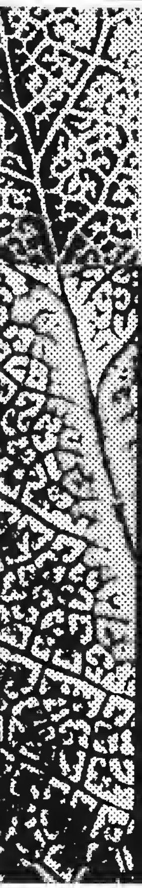
VOLUME 10 1997



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CONTENTS

VOLUME 10 1997

Page

Vascular Plant Systematics

Lichenology

Selected Mycological Papers from 'The 1996 Commemorative Conferences', Melbourne, 29 September to 5 October 1996

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Muelleria 10: 1–11 (1997)

Notes on *Goodia* (Fabaceae, Bossiaeeae)

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Abstract

Two species, *Goodia lotifolia* Salisb. and *G. medicaginea* F. Muell., are recognised. A key to species, descriptions and distribution maps are provided. The difficulty in identifying material in the absence of mature pods containing seeds is discussed. *Goodia medicaginea* is lectotypified.

Introduction

The genus *Goodia* was described by Salisbury in 1806, and commemorates Peter Good, horticulturist and botanical collector who accompanied Robert Brown to Australia on board H.M.S. Investigator where he died in Sydney in 1803. *Goodia* is a distinctive genus which is readily distinguished from all other genera in the tribe Bossiaeeae by having pinnately 3-foliolate leaves. Another character that has been used to distinguish the genus from other members in the tribe Bossiaeeae is that the pod valves do not usually recurve on dehiscence (Crisp and Weston 1987). However, although generally the case, this distinction is not absolute as occasional dehisced pods with recurved valves have been observed amongst material from Victoria and Tasmania.

As discussed by Lee (1984), the status of taxa in *Goodia* has long been in question and opinion has been divided over whether one, two or three species should be formally recognised. Bentham (1864) recognised two species, namely, *G. lotifolia* Salisb. and *G. pubescens* Sims, treating *G. medicaginea* F. Muell. as a synonym of the former. *Goodia pubescens* was subsequently reduced to varietal rank within *G. lotifolia* by Williamson (1931). Curtis (1956) followed Bentham in treating *G. lotifolia* and *G. pubescens* as separate species, but Willis (1973) and Weber (1986) accorded *G. pubescens* varietal rank. Willis (1973) and Lee (1984) maintained *G. medicaginea* as a distinct species but Weber (1986) felt that the nature of the variation in the South Australian populations did not permit the recognition of *G. medicaginea* as a species distinct from *G. lotifolia*.

Following an evaluation of the genus throughout its range, I am persuaded to recognise *G. lotifolia* and *G. medicaginea* as distinct species. Of the character states assessed, the length of the foot of the aril at its point of attachment to the seed provides the most reliable means of separating the two species throughout their ranges. Specimens can be referred to one species or the other very readily on the basis of this character. In *G. medicaginea* the short foot that attaches the aril to the seed is up to 1.1 mm long whereas in G. lotifolia the foot is 1.4–2 mm long. Unfortunately, the infrequent presence of mature seeds on specimens reduces the utility of this character: seeds are present on fewer than 10% of the herbarium specimens examined. It is acknowledged that in the absence of mature fruit it is unquestionably difficult on occasions to differentiate *G. medicaginea* from *G. lotifolia* because most of the diagnostic characters traditionally used to differentiate the species are unreliable. Alleged differential characters such as flower size, length of the raceme, length and shape of the calyx-lobes and the length of the lower lobes in relation to the length of the tube, corolla colour, the size of the pods, and bark characteristics tend to be correlated, with varying degrees of imperfection, with the difference in the length of the foot of the aril at its point of attachment to the seed. Unfortunately, reliance has to be placed on these latter less satisfactory differential tendencies in the absence of mature seeds, although they are correlated to some extent with distribution.

All Western Australian and South Australian *Goodia* populations are referrable to *G. medicaginea*, and the Tasmanian populations to *G. lotifolia*. Both species occur in Queensland, New South Wales and Victoria but the distributional ranges of the two species are known to overlap only in south-western and north-eastern Victoria. In these areas, *G. medicaginea* tends to favour drier and often more inland sites than *G. lotifolia*. The distribution of *Goodia* taxa in Queensland and northern New South Wales is imperfectly understood. Most of the material available currently is inadequate which renders identification difficult. Good fruiting material is required to clarify the distributions of the two species in Queensland and northern New South Wales.

The degree of development of the indumentum on the vegetative parts does not provide a means of separating *G. lotifolia* and *G. medicaginea* as specimens of *G. medicaginea* are often as pubescent as those of *G. lotifolia* var. *pubescens*.

In the field, mature *Goodia* plants often appear as though they are under stress. This impression is obtained because the outer stems tend to die back from the periphery towards the centre of the plant leaving the dead material exposed. New watershoots are produced from the older stems or, more usually, from the base of the plant.

Description of Genus

Goodia Salisb., *Parad. Londin.* 1: t. 41 (1806). *Type: G. lotifolia* Salisb.

Shrubs to 4m high. *Leaves* pinnately 3-foliolate, alternate, petiolate; leaflets entire, the terminal one largest. *Stipules* caducous. *Flowers* in terminal and leaf-opposed racemes, each flower subtended by a single bract and a pair of bracteoles, the bract and bracteoles linear or ovate, caducous. *Calyx* with the 2 upper lobes broad and united into a 2-toothed lip, the lower 3 teeth narrow. *Corolla* yellow or orange with red, brown, green or purplish markings. *Stamen*-filaments joined in a sheath split open on the upper side; anthers uniform, dorsifixed, with a broad brown connective. *Ovary* glabrous or almost so. *Pods* obliquely rhomboid-oblong, stipitate, 2–4-seeded, valves thin, margined beyond the upper sutural nerve. *Seeds* ovoid, with an elliptic or linear hilum covered by a hooded cap-like aril.

Distribution

An endemic genus of two species occurring in all States and the Australian Capital Territory.

Notes

In New South Wales and Victoria the two species usually can be distinguished relatively easily; *G. medicaginea* tends to have shorter racemes, smaller flowers, the lower 3 calyx-lobes less than 2 mm long, shorter than the tube and broadly-lanceolate to deltoid, a corolla which is dull yellow to orange, and smaller pods. With the exception of a few cultivated specimens, in all of the fruiting South Australian material examined, which represents populations from throughout the distributional range in the State, the foot that attaches the aril to the seed is less than 1.1 mm long. On the strength of this, all of the South Australian populations are referred to *G. medicaginea*. The racemes in South Australia are often as long as any found in *G. lotifolia* and the lower calyx-lobes are sometimes longer than the tube. It is not uncommon to find on the same branch some flowers in which the lower calyx-lobes are longer than the tube and other flowers in which the lower calyx-lobes are shorter than the tube. The branchlets in the South Australian populations are often fairly densely pubescent and some specimens are as pubescent as those found in *G. lotifolia* var. *pubescens*.

The colour of the corolla in the two species appears to differ in some respects but this is difficult to confirm from herbarium specimens as few collectors describe flower colour in any detail. Careful field observations are required to establish whether the alleged differences are taxonomically meaningful. Likewise, there is a suggestion that the colour of the mature foliage differs. The bark on the older stems of the two species appears to differ slightly, that of *G. medicaginea* often being dark reddish-brown or purplish and with numerous inconspicuous transverse constrictions or wrinkles that sometimes result in the surface being minutely warted. In contrast, the stems of *G. lotifolia* are usually yellowish- or reddish-to olive-brown and smooth. Bark characters are seldom mentioned by collectors and older stems are infrequently collected.

In common with many legumes, *Goodia* plants usually favour disturbed sites.

Key to Species

1. Foot of aril 1.4–2 mm long at its point of attachment to the seed, the hilum linear; flowers 9–14 mm long, in racemes 4–10 cm long; lower 3 calyx-lobes usually as long as or longer than the tube and more than 2 mm long in mature flowers, linear-lanceolate; bark on older stems relatively smooth .... 1. *G. lotifolia*

1. Foot of aril up to 1.1 mm long at its point of attachment to the seed, the hilum elliptical; flowers 6–10.5 mm long, in racemes 1–5 (10) cm long; lower 3 calyx-lobes usually shorter than the calyx-tube, broad-lanceolate to deltoid and less than 2 mm long in mature flowers; bark on older stems often minutely warted............ 2. *G. medicaginea*

Descriptions of Species and Varieties

1. *Goodia lotifolia* Salisb., *Parad. Londin.* 1: t. 41 (1806). *Type:* 'Sponte nascentem in New South Wales, legit P. Good'; t. 41 in Salisb., *Parad. Londin.* 1:(1806).

Goodia latifolia W.T. Aiton ex Colla, *Hort. Ripul.* 1: 62 (1824). Orthographic variant of *G. lotifolia*.

Illustration: Sims in Curtis, *Bot. Mag.* 23: t. 958 (1806).

Shrub to 4 m high, often fairly slender; young branchlets glabrous to densely clothed with appressed or spreading hairs. *Leaflets* obovate to obovate-cuneate or elliptic, 5–35 mm long, 3–29 mm wide, the terminal one usually obovate, glabrous throughout or lower surface sparingly to densely clothed with appressed to spreading hairs; petiole 5–30 mm long. *Racemes* 4–10 cm long. *Flowers* 9–14 mm long, on pedicels 4–10 mm long. *Calyx* 4–6 mm long, the 3 lower lobes usually as long as or longer than the tube in mature flowers. *Standard* bright yellow internally with a conspicuous deep red or reddish-brown horseshoe-shaped flare around the throat or on either side of the throat; wings externally bright yellow apically, purplish-brown basally; keel externally greenish-yellow basally but suffused with red apically. *Pods* obliquely ovate to oblong, narrowed basally into a slender stipe, usually 1.6–3.8 cm long excluding the stipe. *Seed:* foot of the aril 1.4–2 mm long. **Golden-tip**.

1. Young branchlets, lower surfaces of leaflets, calyces and pedicels glabrous or sparingly clothed with appressed hairs .... 1a. var. *lotifolia*
1. Young branchlets and lower surfaces of leaflets (and often calyces and pedicels) densely clothed with appressed or spreading hairs .... 1b. var. *pubescens*

1a. *Goodia lotifolia* var. *lotifolia.*

Diagnostic features as in key. (Fig. 1a–c)

Distribution and Habitat

South-eastern Queensland, eastern New South Wales, Victoria, Tasmania (Bass Strait islands only) (Fig. 2). Common understorey species in wet and dry sclerophyll forest. Flowers August–November.

Representative Specimens (187 specimens examined)

QUEENSLAND: Moreton Distr., Harland Road, Mount Glorious, *A.R. Bean 2159* (BRI). NEW SOUTH WALES: South Coast, Wallagaraugh Forest Drive, *M.G. Corrick 6054* (CBG, MEL). AUSTRALIAN CAPITAL TERRITORY: slopes of Mt Tidbinbilla on path to Kangaroo Gap, *N.T. Burbidge 5593* (BRI, CANB). VICTORIA: Mt Elizabeth No. 2 State Forest, 2 km below the summit of Mt Elizabeth, *J.H. Ross 3421* (BRI, CANB, MEL, NSW). TASMANIA: Cape Barren Island, *J.S. Whinray 618* (MEL).

1b. *Goodia lotifolia* var. ***pubescens*** (Sims) H.B. Will. in Ewart, *Fl. Victoria* 658 (1931). *Goodia pubescens* Sims, *Bot. Mag.* 32: t. 1310 (1810). *Type:* 'native of Van Diemen's Island ... Communicated by Messrs Loddiges and Sons', t. 1310 in *Bot. Mag.* (1810).

Goodia subpubescens Sweet, *Hort. Brit.* 110 (1826), *nomen nudum.*

Diagnostic features as in key.

Distribution and Habitat

Occurs sporadically in south-eastern Queensland, eastern New South Wales, Victoria and mainland Tasmania (Fig. 3), in dry and wet sclerophyll forest. Flowers August–November.

Representative Specimens (59 specimens examined)

QUEENSLAND: Moreton District, Canungra to Mt Tamborine Road, c. 2km S of Mt Tamborine, *W.F.J. McDonald 1496 and W.G. Whiteman* (BRI). NEW SOUTH WALES: Track to Nothofagus Mtn, 11.3 km N of Woodenbong, *R. Coveny 5172* (BRI, MEL, NSW). VICTORIA: Mt. Slide Rd between Yarra Glen and Kinglake, *M.G. Corrick 10214* (CBG, MEL). TASMANIA: Archers Sugarloaf, *A. Moscal 12499* (HO, MEL).

Notes

Some specimens from the north coast of New South Wales, for example *Wilcox* (MEL 1058235) from the Clarence River, have unusually large pods up to 5.2 cm long (excluding the stipe) and 1.5 cm wide. Mueller assigned the manuscript name 'var. *macrocarpa*' to some of these large-podded specimens but his unpublished variety is not upheld. Similarly, he assigned the manuscript name 'var. *velutina*' to some densely pubescent specimens but this unpublished variety is not recognised either. The large pods on these specimens from the north coast of New South Wales are in contrast to the

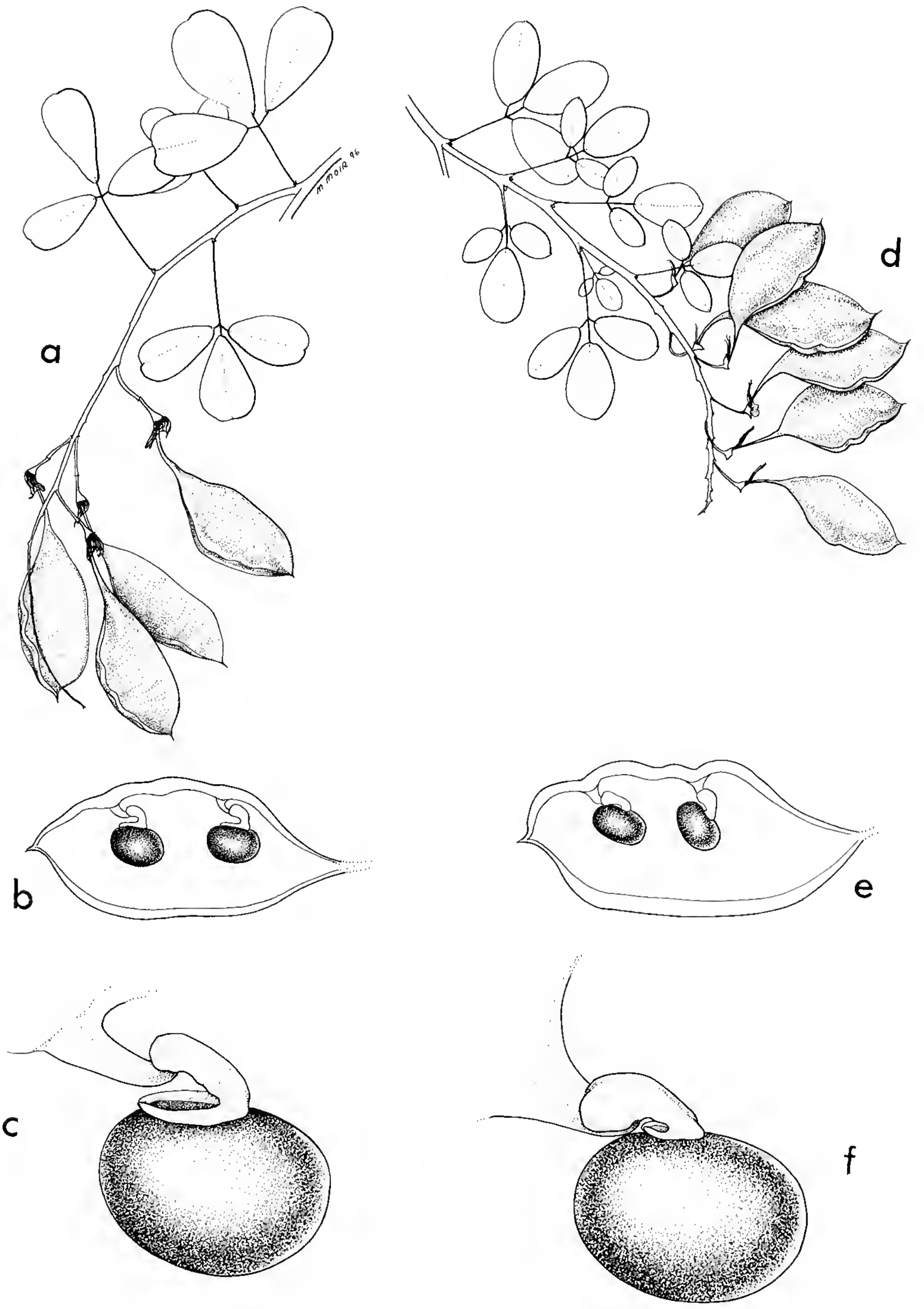

Fig. 1. a–c *Goodia lotifolia* var. *lotifolia* (*J.H. Ross 3709*): **a** fruiting twig, ×1; **b** open pod showing attachment of seeds, ×2; **c** seed, ×8. **d–f** *Goodia medicaginea* (*J.H. Ross 3697*): **d** fruiting twig, ×1; **e** open pod showing attachment of seeds, ×2; **f** seed, ×8.

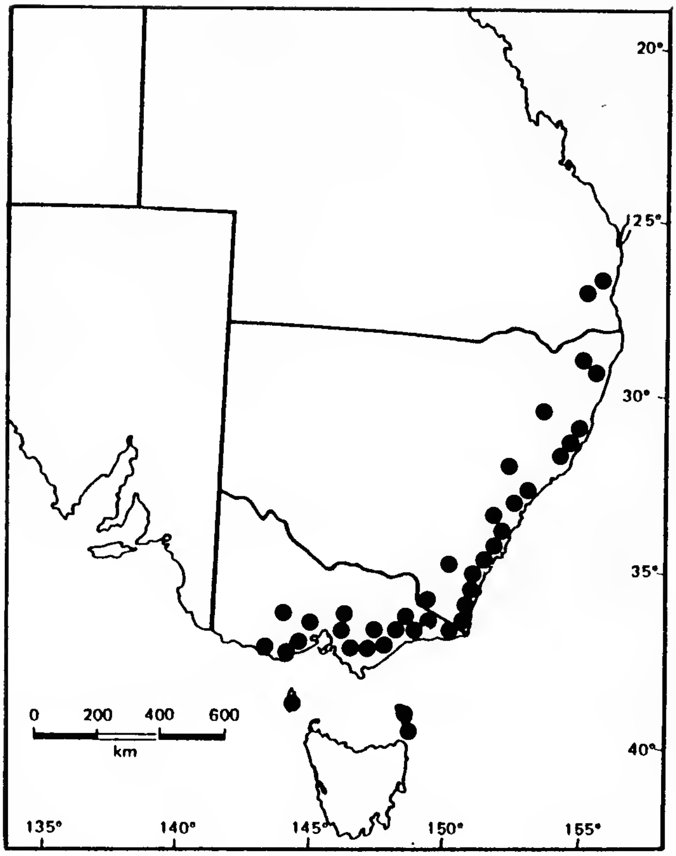

Fig. 2. Distribution of *Goodia lotifolia* var. *lotifolia*.

Tasmanian material of var. *pubescens* in which the leaves and pods are generally small.

2. *Goodia medicaginea* F. Muell., Fragm. 1: 10 (1858). Type: Australia Felix, F. Mueller (lectotype here selected, MEL 237139).

Goodia lotifolia sensu Meisn. in Lehm., *Pl. Preiss.* 1: 88 (1844).

Shrub to 2.5m high, usually spreading and up to 4m wide, young branchlets glabrous to densely clothed with appressed or spreading hairs. *Leaflets* obovate to obovate-cuneate or elliptic, 4–30(–40) mm long, 2–20(–30) mm wide, glabrous throughout or lower surface sparingly to densely clothed with short appressed hairs, occasionally the upper surface with a few scattered appressed hairs, dull blue-green when mature; petiole 5–25 mm long. *Racemes* usually 1–10(–20) cm long. *Flowers* 6–10.5 mm long, on pedicels up to 5 mm long. *Calyx* 3–5.3 mm long, sparingly to densely clothed with appressed or spreading hairs externally, the 3 lower teeth usually shorter than the tube in mature flowers. *Standard* dull yellow or orange-yellow internally with a conspicuous reddish- or purplish-brown horseshoe-shaped flare around the throat, suffused with dark red externally; wings and keel often suffused with brown or purplish-brown. *Pods* obliquely ovate to oblong, narrowed basally into a slender stipe, 1.2–2.3 cm long excluding the stipe. *Seed:* foot of aril up to 1.1 mm long. **Western Golden-tip** (Fig. 1d–f).

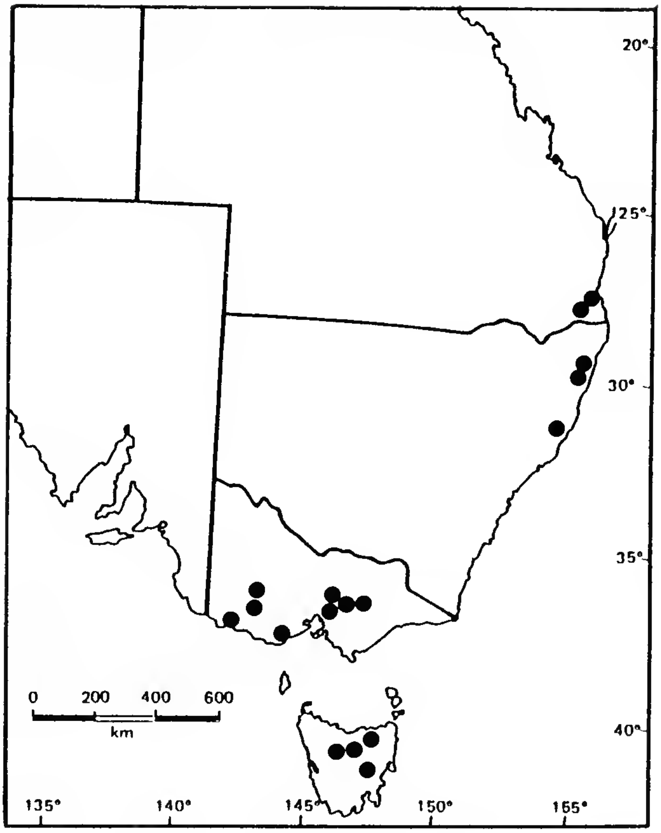

Fig. 3. Distribution of *Goodia lotifolia* var. *pubescens*.

Distribution and Habitat

Found in southern Western Australia; southern South Australia and Kangaroo Island; south-eastern Queensland; inland New South Wales; and western, central and north-east Victoria (Fig. 4). Recorded from a diversity of habitats including coastal heath, mallee, creek beds and open sclerophyll forest and found on limestone, sand, laterite, quartz, clay, loam and granitic soils. Tends to favour drier sites than *G. lotifolia* and often found on hot west- or north-facing slopes. Flowers usually in August and September; recorded in flower in Queensland in March.

Representative specimens (280 specimens examined)

WESTERN AUSTRALIA: Esperance District, base of northern slope on Mt Buraminya, *B. Archer 187* (AD, MEL, PERTH). SOUTH AUSTRALIA: Gawler Ra, hills NE of Kondoolka HS, *J.Z. Weber 3077* (AD, BRI, MEL). QUEENSLAND: Burnett District, Sixteen Mile L.A., Coominglah State Forest, *A.R. Bean 10159* (BRI, MEL). NEW SOUTH WALES: Black Ra., N of Tallebung, *G.M. Cunningham 1462 and P.L. Milthorpe* (NSW). VICTORIA: North-east, c. 18 km NW of Wangaratta, *A.D.J. Piesse 3* (MEL).

Notes

The distribution of *Goodia medicaginea* is interrupted by several large discontinuities. The largest discontinuity occurs between the Western Australian and the South Australian populations but a large discontinuity also separates the Queensland records

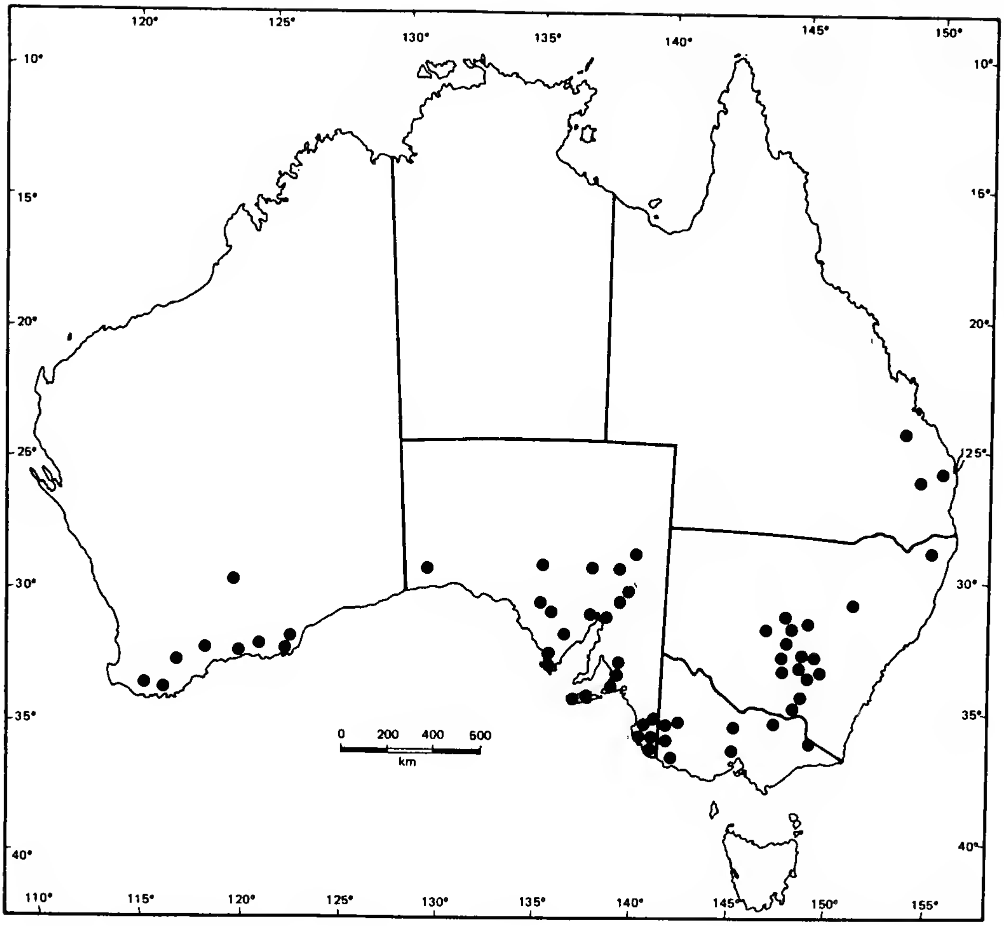

Fig. 4. Distribution of *Goodia medicaginea.*

from the New South Wales populations. It is likely that further populations of G. medicaginea will be found in southern Queensland.

