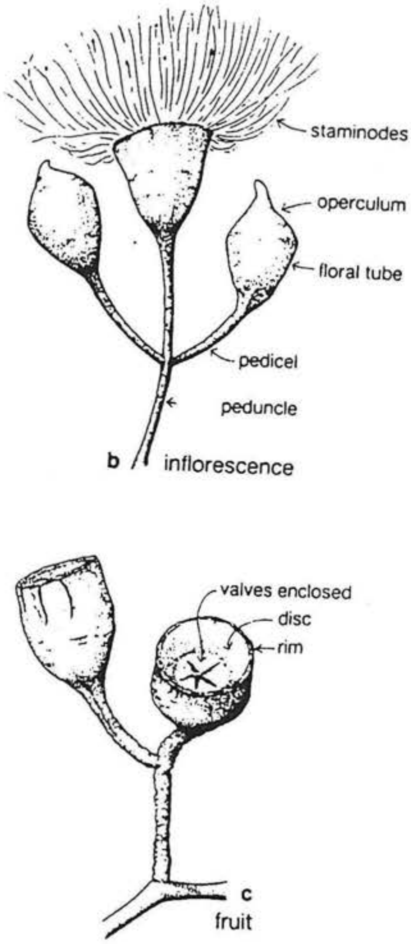
6. Inflorescences of numerous flowers, terminating leafy shoots, the main axis ending in a flower. Calyx lobes shedding separately. Anthers versatile, the chambers short and divergent. N. WA, N. NT, E. Q, New Guinea, Malesia . . . . . . genus 'T' ('**Telocalyptus**') (3 spp. end.)

7. Calyx lobes free, persistent though small in the open flower. Corolla forming a calyptra. Inflorescence terminal or lateral, consisting of several to many umbel-like clusters. SE. Q . . . . genus '**G**' ('**Gaubaea**') (2 spp. end.)

7. Calyx not persistent as free lobes in the open flower. Corolla forming a calyptra or absent. Inflorescence lateral, usually of a single umbel-like cluster or rarely compound 8

8. Calyx fragmenting and shedding in the young bud. Corolla forming a calyptra. Anthers opening by longitudinal slits. Inflorescence compound, of several umbel-like clusters. E. Q . . . . genus '**I**' ('**Idiogenes**') (1 sp. end.)

8. Calyx forming a calyptra. Corolla absent. Anthers commonly with divergent loculi opening by slits which are confluent at the top, less often opening by separate parallel slits. Flowers in single axillary umbel-like clusters. S. WA, E. Q, S. SA, E. NSW, Vic, Tas . . . . **Eucalyptus** L'Hérit. s.s. ('**Monocalyptus**') (c. 100 spp. end.)



Eucalyptus leucoxylon ssp. *megalocarpa* (large-fruited yellow gum) Myrtaceae
(a x0.6, b–c x1.2)

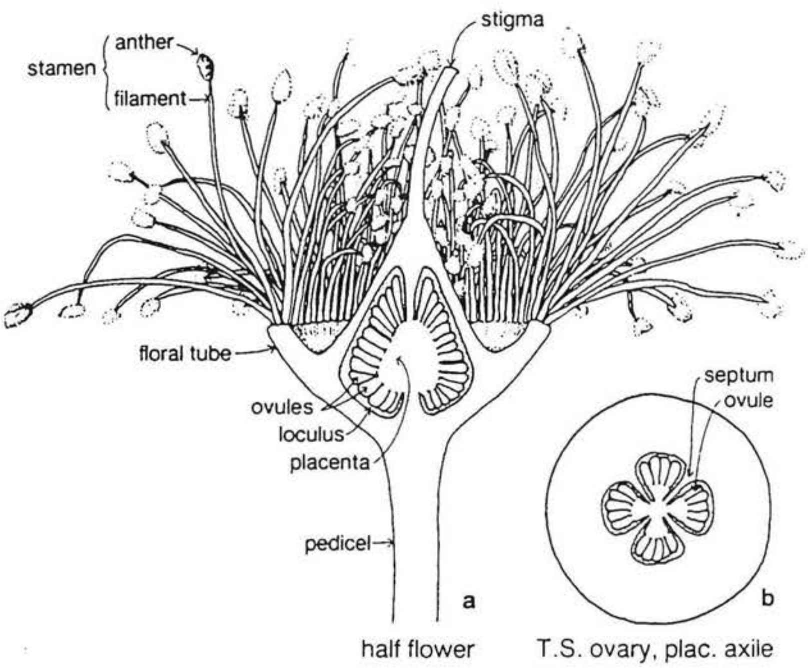


Fig. 81 *Eucalyptus camaldulensis* (river red gum) Myrtaceae
P operculum A∞ G($\overline{4}$) floral tube present

Medium to tall, variable tree to 45 m. Trunk thick, main branches heavy, crown spreading; forest form more upright, with a smaller crown. The gum bark is variable in colour, grey, brown, or pinkish or white, and often patchy. Adult leaves lanceolate, usually 10–15 cm, sometimes to 25 cm long, dull green. Juvenile leaves opposite at first, then alternate; broad lanceolate. Flowers white, or creamy, 7–11 in axillary umbels. Fruit a capsule with exserted valves. Widespread along the river systems of all States except Tas. (a–b x7)

(5) The **Leptospermum** alliance is primarily Australian with one genus in New Caledonia and a few outlying species in Malesia, New Zealand, and the Pacific. *Callistemon* was previously considered to include species in New Caledonia; it is now clear that these are quite distinct from *Callistemon* though not necessarily from *Melaleuca*. If distinct, they provide the only non-Australian genus of the alliance, leaving *Callistemon* as an Australian endemic. The *Beaufortia* infra-alliance is exclusively western but the other main groups are well represented in both east and west. Of the larger genera, the greatest concentration of *Melaleuca* is in the south-west but *Leptospermum* and *Callistemon* are mainly eastern.

The 3 genera *Homalospermum*, *Pericalymma*, and genus 'N' (= *Leptospermum* section *Fabricia* in part) are recognised, leaving *Leptospermum* as a more coherent group, following J. Thompson (pers. comm.). Further small genera allied to *Leptospermum* and *Kunzea* are likely to be recognised and the limits of the large genus *Melaleuca* may also need review.

The alliance includes shrubs and small trees, mostly of infertile soils. A few species of *Leptospermum* and *Kunzea* reach sub-alpine areas whereas a group of broad-leaved *Melaleuca* species (*M. leucadendron* and allies) are prominent in swampy lowlands in the tropics and subtropics.

Key to Sub-alliances and Genera of Leptospermum Alliance

1. Stamens usually more or less united (or at least aggregated) in bundles in front of the petals and usually considerably longer than the petals, or if not in bundles then (**Callistemon** spp.) seeds ascending and the calyx lobes deciduous in fruit. (**Beaufortia** sub-alliance) 9

1. Stamens not all united or aggregated in bundles in front of the petals and usually shorter than or scarcely exceeding the petals; if considerably longer (**Kunzea** spp.) then the seeds horizontal or descending and the calyx lobes persistent in fruit (**Leptospermum** sub-alliance) 2

2. Filaments united into a ring at the base (union more pronounced in front of the petals). Stamens shorter than the petals. NE. Q, New Guinea ... **Sinoga** S. T. Blake (1 sp. native)

2. Filaments all free. Stamens various 3

3. Stamens many in 2 or more rows, *or* if less than 20 and apparently in 1 row then leaves opposite 4

3. Stamens few to many in a single row, leaves always alternate 6

4. Anthers versatile (attached at the back to the filament and at variable angles to it). Seeds free and not winged 5

4. Anthers not versatile. Seeds with a wing formed of undeveloped ovules. NE. Q .... gen nov. '**N**' (2 spp. end.)

5. Stamens longer than petals. Placenta peltate but not on a slender curved stalk. Leaves alternate or rarely opposite and then the flowers in heads. SW. WA, SE. Q, S. SA, NSW, Vic, Tas, 1 sp. to NZ .... **Kunzea** Reichb. (27 spp. end., 1 native)

5. Stamens shorter than petals. Placenta peltate on a slender curved stalk. Leaves regularly opposite and the flowers not in heads. SW. WA .... gen. nov. '**A**' (1 sp. end.)

6. Ovules anatropous; seeds not peltate, not all ascending. (Young stems not conspicuously zig-zag. Petals falling after flowering.) SW. WA, N. NT, E. Q, S. SA, NSW, Vic, Tas, mainly E. Australia; Malaya to NZ ... **Leptospermum** J. R. & G. Forst. (c. 70 spp. end., 2 native)

6. Ovules hemitropous; seeds more or less peltate and/or ascending to erect 7

7. Seeds broadly but irregularly flattened, peltate and fringed. Ovary usually 4-chambered. Ovules numerous. SW. WA .... **Homalospermum** Schau. (1 sp. end.)

7. Seeds not broadly flattened or fringed. Ovary regularly 3-chambered. Ovules 2 to c. 6 in each chamber 8

8. Ovules and seeds spreading or pendulous. Petals falling after flowering. Flowers not in dense heads. SW. WA .... **Pericalymma** Schau. (1 sp. end.)

8. Ovules and seeds erect. Petals more or less persistent after flowering. Flowers usually in dense heads. SW. WA .... **Agonis** (DC.) Lindl. (c. 10 spp. end.)

9. Anthers erect. (**Beaufortia** infra-alliance) 13

9. Anthers versatile. (**Melaleuca** infra-alliance) 10

10. Stamens free (or very shortly united at the base into a ring—**Callistemon viminalis**—but not clustered) or seldom (**C. speciosus**) very shortly united at the base into 5 bundles in front of the petals. Flowers not in groups of 3 within the spike-like inflorescences. Leaves alternate. SW. WA, E. Q, E. SA, NSW, Vic, Tas ... **Callistemon** R. Br. (c. 30 spp. end.)

10. Stamens with filaments united in 5 bundles in front of the petals (or rarely almost free or quite free but clustered—**Conothamnus** sp.—and then flowers in groups of 3 in the spike-like inflorescences and/or leaves opposite). Flowers in groups of 3 or singly within the usually spike- or head-like inflorescences. Leaves alternate or opposite 11

11. Staminal bundles distinct or scarcely united at the base. Flowers aggregated in spikes or heads. Leaves opposite or alternate 12

11. Staminal bundles united at least to the middle into a tube. Flowers solitary on the old wood, surrounded by several small scale-like bracts. Leaves alternate. SW. and N. WA, NT .... **Lamarchea** Gaudich. (2 spp. end.)

12. Ovules several in each chamber. Inflorescences spike-like, head-like, or flowers clustered. Leaves opposite or alternate. All States; Malesia to New Caledonia but mostly Australian .... **Melaleuca** L. (c. 140 spp. end., 3 native)

12. Ovule 1 in each chamber. Inflorescences head-like. Leaves opposite. SW. WA .... **Conothamnus** Lindl. (3 spp. end.)

13. Ovules 1 to 4 in each chamber, peltate and laterally attached. Leaves usually opposite 14

13. Ovules 2 or more in each chamber, erect or ascending, linear or cuneate. Leaves alternate 15

14. Anther chambers opening at the top by transverse valves. Ovule 1 in each chamber of ovary. SW. WA ..... **Beaufortia** R. Br. (15 spp. end.)

14. Anther chambers placed back to back, opening outward by longitudinal slits. Ovules 4 in each chamber of ovary. SW. WA ..... **Regelia** Schau. (5 spp. end.)

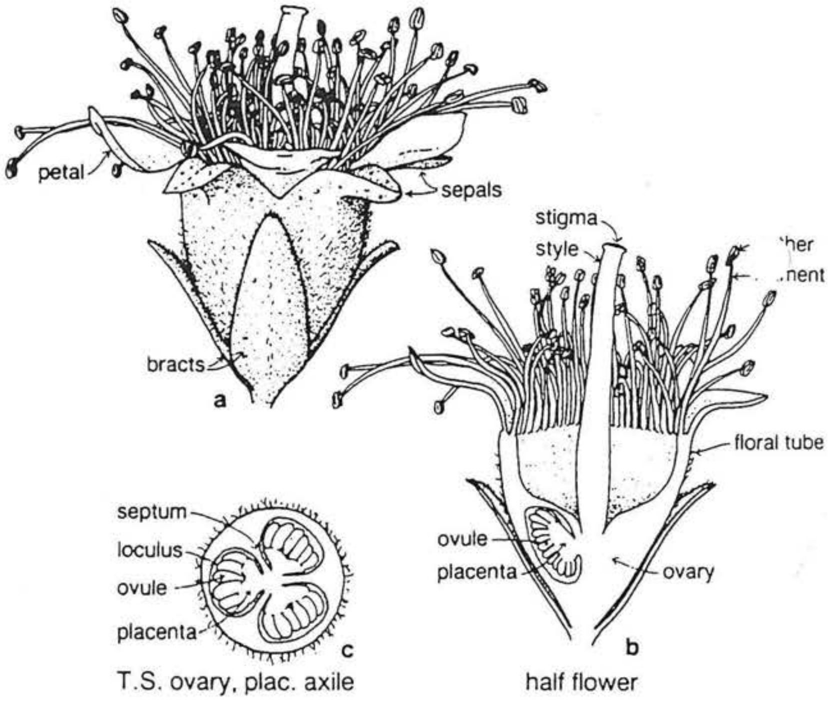
15. Anthers short, chambers back-to-back, opening outward by transverse valves. Leaves small. SW. WA ..... **Phymatocarpus** F. Muell. (2 spp. end.)

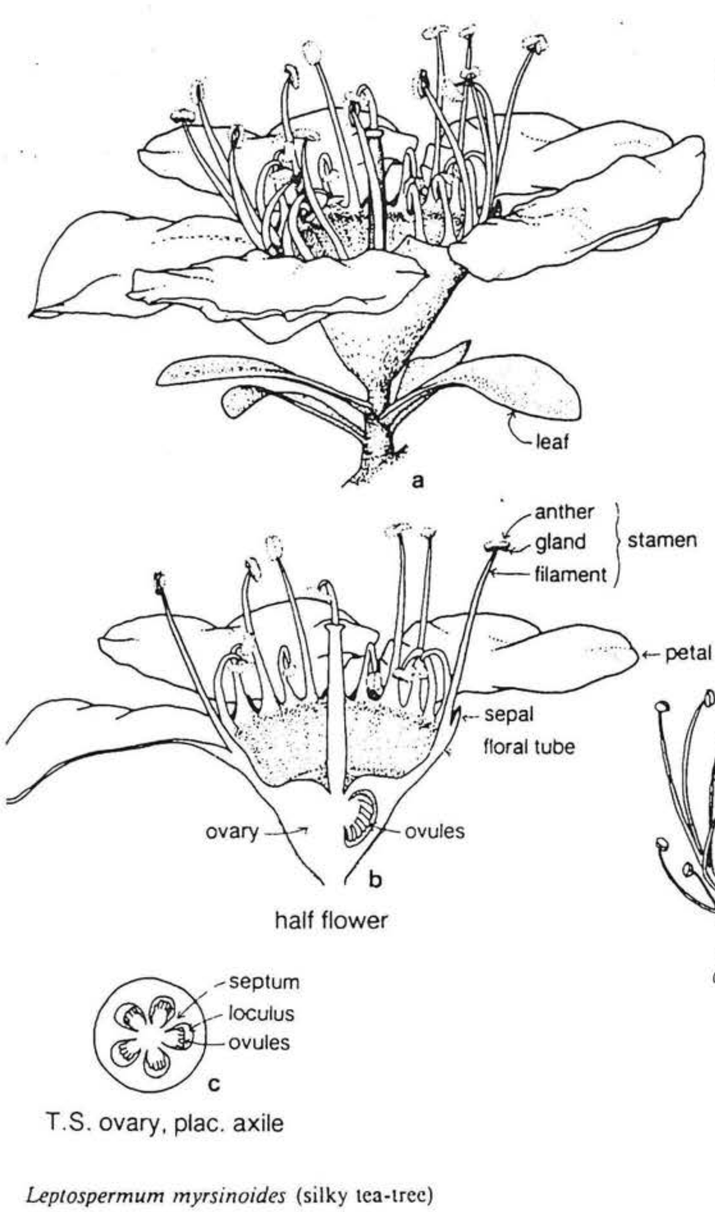
15. Anthers short or long, opening in longitudinal slits. Leaves elongated or small 16

16. Anthers oblong or linear, chambers parallel, opening inwards. Flowers in groups of 3 in the (often 1-sided) spike-like inflorescences. SW. WA ..... **Calothamnus** Labill. (25 spp. end.)

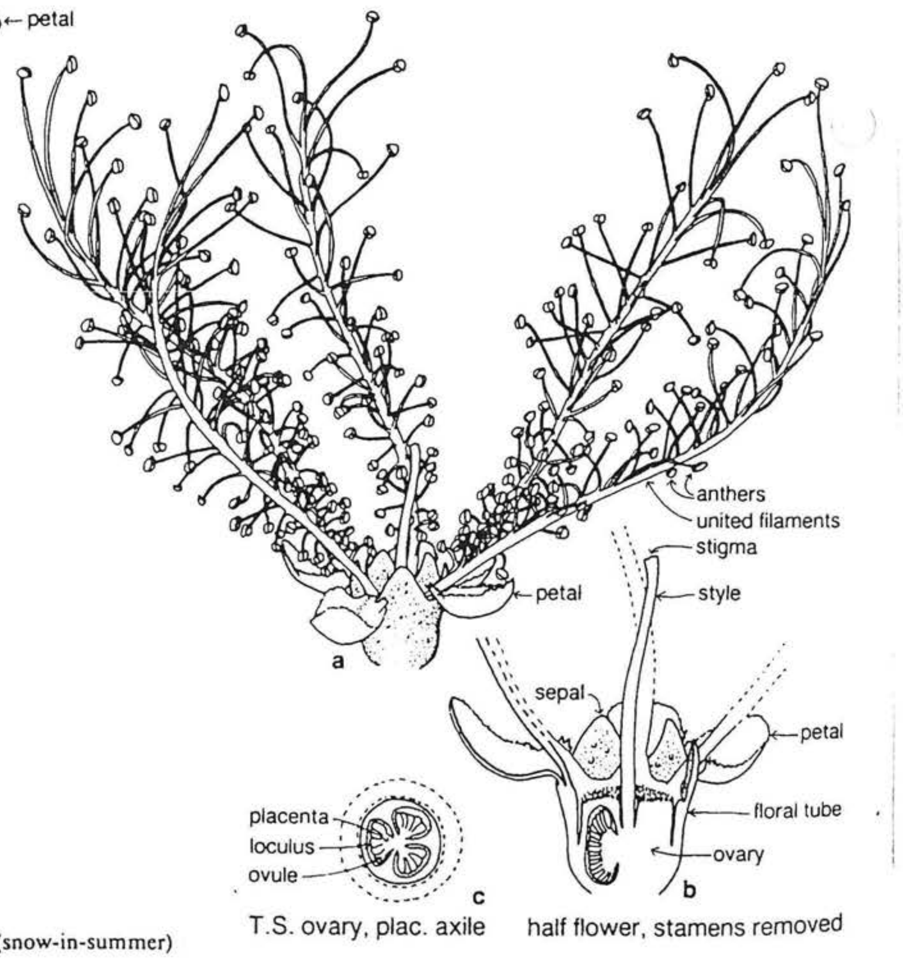
16. Anthers obovoid, chambers back-to-back, opening outwards. Flowers not in regular groups of 3, solitary or a few together. Leaves small. S. WA ..... **Eremaea** Lindl. (c. 8 spp. end.)

Kunzea ambigua (white kunzea)





Leptospermum myrsinoides (silky tea-tree)



Melaleuca linariifolia (snow-in-summer)

(6) The main development of the largely Australian **Chamelaucium** alliance is in the south-west of Western Australia, where 9 genera are endemic. Of the remainder, only *Homoranthus* and *Rylstonea* are exclusively eastern. The genera of the *Baeckea* sub-alliance were formerly

considered more closely allied to the members of the *Leptospermum* alliance than to the genera with indehiscent fruits. The latter have often been treated as a subfamily, Chamelaucioideae, but this is an artificial assemblage of highly advanced genera that show a clear affinity with somewhat less specialised genera such as *Baeckea*. They appear to represent a number of separate lines of specialisation from ancestors with capsular fruit. Generic delimitation in this alliance is in need of review. Among problems are the diversity within *Baeckea* and its relationship to *Astartea*, the limits of *Darwinia* vis-à-vis *Chamelaucium*, the heterogeneity of *Verticordia* and its relation to *Homoranthus* and *Rylstonea*. The anomalous *Darwinia thomasii* (central Queensland) probably represents an additional genus allied to *Rylstonea*; if these are maintained at generic rank, then several species should be transferred to *Rylstonea* from *Homoranthus*. *Lhotzkya*, which lacks awns on the calyx lobes, is here included within *Calytrix*. *Thryptomene* and *Micromyrtus*/*Corynanthera* probably represent convergent lines arising from *Baeckea*-like ancestors. The Key does not cover an unplaced uni-ovulate species from Mingenew (SW. WA) which is allied to the undescribed genus '*M*', both having clear affinity with *Scholtzia*.

Key to Genera of Chamelaucium Alliance

1. Ovary 1-chambered or rarely partially divided (**Verticordia** spp.). Fruit indehiscent 6

1. Ovary with 2 to 3 chambers. Fruit a capsule or rarely separating into cocci 2

2. Stamens seldom more than 20, free or rarely united in bundles, alternating with the petals. Perigynium not urn-shaped 3

2. Stamens numerous (more than 20), often united at the base in a single ring, or if free then either the perigynium urceolate and extending well above the ovary or the flowers in groups of 2 or 4 in the leaf axils 5

3. Ovules several in each chamber or if 2 then side by side. Flowers often single in leaf axils but sometimes in lateral (usually cymose) inflorescences 4

3. Ovules 2 in each chamber, one above the other, or rarely 3 or solitary. Flowers usually in cymes, rarely solitary. SW. WA .... **Scholtzia** Schau. (13 spp. end.)

4. Stamens unfused. SW. and N. WA, S. SA, N. NT, N. and E. Q, E. and S. NSW, Vic, Tas, SE. Asia, New Caledonia .... **Baeckea** L. (c. 70 spp. end., 1 native)

4. Stamens in bundles alternating with the petals. SW. WA .... **Astartea** DC. (4 spp. end.)

5. Perigynium elongate or urn-shaped, red. Flowers solitary in leaf axils. SW. WA .... **Balaustion** Hook. (2 spp. end.)

5. Perigynium short, broad, not red. Flowers 2 or 4 in the leaf axils, usually almost sessile. SW. WA .... **Hypocalymma** Endl. (12 spp. end.)

6. Fertile stamens many or few, without staminodes. Sepals not deeply bilobed. Flowers never in daisy-like heads 7

6. Stamens 10 in a single series alternating with 10 staminodes *or* 20 without staminodes and then the sepals deeply bilobed *or* 8 without staminodes and then the inflorescence a daisy-like head with the outer flowers sterile 14

7. Stamens numerous, *or* if rarely less than 10 then the calyx lobes with a long awn. Ovules 2. Leaves alternate 8

7. Stamens 5 to 10 or rarely up to 30 (**Thryptomene** sp.). Ovules 2 to 10. Calyx lobes without a long awn. Leaves opposite 11

8. Ovary chamber large, occupying almost the whole length of the perigynium below the style base. Ovules 2, erect; placenta short, basal 9

8. Ovary chamber small, almost completely filled by the ovules, usually surrounded by spongy tissue which may disintegrate in old flower. Ovules 2 to many; placenta apical, lateral, or if basal then the ovary cavity separated from the base of the perigynium by spongy tissue 10

9. Perigynium about twice as long as broad, cylindrical, extending beyond the 'bracteoles'. Calyx lobes narrow-triangular, petal-like. N. NT .... **Homalocalyx** F. Muell. (1 sp. end.)

9. Perigynium short and broad, flattened and laterally ridged, covered by a pair of 'bracteoles'. Calyx lobes ovate, membranous. Inland districts of S. and N. WA, S. Q .... **Wehlia** F. Muell. (4 spp. end.)

10. Calyx lobes present, often terminating in a long awn or (less often) truncate. Leaves often linear and spreading. S. and N. WA, N. NT, E. Q, SA, NSW, Vic, Tas .... **Calytrix** Labill. (c. 45 spp. end.)

10. Calyx lobes absent. Petals 4. Leaves narrow-oblong or triangular, closely imbricate. SW. WA .... **Calythropsis** C. A. Gardner (1 sp. end.)

11. Filaments sharply flexed and thick below the anther. Style base sunken into top of ovary. Ovules 4 to c. 8, on a peltate placenta. Flowers 1 to 3 or more in leaf axils. SW. WA .... genus nov. '**M**' (c. 4 spp. end.)

11. Filaments not sharply flexed and thick below the anther. Style base not sunken. Ovules 2 to c. 10, placentas various. Flowers solitary in leaf axils 12

12. Ovules attached to a lateral or sub-basal placenta, usually in collateral pairs. Stamens when 5 alternating with the petals. Perianth usually persistent after flowering with the segments sharply folded in across the top of the ovary. Sepals often petaloid. WA, NT, Q, SA, NSW, Vic, Tas .... **Thryptomene** Endl. (c. 30 spp. end.)

12. Ovules pendulous from near the top of the ovary, if several then arranged in a ring. Stamens when 5 in front of the petals. Perianth deciduous or persistent, not folded in after flowering. Sepals not petaloid 13

13. Stamens without a stalked appendage. Anther chambers 2, each opening by a slit. WA, NT, Q, SA, NSW, Vic, Tas .... **Micromyrtus** Benth. (c. 20 spp. end.)

13. Stamens with a sub-globose stalked appendage above the anther; anther with 1 chamber, opening by a central pore. SW. WA .... **Corynanthera** J. W. Green (1 sp. end.)

14. Anthers elongated or rarely (**Pileanthus** sp.) with a bi-lobed connective, the chamber opening by longitudinal slits. Ovules 6 to 14 15

14. Anthers globose, opening by terminal pores. Ovules 1 to 12 17

15. Stamens 20, without staminodes. Calyx lobes deeply bilobed giving the appearance of 10 erect ovate lobes. Petals red. Perigynium and calyx silky hairy. SW. WA .... **Pileanthus** Labill. (3–4 spp. end.)

15. Stamens 10, usually alternating with 10 staminodes. Calyx various but not consisting of 10 erect ovate lobes. Petal colour various. Perigynium and calyx glabrous or hairy 16

16. Calyx lobes entire or shortly ciliate, without accessory lobes. SW. WA .... **Chamelaucium** Desf. (c. 15 spp. end.)

16. Calyx lobes deeply divided into ciliate or plumose segments and/or with accessory lobes reflexed against the perigynium. SW. and N. WA, N. NT, NW. Q .... **Verticordia** DC. (in part, sect. **Catocalypta**) (c. 15 spp. end.)

17. Calyx lobes deeply divided into ciliate or plumose segments and/or with accessory lobes reflexed against the perigynium. Perigynium pubescent or with a tuft of hairs at the base. Ovules 1 to 2 .... **Verticordia** (in part, sect. **Verticordia**) (c. 40 spp.

