

Acacia Miscellany 6. Review of *Acacia victoriae* and related species (Leguminosae: Mimosoideae: Section *Phyllodineae*)

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Abstract

Maslin, B.R. *Acacia Miscellany 6. Review of *Acacia victoriae* and related species (Leguminosae: Mimosoideae: Section *Phyllodineae*)*. Nuytsia 8(2): 285-309 (1992). A key is presented to the 10 species comprising the informal "*Acacia victoriae* group". Five of these species, all from Western Australia, are described as new, namely, *A. alexandri*, *A. aphanoclada*, *A. chartacea*, *A. ryaniana* and *A. synchronicia*. *Acacia glaucocaesia* Domin (syn. *A. glabripes* Maiden & Blakely, non Domin) is reinstated but may ultimately prove better placed as an infraspecific taxon under *A. victoriae* Benth. Legumes are described for *A. pickardii* Tind. and a full description is given for *A. dempsteri* F. Muell. All species of the group are illustrated.

Introduction

The following account of *Acacia victoriae* Benth. and its allies is the result of studies connected with the preparation of *Acacia* subgenus *Phyllodineae* section *Phyllodineae* DC. for the Flora of Australia. Five new Western Australian species are described and these, together with five close relatives, are here referred to informally as the "*Acacia victoriae* group". The 10 species assigned to this group are: *A. alexandri* Maslin sp. nov., *A. aphanoclada* Maslin sp. nov., *A. chartacea* Maslin sp. nov., *A. cuspidifolia* Maslin, *A. dempsteri* F. Muell., *A. glaucocaesia* Domin, *A. pickardii* Tind., *A. ryaniana* Maslin sp. nov., *A. synchronicia* Maslin sp. nov. and *A. victoriae* Benth. This group is most closely related to *A. murrayana* F. Muell. ex Benth. and its allies (i.e. *A. pachyacra* Maiden & Blakely and *A. praelongata* F. Muell.) and *A. pyrifolia* DC. and its allies (i.e. *A. inaequilatera* Domin, *A. marramamba* Maslin and *A. strongylophylla* F. Muell.).

The species of the *A. victoriae* group occur mainly in the Australian Arid Zone. Except for *A. victoriae* (which occurs in all mainland States) and *A. pickardii* (which is geographically restricted in South Australia and Northern Territory) the species of the group are confined to Western Australia where most have relatively restricted geographic ranges. Distributions are discussed under each species; for previously described taxa these data replace those which are given in Maslin & Pedley (1982).

In the absence of a comprehensive review of the classification of *Acacia* it has not been possible here to identify a single morphological character which uniquely defines the "*A. victoriae* group". There are, however, a number of characters which, when taken in combination, serve to define the

group, however, not all species possess all the characters. Although none of the characters is unique to the group, two of the more important ones, namely, spinose stipules and medial peduncular bracts, are infrequent elsewhere in subgenus *Phyllodineae*.

1. Stipules.

Spinose stipules are seemingly present in all members of the group, although in *A. alexandri*, *A. aphanoclada* and *A. glaucocoesia* they are rather poorly developed. The stipules are often prominent on young plants but are commonly absent with age. On biologically mature plants often only the stipule bases remain and are represented by a pair of blunt protruberances at the base of the phyllodes; sometimes even the protruberances are lacking.

Spinose stipules occur elsewhere in section *Phyllodineae*, but at a rather low frequency, e.g. *A. congesta* Benth., *A. paradoxa* DC., *A. xerophila* W.Fitzg. They also occur in other sections of subgenus *Phyllodineae*, namely, the *Alatae* (*A. alata* R.Br.), *Plurinerves* (in *A. unguicula* Cowan & Maslin and at least three undescribed species from W.A.) and *Pulchellae* (*A. anarthros* Maslin and *A. moirii* subsp. *recurvistipula* Maslin). Spinose stipules occur in all species of subgenus *Acacia* (where they are often very well developed) but in subgenus *Aculeiferum* they are seemingly absent (although the stipules at mature nodes on *A. coulteri* Benth. ex A.Gray from Mexico are somewhat spinose).

2. Peduncular bracts.

A minute bract occurs near or above the middle of the peduncle in all species of the group; the base of the peduncles is ebracteate. Although this supra-basal bract is caducous (it is best observed on very young inflorescences) its scar can usually be observed on at least some mature flowering peduncles of all species except *A. aphanoclada*.

Peduncular bracts are common elsewhere in subgenus *Phyllodineae* but they are usually located at the base of the peduncle. Solitary bracts situated near or above the middle of the peduncle are uncommon but do occur in a few species of section *Phyllodineae* besides the "*A. victoriae* group", e.g. some members of the *A. deltoidea* group (fide Cowan & Maslin 1990), *A. dentifera* Benth., *A. nodiflora* Benth. Similar bracts occur also in subgenus *Aculeiferum* (e.g. *A. tamarindifolia* Willd. and *A. paniculata* Willd. from South America) and in a few species of subgenus *Acacia* (e.g. *A. biacicularis* S. Watson and *A. glandulifera* S. Watson from Mexico).

3. Other characters of the "*A. victoriae*" group.

Species of the "*A. victoriae* group" are assigned to section *Phyllodineae* on account of their globular flower-heads and 4-nerved phyllodes. When the phyllodes are flat, which is the usual condition, there is a nerve along each margin and one on each face; when terete (*A. pickardii*) the nerves are equally spaced around the lamina. The nerves are sometimes submerged and thus seemingly absent.

Other characters commonly encountered in species of the group are the following: tall shrubs or small trees (except for *A. ryaniana* which is \pm prostrate); branchlets often pruinose, glabrous (sometimes hairy in *A. pickardii* and *A. victoriae*); phyllode apices commonly innocuous (pungent in *A. aphanoclada*, *A. cuspidifolia*, *A. pickardii* and sometimes *A. dempsteri*); peduncles commonly twinned, either within axils of phyllodes or along a raceme axis, their base ebracteate; inflorescences commonly initiated on

new shoots within the axils of young phyllodes which usually mature prior to anthesis, determinate racemes are common in *A. aphanoclada*, *A. chartacea*, *A. glaucocaesia* and *A. victoriae* but a secondary phyllode may develop at the base of some peduncles so that a proportion of the inflorescences appear simple and axillary; sepals usually free (variably united in *A. cuspidifolia*); legumes chartaceous, usually flat; seeds transverse to oblique (longitudinal in *A. aphanoclada* and sometimes in *A. alexandri*), brown or black but commonly yellow at the centre in the region of the areole or mottled; aril usually absent or poorly developed.

Methods

All measurements are from dried herbarium material unless stated otherwise. Abbreviations for herbaria are as given in Index Herbariorum ed. 7 (1981) except for the following: KARR (Pilbara Regional Herbarium, Karratha, W.A.) and KP (Kings Park and Botanic Garden, Perth, W.A.).

Key to species of the "*A. victoriae* group"

1. Phyllodes >15 cm long 2. *A. aphanoclada*
1. Phyllodes <15 cm long
 2. Phyllodes pungent
 3. Phyllodes terete 7. *A. pickardii*
 3. Phyllodes flat
 4. Phyllodes linear to narrowly oblong-ob lanceolate, cusp 1-2 mm long; heads pale yellow 4. *A. cuspidifolia*
 4. Phyllodes lanceolate to narrowly lanceolate, cusp <1 mm long; heads golden 5. *A. dempsteri*
 2. Phyllodes innocuous, commonly mucronulate
 5. Phyllodes \pm linear AND some or all >4 cm long; heads cream
 6. Flowers 15-30 per head; inflorescences all or predominantly racemose; legumes 9-16 mm wide (widespread) 10. *A. victoriae*
 6. Flowers 60-80 per head; inflorescences not racemose; legumes 7-8 mm wide (restricted, Western Australia) 1. *A. alexandri*
 5. Phyllodes not as above (if linear then <4 cm long)
 7. Heads creamy white to pale yellow; inflorescences usually all or predominantly racemose; peduncles 6-18 mm long
 8. Phyllodes 10-25(33) mm wide, retuse to sub-retuse, green; heads 60-90-flowered; peduncles robust 3. *A. chartacea*
 8. Phyllode characters not combined as above; heads <60-flowered; peduncles slender
 9. Heads 20-30-flowered; phyllodes 2-10 cm long, 2-11 mm wide, 1:w = 2-20, midrib rather prominent (widespread) 10. *A. victoriae*
 9. Heads 35-50-flowered; phyllodes 1.5-2.5 cm long, (5)7-13 mm wide, 1:w = 1.5-3, midrib not prominent (restricted, Western Australia) 6. *A. glaucocaesia*

7. Heads golden; inflorescences all or mostly not racemose; peduncles 10-30 mm long
10. Phyllodes 3-6 cm long with l:w = 4-12, lanceolate to narrowly lanceolate; heads c. 10 mm diam. when dry; spinose stipules persistent 5. *A. dempsteri*
10. Phyllode 1-3 cm long, shape otherwise; heads 5-7 mm diam. when dry
11. Shrubs 0.3 m tall, ± prostrate; legumes curved; phyllodes 7-15 mm wide, l:w = 1.2-3, midrib rather prominent; spinose stipules usually persistent 8. *A. ryaniana*
11. Shrubs or trees 1-3(6) m tall; legumes straight; phyllodes 1-8(13) mm wide, l:w = (2)3-7(14), midrib obscure or absent; stipules often absent 9. *A. synchronicia*

Taxonomy

1. *Acacia alexandri* Maslin, sp. nov. (Figure 1)

Frutices glabri 1.5-3 m alti. Stipulae spinosae, 3-4 mm longae, graciles, plerumque nullae vel infrequentia aetate provecta. Phyllodia linearia, augustata ad basim, (4)6-13 cm longa, 2.5-6(9-11) mm lata, ratione horum (8)15-50, non rigida, viridia, uninervata, penninervia. Inflorescentiae vulgo simplices et in surculis juvenibus orientes, pedunculis vulgo 2 in quoque axilla, 8-15 mm longis, gracilibus, bractea caduca prope vel super medium orienti, florum capitulis globularibus, cremeis, dense 60-80-floribus. Flores 5-meri. Sepala discreta, anguste spathulata. Legumina anguste oblonga, ad 7 cm longa, 7-8 mm lata, chartacea, plana, super semina rotundata. Semina plerumque transversalia, globosa, circa 4 mm longa, nigricantia, circum pleurogramma luteola, funiculo brevi, arillo depresso-clavato.

Typus: Cape Range, Western Australia, 29 August 1988, *B.R. Maslin* 6284 (holo: PERTH; iso: CANB, K, MEL, NY, NSW).

Open or moderately dense *shrubs* 1.5-3 m tall, sometimes wispy, main stems rather slender. *Bark* dark grey and sometimes irregularly fissured at base of stems, smooth and greenish brown higher up, red-brown to reddish or yellow-green on branchlets. *Branchlets* slender, terete but slightly angled at extremities, finely ribbed, slightly flexuose, glabrous. *Stipules* spinose, commonly absent or infrequent on mature plants, not prominent, slender, 3-4 mm long, straight. *Phyllodes* linear, narrowed at base, 6-13 cm long, sometimes a few shorter (c. 4 cm long), 2.5-6 mm wide, abnormally broad (9-11 mm wide) on *A.S. George* 1334, l:w = (8)15-50, slightly thick and therefore usually slightly wrinkled when dry, not rigid, ± erect, straight or variously curved, glabrous, olive-green to yellow-green, dull; midrib evident but not overly prominent, often drying yellowish, finely penninerved, marginal nerves narrow and yellowish; apices acute or obtuse-mucronate; pulvinus c. 1 mm long, transversely wrinkled. *Gland* situated on upper margin of phyllode 0-2 mm above pulvinus, not prominent, circular to oblong-elliptic, 0.3-0.8 mm long, central pore shallow. *Inflorescences* initiated synchronously with phyllodes on terminal or sometimes axillary new shoots, phyllodes usually maturing prior to anthesis so that peduncles appear axillary, shoots rarely racemose due to phyllode suppression. *Peduncles* 1-4 per axil but commonly 2, 8-15 mm long, slender, glabrous, base ebracteate; bract near or above middle of peduncle caducous (bract scar visible on mature peduncles), narrowly oblong, c. 1.5 mm long, scariosus, brown. *Flower-heads* globular, 8 mm diam. (fresh), c. 5 mm diam. (dry), cream, densely 60-80-flowered.