The young growth in *G. medicaginea* is often as pubescent as that found in *G. lotifolia* var. *pubescens.*

Copley 2079 (AD) from c. 7 km W of Yardea Homestead, Gawler Ranges, Northern Eyre Peninsula, is unusual in having large persistent stipules up to 0.8 cm long and unusually large bracts to 11.5 mm long and 2 mm wide and bracteoles up to 7 mm long and 0.8 mm wide.

Mueller's choice of the specific epithet '*medicaginea*' is explained in a letter to Bentham dated 10 September 1863 (Mueller 1863a): 'Is not Meisners *Goodia lotifolia* = *G. medicaginea*, which I called so from some habitual resemblance to *Medicago arborea*'.

Typification

The protologue indicates that Mueller based his concept of *G. medicaginea* on a range of material from 'Ad rivulos montium Flinders Range, apud sinus Guichen- et Rivoli Bay, ad amnem Crystal Book [Crystal Brook] et in variis locis Australiae felicis occidentalis'. A multitude of syntypes and potential syntypes exist at K and MEL and this illustrates very well the difficulties created by Mueller's decision not to number his collections but to rely instead on names or localities written on his labels. There are at K in Herbarium Hookerianum four sheets of material labelled *Goodia medicaginea* by Mueller; one bears the locality 'Austr Felix', one 'Australia felix', one 'Col. of Victoria' and one 'Scrub of the interior'. None of the labels carries a date but knowledge of Mueller's collecting activities suggests that they were all collected prior to the date of publication of the name and are syntypes. None is a good match of any of the specimens in MEL.

The following collections in MEL labelled by Mueller as *Goodia medicaginea* are regarded as syntypes: between Rivoli Bay and Mount Gambier, 1848 (MEL 630110); Rivoli Bay, undated (MEL 630109); near Rivoli Bay, undated (MEL 237134); Priest-point/ Glenelg, undated (MEL 1058259); Flinders-ranges near Mt Remarkable, Oct. 1851 (MEL 630114); Flinders-ranges, Oct. 1851 (MEL 630112); Crystal brook, Oct. 1851 (MEL 630113); Guichen bay, Aug. 1851 (MEL 630111); St Vinc[ent]. Gulf, 1851 (MEL 237133); Austr felix, undated (MEL 237137); Austral fel., undated (MEL 237138); Australia Felix, undated (MEL 237139).

Although the Rivoli Bay collections are undated, Rivoli Bay was cited in the protologue and it seems reasonable to assume that they were collected while Mueller was still a resident of South Australia and therefore prior to the publication of the species. There is no evidence that Mueller returned to collect in South Australia prior to 1858 after he moved to Victoria in 1852 and took up residence in Melbourne except for a stay of a few days at Mount Gambier in 1857 to visit his sister (Mueller 1857). The specimen from Priest-point/Glenelg was possibly not collected by Mueller. The precise location of Priest-point, Glenelg is uncertain: the name could not be found in any gazetteer and personnel at the State Library of South Australia were unable to shed any light on the locality.

There are two further undated collections in MEL from Reedy-creek, one of which is unnamed (MEL 237136) and the other which bears Mueller's manuscript name '*Goodia intermedia*' (MEL 237132). The epithet on the latter suggests that Mueller may have had second thoughts about the distinctness of his *G. medicaginea*!

A sheet of fruiting material in MEL (MEL 237135) bears a label in Mueller's hand which reads '*Goodia medicaginea* Ferd Mu/Austr felix/Frutex 3-5' alt. ... (illegible)/Jul 53. Dr M'. On the face of it, the specimen appears to be another syntype, but I have some reservations. From what is known of the phenology of the species, it would be extremely unusual to find a specimen in full fruit in July unless the season was exceptional. Although Mueller's exact movements during July 1853 are not clear, it is known that for much of the month he was in or near Melbourne, having only returned in June after an absence on a collecting trip of over four months. Currently the population in closest proximity to Melbourne is the small population at Long Forest Reserve near Melton west of Melbourne, although it is, of course, quite possible that populations were found closer to Melbourne in 1853. There is a suspicion that the label does not belong with the specimen and for this reason this specimen is excluded from consideration as a lectotype. This is unfortunate as it is a good specimen bearing mature fruits and seeds. The description of *G. medicaginea* was published in March 1858 and it is not clear what general area or which specimens Mueller had in mind when citing in the protologue 'et in variis locis Australiae felicis occidentalis'. There is no evidence that Mueller had available to him prior to that date any of the Maxwell, Drummond or Preiss collections from Western Australia so none of their specimens is regarded as syntype material. The first reference by Mueller to Maxwell is contained in a letter to William Haines dated 1 March 1858 in which Mueller (1858a) wrote 'Official letters have been forwarded in this behalf within the month of February to ... Mr G. Maxwell of Albany, West Australia'. In a letter to John O'Shanassy in June 1858 Mueller (1858b) mentions having received 'in the course of May; from Mr G. Maxwell of Albany a valuable collection of more than 200 kinds of West Australian seed'. Mueller also commented in this same letter that 'The correspondence has been extensive … to Jam. Drummond Esq, Swan River'. In a letter to Daniel Oliver dated 25 December 1863 Mueller (1863b) mentions 'I have now, for instance, a set of Steetz's botanical relics, one of the largest sets of Preissian plants, also many of Sieber's, and within the next week I shall possess, from another source, one of the largest of Drummond's collections'. It would appear almost certain that by the term 'Australiae felicis occidentalis' Mueller was referring to western Victoria rather than to Western Australia.

When did Mueller become aware that *G. medicaginea* occurred in western Victoria? Mueller visited western Victoria in November 1853. He visited localities where *G. medicaginea* is known to occur and would certainly have had the opportunity during this trip to collect the fruiting specimens labelled as having come from 'Australia felix'. Mueller's fruiting specimens labelled 'Australia felix' bear mature pods and seeds which suggests that they were collected in late spring or early summer. In January 1857 Mueller visited the mouth of the Glenelg river in far south-west Victoria. In September 1883 he collected in the western wimmera and the mallee country between Lake Hindmarsh and the South Australian border but it is unlikely that he would have seen *G. medicaginea* on this trip. In any event, mature pods and seeds are not found on *G. medicaginea* at this time of the year.

When seeking a suitable specimen from among the syntypes to serve as the lectotype of *G. medicaginea*, it was considered desirable to choose a fruiting specimen bearing mature pods and the diagnostic seeds. Unfortunately none of the syntypes with a date of collection bears mature pods and seeds. Attention then focused on the undated fruiting syntypes in MEL of which there are three, namely, MEL 1058259 from Priest-point/Glenelg, and MEL 237138 and 237139 from Australia felix. I here select from among these MEL 237139 as the lectotype of *G. medicaginea*. Although it could be argued possibly that the absence of a date of collection (although undated, circumstantial evidence suggests strongly that it was collected in late 1853) introduces an element of doubt about the suitability of this specimen as the lectotype, it was considered more important to have as lectotype a specimen bearing the diagnostic seeds, than to have an accurately dated specimen that lacks the diagnostic seeds.

Excluded Species

Goodia polysperma A. DC., *Rapp. Pl. Rar. Genève* 2(2): 13 (1824). *Type:* 'L'espèce qui fait le sujet de cet article est un très-petit sous-arbrisseau de la Nouvelle-Hollande, que nous avons recu de divers jardins' (G-DC).

This is a synonym of the South African species *Argyrolobium tomentosum* (Andr.) Druce, *Bot. Soc. Exch. Club Brit. Isles* 1916: 605 (1917).

Goodia simplicifolia Spreng., *Syst. Veg.* ed 16, 4: 267 (1827). *Type:* Delaunay, *Herb. Amat.* t. 187 (1819).

This is a synonym of *Hovea elliptica* (Sm.) DC., fide J.H. Ross, *Muelleria* 7: 27 (1989).

Names of uncertain application

Goodia retusa Sweet, *Hort. Brit.* 110 (1826).

This is a *nomen nudum* and the taxon to which Sweet applied the name is not clear.

Goodia medicaginea Jacques, *J. Soc. Imp. Centr. Hort.* 10: 116 (1864). *Type:* 'Hort. Paris, 1863 . . . La Nouvelle-Hollande?'

It is not clear whether or not Jacques was formally describing as new the plant that he referred to *G. medicaginea*. I have not located any type material so the application of the name is not clear but, in any event, the name *G. medicaginea* Jacques is a later homonym of *G. medicaginea* Muell. (1858) and therefore illegitimate.

Acknowledgments

I am most grateful to Dr Barry Conn for arranging for photographs of the potential type material housed in K; to Barbara Archer and Tony Bean for making special collections in Western Australia and Queensland respectively; to Helen Cohn, Library Manager, Royal Botanic Gardens Melbourne, for procuring photocopies of descriptions of species of *Goodia* from some obscure publications; to Sara Maroske for information relating to Mueller's correspondence and travel; to Jenny Tonkin for assistance in the field in South Australia and Victoria; to the Directors of AD, BRI, NSW and PERTH for the loan of specimens or access to their collections, and to Mali Moir for executing the illustrations that accompany this paper.

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Eucalyptus macmahonii, a New and Rare Mallee Species from Western Victoria

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Abstract

Eucalyptus macmahonii K. Rule sp. nov., is a recently discovered Western Victorian species of mallee of the series *Rufispermae* with a sepaline operculum that is shed uncleanly. The species is described and its affinities, distribution and conservation status are discussed.

Introduction

The Mt Arapiles-Tooan State Park and a few adjacent reserves of mallee vegetation are located on the south-eastern side of the Little Desert in western Victoria, a region where semi-arid and temperate climates merge. Tragically, from a scientific view-point, they and meagre roadside and farm remnants are all that remain of the natural vegetation after vast tracts of land were cleared for wheat farms As far as is known, the taxon described below is confined to two extremely small populations, one at Mt Arapiles and the other to the north-west of Mitre township near Nurcoung Discovered by Dr Don McMahon in 1994, it is one of a few undescribed eucalypts in this region which occur as remnant populations in these small island reserves.

Taxonomy

Eucalyptus macmahonii K. Rule, sp. nov.

Eucalypto dumosae A. Cunn. ex Oxley affinis sed fragmentis induviis operculorum sepalinorum persistentibus, alabastris laevibus, et foliis adultis angustioribus nitidioribus differt.

Type: Victoria, southern side of Mt Arapiles, Mt Arapiles-Tooan State Park, 36°46’ S, 141°50’ E, *K. Rule 9512 and D. McMahon*, 26.iii.1995 (holotype MEL; isotypes AD, NSW, CANB).

Mallee to 5 m tall, usually erect and slender, lignotuberous. Canopy open or moderately dense with semi-erect, lustrous foliage. *Bark* red-brown, smooth throughout; old bark dark brown, deciduous in long ribbons. *Oil glands* present in pith of branchlets. *Cotyledons* reniform. *Seedling leaves* elliptical, shortly petiolate, opposite for 3 or 4 pairs, discolorous; upper surface dull, blue-green; lower surface pale green. *Juvenile leaves* alternate, lanceolate or elliptical-lanceolate, acuminate, 4–8 cm long, 1.4–2.5 cm wide; dull, grey-green, slightly discolorous, glandular; base tapered; venation densely reticulate; lateral and intramarginal veins somewhat obscure; petioles to 1 cm long. *Intermediate leaves* ovate-lanceolate, dull, blue-green, sometimes grey-green or lightly waxy, slightly discolorous, slightly broader than both juvenile and adult leaves. *Adult leaves* narrow-lanceolate or lanceolate, often slightly falcate, uncinate, semi-erect, 7–11 cm long, 0.8–1.5 cm wide, lustrous, green, concolorous; venation faint, densely reticulate with numerous island and intersectional oil glands; intramarginal vein approximately 1 mm from margin; petioles angular, to 1.3 cm long. *Inflorescences* simple, axillary, 7–11-flowered; peduncles slightly flattened, dilated, relatively slender, to 1.2 cm long, 1.5–2 mm in diameter. *Floral buds* ovoid or slightly clavate, usually angular, shortly pedicellate, 0.7–0.9 cm long, 0.4–0.5 cm in diameter; operculum conical, approximately one-third the length of the hypanthium, non-striate; operculum scar present, the sepaline operculum shedding early, either from the abscission zone or splitting downwards from the apex of the bud, persisting most often as a tattered, small necrotic fragment adhering to the inner operculum. *Stamens* inflexed; anthers all fertile, versatile, sub-basifixed, oblong, dehiscing longitudinally; filaments white. *Ovary* 4-locular; ovules in 4 rows per locule. *Fruits* cupular or sub-cylindrical, smooth, tapering into a short pedicel or less often sessile, 0.6–0.9 cm long, 0.5–0.8 cm in diameter; walls thick; disc descending; valves 4 (rarely 3), below rim level. Fertile seeds lustrous, red-brown, reticulate, flattened. (Fig. 1)

Distribution and Habitat

Eucalyptus macmahonii occurs in mallee communities on sandy soils adjacent to the southern base of Mt. Arapiles and to the north-west of Mitre near Nurcoung on the southern edge of the Little Desert in western Victoria. The nearby town of Horsham has an average annual rainfall of c. 550 mm, with a winter maximum. Flowers spring.

Etymology

The epithet honours Dr Don McMahon who is credited with the discovery of this new species and has been an active participant in the subsequent study. It is further to Dr McMahon's credit that he recognised that the species' floral buds possess a feature rare in the genus (see discussion below).

Associated Species

At Mt Arapiles, *E. macmahonii* grows in pure clumps. Other mallee species occurring in the immediate vicinity include *E. incrassata*, *E. leptophylla*, *E. dumosa*, *E. wimmerensis* and *E. leucoxylon* subsp. *stephaniae*. Near Nurcoung, *E. wimmerensis*, *E. leptophylla* and *E. froggattii* are associated species, and at one collection site a single mallee with features consistent with *E. polybractea* was present. At Mt Arapiles an individual has been located that appears to a hybrid between the new species and *E. wimmerensis*. No other interbreeding with any of the associated taxa has been observed.

Conservation Status

This species is one of Victoria's rarest and was uncollected prior to this study. The Mt Arapiles population, which occurs in two segments, is located in a nature reserve; on the southern side of the mountain several dozen plants are concentrated in six known clumps, and on the south-western side a single clump contains c. ten plants. In contrast, the population near Nurcoung is confined to small roadside remnants extending over a distance of more than 2 kilometres and its continued existence is extremely precarious. Searches for additional remnants in the district are required, particularly on private land around the south-eastern perimeter of the Little Desert. *Eucalyptus macmahonii* is considered vulnerable and a status of 2V using the coding method of Briggs and Leigh (1989) is suggested.

Fig. 1. *Eucalyptus macmahonii* (*K. Rule 9512 and D. McMahon*): **a** seedling, x1; **b** adult leaves and immature buds, x1; **c** young bud shedding sepaline operculum, x2.5; **d** bud with necrotic remnant of sepaline operculum, x4; **e** mature buds, x1; **f** fruits, x1.

Specimens Examined (all at MEL)

VICTORIA: Type locality, *K. Rule 9533*, 10.iv.1995, *K. Rule 9535*, 10.iv.1995, *K. Rule 9636*, 10.ii.1996, *K. Rule 9665*, 8.vii.1996; on the SW side of Mt Arapiles, *K. Rule 9534*, 10.iv.1995; 9.3 km E of the Nhill-Harrow Rd towards Mitre, *K. Rule 96106*, 26.ix.1996; 10.2 km E of the Nhill-Harrow Rd towards Mitre, *K. Rule 9663*, 8.vii.1996; 11.7 km E of the Nhill-Harrow Rd towards Mitre, *K. Rule 9513 and D. McMahon*, 26.iii.1995, *K. Rule 9662*, 8.vii.1996.

Key to Victorian species in the series Rufispermae

1. Adult leaves lustrous, green 2
1. Adult leaves dull, blue-green or blue-grey 3

2. Peduncles markedly thick, 2.5–3.5 mm in diameter; operculum ribbed, slightly less than half the length of the hypanthium .... *E. phenax*
2. Peduncles relatively slender, 1.5–2 mm in diameter; operculum smooth, approximately one third the length the hypanthium .... *E. macmahonii*

3. Adult leaves blue-grey; operculum prominently ribbed .... *E. cyanophylla*
3. Adult leaves blue-green; operculum faintly ribbed .... *E. dumosa*

Discussion

The known populations of *E. macmahonii* are relatively uniform except for limited variation in the size of their juvenile leaves, and an occurrence of lightly waxy intermediate leaves in the case of one individual at Mt Arapiles. Despite the small number of individuals, the new species has not lost its capacity to reproduce sexually: a moderate number of seedlings were present at each site, and viable, reasonably vigorous seedlings resulted from a series of seedlot trials. It is suspected that its rarity is the result of recent clearing rather than genetic decline.

When *E. macmahonii* was first brought to my attention, I assumed it to be a hybrid involving *E. wimmerensis* and *E. dumosa*. Subsequent seedling trials using seedlots collected from both the Mt Arapiles and Nurcoung sites showed no evidence of segregation towards either of the suspected parents. Furthermore, searches in the field located sufficient numbers of mallees at both sites which were regarded as being appreciably uniform in their morphology. This, and an absence of anomalous individuals (except for the apparent hybrid at Mt Arapiles) with features intermediate between *E. macmahonii* and either of the suspected ancestors, suggest that individuals are not of hybrid origin.

The condition where the sepaline operculum is not shed cleanly but persists as tattered remnants is rare in the genus and known in four other taxa belonging to the informal subgenus 'Symphyomyrtus' and two Northern Australian paper-fruited bloodwoods of the unrelated informal subgenus 'Blakella'. Three of the 'Symphyomyrtus' species, *E. sturgissiana* L.A.S. Johnson & Blaxell, *E. denticulata* Cook & Ladiges and *E. benthamii* Maiden & Cambage, although not closely related, belong to section *Maidenaria* where the sepaline operculum is usually shed cleanly well in advance of flowering. The fourth is an undescribed taxon occurring at Devils Peak in the southern Flinders Ranges, South Australia, which Brooker and Kleinig (1990) placed with the mallee-boxes (section *Adnataria*) and tentatively called *E.* '*desquamata*'. In the mallee-boxes, the sepaline operculum is normally retained until anthesis and shed with the petaline operculum. *Eucalyptus macmahonii* belongs to the section *Dumaria* (also 'Symphyomyrtus') where, as in section *Maidenaria*, the sepaline operculum normally is shed cleanly well in advance of flowering. Obviously, the phenomenon of the fragmented sepaline operculum is a development which provides no basis for linking any of these taxa genetically. Most certainly it is a useful diagnostic character. Johnson and Hill (1990), for example, used it as one of their criteria for separating *E. dorrigoensis* (Blakely) L.A.S. Johnson & Hill from *E. benthamii.*

In their comments on *E. benthamii*, Johnson and Hill (1990) suggested that the expanding, immature bud of that species appeared to burst through its sepaline operculum to leave irregular dried remnants attached to petaline operculum. Observations of *E. macmahonii* are consistent with this. In addition, it has been found with this species that the shedding process and the fragmentation of the sepaline operculum follows no particular pattern. Fragmentation may occur in conjunction with abscission, the operculum splitting upwards from the base or by the operculum splitting downwards from the apex before abscission occurs.

Eucalyptus macmahonii is placed within the section *Dumaria*, characterised by juvenile leaves that are petiolate and alternate, adult leaves with densely reticulate venation and numerous intersectional and island oil glands and floral buds with an abscission scar, four ovular rows per locule, strongly inflexed stamens and oblong, basifixed, versatile anthers with longitudinal slits. Further, within this section, the new species is a member of the series *Rufispermae* whose features include oil glands in the pith of the branchlets and fertile seeds that are lustrous, red-brown, oblong and flattened and with a shallow reticulum. However, as discussed above, *E. macmahonii* differs from other members of this series in the unclean shedding of its sepaline operculum.

The relationship between *E. macmahonii* and other members of the series *Rufispermae* (Table 1), particularly those occurring in Victoria, is unclear. However, it is most similar to the widespread *E. dumosa*, from which it differs in its narrower juvenile leaves, its narrower, green, lustrous adult leaves, its shorter, thinner peduncles and its smooth opercula. Whilst its fruit sizes overlap those of some populations of *E. dumosa*, particularly in the Victorian Mallee, the associated form has appreciably larger fruits (to 10 mm long and 9 mm in diameter). Another similar species of limited occurrence in north-western Victoria is *E. phenax* Brooker & Slee (formerly *E.* '*anceps*' (Maiden) Blakely). It also has lustrous, green adult leaves, but differs from the new species in its green juvenile leaves, its longer, striated opercula (slightly less than half the length of the bud), its thicker peduncles and its mostly sessile fruits with valves extending above the rim. A third relative, *E. cyanophylla* Brooker, is confined to the State's extreme north-west and is easily distinguished from *E. macmahonii* by its relatively broad, blue-grey foliage, its longer, thicker peduncles, its larger, prominently striated buds and its larger, rugulose or ribbed fruits (to 10 mm long and 9 mm in diameter).

Table 1. Diagnostic features of Victorian species in the series *Rufispermae*

Character	*E. macmahonii*	*E. dumosa*	*E. phenax*	*E. cyanophylla*
Bark				
Texture	smooth throughout	smooth throughout or box-barked on lower trunk	smooth throughout or basally box-like	smooth throughout or basally box/like
Colour	red-brown	white, pink or grey	white or light grey	brown, white or light grey
Juvenile leaves				
Shape	lanceolate to elliptical-lanceolate	broad-lanceolate to ovate	broad-lanceolate or ovate	lanceolate, broad-lanceolate or ovate-lanceolate
Length (cm)	4–8	8–14	6–10	8–14
Width (cm)	1.4–2.5	2–6	2–3.5	5–8
Colour	blue-green or grey-green	blue-green or grey-green	light green	blue-green or grey-green

Table 1. Continued

Character	*E. macmahonii*	*E. dumosa*	*E. phenax*	*E. cyanophylla*
Adult leaves				
Shape	narrow-lanceolate to lanceolate	narrow-lanceolate to lanceolate	lanceolate	broad-lanceolate or slightly ovate, often slightly falcate
Length (cm)	7–11	6–10	7–13	7–16
Width (cm)	0.8–1.5	1.5–2.5	1–2.0	1.5–3.2
Colour	green	blue-green or grey-green	green	blue-green
Lustre	lustrous	dull or sub-lustrous	lustrous	dull
Petiole length (cm)	up to 1.3	up to 1.8	up to 2	up to 2.2
Peduncle				
Length (cm)	up to 1.2	up to 2.0	up to 1.4	up to 1.2
Diameter (mm)	1.5–2	2–3	2.5–3.5	2.5–3.5
Shape	angular	angular to slightly	slightly flattened	slightly flattened
Buds				
Shape	ovoid, not constricted at abscission zone	ovoid-cylindrical, not constricted at abscission zone	clindrical, constricted at abscission zone	cylindrical or slightly cylindrical, constricted at ascission zone
Length (cm)	0.7–0.9	0.8–1.0	0.6–1.0	0.8–1.1
Diameter (cm)	0.4–0.5	0.4–0.5	0.4–0.5	0.5–0.9
Length relative to hypanthium length	c. 1/3	usually c. 1/3	slightly shorter	slightly shorter
Operculum shape	conical	concial, sometimes beaked	conical, sometimes shortly beaked	conical
Operculum ornamentation	smooth	slightly ribbed	slightly ribbed	prominently ribbed
Outer operculum shedding	uncleanly	cleanly	cleanly	cleanly
Pedicel	sub-sessile or shortly pedicellate	sub-sessile or shortly pedicellate	sessile or less often sub-sessile	sub-sessile or shortly pedicellate
Fruits				
Shape	cupular or sub-cylindrical	cupular or sub-cupular	cupular	cupular
Length	0.6–0.9	0.4–1.0	0.6–0.9	0.8–1.0
Diameter (cm)	0.5–0.8	0.4–0.9	0.5–0.7	0.7–0.9
Pedicel	sessile or sub-sessile	sessile or shortly pedicellate	mostly sessile	sessile or sub-sessile
Ornamentation	smooth	smooth or slightly ribbed	faintly ribbed	ribbed or rugulose

Acknowledgments

Whilst the contributions to Dr Don McMahon have been duly recognised, the splendid assistance given on many occasions by Mr Peter Hawker of Natimuk, the Park Ranger for the Mt. Arapiles-Tooan State Park, is also acknowledged. Mr Neville Walsh of the National Herbarium of Victoria is thanked for providing the Latin diagnosis and for assistance in the field, as is Dr Tim Entwisle for his advice with the preparation of this manuscript and Mali Moir for the excellent line drawings.

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Nymphoides spinulosperma (Menyanthaceae): a New Species from South-eastern Australia

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Abstract

Nymphoides spinulosperma Aston sp. nov., a yellow-flowered species from south-eastern Australia, is described and its diagnostic features illustrated. Floral and fruiting characters ally this species most closely to *N. montana* Aston, although foliage characters sometimes resemble those of *N. crenata* (F. Muell.) Kuntze.

Introduction

This paper is the fifth in a series leading to a revision of *Nymphoides* in Australia, nine new species having been described in previous papers (Aston 1982, 1984, 1986, 1987). *Nymphoides spinulosperma* Aston shares the common generic characters outlined in Aston (1982, p. 35) and belongs in the 'geminata group' defined on the same page.

Taxonomy

Nymphoides spinulosperma Aston, sp. nov.

Nymphoidi montanae Aston affinis sed seminibus tuberculis longis tenuibus acutis, 6-plo (vel plus) longioribus quam latioribus, laminis foliolorum ovatis late crenatis leniter plerumque (saepe simulanti *N. crenata* (F. Muell.) Kuntze) plerumque supra macula parva purpurea ad locum petiolum insertum et saepe viridibus et marronio-brunneis ornatis differt.

Type: Victoria, Wimmera, c. 5.5 km (in a straight line) WNW of St Arnaud, along the St Arnaud–Bayena Rd, altitude 160 m, *H.I. Aston 2872*, 21.i.1996 (holotype MEL 2031021; isotypes MEL 2031022, MEL2031023, NSW).