17. Calyx lobes undivided or divided into 2 or numerous entire awn-like segments or minutely laciniate. Perigynium glabrous. Ovules 1 to 12 18

18. Calyx lobes divided into numerous awn-like segments. Ovules 6 to 12. E. Q, E. NSW, S. SA .... **Rylstonea** R. T. Baker (c. 4 spp. end.)

18. Calyx lobes entire or bifid. Ovules 1 to 10 19

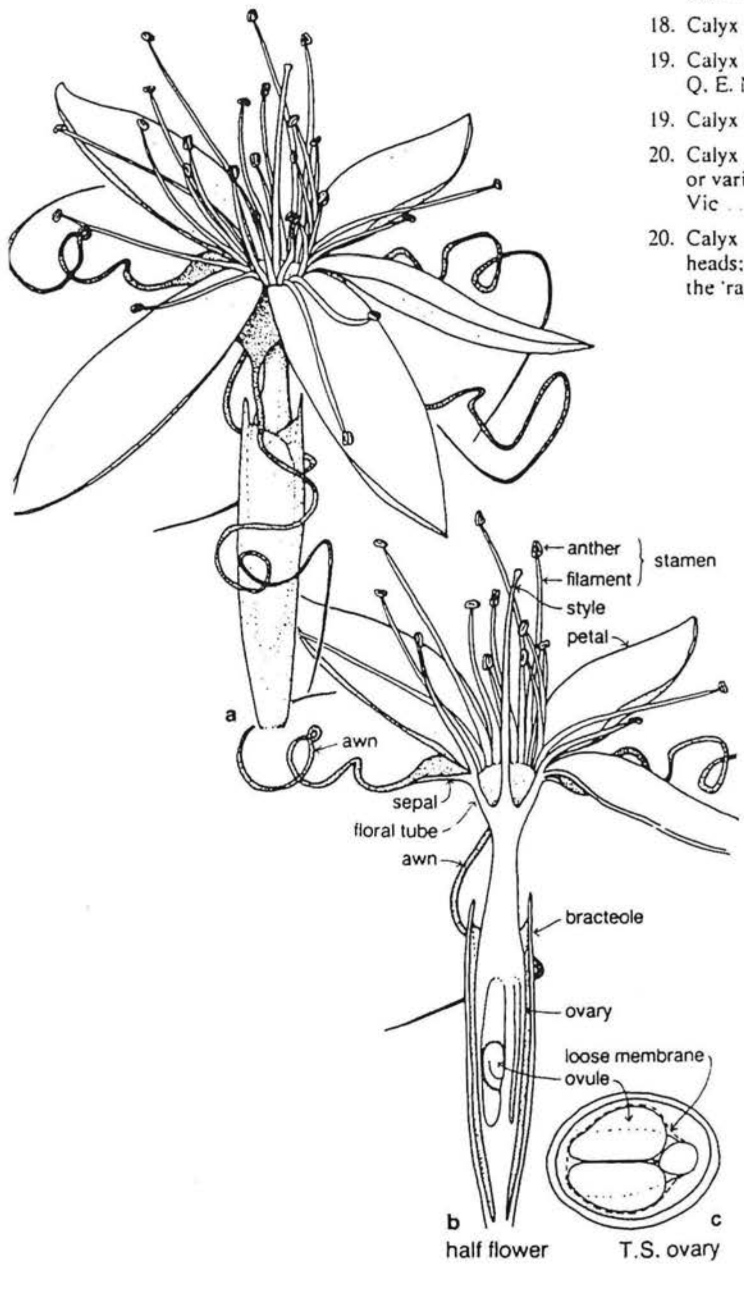
19. Calyx lobes tapering into a long awn or occasionally bifid with 2 awns. Ovules 6 to 10. SE. Q, E. NSW .... **Homoranthus** A. Cunn. ex Schau. (c. 4 spp. end.)

19. Calyx lobes not awned. Ovules 1 to 4 or rarely 10 (**Darwinia homoranthoides**) 20

20. Calyx lobes and petals 5. Stamens 10, alternating with staminodes. Flowers often in pairs or variously aggregated, all fertile, not in daisy-like heads. SW. WA, E. Q, S. SA, E. NSW, Vic .... **Darwinia** Rudge (c. 45 spp. end.)

20. Calyx lobes and petals 5. Stamens 8, without staminodes. Flowers in dense daisy-like heads; the outer flowers sterile, with elongated perianth segments and 'bracteoles' forming the 'rays' of the head. SW. WA .... **Actinodium** Schau. (1 sp. end.)

Calytrix tetragona
(fringe-myrtle) Myrtaceae



MONOCOTYLEDON

Lemnaceae

Flowers 3 in spathe

One female flower - one-locular ovary

Two male flowers - 2 stamens each

Pontederiaceae

Flowers bisexual

Inflorescence a raceme or panicle

6 perianth segments - petal-like and showy

3 or 6 stamens

Ovary of 3 fused carpels, superior.

Hydrocharitaceae

Flowers in spathe-like bract

Flowers bisexual

Perianth in two whorls

Inner whorl showy and petal-like

Stamens 1-numerous

Ovary of 2-15 united carpels, inferior

Zannichelliaceae

Flowers unisexual, solitary or clustered in leaf axils.

Perianth cup-shaped sheath, or a few scales or absent

Male - stamens solitary or 2 or 3 united

Female - 1-9 free carpels, superior.

Najadaceae

Flowers unisexual, solitary or clustered in leaf axils

Male enclosed in a spathe. Stamen solitary

Female naked or enclosed in a spathe. Single carpel, superior.

Zosteraceae

Flowers unisexual

Monoecious or dioecious. In the former case male and female flowers are arranged alternately along the spadix.

Male - 1 stamen with 2 free bilocular anthers

Female - single, naked carpel

Posidoniaceae

Inflorescence a stalked cyme

Flowers bisexual or male and perianth lacking

Stamens 3, sessile, anthers bilocular

Carpel superior, solitary, naked

Ruppiaceae

Inflorescence an umbel-like raceme

Flowers bisexual, small and borne in pairs on slender axillary stalks, at first enveloped in a spathe-like base

Perianth lacking or vestigial.

Stamens 2, anthers bilocular

4 or more free carpels, sessile, becoming staked in fruit, superior.

Potamogetonaceae

Inflorescence a stalked spike

Flowers bisexual, regular, $\pm$ inconspicuous

Perianth of 4 free, bract-like, clawed scales, inserted opposite each stamen

Stamens 4, joined to perianth segment, anthers bilocular

4 free or partly united carpels, superior

Aponogetonaceae

Inflorescence spike-like

Flowers bisexual or occasionally unisexual

Perianth segments absent or up to 6, petal-like or bract-like.

Stamens in 2 or more whorls, 6 or more

Carpels 2 to 9, free, superior.

Typhaceae

Inflorescence a terminal spadix

Flowers unisexual, male in upper half, females below.

Perianth segments thread-like or scale-like

Stamens with 2 to 5 free or fused filaments. Anthers basally attached

Ovary with single locule, superior.

Juncaginaceae

Inflorescence a raceme or spike

Flowers regular, bisexual or unisexual

Perianth in 2 series of three free segments

Stamens 4 or 6

Carpels 4 or 6, free or partly united, superior.

Alismataceae

Inflorescence compound or umbel-like

Flowers regular, bisexual or unisexual

Perianth 3 sepals, 3 petals

Stamens 3, 6, 9 or numerous

Carpels 3-numerous, free, superior.

Poaceae

Inflorescence various

Spikelets usually bisexual, although some have unisexual or barren florets. Male and female spikelets occasionally borne on same plant.

Glumes at base of spikelet

Lemma, palea and lodicules.

Stamens 3, rarely 1 to 6.

Ovary with 2 feathery stigmas, 1-locular, superior.

Cyperaceae

Flowers grouped in spikelets, each flower in the axil of a glume or bract.

Perianth represented by scales, bristles or hairs or absent.

Stamens 1 to 6, usually 3.

Ovary superior, of 2 or 3 fused carpels forming one locule, containing one ovule.

Centrolepidaceae

Inflorescence reduced to a "pseudanthia", with 1, sometimes 2 male flowers and 2 to many female flowers.

Restionaceae

Flowers in spikelets, unisexual, male and female on separate plants.
Spikelets 1 to many flowered, commonly subtended by a sheath-like spathe
Perianth of 6 thin, dry segments in two series or sometimes absent
Stamens 3
Ovary superior, 1-3 carpels. Styles free or connate.

Liliaceae

Inflorescence scapose or in raceme or cyme.
Perianth segments 6, $\pm$ equal, free or united
Outer 3 sometimes smaller and sepal-like
Stamens 6, rarely 3 or up to 12
Ovary, superior, usually with 3 locules.

Xanthorrhoeaceae

Inflorescence spike, panicle or head
Flowers bisexual or unisexual, with male and female borne on separate plants.
Perianth in two whorls of 3 segments.
Stamens in two whorls of 3.
Ovary superior, 3 fused carpels, 3-locular.

Commelinaceae

Inflorescence a cyme, sometimes borne in a boat-shaped leafy bract.
Flowers bisexual, usually regular.
Perianth in two series, with free segments, outer sepaloid, inner petaloid.
Stamens in 2 series of 3.
Ovary superior, 3 fused carpels, 3 locules.

Xyridaceae

Inflorescence a globose or cylindrical head, each flower subtended by a stiff or leathery bract.
Perianth 6, 3 outer sepaloid, membranous, 2 small and keel shaped, 1-hoodshaped, initially, 3 inner petaloid.
Stamens 3, + in some 3 staminodes
Ovary superior, 3 fused carpels, 1-locular.

Philydraceae

Flowers solitary, bisexual, in sheathing bract

Perianth in 2 whorls, each of 2 free segments

Stamen 1

Ovary superior, 3 fused carpels, 1-locular.

Orchidaceae

Inflorescence a spike, raceme or panicle or flowers solitary

Perianth - sepals usually similar but 2 laterals or single dorsal may be elongated.

Petals dissimilar - 2 laterals distinct from median, which is termed the labellum or lip.

Stamens and style united to form a column, which in its simplest, basic form is surmounted by the anthers with the stigmatic surface just underneath them, and separated by a flap of sterile tissue called the rostellum.

Stamens 1 or 2.

Ovary inferior, 1-celled, stigmas 3, 1 transformed into the rostellum.

Iridaceae

Inflorescence usually terminal and cymose.

Flowers bisexual.

Perianth 6 segmented, in 2 whorls regular or irregular, united in a tube or more or less free.

Stamens 3.

Ovary inferior, 3 fused carpels, 3-locular.

Haemodoraceae

Inflorescence in a cyme, raceme or panicle.

Flowers bisexual.

Perianth in one or two whorls, hairy.

Stamens 6.

Ovary superior or inferior, 3 fused carpels, 3-locular.

Dioscoreaceae

Inflorescence axillary and in panicles, spikes or racemes.
Flowers regular, small and inconspicuous, bisexual or unisexual, in which case male and female flowers borne on separate plants.
Perianth with 6 segments borne in 2 whorls, usually fused at the base.
Stamens 2 whorls of 3, one row sometimes reduced to staminodes or absent.
Carpels 3, fused, 3-locular, inferior.
Fruits 3-winged.

Juncaceae

Inflorescence usually compound, in panicles or capitate.
Flowers small, usually bisexual, with or without basal bracts.
Perianth with six segments unfused. Stamens 3 to 6.
Ovary 1 or 3-celled with 3 to many ovules. Style single with 3 stigmas.
Fruit a capsule, dehiscing loculicidally with 1 to many small seeds.

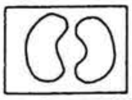
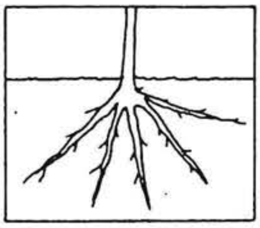
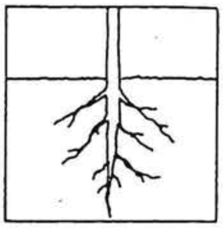
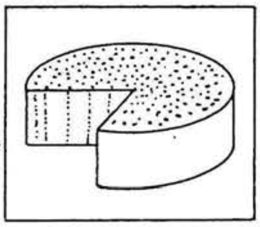
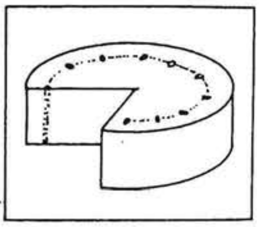
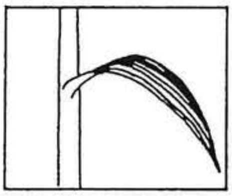
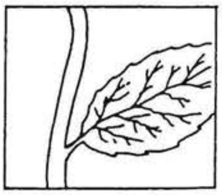
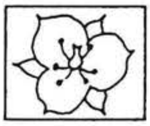
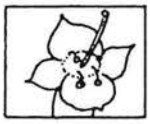
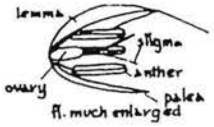
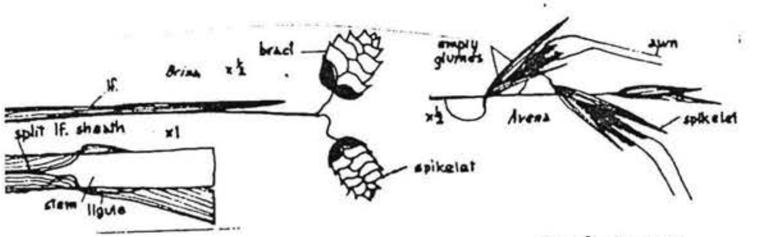
	MONOCOTYLEDONS		DICOTYLEDONS	
Embryo in seed	One seed leaf (cotyledon).		Two seed leaves (cotyledons).	
Growth form	Mostly herbaceous, few arborescent.		Herbaceous or woody. Herbs shrubs, trees.	
Roots	The primary root is soon replaced by adventitious roots which form a fibrous root system.		The primary root persists and becomes a strong taproot with smaller secondary roots. This forms a tap-root system.	
Vascular system	Numerous scattered vascular bundles; few with secondary thickening.		1 ring of vascular bundles, stem differentiating into cortex and pith; secondary thickening common.	
Leaf venation Leaf margin	Parallel venation Almost always entire.		Network venation. Margin varied.	
Flowers	Floral parts usually in threes or multiples of threes.		Floral parts usually in fours or fives.	

Table 1.2
Differences between Monocotyledons and Dicotyledons.

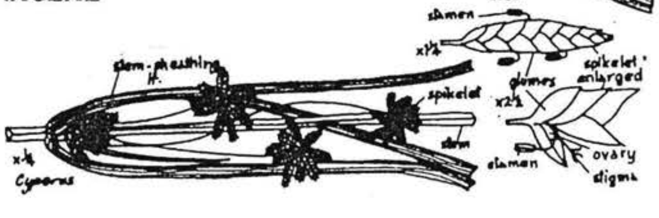
POACEAE
(= GRAMINEAE)





FLOWERS	STEM	LEAVES	LEAF SHEATH
Perianth absent or almost so. Flowers enclosed by glumes, and grouped in spike-lets.	Hollow except at nodes.	Solitary at nodes.	Encloses stem split on one side.

CYPERACEAE

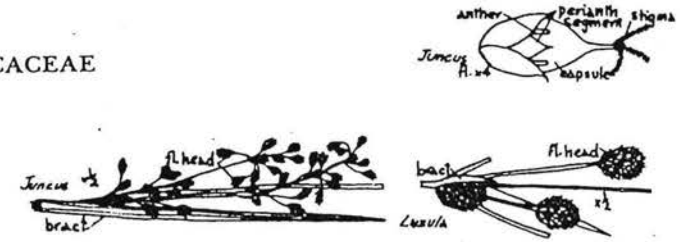


as above.	Solid, without nodes.	Mainly basal.	Not split

CENTROLEPIDACEAE

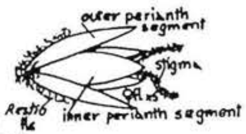
Perianth absent Flowers naked or surrounded by 1-3 hair-like scales.	Very short	Crowded and filiform	Open one side

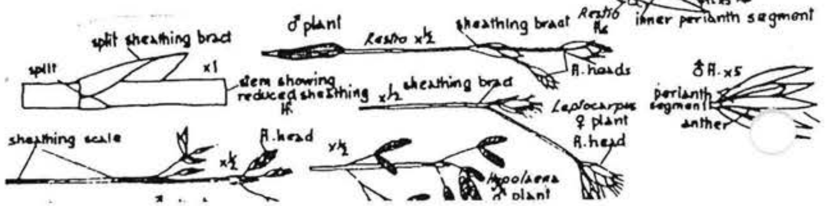
JUNCACEAE



Perianth present, of 6 or less glume-like segments. Flowers in heads, cymes, spikes or clusters.		Mainly basal, may be septate, or reduced to sheaths.	

RESTIONACEAE





as above Flowers usually unisexual and on male or female plants. of 6 or less	Transverse articulations	Reduced to sheathing bracts	Open on one side

This is under development (as of Aug '98).

Identifying Acacias using WATTLE

To start the WATTLE key

- Click WATTLE icon on the desktop
- Click OK (when "Acacia (S Drive)" appears)

Before you begin

Press: File/Advanced mode

To use "Maslin's best" character set

- Click Identification/Use/"QuickID_Phyllodinous" (for species with phyllodes) or "QuickID_Botrycephalae" (for species with bipinnate foliage).
- Click OK
- Click SelectAll
- Click OK

Then answer the questions that will be sequentially presented to you.

- Images: click to show drawings of the character images (you can run your identification from this screen)
- Notes: click to get hints on how to interpret/use the character
- Cancel: click to skip the character (the Esc key will do the same thing)
- Stop (then Cancel): click to finish the session

Hints on using QuickID most effectively

- For numeric characters try and give a range of values (e.g. 4-6)
- For measurements less than 10 mm be sure to measure accurately
- For multistate characters select more than one state if in doubt
- Skip a character if you are not sure how to interpret it

To start a new identification

Press: Identification/Restart

Other helpful functions

- To have the program select the "best" character to discriminate your remaining taxa. Press: Identification/Best
- To view images of remaining taxa. Press: Browse/Illustrate/Taxa/Remaining
- To use a character which is not on QuickID. Press: Identification/Use/Available/OK then Search for the character you want and click OK. **Note:** Not all the characters in the data set are comprehensively (or accurately) coded, so use non QuickID characters with caution.

To finish identification session

Press: File/Quit

To view images of remaining taxa.
Browsing/Illustrate/Taxa/Remaining/OK
Then use the "control" function on the image window to scroll the images

The Environmental and Social Utilisation of Australian *Acacias*

by M W McDonald and B R Maslin

Australia has a rich and diverse endemic woody flora dominated by the two large genera, *Acacia* (with about 950 species) and *Eucalyptus* (with 700-800 species). Much of the flora has evolved in environments that are relatively adverse for plant growth, such as hot, dry climates with extended periods of drought, infertile, often skeletal soils, and seasonal or periodic wildfires. This vast genetic resource offers great scope for economic, environmental and social utilisation, not only for Australia but also for other parts of the world.

Overseas planting of the Australian flora began before white settlement (mainly for horticultural purposes) and continues to the present day. The economic and industrial utilisation and domestication of numerous arborescent *acacias*, casuarinas and eucalypts is well established in many overseas countries. Fast growing species such as *Acacia auriculiformis, A. crassicarpa, A. mangium, A. mearnsii, Casuarina equisetifolia, Eucalyptus camaldulensis* and *E. grandis* provide important sources of timber and pulp production (Boland 1989; Thomson 1994; Turnbull 1986 & 1987; NAP 1983). Historically *acacias* have been utilised in a variety of other products, including gums, perfumes, tannins, ornamentals and medicines (see New 1984 and Searle 1991 for discussion). In recent years there has been increased recognition of the potential of *Acacia* for use in social and environmental applications. The work in this area has been greatly facilitated by the Australian Tree Seed Centre (CSIRO, Division of Forestry), especially through its Seeds of Australian Trees project funded by AusAID (formerly AIDAB).

The social and environmental utilisation of *Acacia* involves multipurpose useage of species in a number of ways as discussed by Turnbull (1986) and Thomson *et al.* (1994), namely:

- fuelwood and charcoal (*Acacia* is an excellent source of fuelwood highly suitable for domestic use particularly in developing countries; it produces good medium-to-high density charcoal);
- wood products (e.g. fencing and light construction);
- fodder for domestic stock;
- environmental protection (e.g. windbreaks, shade and soil rehabilitation);
- pulp and other reconstituted wood products;
- human food (see discussion below).

The principal morphological, biological and ecological attributes of *Acacia* that make it very suitable for these multipurpose uses include the following:

"..... vast genetic resource offers great scope for economic, environmental and social utilisation, ..."

- great diversity in plant form (ranging from prostrate shrubs, e.g. *A. hilliana* and *A. translucens*, to trees that may attain 40 metres in height, e.g. *A. bakeri*; many, however, are medium-sized shrubs or small trees two to five metres tall, e.g. *A. adsurgens, A. ancistrocarpa* and *A. victoriae*;
- hard seedcoats (thus facilitating the long-term, orthodox storage of seed);
- ability to fix atmospheric nitrogen;
- fast growth rates of many

species;

- a range of longevity, varying from relatively short-lived (<10 years) to long-lived (>50 years);
- tolerance of a wide range of climate types (including tropical, subtropical, arid, semi-arid, temperate and sub-alpine);
- adaptation to a wide range of soil types and habitats, e.g. *A. bivenosa, A. sclerosperma* and *A. calcicola* are indicators of alkaline soils; *A. leptocarpa* and *A. simsii,* are found on highly acidic soils; *A. tumida* and *A. victoriae* tolerate both alkaline and acidic soils; *A. pachycarpa* and *A. stenophylla* occur on heavy, cracking clay soils; *A. ligulata* occurs on sand dunes throughout the arid zone; *A. ampliceps* and *A. auriculiformis* tolerate saline soils and sometimes waterlogging; other specialised habitats include coastal foredunes, barren rock outcrops, floodplains, the fringes of salt lakes, clay pans and rivers;
- ease of germination (responding well to simple pre-treatment techniques);
- ease of establishment and management.

Most species of *Acacia* are shade intolerant, primary colonisers, and many produce relatively heavy seed crops which have the potential to form extensive populations, especially following disturbance and favourable climatic conditions. Some, however, proliferate mainly from root suckers and may form dense clonal thickets, e.g. *A. dealbata, A. harpophylla* and *A. murrayana.* The potential therefore exists for certain species to become major environmental weeds (see Stirton 1978) and although observations indicate that in some areas they do not become a problem (Harwood 1994), their potential as weeds should be considered when introducing *Acacia* into social agroforestry situations. Nevertheless, the use of fast-growing, multipurpose *acacias* has the advantage of potentially reducing the utilisation pressure on natural vegetation of other countries, or, enhancing productivity and/or facilitating rehabilitation of landscapes that would otherwise not have been possible.

"..... their potential as weeds should be considered when introducing Acacia into social agroforestry situations."

Factors determining the selection of species for evaluation in social forestry trials include their biological and ecological attributes and the climate of the target country (a useful tool for the latter purpose is the computer program, BIOCLIM, see Booth *et al.* 1988). Under trial conditions, a few species perform well in environments dissimilar to those of their natural habitats (e.g. *A. podalyriifolia* grows well in the winter rainfall zones but occurs naturally in summer rainfall zones). Most, however, are site specific and perform poorly if conditions are not similar to those of their native habitats. For example, *A. ampliceps, A. maconochieana* and *A. stenophylla* which are naturally tolerant of highly alkaline and/or saline soils, have performed successfully on similar soil types in Pakistan where they are used as a source of fuelwood (Marcar *et al.*, 1991). Similarly, the Mediterranean climate and sandy soils of North Africa are highly suited to *A. saligna* and *A. cyclops* which occur naturally in the same habitat in south-west Western Australia. These two species have been successfully used in North Africa where they are used for windbreaks, fuelwood and fodder production (El-Lakany 1987).

Recently in semi-arid regions of sub-Saharan Africa the seeds of some species of *Acacia* (initially planted as a source of fuelwood and windbreaks) have created much interest as a source of human food. Australian Aboriginal people ate *Acacia* seeds, ground into paste, as part of their traditional diet (see House and Harwood 1992). Roasted *Acacia* seed flour is now used as a gourmet flavouring in Australian cuisine. In Maradi, Niger, *A. colei, A. cowleana* sens. lat., *A. thomsonii* (ms name) and *A. tumida,* produced heavy seed crops within two years of planting, even during years of lower than average rainfall (Rinaudo *et al.* 1995). Laboratory studies indicate that the seeds have good nutritional value and when ground into flour can be readily incorporated into local diets by modifying local recipes (Harwood 1994). An international workshop, convened by the Australian Tree Seed Centre, reviewed the knowledge base of Australian species of *Acacia* with human food potential (House & Harwood 1992). The success of these sorts of programs is reliant on a sound taxonomic knowledge of the species concerned and to this end research is currently in progress by the authors.

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Systematics and phytogeography of Australian species of *Acacia:* an overview

by Bruce R Maslin

The purpose of this article is to provide a summary of current knowledge concerning the classification and phytogeography of Acacia, particularly with respect to the Australian component of the genus. Most of the information presented in this article has been abstracted from previous publications by the author and colleagues; these papers provide references to further reading for those wanting more detail than is provided here.

As currently defined *Acacia* is a cosmopolitan genus of 1200-1300 species occurring naturally on all continents except Europe and Antarctica. It is the largest group of vascular plants in Australia with about 950 species presently recognised (*Eucalyptus* has 700-800 species). This number will increase substantially when the remaining new taxa (principally from Western Australia) are described and when existing species (many of which are currently very broadly circumscribed) are more intensively studied. A synoptic treatment of the Australian *Acacia* flora is currently being prepared for the *Flora of Australia* series (to be published in 1996 or 1997) and this will include descriptions, illustrations (flowers, fruits and seeds) and small distribution maps for each species.

Classification and Phylogeny in *Acacia*

The most generally accepted classification of *Acacia* recognises three large subgenera within the group, namely, subgenus *Acacia*, subgenus *Aculeiferum* and subgenus *Phyllodineae*. Although this is a practical classification it is not entirely satisfactory, as will be discussed below.

Subgenus *Acacia* and subgenus *Aculeiferum* have pantropical distributions (see Ross 1981 for maps) and comprise 120-130 species and 180-190 species respectively (Madsen 1990). A synoptic discussion of the classification of these subgenera is given in Maslin & Stirton (in press). Within Australia subgenus *Acacia* and subgenus *Aculeiferum* are principally confined to the north of the continent and are together represented by

State	*Number of species*
Western Australia	560
Queensland	262
New South Wales	219
Northern Territory	168
South Australia	118
Victoria	99
Aust. Capital Territory	22
Tasmania	19

Table 1: Numbers of species of Acacia recorded for States and Territories of Australia. These numbers are based on the species (formally described and currently in preparation) that will appear in the Flora of Australia treatment of the genus.

less than 10 species (see Hnatiuk & Maslin 1988 and Maslin & Pedley 1982).