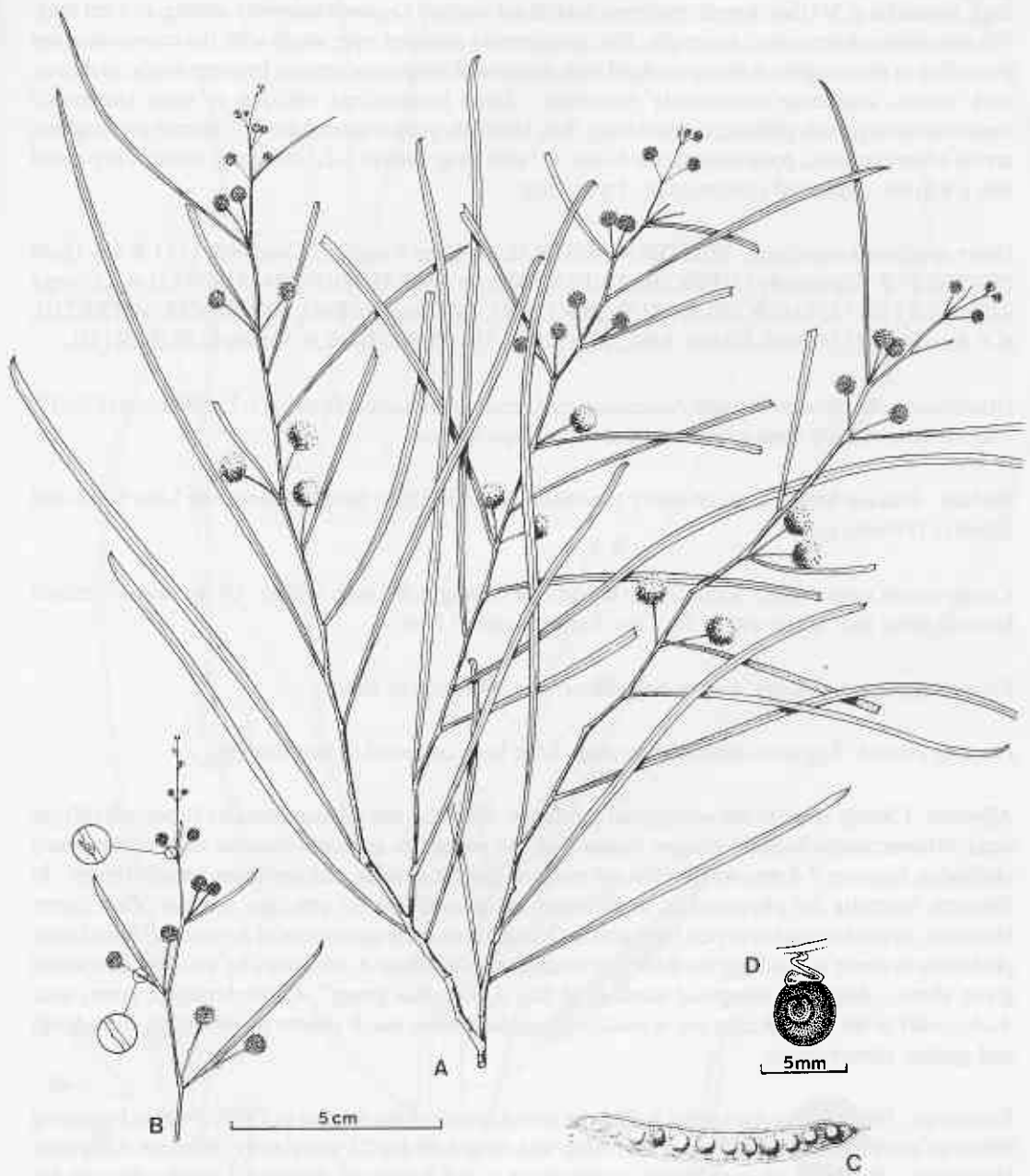


Figure 1. *Acacia alexandri*. A - Flowering branchlet. B - New shoot showing inflorescences arising synchronously with phyllodes (inserts showing supra-basal peduncular bract and, on older peduncle, scar where bract has fallen). C - Legume. D - Seed showing funicle expanded into a narrow, depressed-clavate aril.

A from A.S. George 2479. B from W.B. Edgecombe s.n. C & D from W.B. Edgecombe 13.

Bracteoles similar to sepals except laminae twice as large. *Flowers* 5-merous. *Sepals* 1/2 to 3/4 length of petals, free, narrowly spatulate, brown except base often colourless; claws narrowly linear, glabrous; laminae widely ovate, 0.15 mm wide, concave, apiculate, sparsely ciliolate. *Petals* 1.8-2 mm long, joined for c. 3/4 their length, glabrous, midrib not visible. *Legumes* narrowly oblong, to 7 cm long, 7-8 mm wide, chartaceous, \pm straight, flat, prominently rounded over seeds with the convexities not extending to the margins, \pm straight-edged with occasional deep constrictions between seeds, glabrous, dark brown, obscurely transversely reticulate. *Seeds* longitudinal, oblique or most commonly transverse in legumes, globose, c. 4 mm long, dull, blackish, yellow around the "U"-shaped pleurogram; areole often excentric, open towards the hilum, 0.7 mm long; funicle 1-1.5 mm long, slender, expanded into a narrow, depressed-clavate aril c. 2 mm long.

Other specimens examined. WESTERN AUSTRALIA: Cape Range, *Y. Chadwick* 1353 & s.n. (both PERTH), *W.B. Edgewcombe* 12 (PERTH), 13 (PERTH) & s.n. (PERTH00153354, 00669482), *A.S. George* 2479 (PERTH), 1334 (PERTH) & 10270 (PERTH, K), *S.D. Hopper* 5085, 5086 & 5088 (all PERTH), *K.F. Kenneally* 7337 (BRI, CANB, MEL, PERTH) & 7344 (PERTH), *B.R. Maslin* 6289 (PERTH).

Distribution. North-west Western Australia in the Carnarvon Botanical District (1:250,000 maps F49-12, F50-9). Known only from a few localities in the Cape Range.

Habitat. Pinkish brown loam on rocky limestone slopes in Open Shrub Mallee over Low Scrub and Spinifex (*Triodia* spp.).

Conservation status. 2RC- according to the criteria of Briggs & Leigh (1988). Of the few collections known, about half occur within the Cape Range National Park.

Flowering period. Mostly August-September; one collection in June.

Fruiting period. Legumes with mature seeds have been collected in late October.

Affinities. Closely allied to the widespread species, *A. victoriae*, but distinguished by flowers 60-80 per head, inflorescences initiated on new shoots with 1-4 peduncles arising within the axils of the young phyllodes, legumes 7-8 mm wide, seeds not mottled, funicle slender, and phyllodes usually longer. In Western Australia the phyllodes of *A. victoriae* are generally 2.5-4 cm long and not often linear. However, in the Kimberley region (and also in Queensland) some specimens of *A. victoriae* have linear phyllodes to about 10 cm long but these can be distinguished from *A. alexandri* by the other characters given above. Another widespread member of the "*A. victoriae* group", *A. synchronica*, grows near *A. alexandri* in the Cape Range but is readily recognised by its much shorter phyllodes (c. 2 cm long) and golden flower-heads.

Etymology. Named after Alexander S. George who discovered the species in 1960. Prior to becoming Editor of the Flora of Australia in 1981, Alex was employed for 21 years at the Western Australian Herbarium. He has made significant contributions to the botany of Western Australia through his numerous collections (e.g. almost 800 *Acacia* gatherings) and publications.

2. *Acacia aphanoclada* Maslin, sp. nov. (Figure 2)

Frutices glabri virgati ad 5 m alti, phyllodiis et ramis ultimis pendulis, ramulis pruinosis. Stipulae plus minusve spinosae, 2.5-4 mm longae, aliquando nullae. Phyllodia anguste linearia, 20-45 cm longa, 1.5-2(3)

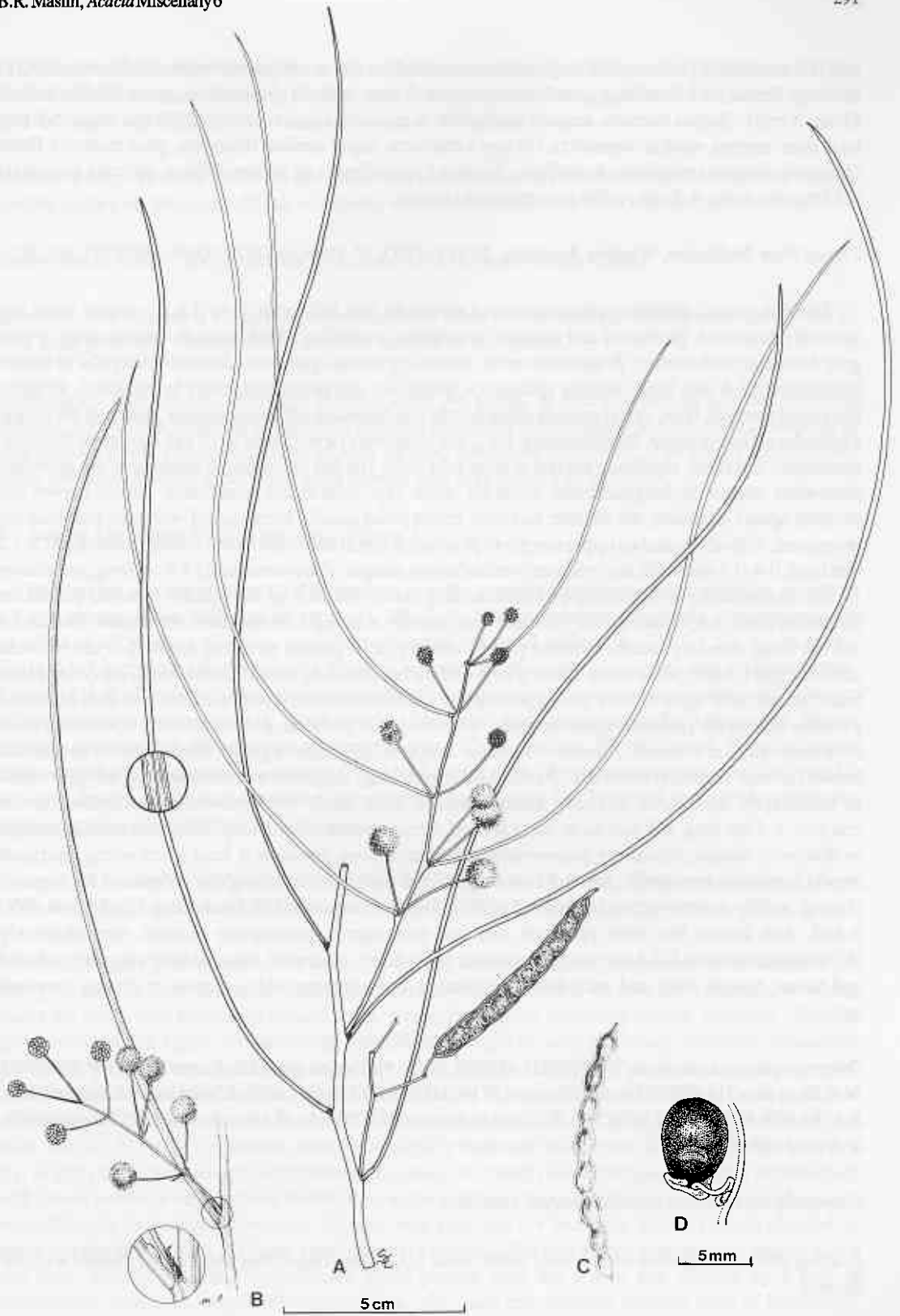


Figure 2. *Acacia aphanoclada*. A - Branchlet showing axillary raceme (with legume) and twinned, axillary peduncles (heads at anthesis). B - Node showing axillary raceme with some peduncles subtended by a reduced phyllode (insert showing base of phyllode and gland). C - Legume. D - Seed. A from *H. Demarz* D4751. B from *N. Perry* 194. C & D from *D. O'Meara* s.n.

mm lata, non rigida, praeter ad basim plus minusve cylindrica plana, costa non prominenti. Racemi 5-9(18) cm longi. Pedunculi 1-2 cm longi, graciles, saepe binati, florum capitulis globularibus, aureis, 70-90-floribus. Flores 5-meri. Sepala discreta, anguste spathulata. Legumina anguste oblonga, 6-7 cm longa, 6-8 mm lata, inter semina modice constricta vel non constricta, super semina rotundata, plus minusve firme chartacea, pruinosa minimum juveniliter. Semina longitudinalia ad leviter obliqua, oblonga lato-ovata vel fere circularia, 4-5 mm, arillo plus minusve clavato.