Perennial aquatic. *Stolons* several from the plant base, flexuose, floating or becoming rooted to the substrate when stranded, forking at most nodes, to 1.5 m long, 2.5–3 mm diam., the terminal portions or side-branches developing the inflorescences; internodes several, each c. 15—36 cm long. Basal leaves several; petiole slender, terete, to 11.5–48 cm long, 1–3.5 mm in diameter; blades mostly very broad-ovate or sometimes near-circular in outline, (2.5–)4–9.5(–12) cm long, 1.8–9(–11) cm wide, with width rarely greater than length, deeply cordate (the lobes mostly 27%–45% of the total blade length and separated by a sinus of 5°–35°(–50°) or rarely slightly overlapping), obtuse or rounded, entire to mildly crenate, the upper surface often highly mottled or zoned in deep-green, yellow-green, maroon-brown and/or brown-tan, but sometimes green only and typically with a small cyclamen-coloured spot at the point of petiole insertion, the lower surface green to whitish-green. *Cauline leaves* from the stolon nodes similar but becoming progressively smaller toward the stolon extremities. *Inflorescence* ('geminata group') terminal on the stolon branches, lax and floating, 3–28 cm long, with a pair of pedicellate flowers and two semi-amplexicaul bracts at each node, the internodes 3–15 in number, each 2–65 mm long, 1.5–3 mm in diameter; bracts lanceolate-ovate, 5–7(–10) mm long; pedicels 28–93(–150) mm long, 1–2 mm in diameter. *Flowers* heterostylous, 5-(6-)partite. *Calyx lobes* lanceolate to narrow-ovate, thick-textured with narrow translucent membranous margin basally, 7.5–12(–14) mm long. *Corolla* 24–45(–55) mm span, yellow. *Corolla lobes* broad-elliptic in outline; mid-section usually glabrous except for a conspicuous transverse fringe of fine papillae near its base and usually also (particularly in long-styled flowers) other papillae forming three short thickened clusters or wings continuous with the proximal edge of the fringe, these clusters adjacent to the centre and sides of the fringe; centre line of mid-section sometimes with one to several lacinia-like projections along its length; side-wings broad, undulate, strongly laciniate (laciniae up to one-third of the total wing width), extending from the apex of the lobe almost to the base. *Corolla tube* papillae consisting of c. 16–33 hairs all free and sessile within the cluster, or sometimes all inserted on a shortly-raised projection of the corolla tube tissue; hairs simple or with 1 or 2 minute spinules near the apex. *Stamens* with filaments c. 0.5–1.7 and 1.0–2.2 mm long in long-styled and short-styled flowers respectively; anthers ± linear-lanceolate, c. 2.5–3.5 times as long as broad, c. 2.3–4 mm long. *Gynoecium (long-styled flower)* c. 9.4–12.1 mm long; ovary free except at the base, ± linear-conical to ovoid, gradually tapered into the style; placentas 2 (rarely 3), long, extending down the central half to two-thirds of the ovary wall; ovules c. 80–200; style c. 1.8–3.5 mm long; stigmas 2 (rarely 3), each an ovate to broad-rhomboid, shortly papillate, laciniate or shortly-lobed, erect wing c. 3.2–5.3 mm long. *Gynoecium (short-styled flower)* c. 5.2–8.6 mm long; style c. 0.9–2.3 mm long; stigmas c. 1.8–3 mm long, each wing broad-deltoid. *Capsule* ellipsoid or ellipsoid-ovoid, more or less equal to the calyx, 7.5–11.5 mm long, 4–7 mm in diameter. *Seeds* 34–133 per capsule; body of seed ellipsoid but strongly laterally compressed, 1.1–1.5 mm long, 0.8–1.1 mm wide, 0.5–0.7 mm thick, black when mature, moderately densely covered with long fine tapered acute tubercles; tubercles c. 0.6–1 mm long and six or more times as long as wide; basal caruncle pale, moderately thick and conspicuous, encircling a short broad projection of the seed body. (Figs 1, 2)

Phenology

Flowers and early fruits recorded in September in Queensland and New South Wales; also ripe fruits in April in the latter State. Flowers and fruits recorded November–February in Victoria.

Etymology

The epithet *spinulosperma* refers to the diagnostic spinulose appearance of the seeds.

Distribution and Conservation Status

Occurs from southern Queensland to western Victoria. In Queensland, known from only one locality in the Maranoa district. In New South Wales (North West Plains) known from only three locations all within 25 km of each other. In Victoria, known only from the Wannon and Wimmera botanical regions, where recorded from Leah Swamp near Apsley and from four locations in the St Arnaud–Marnoo area.

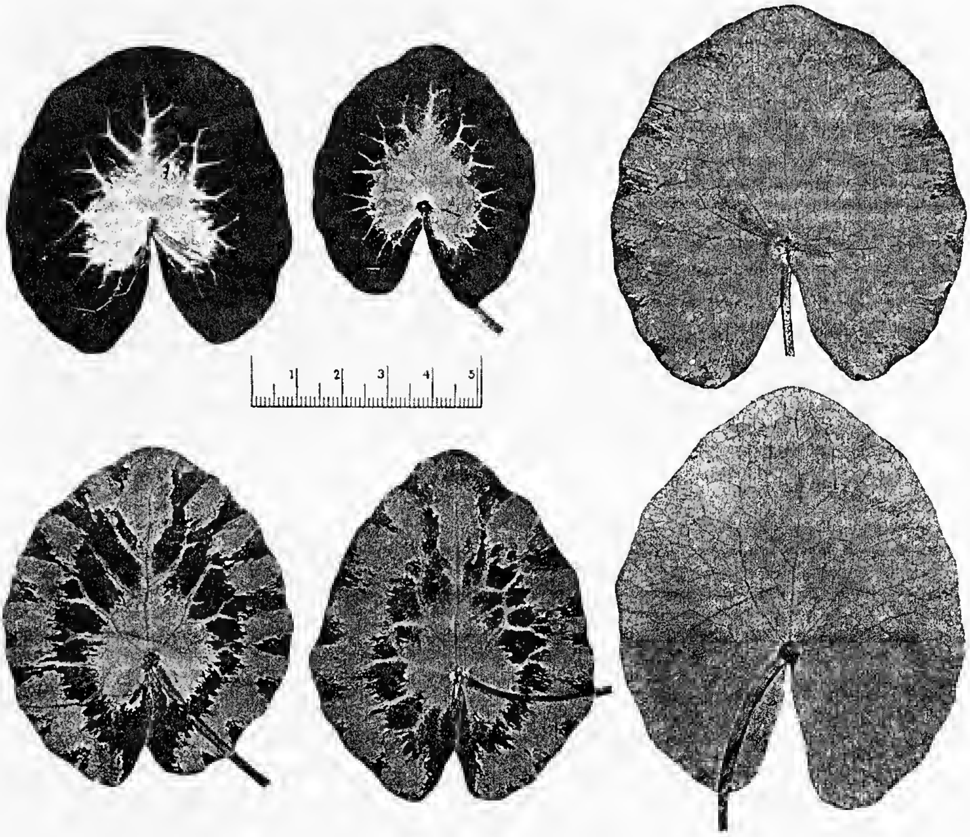

Fig. 1. *Nymphoides spinulosperma.* Upper surface of leaf blades showing colour zoning (upper left), colour mottling (lower left) and leaves with little (upper right) or no (lower right) colour patterning, from *Aston 2869*. Scale in cm.

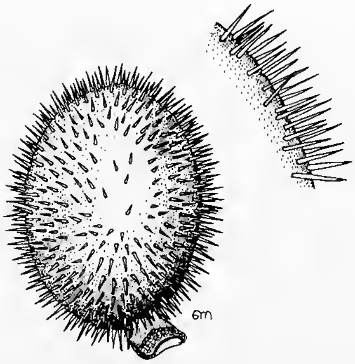

Fig. 2. *Nymphoides spinulosperma.* Seed x30, with enlargement of tubercles, from *Aston 2872*.

Nymphoides spinulosperma is apparently at risk from its very localised occurrences, its dependence on seasonal flooding of shallow swamplands, and the fact that all except two of its known populations are on private property subject to grazing and/or cultivation. The two exceptions are quite small wildlife reserves in Victoria. Further searching in years of suitable flooding may locate additional populations but meantime I suggest a Risk Code of 3KC- (Briggs and Leigh 1988).

Habitat

Occurs in fresh water to 75 cm deep in seasonal, rarely near-permanent, swamps. In Victoria, swamps are chiefly dominated by *Eragrostis infecunda* and sited mostly in open grazing lands. In New South Wales, initially reported from 'shallow water of a lagoon', but recent collections are from shallow ephemeral waters dominated by *Eleocharis plana* and *Amphibromus nervosus*, again surrounded by grazing and subject to stock intrusion. The Queensland population occurs in a shallow disused road quarry converted to a stock dam. Altitude range c. 150–250 m.

Field Observations

In Victorian populations I observed in the field in late January, the colour patterning of the leaves appeared to be enhanced by greater exposure to sunlight. It was absent or less pronounced, both in area and in the darkness of the pattern, on leaves that were semi-shaded amongst higher emergents, such as the grass *Eragrostis infecunda*. Colour patterning was very strong in the Queensland and New South Wales populations examined in late September.

Nick Romanowski, who has plants from St Arnaud in cultivation near Forrest, south of Colac, Victoria, has found (*in litt.* 9.vii.1996) that the intensity of leaf colour is greatest in spring to early summer, fades (and is often absent) during summer, then reappears around mid-autumn although not as intensely as in the spring. He suggests that this seasonal change in intensity is most likely related to internal cycles within the plant.

In the field, the cyclamen-pink colour spot of the upper leaf surface at the point of petiole insertion occurred irrespective of leaf age or size and was rarely absent, even from otherwise totally green leaves. In cultivation, Romanowski (*in litt.* 27.vi.1996) has found that this spot has remained a constant, distinctive, feature. It can be a useful guide to identification but neither it nor the leaf colouration, when present, are totally diagnostic as both may sometimes be found in other species, e.g. *N. crenata* (F. Muell.) Kuntze. Rapid response of this species to inundation is shown by *Biddescombe 320*, which was collected in flower and fruit only two months after flooding of the lagoon where it grew.

Notes

Nymphoides spinulosperma is most closely allied to *N. montana* in seed shape and size, but differs in the distinctive fine acute seed tubercles. Seeds of *N. montana* rarely possess tubercles, and when present they are minute and obtuse. Leaves of *N. spinulosperma*, when near-circular and uniformly green above, are distinguishable from those of *N. montana* only by the cyclamen-coloured spot above the petiole insertion. The more characteristic, broad-ovate, entire to mildly crenate, mottled or colour-zoned leaves differ in both shape and colour from any seen on *N. montana* but could be mistaken for some of the less deeply crenate-leaved populations of *N. crenata*. However, non-vegetative parts of this latter species are distinctive.

Representative Specimens (13 specimens examined)

QUEENSLAND: 20 km NE of St George along the road to Surat, 29 km S of Bindle, *H.I. Aston 2462*, 1.ix.1983 (BRI, MEL, NSW), *H.I. Aston 2877*, 21.ix.1996 (MEL). NEW SOUTH WALES: c. 13 km NNW of Collie, *H.I. Aston 2878*, 27.ix.1996 (BRI, MEL, NSW); 6 miles [9.6 km] SW of Armatree, *E.F. Biddescombe 320*, 18.iv.1955 (CANB). VICTORIA: Leah Swamp, c. 5 km WSW of Apsley, *K.M. Alcock batch no. 7*, 28.xi.1987–7.ii.1988 (MEL); c. 16 km by road (14 km in a straight line) W of St Arnaud along the Wimmera Highway, *H.I. Aston 2869*, 20.i.1996 (AD, BRI, CANB, MEL, NSW); 26 km (in a straight line) W of St Arnaud. Bryces Road, c. 1 km W of Cope Cope Road, *H.I. Aston 2870*, 21.i.1996 (MEL); Creswicks Well Wildlife Reserve, 5 km NE of Marnoo, *G. Cornwall no. CS/14/89*, 29.xi.1988 (MEL).

Acknowledgments

I thank Nick Romanowski for notifying me of an unusual population of *Nymphoides* which he located near St Arnaud in December 1995, and for his comments on field and cultivated material. His discovery allowed me to familiarise myself with plants in the field and to reassess certain earlier herbarium collections which had been puzzling. I also thank Neville Walsh for preparing the Latin diagnosis and Enid Mayfield for illustration of the seed.

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New taxa, New Combinations and an Infrageneric Classification in *Pomaderris* (Rhamnaceae)

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Abstract

An infrageneric classification of *Pomaderris* is presented; 16 new taxa are described (*P. adnata*, *P. apetala* subsp. *maritima*, *P. andromedifolia* subsp. *confusa*, *P. argyrophylla* subsp. *graniticola*, *P. betulina* subsp. *actensis*, *P. bodalla*, *P. coomingalensis*, *P. crassifolia*, *P. delicata*, *P. elliptica* var. *diemenica*, *P. helianthemifolia* subsp. *hispida*, *P. helianthemifolia* subsp. *minor*, *P. ligustrina* subsp. *latifolia*, *P. mediora*, *P. precaria*, *P. reperta*); one new combination is made (*P. phylicifolia* subsp. *ericoides*); and lectotypes, where required, are chosen for established species.

Introduction

Pomaderris is a genus distributed in south-western, southern and eastern Australia, as well as in New Zealand. The taxonomy of representatives in South Australia is relatively well understood (Jessop 1986) and problems in Western Australia have recently been addressed (Rye 1996*a*, 1996*b*; Walsh 1994). However, the genus is most diverse in eastern Australia, and several new species have been described in recent years (Ross 1990; Walsh 1988, 1989, 1990*a*, 1990*b*, 1992). While examining specimens from Australian herbaria in preparation of a comprehensive account of the genus, more new taxa have come to light. In common with other members of the genus, many of these new taxa are rare, and/or narrowly endemic. These new taxa are described in order to make their names available and elucidate their conservation status prior to the publication of Volume 24 of the *Flora of Australia*. Lectotypes are also chosen for taxa where typification has previously been unclear.

Descriptions of Sections

In the course of preparing the account of the genus, it became obvious that several distinct groups could be recognised on floral and fruiting characters, and to a lesser extent, characters of the indumentum. Previous attempts to distinguish groups within the genus were very rudimentary (e.g. Reissek 1858; Wakefield 1951) and have been based principally on characters that have been shown to be of little systematic significance, e.g. presence/absence of petals. We have observed that many species are ambiguous in this respect, and often apetalous and petalous flowers may be found within the same inflorescence. The groups, described below as sections, are based on characters of perceived significance at a level above that of species.

We believe that recognition of these sections improves the understanding of the genus, and that these groups generally form plausible morphological and biogeographic entities. However, further work may refine this classification, particularly with respect to the large section *Pomaderris*. More detailed investigation (e.g. cladistic analysis) should clarify phylogenetic relationships between sections.

Pomaderris sect. ***Psilogyne*** N.G. Walsh, sect. nov.

Frutices; folia lineares ad obovatos anguste; inflorescentia cymis parvis paniculatis; flores apetali, ovarium superum glabrum (plus minusve) disco plano circumcintum, sepala decidua tempore florendi; capsula summo indentata, torus basalis, pyrenae rimis longitudinalibus vel operculis indistinctis dehiscentes.

Type: P. angustifolia N.A. Wakef.

Shrubs. Indumentum of leaf undersurfaces and branchlets of stellate or stellate and simple hairs. *Leaves* linear to narrowly obovate. *Inflorescence* of small paniculate cymes (mostly under 8 cm long). *Flowers* apetalous; ovary 3-locular, superior, glabrous or nearly so at the summit; disc present, flat. *Sepals* deciduous in fruit. *Capsule* indented at apex; torus basal; pyrenes dehiscing by a longitudinal split, or an indistinct membranous operculum almost as long as the pyrene.

Two species in mainland south-eastern Australia: *P. angustifolia* N.A. Wakef., *P. helianthemifolia* (Reissek) N.A. Wakef.

Etymology

The sectional name is derived from Greek (*psilos* = naked, *gyne* = female) and refers to the glabrous ovary of members of the section — a unique feature in the genus.

Pomaderris sect. ***Apetalae*** N.G. Walsh, sect. nov.

Frutices vel arbores parvae; indumentum pilis stellatis tantum; folia ovata ad obovata; inflorescentia paniculata vel racemosa; flores apetali, ovarium infernum ad semi-superum, discus absens, sepala persistentes tempore florendi; capsula summo obtusa, torus medialis ad subapicalem, pyrenae operculis membranaceis, rimis ventralibus dehiscentes, vel indehiscentes apparenter interdum.

Type: P. apetala Labill.

Shrubs or small trees. Indumentum of leaf undersurfaces and branchlets of stellate hairs only. *Leaves* ovate to obovate. *Inflorescence* paniculate or racemose. *Flowers* apetalous; ovary 3-locular, inferior to half-superior, summit pubescent, rarely glabrous; disc absent. *Sepals* persistent in fruit. *Capsule* obtuse at apex; torus medial or nearer apex; pyrenes dehiscing via a membranous operculum, ventral slit, or sometimes apparently indehiscent.

Six species in eastern Australia, three of these also in New Zealand (two indigenous, one naturalised): *P. apetala* Labill., *P. aspera* Sieb. ex DC., *P. oraria* F. Muell. ex Reissek, *P. paniculosa* F. Muell. ex Reissek, *P. halmaturina* J.M. Black, *P. oblongifolia* N.G. Walsh.

Pomaderris sect. ***Flabellares*** N.G. Walsh, sect. nov.

Frutices; indumentum pilis stellatis tantum; folia flabellata; inflorescentia paniculata vel racemosa; flores apetali, ovarium c. semisuperum, discus absens, sepala decidua tempore florendi; capsula summo obtusa, torus medialis ad subapicalem, pyrenae superfacie interiore corrugatae profunde, operculum indistinctum.

Type: P. flabellaris (Reissek) J.M. Black

Shrubs. Indumentum of leaf undersurfaces and branchlets of stellate hairs only. *Leaves* fan-shaped. *Inflorescence* paniculate or racemose. *Flowers* apetalous; ovary 3-locular, c. half-superior, summit pubescent; disc absent. *Sepals* deciduous in fruit. *Capsule* obtuse at apex; torus medial or nearer apex; pyrenes deeply corrugated on inner face, operculum indistinct.

One species endemic on the Eyre Peninsula in South Australia.

Pomaderris sect. ***Pomaderris***

Frutices vel arbores parvae; indumentum pilis stellatis et simplicibus; folia varia; inflorescentia paniculata vel racemosa raro floribus solitariis; flores petali vel apetali, ovarium infernum ad c. semisuperum raro superum, discus absens, sepala decidua tempore florendi; capsula summo obtusa vel acuta, torus medialis ad subapicalem raro ad subbasalis, pyrenae operculis membranaceis dehiscentes.

Type: P. elliptica Labill.

Shrubs or small trees. Indumentum of leaf undersurfaces and branchlets of simple and stellate hairs (rarely stellate hairs only). *Leaves* ovate (mostly), obovate, elliptic, orbicular or linear. *Inflorescence* paniculate or racemose, rarely of solitary flowers. *Flowers* petalous or apetalous; ovary 3-locular, usually inferior to c. half-superior, rarely nearly superior, summit pubescent; disc absent. *Sepals* deciduous in fruit. *Capsule* obtuse to acute at apex; torus medial or nearer apex, rarely below midway; pyrenes dehiscing via a membranous operculum.

Forty-seven species in eastern Australia, two shared with and three endemic in New Zealand: *P. adnata* N.G. Walsh & F. Coates, *P. andromedifolia* A. Cunn., *P. argyrophylla* N.A. Wakef., *P. aurea* N.A. Wakef., *P. betulina* Cunn. ex Hook., *P. bodalla* N.G. Walsh & F. Coates, *P. brogoensis* N.G. Walsh, *P. brunnea* N.A. Wakef., *P. canescens* (Benth.) N.A. Wakef., *P. cinerea* Benth., *P. clivicola* E.M. Ross, *P. cocoparrana* N.G. Walsh, *P. coomingalensis* N.G. Walsh & F. Coates, *P. costata* N.A. Wakef., *P. cotoneaster* N.A. Wakef., *P. crassifolia* N.G. Walsh & F. Coates, *P. delicata* N.G. Walsh & F. Coates, *P. discolor* (Vent.) Poir., *P. elachophylla* F. Muell., *P. elliptica* Labill., *P. eriocephala* N.A. Wakef., *P. ferruginea* Sieb. ex Fenzl, *P. gilmourii* N.G. Walsh, *P. hamiltonii* L. Moore, *P. intermedia* Sieb. ex DC., *P. kumeraho* A. Cunn., *P. lanigera* (Andrews) Sims, *P. ledifolia* A. Cunn., *P. ligustrina* Sieb. ex DC., *P. mediora* N.G. Walsh & F. Coates, *P. nitidula* (Benth.) N.A. Wakef., *P. notata* S.T. Blake, *P. pallida* N.A. Wakef., *P. parrisiae* N.G. Walsh, *P. pauciflora* N.A. Wakef., *P. phylicifolia* Lodd. ex Link, *P. pilifera* N.A. Wakef., *P. precaria* N.G. Walsh & F. Coates, *P. prunifolia* A. Cunn. ex Fenzl, *P. queenslandica* C.T. White, *P. racemosa* Hook., *P. reperta* N.G. Walsh & F. Coates, *P. rugosa* Cheeseman, *P. sericea* N.A. Wakef., *P. subcapitata* N.A. Wakef., *P. subplicata* N.G. Walsh, *P. vaccinifolia* F. Muell. ex Reissek, *P. vellea* N.A. Wakef., *P. velutina* J.H. Willis, *P. virgata* N.G. Walsh.

Pomaderris sect. ***Annulares*** N.G. Walsh, sect. nov.

Frutices; indumentum pilis stellatis et simplicibus; folia ovata ad elliptica anguste; inflorescentia paniculata; flores petali vel apetali, ovarium infernum, discus pracsens, elevatus leniter, sepala decidua tempore florendi; capsula summo obtusa vel acuta, torus medialis ad subapicalem, pyrenae operculis membranaceis dehiscentes.

Type: P. grandis F. Muell.

Shrubs. Indumentum of leaf undersurfaces and branchlets of simple and stellate hairs. Leaves ovate to narrow-elliptic. Inflorescence paniculate. *Flowers* petalous or apetalous; ovary 3-locular, inferior, summit pubescent; disc present, slightly raised. *Sepals* deciduous in fruit. *Capsule* obtuse to acute at apex; torus medial or nearer apex; pyrenes dehiscing via a membranous operculum.

Three species from eastern Queensland and south-west Western Australia: *P. canescens* (Benth.) N.A. Wakef., *P. grandis* F. Muell., *P. tropica* N.A. Wakef.

Etymology

The sectional name refers to the annular disc possessed by members of the section.

Pomaderris sect. ***Umbelliflorae*** N.G. Walsh, sect. nov.

Frutices; indumentum pilis stellatis et simplicibus; folia obovata, cuneata vel orbiculares; inflorescentia terminalis umbellata; flores apetali vel apetali, ovarium infernum vel subinfernum, discus praesens, planus vel elevatus leniter, sepala persistentes tempore florendi; capsula summo obtusa, torus medialis ad subapicalem, pyrenae operculis membranaceis vel rimis basalibus vel medialis dehiscentes.

Type: P. obcordata Fenzl

Shrubs. Indumentum of leaf undersurfaces and branchlets of simple and stellate hairs. *Leaves* obovate, cuneate or orbicular. Inflorescence a terminal umbellate cyme, sometimes head-like. *Flowers* petalous or apetalous; ovary 3-locular, inferior or semi-inferior, summit pubescent; disc present, flat or slightly raised. *Sepals* persistent in fruit, or deciduous. *Capsule* obtuse at apex; torus medial or nearer apex; pyrenes dehiscing via a membranous operculum or a basal or medial slit.

Five species from south-west Western Australia, southern South Australia and far western Victoria: *P. brevifolia* N.G. Walsh, *P. forrestiana* F. Muell., *P. myrtilloides* Fenzl, *P. obcordata* Fenzl, *P. rotundifolia* (F. Muell.) Rye.

Etymology

The sectional name refers to the umbellate inflorescence that characterises members of the group.

Pomaderris sect. ***Biloculares*** N.G. Walsh, sect. nov.

Frutices infirmi; indumentum pilis simplicibus et (obscuris) stellatis; folia ovata vel obovata; inflorescentia cyma terminalis umbellata; flores apetali, ovarium subinfernum, discus praesens anguste inconspicuus, sepala persistentes tempore florendi; capsula summo obtusa, torus subapicalis, pyrenae rimis medialis longitudinalis dehiscentes.

Type: P. bilocularis A.S. George

Weak *shrubs. Indumentum* of leaf undersurfaces and branchlets of simple and (obscure) stellate hairs. *Leaves* ovate to obovate. Inflorescence a terminal umbellate cyme. *Flowers* apetalous; ovary 2-locular, semi-inferior, summit pubescent; disc present, narrow, inconspicuous. *Sepals* persistent in fruit. *Capsule* obtuse at apex; torus near apex; pyrenes dehiscing via longitudinal slits.

One species endemic in south-west Western Australia.

Key to Sections

1. Ovary superior, summit glabrous (rarely with a few scattered hairs); capsule indented at apex; leaves narrow-obovate, oblong or linear, to 10 mm wide .... sect. *Psilogyne*
1. Ovary half-inferior to inferior, summit usually distinctly pubescent (rarely sub-glabrous); capsule obtuse to acute; leaf shape various, mostly wider than 10 mm (if less, then leaves usually ovate to orbicular) 2

2. Leaf undersurfaces, stems and hypanthium with stellate hairs only 3
2. Leaf undersurfaces, stems and/or hypanthium with some simple hairs 5

3. Leaves fan-shaped, wider than long, often partly folded; pyrenes corrugated on ventral surface; Eyre Peninsula (South Australia) only .... sect. *Flabellares*
3. Leaves oblong to orbicular, no wider than long, mostly flat; pyrenes smooth on ventral surface; all States except Northern Territory 4

4. Sepals persistent in fruit; petals absent .... sect. *Apetalae*
4. Sepals deciduous in fruit; petals present or absent .... sect. *Pomaderris*

5. Style 2-branched; ovary 2-locular .... sect. *Biloculares*
5. Style 3-branched or 3-lobed; ovary 3-locular 6

6. Floral disc absent; South Australia, Queensland, New South Wales, Victoria, Tasmania .... sect. *Pomaderris*
6. Floral disc present, forming a raised annulus (sometimes narrow) within the points of attachment of the stamens; Western Australia, South Australia, Queensland, far-western Victoria 7

7. Inflorescence paniculate; stipules deciduous .... sect. *Annulares*
7. Inflorescence a simple terminal umbellate cyme; stipules persistent .... sect. *Umbelliflorae*

Descriptions of Species, Subspecies and Varieties

As in most reasonably large genera, specific and infraspecific boundaries in *Pomaderris* are not always easy to define. It might be argued that several of the infraspecific taxa described below differ in as many characters as do a number of species and could be reasonably treated at specific rank. They have been retained as subspecies or varieties where the differences are subtle (but we believe substantial) so that the component members of a species are readily observed as 'belonging' with each other. New species described below have less immediately appreciated affinities, and may appear equally similar to several other species. Infraspecific taxa are defined as subspecies where the morphological, geographical and/or ecological discontinuity(ies) between them are almost or quite complete. Varietal rank is used where variation within a species is more continuous, but decidedly different at the extreme ranges, and where the geographical distribution and/or ecological amplitude is not or hardly discontinuous.

SECTION *PSILOGYNE*

Pomaderris helianthemifolia (Reissek) N.A. Wakef. subsp. ***hispida*** N.G. Walsh & F. Coates, subsp. nov.

Differt a subspecie typica foliis pagina supera hispidis.

Type: Victoria, East Gippsland, Mangans Lake, Genoa district, *N.A. Wakefield 2249*, 7.xi.1948 (holotype MEL; isotypes NSW, BRI).