Subgenus *Phyllodineae* is the group which has undergone extraordinary evolutionary diversification within Australia and which is such a conspicuous element of the landscape (particularly in arid and semi-arid areas). Less than 20 species of subgenus *Phyllodineae* occur naturally outside Australia and these are found in the Pacific (east to Hawaii), southeast Asia (north to the Philippines) plus Madagascar and the Mascarene Islands (see Pedley 1975). Currently the species of subgenus *Phyllodineae* are arranged in seven sections, following Pedley's (1978) classification: section *Alatae* (21 species), section *Botrycephalae* (42 species), section *Juliflorae* (235 species), section *Lycopodiifoliae* (17 species), section *Phyllodineae* (387 species), section *Plurinerves* (212 species) and section *Pulchellae* (27 species). Maslin & Stirton (in press) provide a synoptic taxonomic discussion of these sections and maps of their distributions are given in Hnatiuk & Maslin (1988). Distributions of individual species are given in Maslin & Pedley (1982) but this information is now somewhat out of date. Pedley's classification of the Australian species is a practical scheme and is certainly a good attempt at bringing together the best aspects of previous classifications (e.g. Bentham 1864 and 1875, Vassal 1972). However, the results of a recent study by Brain & Maslin (in prep.) suggest that major rearrangements to this scheme may be needed.

The following (very simplified) key to Pedley's sections provides a convenient overview of the main morphological characters used to group Australian *Acacias*.

1 Leaves (mature plants) reduced to phyllodes or scales, or absent	
2 Flowers arranged in cylindrical spikes	Section *Juliflorae*
2: Flowers arranged in globular or oblongoid heads	
3 Branchlets winged by decurrent phyllodes	*Section Alatae*
3: Branchlets not winged	
4 Phyllodes arranged in whorls	Section *Lycopodiifoliae*
4: Phyllodes not in whorls	
5 Phyllodes 1-nerved per face (4-7 nerved when terete or quadrangular)	Section *Phyllodineae*
5: Phyllodes more than 1-nerved per face (8 or more nerved when terete or quadrangular)	Section *Plurinerves*
1: Leaves all bipinnate	
6 Heads arranged in elongated racemes	*Section Botrycephalae*
6: Heads on axillary peduncles (solitary to clustered) or in very short racemes	
7 Plants with prominent stipular spines (at least when young) or with prickles	
8 Trees or shrubs with stipular spines	Subgenus *Acacia*
8: Lianes with prickles on stems	Subgenus *Aculeiferum*
7: Plants without prominent stipular spines, prickles absent	Section *Pulchellae*

From this it will be seen that easily-determined attributes of the inflorescence and foliage are the basis for grouping species.

To identify species within these sections using the Flora of Australia key, the user will sometimes need to use more 'cryptic' characters, such as the number of flower parts, degree of fusion of the sepals and details of phyllode nervature: these characters can normally be determined with the use of a x10 hand lens. In some cases certain pod or bark characters will also be important. Therefore future collectors are advised to note when the plant has 'Minni Ritchi' bark and to attempt to collect pods (even dehisced pod valves that persist on the plant or which have fallen on the ground: although in the latter case, care should be taken to ensure that the pods collected do actually belong to the plant from which the foliage and flowers are taken). The need to employ potentially difficult characters in the Flora key is unfortunate, however, in a group the size of *Acacia* one cannot easily arrive at reliable identifications unless these sorts of attributes are used. The problem of identification will be largely overcome when the DELTA multi-access interactive key becomes available (see below).

In recent years there has been considerable discussion concerning the generic status of *Acacia*. Evidence is now accumulating which suggests that subgenus *Acacia* could be treated as a distinct genus (e.g. Guinet 1969, Evans *et al.* 1977, Pedley 1986, Brain 1987) separate from subgenus *Aculeiferum* and subgenus *Phyllodineae* which are closely related to one another (e.g.

Guinet 1990, Evans *et al.* 1977, Pedley 1986, Chappill & Maslin 1995). Although Pedley (1986) attributed generic rank to the three subgenera, namely, *Acacia* (for subgenus *Acacia*), *Senegalia* (for subgenus *Aculeiferum*) and *Racosperma* (for subgenus *Phyllodineae*), his approach has not been widely adopted (see Maslin 1989 and Chappill & Maslin 1995, for discussion). The adoption of Pedley's proposal would mean that 96 per cent of the Australian *Acacia* flora would require a name change to *Racosperma*. In Asia, Africa and the Americas about 200 species would have to change to *Senegalia* while the remaining 120-130 species in these same regions would retain the name *Acacia*. Nomenclatural changes of this magnitude are very disruptive and it is therefore important that they are based on robust scientific evidence if they are to be adopted and if taxonomy is to retain its credibility.

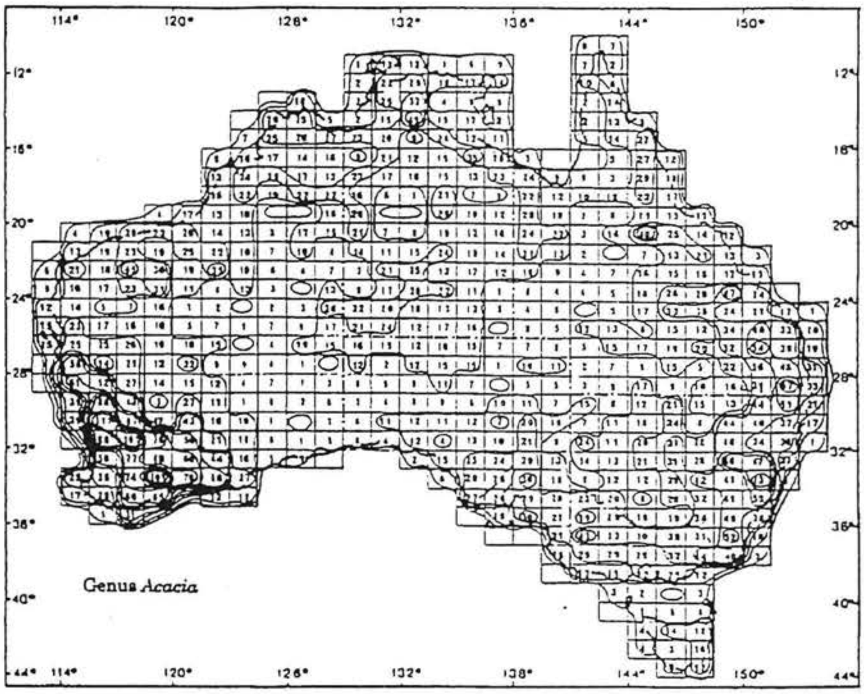

Figure 1:
Isoflor map of the genus Acacia in Australia showing patterns of species richness. Numbers indicate species recorded in each 1° x 1.5° grid; isoflor interval is 10. Although the number of species recorded for Australia is now about 950 the basic geographic patterns depicted by this map (which was based on 840 species) remain essentially unaltered. The map was originally published by Maslin & Hnatiuk (1987) and again in Hnatiuk & Maslin (1988).

Phytogeography of *Acacia*

As discussed by Hnatiuk & Maslin (1988) and Maslin & Pedley (1988), and illustrated in Figure 1, the two principal centres of species richness for *Acacia* in Australia are the southwest of Western Australia and along the Great Dividing Range south of the Tropic of Capricorn in eastern Australia. These areas of richness are dominated by species of sections *Phyllodineae* and *Botrycephalae*. The area of highest species density is in Western Australia along the boundary separating the Arid Zone from the more humid South West Botanical Province where it will be seen that in some cases there are more species in a single 1° x 1.5° grid cell than occur in the entire State of Victoria.

Secondary centres of richness occur in northern and north-eastern Australia, a number of the rocky tablelands of the Arid Zone and in western Victoria. It is species of section *Juliflorae* that are primarily responsible for these secondary centres of richness (see isoflor map in Figure 7 of Hnatiuk & Maslin, 1988). The sandy deserts and riverine areas separating the centres of richness were shown to be very species poor even though, in the deserts at least, *Acacia* is a common element of the landscape. In the study by Hnatiuk & Maslin precipitation, rather than temperature, was shown to be the more important factor governing *Acacia* distribution patterns on a national scale (however, edaphic and geological variables were not included in the study).

Future Work

Despite recent studies of phylogeny and classification within *Acacia*, many uncertainties remain concerning the evolutionary history of the genus and deficiencies exist in the formal hierarchical arrangement of its species. Furthermore, notwithstanding the forthcoming Flora of Australia publication there will remain a need to facilitate the rapid, accurate identification of *Acacia* species. For these reasons my major priorities in the future will include the following:

Classification. The development of a new, comprehensive classification for the Australian *Acacias* is long overdue and has both academic and applied relevance. The scheme envisaged at this stage will be along the lines of Pryor & Johnson's (1971) *A*

Classification of the Eucalypts.

Identification. A database of descriptive and geographic information (incorporating photographs, drawings and maps of each species), giving users a multi-access keying facility is currently being constructed for the Australian *Acacia* flora. This project utilises the powerful DELTA suite of programs which have been developed by Mike Dallwitz and colleagues at CSIRO Division of Entomology, Canberra. It is envisaged that this product will be released on CD-ROM and is likely to be of considerable value to the many workers who need to identify specimens of *Acacia.*

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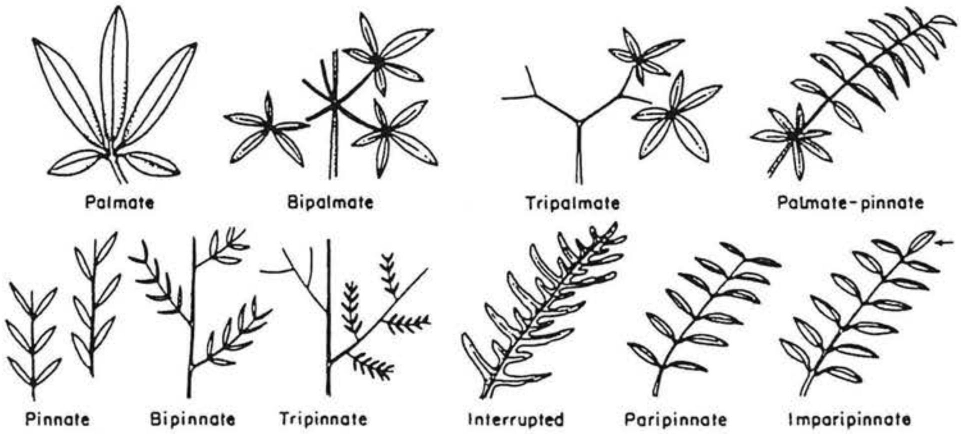
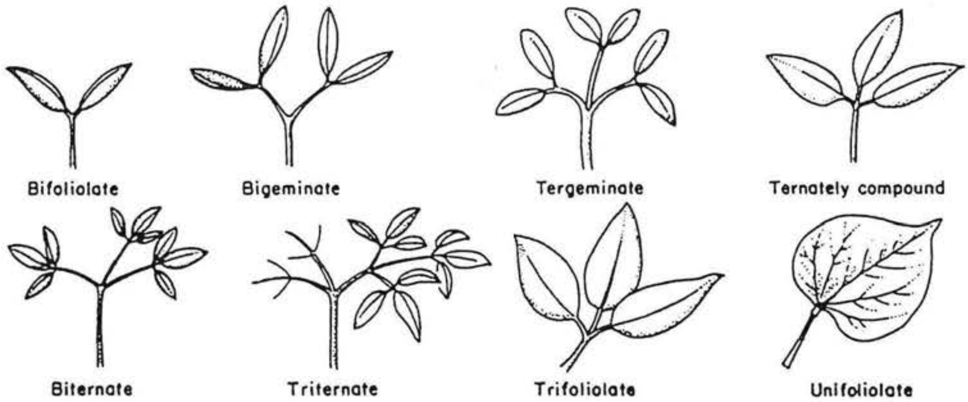
LEAF TYPES and LEAF STRUCTURAL TYPES

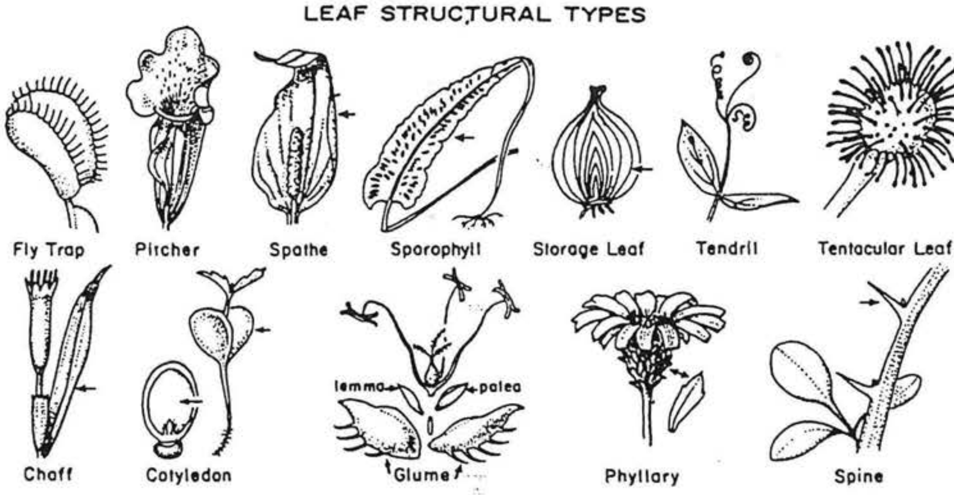
COMPOUND PALMATE and COMPOUND PINNATE



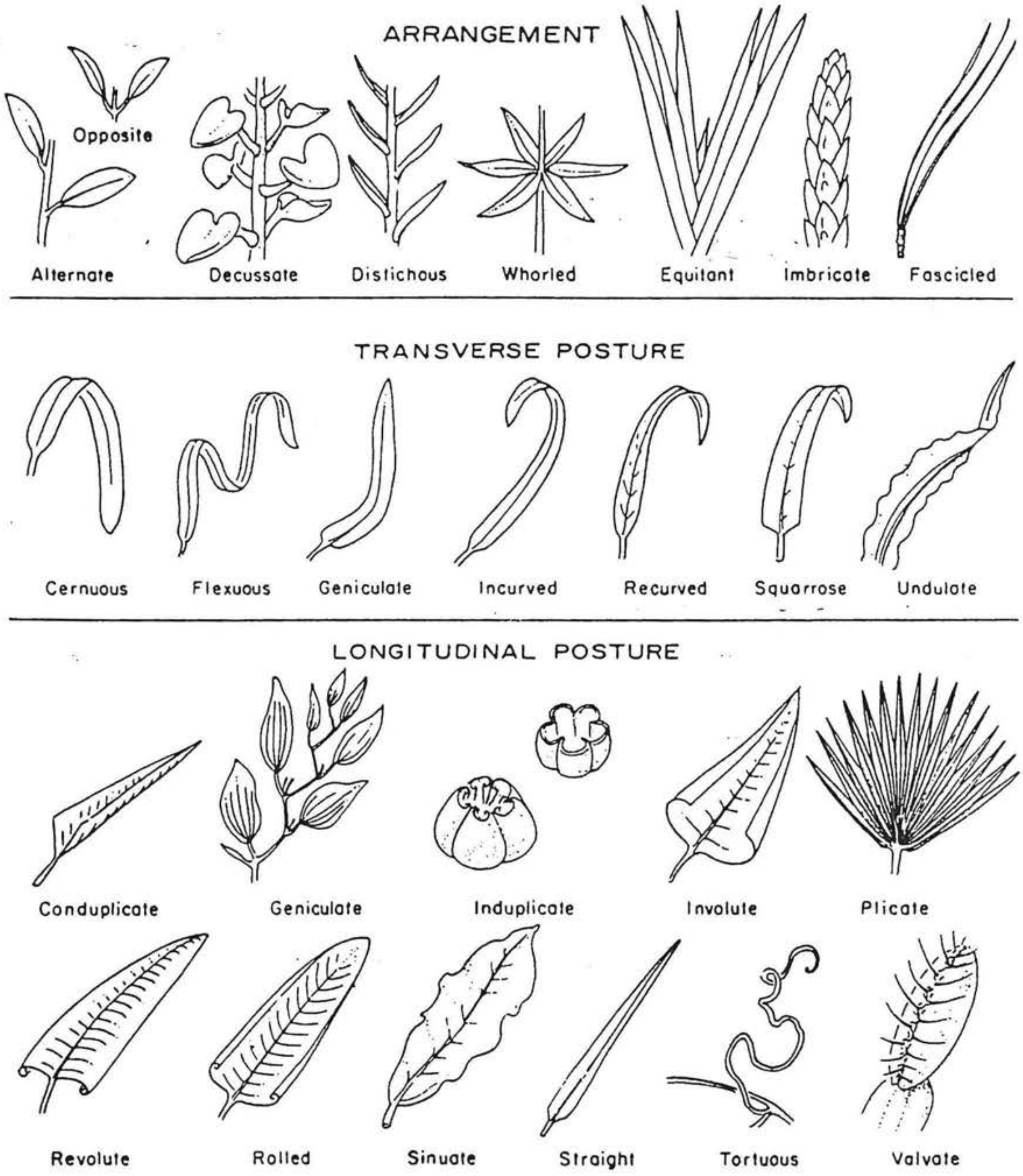
OTHER TYPES



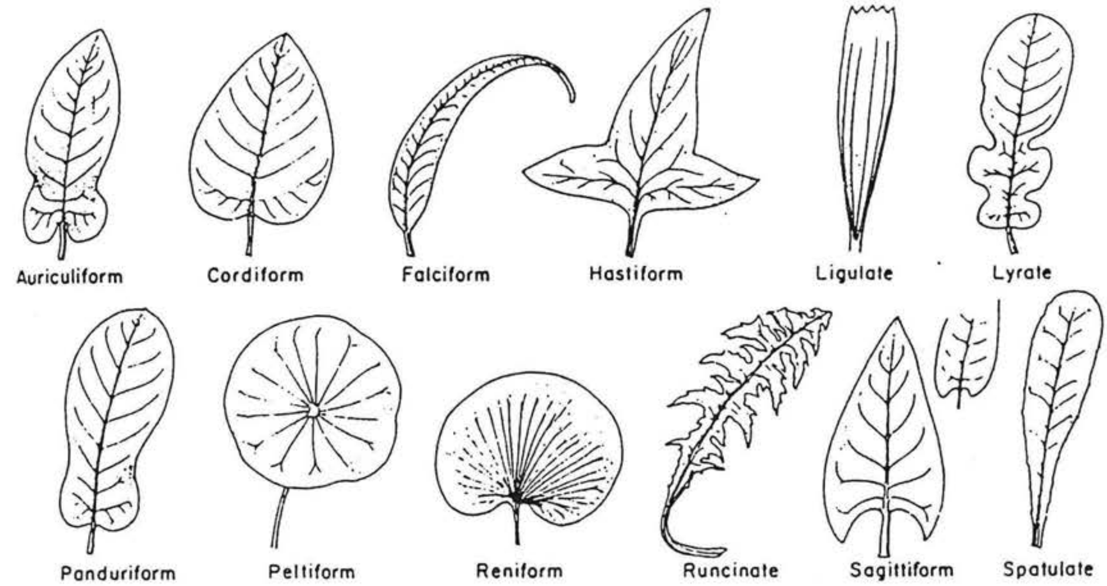
LEAF STRUCTURAL TYPES



2

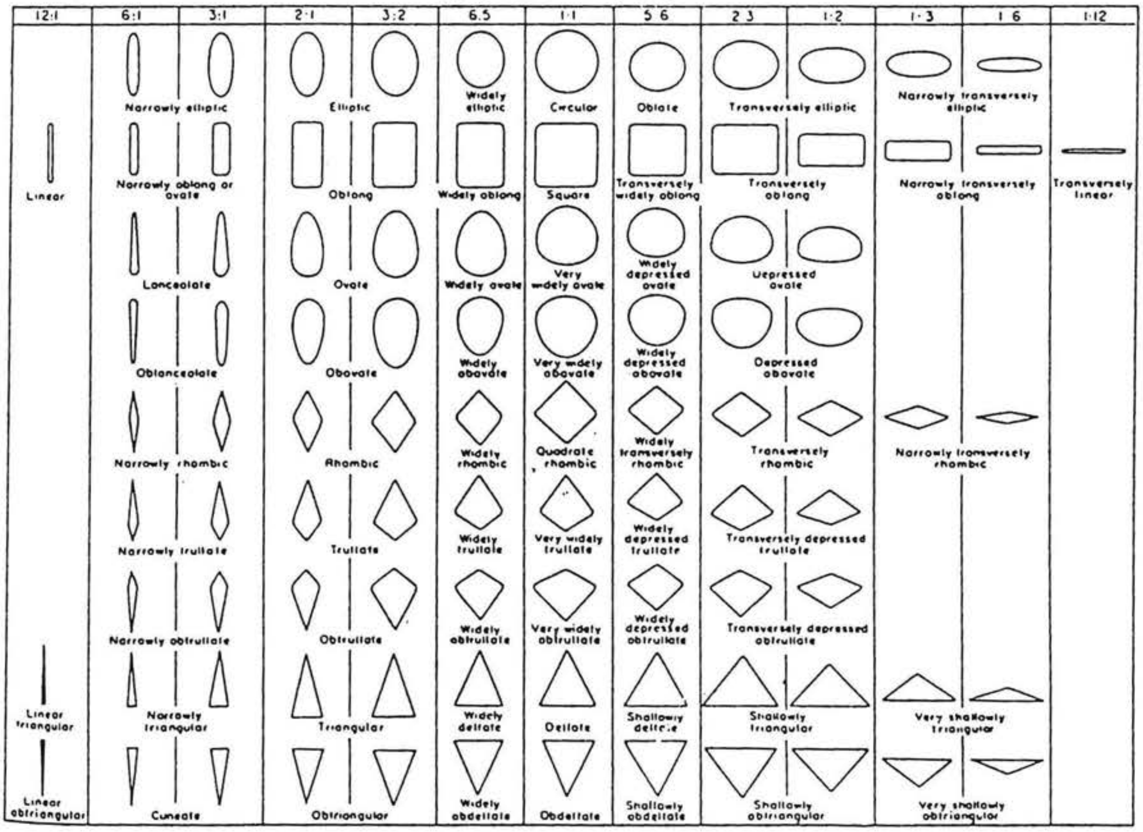

ARRANGEMENT
Opposite
Alternate
Decussate
Distichous
Whorled
Equitant
Imbricate
Fascicled
TRANSVERSE POSTURE
Cernuous
Flexuous
Geniculate
Incurved
Recurved
Squarrose
Undulate
LONGITUDINAL POSTURE
Conduplicate
Geniculate
Induplicate
Involute
Plicate
Revolute
Rolled
Sinuate
Straight
Tortuous
Valvate

SHAPES

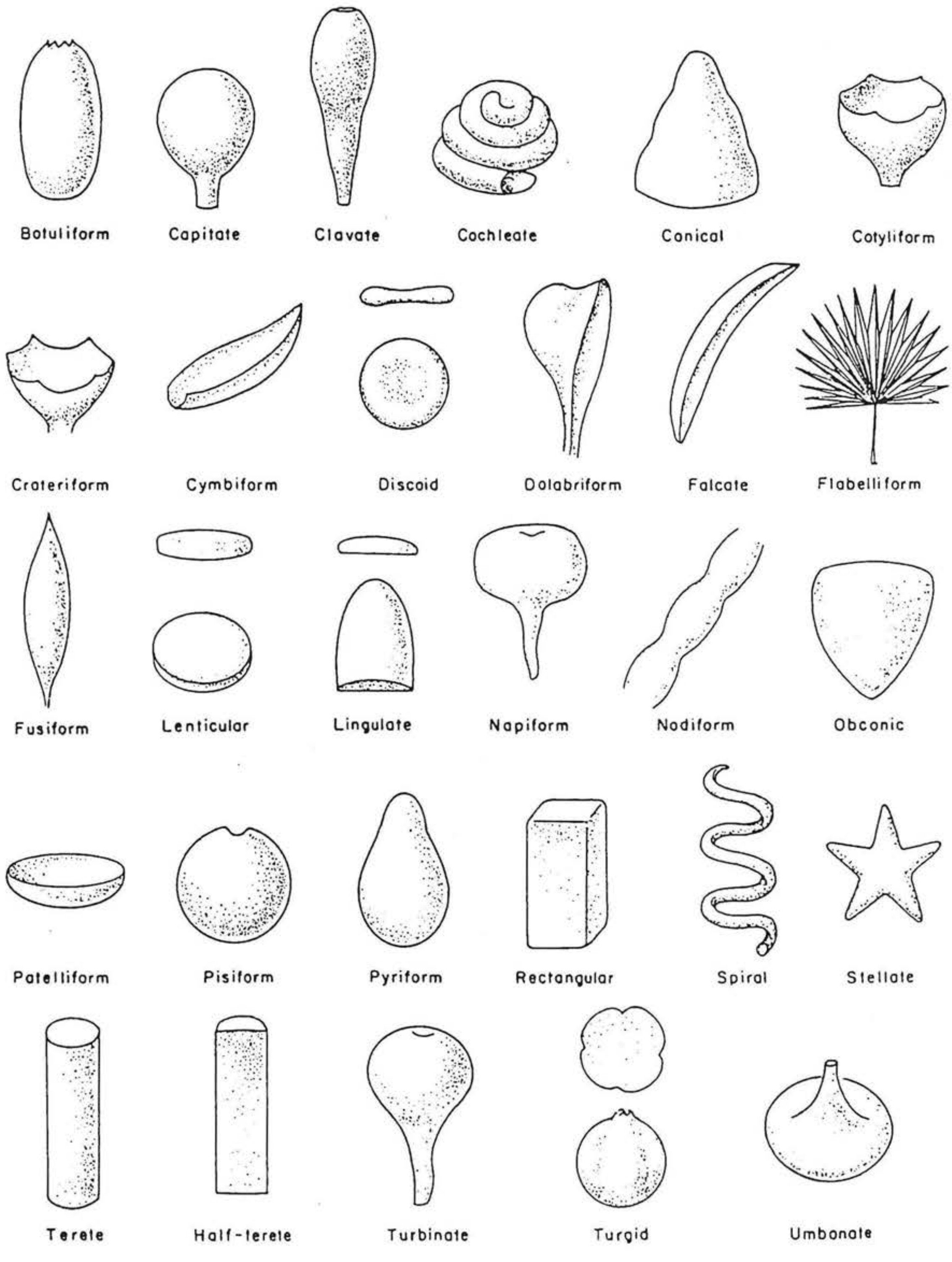


SYMMETRIC PLANE FIGURES

(Adapted from Taxon, 1962)



SHAPES


Botuliform
Capitate
Clavate
Cochleate
Conical
Cotyliform
Crateriform
Cymbiform
Discoid
Dolabriform
Falcate
Flabelliform
Fusiform
Lenticular
Lingulate
Napiform
Nodiform
Obconic
Patelliform
Pisiform
Pyriform
Rectangular
Spiral
Stellate
Terete
Half-terete
Turbinate
Turgid
Umbonate