Typus: Near Nullagine, Western Australia, 26 Oct. 1973, H. Demarz D4751 (holo: PERTH; iso: K).

Slender, wispy, glabrous, single-stemmed *shrubs* to 5 m tall, stem 2 cm d.b.h., canopy open and sparingly branched, phyllodes and ultimate branchlets pendulous. *Bark* smooth, reddish grey to pale grey-brown or mid-brown. *Branchlets* terete, obscurely nerved, pruinose. *Stipules* triangular to linear-triangular, 2.5-4 mm long, usually spinose or almost so, not prominent, erect to sub-erect, straight, thickened towards base, distal portion often brittle and breaking-off, occasionally absent at all nodes. *Phyllodes* narrowly linear, 20-45 cm long, 1.5-2 mm wide, very rarely 3 mm, to 10 mm on regrowth shoots, pendulous, not rigid, shallowly curved at least near base, flat but becoming \pm terete near the pulvinus, somewhat obscurely longitudinally wrinkled when dry, midrib not prominent, lateral nerves not evident; apices attenuate, the slender, indurate, brittle point usually breaking off with age; pulvinus not prominent. *Gland* situated on upper margin of phyllode 2-6 mm above the base, circular to oblong, 0.7-1.2 mm long, 0.4-0.7 mm wide, not or scarcely raised above margin. *Racemes* usually 5-9 cm long, sometimes 18 cm, occasionally a secondary phyllode arising below the axil of the usually twinned peduncles rendering these simple and axillary; raceme axis slender, \pm straight, terete, base ebracteate. *Peduncles* 1-2 cm long, slender, usually twinned (rarely solitary or in groups of three) with 1.5-2 cm between adjacent pairs, basal peduncular bracts 1 or 2 and early caducous, an additional small, early caducous bract located near apex of very young peduncles, it sheathes the developing heads and does not leave a visible scar on the peduncle upon dropping. *Flower-heads* globular, golden, densely 70-90-flowered. *Bracteoles* similar to sepals. *Flowers* 5-merous. *Sepals* c. $2/3$ length of petals, free, narrowly spathulate, brown (at least at apices) when dry. *Petals* 1.8-2.5 mm long. *Legumes* narrowly oblong, straight edged to moderately constricted between seeds, rounded over seeds with convexities extending to the margins, 6-7 cm long, 6-8 mm wide, to 11 seeded, firmly chartaceous to very thinly coriaceous, straight to shallowly arcuate, obscurely transversely reticulate, brown, pruinose at least when young, marginal nerves narrow, stipe slender and 3-5 mm long. *Seeds* longitudinal to slightly oblique in the legume, oblong, widely ovate or almost circular, turgid to slightly compressed, 4-5 mm long, 3.5-4.5 mm wide, \pm dull, dark brown but often yellowish near the pleurogram; pleurogram obscure, very shallowly "U"-shaped; areole 0.3-0.4 mm long, open towards the hilum, excentric, situated between centre of seed and hilum; funicle short and once-folded, expanded into a creamy white, narrow, \pm clavate, terminal aril.

Other specimens examined. WESTERN AUSTRALIA: Nullagine area, J.S. Beard 2824 (KP, PERTH), M.K. Deighton 311 (PERTH), A.S. George 15716 (MEL, PERTH), F. Lullfitz L2699 and A.R. Fairall (KP), B.R. Maslin 4957 (NSW, PERTH), K. Newbey 10202 (PERTH), D. O'Meara s.n. (PERTH 00856320), N. Perry 194 (PERTH).

Flowering and fruiting period. August-October.

Fruiting period. Legumes with mature seeds occur in October-November and may be present with the flowers.

Distribution. North-west Western Australia in the Fortescue Botanical District (1:250,000 map F51-5). Known only from near Nullagine. Further work in this relatively under-collected area may extend the species range, especially in areas east and west of Nullagine.

Habitat. Rocky "spinifex" (*Triodia* spp.) hills with scattered eucalypts and acacias. Geologically the new species occurs on Mosquito Creek sediments and on conglomerates (D. O'Meara, pers. comm.)

Conservation status. 2[k] according to the criteria of Briggs & Leigh (1988).

Affinities. The species is readily distinguished from other members of the "*A. victoriae* group" by its very long phyllodes (which are perhaps the longest in the genus).

Etymology. The specific epithet is derived from the Greek *aphanes*, meaning unseen, invisible, obscure, and *klados*, meaning a branch. It refers to the characteristic wispy growth habit consisting of very slender stems and open crowns of very narrow, pendulous phyllodes. The plants are therefore rather difficult to detect in the field even though they may reach 5 m in height.

3. *Acacia chartacea* Maslin, sp. nov. (Figure 3)

Frutices vel arbores glabrae 1.5-4(6) m altae, ramulis et ramis superis pruinosis. Stipulae spinosae, 3-6 mm longae, saepe nullae aetate provecta. Phyllodia plus minusve asymmetrica, plerumque ovata ad elliptica vel anguste elliptica, rotundato-obtusa et retusa ad subretusa, (2)2.5-5.5(6.5) cm longa, (0.7)1-2.5(3.3) cm lata, ratione horum (1.5)2-4(5), coriacea, viridia, costa prominenti, obscure penninervia. Racemi (1)3-8(14) cm longi, pedunculis aliquando a phyllodium secundarium subtendentibus, infrequenter inflorescentiae simplices ut in *A. synchronicia*. Pedunculi plerumque binati, 8-15 mm longi, florum capitulis globularibus, dilute citreis ad cremeis, dense 60-90-floribus. Flores 5-meri. Sepala discreta anguste spatulata. Legumina anguste oblonga, ad 5 cm longa, 8-12 mm lata, chartacea, pallide (luteola) brunnea. Semina plus minusve transversalia, elliptica, 3 mm longa, 2-2.3 mm lata, funiculo lineari et plus minusve recto, arillo plerumque subconico.

Typus: 49.5 km S of Billabong Roadhouse, North West Coastal Highway, Western Australia, 22 Sept. 1976, B.R. Maslin 4331 (holo: PERTH; iso: CANB, K, MEL, NSW, NY).

Erect, straggly, glabrous *shrubs* or *trees*, 1.5-4 m tall, sometimes to 6 m, crown somewhat diffuse. *Bark* dark grey and fissured on main trunks, upper branches and branchlets smooth and pruinose, on young plants the pruinosity extends to ground level. *Branchlets* terete, obscurely ribbed, pruinose. *Stipules* spinescent, robust, rigid, 3-6 mm long, spreading, straight to very shallowly recurved, frequently deciduous or only bases remaining at many nodes. *Phyllodes* slightly to moderately asymmetric, occasionally markedly asymmetric, upper margin usually more convex than the lower, ovate to elliptic or narrowly elliptic, sometimes a few obovate or lanceolate, (2)2.5-5.5(6.5) cm long, (0.7)1-2.5(3.3) cm wide, 1:w=(1.5)2-4(5), coriaceous, smooth and slightly thickened when fresh, very finely wrinkled when dry, slightly undulate, green; midrib prominent, central or towards lower margin, obscurely penninerved with lateral nerves diverging from midrib at an acute angle; apices rounded-obtuse, retuse to sub-retuse, insignificantly mucronulate, mucro c. 0.5 mm long; pulvinus 2-4 mm long, terete. *Glands* situated on upper margin of phyllode, the basal gland circular or oblong, 0-2 mm above pulvinus and usually 0.5-1 mm long, usually a second insignificant gland present near the mucro and flanked by a pair of microscopic, caducous, stipule-like appendages. *Racemes* concentrated towards ends of branchlets, 1-2 per axil, sometimes a secondary phyllode developed within axil of the twinned peduncles so that

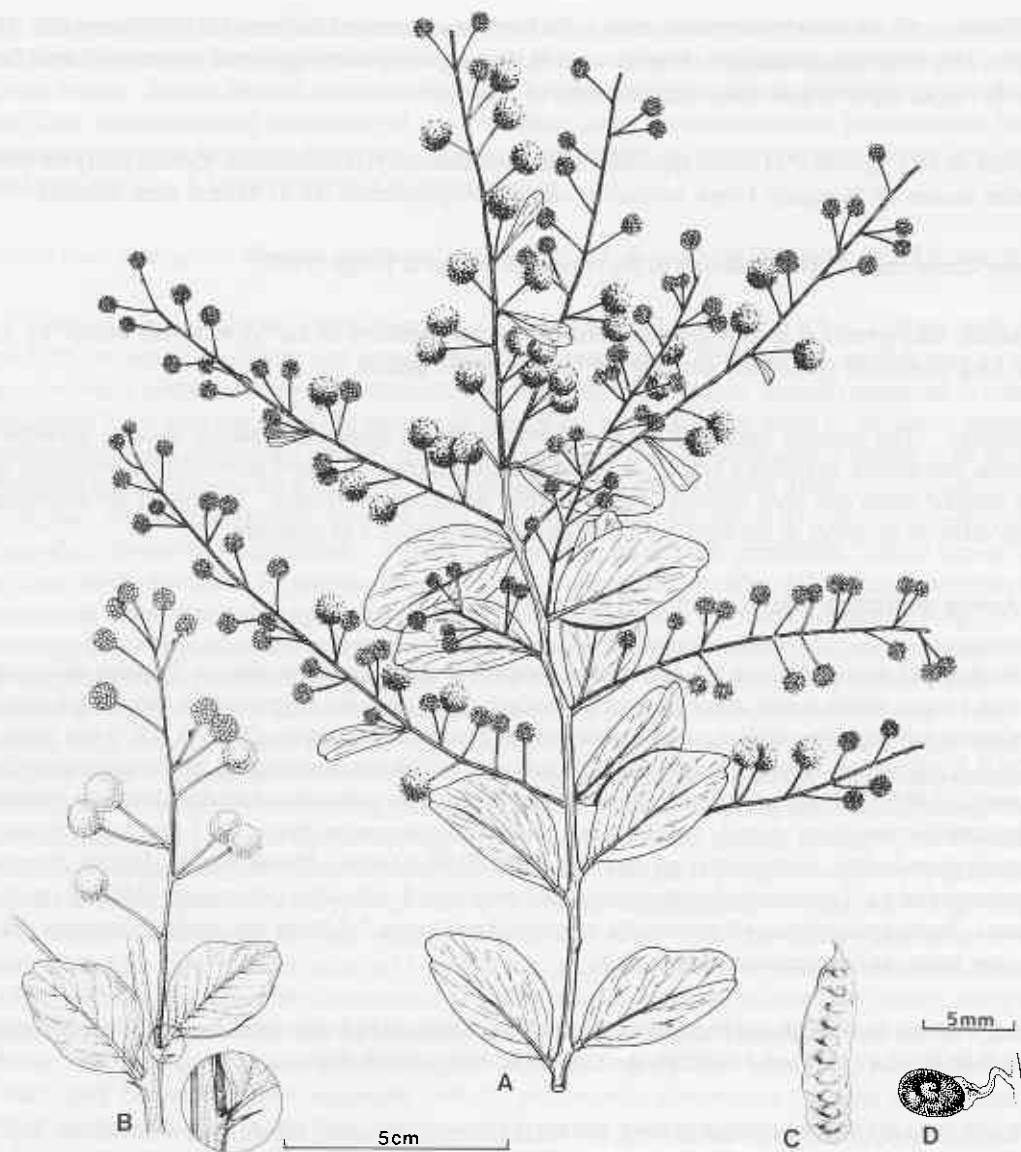


Figure 3. *Acacia chartacea*. A - Flowering branchlet. B - Portion of branchlet, note two peduncles with a supra-basal bract (insert showing spinose stipules). C - Legume. D - Seed.