Pubescent *shrub* 1–2 m tall. *Leaves* oblong, 10–45 mm long, 2–10 mm wide, adaxial lamina hispid with loosely appressed to spreading simple hairs. *Inflorescence* of 20 to >50 flowers, pyramidal, terminal or axillary, 6–8(–12) cm long, 2–3(–6) cm wide; bracts caducous; pedicels (1.5–)2–3(–3.5) mm long. *Flowers* yellow; externally pubescent, with sparse, spreading, greyish and rusty simple hairs and medium to dense, greyish stellate hairs; hypanthium 1–2 mm in diameter, 0.5–1 mm long; sepals 1.5–2 mm long; stamens 1–2 mm long; anthers 0.5–0.8 mm long; disk smooth, glabrous; style 0.5–0.8 mm long, branched in middle or lower third. *Fruit* c. 3 mm long, purplish or blackish, obovoid; torus basal. Pyrene dehiscence via a longitudinal split; seed 1.5–2 mm long. (Fig. 1a–b)

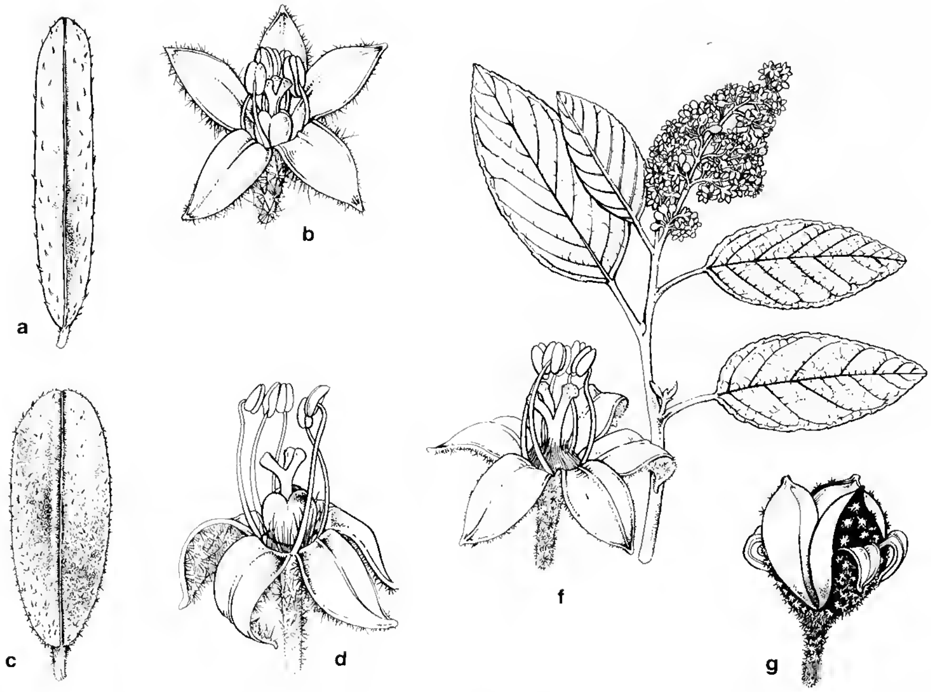

Fig. 1. **a–b** *Pomaderris helianthemifolia* subsp. *hispida* (*Wakefield 2249*): **a** leaf, x3; **b** flower, x7. **c–d** *P. helianthemifolia* subsp. *minor* (*Muir 1644*): **c** leaf, x3; **d** flower, x7. **e–g** *P. apetala* subsp. *maritima* (**e–f**, *Walsh 2149*, g, *Beauglehole 75235*): **e** flowering branch, x0.5; **f** flower, x7; **g** fruit, x5.

Representative Specimens (19 specimens examined)

VICTORIA: East Gippsland, Genoa River, 1 km downstream from Yambulla Creek confluence, *N.G. Walsh 574*, 12.v.1981 (MEL). NEW SOUTH WALES: Boonoo Boonoo National Park, Cypress Rest Area (NNE of Tenterfield via the Mount Lindsay Highway), *R.G. Coveny 16573*, 14.x.1993 (MEL, NSW, BRI, NE, CANB).

Distribution and Conservation Status

Occurs along the Great Dividing Range from Tenterfield, New South Wales, south to East Gippsland and Eastern Highlands, Victoria. Not considered rare or threatened at present. The commonest and most widespread representative of the species.

Habitat

Riparian shrubland, woodland and open forest on a variety of substrates including skeletal, rocky soils, gravels and sandy loam. Altitude range 40–600 m.

Phenology

Flowers: October–November. Fruits: November–January.

Etymology

The subspecific epithet refers to the nature of the indumentum on the adaxial surface of the leaf.

Notes

Pomaderris helianthemifolia subsp. *hispida* differs from the type subspecies in the leaves being hispid on the adaxial surfaces (subsp. *helianthemifolia* is glabrous adaxially). Subsp. *helianthemifolia* is narrowly endemic in the eastern part of the Avon River catchment near Briagolong area.

Pomaderris helianthemifolia (Reissek) N.A. Wakef. subsp. ***minor*** N.G. Walsh & F. Coates, subsp. nov.

Differt a subspecie typica foliis minoribus pagina supera hispidis et disco hispido.

Type: Victoria, Eastern Highlands, beside Rose River at its crossing by the Lake Buffalo Road, *N.G. Walsh 3455*, 19.ix.1992 (holotype MEL; isotypes CANB, NSW).

Pubescent shrub 1–2 m tall. Leaves narrow-obovate, (5–)6–9(–13) mm long, 2–4 mm wide; adaxial lamina with sparse, loosely appressed, greyish simple hairs. *Inflorescence* of 10–50 flowers, pyramidal, terminal or axillary, c. 3 cm long, 2 cm wide; bracts caducous; pedicels 1–1.5 mm long. *Flowers* yellow; externally moderately to densely pubescent with greyish long and short stellate hairs; hypanthium c. 1 mm in diameter, 0.5 mm long; sepals 1.5–2 mm long; stamens 1.5–2 mm long; anthers 0.5–0.8 mm long; disk moderately to densely pubescent; style 0.5–1 mm long, branched from near base. *Fruit* 2–3 mm long, purplish to blackish, obovoid; apex impressed; torus basal. *Pyrene* dehiscence via a longitudinal split; seed 1.5–2 mm long. (Fig. 1c–d)

Representative Specimens (10 specimens examined)

VICTORIA: Campaspe River above Kileens Bridge, above Eppalock, *F. Robbins s.n.*, 21.x.1961 (MEL); 28.5 km S of Whitfield, in Wabonga Plateau State Park, near the King R. above Lake William Hovell, 1.2 km E of Park boundary, *A. Piesse 727*, 7.i.1987 (MEL).

Distribution and Conservation Status

Endemic in Victoria, occurring in the north east and perhaps central parts of the State along the Buffalo and Wonnangatta rivers and their tributaries, and possibly, from the Campaspe River catchment. The single central Victorian collection, purportedly from near Eppalock, (Robbins s.n.) was from a site that was flooded after completion of Lake Eppalock. It is possible that the subspecies no longer occurs in central Victoria. Localised but not currently considered rare or threatened.

Habitat

Riparian shrubland and dry open forest. Altitude range 400–600 m.

Phenology

Flowers: October–November. Fruits: November–January.

Etymology

The epithet refers to the small leaves, on average, the smallest of the three subspecies.

Notes

Subsp. *minor* is distinguished from both other subspecies by the hispid floral disc and the smaller leaves (rarely longer than 1cm). It is further distinguished from subsp. *helianthemifolia* in having leaves that are hispid adaxially.

Key to subspecies of P. helianthemifolia

1. Leaves glabrous on upper surface .... subsp. *helianthemifolia*
1. Leaves hispid on upper surface 2

2. Leaves 10–45 mm long; disc glabrous .... subsp. *hispida*
2. Leaves 5–9(–13) mm long; disc hispid .... subsp. *minor*

SECTION *APETALAE*

Pomaderris apetala Labill. subsp. ***maritima*** N.G. Walsh & F. Coates, subsp. nov.

Differt a subspecie typica foliis obtusis, ad bis longioribus quam latioribus, pagina supera pilis stellatis persistentibus et in habitatione maritima.

Type: Tasmania, Asbestos Ra. National Park, c. 1.7 km due S from northern tip of Badger Head, *N.G. Walsh 2368*, 23.ii.1989 (holotype MEL; isotype HO).

Pomaderris sp. aff. *apetala* (Coastal) *sensu* J.H. Ross (Ed.), *Census Vasc. Pl. Victoria*, 4th edn (1993).

Pomaderris tainui Hector, *Trans. & Proc. New Zealand Inst.* 11: 429 (1879). *Type:* New Zealand, North Island, Mokau, *J. Hector*, 1879 (holotype AK; isotype K).

Pubescent shrub 1–3 m tall. *Leaves* ovate, 30–60 mm long, 15–30 mm wide; base obtuse; margins shallowly serrulate; apex obtuse; adaxial lamina wrinkled, sparsely pubescent with greyish stellate hairs; abaxial lamina densely pubescent with greyish (rarely rusty on veins) stellate hairs. *Inflorescence* of 20 to >50 flowers, pyramidal, terminal or upper-axillary, 5–15 cm long, 2–7 cm wide; bracts caducous; pedicels 1.5–2.5 mm long. *Flowers* cream, externally densely pubescent with greyish stellate hairs; hypanthium 1.25–2 mm in diameter, 1–1.5 mm long; sepals 1.8–2.1 mm long; stamens 1.5–2.5 mm long, erect; anthers 0.75–1 mm long; ovary virtually inferior, pubescent with long stellate hairs; style 1–1.5 mm long, branched in middle third. *Fruit* 3–4 mm long, blackish, obovoid to ovoid; apex obtuse; torus in middle third; operculum membranous, occupying most of inner face; seed 1.5–1.75 mm long. (Fig. 1e–g)

Representative Specimens (17 specimens examined)

VICTORIA: Reeves Beach, near western limit of Ninety Mile Beach, *N.G. Walsh 1601*, 14.vi.1986 (MEL, CANB); Wilsons Promontory, Lighthouse Point, *P.C. Heyligers 81034*, 13.xi.1981 (MEL). TASMANIA: Hawley, c. 1.5 km W of Freers Beach, *F. Coates s.n.*, 22.xii.1992 (MEL). NEW ZEALAND: Taranaki, North of Mohakatino River mouth, *N.G. Walsh 4670*, 5.i.1997 (MEL).

Distribution and Conservation Status

Restricted to South Gippsland at Wilsons Promontory and 90 mile Beach in Victoria; central northern Tasmania and Mokau area, North Island New Zealand. Conservation Code (Briggs and Leigh 1989) 3RCat.

Habitat

Predominantly dry coastal vegetation, ecotone between dune scrub or salt marsh and coastal woodland, but also known from grassy *Allocasuarina littoralis* woodland on dolerite in central northern Tasmania. Altitude range 0–60 m.

Phenology

Flowers: October–November. Fruits: December–January.

Etymology

The epithet refers to the coastal habitat of the subspecies.

Notes

Subsp. *maritima* differs from the typical subspecies in the relatively shorter (less than twice as long as wide), obtuse leaves with persistent indumentum on the upper surface. The coastal habitat further distinguishes the two taxa. Subsp. *apetala* is typically a species of wet forests, occurring in Tasmania and in the Grampians mountains in Victoria. Both subspecies occur at the type locality — subsp. *apetala* approaching the coast along a gully from the adjoining forest, and subsp. *maritima* growing quite independently of the forest community and closer to the coast than the other subspecies. The habit and general appearance of the plants is quite different at this locality, subsp. *apetala* being more slender and having leaves that are considerably darker and sub-glossy on the adaxial surface, whereas subsp. *maritima* is a compact shrub with an overall greyish or grey-green cast.

Key to subspecies of P. apetala

1. Leaves more than twice as long as wide, usually acute; upper surface glabrescent; plants generally of wet forests and gullies .... susbp. *apetala*
1. Leaves up to twice as long as wide, obtuse; stellate hairs persisting on upper surface; plants of coastal dunes and cliffs .... subsp. *maritima*

SECTION *POMADERRIS*

Pomaderris crassifolia N.G. Walsh & F. Coates, sp. nov.

Pomaderridi velleae N.A. Wakef. affinis sed foliis pagina supera glabris et floribus apetalis differt.

Type: Queensland, Mount Ernest, MacPherson Ra., *P.I. Forster 7411*, 14.ix.1990 (holotype MEL; isotypes BRI, CANB, K, NSW).

Shrub 1–2 m high. *Young stems* woolly. *Leaves* ovate or elliptic, 20–60 mm long, 10–28 mm wide; base obtuse; margins recurved; apex obtuse; adaxial lamina glabrous, smooth; abaxial lamina densely villous-woolly consisting of dense, curled, spreading, rusty simple hairs and greyish stellate hairs; secondary veins apparent beneath; petiole 5–10 mm long; stipules ovate, 4–6.5 mm long, deciduous. *Inflorescence* terminal, of 20 to >50 flowers, hemispherical or globoid (either a single globoid cluster or several clusters forming a more or less hemispherical panicle), 1.5–5 cm long, 1.5–5 cm wide; bracts caducous; pedicels 1–2.5 mm long. *Flowers* cream; externally densely villous with simple and stellate silvery-greyish hairs; hypanthium c. 1.2 mm in diameter at summit, 1.5–2 mm long; sepals 2.3–3 mm long; petals absent (rarely 1 to a few in some flowers, then spathulate, 1–1.5 mm long); stamens 2.5–3 mm long; anthers 1–1.4 mm long; ovary inferior, summit simple-pubescent; style glabrous or simple-pubescent near base, 1–1.3 mm long, branched in upper or middle third. *Fruit* c. 4 mm long, brown, broadly ellipsoid; apex obtuse (sometimes shortly beaked); torus in middle third; operculum membranous, occupying c. half of inner face of pyrene; seed c. 2 mm long. (Fig. 2a–b)

Representative Specimens (6 specimens examined)

QUEENSLAND: summit of Mt Ernest, *G. Leiper s.n.*, 11.ix.1989 (BRI); Johnsons Mountain, 8 km from Swanfels, *M.E. Ballingall 2727*, 9.viii.1992 (BRI). NEW SOUTH WALES: 2 miles (3.2 km) E of Gloucester, *R. Coveny s.n.*, 4.ix.1967 (NSW).

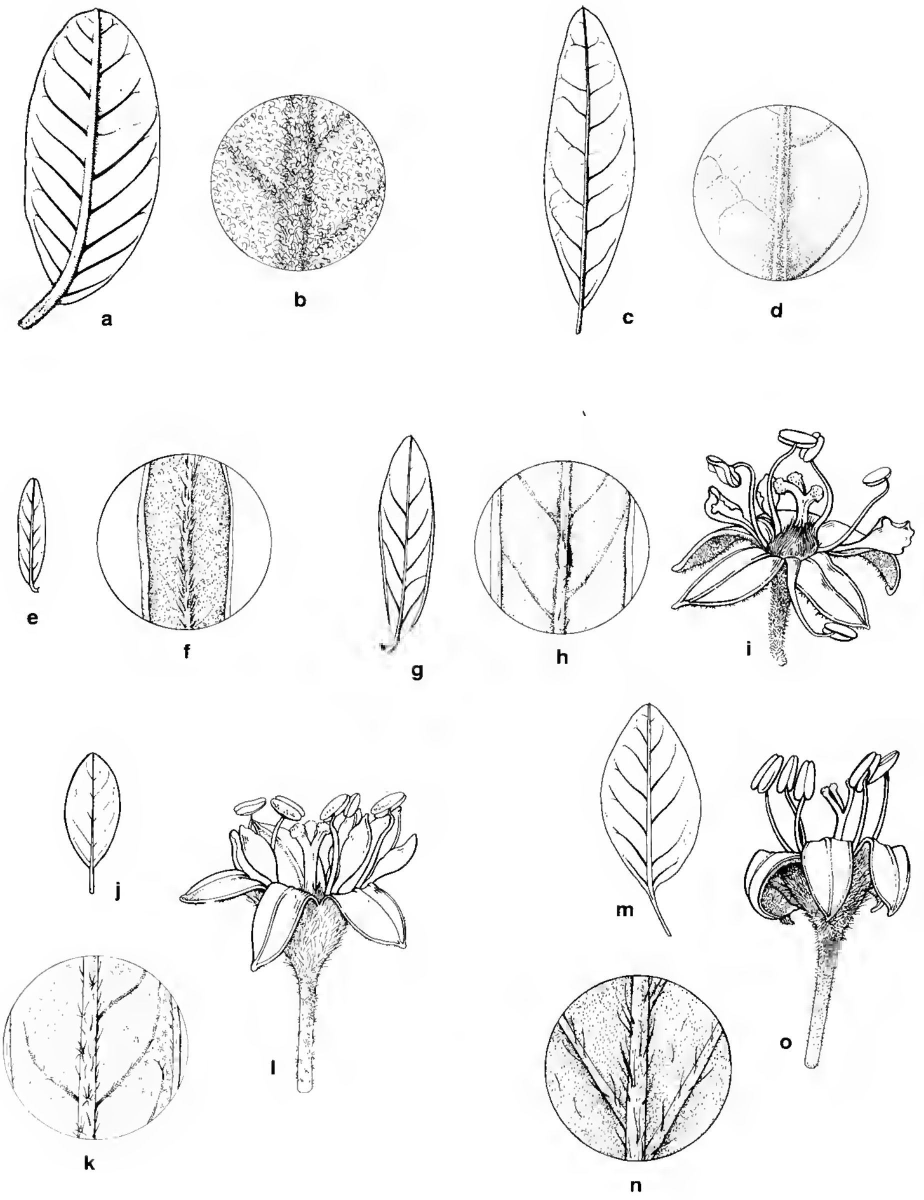

Fig. 2. **a–b** *Pomaderris crassifolia* (*Forster 7411*): **a** leaf, x1; **b** undersurface detail, x3. **c–d** *P. coomingalensis* (*Forster 15904*): **c** leaf, x1; **d** undersurface detail, x3. **e–f** *P. mediora* (*Walsh 3910*): **e** leaf, x1; **f** undersurface detail, x3. **g–i** *P. adnata (Walsh 3911)*: **g** leaf, x1; **h** undersurface detail, x3; **i** flower, x7. **j–l** *P. delicata* (*Walsh 4035*): **j** leaf, x1; **k** undersurface detail, x3; **l** flower, x7. **m–o** *P. bodalla* (*Walsh 4045*): **m** leaf, x1; **n** undersurface detail, x4; **o** flower, x7.

Distribution and Conservation Status

South-eastern Queensland to north-eastern New South Wales; Warwick region, D'Aguilar and MacPherson Ranges, with a disjunct southerly occurrence near Gloucester. Conservation Code (Briggs and Leigh 1989) 3K.

Habitat

Closed heathland, shrubland and open woodland on shallow soils. Exposed, rocky sites amongst rocks, on cliffs and mountain summits. Altitude range 200–820 m.

Phenology

Flowers: August–September. Fruits: October.

Etymology

The epithet is Latin (*crassus* = thick, *folia* = leaves) and refers to the relatively thick-textured leaves.

Notes

The new species appears to be most closely related to *P. vellea* N.A. Wakef., resembling it in inflorescence shape and relatively large flowers, a very dense woolly indumentum of young stems, petioles and abaxial surfaces of the leaves, and in the relatively thick-textured leaves. It is immediately distinguishable from that species however by the leaves being glabrous (rather than velutinous) on their adaxial surfaces. It is further distinguishable from *P. vellea* by the normally apetalous flowers and the sepals free to the base (usually shortly fused near the base in *P. vellea. Pomaderris crassifolia* resembles *P. ferruginea* in some respects and some specimens had been ascribed to that species, but the blunt, thickish leaves and denser woollier indumentum comprising strongly curled hairs, and the (normally) apetalous flowers distinguish *P. crassifolia.*

Pomaderris coomingalensis N.G. Walsh & F. Coates, sp. nov.

Pomaderridi clivicolae E.M. Ross affinis sed foliis pagina supera glabro et pagina inferna pilis internervis destitutis differt.

Type: Queensland, Coominglah Ra., Burnett District, Aliens Rd south end, *P.I. Forster 15904*, 28.xi.1994 (holotype MEL; isotypes AD, BRI, CANB, K, MO, NSW).

Shrub 3–5 m high. *Young stems* with dense, greyish stellate hairs. *Leaves* ovate or elliptic, 20–60 mm long, 7–18 mm wide; base cuneate; margins entire, plane or recurved; base cuneate; apex obtuse; adaxial lamina glabrous, smooth, lateral veins not or slightly impressed; abaxial lamina pubescent with dense, greyish stellate hairs; veins with sparse to medium, closely appressed, greyish or rusty simple hairs and dense, greyish stellate hairs, projecting beyond indumentum of internerves; petiole 2–5 mm long; stipules narrow-triangular or triangular, acute, 2–3 mm long, caducous. *Inflorescence* of 20–50 flowers, pyramidal or hemispherical, terminal, 1–1.8 cm long, 1–1.5 cm wide; bracts caducous (or a few weakly persisting to anthesis); pedicels 1–2 mm long. *Flowers* cream or yellow; externally densely pubescent, consisting of sparse to moderate, closely appressed to loosely appressed, greyish or rusty simple hairs and dense, greyish stellate hairs; hypanthium c. 1 mm in diameter, 0.5–0.8 mm long; sepals 1.2–1.5 mm long; petals absent; stamens 1–1.5 mm long; anthers 0.5–0.7 mm long; ovary inferior, summit pubescent with simple and stellate hairs; style glabrous, 1–1.5 mm long, branched in middle third. *Fruit* not seen. (Fig. 2c–d)

Representative Specimens (3 specimens examined)

QUEENSLAND: State Forest 28, *P.I. Forster 6713*, 28.iv.1990 (BRI, CANB, MEL); Coominglah State Forest, west of Monto, *A.R. Bean 2084*, 13.viii.1990 (BRI).

Distribution and Conservation Status

Queensland, narrowly endemic to the Coominglah Range between Monto and Theodore. Conservation Code (Briggs and Leigh 1989) 2K.

Habitat

Occurs in *Eucalytpus decorticans* and *Corymbia maculata* open forest on red soil. Altitude 460 m.

Phenology

Flowers: November–December.

Etymology

Derived from the only known locality for the species.

Notes

Pomaderris coomingalensis appears most closely related to *P. clivicola* E.M. Ross (Ross 1990), also a Queensland endemic. Both species have relatively narrow leaves, very small apetalous flowers and similar indumentum, but *P. coomingalensis* is immediately distinguished by the leaves being glabrous (rather than minutely but densely stellate-pubescent) on the adaxial surface, and lacking simple hairs on the internerves of the abaxial surface. Both species, on current knowledge, are very localised.

Pomaderris mediora N.G. Walsh & F. Coates, sp. nov.

Pomaderridi phylicifoliae Lodd. ex Link affinis sed foliis pagina supera glabro, pagina inferna villosa, stipulis deciduis, floribus minoribus differt.

Type: New South Wales, Turrimetta Head, between Narrabeen and Mona Vale, c. 22 km N of Sydney central, *N.G. Walsh 3910*, 18.ix.1994 (holotype MEL; isotypes CANB, NSW).

Pomaderris sp. B *sensu* S.W.L. Jacobs & J. Pickard, *Pl. New South Wales* 185 (1981).

Shrub, procumbent to 3 m high. *Young stems* villous with sparse to medium, spreading, greyish or rusty simple hairs overlying dense, greyish stellate hairs. *Leaves* narrow-elliptic or narrow-obovate, 10–18 mm long, 1.5–5 mm wide; base cuneate; margins entire, recurved or occasionally revolute; apex obtuse, recurved; adaxial lamina glabrous, smooth, lateral veins not or slightly impressed; abaxial lamina villous with medium to dense, curved, spreading, greyish or yellow-rusty simple hairs and dense, white-greyish stellate hairs; lateral veins obscure; petiole 1.5–3 mm long; stipules narrow-triangular, acute, 1–4 mm long, caducous. *Inflorescence* of 10 to >50 flowers, pyramidal, terminal or axillary, 2–7 cm long, 1–6 cm wide; bracts persistent (at least the smaller ones); pedicels 1–3 mm long. *Flowers* cream; outer surface villous with medium to dense, loosely appressed to spreading greyish or yellow-rusty simple hairs (sparser on sepals) and dense, white-greyish stellate hairs; hypanthium 0.6–0.7(–0.9) mm in diameter, 0.7–1 mm long; sepals 1–1.5 mm long, erect or spreading; petals absent; stamens 1–1.3 mm long, erect; anthers c. 0.5 mm long; ovary half-inferior to inferior, summit simple-pubescent; style glabrous, 0.7–1 mm long, branched in upper or middle third. *Fruit* 2.5–3 mm long, brown to grey, obovoid to ellipsoid; apex obtuse (sometimes very shortly beaked); torus approximately equatorial; operculum membranous, occupying most of pyrene inner face; seed 2–3 mm long. (Fig. 2e–f)

Representative Specimens (16 specimens examined)

NEW SOUTH WALES: Sublime Point, *P. Moore s.n.*, x.1985 (MEL); Frenchs Forest, Bluffs Track, *L. McDougall 89*, 12.x.1988 (NSW).

Distribution and Conservation Status

Endemic to the central coast of New South Wales, south from the mouth of the Hawkesbury River to Bulli near Wollongong. Conservation Code (Briggs and Leigh 1989) 2RC.

Habitat

Apparently confined to undifferentiated sandstones and shales of the Narrabeen Group. Occurring in heathland and scrub formations on ridges and headlands. Altitude 20–500 m.

Phenology

Flowers: September–October. Fruits: October–November.

Etymology

The epithet is derived from Latin (*medius* = middle, *ora* = coast) alluding to the species' distribution within the Central Coast floristic division of New South Wales (Anderson 1961, 1968).

Notes

The new species has been placed previously with *P. phylicifolia* with which it shares features such as relatively narrow leaves that have recurved or revolute margins, apetalous flowers, and fruits having the pyrene operculum almost as long as the pyrene itself. It differs from *P. phylicifolia* susbp. *phylicifolia* in having leaves that are glabrous adaxially and villous beneath, deciduous stipules and generally smaller flowers. From *P. phylicifolia* subsp. *ericifolia*, which is sometimes glabrous above (see below) it is immediately distinguishable by the broader, non-linear leaves. Plants from the Wollongong, Austinmer, Sublime Point and Bulli Pass areas have a more densely villous leaf abaxial surface and calyx; flowers and stipules are at the large end of the range for the species.

Pomaderris adnata N.G. Walsh & F. Coates, sp. nov.

Pomaderridi phylicifoliae Lodd. ex Link et *P. mediorae* N.G. Walsh similis strictim sed caulibus pilis destitutis et foliis pagina inferna pilis sparsis parvis adpressis, et floribus petalis differt.

Type: New South Wales, Sublime Point, *N.G. Walsh 3911*, 21.ix.1994 (holotype MEL; isotypes CANB, NSW).