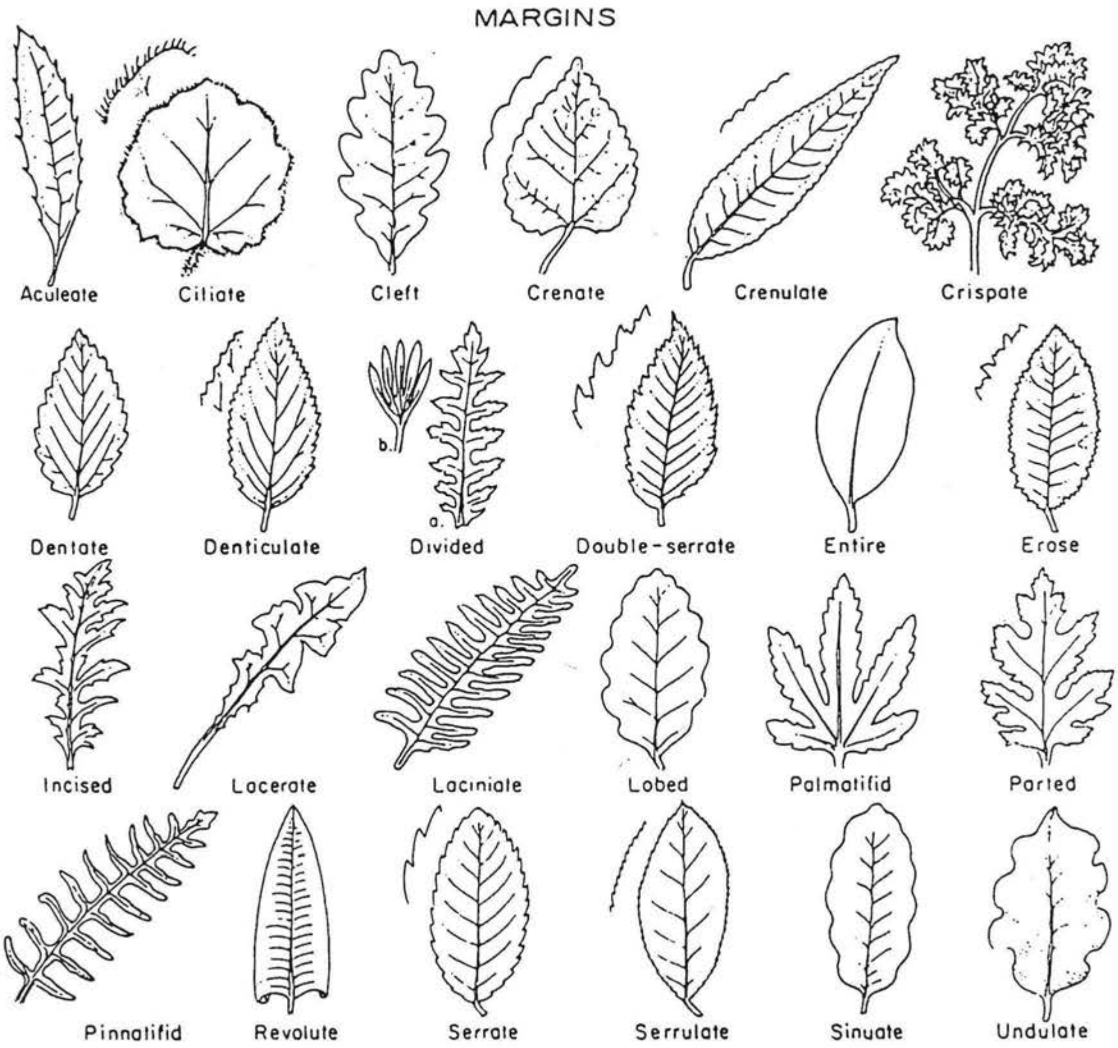
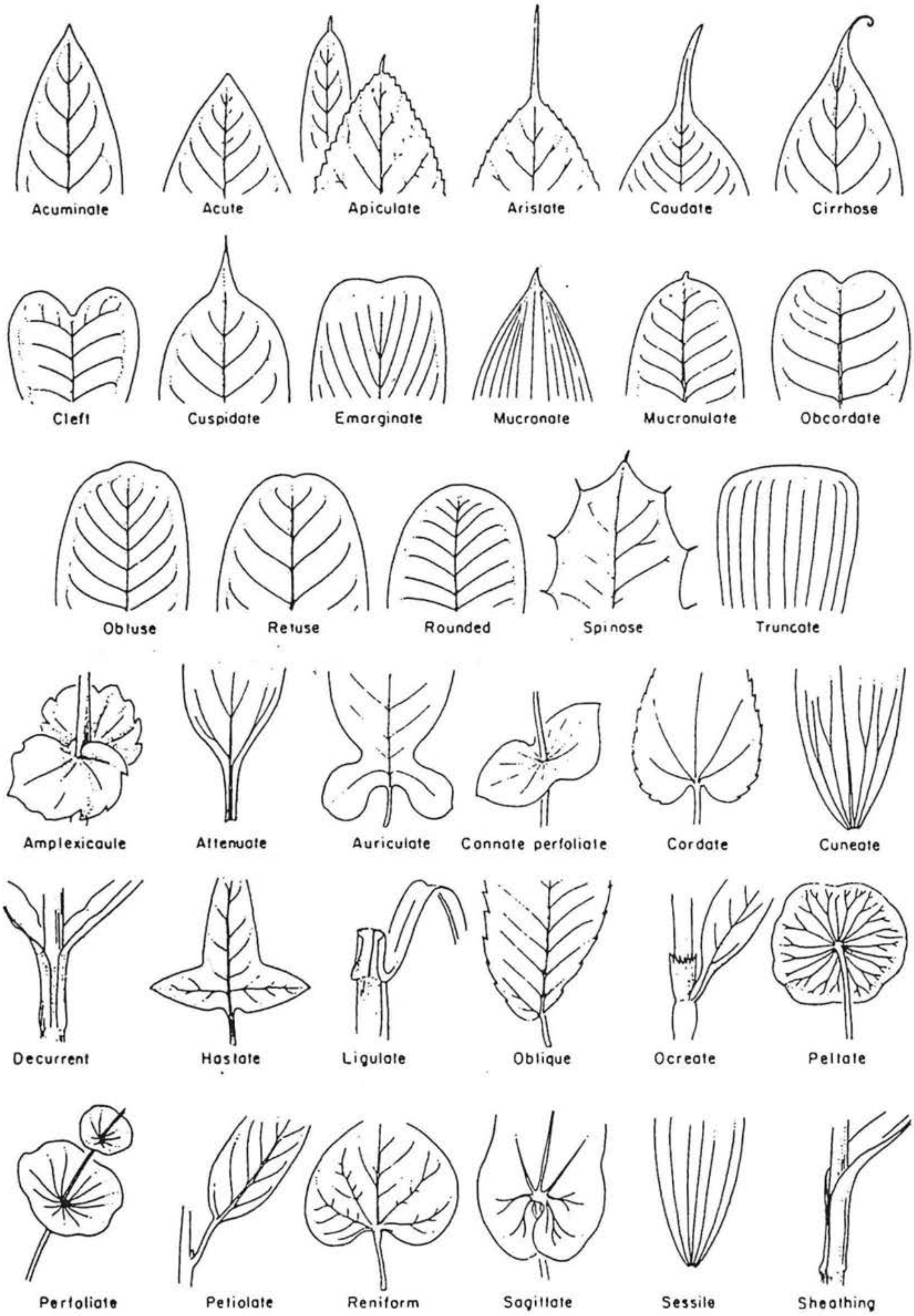


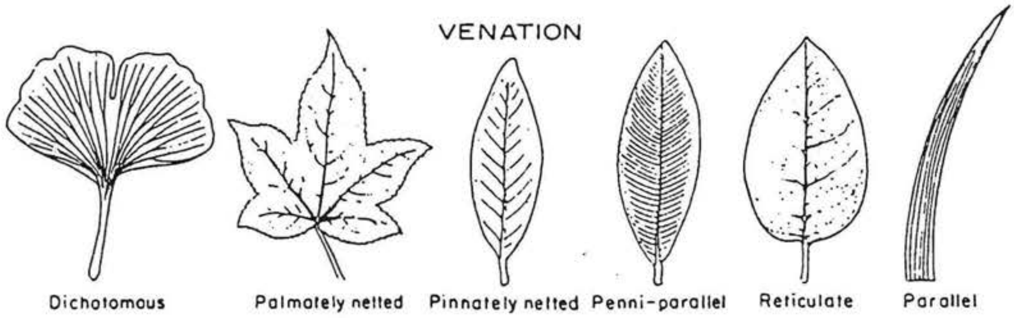
Figure 5.5 Margins.

q. Incised. Margins sharply and deeply cut, usually jaggedly.
r. Involute. Margins rolled inward.
s. Lacerate. Margins irregularly cut, appearing torn.
t. Laciniate. Margins cut into ribbonlike segments.
u. Lobed. Large, round-toothed, cut $\frac{1}{8}$–$\frac{1}{4}$ distance to midrib.
v. Palmatifid. Cut palmately.
w. Parted. Indentations or incisions cut $\frac{1}{2}$–$\frac{3}{4}$ distance to midrib.
x. Pinnatifid. Cut pinnately.
y. Repand. Sinuate with indentations less thant $\frac{1}{16}$ distance to midrib or midvein.
z. Retrorsely Crenate. Rounded teeth directed toward base.
aa. Retrorsely Serrate. Sharp or pointed teeth directed toward base.

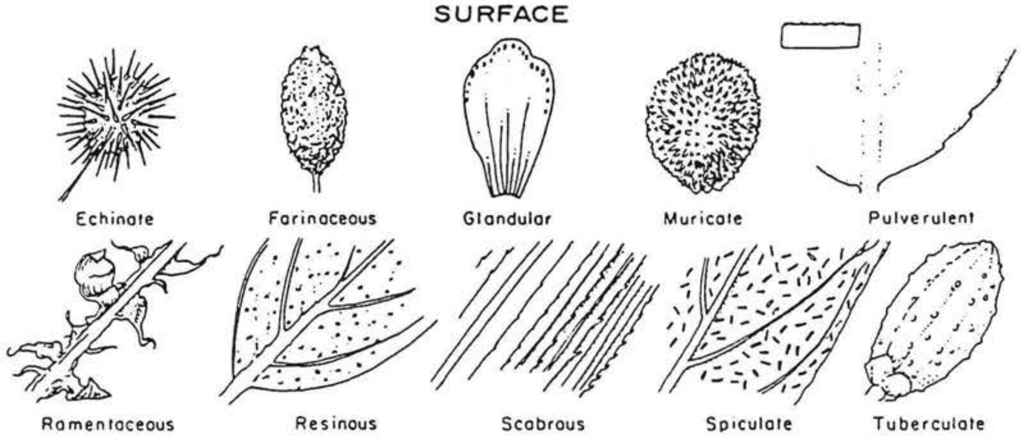
LEAF APICES, ATTACHMENTS AND BASES



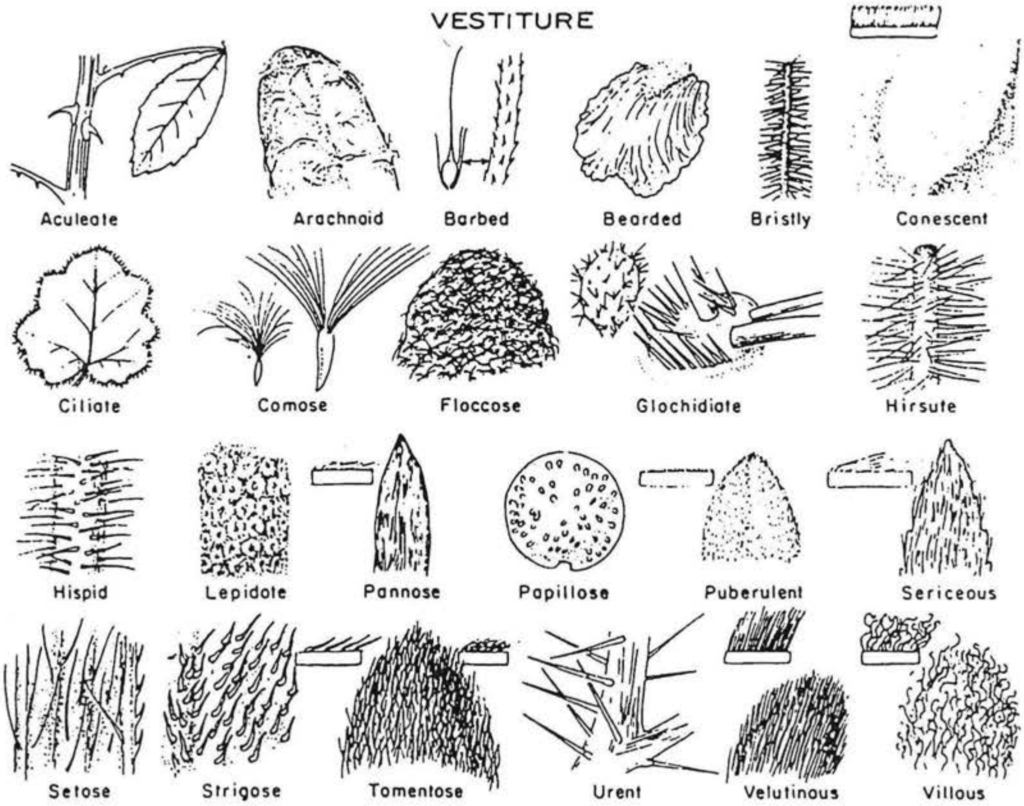
VENATION



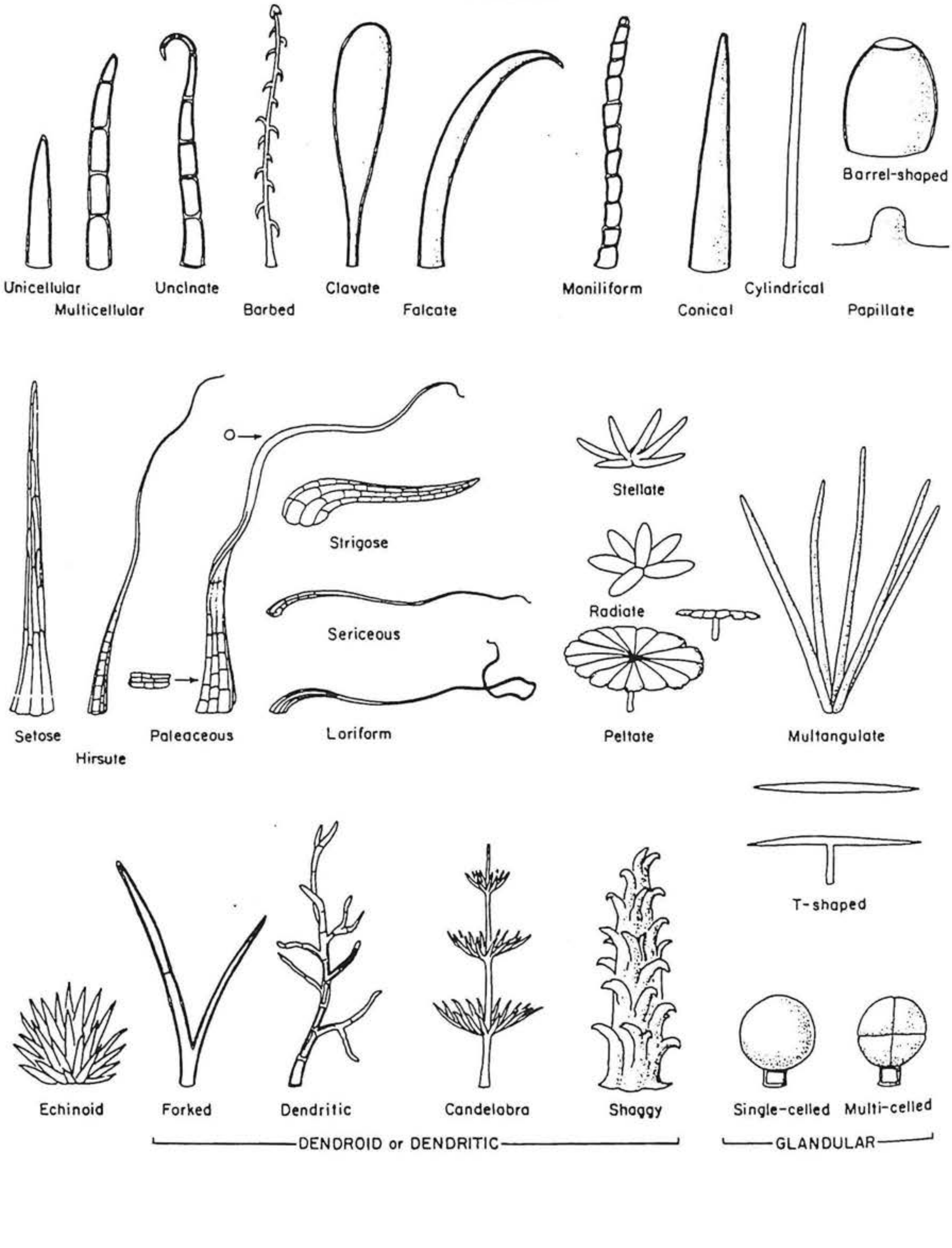
SURFACE



VESTITURE



TRICHOMES


Unicellular
Multicellular
Unclnate
Barbed
Clavate
Falcate
Moniliform
Conical
Cylindrical
Barrel-shaped
Papillate
Setose
Hirsute
Paleaceous
Strigose
Sericeous
Loriform
Stellate
Radiate
Peltate
Multangulate
T-shaped
Echinoid
Forked
Dendritic
Candelabra
Shaggy
Single-celled
Multi-celled
DENDROID or DENDRITIC
GLANDULAR

HABIT

Duration:

Annual	living one year or less
ephemeral	germinating, flowering & fruiting in a short period, as most desert herbs
summer	germinating in spring or early summer; flowering & fruiting in late summer or early autumn
winter	germinating usually in late autumn; flowering & fruiting in early spring
Biennial	living two years, usually flowering in second year
Perennial	living more than two years; fruiting more than once

Form:

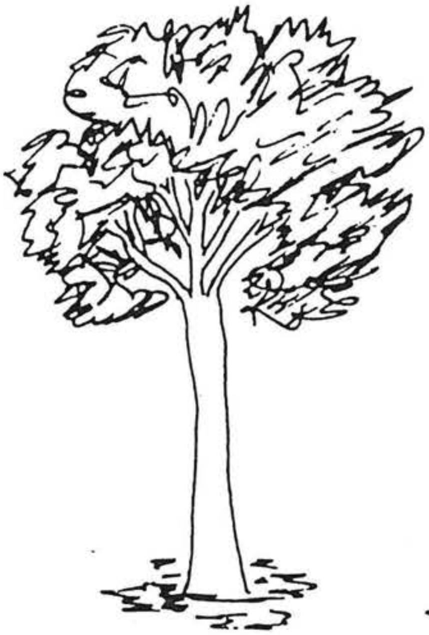
Herb	a plant which is non-woody or woody at the base only, the above ground stems usually being ephermeral
Subshrub	a small, usually sparsely branched woody shrub < 1 m high
Shrub	a woody plant usually < 5 m high & many-branched without a distinct main stem except at ground level
Tree	a woody plant usually > 5 m high & with an unbranched lower stem
Vine, liana	an elongate, weak-stemmed, often climbing annual or perennial

Size:

Adjectives	e.g. gigantic, giant, large, medium, small, reduced, minute dwarf, tall, short, etc.
Class	eg < 5 m high, 5-15 m high, > 15 m high, etc.
Dbh	eg 3 m dbh, etc.

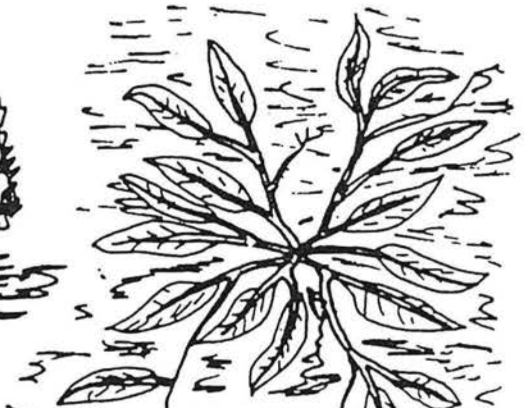
Adjectives relating to habit:

arborescent	tree-like, applied to non-woody plants attaining tree height
ascending	arched upwards in the lower part & becoming erect in the upper part
caespitose	growing densely in tufts, as in grasses
clambering	forming a mat or canopy over the undergrowth, often without the aid of tendrils or twining stems
creeping	trailing horizontally along the ground & taking root mostly throughout its length
decumbent	spreading horizontally with the apex growing upwards
dichotomous	divided almost equally into two parts, forked
divaricate	with branches widely spreading
erect	upright, perpendicular
fastigiate	with branches erect & more or less appressed, as in "Poplar"
fruticose	shrubby, or shrub-like
geniculate	bent, like a knee
spreading	standing outward or horizontally
procumbent	trailing or spreading along the ground but not rooting at the nodes
prostrate	lying flat on the ground
rhizomatous	with creeping stems, usually below the ground, which branch into roots
soboliferous	bearing or producing shoots from the ground, clump-forming, usually applied to shrubs or small trees
stoloniferous	with stems that bend to the ground & take root giving rise to a new plant at its tip
suffruticose	producing leafy & flowering shoots each year from a woody underground rootstock
twining	growing in convolutions about a support, often with the aid of tendrils



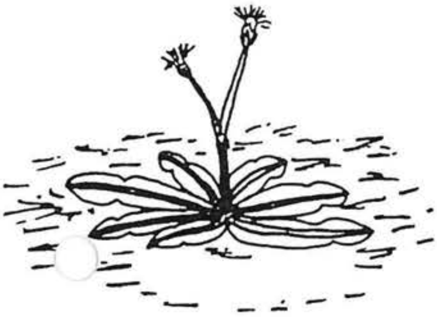
TREE

SHRUB



CREEPER

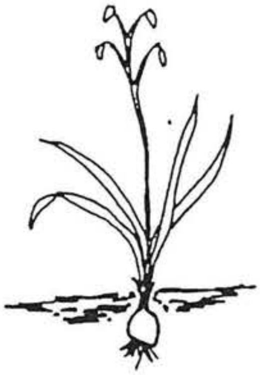
CLIMBER



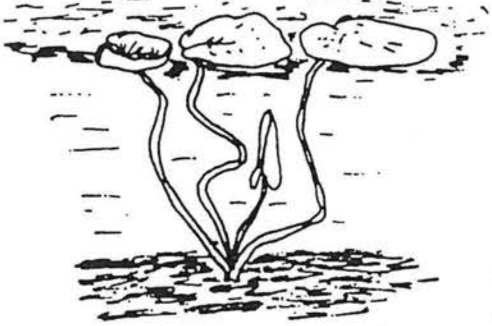
ROSETTED

PERENNIAL
GRASS

SEDGE

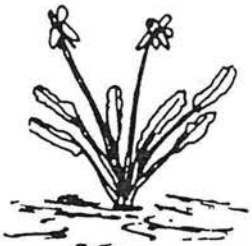


GEOPHYTE

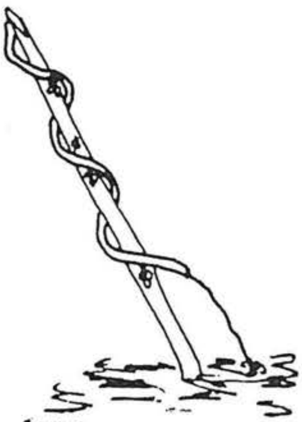


AQUATIC

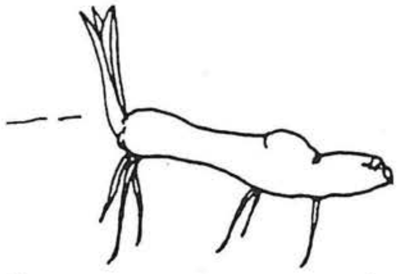
ANNUAL GRASS



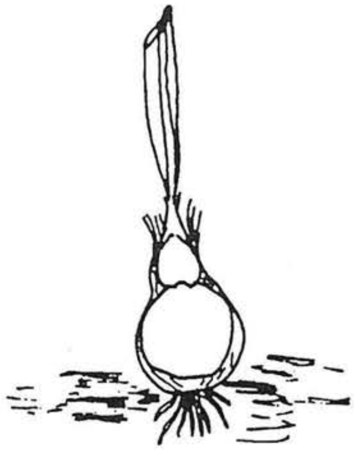
ANNUAL HERB



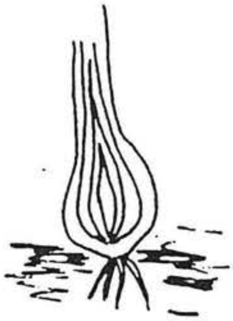
PARASITE



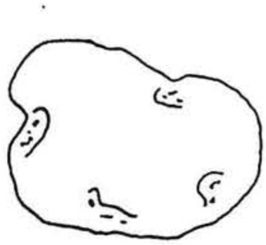
RHIZOME



CORM

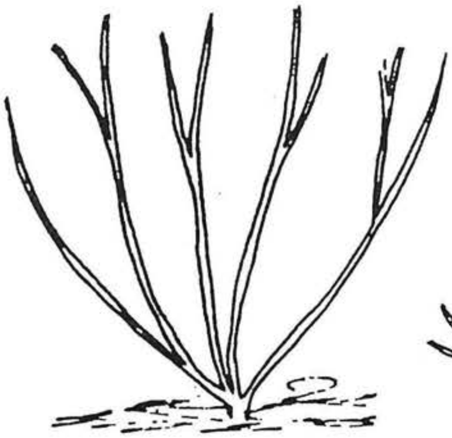


BULB



TUBER

STEM

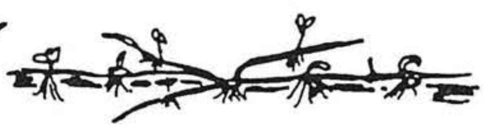


ASCENDING

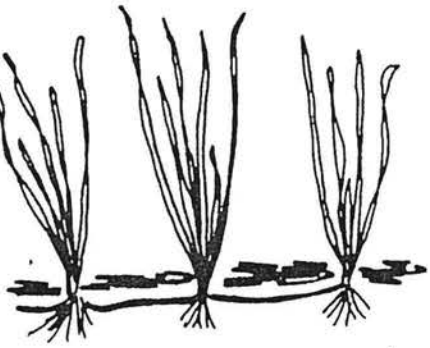
DECUMBENT

PROCUMBENT

STOLONIFEROUS



REPENT



SOBOLIFEROUS

PRONUNCIATION OF BOTANICAL NAMES

Botanists, at least English-speaking botanists, who have expressed themselves on the matter of pronunciation seem to agree generally that for our purposes it is probably best to use the English sounds for vowels and consonants, while following the rules of classical Latin for accenting. In the following index a grave accent (\) denotes a long vowel and an acute accent (/) a short vowel.

SPECIFIC EPITHETS INDEX

*Common usage

SPECIFIC EPITHETS INDEX (cont.)

*Common usage

*Common usage

Vowels.

1. Final vowels have the long sound (alsin<u>e</u>, al-si-nee), except final <u>a</u>, which has the sound of an unstressed "ah" (vern<u>a</u>, vernah).
2. Final <u>es</u> sounds like the English word "ease": alsod<u>es</u>, al-so-deez.
3. <u>Y</u> is always a vowel with the quality of <u>i</u>: diph<u>y</u>llus, di-fil-lus.
4. Two vowels together that do not form a dipthong, are always sounded separately. The first of the two has the short sound: filifo<u>lia</u>, fi-li-fo-li-ah. It should be noted that this rule does not hold for words transcribed from the Greek, e.g., the <u>e</u> in <u>Achillea</u> is long because it is a contraction of the Greek diphthong <u>ei</u>. A diphthong is treated as a long vowel wherever it occurs, even if transcribed by a single letter.