A from *B.R. Maslin* 4331. B from *A.C. Burns* 1056. C & D from *A.M. Ashby* 4495.

some (rarely all) inflorescences are simple, infrequently all inflorescences simple and initiated on new shoots as in *A. synchronica*; raceme axis (1)3-8(14) cm long, \pm straight, base ebracteate. Peduncles commonly twinned, 8-15 mm long, base ebracteate at anthesis, a usually caducous bract normally situated near apex of peduncle is triangular-ovate and c. 1 mm long. Flower-heads globose, cream to pale lemon yellow, densely 60-90-flowered. Bracteoles similar to sepals. Flowers 5-merous. Sepals free, $1/2$ to $2/3$ length of petals, narrowly spatulate, claws narrowly linear. Petals c. 2.5 mm long. Legumes narrowly oblong, to 5 cm long, 8-12 mm wide, chartaceous, straight, not or scarcely constricted between seeds although occasional moderately deep constrictions occur, rounded over seeds along midline, finely transversely reticulate, light (yellowish) brown, slightly shiny, obtuse-apiculate, stipe slender and to 5

mm long. *Seeds* transverse to slightly oblique, elliptic, 3 mm long, 2-2.3 mm wide, shiny, dark brown to black except areolar region which is usually yellowish; pleurogram very obscure, "U"-shaped; areole c. 0.5 mm long, open towards the hilum; funicle linear and \pm straight, expanded into a once-folded, usually sub-conical aril.

Selected specimens examined. WESTERN AUSTRALIA: 23 miles [37 km] from Gnaraloo Station, *K.M. Allan* 394 (CANB, K, MEL, PERTH); 100 mile tank [48 km N of Murchison River] on North West Coastal Highway, 7 Jan. 1972, *A.M. Ashby* 4495 (CBG, NSW, PERTH); 390-394 mile peg on Carnarvon road [11-17 km N of Murchison River, North West Coastal Highway], *A.C. Burns* 1056 (BRI, PERTH); Peron Station, 25° 46' S, 113° 31' E, *R.J. Cranfield* 2515 (PERTH); Nanga Station, 26° 08' S, 113° 51' E, *R.J. Cranfield* 2572 and 2573 (both PERTH); Useless Loop, Tamala road, 26° 10' S, 113° 25' E, *H. Demarz* D6003 (KP); 14 miles [22.5 km] N of Quobba Station, *A.S. George* 10171 (CBG, NSW, PERTH); 31 miles [49.9 km] N of Murchison River, North West Coastal Highway, *A.S. George* 11236 (CANB, K, PERTH); Cooloomia Nature Reserve, c. 13 km W of Cooloomia homestead, *S.D. Hopper* 1396 (PERTH); 48 km N of Murchison River on North West Coastal Highway, *B.R. Maslin* 3344 (PERTH); 10.5 km W of Overlander-Denham road towards Tamala, *B.R. Maslin* 3686 (CANB, K, PERTH); Meadow Station, *A. Payne* 339 (PERTH); Gnaraloo Station homestead, Lake MacLeod district, *L. Thompson* LXT 1200 (PERTH); Old Haul road, 5 km from Cape Cuvier, 1 Oct. 1982, *J. Tyler* s.n. (PERTH 00165530).

Distribution. Western Australia in the Carnarvon and Irwin (northern extremity) Botanical Districts (1:250,000 maps G49-4, 8, 12; G50-9, 13). Near the Murchison River north to Shark Bay with an outlying population near Cape Cuvier (c. 150 km north of Shark Bay).

Habitat. Sand or sandy clay on flat or gently undulating country. In tall dense shrubland commonly with *Acacia longispinea*, *A. neurophylla*, *A. rostellifera* and species of *Banksia*, *Eucalyptus* and *Hakea*. At Cape Cuvier it grows in *Triodia*-shrub steppe on alkaline sand (pH9) with *Acacia coriacea*, *A. tetragonophylla* and *Eucalyptus fruticosa*.

Affinities. Most readily distinguished from other members of the "*A. victoriae* group" by a combination of its broad phyllodes which are retuse to sub-retuse and its predominantly racemose inflorescences with cream to pale lemon yellow heads (each 60-90-flowered). Within this group it appears that only *A. chartacea* and *A. ryaniana* have a (minute) gland which is flanked by a pair of stipule-like appendages at the apices of at least some phyllodes. These two species grow in close proximity in the Cape Cuvier region but *A. chartacea* is readily recognised, in addition to the characters given above, by its tall, erect habit (prostrate and low-domed in *A. ryaniana*).

Etymology. The specific epithet refers to the papery legumes.

4. *Acacia cuspidifolia* Maslin, *Nuytsia* 4: 79, fig. 4 (1982).

The species is described and illustrated in the above publication.

Distribution. North-west Western Australia in the Ashburton and Carnarvon Botanical Districts, also on the border of the Ashburton-Austin and Ashburton-Fortescue Botanical Districts (1:250,000 maps F49-16; F50-13,15; F51-13; G49-4; G50-1,2,4,5,6,8,10). Extending from Minilya Station E to near Mundiwindi and S to near Ballythana Hill.

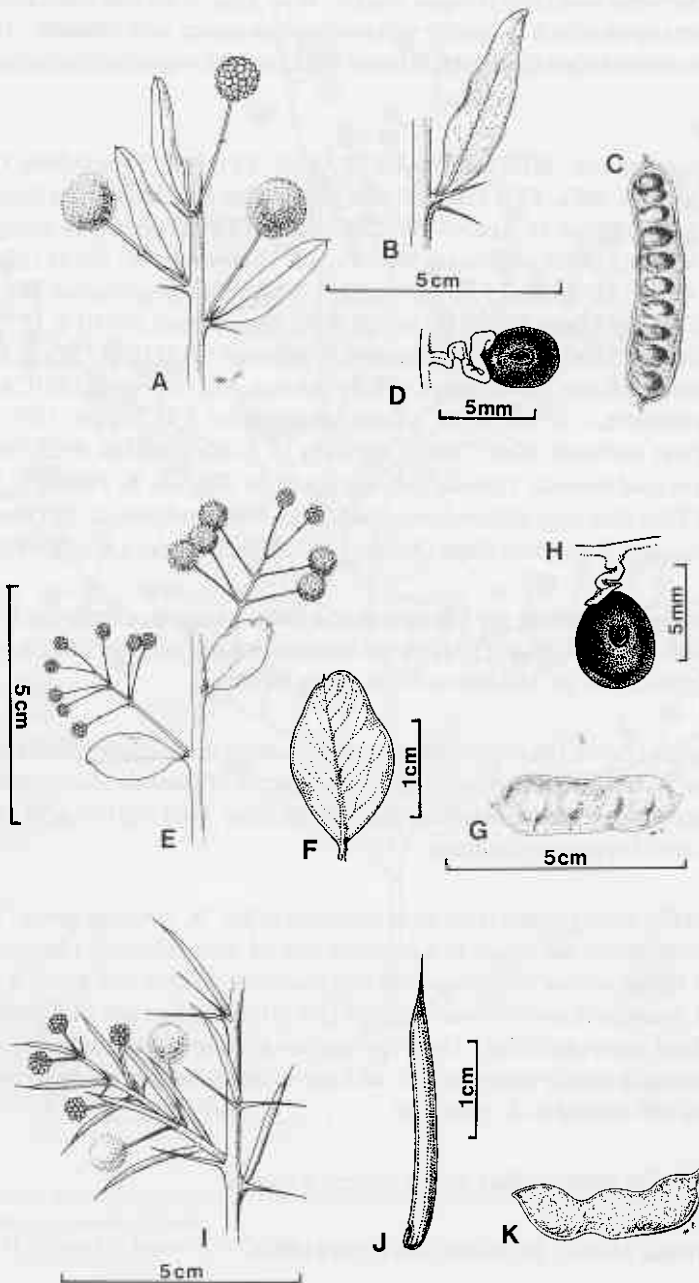


Figure 4. (A-D) *Acacia dempsteri*. A - Portion of branchlet showing peduncles with scar of supra-basal bract and large heads. B - Node showing spinose stipules. C - Legume. D - Seed. (E-H) *Acacia glaucocaesia*. E - Portion of branchlet showing racemes with slender axes and twinned peduncles with scar of supra-basal bract. F - Phyllode. G - Legume. H - Seed. (I-K) *Acacia pickardii*. I - Portion of branchlet showing prominent stipules. J - Phyllode (terete) with basal gland. K - Legume. A & B from R.J. Chinnock 3023. C & D from J. Kitcher S907. E & F from P. Glennon 13. G & H from L. Thomson LXT 1183. I & J from P.K. Latz 8516 (PERTH). K from R. Grandison 231.

5. *Acacia dempsteri* F. Muell., *Fragm.* 11: 65 (1879). (Figure 4A-D)

Type: between Esperance Bay and Frasers Range, Western Australia, 1876, *Dempster* (holo: n.v.; iso: PERTH - fragment ex MEL).

Straggly *shrubs* or *trees* to c. 3 m tall. *Branchlets* terete, finely ribbed, glabrous, pruinose. *Stipules* spinose, (2)5-12 mm long, straight. *Phyllodes* lanceolate to narrowly lanceolate, often slightly asymmetric, excentrically mucronulate, mucro <1 mm long and sometimes pungent, 3-6 cm long, 4-10(13) mm wide, 1:w = 4-12, thinly coriaceous, straight to shallowly curved or shallowly sigmoid, glabrous, green to grey-green, midrib rather prominent, lateral nerves obscure. *Inflorescences* initiated synchronously with phyllodes on new shoots, the phyllodes normally maturing prior to anthesis so that the peduncles appear axillary, a few determinate racemes 1-8 mm long commonly occurring with some at least the result from phyllode suppression on the young shoots. *Peduncles* 1 or 2 per axil, 15-25 mm long, glabrous, base ebracteate; bract above middle of peduncle caducous (bract scar visible on mature peduncles), triangular-ovate, 0.5-1 mm long. *Flower-heads* globular, golden, densely 40-50-flowered, large, c. 1 cm diam. when dry. *Flowers* 5-merous. *Sepals* 1/3-2/5 length of petals, free, narrowly spatulate. *Petals* 2.5-3 mm long, glabrous, midrib not visible. *Legumes* narrowly oblong, raised over seeds, to 5 cm long, 8-10 mm wide, firmly chartaceous, glabrous, dark brown. *Seeds* transverse, oblong-elliptic, 3-4 mm long, 2-3 mm wide, shiny, dark brown except yellow at centre; pleurogram "U"-shaped, not prominent; areole c. 1 mm long, open towards the hilum, aril once- or twice-folded, cream.

Selected specimens examined. WESTERN AUSTRALIA: Rocky outcrop 68 km NW of Mount Ragged, *W. Archer* 22099022 (PERTH); Breeborinia Rock, *K. Bradby* KLB60 (PERTH); Dundas Rocks, ca 22 km S of Norseman, *R.J. Chinnock* 3023 (PERTH); about 22 km S of Norseman, *R.J. Chinnock* (PERTH); Gilmores, *C.A. Gardner* 2849 (K, PERTH); cultivated, Kings Park Botanic Garden, *J. Kücher* S907 (PERTH); near Kundas Rock, *B.R. Maslin* 2473 (PERTH); 26 km W of Ponier Rock, *K. Newbey* 7620 (PERTH).