Spreading *shrub* to 2 m high. *Young stems* pubescent with dense, greyish stellate hairs. *Leaves* narrow-elliptic, narrow-obovate, elliptic or obovate, 15–30 mm long, 3–8 mm wide; base cuneate; margins entire or very slightly sinuate, recurved; apex obtuse; adaxial lamina glabrous, smooth, lateral veins not or slightly impressed; abaxial lamina pubescent with dense, greyish stellate hairs; lateral veins apparent, penninerved, with very sparse, closely to loosely appressed, greyish or yellow-rusty simple hairs and medium to dense, greyish stellate hairs; petiole 1–3 mm long; stipules narrow-ovate, acute, 1–2 mm long, deciduous. *Inflorescence* of c. 20–50 flowers, hemispherical or globoid, terminal or axillary, 1–4 cm long, 1–3 cm wide; bracts caducous; pedicels

1–2.5 mm long. *Flowers* cream; externally densely pubescent with white-greyish stellate hairs; hypanthium 1–2 mm in diameter, 0.7 mm long; sepals 1.8–2 mm long; petals present on most flowers but sometimes fewer than 5, 1.2–1.5 mm long, oblanceolate, flat or slightly cupped; stamens 1.8–2.2 mm long, distinctly longer than petals, the filaments shortly adnate to the petal base; anthers 0.7–0.8 mm long; ovary half-inferior, stellate-pubescent; style glabrous, 0.8–1.3 mm long, branched in middle third. Fruit ovoid, c. 3 mm long, blackish; apex acute; torus slightly below midway; operculum membranous, occupying most of pyrene inner face; seed c. 1.8 mm long. (Fig. 2g–i)

Other Specimens Examined

NEW SOUTH WALES: type locality, *N.G. Walsh 4074*, 19.xii.1995 (MEL); *P.C. Jobson 4285*, 2.vi.1996 (MEL, NSW).

Distribution and Conservation Status

Known only from a very small population from Sublime Point, near Wollongong, Central Coast floristic subdivision of New South Wales (Anderson 1961, 1968). Conservation Code (Briggs and Leigh 1989) 1V.

Habitat

Heathy woodland and open forest on sandy loam. Altitude c. 320 m.

Phenology

Flowers: September. Fruits: November–December.

Etymology

From the Latin *adnatus* (= joined) referring to the base of the staminal filament which is shortly united with the petal claw.

Notes

In its narrow-elliptic to obovate leaves, *P. adnata* bears a superficial resemblance to *P. mediora* and *P. phylicifolia*, but the indumentum of the stems and abaxial leaf surfaces is very different, with simple hairs being absent from the stems, and rather short, sparse and appressed on the midrib and larger lateral veins of the abaxial leaf surfaces. The flowers are quite unlike either of those two species however, being petalous and bearing only stellate hairs on the hypanthium and sepals. The condition of each of the staminal filaments being shortly united with the claw of its subtending petal occurs also in the narrowly endemic Victorian species *P. subplicata* (Walsh 1992), but that species differs substantially from *P. adnata* in its smaller (to 10 mm long), relatively broader leaves that are finely stellate pubescent on both surfaces.

Pomaderris delicata N.G. Walsh & F. Coates, sp. nov.

A *P. andromedifolia* A. Cunn. foliis minoribus, pagina abaxiali non sericea et stipulis minoribus non persistentibus differt.

Type: New South Wales, Goulburn-Bungonia Rd, 12 km ESE of Goulburn, *N.G. Walsh 4035*, 11.x.1995 (holotype MEL; isotypes BRI, CANB, HO, NSW).

Shrub 1–2 m high. *Young stems* pubescent with very sparse, loosely appressed greyish-yellow or rusty simple hairs and dense, greyish-yellow stellate hairs. *Leaves* elliptic, 13–30 mm long, 5–15 mm wide; base cuneate; margins entire, plane or slightly recurved; apex obtuse to broadly acute; adaxial lamina glabrous, smooth, lateral veins not or only slightly impressed; abaxial lamina densely pubescent with greyish stellate hairs; midrib with a few appressed, pale or rusty simple or comb-like hairs, sometimes extending onto lateral veins; petiole 3–5 mm long; stipules triangular, acute, 1–2 mm long, caducous. *Inflorescence* of 20 to >50 flowers, pyramidal, terminal, 1.5–4 cm long, 2–5 cm wide; bracts caducous; pedicels 1.5–3 mm long. *Flowers* golden-yellow; externally pubescent with sparse to moderately dense, loosely appressed to spreading greyish simple hairs (sometimes very short) and dense, greyish stellate hairs, both hair types less dense on sepals; hypanthium 0.8–1.2 mm in diameter, 0.8–1 mm long; sepals 1.7–2 mm long, spreading; petals 1.7–2 mm long, spathulate; stamens c. 1.5 mm long; anthers 0.9–1.1 mm long; ovary inferior, pubescent with simple and stellate hairs; style glabrous, 1–1.5 mm long, branched in upper to middle third. Fruit ellipsoid to obovoid, 2.5–3.5 mm long, brown; apex obtuse; torus c. equatorial; operculum c. two-thirds pyrene length; seed c. 2 mm long. (Fig. 2j–l)

Representative Specimens (6 specimens examined)

NEW SOUTH WALES: Goulburn-Bungonia, *C.W.E. Moore 2735*, 20.x.1953 (CANB, MEL, NSW); Bungonia Road, 8 miles (10.8 km) from Goulburn, *I.C.R. Holford*, 14.x.1955 (NSW); Beside Goulburn-Bungonia Rd, c. 11 km by road from Goulburn, *N.G. Walsh 3917*, 21.ix.1994 (CANB, MEL, NSW).

Distribution and Conservation Status

Narrowly endemic to an area between Bungonia and Goulburn, Southern Tablelands of New South Wales (Anderson 1961, 1968), occurring along the roadside for a distance of c. 0.2 km, and extending for an unknown distance into woodland on adjacent private properties. Conservation Code (Briggs and Leigh 1989) 2Ri, but further surveys are warranted to assess potential habitat threats.

Habitat

Dry open forest (*Eucalyptus sieberi*, *E. macrorhyncha* dominant) on skeletal to shallow soil derived from Silurian sandstones and siltstones (Towrang Beds). Altitude c. 750 m.

Phenology

Flowers: October. Fruits: December.

Etymology

The epithet is derived from Latin and refers to the dainty appearance of the plant.

Notes

This entity has formerly been referred (tentatively) to *P. andromedifolia*, a species that occurs close to populations of *P. delicata* but differs significantly in its generally longer leaves that are always silky-pubescent on the abaxial surface, as are the young stems, hypanthium and sepals. *P. andromedifolia* also differs in having larger stipules (2–4 mm long) that usually persist for several nodes below the growing tip, whereas those of *P. delicata* fall before or soon after the expansion of the leaf blade. Further, the stems of *P. delicata* become glabrous by the second year and adopt a polished appearance, whereas those of *P. andromedifolia* usually retain a covering of hairs for several seasons.

Pomaderris bodalla N.G. Walsh & F. Coates, sp. nov.

Pomaderridi brunneae N.A. Wakef. affinis sed foliis marginibus non recurvatis, pagina inferna non villosa et nervis lateralibus impressis vix differt.

Type: New South Wales, Dignam Ck, 6.5 km SW of Tilba Tilba, *N.G. Walsh 4045*, 13.x.1995 (holotype MEL; isotypes CANB, NSW).

Shrub 2–4 m high. *Young stems* with spreading; rusty simple hairs and dense, greyish stellate hairs. *Leaves* elliptic, broad-elliptic, broad-obovate, or often, sub-rhombic, (15–)20–25(–30) mm long, (10–)12–15(–20) mm wide; base cuneate; margins entire but often slightly undulate; apex obtuse to broadly acute, occasionally terminated by a tuft of simple hairs; adaxial lamina glabrous, smooth; lateral veins not or slightly impressed; abaxial lamina pubescent with sparse to very sparse, spreading rusty simple hairs overlaying dense, greyish stellate hairs; lateral veins clearly visible, with simple hairs denser than those of internerves; petiole 2.5–6 mm long. *Stipules* triangular or narrow-triangular, 2–7 mm long, deciduous. *Inflorescence* many-flowered, narrowly pyramidal, terminal, 2–8 cm long, 1.5–4 cm wide; bracts caducous; pedicels 1–2 mm long. *Flowers* cream; externally densely pubescent, greyish with loosely appressed or spreading simple hairs overlaying stellate hairs, sparser on sepals; hypanthium 0.8–1.2 mm in diameter, 0.6–0.8 mm long; sepals 1.5–1.7 mm long, erect to slightly spreading; petals absent; stamens 1–1.5 mm long; anthers 0.7–0.9 mm long; ovary inferior, stellate-pubescent or with simple hairs largely obscuring stellate hairs; style glabrous, 0.8–1.2 mm long, branched in middle third. *Fruit* not seen. (Fig. 2m–o)

Representative Specimens (10 specimens examined)

NEW SOUTH WALES: Bodalla-Runnyford, *M. Shoobridge*, 2.x.1961 (BRI, CANB, NSW); Nerrigundah, *W. McReadie*, x.1966 (NSW); Bodalla State Forest, Red Creek Rd, 1 km N of Tinpot Rd, *N.G. Walsh* 4047, 12.x.1995 (CANB, MEL); 2 km ESE of Brogo Hall, *N.G. Walsh 4051*, 12.x.1995 (CANB, MEL, NSW).

Distribution and Conservation Status.

Occurs in the South Coast botanical subdivision of New South Wales (Anderson 1961, 1968) where apparently endemic between Nerrigundah and Brogo. Conservation Code (Briggs and Leigh 1989) 2R.

Habitat

Occurs in sheltered sites (streambanks, gully heads etc.) in moist open-forests. Altitude range 40–350 m.

Phenology

Flowers: October.

Etymology

From the locality of Bodalla, the centre of known distribution of the species; an Aboriginal word of somewhat obscure meaning, but which probably refers to the locality's proximity to water.

Notes

Pomaderris bodalla has previously been confused with *P. brunnea* — a species having leaves with recurved margins, villous abaxial indumentum and strongly impressed lateral veins. Some specimens have also been determined as *P. discolor* which also has recurved leaf margins. The latter species characteristically has leaves that are evenly tapered to the cuneate base and acute apex, and has (sometimes petalous) flowers with sparser simple indumentum on the hypanthium and widely spreading sepals. Near Brogo, *P. bodalla* sometimes grows with *P. brogoensis*, and some plants have been collected that may be hybrids between the two. These have the general appearance of *P. bodalla*, but the leaves are minutely stellate-pubescent adaxially, and the new growth is often rusty villous as it is in *P. brogoensis*.

Pomaderris precaria N.G. Walsh & F. Coates, sp. nov.

Pomaderridi cocoparranae N.G. Walsh et *P. repertae* N.G. Walsh affinis sed floribus apetalis; a *P. cocoparrana* foliis pagina inferna pilis in internervis dispersis differt; a *P. reperta* foliis pagina supera indumento sparsiori, pagina inferna pilis in internervis sparsioribus differt.

Type: New South Wales, Rylstone-Bylong Rd, *N.G. Walsh 3906*, 18.ix.1994 (holotype MEL; isotypes CANB, NSW).

Pomaderris sp. D *sensu* G.J. Harden, *Flora New South Wales* 1: 364 (1990).

Slender *shrub*, 1.5–3 m high. *Young stems* greyish-rusty with sparse to medium, loosely appressed simple hairs overlying dense stellate hairs. *Leaves* elliptic or obovate, 10–45 mm long, 8–25 mm wide, entire; base cuneate to obtuse; margins plane; apex obtuse; adaxial lamina subvelutinous with very short (c. 0.1 mm long), simple, straight hairs that are shortly hooked apically, lateral veins not or only slightly impressed; abaxial lamina densely pubescent with sparse, loosely appressed to spreading greyish or rusty simple hairs overlying dense greyish stellate hairs; midrib and lateral veins pubescent or villous, clearly visible, with a moderately dense indumentum of appressed or semi-appressed simple rusty hairs overlying greyish stellate hairs; petiole 3–9 mm long; stipules ovate, acuminate, 3–5 mm long, deciduous. *Inflorescence* of c. 50–200 flowers in terminal, approximately hemispherical panicles 3–5 cm long, 3–8 cm wide; bracts deciduous (or a few weakly persisting); pedicels 2–4 mm long. *Flowers* yellow; indumentum greyish, densely pubescent to villous with loosely appressed to spreading simple hairs overlaying stellate hairs, sparser on sepals; hypanthium c. 1 mm in diameter, 0.8 mm long; sepals 1.8–2.7 mm long; petals 1.2–2.2 mm long, spathulate, margins entire or crenulate, distinctly clawed; stamens 1–2 mm long; anthers 0.8–1.4 mm long; ovary inferior, summit villous with simple and stellate hairs; style glabrous, 1.3–1.8 mm long, slightly lobed to branched in middle third. *Fruit* blackish, 4–5 mm long, ovoid or ellipsoid, obtuse but shortly beaked; torus c. equatorial; operculum c. half as long as pyrene; seed c. 2.5 mm long. (Fig. 3a–c)

Representative Specimens (7 specimens examined)

NEW SOUTH WALES: Rylstone, 3 miles (5 km) along Bylong Rd, *R.O. Cross*, 29.ix.1938 (MEL, NSW); Bylong Rd, c. 5.5 miles (9 km) N of Rylstone, *J.H. Willis*, 6.x.1969 (MEL); Sir Johns Point, Mt Gundangaroo, 15 miles ENE of Capertree, *E. F. Constable 7223*, 18.x.1966 (NSW).

Distribution and Conservation Status

Apparently confined to the Rylstone area, in the Central Tablelands and/or Central Western Slopes of New South Wales (Anderson 1961, 1968). Recorded from a roadside and adjacent private property, and at St Johns Point, Wollemi National Park (but not collected from this latter area since 1966). Conservation Code (Briggs and Leigh 1989) 2VC-.

Habitat

Skeletal or gravelly soils derived from sandstone (Hawkesbury Sandstones) on rocky ridges or below cliffs in shrubland or dry eucalypt woodland. Altitude range c. 700–900 m.

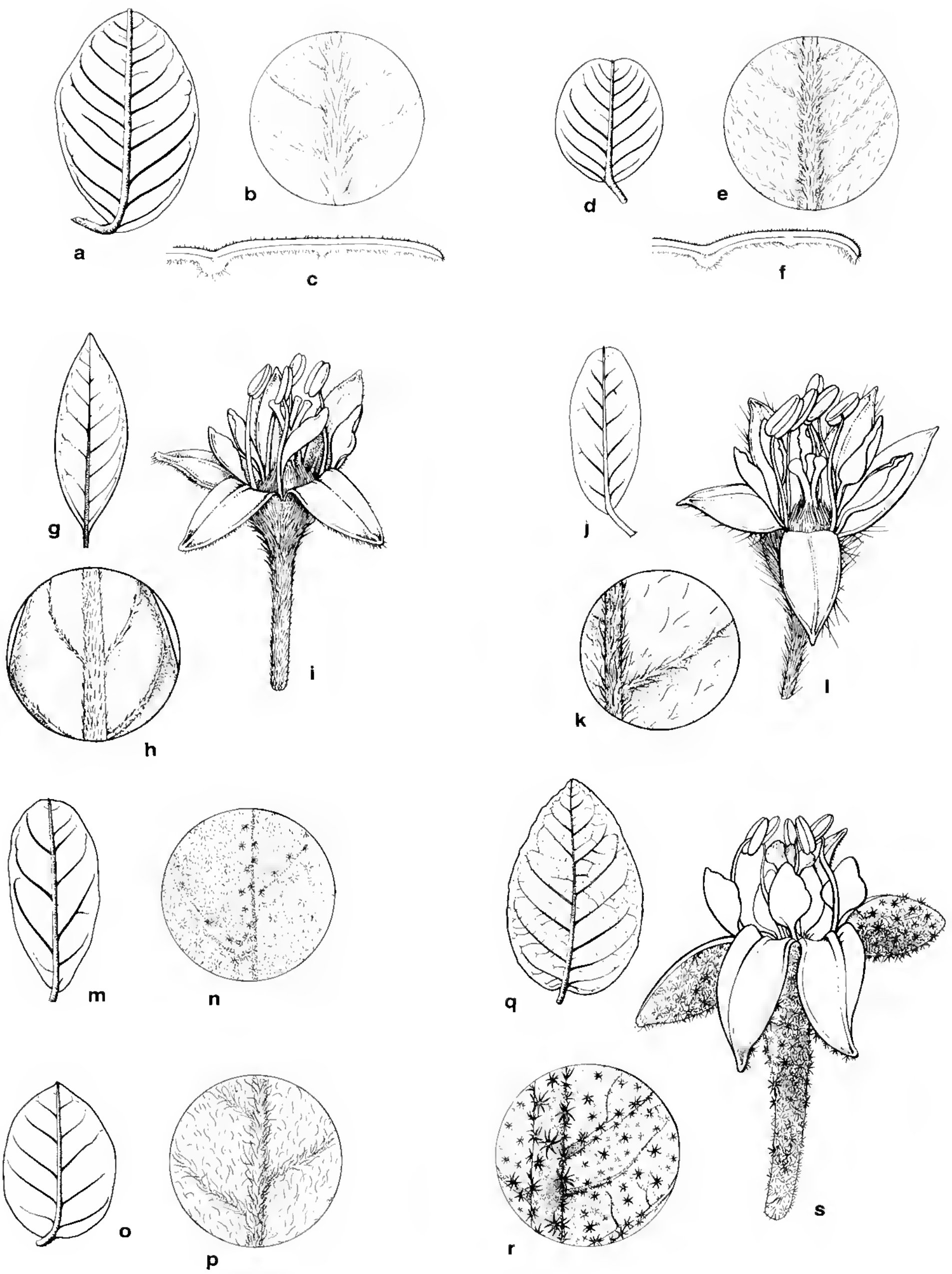

Fig. 3. **a–c** *Pomaderris precaria* (*Walsh 3906*): **a** leaf, x1; **b** undersurface detail, x3; **c** transverse section, x3. **d–f** *P. reperta* (*Jobson 3872*), **d** leaf, x1; **e** undersurface detail, x3; **f** transverse section, x3. **g–i** *P. argyrophylla* subsp. *graniticola* (*Walsh 3883*): **g** leaf, x1; **h** undersurface detail, x3; **i** flower, x7. **j–l** *P. andromedifolia* subsp. *confusa* (*Pullen 2893*): **j** leaf, x1; **k** undersurface detail, x3; **l** flower, x7. **m–n** *P. betulina* subsp. *actensis (Canning 5042)*: **m** leaf, x1; **n** undersurface detail, x3. **o–p** *P. ligustrina* subsp. *latifolia* (*Coveny 2210*): **o** leaf, x1; **p** undersurface detail, x3. **q–s** *P. elliptica* var. *diemenica* (*Hemsley 6276*): **q** leaf, x0.5; **r** undersurface detail, x3; **s** flower, x7.

Phenology

Flowers: September–October. Fruits: December.

Etymology

From the Latin meaning precarious, pertaining to the insecure roadside situation of the only recently-collected population.

Notes

Pomaderris precaria appears to be most closely related to *P. cocoparrana* and *P. reperta* (see below), both localised species that occur on the western fall of the Great Dividing Range in New South Wales. Shared characters include medium-sized leaves having a rather stiff texture and a very fine indumentum on the adaxial surface, and a general similarity in the nature (but not density or distribution) of the abaxial indumentum. *Pomaderris precaria* differs from both species in having regularly petalous flowers (rarely a few petals present in *P. reperta*). It differs further from *P. cocoparrana* in having scattered simple hairs in the internerves of the leaf abaxial surface. It differs from *P. reperta* in having leaves with a sparser adaxial indumentum and far fewer simple hairs on the abaxial surface. *Pomaderris lanigera* and *P. aurea*, both petalous species, are superficially similar, but both have leaves with a sparser, longer adaxial indumentum and denser, non-appressed simple hairs abaxially. *Pomaderris aurea* is not known to occur in New South Wales.

Pomaderris reperta N.G. Walsh & F. Coates, sp. nov.

Pomaderridi cocoparranae N.G. Walsh affinis sed floribus majoribus, foliis pagina supera indumento sparsiori et grossiori differt.

Type: New South Wales, 2 km E of Denman, *P.C. Jobson 3872*, 22.ix.1995 (holotype MEL; isotypes BRI, CANB, HO, K, NSW).

Shrub 1–3 m high. *Young stems* densely villous with rusty simple and stellate hairs. *Leaves* ovate to broad-ovate, elliptic to broad-elliptic or obovate to broad-obovate, 10–35 mm long, 8–20 mm wide; base obtuse; margins entire, flat to recurved; apex obtuse, or commonly, shallowly emarginate; adaxial lamina velutinous with very short (c. 0.1 mm long), dense, erect simple hairs; lateral veins often strongly impressed; abaxial lamina pubescent with mid-dense, loosely appressed or spreading pale and rusty simple hairs overlaying dense white or greyish stellate hairs; midrib and lateral veins clearly visible, more densely indumented than internerves; petiole 3–10 mm long. *Stipules* narrow-triangular or narrow-ovate, acute 3–5 mm long, deciduous. *Inflorescences* of 1–several globoid clusters each of c. 10–30 flowers, often forming a loose hemispherical panicle, terminal, 3–4 cm long, 3–4 cm wide; bracts deciduous; pedicels 1.5–3 mm long. *Flowers* cream; externally villous with spreading silvery or pale rusty simple hairs overlaying greyish stellate hairs; hypanthium c. 1.5 mm in diameter, 1–1.5 mm long; sepals 2.3–2.8 mm long; petals absent (rarely some flowers with 1–3 petals to c. half as long as the sepals); stamens 2–2.5 mm long; anthers 1.3–1.5 mm long; ovary inferior, summit villous with simple and stellate hairs; style glabrous or simple-pubescent near base, 1.4–1.6 mm long, branched in middle third or from near base. Fruit c. 3.5 mm long, obovoid, dark grey-brown, apex obtuse; torus c. equatorial; operculum slightly more than half pyrene length; seed c. 2 mm long (only 1 sparsely fruiting specimen seen). (Fig. 3d–f)

Other Specimens Examined

NEW SOUTH WALES: Timber Reserve 62282, Parish of Denman, County of Brisbane, *J. Kennedy*, ix.1961 (NSW); Denman, *C.F. Cameron*, vii.1924 (NSW); Denman, *C.R. Stafford*, 25.v.1945 (NSW); type locality, *T. Turner*, 10.x.1995 (MEL), *N.G. Walsh* 4070, 19.xii.1995 (MEL).

Distribution and Conservation Status.

Narrowly endemic to the Denman area, New South Wales, Central Western Slopes botanical subdivision (Anderson 1961, 1968), and currently known from only the type locality where shrubs are seattered over an area of c. 1 ha. Conservation Code (Briggs and Leigh 1989) is assessed at 2V.

Habitat

Occurs in dry *Eucalyptus crebra-E. blakelyi* woodland, on brown sandy loam derived from sandstone (Hawkesbury Sandstones). Altitude c. 300 m.

Phenology

Flowers: October. Fruits: December (1 record).

Etymology

From the Latin *reperta*, to rediscover, or find after searching. The species was rediscovered following a targeted search of the type area, after not having been collected since 1961.

Notes

Related to *P. cocoparrana*, a species confined to the Cocoparra Range (near Griffith in New South Wales), but the adaxial indumentum of the leaves is sparser and coarser and the flowers are larger (sepals 2.0–2.2 mm long in *P. cocoparrana*). See also notes following *P. precaria*. Specimens at NSW had been determined as *P. vellea*, a rare species of scattered distribution from the New England area of New South Wales to near Sydney, but that species has larger flowers (with sepals often shortly united near base and forming a short tube), finer and shorter adaxial indumentum, and simple hairs on young branchlets and leaf undersurfaces that are extremely dense, rusty and flexuose or curled. Possibly also related to *P. subcapitata* and *P. eriocephala*, but differs in the floral bracts falling prior to anthesis, and in the absence of long, thread-like simple hairs on branchlets and leaf undersurfaces.

Pomaderris argyrophylla N.A. Wakef. subsp. ***graniticola*** N.G. Walsh & F. Coates, subsp. nov.

Differt a subspecie typica foliis minoribus obtusis plerumque, sepalis longioribus, petalis praesentibus plerumque.

Type: Queensland, Girraween National Park, c. 50 m W of Dr Roberts Waterhole, toward its southern reach, *N.G. Walsh 3883*, 15.ix.1994 (holotype MEL; isotypes BRI, CANB, NSW, UNE).

Pomaderris sp. 1 *sensu* E.M. Ross, Fl. South-eastern Queensland 2: 50 (1986).

Shrub 1.5–5 m high. *Young stems* with medium to dense, closely to loosely appressed, white-greyish or silvery (rarely golden) simple hairs and medium to dense, white-greyish stellate hairs. *Leaves* ovate or elliptic, 15–65 mm long; 8–30 mm wide; base cuneate or obtuse; margins entire, plane or slightly recurved; apex acute or obtuse; adaxial lamina glabrous, smooth; lateral veins not or slightly impressed; abaxial lamina pubescent with sparse to medium, closely to loosely appressed, white-greyish simple hairs (denser and sometimes yellowish on veins), and dense white-greyish stellate hairs; lateral veins clearly visible; petiole 4–10 mm long. *Stipules* ovate, acute, 3–5 mm long, soon deciduous. Inflorescence of 10–c. 100 flowers, pyramidal, terminal, 2–8 cm long and wide; bracts deciduous; pedicels 1.5–3.5 mm long. *Flowers* cream or yellow; externally pubescent to villous with moderately dense, loosely appressed, white-greyish or silvery simple hairs and dense greyish, or silvery stellate hairs (sepals less densely indumented than hypanthium); hypanthium c. 0.8 mm in diameter, 1–1.3 mm long; sepals 2–2.5 mm long; petals, c. 1.5 mm long, spreading, spathulate, rarely absent; stamens 2–2.5 mm long; anthers 0.7–1 mm long; ovary inferior, summit simple-pubescent; style glabrous or simple-pubescent near base, 1.5–1.7 mm long, branched in upper or middle third. *Fruit* 3–4 mm long, ovoid, blackish, apex obtuse; torus c. equatorial; operculum c. half as long as pyrene; seed c. 1.8 mm long (only 1 fruiting specimen seen). (Fig. 3g–i)

Representative Specimens (35 specimens examined)

QUEENSLAND: Bald Rock Creek, Dr Roberts Waterhole, c. 10 km N of Wallangarra, *I. R. Telford 10698*, 7.ix.1988 (BRI, MEL, NSW, CANB). NEW SOUTH WALES: N of Bruxner Highway, 34 km WNW of Tenterfield, *G. J. White*, 24.v.1984 (BRI, NE, NSW, CANB, MEL); Gibralter Ra., c. 67 km E of Glen Innes, on the Gwyder Highway, *R. Coveny 2219*, 2.x.1969 (NSW, BRI).

Distribution and Conservation Status

Occurs in south-eastern Queensland in the Stanthorpe and southern Darling Downs districts; and north-eastern New South Wales in the Gibraltar Range, Wyberba and New England regions. Not considered rare or threatened at present; conserved in Girraween, Sundown, Bald Rock and Gibraltar Range National Parks.

Habitat

Open forest and in scrub along water courses on alluvium, clay loam and sandy soils derived from granite. Altitude range 700–1000 m.

Phenology

Flowers: September–October. Fruits: January (1 collection only)

Etymology

From the Latin (*granites* = granite, *-cola* = dweller), referring to the subspecies' almost exclusive occurrence on granitic substrates.