Diphthongs.*

1. <u>ae</u> and <u>oe</u> have the sound of long <u>e</u> in "me": l<u>ae</u>vis, lee-vis; rh<u>oe</u>as, ree-as.
2. <u>au</u> sounds like <u>au</u> in "c<u>au</u>dal" or <u>aw</u> in "awful": c<u>au</u>datus, caw-da-tus.
3. <u>ei</u> usually becomes <u>i</u>, and is like English long <u>i</u>, in "k<u>i</u>te."
4. <u>eu</u> sounds like <u>u</u> in "ne<u>u</u>ter," or "ne<u>u</u>rology": eurycarpus, <u>u</u>-ri-car-pus.
5. Diphthongs are always classed as long vowels.

COLLECTIONS OF THE WESTERN AUSTRALIAN HERBARIUM

Arrangement

According to Engler and Prantl, Die Naturlichen Pflanzenfamilien (1889-1899) as modified in Engler, Syllabus der Pflanzenfamilien, edn 7 (1912).

Some families have been divided to accord with modern botanical thought.

Specimens:
Label data: Name of taxon
Notes on plant
Habitat
Locality including Latitude and Longitude
Collector, collector's number, date

The specimens provide an indication of the geographical distribution of the taxon and its morphological variation.

Determinavit slips: 'determinavit' means 'he has identified it'; the slips are used by a person, often an authority on the taxonomy of the group, who has critically identified the collection.

Types
The type is the element to which the name of a taxon is permanently attached.
Holotype: One specimen designated by the author (essential after 1958).
Isotype: A duplicate of a holotype
Syntype: One of two or more specimens that was cited as type (legitimate before 1958).
Lectotype: A specimen selected as type when no holotype was designated.
Neotype: A specimen selected as type if the designated type (or types) is missing.

There is always an australian botanist in Europe (based at Kew Gardens - this year?). to answer questions on Australian types

CRITERIA WHICH HAVE BEEN USED IN ATTEMPTS TO DEFINE THE SPECIES

1. *Museum criteria*

(*a*) Among members of one species, there is normally a limited and continuous variation in characters of structure and pigmentation, whereas a discontinuity in one or both these respects will normally show itself when members of two different species are compared.

(*b*) A species has normally a limited and continuous area of natural distribution, rarely coinciding exactly with that of any other species.

2. *Ecological criteria*

(*c*) Between members of different species, there are normally differences of habits and behaviour, not bridged by transitional forms.

(*d*) It is very rare to find, in nature, matings between members of different species.

3. *Physiological criterion*

(*e*) Within a species, there is normally the same kind of limited and continuous variation in physiological and biochemical characters as there is in structural ones, and the same type of unbridged gap when members of two different species are compared.

4. *Genetical criteria*

(*f*) Sexual crossings between members of one species are normally fully fertile, giving offspring with characters of the same species and themselves fully fertile, whereas interspecific crosses usually yield infertile offspring or none at all.

(*g*) Between members of two different species there are normally differences in large numbers of hereditary factors (genes), usually accompanied by complex chromosomal differences (inversions, translocations, reduplications, etc.); intraspecific variation generally involves far fewer factors, and only simple chromosomal changes (if any) are found in it.

5. *Palaeontological criterion*

(*h*) A species has a limited and continuous range in time.

2

DIFFERENT KINDS OF CLASSIFICATION

TAXA

↓

TAXONOMIC CHARACTERS

Use of habit and importance to man as characters	Use of one or a few selected characters to group taxa	Use of as many characters as possible to group taxa	Use of as many characters as possible plus phylogenetic (evolutionary) interpretation
↓	↓	↓	↓
Artificial Classifications	Mechanical Classifications	Natural Classifications	Phylogenetic Classifications

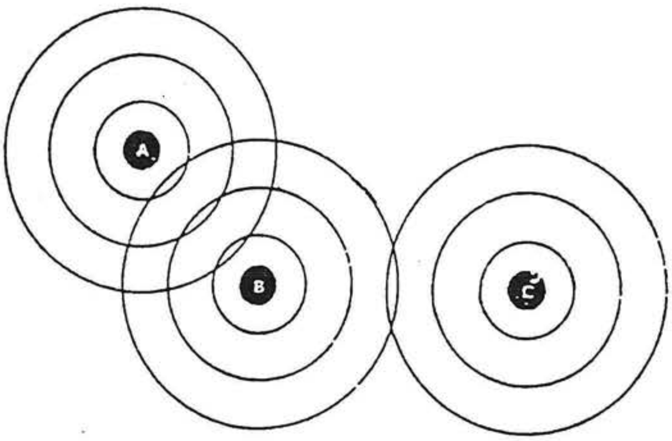


Diagram illustrating the use of the type concept.

A and *C* represent the types of hypothetical species, the circles around them indicating the range of variation found in subsequently discovered individuals. Unknown plant *B* can be shown by extrapolation to be nearer *A* than *C*.

Classification of Plants[a] Through the Level of Class

Subkingdom I. Prokaryota[a]

Division 1. Cyanophycophyta[b]
Class 1. Myxophyceae (Blue-green algae)

Division 2. Schizomycota
Class 1. Schizomycetes (Bacteria)

Subkingdom II. Chlorota

Division 1A. Chlorophycophyta[b]
Class 1. Chlorophyceae (Green algae)

Division 1B. Euglenophycophyta[b]
Class 1. Euglenophyceae (Euglenoids)

Division 1C. Phaeophycophyta[b]
Class 1. Phaeophyceae (Brown algae)

Division 1D. Chrysophycophyta[b]
Class 1. Xanthophyceae (Yellow-green algae)
Class 2. Chrysophyceae (Golden-brown algae)
Class 3. Bacillariophyceae (Diatoms)

Division 1E. Pyrrophycophyta[b]
Class 1. Cryptophyceae (Cryptomonads)
Class 2. Dinophyceae (Dinoflagellates)

Division 1F. Rhodophycophyta[b]
Class 1. Rhodophyceae (Red algae)

Division 2. Charophyta
Class 1. Charophyceae (Stoneworts)

Division 3. Hepatophyta[c]
Class 1. Hepatopsida (Liverworts)
Class 2. Anthocerotopsida (Horned liverworts)

Division 4. Bryophyta[c]
Class 1. Sphagnopsida (Peat mosses)
Class 2. Andreaeopsida (Rock mosses)
Class 3. Mnionopsida (True or common mosses)

Division 5. Psilophyta[d]
Class 1. Psilopsida (Whisk ferns)

Division 6. Microphyllophyta[d]
Class 1. Aglossopsida (Eligulate lycopods)
Class 2. Glossopsida (Ligulate lycopods)

Division 7. Arthrophyta[d]
Class 1. Arthropsida (Arthrophytes)

Division 8. Pterophyta[d]
Class 1. Eusporangiopsida (Eusporangiate ferns)
Class 2. Leptosporangiopsida (Leptosporangiate ferns)

Division 9. Cycadophyta[c]
Class 1. Cycadopsida (Cycads)
Class 2. Pteridospermopsida (Seed ferns)
Class 3. Cycadeoidopsida (Cycadeoids)

Division 10. Ginkgophyta[c]
Class 1. Ginkgopsida (*Ginkgo* and precursors)

Division 11. Coniferophyta[e]
Class 1. Coniferopsida (Conifers)
Class 2. Taxopsida (Taxads)

Division 12. Gnetophyta[e]
Class 1. Gnetopsida (*Gnetum, Ephedra, Welwitschia*)

Division 13. Anthophyta[f]
Class 1. Angiospermae (Flowering plants)

Subkingdom III. Mycota

Division 1A. Myxomycota[g]
Class 1. Myxomycetes (Slime molds)
Class 2. Acrasiomycetes (Cellular slime molds)

Division 1B. Phycomycota[g]
Class 1. Phycomycetes (Algalike fungi)

Division 1C. Ascomycota[g]
Class 1. Ascomycetes (Sac fungi)

Division 1D. Basidiomycota[g]
Class 1. Basidiomycetes (Club fungi)

Division 1E. Deuteromycota[g]
Class 1. Deuteromycetes (Imperfect fungi)

Fungi are now thought to be something different to either plants or animals.

RANK	NAME ENDING	THE 'DANDELION'
kingdom		Plantae
subkingdom		Chlorota
division		Anthophyta
class		Angiospermae
subclass		Dicotyledonideae
order	-ales	Asterales
suborder	-ineae	Asterineae
family	-aceae	Asteraceae
subfamily	-oideae	Cichorioideae
tribe	-eae	Cichorioideae
subtribe	-ineae	Crepidinae
genus		Taraxacum
subgenus		
section		Vulgaria
species		officinale
subspecies (ssp.)		
variety (var.)		
form (f.)		

<u>subspecies</u> - a morphologically and geographically distinct race, i.e. a <u>regional</u> facies

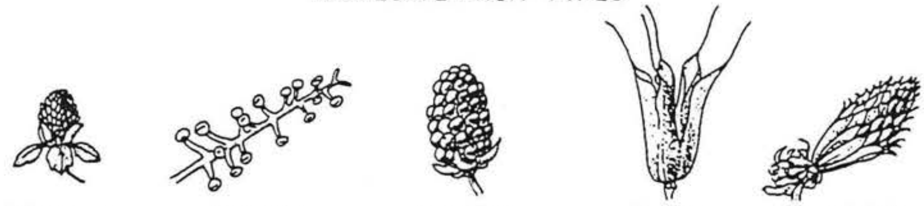
<u>variety</u> - morphologically distinct population of restricted distribution, i.e. a <u>local</u> facies often used for variations whose precise nature is not understood

<u>form</u> - a sporadic variant distinguished by a single or very few characters without a distinct distribution

2

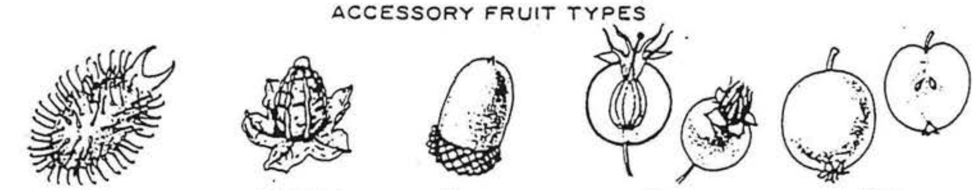
FRUIT TYPES, Cont'd., SEED PARTS and EMBRYO TYPES

AGGREGATE FRUIT TYPES

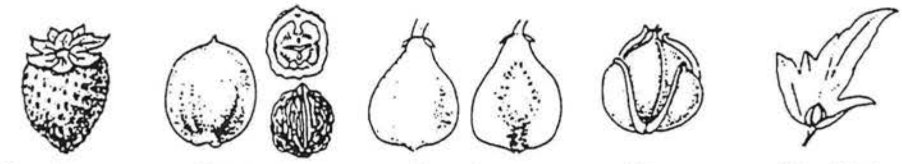


Achenecetum Baccacetum Drupecetum Follicetum Samaracetum

ACCESSORY FRUIT TYPES



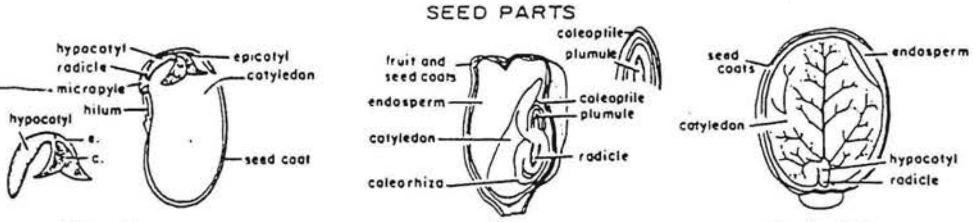
Bur Diclesium Glans Hip Pome



Pseudocarp Pseudodrupe Syconium Tryma Winged Nut

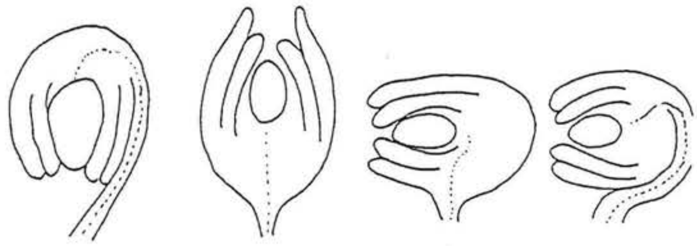
SEED PARTS

seed tube grows in through here



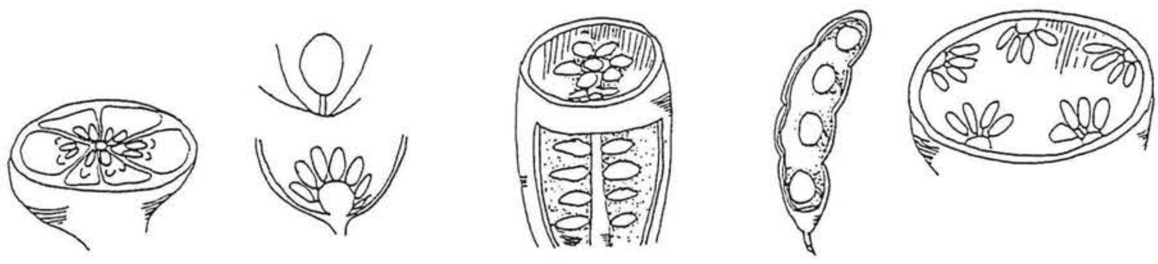
Lima Bean Corn Castor Bean

OVULES



ANATROPOUS ORTHOTROPUS CAMPYLOTROPOUS AMPHITROPOUS

PLACENTATION

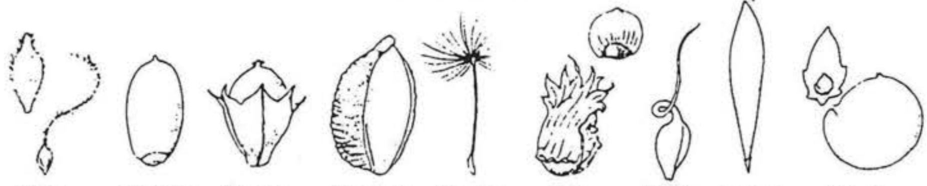


AXIL BASAL FREE CENTRAL MARGINAL PARIETAL eg Allocasuarina

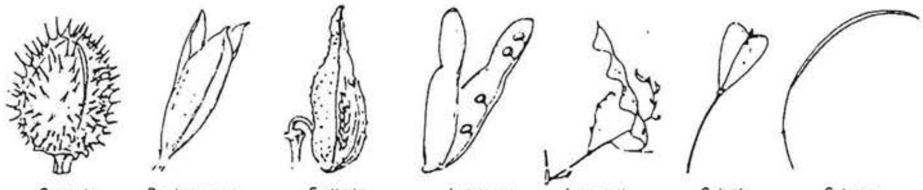
1

FRUIT TYPES

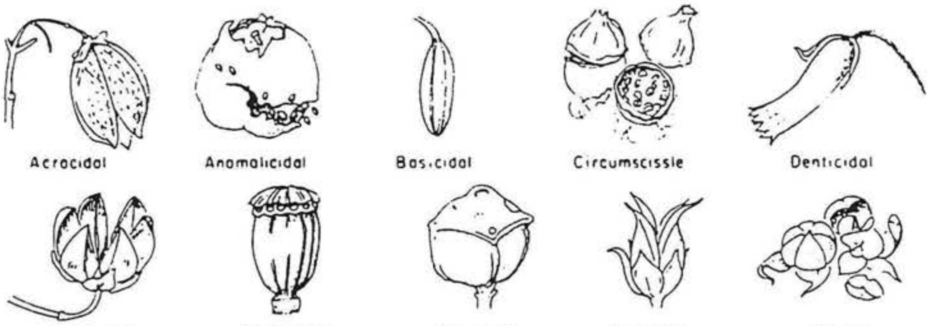
DRY INDEHISCENT FRUIT TYPES



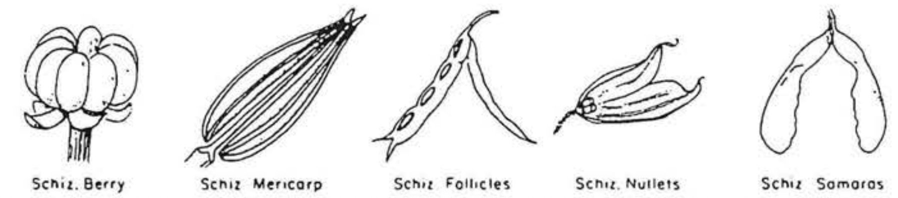
DRY DEHISCENT FRUIT TYPES



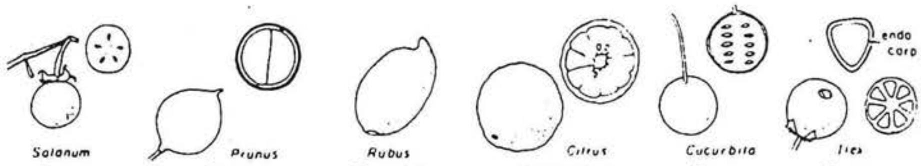
CAPSULE TYPES



SCHIZOCARPIC FRUIT TYPES

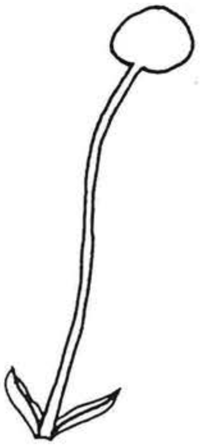


FLESHY FRUIT TYPES



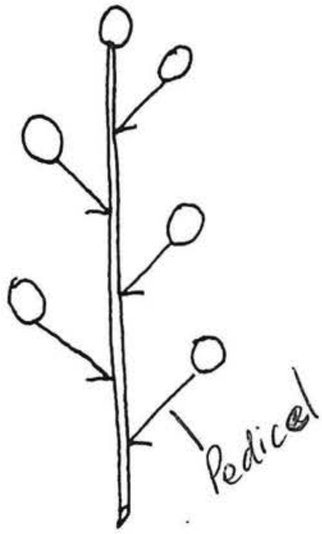
eg orange

INFLORESCENCES

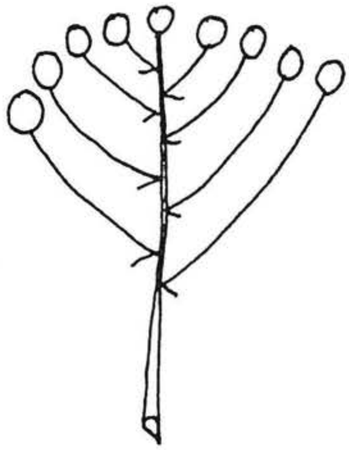


SCAPOSE

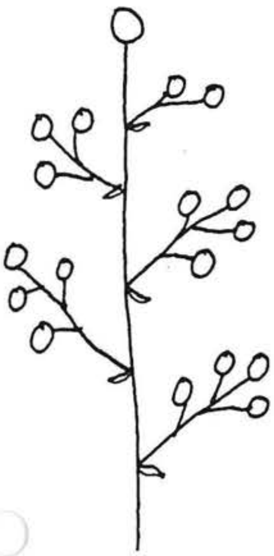
SPIKE



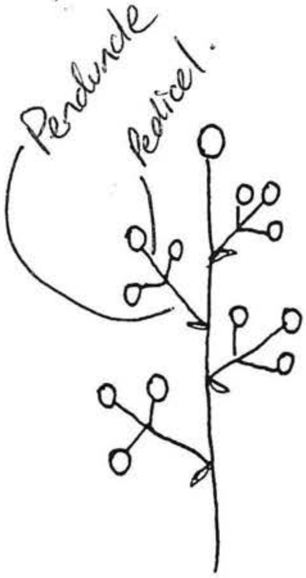
RACEME



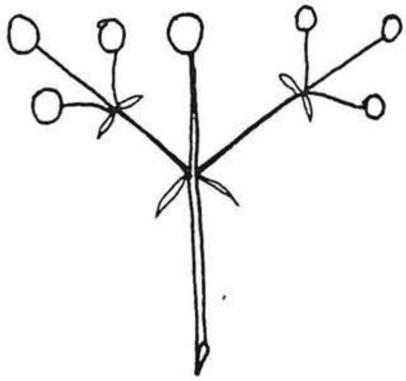
CORYMB



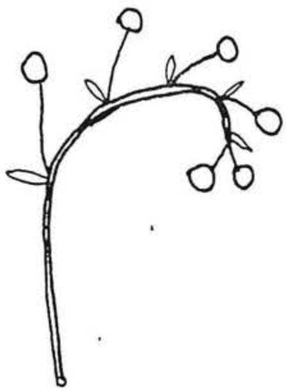
PANICLE .



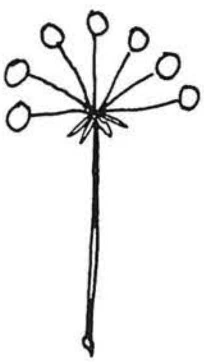
THYRSE



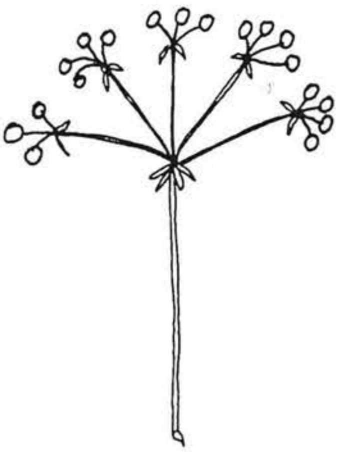
CYME



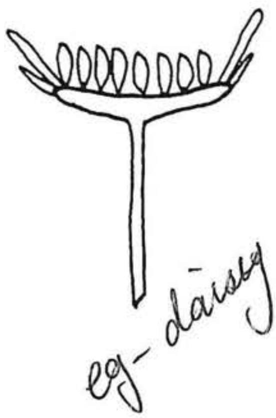
SCORPIOID CYME



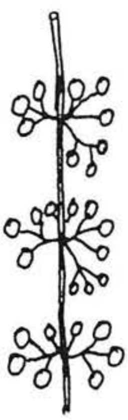
UMBEL



COMPOUND UMBEL

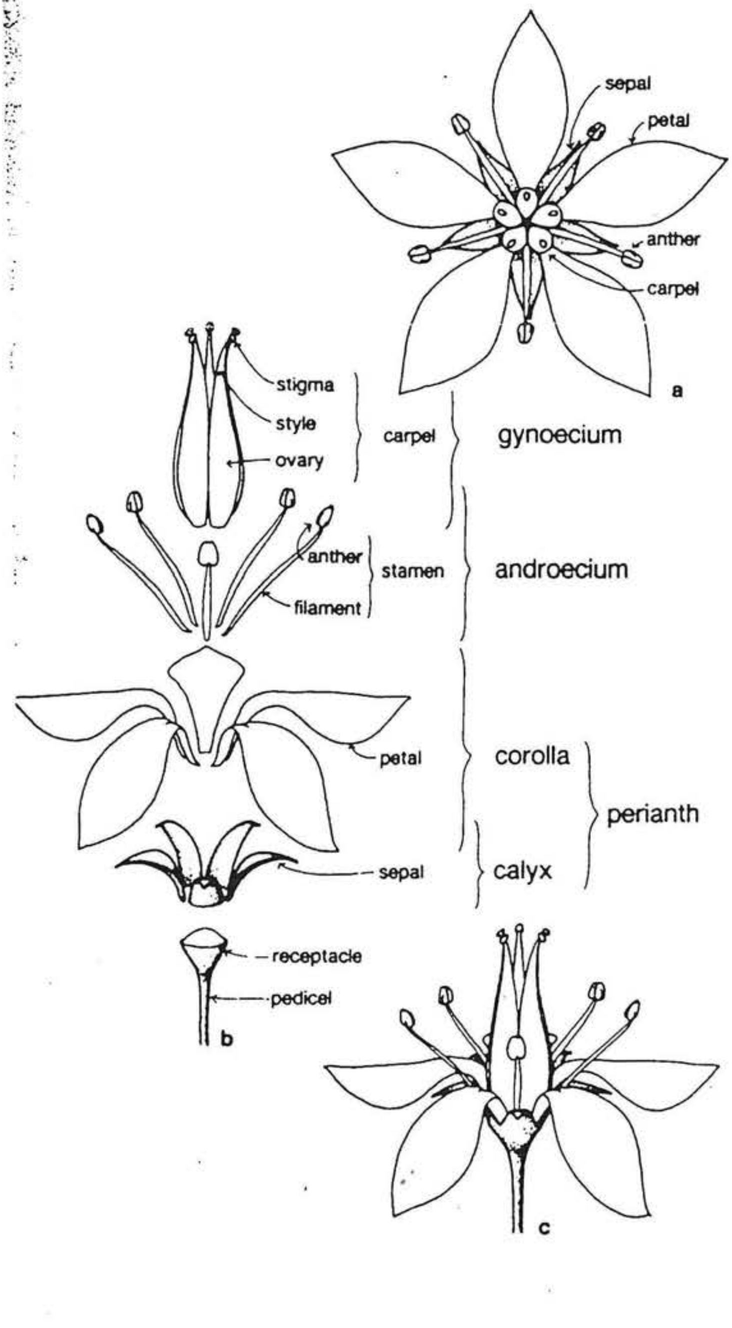


CAPITULUM



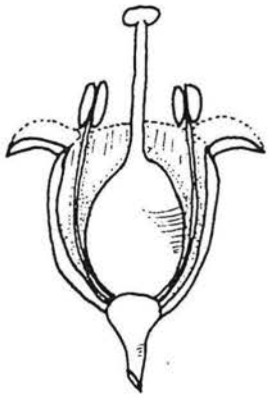
VERTICILLATE CYME

2

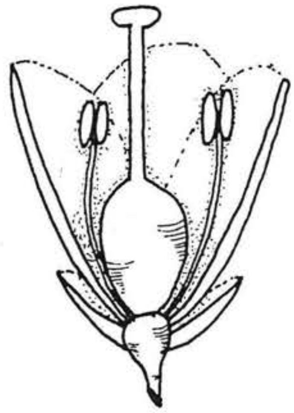


sepal
petal
anther
carpel
a
stigma
style
ovary
carpel
gynoecium
anther
filament
stamen
androecium
petal
corolla
perianth
sepal
calyx
receptacle
pedicel
b
c

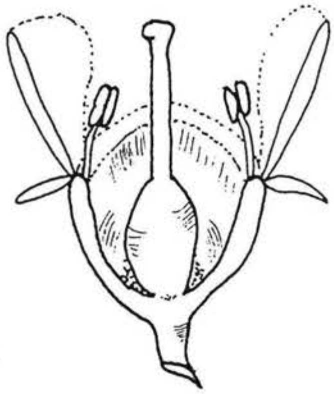
THE FLOWER



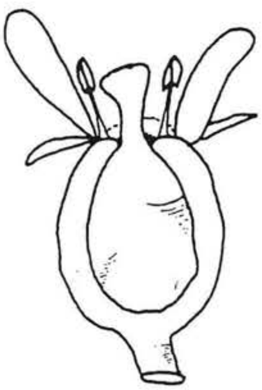
OVARY SUPERIOR



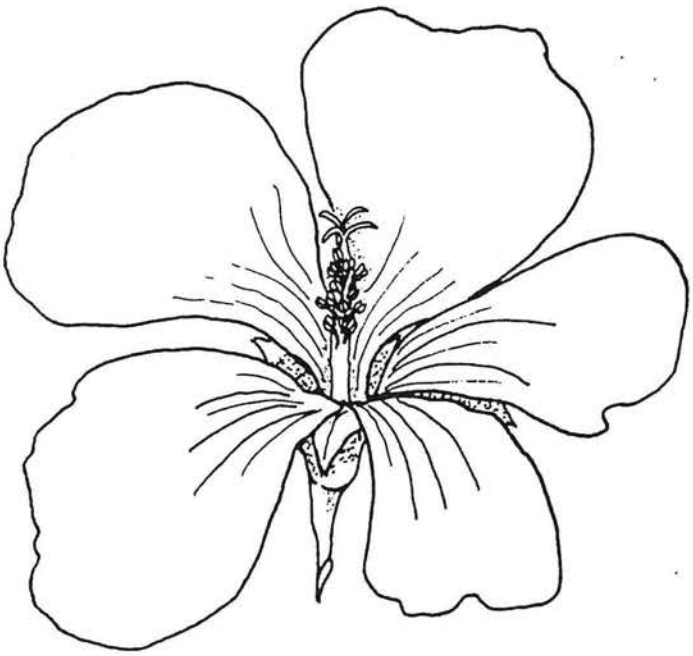
HYPOGYNOUS



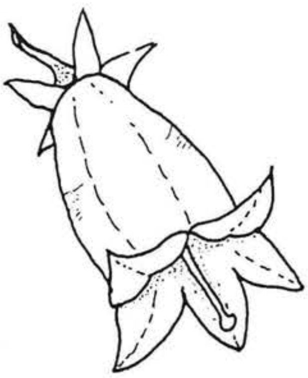
PERIGYNOUS



OVARY INFERIOR



PETALS FREE



PETALS FUSED

Diagram of a flower and its parts.