Distribution. South-west Western Australia in the Coolgardie Botanical District (1:250,000 maps H51-13,14; I51-1,2,3,7). Scattered from Depot Rock near Kambalda S to Gilmore Rocks and E to Breeborinia Rock, c. 100 km S of Balladonia.

Habitat. Confined to granite outcrops where it grows on sand or sandy loam.

Affinities. Distinguished from other members of the "*A. victoriae* group" by its large golden heads, lanceolate phyllodes and prominent, persistent stipules.

6. *Acacia glaucocaesia* Domin, *Biblioth. Bot.* 89: 252 (1926). (Figure 4E-H)

Type: Between the Ashburton and De Grey Rivers, Western Australia, *E.E. Clement* (syn: PR 527979 (sphalm, "legit. A.A. Dorrien-Smith") and PR 527978).

A. glabriflora Maiden & Blakely, *J. Roy. Soc. W. Australia* 13: 12 pl.3 figs. 12-18 (1928), non Domin (1926), *synon. nov.* *Type:* Between the Ashburton and De Grey Rivers, Western Australia, *E.E. Clement* (holo: NSW 206821; iso: K, PERTH).

Illustration. J.H. Maiden & W.F. Blakely, *loc. cit.*

Dense, glabrous *shrubs* or *trees* 2-6 m tall. *Branchlets* terete, obscurely ribbed, conspicuously pruinose. *Stipules* presumably spinose on young plants (see *Variation* below) but only the minute, blunt bases persisting as tooth-like projections at nodes on mature plants. *Phyllodes* elliptic to narrowly elliptic or lanceolate, sometimes obovate to oblong-oblongate, rounded to obtuse, 1.5-2.5 cm long, (5)7-13 mm wide, 1:w = 1.5-3, thin, glaucous, rarely green except on new growth, midrib not prominent, obscurely penninerved. *Gland* situated on upper margin of phyllode at distal end of pulvinus, not overly prominent, c. 0.5 mm long. *Inflorescences* most commonly racemose with some peduncles subtended by secondary phyllodes as in *A. victoriae*, sometimes a few simple and initiated on new shoots as in *A. synchronicia*, both types may be present on a single plant. *Racemes* 1-6 cm long, axes slender, ebracteate at base. *Peduncles* mostly twinned, 7-10 mm long, slender, base ebracteate; bract above middle of peduncle caducous (bract scar visible on mature peduncles). *Flower-heads* showy and prolific, globular, small, 4 mm diam. (when dry), pale yellow, densely 35-50-flowered. *Flowers* 5-merous. *Sepals* free, narrowly spatulate. *Petals* 1-1.4 mm long, nerveless. *Legumes* narrowly oblong, to 4 cm long, 10-13 mm wide, chartaceous, flat, rounded over seeds along midline, moderately pruinose. *Seeds* transverse, oblong to ovate, 4.5-5 mm long, 3-4 mm wide, slightly shiny, brown to blackish, sometimes very obscurely mottled; pleurogram "U"-shaped, not prominent; areole c. 0.5 mm long, open towards the hilum; funicle short, thick, cream, scarcely arillate.

Other specimens examined. WESTERN AUSTRALIA: Nickol River, 1878, *A. Forest* s.n. (MEL 118332); Mardie Station, Fortescue River, *C.A. Gardner* 3079 (PERTH); Karratha-Port Hedland area, *P. Glennon* 13 (PERTH00152897 - in flower & PERTH 00669423 - immature fruit); Dampier Salt leases, Dampier, *P. Glennon* 236 (PERTH) & 381 (CANB, PERTH); Muda-Karratha, *L.C. Snook* s.n. (PERTH 00153397); Turtle Island [North Turtle Island, off Port Hedland], Capt. *Wickham*, coll. *Bynoe* and *Stokes*, Voyage of H.M.S. "Beagle", 1839-1840 (K); 2.8 km W of Goldsworthy turn-off on North West Coastal Highway, *L. Thompson* LXT 1183 (PERTH).

Distribution. North-west Western Australia in the Fortescue and (western extremity of) Canning Botanical Districts (1:250,000 maps F50-2, 4, 6). Known only from a few scattered localities in the western part of the Pilbara region between the Fortescue and De Grey Rivers. A variant from Salt Creek (E51-13) is discussed below.

Habitat. Sandy loam on flood plains; commonly forming almost monospecific stands.

Flowering and fruiting period. Flowers late July-September. Legumes mature from late October into November.

Synonymy. In describing *A. glabriflora* Maiden and Blakely must have been unaware that Domin had already published the name *A. glaucocaesia* for the same taxon some two years previously. Not only did Maiden & Blakely base their name on the same E.E. Clement collection as was used by Domin (seemingly using different specimens) but they also adopted an epithet that Domin had used for quite a different species in 1926.

Variation. The following vegetative specimen is tentatively referred to *A. glaucocaesia*: Salt Creek, 27 km due E of Great Northern Highway between Port Hedland and Broome, 19° 44' S, 121° 28' E, *B.R. Maslin* 4874 (PERTH). It differs from the other material of this species in that it has persistent spinose stipules (2 mm long, slender, straight) and often slightly narrower phyllodes than normal (5-9 mm wide, 1:w = 2-4). This specimen was taken from a regrowth population which may account for these slight aberrations. Salt Creek is located about 250 km NE of the most northerly known occurrence of "typical"

A. glaucocaesia. All other specimens seen of *A. glaucocaesia* have been biologically mature (i.e. in flower or fruit) and have only the minute, thickened stipule bases persisting at the nodes.

Affinities. The taxonomic status of this poorly collected species is uncertain. Until now specimens here attributed to *A. glaucocaesia* had been placed under *A. victoriae*. While these two taxa are certainly closely related, current evidence suggests that *A. glaucocaesia* is better treated as a distinct species rather than as a subspecies of *A. victoriae*. These two taxa share the following significant characters: inflorescences predominantly racemose, peduncles slender, flower-heads pale yellow, phyllodes with small glands, legumes chartaceous, flat, rounded over seeds along the midline and funicles thick and scarcely arillate. *Acacia glaucocaesia* is most readily distinguished from the widespread *A. victoriae* by its more numerous flowers per head and its short, broad phyllodes with a less pronounced midrib. Furthermore, in *A. victoriae* the branchlets are sometimes not pruinose, the spinose stipules are commonly persistent at some mature nodes and the legumes reach 8 cm long. Although both species occur in the Pilbara they are not sympatric, *A. glaucocaesia* occurring near the coast and *A. victoriae* occurring inland.

Acacia glaucocaesia is also related to *A. synchronicia*. The two species grow in close proximity around Karratha where *A. glaucocaesia* is recognised by its less straggly growth habit and denser crowns. Furthermore, it commences flowering earlier (late July compared with September) and the heads are smaller, more abundant, a lighter yellow and at least a proportion are arranged in racemes. Other characters useful in distinguishing *A. glaucocaesia* include its pruinose branchlets and usually narrower phyllodes. In *A. synchronicia*, however, there is considerable variation in size of phyllode whose dimensions are occasionally similar to those of *A. glaucocaesia*. These broad phyllode forms of *A. synchronicia* differ from *A. glaucocaesia* in their non-racemose inflorescences and their thicker phyllodes (thus the lateral venation is very obscure or seemingly absent) which possess a more prominent gland.

Utilization. According to the collectors note on *Thompson* LXT 1183 this species is a favoured browse of cattle. Because of its prolific flowering it does make a very attractive ornamental.

7. *Acacia pickardii* Tind., *Telopea* 1: 372 (1978). (Figure 4I-K)

As only flowering specimens were described in the protologue, a description of the fruits are given here. This is based on a specimen collected from c. 3 km S of Mt Gason on Birdsville Track (*R. Grandison* 231, AD) but unfortunately mature seeds were not present. The species is described and illustrated by Whibley (1980 and 1986) and Maslin (1981).

Legumes narrowly oblong, straight-edged or somewhat irregularly constricted between the seeds, to 4 cm long and 14 mm wide, chartaceous, \pm straight, flat, light brown, glabrous, finely and openly obliquely reticulate. *Seeds* (very immature) seemingly transverse with a filiform, straight funicle.

Distribution. South Australia and Northern Territory (1:250,000 maps G53-3,7; G54-9,13). Known only along the Birdsville track S of Mt Gason Bore in north eastern South Australia and the Andado Station - O'Neill Point area in south eastern Northern Territory.

Affinities. Although the protologue contrasts this species with *A. teretifolia* (from southwest Western Australia) its affinities are clearly with the *A. victoriae* group, as evidenced by its inflorescence and legume characters. Among other things, *A. teretifolia* differs in being a sub-shrub 0.2-0.5 m tall, its phyllodes have a minute gland (c. 0.2 mm diam.) located near their middle and its peduncles possess a

caducous, brown basal bract but lack the very unusual supra-basal bract of *A. pickardii*. The legumes of *A. teretifolia* are totally different from those of *A. pickardii* in being \pm terete, sub-woody and red-brown in colour while the seeds are as equally different in being longitudinal and possessing a terminal, conical aril.

8. *Acacia ryaniana* Maslin, sp. nov. (Figure 5)

Frutices prostrati vel demisso-tholiformes ad 0.3 m alti. Stipulae persistentes, 2-6 mm longae. Phyllodia ovata vel elliptica ad anguste elliptica, 12-25(30) mm longa, (5)7-15 mm lata, ratione horum 1.2-3, coriacea, glabra, viridia, uninervata, subtiliter penninervia. Inflorescentiae simplices et in surculis juvenibus orientes, pedunculis 1 in quoque axilla, 15-30 mm longis, glabris, florum capitulis globularibus, aureis, dense 60-70-floribus. Flores 5-meri. Sepala discreta, anguste spatulata. Legumina arcuata, ad 8 cm longa, 10-18 mm lata, chartacea, plana, super semina rotundata, globosa ad lato-elliptica, 5-6 mm longa.

Typus: Miaboolia Beach, c. 7 km N of Carnarvon, 31 Aug. 1988, *B.R. Maslin* 6295 (holo: PERTH; iso: CANB, K, MEL, NY).

Prostrate or low-domed *shrubs* to 0.3 m tall. *Branchlets* terete, finely ribbed, glabrous, rarely puberulous (hairs short, straight, patent and a little coarse), usually pruinose. *Stipules* persistent, spinescent, 2-6 mm long, slender or stout, sometimes breaking so that on old branches only the bases remain, spreading, straight to shallowly recurved, light brown but often yellowish at base. *Phyllodes* ovate or elliptic to narrowly elliptic, some tending obovate in cultivation, 12-25(30) mm long, (5)7-15 mm wide, l:w = 1.2-3, coriaceous, slightly undulate, glabrous, green, slightly shiny; midrib rather prominent, central, sometimes drying yellowish, lateral nerves fine but evident and anastomosing; marginal nerves narrow, yellow; apices obtuse to sub-acute, excentrically mucronulate; pulvinus c. 1 mm long. *Glands* situated on upper margin of phyllode, basal gland not prominent, 0-1 mm above pulvinus, 0.2-0.5 mm long, lip not raised, sometimes a second, insignificant gland adjacent to the mucro and flanked by a pair of microscopic, caducous, stipule-like appendages. *Inflorescences* initiated within axil of juvenile phyllodes on some new shoots, subtending phyllodes usually reaching maturity before anthesis. *Peduncles* 1 per axil, 15-30 mm long, glabrous, base ebracteate, a caducous bract situated near or above middle of peduncle narrowly triangular, c. 1.5 mm long, scarious and yellowish, the bract scar visible on mature peduncles. *Flower-heads* globular, 10 mm diam. (fresh), golden, densely 60-70-flowered. spatulate, claws narrowly linear. *Petals* 2-2.5 mm long, united for c. 1/2 their length, glabrous, nerveless or obscurely 1-nerved. *Legumes* curved, to 8 cm long, 10-18 mm wide, chartaceous, flat, rounded over seeds and not or variably constricted between them, glabrous, light brown or yellow-brown, finely transversely reticulate. *Seeds* transverse to oblique in the legume, globose to widely elliptic and slightly compressed, 5-6 mm long, slightly shiny, dark brown but frequently light brown or yellowish brown in vicinity of the "U"-shaped pleurogram; areole 1.5-2 mm long, open towards the hilum; funicle expanded into a once- or twice-folded narrow aril which is sometimes curved over end of seed.