Notes

The distinctions between *P. argyrophylla* subsp. *argyrophylla* and subsp. *graniticola* are outlined in the key below. At their extremes, the two subspecies are quite distinct, but in the range areas east of Stanthorpe, where their distributions overlap, plants may be difficult to assign to either subspecies. Small-leaved variants of subsp. *graniticola* (as represented by the type) resemble small-leaved variants of *P. andromedifolia* subsp. *andromedifolia* which occur in southern New South Wales and eastern Victoria. The simple hairs on the abaxial leaf surfaces of *P. argyrophylla* subsp. *graniticola* are shorter and sparser than those of *P. andromedifolia* and never rusty as in that species. *Pomaderris delicata* also resembles the type variant of *P. argyrophylla* subsp. *graniticola* but it has even fewer simple hairs on the abaxial surfaces of the leaves, and has exceedingly short (1–2 mm long) stipules that do not persist beyond expansion of the leaf blade. Larger-leaved variants of subsp. *graniticola* to the north of Girraween National Park (e.g. Amiens, Messines) resemble *P. queenslandica* but lack the large, broad-ovate stipules characteristic of that species.

Key to subspecies of P. argyrophylla

1. Leaves 50–120 mm long, acute to acuminate; sepals 1.3–2 mm long; petals usually absent, white or cream if present; from North Queensland (Atherton area) to Barrington Tops area, New South Wales .... subsp. *argyrophylla*
1. Leaves 15–65 mm long, often obtuse; sepals 2–2.5 mm long; petals usually present, usually yellow, rarely white or cream; Granite Belt area of south-eastern Queensland and north-eastern New South Wales .... subsp. *graniticola*

Pomaderris andromedifolia A. Cunn. subsp. ***confusa*** N.G. Walsh & F. Coates, subsp. nov.

Differt a subspecie typica foliis pagina inferna in internervis pilis sparsioribus arcuato-patentibus, bracteis inflorescentiae persistentibus ad anthesin plerumque.

Type: Australian Capital Territory, Molonglo Gorge, Kowen District, *R.Pullen 2893*, 12.x.1961 (holotype MEL; isotypes A, AD, BH, BM, BRI, CANB, K, L, NSW, US).

Pomaderris sp. A *sensu* S.W.L. Jacobs & J. Pickard, *Pl. New South Wales* 185 (1981) p.p.; G.J. Harden, *Fl. New South Wales* 1: 362 (1990) *p.p.*

Shrub 1–2 m high. *Young stems* with medium, flexuose, loosely appressed to spreading, greyish or rusty simple hairs and dense, greyish or rusty stellate hairs. *Leaves* ovate, elliptic or obovate, 15–40 mm long, 10–15 mm wide; base cuneate; margins entire, recurved; apex acute or obtuse; adaxial lamina glabrous, smooth, veins not or slightly impressed; abaxial lamina pubescent with sparse to medium, curved to slightly flexuose, loosely appressed to spreading, yellow-grey simple hairs and dense, greyish stellate hairs, rusty on veins; lateral veins clearly visible; petiole 3–6 mm long. *Stipules* narrow-triangular to triangular, acute, 1.5–3.5 mm long, deciduous. *Inflorescences* >50-flowered, pyramidal, terminal, (1.5–)3–7(–10) cm long, (1.5–)3–5(–7) cm wide; bracts often persisting until anthesis; pedicels 1.5—3.5 mm long. *Flowers* cream, externally pubescent with dense, straight, loosely appressed to spreading, whitish simple hairs (sparse on sepals) and dense, whitish stellate hairs; hypanthium 1 mm in diameter, 1 mm long; sepals 2–2.5 mm long; petals 2–2.5 mm long, spathulate; stamens 2–2.5 mm long; anthers 1.2–1.5 mm long; ovary inferior, pubescent with simple hairs concealing a layer of stellate hairs; style glabrous, 1.5–2 mm long, branched in middle third. Fruit 3.5–4 mm long, brown to grey, obovoid; apex broadly obtuse but sometimes shortly beaked; torus c. equatorial; operculum c. half pyrene length; seed 1.5–2 mm long. (Fig. 3j–l)

Representative Specimens (32 specimens examined)

NEW SOUTH WALES: 4.6 km E of Snowy R. above its junction with Delegate R., *A. V. Slee 2366*, 27.x.1988 (MEL, CANB, NSW); Below Newtons Crossing picnic area, above bank of Wallagaraugh R., Yambulla State Forest, *M. Parris 9872* and N. Fisher, 25.vi.1991 (CANB, NSW). AUSTRALIAN CAPITAL TERRITORY: near Gibraltar Creek, c. 3 km E of Woods Reserve, *P. Gilmour 5939*, 30.x.1986 (MEL); Molonglo R., Lower Molonglo Gorge, *P. Barrer*, 20.xi.1990 (CANB, K, MEL, NSW).

Distribution and Conservation Status

Occurs in the Australian Capital Territory at Molonglo Gorge and Gibraltar Creek, and in New South Wales at Mt Jerrabombera near Queanbeyan, extending south to the coast near the Victorian border. Currently not considered rare or threatened.

Habitat

Riparian scrub, ridge top shrubland, woodland and forest on shallow or skeletal soils. Altitude range 30–920 m.

Phenology

Flowers: September–October. Fruits: December.

Etymology

From the Latin meaning confused; a reference to the confusion surrounding this entity, having been regarded by Burbidge and Gray (1970) and Harden (1990) as intermediate (and possibly of hybrid origin) between *P. andromedifolia* and *P. betulina.* A re-examination of specimens suggests that the correct placement of specimens of this taxon had been complicated by the inclusion of another, partly co-extensive, undescribed taxon, described below as *P. betulina* subsp. *actensis.*

Notes

The distinctions between *P. andromedifolia* subsp. *confusa* and subsp. *andromedifolia* are outlined in the key below. *Pomaderris betulina* subsp. *actensis* (described as new below), which had in the past been confused with this taxon, differs in having virtually sessile, apetalous flowers (rarely some flowers with 1 or 2 small petals), and leaves lacking any simple hairs on the abaxial surface.

Key to subspecies of P. andromedifolia

1. Nerves and internerves on abaxial surface with straight, appressed or semi-appressed simple hairs, often appearing silky; bracts of inflorescence usually deciduous before anthesis ....subsp. *andromedifolia*

1. Nerves and internerves with spreading, curved to flexuose simple hairs; bracts of inflorescence persisting until anthesis ....subsp. *confusa*

Pomaderris betulina A. Cunn. subsp. ***actensis*** N.G. Walsh & F. Coates, subsp. nov.

Differt a subspecie typica sepalis longioribus, foliis nervis lateralibus impressis leniter modo, marginibus recurvatis non vel vix.

Type: Australian Capital Territory, slopes near lower Gibraltar Ck, *P. Gilmour 5926*, 30.x.1986 (holotype CANB; isotype MEL).

Pomaderris sp. A *sensu* S.W.L. Jacobs & J. Pickard, *Pl. New South Wales* 185 (1981) *p.p.*; G.J. Harden, *Fl. New South Wales* 1: 362 (1990) *p.p.*

Shrub 1–4 m high. Young stems with dense, rusty stellate hairs. *Leaves* narrow-obovate, elliptic or obovate to oblong, 15–40 mm long, 8–22 mm wide; base cuneate; margins entire, plane to recurved; apex obtuse; adaxial lamina glabrous, smooth, lateral veins not or slightly impressed; abaxial lamina densely pubescent with greyish stellate hairs (occasionally a few scattered stalked rusty hairs); veins clearly visible; petiole 3–11 mm long. Stipules narrow-triangular, acute to acuminate, 2–3 mm long, deciduous. *Inflorescence* a panicle of several globular clusters of c. 10–20 flowers, terminal, 2–8 cm long, 2–4 cm wide; bracts persisting until (and usually beyond) anthesis; pedicels 0–1.5 mm long. *Flowers* cream; externally pubescent with medium to dense, loosely appressed to spreading, white or occasionally rusty simple hairs over dense, white or greyish stellate hairs (indumentum sparser on sepals than hypanthium); hypanthium 1.2–1.5 mm in diameter, 1–1.5 mm long; sepals 2–2.5(–3) mm long; petals usually absent, occasionally 1 or 2 (to 2 mm long) in some flowers; stamens 2–2.5(–3) mm long; anthers 1.2–1.5 mm long; ovary inferior, simple-pubescent; style glabrous, 1.5–2(–2.5) mm long, branched in upper to middle third. *Fruit* 3–4 mm long, brown, obovoid; apex obtuse; torus c. equatorial; operculum c. half pyrene length (sometimes poorly developed); seed 1.5–2 mm long. (Fig. 3m–n)

Representative Specimens (23 specimens examined)

NEW SOUTH WALES: Southern Tablelands, Burrinjuck, *E. Gauba s.n.*, 15.x.1952 (CANB). AUSTRALIAN CAPITAL TERRITORY: Paddys River, *E.M. Canning 5042*, 18.viii.1981 (CANB, MEL); near Gibraltar Creek, about 3 km ENE of Woods Reserve, *P. Gilmour 5936*, 30.x.1986 (MEL); 2.3 km N of Deadmans Hill, rocky knoll west of Bushfold Flat, *E. M. Canning 6654A*, 16.xi.1990 (MEL, NSW, CANB).

Distribution and Conservation Status

Occurs in the Australian Capital Territory at Gibraltar Creek, Paddys River, and Mts Tennent and Tharwa, and near the border with New South Wales at Burrinjuck. Conservation Code (Briggs and Leigh 1989) 2R.

Habitat

Shrubland, riparian scrub, woodland, and forest associated with rocky ridges, cliff lines and dry gullies; soils skeletal or shallow, derived from sediments or granite. Altitude range 500–1220 m.

Phenology

Flowers: October. Fruits: November–December.

Etymology

From the acronym for the Australian Capital Territory from where virtually all specimens have been collected.

Notes

Distinguished from the typical subspecies by features outlined in the key below. See also notes following the description of *P. andromedifolia* subsp. *confusa* (above).

Key to subspecies of P. betulina

1. Sepals 1.5–2 mm long; leaves with secondary veins strongly impressed above, margins usually distinctly recurved .... subsp. *betulina*
1. Sepals 2–2.5(–3) mm long; leaves with secondary veins hardly impressed above, margins not or hardly recurved .... subsp. *actensis*

Pomaderris ligustrina Sieb. ex DC. subsp. ***latifolia*** N.G. Walsh & F. Coates, subsp. nov.

Differt a subspecie typica foliis ovatis late vel subrotundatis (sub bis longioribus quam latioribus) et sepalis longioribus.

Type: New South Wales, Gibraltar Ra. National Park, c. 67 km E of Glen Innes, on the Gwydir Highway, *R. Coveny 2210*, 2.x.1969 (holotype NSW; isotypes BRI, W).

Shrub 0.4–4.5 m high. *Young stems* densely greyish stellate-pubescent, with scattered long simple hairs, but becoming glabrous by the second year of growth. *Leaves* broad-ovate to suborbicular, 17–30 mm long, 10–20 mm wide; base obtuse; margins entire, weakly recurved; apex broadly acute or obtuse; adaxial lamina glabrous, lateral veins slightly impressed; abaxial lamina villous with spreading golden to rusty simple hairs above fine whitish stellate hairs; lateral veins clearly visible but exceeded by the simple hairs; petiole 3–10 mm long. *Stipules* ovate, 2–4 mm long, acuminate, deciduous. *Inflorescence* a narrow panicle, 1–5 cm long, 1–3 cm wide, comprising several loose globular clusters each of c. 10–30 flowers, terminal and upper axillary; bracts deciduous; pedicels 1.5–2.5 mm long. *Flowers* cream; externally villous with longer grey or yellowish simple hairs over fine stellate hairs; hypanthium c. 1 mm in diameter, 0.8–1 mm long; sepals 1.5–2 mm long; petals absent; stamens c. 1.5 mm long; anthers 0.5–0.7 mm long; ovary inferior, summit villous; style glabrous, 1–1.5 mm long, branched near base. *Fruit* 3–3.5 mm long, ellipsoid; apex obtuse; torus c. equatiorial; operculum c. half pyrene length; seed c. 1.5–2 mm long. (Fig. 3o–p)

Representative Specimens (4 specimens examined)

QUEENSLAND: Ballandean National Park, *M.S. Clemens*, xi.1944 (BRI). NEW SOUTH WALES: Pheasant Mountain, 25 miles (40 km) NE of Guyra, *H.J. Wissmann*, x.1971 (NE).

Distribution and Conservation Status

Localised in granite country in south-eastern Queensland near Stanthorpe and north-eastern New South Wales east of Glen Innes. Known from only four collections, the most recent being 1971. It is unquestionably rare but further surveys are required to ascertain if it is threatened. Conservation Code (Briggs and Leigh 1989) tentatively 2R.

Habitat

Ecological notes on the type specimen suggest a damp situation (perhaps a gully or slope above a watercourse), with associated species including *Acacia irrorata*, *Calochlaena* (*Culcita*) *dubia* and *Gahnia* sp. Soil is likely to be derived from granite. Altitude range 800–900 m.

Phenology

Flowers: October. Fruits: November.

Etymology

From Latin, meaning broad-leaved, referring to the trait most readily separating subsp. *latifolia* from the typical subspecies.

Notes

Distinguished from subsp. *ligustrina* by features outlined in the following key.

Key to subspecies of P. ligustrina

1. Leaves lanceolate to narrow-elliptic, more than twice as long as wide; margins usually distinctly recurved; sepals 0.8–1.4 mm long .... subsp. *ligustrina*

1. Leaves broad-ovate to suborbicular, less than twice as long as wide; margins plane to weakly recurved; sepals 1.5–2 mm long .... subsp. *latifolia*

Pomaderris elliptica Labill. var. ***diemenica*** N.G. Walsh & F. Coates, var. nov.

Differt a varietate typica indumento grossiori, sepalis et petalis longioribus.

Type: Tasmania, Mt Stronach, 4 km E of Scottsdale, *A. Moscal 3528*, 15.x.1983 (holotype HO; isotype MEL).

Shrub 1–4 m high. *Young stems* with dense, rusty stellate hairs. *Leaves* ovate, 35–100 mm long, 20–45 mm wide; base obtuse (rarely cordate); margins entire, plane; apex acute or obtuse; adaxial lamina glabrous; abaxial lamina densely pubescent with white,-greyish or yellowish stellate hairs, sometimes with scattered larger, rusty hairs (c. 0.5 mm in diameter), lateral veins and midrib clearly visible, densely stellate pubescent with longer rusty, comb-like hairs, frequently with sparse, very short, rusty, simple hairs; petiole 8–15 mm long. *Stipules* narrow-ovate, 4–7 mm long, acute, deciduous. *Inflorescences* many-flowered, pyramidal or hemispherical, terminal, 4–10 cm long and wide; bracts caducous; pedicels c. 3 mm long. *Flowers* yellow; externally densely pubescent with white or greyish (rarely rusty) stellate hairs (occasionally with a few very short, sparse simple hairs); hypanthium c. 1 mm in diameter, 1.5 mm long; sepals 2.2–2.8(–3.2) mm long; petals 2–2.5 mm long, spathulate or cordiform; stamens 2–2.5 mm long; anthers c. 1–1.4 mm long; ovary semi-inferior, summit stellate-pubescent; style glabrous, 1.5–2 mm long, slightly lobed, or branched in upper third. *Fruit* obovoid or ellipsoid, 3–4 mm long; apex obtuse (sometimes shortly beaked); torus c. equatorial; operculum c. half as long as pyrene; seed c. 2 mm long. (Fig. 3q–s)

Representative Specimens (34 specimens examined)

TASMANIA: Stumpys Bay, *A. Moscal 3528*, 15.x.1983 (HO, MEL); mouth of Derwent R., South Arm Rd at Gellibrand Rd, c. 4.5 km E of South Arm, *A.E. Orchard 5023*, 9.x.1978 (HO).

Distribution and Conservation Status

Endemic in Tasmania. Widespread but scattered, occurring in the east from near Hobart to Cape Barren Island. Conservation Code (Briggs and Leigh 1989) 3RCat.

Habitat

Scrub and open forest, frequently in damp places but also drier, rocky sites. Altitude range 10–500 m.

Phenology

Flowers: September–October. Fruits: November–December.

Etymology

The epithet refers to the taxon's restricted occurrence in Tasmania (van Diemens Land).

Notes

Distinguished from the typical variety by characters outlined in the key below. It is also close to *P. intermedia* Sieb. ex Fenzl and *P. pilifera* N.A. Wakef. (both occurring in Tasmania), but distinguished from both of these by the general absence of simple hairs. However, some plants have extremely short, sparse simple hairs on the sepals and leaf abaxial midvein. More particularly it differs from *P. intermedia* by the complete absence of simple hairs in the internerve area on the leaf abaxial surface, and from *P. pilifera* by the generally larger leaves and flowers.

Key to varieties of P. elliptica

1. Leaves ± evenly and minutely stellate-pubescent beneath (stellae to c. 0.2 mm in diameter); sepals 1.5–2 mm long, lacking simple hairs; petals 1.5–2 mm long; New South Wales to Tasmania .... var. *elliptica*
1. Leaves with sparse simple hairs along midvein and/or scattered larger stellate hairs (to c. 0.5 mm in diameter) on midvein or internerves beneath; sepals 2–2.8 mm long, sometimes with sparse, short, appressed simple hairs; petals 2–2.5 mm long; endemic in Tasmania .... var. *diemenica*

New Combination

Pomaderris phylicifolia Lodd. ex Link subsp. ***ericoides*** (Maiden & Betche) N.G. Walsh & F. Coates, comb. nov.

Pomaderris phylicifolia var. *ericoides* Maiden & E. Betche, *Proc. Linn.* Soc. *New South Wales* 29: 737 (1905).

Type: New South Wales, Mongarlowe near Braidwood, *W. Baeuerlen*, xi.1898 (lectotype here selected, NSW; isolectotype MEL).

Remaining Syntypes

NEW SOUTH WALES: Tantawangelo Mountain, *J.H. Maiden*, xii.1896 (NSW); Barbers Ck, *H.J. Rumsey*, x.1898 (NSW); Mt Kosciusko, *J.H. Maiden and W. Forsyth*, i.1899 (NSW); Mt Wilson, *J. Gregson*, x.1890 (NSW).

Notes

The Baeuerlen specimen was chosen as lectotype above the others (although all are representative), because it is the only one for which a duplicate at another institution has been found.

Pomaderris ericifolia Hook. has often been regarded as a synonym for *P. phylicifolia* subsp. *ericoides* (e.g. Moore 1961; Chapman 1991; Willis 1973), but examination of the type of *P. ericifolia* at K shows it to belong to a narrow-leaved form of *P. phylicifolia* subsp. *phylicifolia* (see typification for *P. phylicifolia* below). Both (relatively) broad- and narrow-leaved plants of subsp. *phylicifolia* often grow in the same area. Subsp. *phylicifolia* and *ericoides* are generally allopatric, with the latter restricted to montane or subalpine areas, but they are known to occur together in the Wulgulmerang area of Victoria, and may also both occur in areas of the Southern Tablelands of New South Wales (imprecise geographical details on specimen labels makes the latter assertion difficult to prove). The two subspecies are distinguished by characters given in the following key.

Key to subspecies of P. phylicifolia

1. Leaves narrow-ovate to narrow-obovate, 6–15 mm long, 1–6 mm wide; margins recurved to revolute but not entirely obscuring lower lamina ....subsp. *phylicifolia*
1. Leaves linear, 3–8 mm long, 0.75–1.25 mm wide; margins revolute, entirely obscuring lower lamina ....subsp. *ericoides*

Typification

Pomaderris betulina Cunn. ex Hook., *Curtis's Bot. Mag.* 60: t. 3212 (1833).

Type: hort. Kew, Herb. Hooker, *s.d.* (lectype here selected, K).

The figure in *Curtis's Bot. Mag.* is of a flowering branch. The accompanying protologue indicates that the species was 'introduced to the Royal Gardens at Kew, whence flowering specimens were ... communicated ... in April, 1832'. There are two sheets from Hooker's herbarium at K annotated as having been grown at Kew; one is a flowering branch, the other a branch in bud. The former is preferred as matching the protologue.

Pomaderris discolor (Vent.) Poir. in Lam., *Encycl. Mèth. Bot.* 8: 591 (1808). *Ceanothus discolor* Vent., *Jard. Malm.* t. 58 (1804).

Type: cultivated at Malmaison, France (lectotype here selected, G 8129 (herb. Ventenat); ?isolectotype FI).

Although G 8129 consists of separate branchlets in bud, flower and fruit (and doubtfully collected simultaneously), each is unmistakably *P. discolor*, and all elements are represented in both the figure (by P.J. Redoute) and description in *Jard. Malm.* The whole sheet is therefore chosen as lectotype. A possible isolectotype is a fragment in bud (of the same degree of maturity as the branchlet on G 8129) pinned to the lower left corner of the type sheet of *P. elliptica* Labill. at FI (photo seen only).

Pomaderris forrestiana F. Muell., *Fragm.* 9: 139 (1875).

Type: Western Australia, Point Dover, *Forrest* (lectotype here selected, MEL 55212).

Two localities, Point Dover and Port Eucla (both Forrest collections) are given in the protologue for *P. forrestiana* and these are matched by syntype specimens at MEL. Of these, the Point Dover one is the more complete, with several intact budding inflorescences and is therefore nominated as the lectotype. The remaining syntype (Port Eucla, MEL 55213) is fragmentary, with two near-naked twigs and a bag of leaf fragments and few buds and flowers. A sheet at K labelled 'Port Eucla, com. 10/(18)84, no collector indicated' (photo sent as possible type), in full flower is unlikely to be of the same gathering. It is uncertain whether the 'com.' date refers to the date of collection or communication to K, but it seems likely that it was collected later than the date of description of the species and is not regarded as a type.

Pomaderris obcordata Fenzl, *Enum. Pl. 23* (1837).

Type: N. Holl., *Ferd Bauer* (lecotype here selected, W).

Trymalium bilobatum F. Muell., *Defin. Austral. Pl.* 41 (1855); *Trans. Philos. Soc. Victoria* 1: 121 (1855).

Type: Port Lincoln, Wilhelmi (lectotype here selected, MEL 55371; isolectotype W).

Trymalium biauritum Reissek, *Linnaea* 29: 281 (1857). *Pomaderris biaurita* (Reissek) F.Muell (as '*biauritum*'), *Fragm.* 3: 73 (1862).

Type: Austral. merid., *F.Mueller* (lectotype here selected, W).

The type sheet of *P. obcordata* consists of four twigs (1 flowering, 2 sterile, 1 fruiting). The two sterile twigs have rather long internodes like the flowering one and are likely to be part of the same collection. The fruiting specimen has distinctly shorter internodes. All twigs are genuine *P. obcordata.* Accompanying the specimens are two labels; one has 'P. obcordata Fenzl, N. Holl. (Ferd. Bauer)' (i.e. agreeing with the protologue) and is mounted in the lower left corner below the flowering twig; the other, mounted closest to the fruiting specimen at lower right, has '*Trymalium bilobatum* Ferd. Mueller, Port Lincoln proper, legit. Carl Wilhelmi, exam. Dr Ferd. Mueller'. As the protologue for *P. obcordata* describes floral but not fruiting characteristics, it follows that the flowering (and probably sterile) twigs belong with the adjacent label (i.e. the Bauer label). These elements form the lectotype. The remaining material (i.e. fruiting twig and label at lower right) is of material forwarded by Mueller to Reissek at W and subsequently mounted with the Bauer collection. It is almost certainly part of the same collection as the sole specimen at MEL labelled by Mueller as *Trymalium bilobatum.*

The protologue of *T. bilobatum*, emphasises fruiting, not flowering, characteristics, so it appears the MEL and W material are appropriately regarded as lectotypes of that name. *Trymalium bilobatum* is here reduced to a synonym of *P. obcordata.*

The only type sheet of *Pomaderris biaurita* (another synonym of *P. obcordata*) to have been located is housed at W. It forms part of the Plantae Muellerianae collection, and is annotated in Reissek's hand. It is designated as the lectotype.

Pomaderris phylicifolia Lodd. ex Link, *Enum. Pl. Hort. Reg. Berol.* 1: 252 (1821).

Type: 'native of New Holland', t. 120 in *Lodd. Bot.Cab.* 2 (1818).

Pomaderris ericifolia Hook., *J. Bot.* 1: 257 (1834). *Pomaderris phylicifolia* var. *ericifolia* (Hook.) L.B. Moore in H.H. Allan, *Fl. New Zeal.* 1: 423 (1961).

Type: Tasmania, Van Dms Land 1833, *Mr Gunn* (lectotype here selected, K (Herb. Hooker) *p.p.*).

Despite searches at several European herbaria (including BR, CGE, FI and K where G. Loddiges specimens have been located), no specimens in herbaria were detected to typify *P. phylicifolia*. The illustration of the species in *Loddiges Botanic Cabinet* is sufficient for identification, so has been chosen as the lectotype. A specimen at G (DeCandolle 2: 34, no 9, hort. Kew) of *P. phylicifolia* is dated 12.vi.1819, i.e. after Loddiges' publication, so is not a type but confirms that the species was in cultivation in Britain at the time, reinforcing the identity of Loddiges' illustration.

The type sheet of *P. ericifolia* (a synonym of *P. phylicifolia*) consists of five pieces. All are *P. phylicifolia*, but two are in bud and three in flower. Several annotations on the sheet ('Mr Gunn 1833, Van Dmns Land', 'N. Zealand, Dr Logan', 'Mersey River 231/1842' — the latter a Gunn label) further suggest the material is not of the one gathering. Two substantial flowering stems on the lower left of the sheet are separated by the first annotation given above, and are the preferred pieces for typification. The other, smaller, flowering twig is of a form with less villous indumentum on the young stems and is unlikely to have been collected from the same population as the larger flowering pieces. It is therefore rejected as part of the lectotype as are the two twigs in bud. These presumably relate to the other annotations on the sheet, but it is not possible to be certain to which each refers.

Pomaderris prunifolia A. Cunn. ex Fenzl, *Enum. Pl.* 22 (1837).

Type: New South Walse, interior beyond Bathurst Ranges, *A. Cunningham*, 1822 (lectotype here selected, W *p.p.*).

The type sheet at W contains one flowering stem (mounted on the right of the sheet) and one fruiting stem (mounted to the left). These could not be from the same gathering. As the protologue describes floral characters only, the flowering specimen has been chosen as the lectotype. Three sheets at K have been regarded as types of *P. prunifolia*. Two of these are of fruiting specimens, one labelled '*P. betulina* ... Bathurst Dec 1825' (this separated from a mixed collection), and the other '*Pomaderris* sp., *P. elliptica* Labill. *aff.*, ranges of granite N from Bathurst' and are related to Cunningham's manuscript (entries on pp. 91 and 122, R. Melville *in sched.*). The third is a flowering specimen with the label '*Pomaderris betulina* roadside near Liverpool' and annotated '?coll. 1818' (later annotated by Hooker as *P. prunifolia*). The collector is not given, but the handwriting appears to be that of Cunningham. The three K sheets are unlikely to have been seen by Fenzl and none has been named by Cunningham as *P. prunifolia*. These are rejected as types.

Pomaderris nitidula (Benth.) N.A. Wakef., *Victorian Naturalist*, 68: 142 (1951). *Pomaderris phillyreoides* var. *nitidula* Benth., *Fl. Aust.* 1: 418 (1863).

Type: Queensland, Mt Lindsay, *W. Hill* (lectotype K; isolectotype MEL, *fide* N.A. Wakefield, *Victorian Naturalist* 68: 142 (1951)).