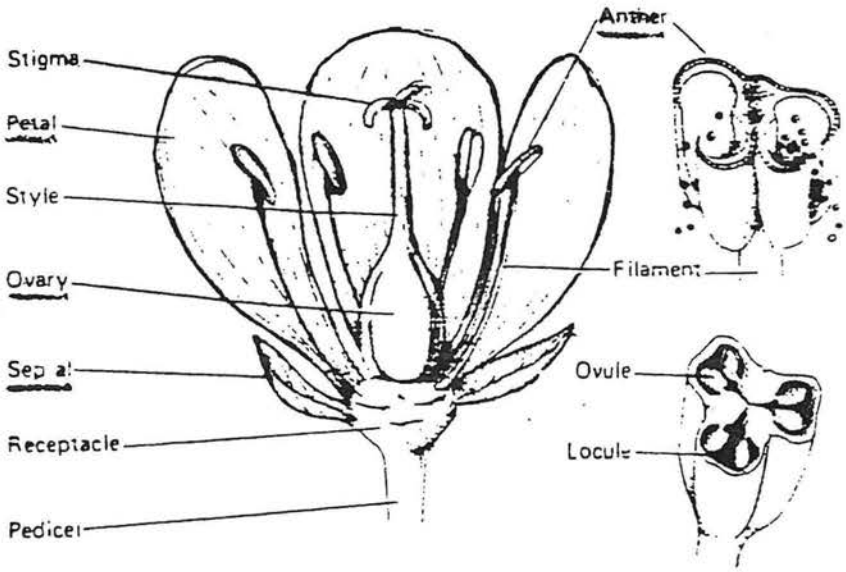
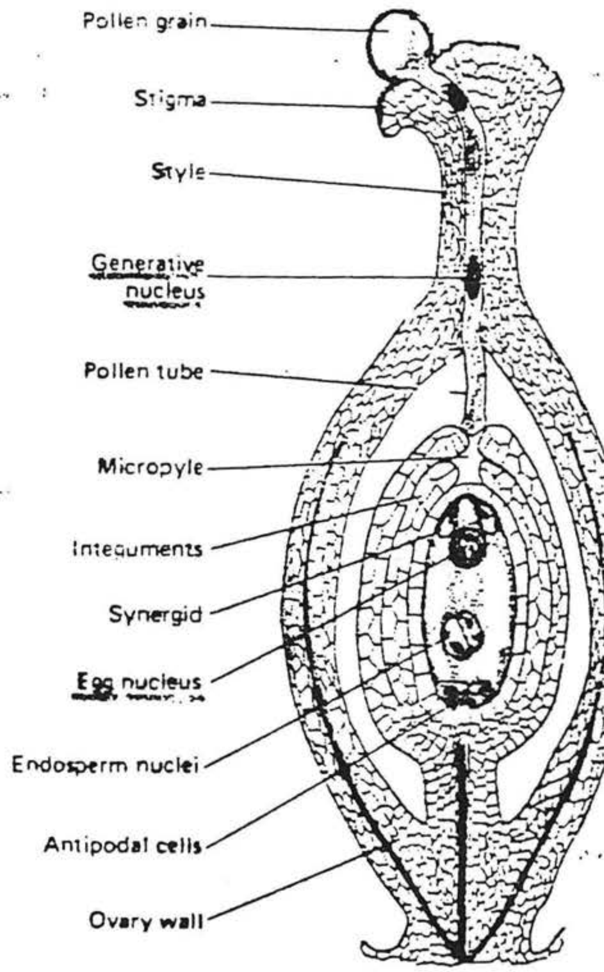
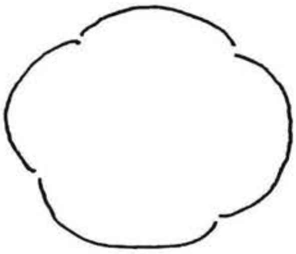


Diagram of fertilization. The pollen grain, landing on the stigma, grows down through the style to the ovary where it bursts, releasing the two haploid generative nuclei. One generative nucleus fuses with the egg nucleus and the other fuses with the two endosperm nuclei.

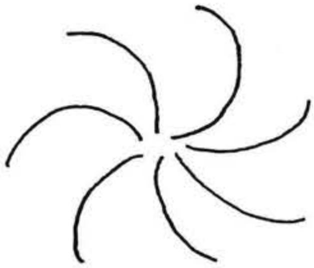


AESTIVATION

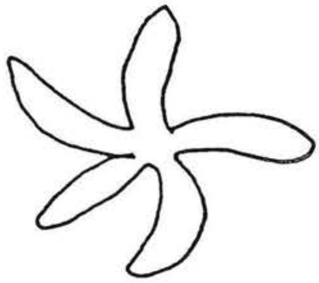


VALVATE

IMBRICATE



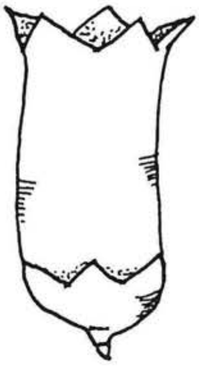
CONVOLUTE



PLICATE

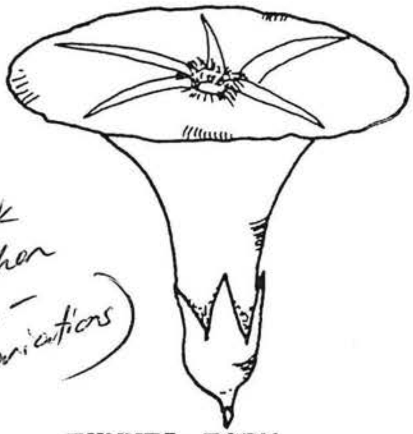
COROLLA TYPE

URCEOLATE

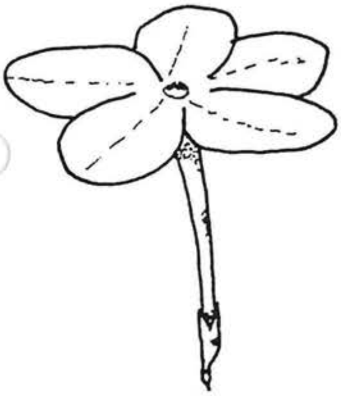


CAMPANULATE

always look at more than one flower - (can get variations)



FUNNEL-FORM



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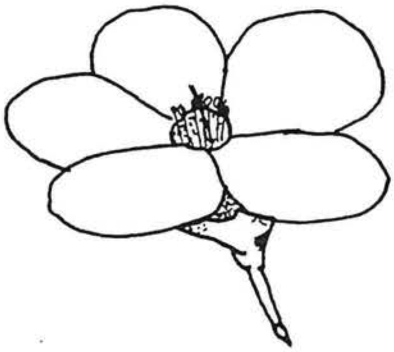

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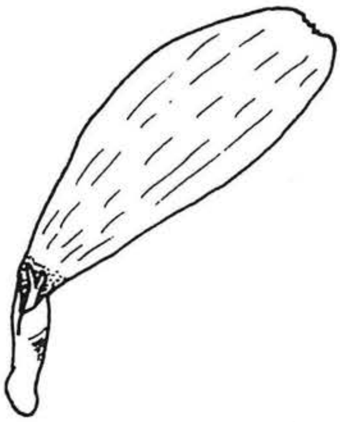

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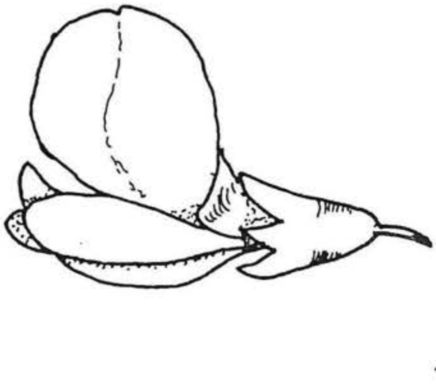

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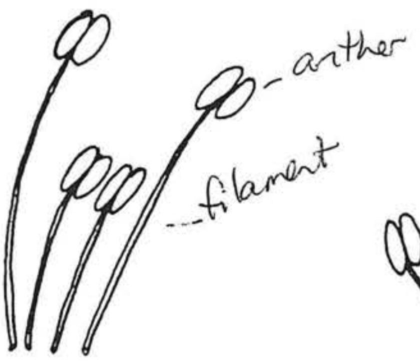

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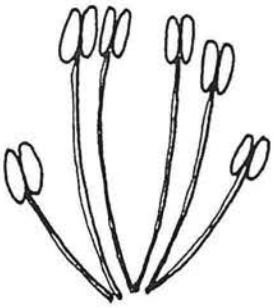

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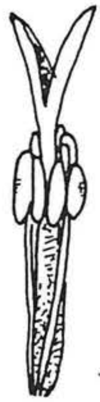

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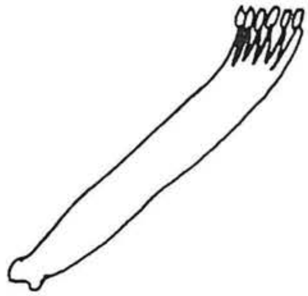

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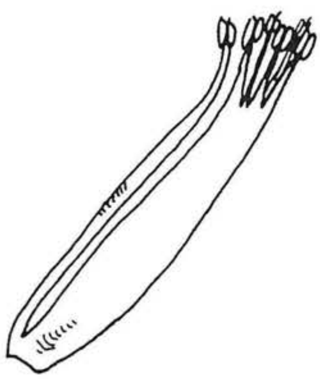

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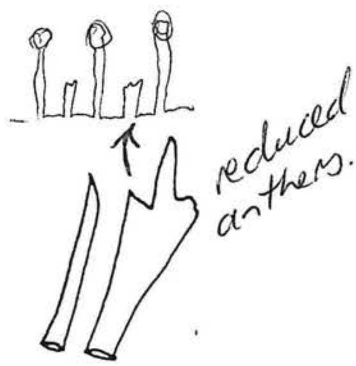

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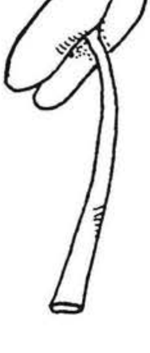

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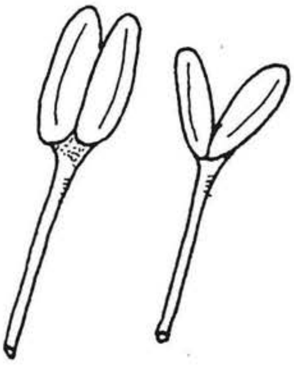

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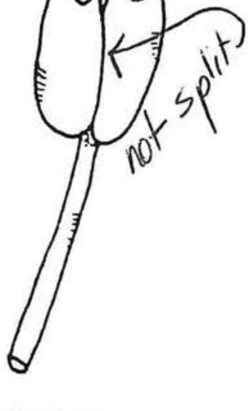

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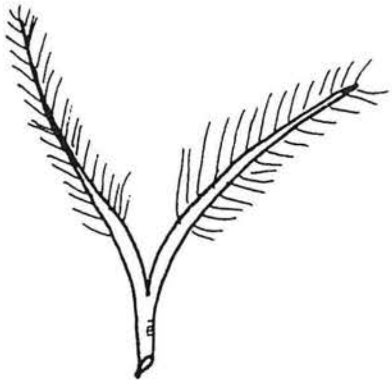
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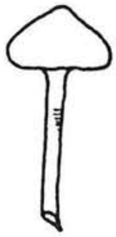
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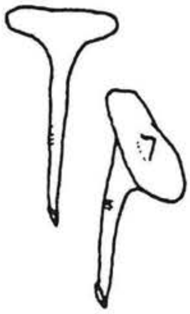
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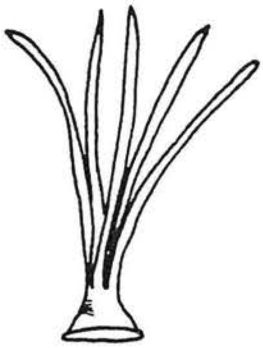
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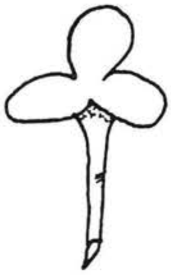
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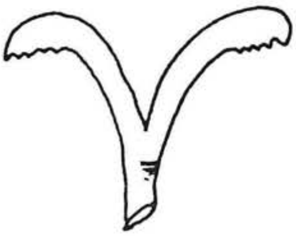
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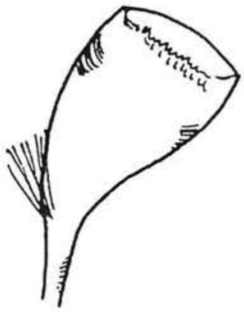
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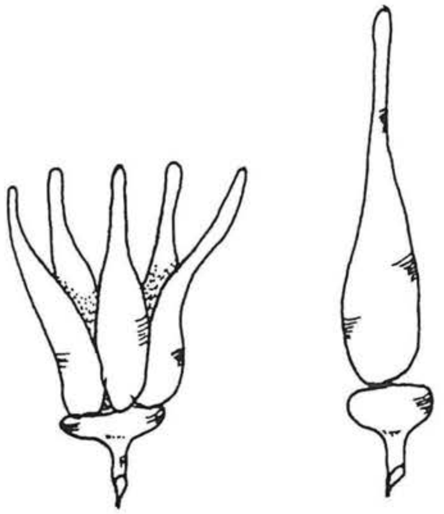

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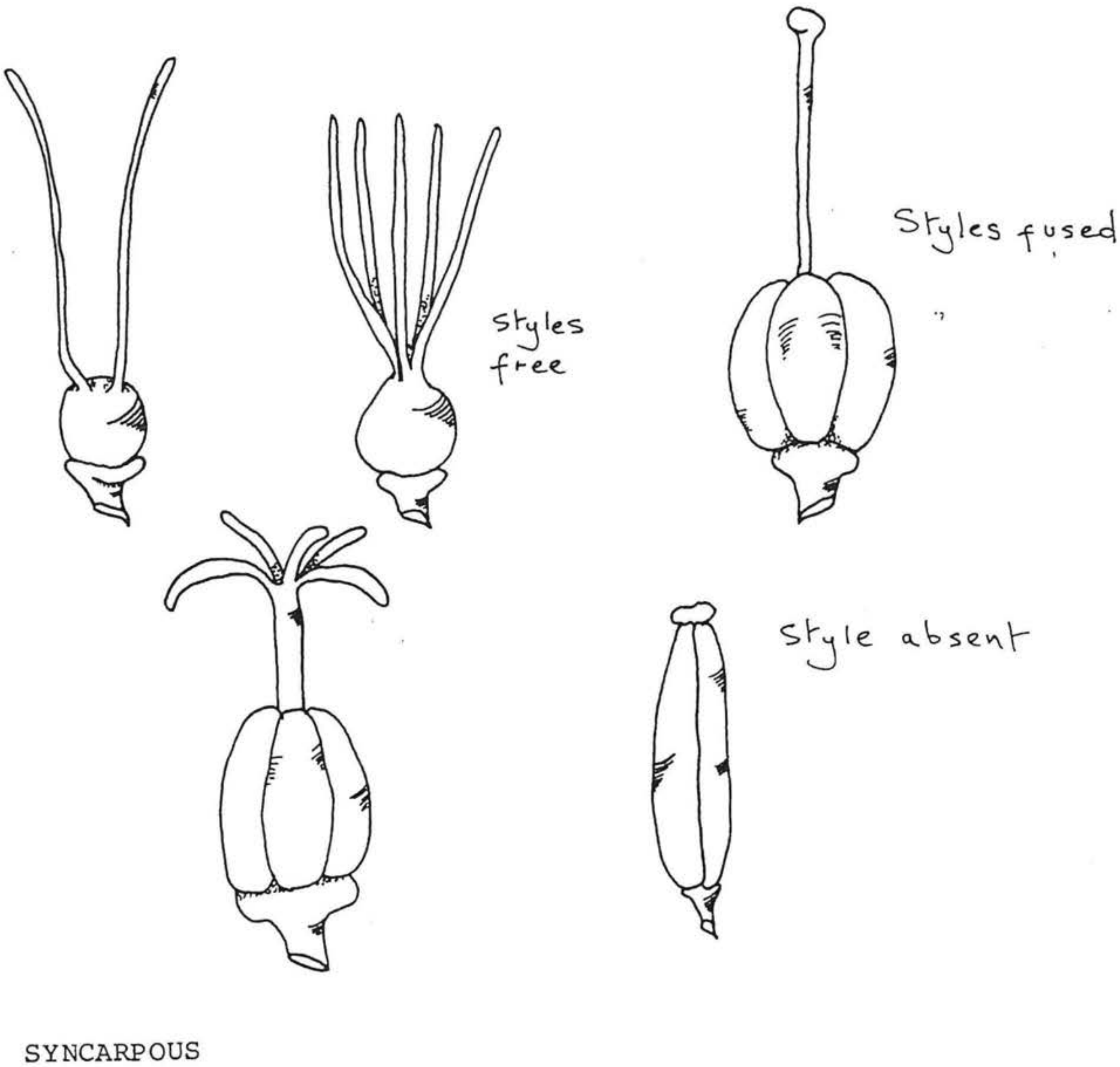
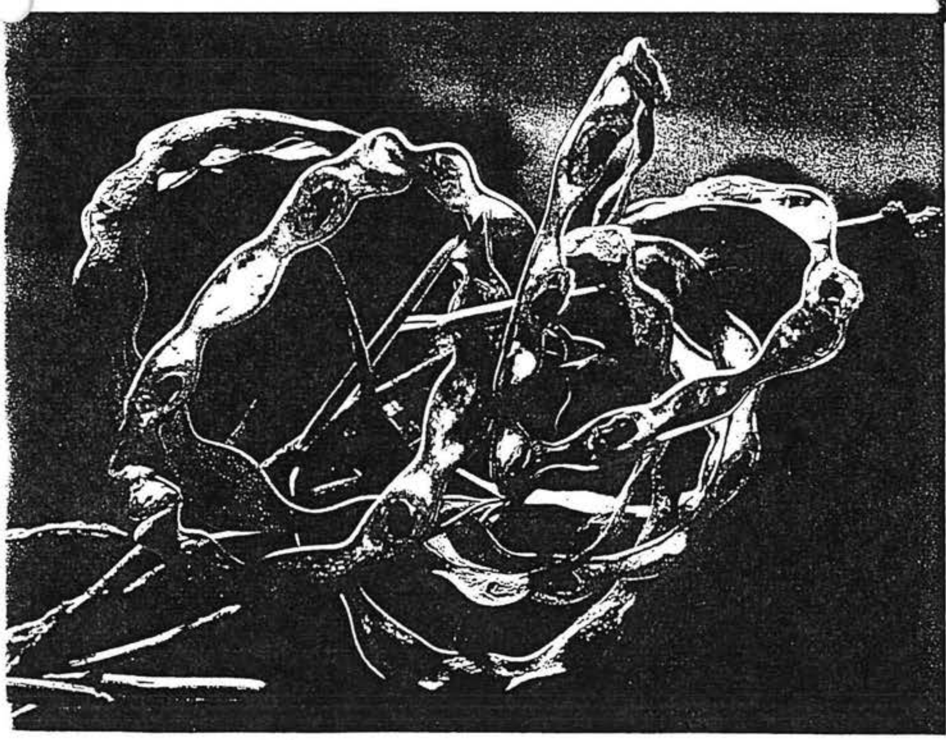


SYNCARPOUS

The Smart Collection



The Western Australian Herbarium is no longer simply a plant museum, it is a dynamic scientific resource. By using the latest technology, staff and volunteers have turned historically collected information into a research tool that is ready to speed along the information super highway.

by
Alex Chapman
and
Paul Gioia

Working smart has become a byword of the modern corporation, but it seems at first glance irrelevant to something as steeped in history and archaic charm as a herbarium. After all, this is the place where you can wander up to a shelf and pull out two folders containing what seem to be identical specimens of dried plant material. One was collected by John Drummond in 1839, the other was collected last year by a PhD student. But then you notice a difference. The label on Drummond's specimen is laboriously, albeit beautifully, written by hand in copperplate. The student's has a computer-generated label, the work of WAHERB, a dynamic resident of cyberspace that has been developed by the Western Australian Herbarium and is equipping it for life in the 21st century.

HOW IT WORKS

For many centuries, plant specimens have been collected from the wild, pressed and described in Latin according to the Linnaean system of classification, established by the 18th century Swedish naturalist Linnaeus, that uses two Latin names—the first being the genus and the second the specific name—to arrive at the species name.

Although the practice of collecting has not changed greatly since the days of the earliest botanists, the way in which this information is stored and used has undergone enormous change thanks to technological advances.

Dried specimens are still the basic tools of taxonomists, the scientists who name, describe and classify species. When a plant is collected in the field, information about its locality, latitude and longitude and habitat is recorded in a field book. Specimens for the vascular collection (flowering plants, ferns and their allies and cone-bearing plants) are dried, then frozen, to preserve them and to kill any insects they may harbour. The specimens are then mounted on stiff sheets of cardboard and labelled with all the pertinent habitat information from the collector's field book. The non-vascular collection (mosses and their relatives, algae, fungi and lichens) is usually stored in special packets or boxes.

It is estimated that about one-third of Western Australia's flora has still not been described, despite the fact that the Herbarium has about 350 000 plant specimens in its collection and is adding to it at a rate of about 12 000 per year. The importance of such work is sometimes overlooked, but without this basic building block, the more glamorous fields, such as DNA research and tissue culture, could not exist.

The Herbarium's work is vital to the Department of Conservation and Land Management (CALM). If plants are classified authoritatively, information related to a species can be reliably documented. While this information is obviously important as a basic research tool in botany, it has a number of practicable and commercial applications as well. For example, it is often vital for land managers to know how certain plants cope with fire or salinity; what sort of plants were indigenous to an area due for rehabilitation; and how the State's threatened flora can best be conserved. The core information about different forms of a particular plant is also vital to commercial growers experimenting with the development of new varieties.

PLANTS WITH BAR CODES

The data now managed by the Herbarium fall into four major types: specimen labels, names, descriptions and biogeographic data. Having all this information is no use at all unless it can be accessed quickly and easily; and integrating all four types of data will provide a powerful conservation device.

In an innovative move, the WA Herbarium introduced a bar coding system for its research collection almost a decade ago—when supermarkets were only just starting to toy with the idea. This was a turning point in the management of the vast pool of knowledge contained in the Herbarium collection, as it revolutionised the processing of specimens. It accompanied the development of the database, known as WAHERB, which has proven to be a powerful tool. WAHERB effectively manages the flow of specimens, while providing fast access to invaluable label information and forming a dynamic link to the never-ending

Previous page
Top left: Rhubarb fungus.
Top right: Cauliflower fungus.
Centre: Flowers of the Pindan wattle.
Bottom: Seed pods of the Kurara.
Photos – Babs & Bert Wells/CALM

Below: The WA Herbarium now tightly integrates its specimen databasing operations (*below left*) with its traditional tasks of taxonomy and curation (*below right*). In late 1994, operators finished the initial phase of databasing the specimen collection when the last of the 350 000 record backlog was entered into the WAHERB database.
Photos – Donna Swan

reclassification of the collection.

In 1990, a database administrator was appointed and external funds granted to increase the rate of data input. This led to a doubling of the annual rate at which specimen details were entered, with about 90 000 specimens being put into the database each year. In December 1994, the databasing of label information from the specimens already in the collection was completed. This was the culmination of ten years' sustained effort by many staff and volunteers. Other advances included the automated production of specimen labels, automation of herbarium loan procedures and a major shift towards obtaining data from all new collections.

The aim of the WAHERB system was to make information on a specimen's identity, appearance and location readily accessible, and to link it to other information systems, thereby fulfilling CALM's role for providing information on the State's flora and fauna.

This year, the focus is on refining data quality and standards, and on ensuring the accuracy of location data so that future products are reliable.

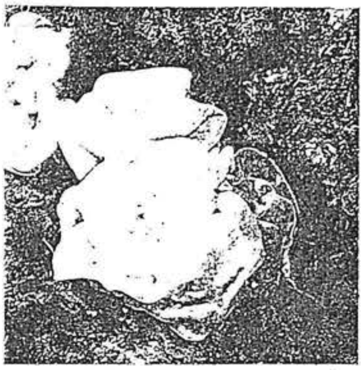
WAHERB's companion, HERBIE, is a personal computer program that allows individual collectors, such as CALM staff, volunteers and other related conservation groups, to maintain their own specimen collection details. There are a number of advantages to using HERBIE. For the user, the program helps store, retrieve and print label information for their own use. HERBIE also allows individual collectors to capture data in a compatible format so specimen information can be uploaded directly into WAHERB without retyping.

WHAT'S IN A NAME?

The name identifying a plant is the foundation upon which all other information about it is built. In 1985, the WA Herbarium published a revised second edition of the *Census of the Vascular Plants of Western Australia*, which includes species names of most plants in the State. However, there was no way of ensuring that the Herbarium contained a valid representative of those names.

In 1991, the WACENSUS database was initiated in order to automate, where possible, the tasks involved in keeping an up-to-date list of published names, to build on the foundation of the previous census and to broaden its scope to include non-vascular plants as well as unpublished names that were in use.