Selected specimens examined. WESTERN AUSTRALIA: 7 miles [11.2 km] N of Quobba Station, *K.M. Allan* 387 (CANB, K, PERTH); 6 miles [9.6 km] N of Quobba H.S., *A.S. George* 10157 (CANB, PERTH, TLF); Miaboolia Beach, c. 5-6 km due N of Carnarvon, 22 July 1986, *P. Loeper* s.n. (PERTH 00649910); Sandy Bay Camp, Exmouth, Aug. 1987, *H. Pringle* s.n. (PERTH 00805769); Cultivated at 10 Dodd Court, Karratha, *B.R. Maslin* 5739 (PERTH); 1.2 km W of the Exmouth-Minilya road on road to Coral Bay, *B.R. Maslin* 6280 (K, PERTH); Cultivated at 10 Dodd Court, Karratha (from seed collected on roadside between Exmouth road and Coral Bay), 15 Sept. 1983 and 7 Oct. 1983, *P. Ryan* s.n. (PERTH 00165573 and 00165581); Near Cape Cuvier, 10 Nov. 1982, *J. Tyler* s.n. (PERTH 00165603).

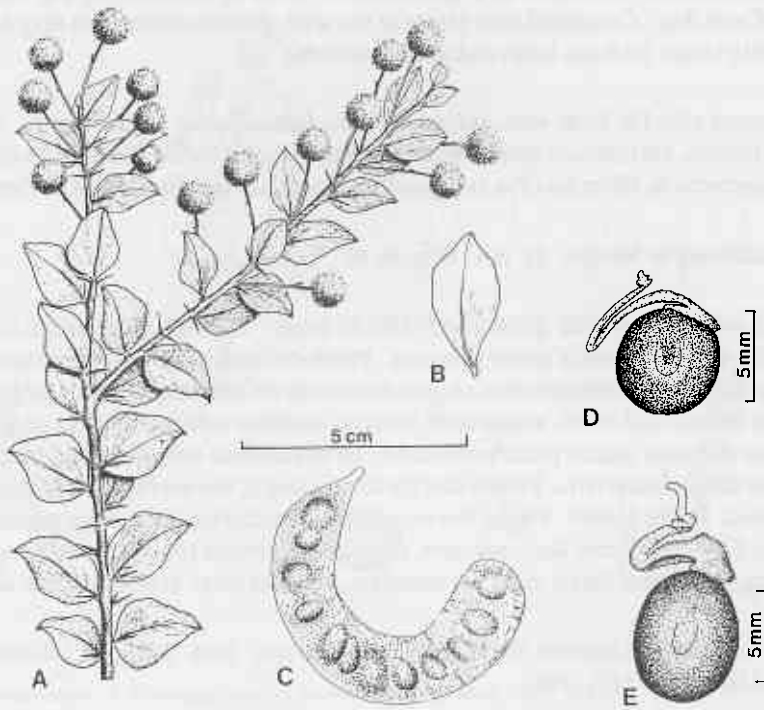


Figure 5. *Acaciaryaniana*. A - Flowering branchlet. B - Phyllode (oblong-ovate) from cultivated plant. C - Legume. D & E - Seeds showing shape and funicle-aryl variation.

A from B.R. Maslin 6295. B from B.R. Maslin 5739. C to E from A.S. George 10157.

Distribution. Western Australia in the Carnarvon Botanical District (1:250,000 maps F49-12, 16, G49-4). Known only from coastal and near-coastal areas between Carnarvon and Exmouth. The species is not very common at the few localities where it occurs.

Habitat. Grows in sand (either over clay or limestone - P. Ryan pers. comm., 31/3/88) on dunes and associated flats in scrub or heath, often with *Triodia* spp.

Flowering period. Paucity of collections makes it difficult to accurately ascertain the flowering period. In cultivation the species flowers between May and September/October. Under natural conditions it is known to flower from late June - August and in November. One collection made in September had both buds and mature fruits present on the same plant. These data suggest that the species may flower throughout the entire year, perhaps in response to rainfall (P. Ryan, pers. comm. 31/3/88).

Fruiting period. Legumes with mature seeds have been collected in September and October.

Affinities. The new species is readily distinguished from the other members of "*A. victoriae* group" by its broad, curved legumes and \pm prostrate habit. Other characteristic features are its persistent spinose stipules, short, broad phyllodes, golden head of 60-70 flowers, simple inflorescences which are initiated on new shoots, and large seeds. Grows in close proximity to *A. chartacea* and *A. victoriae* at Cape Cuvier.

Cultivation. Successfully cultivated as a ground-cover shrub in Karratha by Pat Ryan from seed collected near Coral Bay. Compared with plants in the wild, those in cultivation may have phyllodes which are slightly larger (to 3 cm long) and tending obovate.

Etymology. Named after Pat Ryan who, although not the first collector of this species, was the first to bring it to my attention. He first cultivated it while Nursery Manager for the Department of Conservation and Land Management in Karratha. Pat is currently a Rural Advisor for CALM in Geraldton.

9. *Acacia synchronicia* Maslin, sp. nov. (Figure 6)

Frutices vel arbores expansae glabrae 1.5-3(6) m altae. Stipulae spinosae, 3-10 mm longae, plerumque nullae vel infrequentia aetate provecta. Phyllodia variabilia, anguste oblonga ad anguste elliptica vel anguste oblongo-oblancoolata, aliquando linearia vel elliptica, 1.5-3 cm longa, (1-2)3-8(13) mm lata, ratione horum (2)3-7(14), subcarnosa, in sicco subtiliter corrugata viridia ad glauca, costa et nervis lateralibus obscuris, glande paulo prominenti. Inflorescentiae simplices et in surculis juvenibus orientes, racemis determinatis raris. Pedunculis 10-20 mm longis, florum capitulis globularibus, aureis (35)40-70-floribus. Flores 5-meri. Sepala discreta, anguste spathulata. Legumina anguste oblonga, ad 4-5(7) cm longa, (7)8-12(14) mm lata, chartacea, plana, super semina rotundata. Semina transversalia, ovata ad elliptica, (3)4-5 mm longa, nigra vel maculata, funiculo brevi, crasso, anguste arillata.

Typus: Karratha, opposite Clarkson Road, Western Australia, Sept. 1988, P. Glennon s.n. (holo: PERTH; iso: CANB, G, K, MEL, NY).

Spreading, somewhat diffuse, open or mid-dense *shrubs* or small *trees* commonly 1.5-3 m tall, sometimes 6 m, single-stemmed or sparingly divided at or near ground level. *Bark* greenish or grey and finely fissured on main trunks, upper branches green to bronze. *Branchlets* terete, very finely ribbed, glabrous, sometimes pruinose. *Stipules* spinescent, rigid, 3-10 mm long, spreading, straight, present on young plants but commonly absent or infrequent with age, herbarium specimens usually show only the short basal portions persisting as blunt protruberances flanking the phyllodes. *Phyllodes* variable in shape and size, narrowly oblong to narrowly elliptic or narrowly oblong-oblancoolate, sometimes linear or elliptic, 1.5-3 cm long, (1-2)3-8(13) mm wide, l:w = (2)3-7(14), smooth and sub-fleshy when fresh, very finely wrinkled when dry, \pm straight, glabrous, pale green to grey-green to glaucous; midrib and lateral nerves not prominent, sometimes submerged and thus seemingly absent; apices obtuse to sub-acute, rarely acute, mucro central or excentric; pulvinus c. 1 mm long. *Gland* situated on upper margin of phyllode 0-2 mm above pulvinus, circular to widely elliptic, prominent, (0.3)0.5-1.2 mm long, (0.3)0.5-1 mm wide, usually wider than margin. *Inflorescences* mostly initiated on new shoots with 1 or 2 peduncles arising from within axils of developing phyllodes, subtending phyllodes reaching maturity before anthesis, rarely a few determinate racemes present. *Peduncles* 10-20 mm long, glabrous, base ebracteate, a caducous bract situated near or above middle of peduncle narrowly triangular, 1-1.5 mm long, scarious and brown, the bract scar visible on mature peduncles. *Flower-heads* globular, golden, densely (35)40-70-flowered. *Bracteoles* similar to sepals except the lamina is about twice as large. *Flowers* 5-merous. *Sepals* 1/2-3/4 length of petals, free, narrowly spathulate; claws narrowly linear, colourless, glabrous; laminae 0.1-0.2 mm wide, acute, light brown, glabrous, rarely hirsutellous. *Petals* 1.5-2 mm long, joined for c. 1/2 their length, glabrous, rarely sparsely hirsutellous, midrib not visible. *Legumes* narrowly oblong, to 4-5(7) cm long, (7)8-12(14) mm wide, chartaceous, flat, rounded over seeds along the midline, scarcely constricted between seeds, glabrous, light brown or purplish brown, sometimes slightly pruinose, obscurely transversely reticulate. *Seeds* remaining attached to valve for some time following dehiscence, transverse in the legume, ovate to widely elliptic, (3)4-5 mm long, 3-4 mm wide, compressed (2-2.5 mm thick), \pm dull but areole sometimes shiny, mottled black over

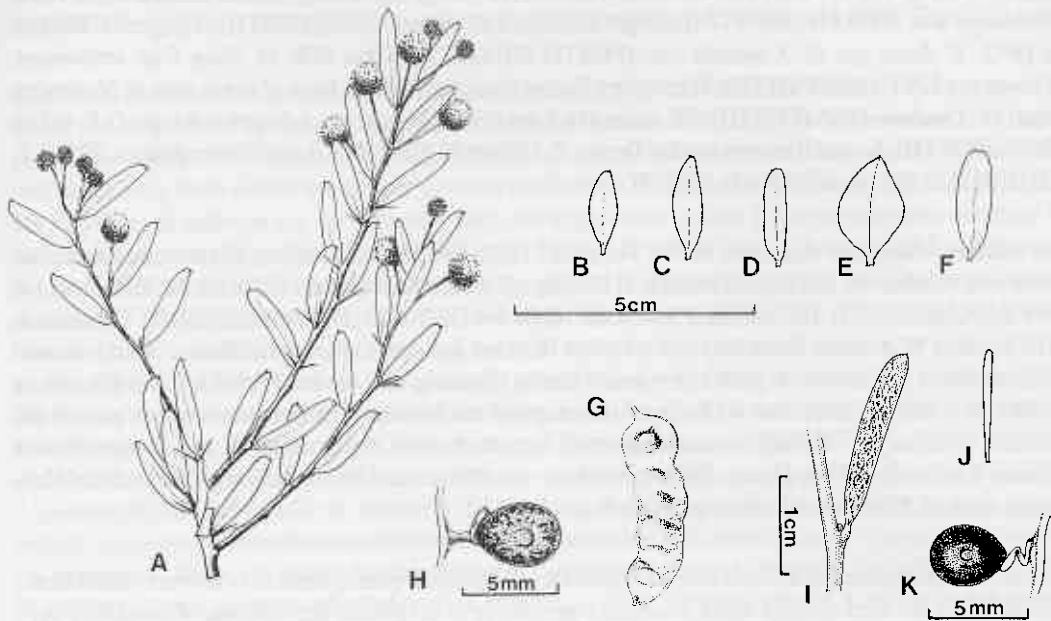


Figure 6. *Acacia synchronicia*. A - Flowering branchlet showing axillary peduncles. B-F - Phyllode variation (note obscure midrib). G - Legume. H - Seed. (I-J) Narrow phyllode variant. I - Node showing narrow, wrinkled phyllode. J - Phyllode (at same scale as typical variant). K - Seed.