In making the new combination for, and lectotypifying, *P. nitidula*, Wakefield had the choice of selecting from 2 syntypes listed by Bentham, viz Mt Lindsay, *W. Hill*, and New England, *C. Stuart*. He chose the former and selected a specimen (a single leaf!) removed from a sheet at MEL and forwarded to K as the lectotype, the MEL sheet then being the isolectotype. The remaining syntype for Bentham's variety, i.e. Mt Lindsay, *W. Hill*, of which there are two sheets at MEL, is of *P. argyrophylla* subsp. *graniticola* described as new in this paper, and is therefore not to be regarded as part of the type of Wakefield's *P. nitidula*.

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Muelleria 10: 57–61 (1997)

Notes on *Callistemon* in East Gippsland, Including the Description of *C. genofluvialis* sp. nov.

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Abstract

Callistemon genofluvialis W. Molyneux is described and illustrated. Its relationship with *Callistemon sieberi* F. Muell., *C. pallidus* (Bonpl.) DC. and *C. forresterae* W. Molyneux is discussed. Further information is provided about the recently described species *C. forresterae* W. Molyneux and *C. kenmorrisonii* W. Molyneux, and about *C. subulatus* Cheel.

Introduction

When I described *Callistemon forresterae* Molyneux from the Genoa River (Molyneux 1993), I indicated that other taxa awaited further investigation in this region. One of these taxa is now described.

Callistemon genofluvialis is a rheophytic chasmophytic shrub or chasomophyte (when growing well above normal water levels), and is currently known from a population of c. 10 plants on and above the west bank of the Genoa River, c. 0.5 km downstream of the New South Wales-Victorian border.

Taxonomy

Callistemon genofluvialis W. Molyneux, sp. nov.

Species sine affinitate proxima, sed in habitu et dispositione foliorum *Callistemonem sieberi* et forma localis *Callistemonis pallidus* simulans aliquantum sed ab ambabus floribus rufo-purpureis et ab speciebus aliis foliis olentibus *Eucalypto* differt; a *Callistemone forresterae* in habitu multicauli, ramulis effusis vel cernuis, foliis majoribus et petiolis tortis plerumque, conflorescentiis brevioribus et latioribus, floribus rufo-purpureis differt.

Type: Victoria, East Gippsland, Genoa R., c. 0.5 km downstream of the New South Wales border, 37°15'S, 149° 26'E, on west bank, *W.M. Molyneux and S.G. Forrester s.n.*, xi.1995 (holotype MEL; isotypes BRI, CANB, NSW).

Spreading *shrub*, 2–2.5 m tall, 1.8–2.5 m wide, multi-stemmed from a swollen rootstock; ends of branches weeping, new growth sericeous white soon becoming glabrous, mid-green. *Bark* tight, papery, not dense, with small loose patches. *Leaves* dense or open and irregularly arranged, spreading (up to 60°) to stems, petioles mostly straight, occasionally twisted, upper leaf surface mainly facing stems, lamina flexible, older leaves coriaceous, lanceolate to broadly lanceolate, often asymmetrical, mucronate, (17–)22–48(–80) mm long, (3–)4–6(–8.5) mm wide, mid-vein raised on both surfaces, margins thickened, secondary venation faint but discernible on upper surface, oil glands dark, numerous, obvious on both surfaces, emitting a peppermint-eucalyptus-like aroma when crushed. *Conflorescence* usually distally frondose, mostly drooping or less often horizontal to slightly ascending, 24–66-flowered, 60–105 mm long, 50–68 mm wide, rachis white villous, reducing with age to irregular inclined white patches; bracts deciduous early, chaffy, sericeous on the back, eventually mostly only in the bottom half, convex, broadly subulate, c. 10–15 mm long, 2–4 mm wide. *Perigynium* white villous early, soon becoming less so or irregularly bearded. *Sepals* c. 1.5 mm deep and 1.8 mm wide, chaffy, woolly, margin ciliate. *Petals* c. 4 mm deep and 2.5 mm wide, green, margin irregularly ciliate. *Stamens* 20–30 per flower, 12–19 mm long, not all fertile, red/purple (RHS 58A), anthers red/purple, gland clear, not conspicuous. *Ovary* hoary, obscured, c. 2 mm across, c. 0.5 mm below rim; style nearly straight or variously curved, often very reduced and c. half the length of, or up to c. 10 mm longer, than stamens, reddish-purple, 6–29 mm long, gradually broadening behind the shallowly domed style end. *Fruit* retained for at least 11 years, squat, eventually truncate, 5–6 mm long, c. 6–9 mm wide, closely but not densely packed on stems, orifice c. 2–3 mm wide, 1–1.5 mm deep. (Fig. 1)

All measurements taken from live material in the wild and in cultivation.

Distribution and Habitat

Callistemon genofluvialis is presently known from a population of c.10 plants, limited to the west side of the Genoa River on Ordovician sandstones (Douglas 1974). It

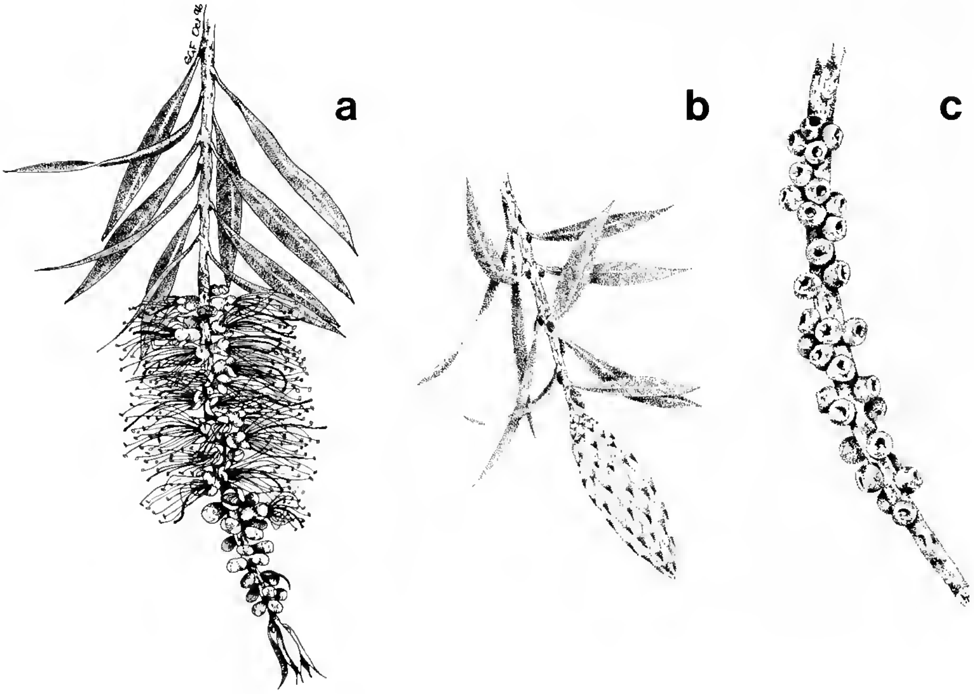

Fig. 1. *Callistemon genofluvialis:* **a** flowering branch, x0.5; **b** bud x0.5; **c** fruiting branch x0.5.

grows both in and well above the water as a chasmophyte, although those plants situated above normal river flow are inundated during periods of high flood. *Callistemon subulatus* Cheel is fairly common in the region, and the plant from which the type of *C. forresterae* was collected grows nearby. Flowers late winter–late spring, sporadically in autumn.

Conservation Status

2V (Briggs and Leigh 1989).

Etymology

The specific epithet alludes to the locality, the Genoa River, from which this taxon was collected.

Notes

While *C. genofluvialis* shares some leaf characters with *C. sieberi*, namely general size range, an often irregular and dense arrangement and an often asymmetry of shape, it differs in habit and trunk number, bark, flower colour and seed capsule. It is similar to *C. pallidus* in that both species have a number of trunks and loose papery bark, but differs in habit, leaf shape and arrangement, and in flower colour. With *C. forresterae* it (occasionally) shares the character of multiple trunks, dark oil glands evident on both leaf surfaces, and filaments in the reddish-purple group, but differs in habit, bark, leaf colour, arrangement and size. Further comparative data is included in Table 1.

Table 1. Diagnostic features of *Callistemon genofluvialis*, *C. sieberi*, *C. pallidus* (regional form) and *C. forresterae*

Character	*C. genofluvialis*	*C. sieberi*	*C. pallidus* (regional form)	*C. forresterae*
Habit	spreading shrub, ends of branches weeping	upright shrub	upright shrub	upright shrub
Height (m)	2–2.5	c. 4	c. 3.5	c. 2
Width (m)	1.8–2.5	1.5–2	c. 1.5	c. 1
Trunks	numerous	mostly single	many	single to few
Bark	tight, papery with small loose patches	hard, interwoven	papery, loose, peeling	tight, papery
Leaf				
Arrangement	often irregular and dense	often irregular and dense	irregular and open	mostly regular and dense
Orientation	to c. 60°	to c. 70°	to 75°	to c. 45°
Length (mm)	17–80 mm	20–80 mm	45–90 mm	22–55 mm
Width (mm)	3–8.5 mm	1.5–9 mm	8–14 mm	2.5–5 mm
Colour	mid-green	grey-green	mid-green	light green
Oil glands	dark, numerous on both surfaces, emitting a peppermint-eucalyptus-like aroma when crushed	absent	numerous on upper surface, emitting an apple-like aroma when crushed	dark, scattered on both surfaces, emitting a light peppermint aroma when crushed
Petiole	mostly straight	straight or twisted	variously twisted	mostly twisted

Table 1. Continued

Character	*C. genofluvialis*	*C. sieberi*	*C. pallidus* (regional form)	*C. forresterae*
Conflorescence				
Orientation	drooping, less often slightly ascending	mainly upright, sometimes ascending	mainly upright, sometimes ascending	upright or ascending, seldom drooping
Length (mm)	60–105 mm	30–50 mm	40–75 mm	60–120 mm
Width (mm)	50–68 mm	25–30 mm	30–45 mm	38–50 mm
Colour	reddish-purple (RHS 58A)	cream, less often pale pink	cream to creamy-yellow	mauve (RHS 66B)
Capsule				
Shape	squat, eventually truncate	squat	compressed	squat, often truncate
Texture	woody	papery	woody	woody
Width (mm)	6–9 mm	4–6 mm	5–6 mm	5–8 mm
Length (mm)	5–6 mm	3 mm	2.5–3 mm	4–6 mm

Discussion

In Molyneux (1995, p. 382), I extended the known range of *Callistemon forresterae* by recording a number of smallish populations in the lower and middle reaches of the Genoa River in East Gippsland. During November 1995, while investigating other sections of the Genoa River in Victoria, and Imlay Creek in New South Wales, further populations of *C. forresterae* were recorded. In all cases, *C. subulatus* was well represented in the area.

The Genoa River population of *C. forresterae* had about 100 plants, erect in habit to c. 1.8 m tall, often intermixed with c. 75 plants of *C. subulatus*, which were (mostly) smaller in habit to 1.3 m tall and wide. Also present were a few of what appeared to be intermediate specimens, both in flower colour, leaf shape and habit; as was a scattering of *C. pallidus* to 2.1 m tall. All were growing in rock, or sand in rock, on the east bank of the river.

On Imlay Creek, below the Wallagaraugh River Track, there is a population of c. 50 *C. forresterae.* Here they are c. 2 m tall and 1 m wide, growing on a rock island in the middle of the river, in association with *C. subulatus*. A number of callistemons here bear further investigation, including the mauve-flowered taxon referred to as *C. pallidus* 'Mauve' in nursery catalogues. Willis (1972) refers to a form with rosy-lilac filaments at the Avon Channels in Gippsland. It also occurs on the Genoa River, and I have collected it elsewhere on the Cann River Highway, and at the Avon Channels.

In Molyneux (1995, p. 379), I named *C. kenmorrisonii* from one population on the Betka River downstream from the Stony Peak Road bridge in East Gippsland. During November 1995, I located a further population of c. 60 plants to c. 1.8 m tall and 2 m wide growing on granite in the Betka River at the Roger Track crossing. This new locality is c. 4.5 km downstream from the type locality. The only other callistemon nearby was *C. citrinus*, which grows in moist sands at the edge of rock bars above the river, and in moist forest nearby. The discovery of this second uniform and substantial population of *C. kenmorrisonii*, as well as the stability indicated through sexual reproduction from the type site, should dispel any doubts that may have existed regarding the status of this species.

Also in Molyneux (1993, p.63), I discussed an incorrect reference in Willis (1973, p. 451) to *C. subulatus* at Nowa Nowa, central East Gippsland. The mistake was mine, not Willis's. In 1995, I located scattered plants of a *Callistemon* taxon in the region with an undoubted affinity to *C. subulatus*. While it bears a resemblance to this species, this taxon, which grows on Boggy Creek, has characters which exhibit considerable differences. Cheel (1925) described the leaves of *C. subulatus* as having a somewhat obscure, slightly channelled midvein on the lower surface. The Boggy Creek taxon has a strongly raised midvein on the lower surface as well as distinct intermarginal veins.

The alignment of leaves of *C. subulatus* has the upper surface more or less facing towards the stem, and in juvenile leaves in particular, distinctly curved backwards from the stem. The petiole of the Boggy Creek taxon is mostly distinctly twisted, causing leaves to be edge-on or distinctly angled to stems. The buds of *C. subulatus* are considerably smaller than the Boggy Creek taxon, and fruits are of a different size and shape. The habit of this taxon is more upright and less spreading than *Callistemon subulatus*, which is often as wide or wider than high.

Future workers on *Callistemon* should check all specimens under *Callistemon subulatus*. Remarks by Cheel (1925) concerning variations in Gippsland specimens may refer to collections of *Callistemon forresterae* (and possibly other species).

Acknowledgments

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Chiloglottis jeanesii (Orchidaceae), a New Species from Victoria

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Abstract

Chiloglottis jeanesii D.L. Jones sp. nov., from Victoria, related to *C. valida* D.L. Jones and *C. chlorantha* D.L. Jones, is described and illustrated. *Chiloglottis jeanesii* can be distinguished by its widely spreading petals, relatively narrow (c. 5 mm wide) column and usually three columnar basal calli on the labellum.

Introduction

Continuing studies into the genus *Chiloglottis* R. Br. (Jones 1991) in south-eastern Australia have revealed the presence of a taxon in southern Victoria which is here described as a new species. This species was at first suspected to be a natural hybrid between *C. valida* D.L. Jones and *C. cornuta* Hook. f. but an isozyme analysis of all three taxa, using leaf material supplied by Jeffrey Jeanes, has shown that this is not the case. As well, my studies have shown that *C. cornuta* is autogamous and unlikely to be involved in hybridisation. Pollination of most species in this genus is by sexual deception and experiments by Bower (1992, 1996) have shown a high degree of pollinator specificity exploiting male flower wasps (Tiphidae: Thynninae). Choice baiting studies on the new taxon have shown that it has a unique pollinator (C. Bower pers. comm.). These data suggest that the morphological novelty of this taxon arose via divergence rather than hybridisation and taxonomic recognition at specific rank is justified.

Methods

This study is based on the examination of fresh flowers collected from localities in south-eastern Australia, examination of dissected flowers mounted on cards, also dried and spirit-preserved herbarium specimens and photographs of living flowers of the taxa involved. Herbarium collections (spirit and dried) were examined from AD, CANB, HO and MEL. Measurements given in the description are from living plants or dissected flowers on cards.

The isozyme banding patterns of leaf portions sampled from populations of *C. valida*, *C. cornuta* and *C. jeanesii* were obtained by Ish Sharma using starch gel electrophoresis. The methods used in this study have been outlined previously (Sharma and Jones 1992).

Taxonomy

Chiloglottis jeanesii D.L. Jones, sp. nov.

Affinis *C. validae* D.L. Jones sed partibus perianthii minoribus (sepalo dorsali ad 20 x 7 mm, sepalis lateralibus ad 17 x 2.5 mm; petalis ad 16 x 3 mm), petalis late patentibus; callis basalibus columnaris 3, et columna multo angustiore, differt; etiam *C. chloranthae* D.L. Jones affinis sed callis basalibus columnaris paucioribus (plerumque 3), differt.

Type: Victoria, Toorongo, *C. Bower (Jones 13809)*, 14.i.1995 (holotype CANB, isotypes AD, BRI, MEL, NSW).

Chiloglottis sp. aff. *valida sensu* Backhouse & Jeanes, *Orchids of Victoria* 137 (1995); *Chiloglottis* sp. A *sensu* Entwisle, *Fl. Victoria* 2: 747 (1994).

Illustration: Backhouse and Jeanes, *Orchids of Victoria* 137 (1995).

Terrestrial tuberous herb forming colonies. *Leaves* broadly elliptical, 5–7 cm long, 2–3 cm wide, dark green above, paler beneath, with prominent veins, entire; petioles 8–18 mm long. *Peduncle* 3–5 cm long, green to brownish, fleshy. *Fertile bracts* elliptical-lanceolate to obovate-lanceolate, acuminate, 15–20 mm long, 7–10 mm wide, closely sheathing, acuminate. *Pedicel* 15–20 mm long, very slender. Ovary c. 10 mm long, green. *Flower* solitary, 25–30 mm across, green to dark purplish brown, with shiny black labellum calli. *Dorsal sepal* obovate, 17–20 mm long, 7–9 mm wide, erect, incurved close to the column; osmophore c. 1.3 mm long, linear-terete, tapered. *Lateral sepals* narrowly linear-tapered, 14–17 mm long, c. 2 mm wide, broadest near the base then tapered to the apex, projected forwards beneath the labellum, more or less parallel; osmophore c. 1 mm long, linear-filiform, green. *Petals* narrowly lanceolate, 13–16 mm long, c. 2.3 mm wide, falcate, acute, widely divergent, curved upwards towards the apex. *Labellum* articulated on a short claw c. 0.7 mm long, tremulous; lamina ovate-cordate in outline, 10–13 mm long, 9–12 mm wide, entire, often with a light marginal band. *Lamina callus* occupying the central proximal half of the ventral surface area, the calli shiny black; major central gland c. 2.5 mm long, linear-terete, columnar, obtuse, erect, curved apically, this flanked by 2 similar, but shorter, calli; distal to these 3 basal calli are 3 or 4 pairs of short, irregular calli; distal gland more or less quadrate, c. 1 mm across, sessile. *Column* incurved, 12–15 mm long, 5–6 mm wide, green to brown, with reddish flecks and irregular markings on the anterior surface; wings c. 2.3 mm broad, extending above the anther, subacute. *Anther* c. 2.2 mm long, c. 2 mm, smooth, with a short rostrum, yellow. *Pollinia* boomerang-shaped, c. 2.7 mm long, yellow, mealy. *Stigma* ovate-elliptical, c. 2.2 mm across. *Capsule* obovoid, 10–12 mm long, 5–6 mm wide, on a swollen pedicel c. 15 cm long. (Fig. 1)

Distribution

Endemic in southern Victoria where restricted to montane habitats of the Eastern Highlands between the Sherbrooke Forest and the Baw Baw Plateau.

Ecology

Occurs in tall wet sclerophyll forest dominated by *Eucalyptus regnans* F. Muell. or *E. obliqua* L'Hérit and cool temperate rainforest dominated by *Nothofagus cunninghamii* (Hook.) Oerst. Soils are well-structured clay loams, often krasnozems. Altitude range 800–1500 m. Flowering November–January.

Recognition

This species has similarities to both *C. valida* and *C. chlorantha*. It can be distinguished from *C. valida* by its smaller perianth parts (dorsal sepal to 20 mm long

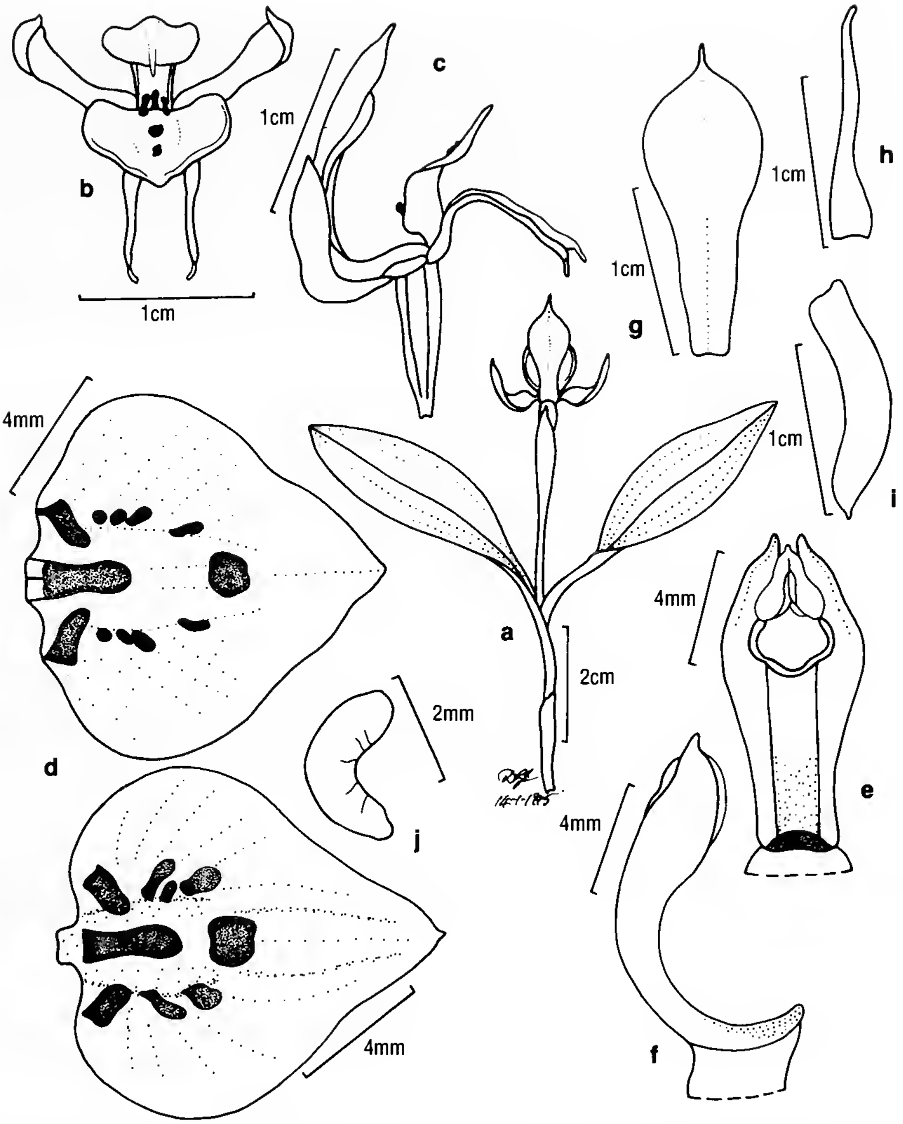

Fig. 1. *Chiloglottis jeanesi* (*Jones 13809*): **a** plant habit; **b** flower from front; **c** flower from side; **d** two labella, flattened out; **e** column from front; **f** column from side; **g** dorsal sepal; **h** lateral sepal; **i** petal; **j** pollinium.

and 7 mm wide cf. to 30 mm long and 17 mm wide; lateral sepals to 17 mm long and 2.5 mm wide cf. to 23 mm long and 11 mm wide; petals to 16 mm long and 3 mm wide cf. to 23 mm long and 11 mm wide), widely spreading petals (incurved close to the labellum in *C. valida*), three columnar basal calli (one in *C. valida*) and a much narrower column (to 5 mm wide cf. 8 mm in *C. valida*). It shares widely spreading petals with *C. chlorantha* but that species has more lamina calli, especially on the labellum base where 5–9 calli may be grouped together in close proximity (usually three in *C. jeanesii*).

Isozymes

Leaves from sympatric populations growing at Toorongo, Victoria of *Chiloglottis cornuta* (*Jones 11254*), *C. valida (Jones 11255*) and *C. jeanesii* (*Jones 11256*) collected by Jeffrey Jeanes in late January 1993 were analysed for seven enzyme systems. All the enzyme systems — isocitrate dehydrogenase (IDM, EC1.1.1.42), uridine diphospho-gluconic pyrophosphatase (UGP, EC 3.4.11.2), gluco-phosphate dehydrogenase (GPI, EC 5.3.1.9), malate dehydrogenase (MDH, EC 1.1.1.37), menadine reductase (MR, EC 1.6.99.2), malic enzyme (ME, EC 1.1.1.82), phosphogluconate dehydrogenase (PGM, EC 2.7.5.1) — were found to be monomorphic. Isozyme banding patterns and migration distances obtained for *C. jeanesii* were identical in all the specimens assayed for all the seven enzyme systems, showing that *C. jeanesii* is not of hybrid origin between *C. valida* and *C. cornuta*.

Pollination

Bower (1996) used three designs of field choice experiments to demonstrate reproductive isolation in eight species of *Chiloglottis* which have a pollination syndrome of sexual deceit involving male thynnine wasps. Multiple choice baiting tests involving *C. valida*, *C. chlorantha* and *C. jeanesii* show that all three species have unique pollinators and that *C. jeanesii* is pollinated by the thynnine wasp *Neozeleboria* aff. *impatiens* (C. Bower pers. comm.). This study will be detailed in a separate paper.

Etymology

It gives me very great pleasure to name this species after Jeffrey Jeanes, botanist and keen photographer. Jeffrey, an Orchidaceae specialist, has assisted my research with specimens, provided constructive criticisms of manuscripts and has brought a number of interesting taxa to my attention.

Conservation Status

Of restricted distribution but locally common and probably overlooked; conserved in the Baw Baw National Park (Backhouse and Jeanes 1995) and the Dandenong Ranges National Park.

Other Specimens Examined

VICTORIA: Sherbrooke Forest, *Bower (Jones 14659)*, 29.xi.1995 (CANB); Toorongo, *Jeanes (Jones 11256)*, 29.i.1993 (CANB).

Acknowledgments

I thank Ish Sharma for carrying out the isozyme analysis on leaf material supplied by Jeffrey Jeanes, and Colin Bower for collecting specimens and for supplying information on pollination vectors. Alex George provided the Latin diagnosis which was modified by Peter Bostock. Mark Clements, Peter Bostock, Laurie Adams, Bob Bates and Jeff Jeanes commented on the manuscript. The Directors of the Australian Orchid Foundation are thanked for their support of field operatives and I thank the Directors of AD, CANB, HO and MEL for allowing me access to specimens. Marion Garratt provided technical assistance.

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Muelleria 10: 69–73 (1997)

Miscellaneous Notes on *Corybas neocaledonicus* (Orchidaceae)

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Abstract

The identity of *Corybas neocaledonicus* (Schltr.) Schltr., endemic to New Caledonia, is established and a full description provided. Its relationship with other members of the *C. aconitiflorus* complex is discussed.

Introduction

While carrying out revisionary research into Australian species of *Corybas*, I extended the studies to encompass related taxa from New Caledonia and New Zealand. Those New Zealand species which have at times been confused with Australian taxa, will be the subject of a separate paper, while *C. neocaledonicus* (Schltr.) Schltr., erroneously recorded from Australia (Gray and Jones 1985), is detailed here. *Corybas neocaledonicus* is part of a complex of taxa surrounding *C. aconitiflorus* Salisb. and this group will be the subject of a separate detailed paper, including keys and illustrations.