Above: A cone-bearing plant from the genus *Cycas*.
Photo – Kevin Kenneally



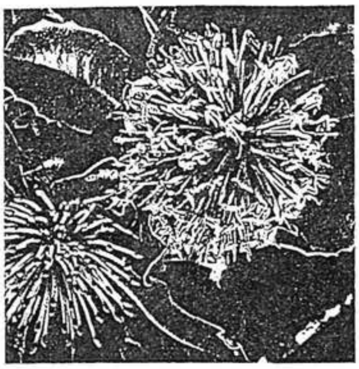
Right (top to bottom): Jelly fungus, beard lichen, scarlet bracket fungus, the earthball and club moss. Information about the names of cryptogamic plants such as these is included for the first time in the new publication of the *Census of WA Plants*.
Photos – Babs & Bert Wells/CALM

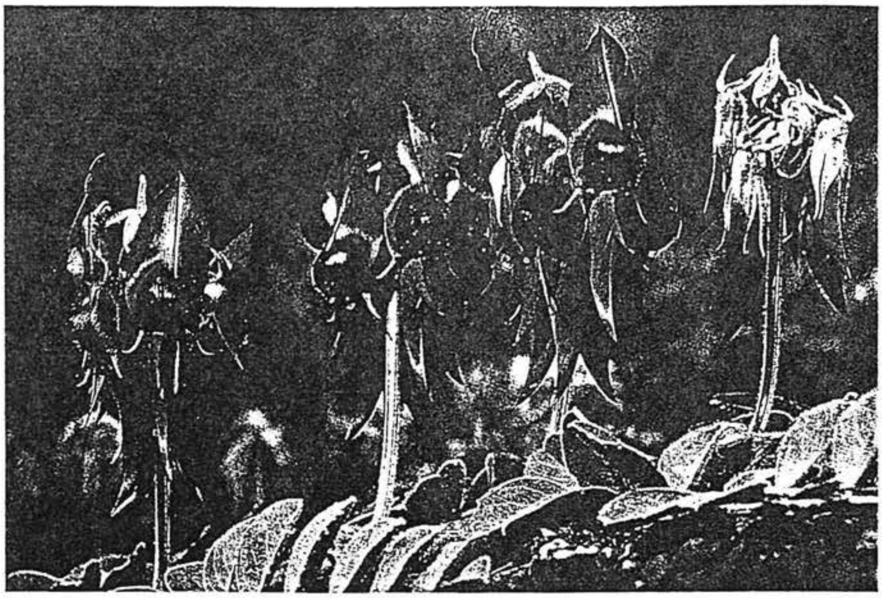
Plant taxonomy is not a static field. Names sometimes change, plants are reclassified or species are divided. WACENSUS was designed to track relationships between names. For example, it could indicate not only that a name was no longer current, but also which other names needed to be considered in finding the most appropriate current name. WACENSUS provides name data linked to WAHERB and individual users' databases, and also automates the production of the new *Census of Western Australian Plants*.

In the same way that HERBIE is a small version of WAHERB, a companion to WACENSUS, called SEDIT, exists for personal or project use. SEDIT allows users to enter species names, which can be validated against the names supplied by WACENSUS. This helps ensure that species names in users' databases remain consistent with WACENSUS and retain their integrity and value.

THE KEY TO IDENTITY

Plants are commonly identified by the use of a 'key'—a sequence of statements about their physical characteristics. A key consists of a series of 'either/or' choices ('Is the flower blue or pink?'), each choice leading to another. Through the process of elimination, the reader is guided to the correct plant name.





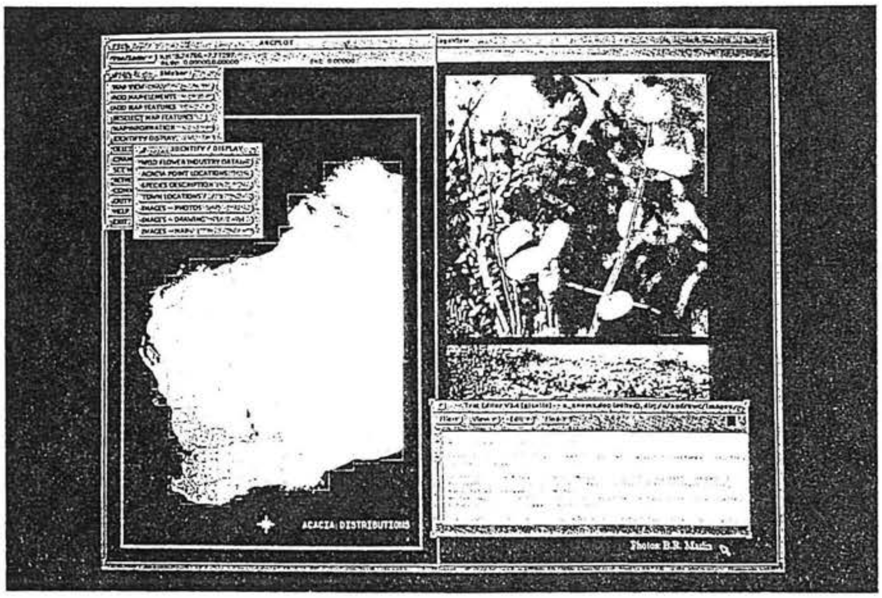
Designing a useful key is a challenge, a task that computers can make easier. The Descriptive Language for Taxonomy (DELTA) is an international standard developed over the last twenty years. It allows those involved with classifying and describing organisms to capture their base data in such a way that it can be automatically transformed into a number of different products, including keys. Once the data is fully entered in this manner, it may be automatically converted into descriptions, either printed or interactive keys, or output for further scientific analysis of relationships. It is the plain descriptive text and the interactive keys that are the most used features of the DELTA system.

MAPPING THE FLORA

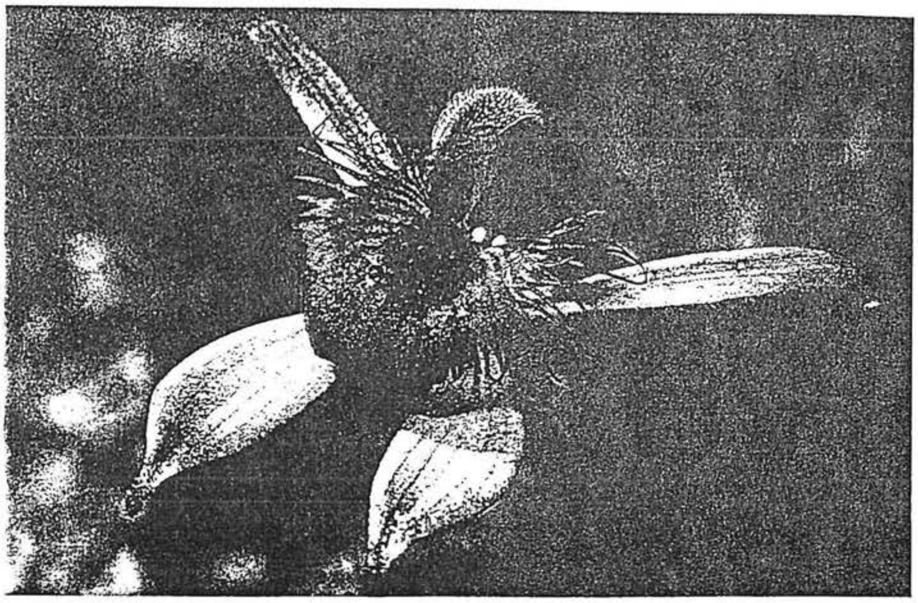
The main purpose of checking location accuracy for WAHERB specimen records is to provide reliable maps at a specified accuracy level to CALM staff. Perhaps the greatest demand in this area

Left (top to bottom): Holly-leaf banksia, honey-suckle grevillea, nodding banksia and pink pokers. Descriptive database projects compiling DELTA data on the genera of WA flowering plants (initially those in Proteaceae), Australian *Acacias* and the genus *Olearia* will result in a comprehensive set of interactive keys.
Photos – Babs & Bert Wells/CALM

Below: Interactive mapping applications can help visualise species distributions and display descriptions, drawings and images of the plant derived from a range of DELTA projects.
Photo – Leonie O'Halloran



Left: The Sturt pea was one of the first Australian plants collected by an Englishman (William Dampier in 1699) and was one of the first to be described, albeit using the pre-Linnaean system, in 1703. It was formally named in 1832 and given its most well-known name, *Clianthus formosus*, in 1950. It was reclassified as *Swainsona formosa* in 1990.
Photo – Babs & Bert Wells/CALM



Right: Dancing orchid. The *Descriptive Catalogue of WA Plants* is a joint project between the WA Herbarium, the Wildflower Society of WA and Kings Park to produce a book and interactive key briefly describing every plant species in the State. To date, all monocots have been described.
Photo – Babs & Bert Wells/CALM

is for simplified but informative maps of where species occur. Geographic Information Systems software is used to manipulate and view this information.

Another of the WA Herbarium's innovative software applications allows users to prepare and place existing species distribution data from WAHERB onto a scalable map of the State. Predefined additional information such as roadways, hydrology, conservation reserves and place names, as well as scale and title information, can also be added. The resulting map can then be printed, if required, or used for further interrogation of the data. For example, when the user enters the name of the species to be mapped, the application retrieves the locations directly from WAHERB and displays them as points on the map. Selecting any point will then display the related specimen data and, optionally, bring up a standard species description, illustration or image prepared from one of the DELTA projects. This illustrates the application's ability to integrate all four major types of Herbarium data (specimen labels, names, descriptions and biogeography).

HERBARIUM IN CYBERSPACE

With the establishment of CALM communications networks and access to the Internet worldwide network, the possibilities for distributing information are enormous. A site on the Internet is aready being established by CALM, with access to selected herbarium data being one of the features. Specimen data (with only generalised localities to protect the native flora) and census information can be made available for query, and collaboration with CSIRO scientists will result in the ability to transform DELTA descriptive data directly for presentation on the Internet.

As we move into the 21st century, conservation will remain the key role of the WA Herbarium. And it is well equipped for the job, having embraced the notion of electronic databasing 10 years ago. Now wasn't that a smart move?

DELTA AT WORK: THE INTERACTIVE KEY

The traditional printed key requires the user to have considerable taxonomic knowledge. An interactive key prompts users to answer appropriate questions about the plant they are trying to identify. As well as selecting the questions based on a user's previous answer, it can also display notes or images to illustrate the terminology. The program can then display photos and line drawings of the resulting species to confirm the identification.

CALM's Science and Information Division is developing a method of using DELTA (Descriptive Language for Taxonomy) that will ultimately lead to the availability of interactive keys for all the State's flora. Although this is a very long-term goal, various groups, such as the 282 threatened flora species, can be prioritised for this treatment. Choosing from a range of 120 characters coded for each species, a user can key out a specimen to find out if they have a threatened species and display the images and map of known distribution to confirm the identification. Once the project is finalised and the appropriate images gathered, this set of data can be published as a CD-ROM providing a very informative and easily distributable source of reliable data on these important species. The data can be updated and released at the same time as the yearly gazettal of threatened flora prepared by CALM's Wildlife Branch.

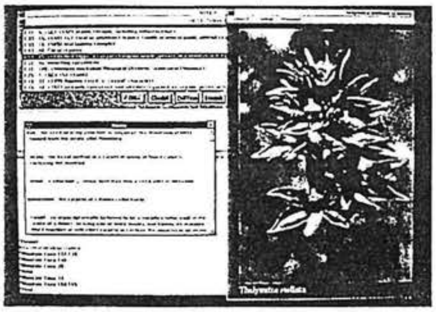


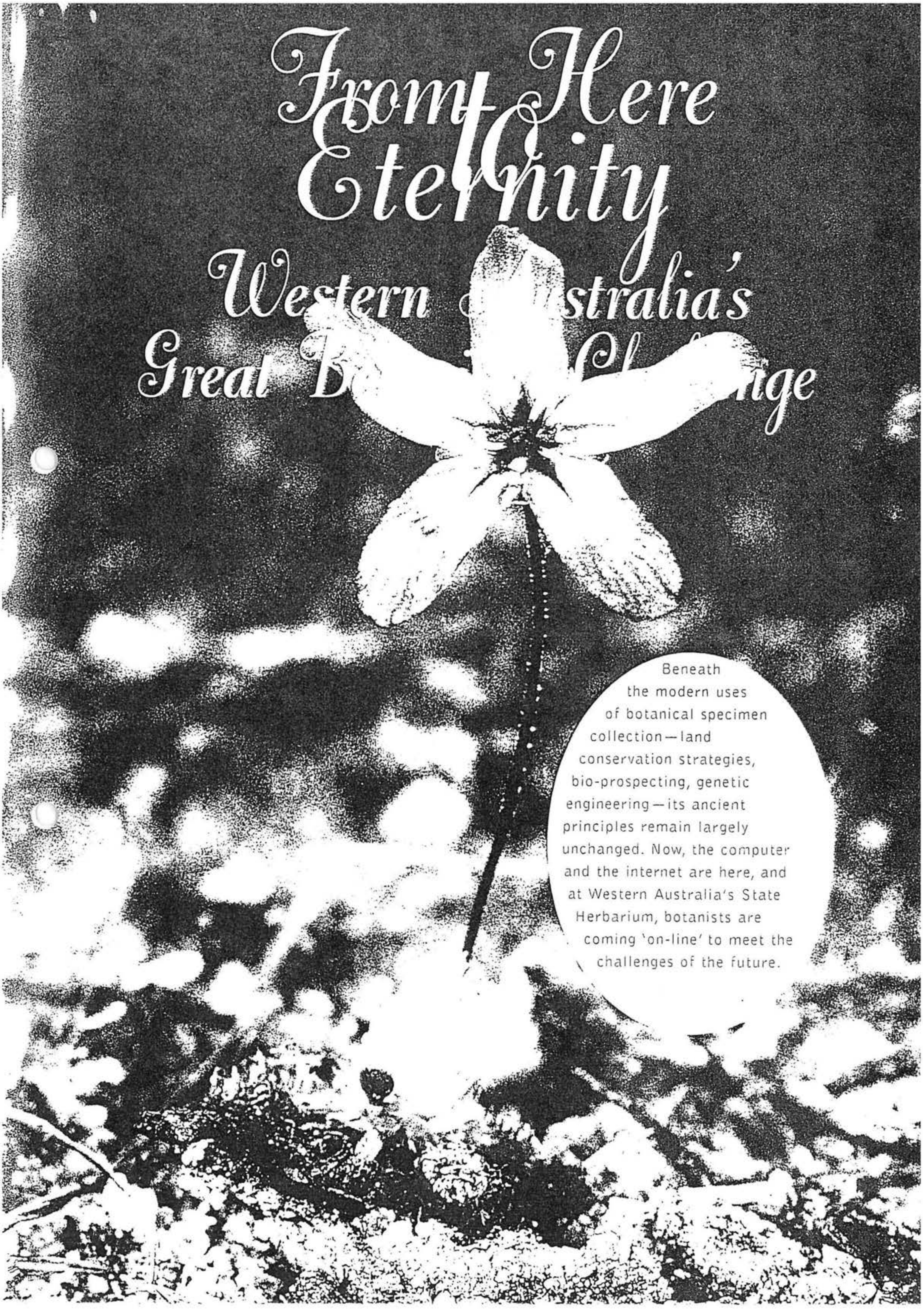
Photo — Leonie O'Halloran

Alex Chapman is a research scientist with CALM and has a research interest in presenting DELTA descriptive data on the Internet. He can be contacted at CALM's WA Herbarium on (09) 334 0500.

Paul Gioia is a research scientist with CALM and has a particular interest in designing computer systems for biological data. He can be contacted at CALM's Wildlife Research Centre (Woodvale) on (09) 405 5140.

From Here to Eternity

Western Australia's Great B[illegible] Challenge



Beneath the modern uses of botanical specimen collection—land conservation strategies, bio-prospecting, genetic engineering—its ancient principles remain largely unchanged. Now, the computer and the internet are here, and at Western Australia's State Herbarium, botanists are coming 'on-line' to meet the challenges of the future.

estern Australia is renowned the world over for the richness of its plant life. The State's flora represents almost half of Australia's estimated 25 000 plant species. Yet until recently, some 20 per cent of the species in this botanists' paradise had gone largely undescribed. With the ever-expanding resources of the Department of Conservation and Land Management's Western Australian Herbarium, botanists are intensifying the challenge of classifying and naming our wealth of native flora, in the service of scientific endeavour as well as natural heritage.

Although recently computerised, CALM's WA Herbarium maintains traditional principles and practices handed down over hundreds of years. As biological specimens go, plants have always lent themselves particularly well to preservation and study. The technique of plant pressing dates back to the middle ages, when it was first discovered that a plant specimen pressed firmly between soft absorbent surfaces dried quickly, did not shrivel, and could be preserved indefinitely. It was on this basis that the first herbaria were developed. These early collections became virtual libraries of specimens carefully pressed and stored, along with simple field observations, such as the time and place of collection or any noteworthy features of the environment.

Nowadays, herbaria have been transformed from quaint early museums of plant specimens to modern scientific resources. Each specimen is a databank of information, representing a species whose significance may vary, from its geographic region, to its phytochemistry, to its insect damage or disease resistance, to any combination of features. DNA samples, leaf or wood anatomy, or chemical characters can be observed, and such information can assist with naming the species and identifying its relationship to other species. Today's herbaria persist as the main tool of the modern botanist, whose science has survived and evolved with the times to be as important as any other to modern human endeavour.

Previous page
WA is renowned for its high number of sundews. Many, like this *Drosera miniata,* live on winter-moist soil and survive the summer as balls of white, protecting leaf parts.
Photo – Babs & Bert Wells/CALM

Left: A dried, mounted and labelled herbarium specimen is a single sample of a population of plants, and can reveal much about a species.
Photo – Neville Marchant

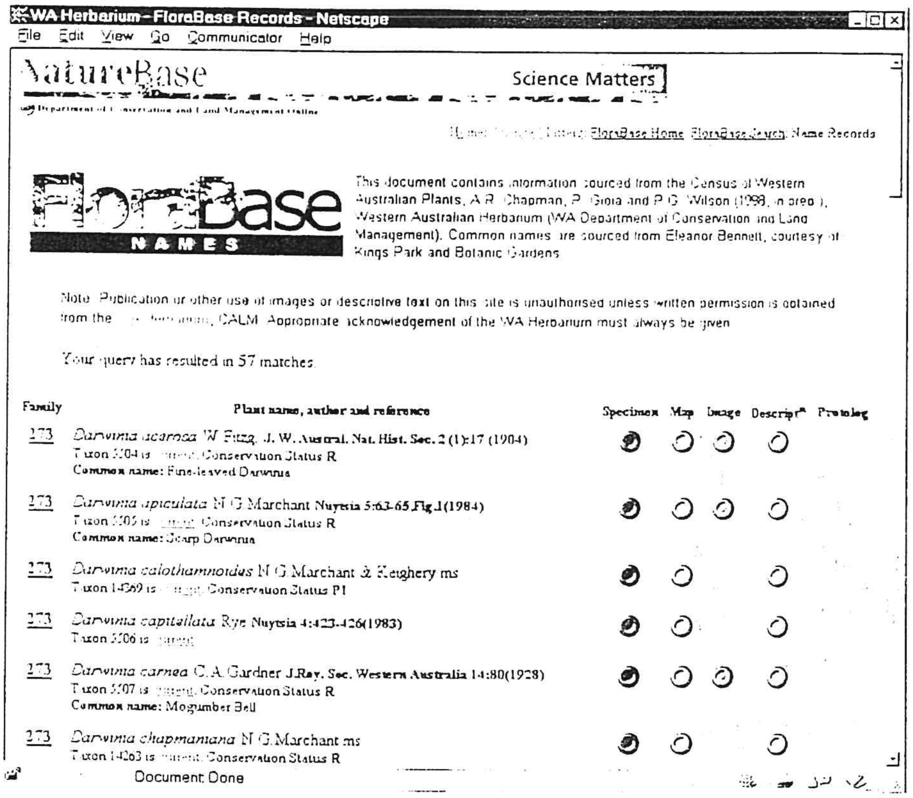
Below: WA has a huge variety of wildflowers. We see here spider orchid (*Caladenia multiclavia*), and many everlastings, with wattle and sheoak trees.
Photo – Babs & Bert Wells/CALM

For example, botanical knowledge holds the key to advances in land conservation and in bio-prospecting, the growing technology of finding and putting to use the natural chemical and pharmaceutical properties of the plant world. Economic botanists and ethnobotanists, who collate knowledge from indigenous people, still search the world for economic plants or active pharmaceutical compounds to combat antibiotic resistance or emergent diseases such as AIDS.

HERBARIA THROUGH HISTORY

Herbaria have not just achieved this political and economic significance recently. Botanical collections were at the cutting edge of the age of exploration and political expansion. From the 1700s herbarium botanists and their herbaria played a major role in documenting the world's economic plants and their characteristics. Botanists such as Joseph Banks held high scientific and political status as important members of European exploration voyages for their contribution to the expanding empires. The discovery of the anti-malarial properties of quinine, a substance found in plants of the American genus *Cinchona*, is a prime example. It led to a concerted effort by chemists, working with specimens collected by exploration botanists from the information provided by Kew herbarium taxonomists, to find the highest yielders of the substance. This enabled the quinine-rich species to be propagated and the seed to be taken to British India. Eventually the refinement of quinine enabled the expansion of European empires to other parts of the world where malaria was endemic.

The development of many natural products such as jute, rubber, cotton, tobacco and sisal also depended heavily on herbaria, as did the enhancement of food crops such as wheat, rice and potatoes, and a huge variety of medicinal plants. Information about where and under what condition the species grew, the variation, how they could be propagated, how they were pollinated, and their potential or actual use, was stored in herbarium specimen labels, in files, and in books.



WA Herbarium – FloraBase Records – Netscape

File Edit View Go Communicator Help

NatureBase — Science Matters

Department of Conservation and Land Management Online

FloraBase Home FloraBase Search Name Records

FloraBase NAMES

This document contains information sourced from the Census of Western Australian Plants, A.R. Chapman, P. Gioia and P.G. Wilson (1998, in prep.), Western Australian Herbarium (WA Department of Conservation and Land Management). Common names are sourced from Eleanor Bennett, courtesy of Kings Park and Botanic Gardens.

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Your query has resulted in 57 matches.

Family	Plant name, author and reference	Specimen	Map	Image	Descript	Protolog

Family | Plant name, author and reference | Specimen | Map | Image | Descript* | Protolog

273 *Darwinia acerosa* W.Fitzg. J. W. Austral. Nat. Hist. Soc. 2 (1):17 (1904)
Taxon 5304 is [illegible]. Conservation Status R
Common name: Fine-leaved Darwinia

273 *Darwinia apiculata* N.G.Marchant Nuytsia 5:63-65 Fig.1(1984)
Taxon 5305 is [illegible]. Conservation Status R
Common name: Scarp Darwinia

273 *Darwinia calothamnoides* N.G.Marchant & Keighery ms
Taxon 14369 is [illegible]. Conservation Status P1

273 *Darwinia capitellata* Rye Nuytsia 4:423-426(1983)
Taxon 5306 is [illegible]

273 *Darwinia carnea* C.A.Gardner J.Roy. Soc. Western Australia 14:80(1928)
Taxon 5307 is [illegible]. Conservation Status R
Common name: Mogumber Bell

273 *Darwinia chapmaniana* N.G.Marchant ms
Taxon 14203 is [illegible]. Conservation Status R

Document: Done

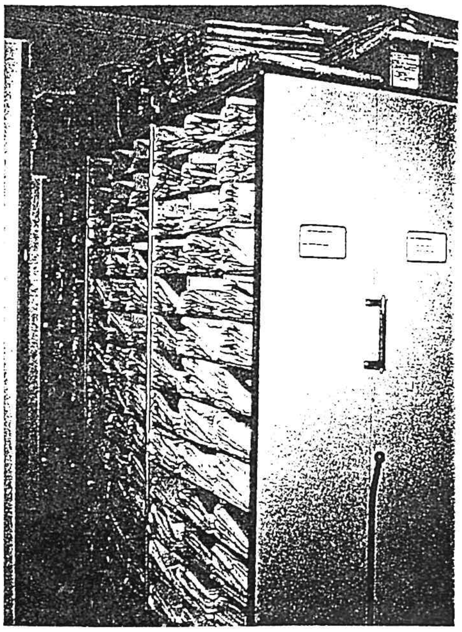
Top (left and right): Look-alike bell 'flowers' Qualup bell (*Pimelea physodes*) and tulip bell (*Darwinia macrostegia*) from the Stirling Range belong to different plant families and have very different individual flowers within the bell.
Photos – Babs & Bert Wells/CALM

Above: The Herbarium databases are accessed on one page of the web page 'FloraBase'. The current scientific name, synonyms and details of the original publication of the name are given.

THE EVOLUTION OF CALM'S WA HERBARIUM

In international terms, the Western Australian Herbarium was a late starter. Although the earliest surviving specimen was collected in 1801, more than twenty years before European settlement, it was not until the 1920s that formal documentation of the State's flora began. The State Collection was formed out of three existing collections: an economic collection of WA weeds and plants used by pastoralists, and poison plants to be avoided; a forestry collection; and a general museum collection.

Following World War II, the field of taxonomic botany declined, and herbaria the world over languished along with it. Most of the flora of the technologically



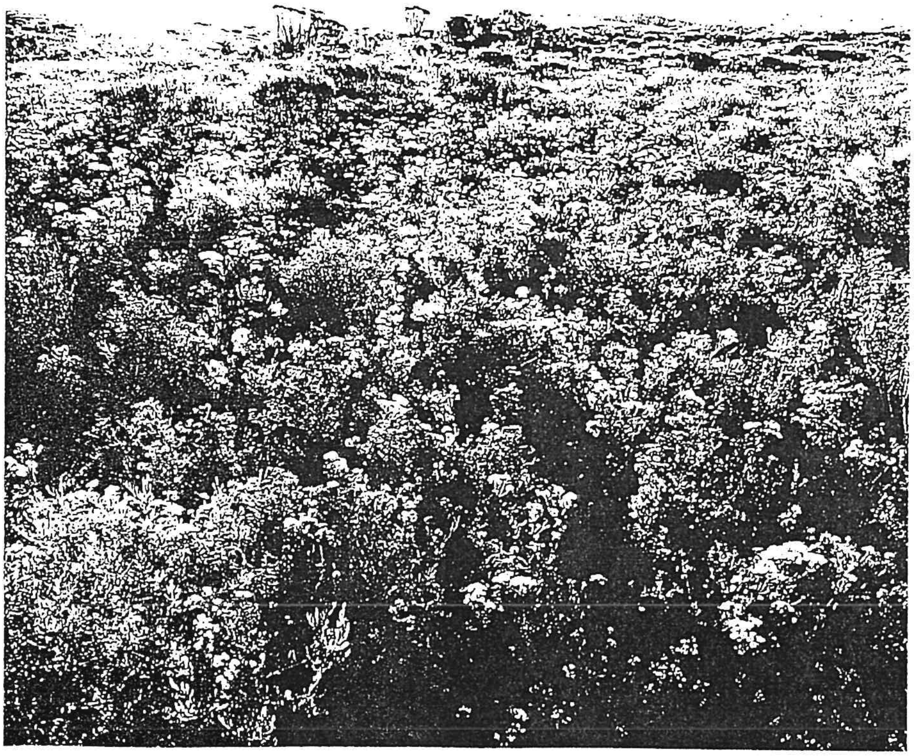
advanced countries was well known and advancing biotechnology appeared to be eclipsing the role of botanical science. However, its importance began to resurge in the 1970s with the recognition of the conservation value and pharmaceutical potential of plants in tropical and subtropical countries.