A & D from *J.R. Maconochie* 1716. B from *J.V. Blockley* 440. C from *B.R. Maslin* 5290. E from *B.R. Maslin* 5267. F from *C.A. Gardner* 6234. G & H from *A.M. Ashby* 4490. I from *A.S. Mitchell* 724. J from *P.G. Wilson* 10293. K from *M. McInness* s.n.

either yellow or light brown, entirely black or very obscurely mottled on the narrow phyllode variant; areole "U"-shaped, open towards the hilar end, 0.5-1.5 mm long, 0.4-1 mm wide; funicle narrowly oblong to linear, short and thick, 1-2 mm long, 0.5-0.6 mm wide, slightly expanded into a small sub-terminal aril.

Selected specimens examined. WESTERN AUSTRALIA: 58 miles [93.3 km] from Halls Creek on road to Fitzroy Crossing, *I.B. Armitage* 166 (PERTH); S of 506 mile peg, North West Coastal Highway, *A.M. Ashby*, 4490 (CANB, K, MEL, PERTH); Duck Creek, 5 miles (8 km) from Station, *J.V. Blockley* 440 (PERTH); Barrow Island, *R. Buckley* 6952 (PERTH); Near Mindi Springs, Hamersley Range National Park, *C. Done* 093 (BRI, K, PERTH); Fitzroy River on Cherrabun Station, *D. Fell* 285 (DNA, PERTH); 10 km NE of Nita Downs Station, *P.R. Foulkes* 23 (PERTH); Hamersley Pass, Hamersley Range, *C.A. Gardner* 3131 (PERTH); near Winning Pool, *C.A. Gardner* 6234 (PERTH); E of No.2 Well, Charles Knife Road, Cape Range, *A.S. George* 10334 (PERTH, TLF); Maitland River, S of Karratha, *P. Glennon* 14 (PERTH); c. 27 miles [43.4 km] W of Fitzroy Crossing, *J.R. Maconochie* 1299 (DNA, PERTH); Alice Bore, Gordon Downs, *J. Maconochie* 1761 (PERTH); Upper Rudall River area, c. 22°30'S, 122°15'E, *B.R. Maslin* 2046, (BM, G, MO, NY, PERTH), 2053 (K, NSW, PERTH, US), 2053a (CANB, K, PERTH) and 2076 (BRI, CANB, K, MEL, PERTH); About 24 km S of Carnarvon, near Callagiddy turn-off on North West Coastal Highway, *B.R. Maslin* 2770 (PERTH); 14.5 km from Cue towards Mileura Station, *B.R. Maslin* 3597 (PERTH); Hamelin Pool Station, *B.R. Maslin* 3653 (PERTH); 57.5 km SE of Yalgoo towards Paynes Find, *B.R. Maslin* 4253 (PERTH); 51.5 km W of Gascoyne Junction on the road to Carnarvon, *B.R. Maslin* 5000 (PERTH); Mount James Station, 47 km N of Landor Station Homestead on track to Mount Augustus Station, *B.R. Maslin* 5185 (PERTH); 6 km S of Nullagine on Great Northern Highway, *B.R. Maslin* 5267 (PERTH); Tangadee Station, about 10 km NE of Homestead, *B.R. Maslin* 5290 (PERTH); Upper Rudall River area, *M. McInnes* s.n. (PERTH 00156698); Little Sandy

Desert, 22°53'S, 122°37'E, *A.S. Mitchell* 724 (PERTH); Gorge top, Elong, Barlee Range, Sept. 1959, *A. Robinson* s.n. (PERTH 00155764); Gogo Station, *R.D. Royce* 3279 (PERTH); Pingandy Station, Jan. 1972, *E. Scott* per *G. Kendrick* s.n. (PERTH 00153877); 5 km NW of Shay Gap settlement, *L. Thompson* LXT 1180 (PERTH); Hamersley Range National Park, at base of north side of Marandoo Ridge, *M. Trudgen* 1865 (PERTH); 26 miles [41.8 km] S of Onslow on Ashburton River, *D.E. White* 630805 (PERTH); Logue River on road to Derby, *P.J. White* 32 (PERTH); Rudall River district, 22°35'S, 122°10'E, *P.G. Wilson* 10293 (AD, PERTH).

Distribution. Western Australia in the Dampier, Hall, Fitzgerald, Mueller, Fortescue, Kearthland, Carnarvon, Ashburton and Austin Botanical Districts (1:250,000 maps E51-3,7,8,12,14; E52-9,10,14; F50-1,2,3,4,5,6,7,9,10,11,13,14,15,16; F51-1,5,6,9,10; G49-4; G50-1,2,4,5,6,7,9,11,15; H50-2). Common in north-western W.A. from Shark Bay north to Port Hedland and east to the Rudall River. Also common in the southern Kimberley region from near Fitzroy Crossing east to the W.A./N.T. border. (It is probable that future collections will extend the range of the species to at least the western part of the Northern Territory.) Isolated occurrences are recorded from the Robinson and Logue Rivers (western Kimberley), Nita Downs Station (between the Pilbara and Kimberley regions) and the Cuelgo area, c. 350 km south-west of Shark Bay.

Habitat. Watercourses and alluvial flats in often rocky (limestone, quartz) sand, clay or loam. Sometimes on rocky hills but then usually along drainage channels or in clay/loam depressions. Commonly very abundant in places where it occurs.

Flowering period. August-December.

Fruiting period. Legumes with mature seeds have been collected in January, April, May, November and December.

Variation. The phyllodes of *A. synchronicia* vary considerably in shape and size (particularly in width) with the variation appearing to be continuous. Usually they are narrowly oblong to narrowly elliptic or narrowly oblong-oblongate, 3-8 mm wide, l:w = 3-7 and the seed is mottled and 4-5 mm long. Specimens with \pm linear, especially narrow phyllodes (1-3 mm wide, l:w = 10-14) and \pm non-mottled, black seeds 3-4 mm long are common in the Rudall River area (e.g. *B.R. Maslin* 2046, & 2076, *M. McInnes* s.n., *A.S. Mitchell* 724 and *P.G. Wilson* 10293) and at a few scattered localities in the Pilbara region, e.g. Barrow Island (*R. Buckley* 6952), near Shay Gap (*L. Thompson* LXT 1180). This narrow phyllode variant which was called *A. aff. victoriae* in Maslin (1981: 131) may ultimately be shown to warrant formal rank. Plants of "typical" *A. synchronicia* also occur at the Rudall River (e.g. *B.R. Maslin* 2053 and 2053a) and these have phyllodes which are elliptic to narrowly elliptic and 5-8 mm wide.

Two sterile specimens (*B.R. Maslin* 5000 and 5267) with unusually broad, elliptic phyllodes (8-13 mm wide, l:w = 2-3) and pruinose branchlets resemble *A. glaucocaesia* but are included in *A. synchronicia* because the phyllodes are fleshy (finely wrinkled when dry) and have a prominent basal gland.

Three specimens from the west Kimberley region which appear to represent the same entity are unusual. They have thinner than normal phyllodes and, according to the label on one of them, have pale yellow flowers (a character of *A. victoriae*). They are tentatively referred to *A. synchronicia* because of their inflorescence structure and because the heads bear 35-70 flowers (legumes unknown). The entity is represented by the following gatherings. Meda-Oobagooma road, 97.5 km by road N of the Derby-Gibb River road, *A.C. Beaglehole* 52774 (PERTH); Fraser River Bore No. 1, 24 km due

N of Great Northern Highway, 111 km E of Broome on Derby road, *K.F. Kenneally* 7665 (BRI, CANB, K, PERTH); At gate, 1.7 km S of Oobagooma Station homestead, *T. Willing* 46 (PERTH).

Affinities. Until now *A. synchronicia* has been confused with *A. victoriae*. The two species are most reliably distinguished by their inflorescences but there are also differences in indumentum, phyllodes, glands and seeds. In *A. synchronicia* the inflorescences are initiated on the new shoots where 1 or 2 peduncles arise from within the axils of juvenile phyllodes. These phyllodes usually mature by the time the heads reach anthesis but occasionally they are suppressed so that a few determinate racemes (or more correctly, racemes of heads) are developed. The heads are (35)40-70-flowered and judging from the (somewhat scant) specimen label records are golden in colour (except for the Kimberley variant noted under *Variation* above). By contrast *A. victoriae* has cream to pale lemon yellow heads with fewer flowers (20-30). Furthermore, as discussed under *A. victoriae* below, the inflorescences on this species are usually all or mostly racemes (these occur in great profusion so that at anthesis *A. victoriae* is a more floriferous plant than *A. synchronicia*). Elsewhere in section *Phyllodineae* closely related species are discriminated using the same sort of inflorescence difference, e.g. *A. pyrifolia* DC. - *A. strongylophylla* (fide Maslin 1981), *A. ligulata* A.Cunn. ex Benth - *A. bivenosa* DC., *A. calamifolia* Sweet ex Lindley - *A. nematophylla* (fide Maslin & Whibley 1987). Also, elsewhere in the "*A. victoriae* group", closely related species-pairs show the same inflorescence differences, e.g. *A. chartacea* - *A. ryaniana*, *A. victoriae* - *A. alexandri*. Other characters distinguishing *A. synchronicia* from *A. victoriae* include the following. Branchlets always glabrous; phyllodes often shorter (in W.A. the phyllodes of *A. victoriae* are usually 2.5-4 cm long, however, elsewhere they can be much longer), thicker (thus more obviously wrinkled when dry) and with a less pronounced midrib; glands often larger, more pronounced and rarely removed from the pulvinus; seeds not globose. Although the geographic ranges of the two species overlap, *A. synchronicia* has a more restricted distribution and is more common in north-west W.A. and southern Kimberley than is *A. victoriae*. The plant illustrated as *A. victoriae* in Petheram and Kok (1983) is probably *A. synchronicia*.

Etymology. The specific epithet refers to the synchronous initiation of phyllodes and inflorescences on new shoots.

10. *Acacia victoriae* Benth. in T.Mitch., J.Exped. Trop. Australia 333 (1848). (Figure 7)

A. sentis F. Muell. ex Benth., Fl. Austral. 2: 360 (1864), *nom. illeg.* (includes type of *A. victoriae*); *A. sentis* var. *victoriae* (Benth.) Domin, Biblioth. Bot. 89: 254 (1926); *Racosperma victoriae* (Benth.) Pedley, Austrobaileya 2: 347 (1987). *Type:* "Victoria River" [=Barcoo River, 24° 40' S, 146° 01' E], Qld, 1 Oct. 1846, *T.L. Mitchell* "620" (holo: K; iso: CGE).

A. sentis F. Muell, Second Gen. Rep. 12 (1854), *nom. nud.*; Pl. Indig. 2: 18 (1863), *nom. invalid.* (not effectively published).

A. decora var. *spinescens* Benth. (sphalm. "*pinescens*"), Linnaea 26: 620 (1855), *synon. nov.* *Type:* Between Flinders Range and Spencers Gulf, S.A., *F. Mueller* s.n. (syn: K). Darling River, N.S.W., *F. Mueller* s.n. (syn: n.v.).

A. hanniana Domin, Biblioth. Bot. 89: 253 (1926). *Type:* Cape York Peninsula [Palmer River, fide L. Pedley, Austrobaileya 1: 271 (1980)], Qld., *W. Hann* 59 (holo: K, the seeds mounted on the type sheet are possibly those of *Distichostemon malvaceus*, fide L. Pedley, *loc. cit.*).

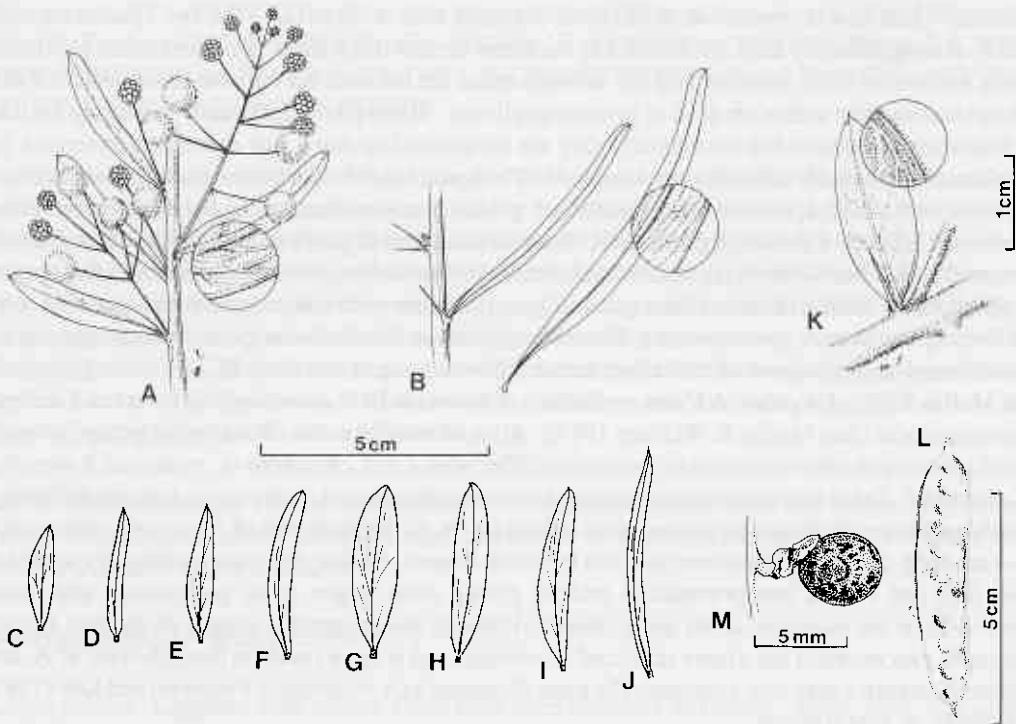


Figure 7. *Acacia victoriae*. A - Flowering branchlet showing predominantly racemose inflorescences, most peduncles with a minute supra-basal bract or, where bracts have fallen, a scar. B - Node showing spinose stipules. C-J - Phyllode variation (note pronounced midribs). K - Node showing spinose stipule and hairy phyllode (subsp. *arida*). M - Seed. L - Legume.

A from T. & J. Whaite 4241a. B from N. Hall H82/11. C from N.H. Speck 685. D from G.J. Keighery 7006. E from T. & J. Whaite 4215. F from C.A. Gardner 7894. G from S.J. Forbes 1531. H from C.A. Gardner 3126. I from A.S. George 2918. J from P.E. Conrick 1599. K from B. Maloney 12/83. L & M from I. Tyson s.n.

A. coronalis. J. Black, Trans. Roy. Soc. S. Australia 71: 20 (1947). Type: Crown Point, Finke River, N.T., n.v., *fide* B.R. Maslin, J. Adelaide Bot. Gard. 2: 319 (1980).

[*A. decora* auct. non Reichb.: G. Bentham, Linnaea 26: 620 (1855) and F. Mueller, J. Proc. Linn. Soc. Bot. 3: 128 (1859)].

Illustrations. F. Mueller, Iconogr. Austral. *Acacia* dec. 4 (1887) - as *A. sentis*; J.H. Maiden, Forest Fl. New South Wales 8(7): pl. 254 A-I (1921); C.D. Boomsma, Native Trees S. Australia 51 (1972); K. Askew and A.S. Mitchell, Fodder Trees Shrubs N. Terr. 23 (1978); G.M. Cunningham *et al.*, Pl. W. New South Wales 375 (1981); L. Costermans, Native Trees Shrubs S.E. Australia 316 (1981); B.R. Maslin, Fl. Cent. Australia 120 (1981); M. Simmons, Acacias of Australia 1: 181 (1981); D.J.E. Whibley, Fl. S. Australia 4th edn 2: 567 (1986).

Shrubs or *trees* 2-5 m tall, sometimes to 8 m, can readily regenerate from suckers, sometimes forming thickets. *Branchlets* often pruinose, glabrous or sometimes hairy, hairs spreading or appressed. *Stipules* spinose, 2-12 mm long, commonly only the short blunt bases persisting at mature nodes.

Phyllodes variable, linear to narrowly oblong, lanceolate or narrowly elliptic, commonly 2-5 cm long and 2-8 mm wide with l:w = 2-13, sometimes to 11 mm wide or (especially Qld plants) to 10 cm long with l:w to 25 or more, straight or incurved, glabrous, sometimes hairy, green, grey-green or glaucous, midrib prominent, lateral nerves normally obscure. *Gland* 0-5 mm above pulvinus, obscure or prominent. *Inflorescences* usually all or mostly long slender racemes with some peduncles sometimes subtended by a secondary phyllode, rarely all simple as in *A. synchronicia*; peduncles 6-18 mm long, mostly twinned, slender, glabrous, sometimes hairy; heads globular, creamy white to pale lemon-yellow, 15-30-flowered. *Flowers* 5-merous; sepals free, narrowly spatulate. *Legumes* narrowly oblong, to 8 cm long, 9-16 mm wide, chartaceous, flat, rounded over seeds along midline. *Seeds* transverse, ± globose, 4-6 mm long, mottled blackish on brown, funicle short, thick and scarcely arillate. Elegant Wattle, Bramble Wattle, Prickly Wattle, Gundabluey, and others, *vide* G.M. Cunningham *et al.*, *loc. cit.*

Selected specimens examined. WESTERN AUSTRALIA: 8 km S of Mt Anderson, near Fitzroy River, T.E.H. Aplin 5168 (BRI, PERTH); near Munjina Gorge, J.V. Blockley 420 (PERTH); 100 km S of Nullagine, P.E. Conrick 1599 (MO, PERTH); 40 km SW of Laverton on Leonora road, S.J. Forbes 1531 (BRI, MEL, PERTH); Hamersley Range, West of and near Mount Bruce, C.A. Gardner 3126 (PERTH); 103 miles [166 km] E of Mullewa, C.A. Gardner 7894 (PERTH); ca 6 mi [9.6 km] S of Warburton Mission, A.S. George 2918 (PERTH); Haig, G.J. Keighery 7006 (PERTH); 66 km from Wittenoom towards Roebourne, B.R. Maslin 2729 (AD, NT, PERTH); Afghan Rock, 35 km due NW of Cue, B.R. Maslin 5384 (PERTH); Barlee Range, Henry River, R.D. Royce 6524 (PERTH); 15 miles [24.1 km] SE of Berringarra, N.H. Speck 685 (PERTH); Mt Narryer, Murchison River, I. Tyson s.n. (PERTH 00155799); Newman area, K. Walker 191 (PERTH); on Murchison River, 83 miles [133.5 km] N of Mullewa on road to Carnarvon, T. & J. Whaite 4214a and 4215 (both PERTH).

NORTHERN TERRITORY: 12 miles [19.2 km] NW of Lucy Creek Homestead, G. Chippendale 3522 (PERTH); 4.2 miles [6.7 km] E of Allua Well, Ross River, G. Chippendale 4963 (PERTH); Lake Amadeus, P.K. Latz 5705 (PERTH); 10 miles [16.1 km] SW of Soudan Station, R.A. Perry 691 (PERTH); 46 miles [74 km] SSW of Limbunya Station, R.A. Perry 2349 and M. Lazarides (PERTH); Palm Valley, c. 12 km SSW of Hermannsburg, 16 Sept. 1965, J.H. Willis s.n. (PERTH 00155683).

SOUTH AUSTRALIA: ca 130 km along Big Road, E of Purnie Bore, Simpson Desert, B. Maloney 12/83 (PERTH); Indulkana Creek at Stuart Highway, L. Thomson 44 (PERTH); Black Oak Creek, 62 km SE of Pimba on Stuart Highway, L. Thomson 48 (PERTH); between Point Paterson and Red Cliff Point, W of Winninowie, D.J.E. Whibley 5465 (PERTH).

QUEENSLAND: 11 miles [17.6 km] W of Townsville on Hervey Range road, R. Cumming 3276 (PERTH); 35 miles [56.3 km] S of Boulia on road to Birdsville, B. Maloney 20/70 (PERTH); 20 miles [32.2 km] E of Thargominah, B. Maloney 30/70 (PERTH); 20 miles [32 km] NNE of Punjaub Station, R.A. Perry 1390 (PERTH).

NEW SOUTH WALES: 30 miles [48.3 km] by road NW of Wilcannia, E.F. Constable 4627 (PERTH); 62 km N of Bourke on Mitchell Highway, L. Thomson 9 (PERTH).

VICTORIA: Red Cliffs, S of Mildura, A.C. Beauglehole 18959 (MEL); between Rainbow and Yaapeet, D.C. Cheal s.n. (MEL 619570); Sunset Desert N of Birthday Tank, J. Luly, ANU no. 30086 (MEL).

Distribution. Widespread in all mainland States of Australia except Victoria where it occurs only near Mildura. In view of the reassessment of *A. victoriae*, the distribution of the species in W.A., as given in Maslin and Pedley (1982), has been altered considerably. Within W.A. *A. victoriae* is now recorded from the following 1:250,000 maps: E51-4, 10, 11; F50-7, 11, 12, 14, 16; G50-6, 8, 10, 11, 14, 15, 16; G51-8, 9, 10, 14; G52-9; H50-2, 3, 4, 7; H51-1, 2; H52-13. For all other states the distribution is as given in Maslin and Pedley (1982) except for the following modifications. N.T.: add D53-13; F53-16; G53-8. S.A.: add G53-9; G54-9; I53-3; delete G53-16; H53-3, 6; H54-10, 14. Qld: add D54-15; E55-5; F54-8; G54-6; G55-6; delete G56-14. N.S.W.: add H54-11; delete I55-9.

Habitat. Arid and subtropical areas in a variety of habitats but commonly in clay or loam on alluvial flats, also (especially subsp. *arida*) in sand.

Variation. *Acacia victoriae* is quite a variable species. Its inflorescences are usually long, slender, determinate racemes with a profusion of heads so that at anthesis the plants are very floriferous. Sometimes a few racemes may become "leafy" through the development of a secondary phyllode at the base of some of the (usually twinned) peduncles. In these cases the specimens show a mixture of racemes and simple inflorescences with the former usually occurring in greater abundance. Only very rarely have I observed the inflorescences on *A. victoriae* to be all simple, being initiated on new shoots with 1 or 2 peduncles arising from within axils of developing phyllodes as in *A. synchronicia*.

The phyllodes are quite variable as noted in the description above. According to Pedley (1980) the phyllode penninervation is prominent on specimens from north-west Qld. Elsewhere the lateral nervation is not prominent or even seemingly absent.

The taxonomic status of *A. victoriae* subsp. *arida* requires further investigation. Specimens ascribed to this taxon have densely tomentose branchlets and phyllodes and occur on sandy soil in southern N.T., northern S.A., western N.S.W. and south-western Qld. Hairy branchlets and phyllodes occur in typical *A. victoriae* but the indumentum, especially on the phyllodes, is usually sparse. Intermediates occur between the two subspecies.

A. victoriae* subsp. *arida Pedley, *Austrobaileya* 1: 271 (1980). *Type:* Poeppel Corner, Sept. 1966, *D. Boyland* 254 (holo: BRI, n.v.; iso: K, n.v.). (Figure 7K)

[*A. brachybotrya* auct. non Benth.: L. Pedley, *Contr. Queensland Herb. No. 4:* 6 (1969)].

Affinities. In the absence of flowers the species may be confused with *A. synchronicia*. Long phyllode forms from Qld superficially resemble *A. alexandri* (W.A.), *Acacia glaucocaesia* (W.A.) may ultimately be shown to be conspecific with *A. victoriae*. Refer to the above-mentioned species for discussion.

Utilization. Moderate nutritive value and a useful stock food supplement during droughts. Useful as a low windbreak and for soil stabilization in dry country. Numbers may increase markedly during a succession of wet seasons and can become a nuisance, especially around watering points. Fodder potential and other uses are discussed in Everest (1969), Askew and Mitchell (1978), Rachie *et al.* (1979), Hall *et al.* (1981) and Turnbull (1986).

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