Today, the vast amounts of information stored in CALM's WA Herbarium have been recorded in an electronic database and are readily accessible to conservation scientists and planners (see *LANDSCOPE*, Winter 1995). The main database, WACENSUS, is a world-class information system where there has been value-adding to an electronic list of names. Users can cross-refer to the actual specimen records, a map of where the species occurs and, where they are available, full colour images of the whole plant and a close-up of the leaves and flowers. This system is currently available to CALM researchers and is soon to be made accessible to subscribers over the Internet.

As well as sophisticated storage and retrieval systems, CALM botanists are now producing electronic guides to the flora of WA. A network of regional field herbaria are now linked to the State collection in a program to ensure that information about the rich flora of WA can be accessed by Landcare and a number of other regional conservation groups. The main herbarium in south Perth has a parallel resource, a separate reference collection for the use of outside botanists. Each of the 11000 specimens in the reference collection is a duplicate of a fully labelled specimen in the main collection. In addition to the main reference collection, which is managed by volunteers, there are reference collections in Albany, Manjimup and Karratha, as well as almost 50 other smaller herbaria in centres ranging from Broome to Esperance.

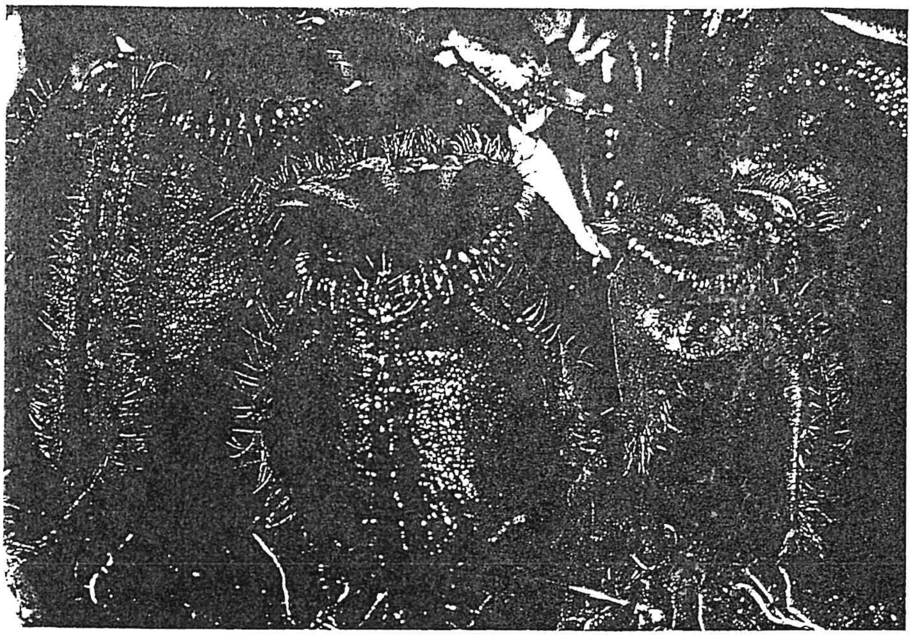
A JOB NEVER FINISHED

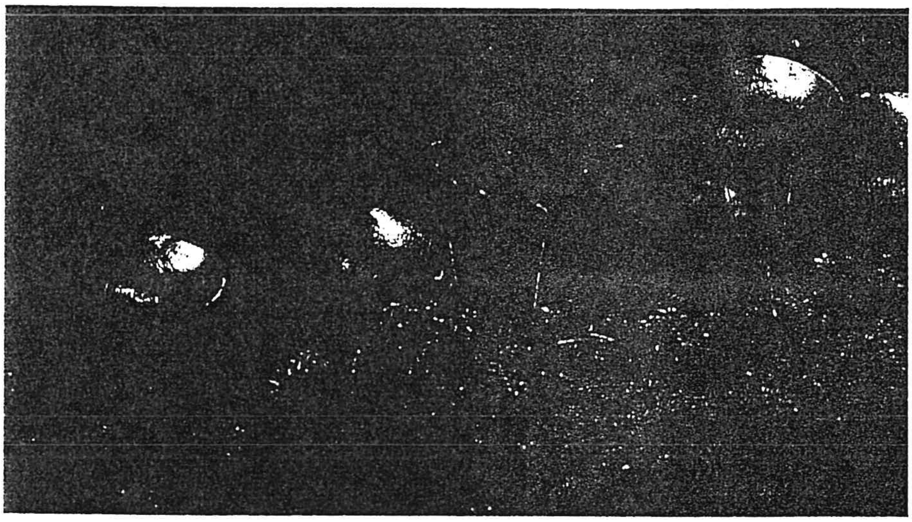
Just as the process itself is timeless, the techniques of collecting and examining specimens remain largely unchanged from the past. Herbarium specimens are mounted on special thick paper and, after naming and labelling with field details, are stored in special cupboards. Each sample can be studied simply by examining the character of the leaves, or even the dry flowers, as well as the detailed notes on each label. When correctly prepared, even the specimen's flower colour can usually be maintained. Certainly, the features of leaves, stems, and flower parts—be they hairy, prickly or otherwise textured—are retained forever. For detailed study, an individual flower can be carefully removed and soaked in a little ordinary washing-up liquid, which will cause it to swell to the same size and shape as it was when it was fresh. Even though they are non-living, the minute parts can be measured, photographed or drawn, and the whole flower can be re-dried and placed back onto the herbarium sheet.



Above left and right: Specimens at CALM's WA Herbarium are stored in insect-free vaults. Related species are stored together and are readily accessible to researchers.
Photos – Neville Marchant

Left: The extensive heaths of low shrubs of WA are world-famous for their incredible diversity. Small areas have as many species as similar areas of the rich tropical rainforest of other countries.
Photo – Jiri Lochman





UNCHARTED BOTANICAL TERRITORY

CALM's WA Herbarium boasts hundreds of thousands of 'voucher' specimens, covering the plant kingdom from the lowly algae, fungi and lichens to the highly evolved and intricate orchids, triggerplants and everlastings. But the collection is only the beginning. Despite the renowned abundance of plant species in Western Australia—the south-west alone is one of the world's richest botanical areas, with an estimated 9000 species—it remains the only State without a published account of its flora. The flora of the Kimberley and metropolitan areas have been documented, but a vast amount of work remains. Botanists in WA have barely started to document organisms other than the flowering plants. Even though there are extensive collections of mosses, liverworts, algae and microfungi and their allies, an enormous task lies ahead in classifying them. The vascular plant flora, which includes the ferns, fern allies, pines, cycads and flowering plants, is still being documented and, judging by the number of new species being discovered, it will be many years before there is a representative list of species of WA.

FISH OR FLESH?

Taxonomy is the science of assigning a biological specimen to a series of ordinal classifications based on its observed characteristics. To begin with it may belong, for example, to either the plant or animal kingdom. As the observations become more detailed, the specimen is assigned to a phylum, class, order, family and, finally, to a genus and a species. So it is that taxonomists may end up describing a new species, and giving it a name.

The fact that WA is such a special place for native plants, widely acclaimed for its abundance of species, particularly woody shrubs, makes classifying its botanical species particularly tricky. This flora has evolved in a harsh climate and many species of different families look superficially similar. Hundreds of shrubby species all have small needle-like leaves, any many others have similar looking flowers. This parallel evolution in harsh climatic conditions has created many types of plants, which, at a glance, appear to be the same, or closely related. To a trained eye, however, these look-alikes may have significant structural differences that set them far apart, and these differences may extend a long way up the taxonomic ranks. Such distinctions, which may seem minor on the surface, become extremely important in the face of the issues of conservation, land rehabilitation, and bio-prospecting.

Top left: A 'broth' of decomposing insect victims supplies nourishment to pitcher plants. These can grow in dense thickets without need for many roots to compete for space in the surface soil.

Top: Many of WA's species are unique and only distantly related to plants of other regions. The pitcher plant (*Cephalotus follicularis*) ranges from near Yallingup to east of Albany.

Above: CALM's WA Herbarium now has a comprehensive preserved collection of mosses and their allies. Fungi are widespread in WA and are increasingly becoming known as studies and collections increase.
Photos – Babs & Bert Wells/CALM

NAMING TROUBLES

A plant inventory is like a jigsaw puzzle with an infinite number of pieces. Any herbarium, ancient or modern, is part of a process of continual evolution and change, as more pieces of the puzzle—knowledge—becomes available.

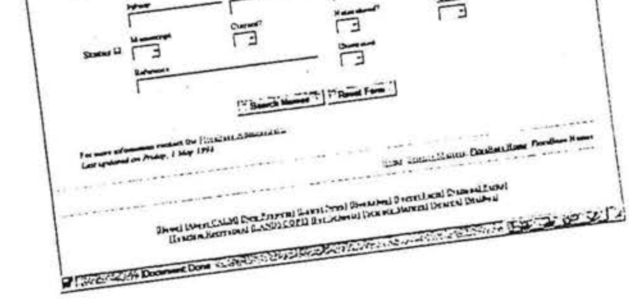
KEEPING THE STATE COVERED

CALM's WA Herbarium receives duplicates from volunteer regional group plant collectors who have been trained to collect and label specimens. The label information includes the height and growth form of the plant, soil type, surrounding vegetation and any available observations on pollinators, salinity level of the site, logging history or fire history. Some regional groups send details on a computer disk and these are loaded into the appropriate herbarium databases. Once a specimen has been identified correctly by herbarium botanists, a printed label is returned to the country based group, labelled with a barcode identical to that on the parent specimen in the State collection. Through this system, affiliated country groups can keep abreast of any corrections to the original identification, and can also gain access to any name changes a particular species may have undergone.

Regional herbaria act as a local interactive resource. Landcare groups, for example, may use their local reference collection to find plant species that can grow in saline soils. Those concerned with managing remnant vegetation are documenting the species of reserves and roadsides. People interested in developing nature trails can collect the commonly seen, interesting species along the proposed route, and consult the collection to produce guided walks with botanical information. The potential uses of CALM's WA Herbarium and its allied regional resources are limitless.

Above: Taping specimens to special cards, affixing the correct label, and ensuring that fruits or seeds are added to the correct sheet, require painstaking effort. About 30 000 specimens are added to the collections each year.
Photo – Neville Marchant

Below left: The FloraBase search screen is the starting point for searching for plant information.



There are still many species yet to be discovered in Western Australia. In many cases, even where there are specimens of an unknown species available, botanists have insufficient information about its relationships and often only a superficial knowledge of variation. This sort of uncertainty makes it difficult to assign a reliable scientific name to a new specimen, and there are too many species in Western Australia for common names to be used with confidence.

Errors of identification and difficulties with the determination of the limits of genera and species can frequently result in name changes. Knowledge of the names of the WA flora is rapidly advancing, and the accompanying rapid changes can make it difficult for researchers to keep up. Nomenclature, the branch of systematic botany concerned with naming procedures, is a precise and well-ordered discipline with strict internationally agreed rules. Name changes are not made frivolously. One of the biggest challenges facing the taxonomist is the development of a classification system that groups related plants together. The WA Herbarium's computer systems enable users to keep up to date with name changes and additions to the inventory of the State's flora.

INTO THE FUTURE

The first botanists of the Middle Ages, with their pressings, were building a legacy for the generation to follow, and at CALM's WA Herbarium the tradition continues. The value of any herbarium is cumulative, through the ages, and the definitions and names and associations of different species change over time. Beneath the layers of state-of-the-art computer technology which now makes the botanists' job easier, are two timeless scientific methods that will extend into perpetuity as far as they extend back into history: the gentle technique of specimen gathering and plant pressing, and the rigorous intellectual exercise of classification and nomenclature.

An important part of the WA Herbarium's recent resurrection is the recovery of early specimens sent abroad. Even in the first few decades of European settlement, thousands of specimens were sent to botanists and horticulturists overseas. Plans to repatriate numbers of these early samples are taking shape. A recent agreement between the WA Herbarium and those of Paris and Geneva will result in the exchange of valuable specimens collected by early French expeditions to WA as well as duplicates of the collections of colonial botanist James Drummond. Arrangements such as these mark the coming of age of CALM's WA Herbarium and the bright future for documenting our unique flora.

Dr Neville Marchant is Director of CALM's Western Australian Herbarium and Manager of the CALMScience Biological Information Group. He can be contacted by telephone on (08) 9334 0555 or email (nevillem@calm.wa.gov.au).

A Stately Collection

by Carolyn Thomson

Botanists from CALM's Herbarium can find themselves knee-deep in a North-West billabong dappled with water-lilies . . . and saltwater crocodiles. They may have to wade across the reefs fringing offshore islands in the West Kimberley at low tide, dodging sea-snakes and stingrays. Or they may be studying the plants on an isolated scrub-covered hill in the Stirling Range, or pushing through the dense, prickly heathlands on the sandplains of the South-West. But for dedicated botanists the effort is well worth it. They may be lucky enough to find a plant that has never been collected and described before.

THE WESTERN AUSTRALIAN HERBARIUM
Department of Conservation and Land Management

From top:
red boronia
(Boronia heterophylla);
Diplopeltis stuartii;
bush pomegranate
(Balaustion microphyllum);
and Albany pitcher plant
(Cephalotus follicularis).
Photos - Michael Morcombe

THE more mundane work of mounting specimens and classifying plants is just as vital, as it too contributes to the huge task of documenting and managing the extensive flora of the State.

The hub of these activities is the Western Australian Herbarium in Kensington, where rows of steel shelves house over 400 000 pressed and dried plant specimens. Here, botanists can be found identifying, naming, classifying, curating and generally probing into WA flora, much of it unique to the State and quite a bit of it still poorly known and unstudied.

Along with the extensive research collection, the Herbarium contains a Community Reference Herbarium, the State's botanical library and a huge computerised database that will eventually store readily accessible information on the entire Herbarium collection. There are also regional herbaria in Albany, Manjimup and Karratha as well as 55 field herbaria in national parks, reserves and CALM's regional and district offices.

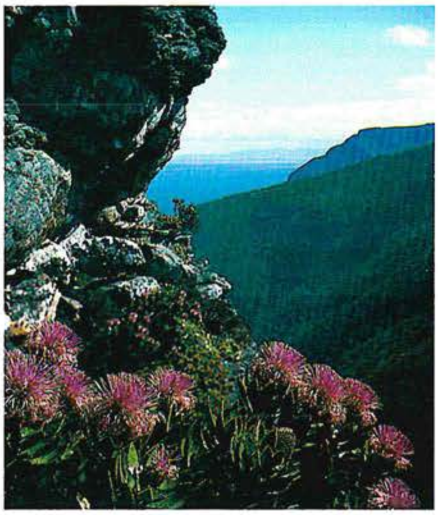
DISCOVERY AND GROWTH

The discovery of the Australian continent created great excitement in botanic circles. Since 1699 a host of visiting botanists and explorers have collected Western Australian plants, including William Dampier, Robert Brown (the botanist on Matthew Flinder's voyage), James Drummond and Ludwig Preiss. Most of these historic specimens found their way into vast collections in herbaria in Berlin, Geneva, Paris, London, Florence, Kiev and other parts of Europe.

It wasn't until the 1890s that official herbaria were established in the State, in the newly formed Museum and in the Department of Agriculture. The latter appointed a botanist and began a collection of economically important plants. In 1916 the Forests Department established a herbarium for species from South-West forests. However, the unique character of Western Australia's flora attracted world-wide interest and the State needed a single herbarium recognised by the herbaria of the world.

The decision was made in 1928 to merge the three herbaria into a single State Herbarium. The amalgamation was finally completed in 1959 when the Museum collection was transferred on permanent loan to the Herbarium in the Department of Agriculture.

The whole Herbarium was transferred in 1988 to the Department of Conservation and Land Management (CALM) to form a vital arm of its Research Division. Along with its expanded role in CALM, the Herbarium also has a new



Pink-flowering *Isopogon latifolius* is confined to the upper peaks of the Stirling Ranges. It was described in 1830 by Robert Brown, the botanist on the Matthew Flinders expedition.
Photo - Michael Morcombe ▲

Large hibbertia *(Hibbertia lasiopus)* is common in the gravel soils of the jarrah forest.
Photo - Michael Morcombe ▼

Curator, Jim Armstrong, formerly the Assistant Director of the Australian National Botanic Garden in Canberra.

MANAGING FLORA

The Herbarium aims to provide a system of internationally accepted names for the estimated 11 000 plant species found in WA. Of these, about 8 000 species are currently described and a further 3 000 are recognised yet have no scientific names. About 800 exotic species are naturalised in WA. Without the Herbarium to provide information on the characteristics, habitat and distribution of the State's species, managing flora in natural areas would be difficult.

The Herbarium's work is vital to CALM. If plants are reliably named and can be identified, then information about their biology can be stored and retrieved. For example, information on how plants cope with fire is of particular use for land managers. CALM also needs botanical information on the State's rare flora in order to manage and conserve it.

Because of its origin in the Department of Agriculture, the Herbarium has always played an important role in identifying poisonous and other problem plants. For example, in some areas of the State the introduced prickly pear threatens agriculture and it is hard to eradicate when established.

But some varieties are more damaging than others, and that's where the Herbarium comes in. The Department of Agriculture collects samples in the field and the Herbarium's identification will show whether or not an infestation must be destroyed. Similarly, all agricultural weeds and naturalised plants in reserves and national parks must be identified accurately before the Herbarium can give advice on their control.

TERMITES AND HELICOPTERS

The task of collecting WA's flora takes the Herbarium's botanists to some of the most isolated and far-flung parts of the State. At the moment a major project is to document the flora of the Kimberley, which until recently was largely uncharted botanical territory. They might work in luxuriant Kimberley rainforests, with orchids festooning the branches, or in the dry and highly dissected Edgar Ranges at the top of the Great Sandy Desert, south-east of Broome.

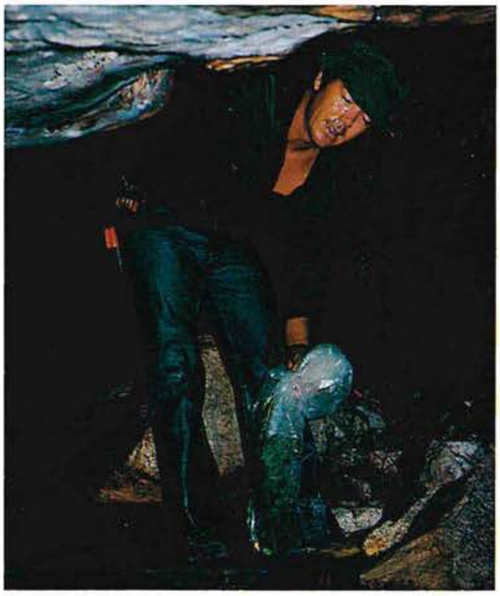
Collecting techniques in these parts have to be adapted to the region's special conditions. A lot of rainforest trees and tall eucalypts in the North-West, for example, are heavily "piped out" by termites and are too dangerous to climb, so botanists have to use a gun to shoot the flowering branches off the tree to obtain specimens.

Then there are the hazards, which amount to more than just the crocodiles. Kevin Kenneally described an occasion when he and fellow botanist Bruce Maslin were collecting specimens on the Mitchell Plateau when a cyclone suddenly developed.

"The rain was so heavy we could not see. We had to take refuge in a cave while we waited for the helicopter that had dropped us off to come and collect us. Fortunately the pilot made it through, but because of poor visibility we had to land four times on the way back," he said.

The Mitchell Plateau Falls during a collecting expedition in 1982; 400 mm of rain fell in only 48 hours due to Cyclone Bruno.
Photo - Kevin Kenneally ▼

Botanist Kevin Kenneally had to shelter in a rock cave on the Mitchell Plateau, after Cyclone Bruno developed during a collecting expedition in January 1982.
Photo - Bruce Maslin ▶



From top: illyarrie *(Eucalyptus erythrocorys)*; Sturt's desert pea *(Clianthus formosus)*; lemon-scented darwinia *(Darwinia citriodora)*; and native bee on *Boronia gracilipes*.
Photos - Jiri Lochman

From top:
flying duck orchid *(Paracaleana nigrita)*; scarlet banksia *(Banksia coccinea)*; jewel beetles feeding on *Melaleuca* flower; and native bee on wild tomato *(Solanum* sp.*)*.
Photos - Jiri Lochman

Much Herbarium collecting is done in the plant-rich South-West of Western Australia, one of the richest botanical areas of the world, noted especially for the number of woody shrub species. The Stirling Range, for example, or the Mount Lesueur area (*Landscope*, Winter 1989), have yet to reveal all their botanical treasures. New species and new localities for plants, many of which may be rare, are recorded on almost every field trip.

SPECIMENS

Dried and liquid preserved specimens form the basis for botanical studies on the naming and classification of plants. When properly prepared, they retain the features needed for their accurate identification. When a plant is collected in the field, the locality, latitude and longitude and habitat information is recorded in a field book. Individual plants always grow in identifiable plant groups or communities, so it is also important to record the plant's habitat.

When the specimen arrives at the Herbarium it must be thoroughly dried, then frozen at sub-zero temperature for several days to kill insects. Insects could wipe out decades of work, so it is also necessary to fumigate the building regularly. The specimen is mounted on a stiff sheet with the accompanying habitat details, and the task of incorporating it into the collection commences. Each of the Herbarium's 400 000 specimens is filed according to a system of classification that reflects its relationships.

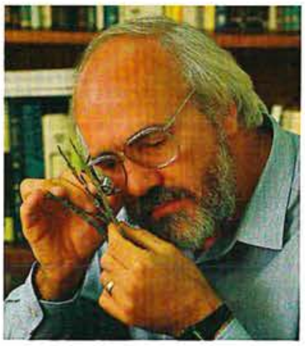
Most of the collection is of flowering plant species. But the Herbarium also has separate collections of Western Australian fungi, mosses and liverworts and a large collection of lichens and marine and freshwater algae.

NAMING

Research carried out at the Herbarium often results in discoveries, and in the last decade Herbarium staff named more than 300 new plant species.

The scientific naming of plants is governed by a set of rules established by an international committee. Each new species must be described in Latin and published in an appropriate scientific journal. The name can commemorate the plant's discoverer or some other person, relate to its geographical region, or describe an interesting feature of the plant.

New Curator, Jim Armstrong, wants to increase the Herbarium's public profile.
Photo - Wilf Hendriks ▼



When it is formally described, the botanist must designate one Herbarium specimen from among those studied as the Type of the species. This "Type Specimen" assumes special importance - it becomes the physical reference point for the new name.

TAKING PLANTS TO THE PEOPLE

Jim Armstrong is keen to enhance the Herbarium's profile, to let the public know what it does and how important its work is.

Publications are one approach. A two-volume *Flora of the Perth Region* was published in 1987; it describes 2057 species and retails for $47.00. *The Flora of the Kimberley Region* should be published by 1991. The Herbarium will eventually produce a series of publications on the flora of most of the State's regions. A range of research publications and journals, including *Kingia* and *Nuytsia*, are also produced.

CALM's Suzanne Curry collecting a Type specimen from an *Acacia* on Landor Station, on the Gascoyne River.
Photo - Bruce Maslin ▲

Plants grow in identifiable plant communities. This jarrah forest understorey contains white myrtle, coral vine and zamias.
Photo - Michael Morcombe ◀

Members of the public who wish to identify their own specimens can use the Community Reference Herbarium. With representative specimens of two thirds of the State's flora, it is an important resource for use in identifying and obtaining information on the native and naturalised plants of WA. To identify a plant using the Community Reference Herbarium, you would need to bring your specimen to the Herbarium and compare it with those in the reference collection.

However, to ensure the security of the collection, Herbarium staff must treat all incoming specimens for insects before they can be taken into the building. Enquire at the front office. If the collection is less than 9 cm thick it can be treated immediately in a microwave oven. Otherwise, arrangements need to be made in advance.

A reference library is located with the Community Reference Herbarium. It has many helpful botanical works to assist users to identify their specimens. The Herbarium is open from 8.30 am to 4.30 pm on weekdays.

COLLECTIONS

The Herbarium's 400 000 plant specimens have a replacement value of $15 million!

There are two major collections. The vascular collection (flowering plants, ferns and their allies, and cone-bearing plants) is mounted on stiff sheets of paper for storage, whereas the non-vascular collections (mosses and their relatives, algae, fungi and lichens) are mostly placed in special packets.

The entire collection is named and arranged according to a standard classification system that groups related plants. Using such a system, specimens of any particular species can be quickly located and the label information on it retrieved by researchers.

Many of the 12 000 plant specimens added to the Herbarium each year are collected by Herbarium staff and other research staff in CALM. Duplicate material of the specimens is used by the Herbarium to exchange with other herbaria throughout the world and to acquire additional specimens for the collection.

Properly conserved and maintained, the Herbarium collections are an increasingly valuable permanent record of the State's vanishing spectrum of plant life.

From top: teasel banksia *(Banksia pulchella)*; blue pincushion flower *(Brunonia australis)*; native bee on pigface *(Carpobrotus* sp.*)*; and Albany bottlebrush *(Callistemon speciosus)*.
Photos - Jiri Lochman

From top: a sundew *(Drosera indica)*; *Cassia venusta*; *Guichenotia macrantha*; and wild honeysuckle *(Lambertia ericifolia)*.
Photos - Jiri Lochman

One seed of the deadly crab-eyes *(Abrus precatorius)* will kill an adult. It is found throughout the tropics and the seeds were used for decorations by some Aboriginal tribes.
Photo - Michael Morcombe ▲

NEW HORIZONS

WA is one of the last frontiers of botanical studies. Despite the huge number of specimens housed at the Herbarium, there is still much to find out. New plants are being discovered all the time.

"We still know very little about the flora of this State," says Jim Armstrong. He points out that the National Herbarium of NSW has more than a million specimens for an area representing a third of the size of WA.

"Every time we take a close look at a group it results in a 40 to 50 per cent increase in the number of named species, subspecies and varieties (taxa). For example, 150 new taxa of eucalypts have been discovered in the last decade.

"Least is known about the marine flora of the State," says Jim. "There are flowering plants in the sea with bizarre reproductive systems - they are actually pollinated by water. Understanding the State's marine flora is becoming increasingly relevant with the establishment of marine parks."

LOOKING TO THE FUTURE

As well as its vital role in flora management, the Herbarium also provides an indispensable public service. Many people rely on the Herbarium to determine the identity of botanical materials, including investigators from a variety of scientific fields and land-use professionals who prepare environmental impact reports or planning documents.

Graham Donation collecting gubinge fruit from coastal rainforest near Broome. The Herbarium is documenting Aboriginal uses of plants in the region.
Photo - Kevin Kenneally ▼

The collection is also used by visiting researchers from other institutions. Working space is provided for the 20 to 30 interstate and overseas botanists who visit WA each year. Specimens are routinely loaned to other botanical institutions for study and in 1988 more than 8 000 specimens were loaned to herbaria throughout the world.

Jim summed up the Herbarium's role succinctly: "I see it as a museum with a difference - it's the centre for botanical research in Western Australia and the heart of flora conservation research in CALM."

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