Corysanthes neocaledonica Schltr. was described in 1906 based on specimens collected by Rudolph Schlechter in New Caledonia (Schlechter 1906), and was later transferred to *Corybas* (Schlechter 1924). This collection was destroyed when the Berlin Herbarium was bombed during the Second World War. A neotype was selected by van Royen (1983): *McKee 11472* from near Mt Koghi (wrongly recorded by van Royen as being from the Thy Valley) in New Caledonia. *Corybas neocaledonicus* was assumed to be endemic to New Caledonia (Hallé 1977; van Royen 1983) until a taxon, identified as being conspecific, was recorded from Queensland (Gray and Jones 1985).

Fresh flowering material of *C. neocaledonicus* showed that it was distinct from the undescribed Australian taxon previously confused with it by Gray and Jones (1985). This latter species will be described separately in a forthcoming revision of the Australian species. This mixup highlights the inadequacies of relying solely on herbarium material for the identification of species of *Corybas*, which when pressed, commonly end up as blobs with most of the diagnostic characters either lost or masked in the drying process. Live material, spirit specimens and colour transparencies are much more useful for diagnostic purposes.

Because of similarities between *C. neocaledonicus* and some Australian taxa and the confusion that has arisen in the past, it is here described fully and characterised.

Methods

This study is based on the examination of herbarium specimens at P and CANB, together with living plants of *C. neocaledonicus* and other species cultivated in the collection of the Australian National Botanic Gardens, Canberra, and photographs of living flowers. Measurements given in the description are from living plants or spirit-preserved specimens. Notes on habitat were contributed by Mark Clements or derived from herbarium labels.

Taxonomy

Corybas neocaledonicus (Schltr.) Schltr., *Repert Spec. Nov. Regni Veg.* 19: 23 (1924). *Corysanthes neocaledonica* Schltr., *Bot. Jahrb. Syst.* 39: 47 (1907). *Type:* New Caledonia, Southern District, on the summit of Mount Mou near Paita, altitude c. 1250 m, between shrubs and *Xyris, R. Schlechter 14918*, x.1902 (holotype B, destroyed); New Caledonia, Ridge from Chapeau de Gendarme to Mt Koghi, altitude 600 m, *McKee 11472*, 27.iv.1964 (neotype CANB!; van Royen 1983).

Illustration: Hallé, *Fl. Nouvelle Caledonie et Dépendances* 8: pl. 171 (1977).

Terrestrial tuberous herb growing in colonies. *Leaf* cordate to orbicular, 10–36 mm long, 8–32 mm wide, dark green adaxially, secondary veins not conspicuous, light reddish purple and pellucid abaxially, apex apiculate. *Peduncle* c. 1 mm long. *Floral bract* narrowly ovate, 3–4 mm long, 2–2.5 mm wide, closely sheathing, acuminate. *Ovary* straight or incurved, c. 7 mm long, c. 2 mm wide. *Flower* solitary, 10–16 mm long, 5–7 mm wide, commonly dark reddish purple, rarely greyish red. *Dorsal sepal* narrowly oblong-elliptical when flattened, 16–25 mm long, 8–12 mm wide, narrowed at base, curved throughout, concave, margins more or less incurved, apex apiculate, inner surface heavily blotched with dark purplish-red. *Lateral sepals* linear-tapered, 1.3–2 mm long, c. 0.2 mm wide, acuminate, projected upwards against the base of the labellum. *Petals* linear-tapered, 0.6–0.8 mm long, c. 0.25 mm wide, acute, falcate, hidden behind the labellum auricles. *Labellum* much shorter than, and mostly hidden by, the dorsal sepal, wholly dark reddish, sometimes whitish dorsally, a large, dark purple blotch on the inner base; labellum tube c. 3.5 mm long, erect then recurved sharply and expanded into a lamina; lamina narrowly oblong-obovate when viewed from the front, c. 7 mm long, c. 3 mm wide, lacking an anterior pocket, the outer margins folded back, the inner surface with 3 or 4 longitudinal folds or pleats, the lower surface with a few scattered, short, hispid hairs, the margins irregularly crenulate; callus slightly thickened, folded or convoluted. *Labellum* auricles c. 2 mm long, closed, deflexed, whitish, hollow, tapered. *Column* c. 3.5 mm long, semi-erect, broadest at the base (c. 1.5 mm across), minutely winged, with 2 very short basal auricles and a thick, prominent, fleshy, red, pseudo column-foot. *Anther* c. 1.3 mm long, c. 0.8 mm wide, with a very short, blunt rostrum. *Stigma* c. 0.7 mm across, c. 0.5 mm high, rectangular, sunken. *Pollinarium* c. 1 mm long, c. 0.7 mm wide, consisting of 4 pollinia in 2 pairs, attached directly to an oblong viscidium c. 0.5 mm long; pollinia oblong, cream to yellowish, mealy. *Capsule* ovoid, 10–14 mm long, 3–5 mm wide, on an elongated peduncle 10–15 cm long. (Fig. 1)

Distribution

Endemic to New Caledonia.

Ecology

On damp, sheltered slopes in humid forests, growing under shrubs and among moss in loamy soil. Also in dense shade in rainforest with the plants nearly hidden by dead

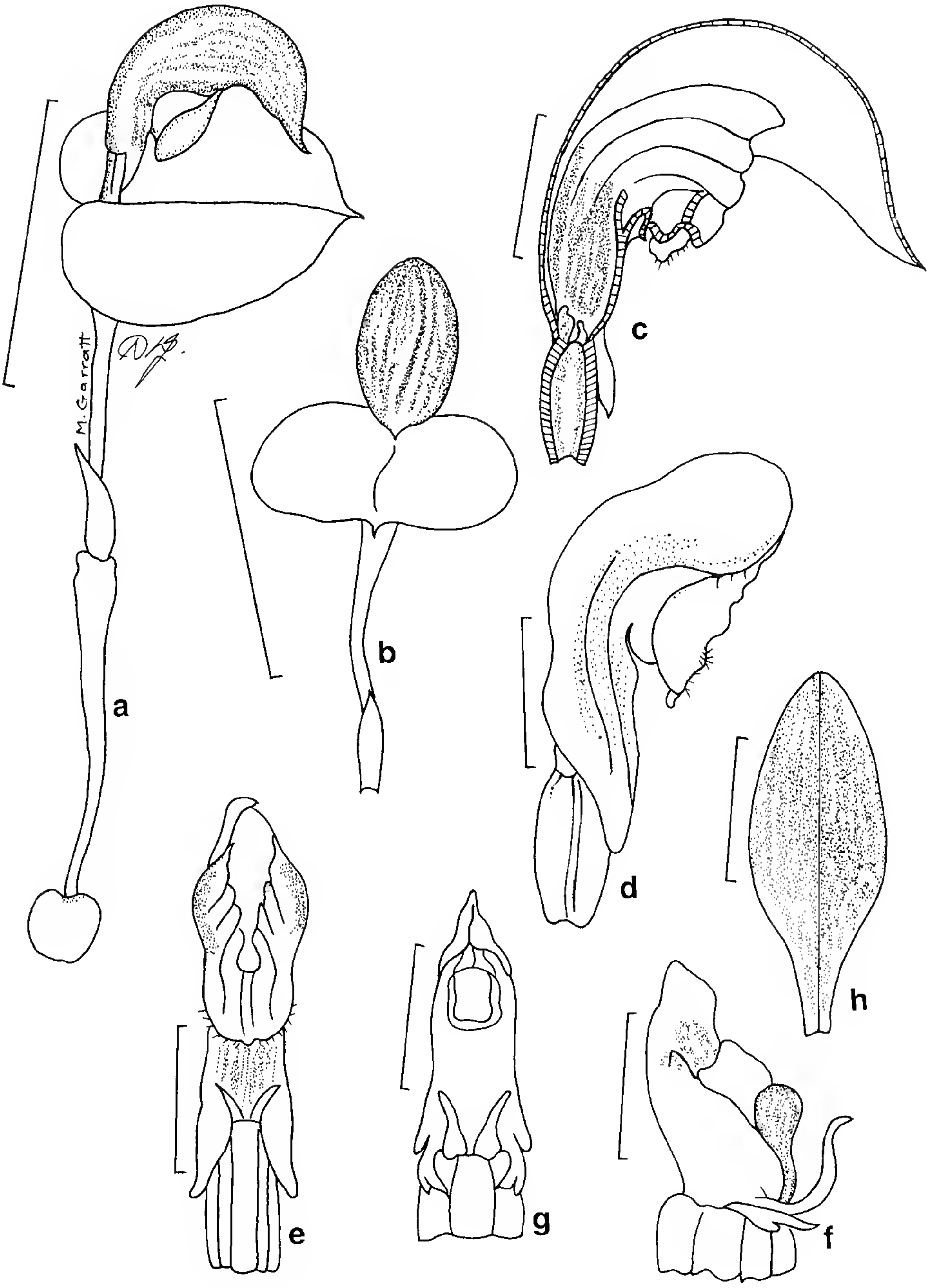

Fig. 1. *Corybas neocaledonicus* (*Clements 7797*): **a** plant habit (flower from side), scale 2 cm; **b** flower from front, scale 2 cm; **c** longitudinal section of flower, scale 5 mm; **d** labellum and ovary from side, scale 4 mm; **e** labellum and ovary from front, scale 4 mm; **f** column from side, scale 2 mm; **g** column from front, scale 2 mm; **h** dorsal sepal (flattened out), scale 1 cm.

leaves and other litter and among low shrubs in damp soil on ridges and mountain summits. Altitude range 100–1250 m. Flowering April–October.

Recognition

This member of the *C. aconitiflorus* complex can be distinguished from all other species by the following combination of features; relatively small (10–16 mm long), usually dark red flowers; a very narrow (c. 3 mm wide), sparsely hispid labellum which lacks an anterior pocket, and has three or four pleats along the inner walls; and, a relatively thin, irregularly folded or convoluted callus.

Similar Species

The undescribed Australian taxon confused with *C. neocaledonicus* (Gray and Jones 1985) can be distinguished by a broader, strongly hispid labellum (5–6 mm wide), lacking any longitudinal pleats or folds and with an anterior pocket. *Corybas aconitiflorus* can be distinguished from *C. neocaledonicus* by its larger (to 28 mm long) flowers which are greyish red to reddish purple and the labellum is covered with short, hispid hairs and lacks any pleats on the inner walls.

Notes

Schlechter (1906), noted that he had found *Corybas* (as *Corysanthes*) leaves in many places during his travels in the Southern District of New Caledonia, but flowers were only found on plants growing at high altitudes. He may have noticed variation in leaves for he stated 'I think it possible or even probable, that several species occur on the island' (Schlechter 1906). Clements *et al.* (1994) also noted variation in *Corybas* leaves at various localities. These conclusions are perhaps not surprising in view of the range of habitats at which collections have been made, viz. lowlands at altitude c. 100 m to mountain tops at c. 1250 m, and on soils derived from such diverse rocks as schists and serpentenites. Flowering times noted on herbarium labels range from April to October, which is extraordinary even allowing for the large range in altitude.

A study of the specimens at P indicates that two taxa of *Corybas* may be present in New Caledonia, a small-flowered, dark red species and a larger-flowered species which has a reddish-purple dorsal sepal with translucent white patches and a white labellum. Neither taxon is a match for the Australian species previously confused with it (Gray and Jones 1985). Leaf size is also distinctive in the New Caledonian plants (Clements pers. comm.) and it is noticeable from herbarium specimens that plants from lower elevations have leaves at least twice as large as those from montane localities. This variation needs to be followed up by future collectors but it also has implications regarding the neotypification of the species.

Typification

Because Schlechter's type material is presumed to have been destroyed during the Second World War, van Royen (1983) selected a neotype (CANB 145223). This collection consists of a single, poorly pressed specimen. Van Royen apparently did not look at the P collections as none has been determined by him. There are four collections in P from Mont Mou (Schlechter's type locality) ranging in altitude from 200 m (*McKee 35447*) to 1150 m (*McKee 36948*). The latter collection would have been a better selection as neotype rather than van Royen's choice which was from a very different locality to Schlechter's and at a much lower altitude (600 m cf. 1250 m). The choice is particularly pertinent when there is a distinct possibility that more than one taxon may occur on the island.

Etymology

Derived from the Latin for New Caledonia.

Specimens Examined

NEW CALEDONIA: Mt Bouo, alt. 700 m, *Guillaumin and Baumann-Bodenheim 12666*, 20.iv.1951 (P,Z); Mont Koghi, road near waterfall, 3.7 km from turnoff, *Clements 7766, Thiriet and Wallace*, 18.viii.1992 (CANB); Mont Do, summit, ridge running E, *Clements 7797, Thiriet and Wallace*, 19.viii.1992 (CANB); Mont Mone, alt. 551 m, *Guillaumin and Baumann-Bodenheim 14828*, 27.vii.1951 (P,Z); Rimbea Valley, above barrage, alt. 100–200 m, *McKee 4544*, 12.v.1956 (P); Mont Koghi, alt. 500 m, *McKee 12501*, 2.v.1965 (P); Coldes Rousettes, alt. 500 m, *McKee 12817*, 23.vi.1965 (P); Mont Koghi, alt. 500 m, *McKee 25173*, 30.iii.1972 (P); Mont Mou, alt. 1100 m, *Mckee 32031*, 26.ix.1976 (P); Mont Mou, west base, alt. 200 m, *McKee 35447*, 15.vii.1978 (P); Mony Mou, alt. 1150 m, *McKee 36948*, 27.v.1979 (P); Mont Oungone, alt. 450 m, *McKee 37012*, 17.vi.1979 (P); Valley de Thy, alt. 100 m, *McKee 39052*, 17.v.1981 (P); Valley de Thy, alt. 200 m, *McKee 42086*, 3 Aug. 1984 (P); Mont Algaoue, alt. 400 m, *McKee 43605*, 14.vii.1987 (P); Thy River Valley, *McPherson 1680*, 6.vi.1979 (MO,P).

Acknowledgments

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Muelleria 10: 75–83 (1997)

A Taxonomic Revision of *Cheirostylis* (Orchidaceae) in Australia

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Abstract

The genus *Cheirostylis* in Australia is revised. Two species are recognised, *C. ovata* (F.M. Bailey) Schltr. and *C. notialis* D.L. Jones sp. nov. *Cheirostylis ovata* has ovate-lanceolate leaves to 50 mm long and 20 mm wide, with a pale median band, freely opening, entogamous flowers to 14 mm long and 10 mm wide, and a functional viscidium. *Cheirostylis notialis* has uniformly green, ovate leaves to 35 mm long and 20 mm wide, cleistogamous or rarely opening, autogamous flowers to 9 mm long and 6 mm wide, and a non-functional viscidium.

Introduction

The genus *Cheirostylis* was described by Blume (1825) based on a single species, *C. montana* Blume, from mountains near Tjanjor in the Parang Province, western Java. Subsequently more than 20 species have been described from regions as diverse as Africa, Asia, South-east Asia, Polynesia, Malesia and Australia.

Cheirostylis belongs in the subtribe Goodyerinae, which includes an assemblage of autotrophic or saprophytic taxa with a terrestrial or epiphytic growth habit. Generic delimitations are not always clear in the subtribe as evidenced by the placement of *C. ovata* (F.M. Bailey) Schltr. in two different genera (Bailey 1896; Schlechter 1911–14) and a synonym being described in *Zeuxine* (Rogers and White 1921). *Cheirostylis* is however distinctive and it belongs in an alliance of genera which have two, well separated stigmata. Overall *Cheirostylis* shares many characters with *Zeuxine* Lindley, but can be distinguished by the absence of roots on the fleshy rhizome, these being replaced by ventral ridges from which masses of rhizoids arise; the sepals being connate basally with the lateral sepals united to form a synsepalum; and, the labellum lamina being deeply divided into two dentate lobes.

The distinctions between some taxa in *Cheirostylis* remain unresolved. No monograph of the genus has been attempted, herbarium material is scanty and often poor, and the circumscriptions of many of the named taxa are brief and unsatisfactory. In Australia one species of *Cheirostylis* is commonly recognised, namely *C. ovata* (Dockrill 1969; Rupp 1969; Clements 1989; Stanley and Ross 1989; Dockrill 1992; Weston 1993), although Maiden and Betche (1896) erroneously recorded *C. grandiflora* Blume as occurring in northern New South Wales. This species, based on a specimen collected by Zippelius in Dutch New Guinea (Blume 1825), is endemic to New Guinea. Maiden and Betche's identification was based on a 'plant collected by Dr W. Finselbach on rocky hills, in a shady locality in the dense scrub on the Richmond River, near Lismore'. Maiden and Betche suggested that this species was 'perhaps identical with *Gastrodia* *ovata* F.M. Bailey' and in the same paper provided an abbreviated translation of Blume's original description of *C. grandiflora*. The species previously confused by Maiden and Betche with *C. grandiflora*, is described here as new.

Cheirostylis also occurs in countries adjacent to Australia, namely Java (Comber 1990), New Guinea (Blume 1825; Schlechter 1911–14), and New Caledonia (Hallé 1977). As deduced from available descriptions, drawings, specimens and photographs, the taxa occurring in these regions are distinct from the Australian species.

Methods

This revision is based on my field collections, specimens collected by field operatives and the examination of herbarium specimens at AD, BRI, L, MEL, NSW and QRS. Floral descriptions are based on fresh specimens or spirit-preserved material.

Description of Genus

Cheirostylis Blume, *Bijdr.* 6: t. 1 fig.1b; 8: 413 (1825). *Type: Cheirostylis montana* Blume.

Epiphytic, epilithic or terrestrial herbs growing singly or in small, loose groups. *Rhizome* prostrate to decumbent, fleshy, irregularly swollen at the internodes, constricted at the nodes, with dense clusters of short, white rhizoids arising ventrally from points of contact with rocks and leaves. *Stem* apical, erect, short. *Leaves* simple, entire, thin-textured, spirally arranged in a loose rosette, often withered at anthesis, petiolate; venation reticulate; petiole sheathing at the base. *Inflorescence* a few-flowered terminal raceme; scape and rachis hairy. *Flowers* small, white, hairy. *Sepals* connate basally, the lateral sepals forming a synsepalum. *Petals* free. *Labellum* lamina bilobed, the narrow base developed into a shallow sac containing calli. *Callus* elongate, with or without apical swellings. *Column* small, with elongate stigmatic arms and rostellum. *Anther* dorsal. *Pollinia* 4, elongate, attached to an elongate stipe.

Etymology

(Greek) *cheir* = hand, *stylis* = style; in reference to the lobed apical margins of the clinandrium which resemble a hand.

Taxonomic History

Cheirostylis was first recorded from Australia by Maiden and Betche (1896) who wrongly identified material collected in northern New South Wales as *C. grandiflora* Blume (see introduction). Bailey (1896) described *Gastrodia ovata* from near Cairns, and Schlechter (1911), realising its erroneous generic placement, transferred it to *Cheirostylis*. In the same year *Zeuxine attenuata* was described from specimens collected near Mackay (Rogers and White 1921). *Zeuxine attenuata* is a taxonomic synonym of *Cheirostylis ovata*.

Key to Australian species of *Cheriostylis*

1. Leaf dark green with a pale median band, flowers opening freely, 10–14 mm long .... 1. *C. ovata*
1. Leaf uniformly dark green, flowers mostly cleistogamous, 5–9 mm long........................ 2. *C. notialis*

1. *Cheirostylis ovata* (F.M. Bailey) Schltr., *Bot. Jahrb. Syst.* 45: 394, in obs. (1911); *Gastrodia ovata* F.M. Bailey, *Bot. Bull. Dept. Agric. Queensland* 14: 13 (1896). *Type:* Queensland, Mountain Ra., near Cairns, *L.J. Nugent* (holotype BRI, not found); Queensland, Russell River, below the First Combo, *R.L.Jago 466*, 23.viii.1981 (neotype here selected, QRS 65146).

Zeuxine attenuata R.S. Rogers & C.T. White, *Proc. Roy. Soc. Queensland* 32: 123–4, fig. 2 (1921). *Type:* Queensland, Mackay, 13.ix.1895, *L.J.Nugent* (holo BRI!).

Illustration: Lavarack and Gray, *Australian Tropical Orchids* 14, top plate (1992).

Rhizome 4–10 mm in diameter. *Stem* 1–2 mm in diameter. *Leaves* 4–7; petioles 5–12 mm long, 2–3 mm wide, channelled, sheathing at the base; lamina ovate-lanceolate, 25–50 mm long, 12–20 mm wide, dark green, dull, with a light band along the midrib, apex acute to acuminate. *Inflorescence* 10–25 cm tall, slender, 1–6-flowered. *Sterile bracts* 3 or 4, ovate-lanceolate, 13–21 mm long, 5–6 mm wide, closely sheathing, acuminate. *Fertile bracts* ovate-lanceolate, 5–15 mm long, 3–5 mm wide, closely sheathing, acuminate. *Pedicels* 3–10 mm long, slender, semi-erect, hairy. *Ovaries* narrowly obovoid, 4–8 mm long, 2–4 mm wide, constricted near the apex. *Flowers* white, 10–14 mm long, 9–10 mm wide. *Dorsal sepal* ovate-lanceolate, 7–8 mm long, 4–4.5 mm wide, porrect proximally where connate with the lateral sepals, erect to suberect in the distal half, apex obtuse. *Synsepalum* 7–8 mm long, 4.5–5 mm wide, porrect, the lobes obtuse, divaricate, c. 3 mm apart at the tips. *Petals* narrowly linear-oblong, 7–8 mm long, 2–2.5 mm wide, slightly falcate, obliquely erect, divergent, apex obtuse. *Labellum* porrect to obliquely deflexed, 12.5–14 mm long, c. 9 mm wide; labellum base 5–5.5 mm long, 2.5–2.8 mm wide, channelled, base saccate, bearing 1–3, irregularly lobed calli, c. 1 mm long; lamina deeply bilobed, each lobe more or less oblong-cuneate, 5–6 mm long, 3–4.5 mm wide, divergent, 5–6 mm apart at the apex, the anterior margins irregularly lobed, all margins minutely denticulate. Callus elongate, with two small, apical swellings. *Column* 4.5–5 mm long, c. 2.5 mm wide. *Stigma arms* c. 3.5 mm long, obliquely erect to porrect. *Rostellum* elongate. *Anther* ovate, c. 1.3 mm long, c. 1.5 mm wide, brown, with a slender rostrum. *Pollinarium* c. 3.5 mm long; viscidium elliptic, 0.7 mm long; stipe ligulate, c. 10 mm long; pollinia linear clavate, 1.5–1.8 mm long, white, mealy. *Capsules* narrowly obovoid, 7–10 mm long, 4–5 mm wide, suberect to erect. (Fig. 1)

Distribution

Endemic to north-eastern and central-eastern Queensland (Iron Range to Eungella) (Fig. 2).

Ecology

Commonly grows among rocks in monsoonal rainforest and vine thickets. The plants are regularly covered by fallen leaves throughout the year, but especially when the forest trees shed their leaves during the late dry season. At this time the orchid plants are dormant, surviving as the fleshy rhizome which becomes completely covered by leaves and other litter. The new shoots of the orchid grow up through this layer and the fine root hairs produced from the ventral swellings on the rhizome become attached to the decaying leaves and other litter as well as rocks. Altitude range 20–750 m. Flowering period August–October.

Recognition

Differs from *C. notialis* by its larger (to 50 mm long and 20 mm wide), ovate-lanceolate leaves which have a pale band along the midrib; larger (to 14 mm long and 10 mm wide) flowers which open freely, with the perianth tips spreading and recurving;

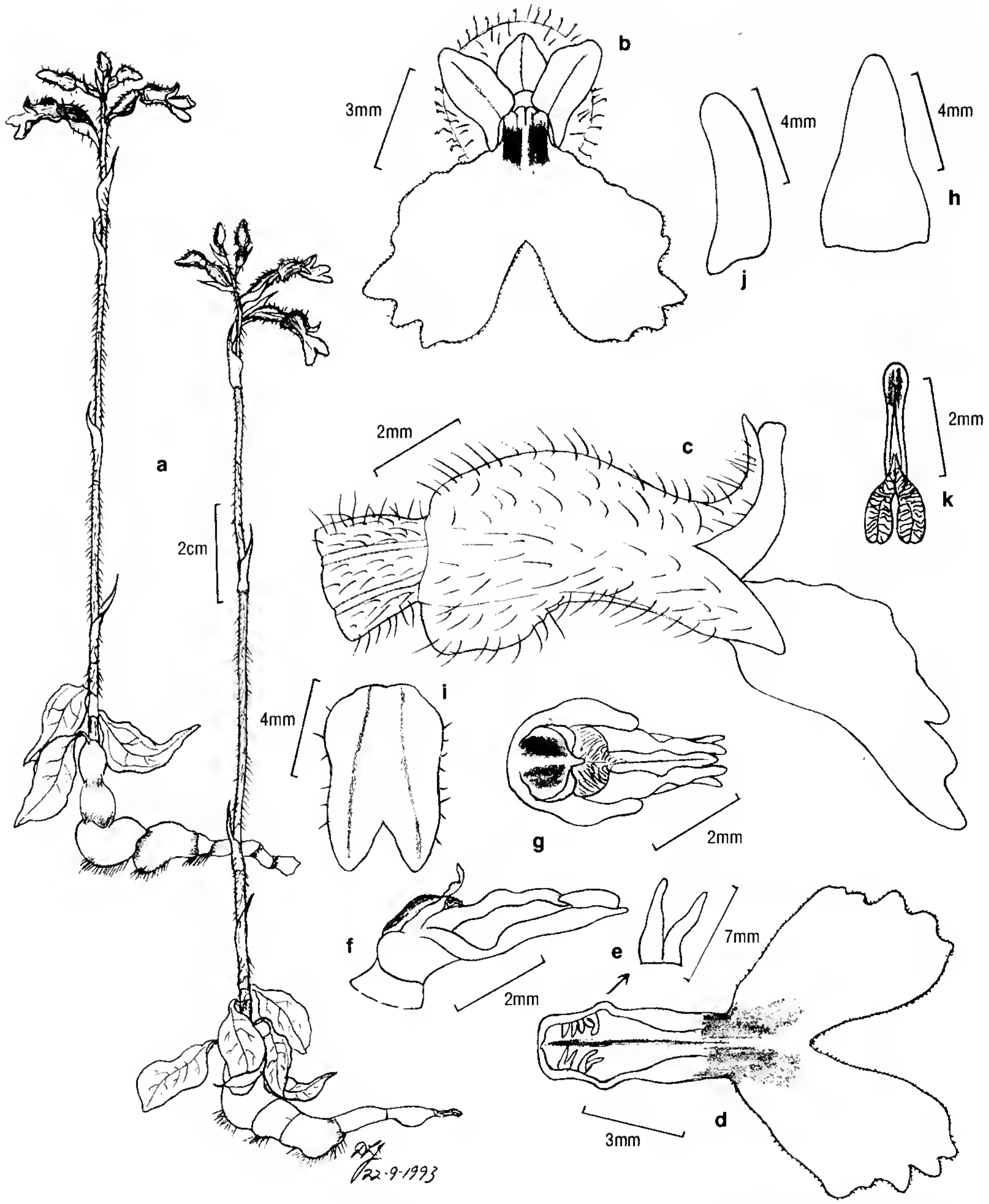

Fig. 1. *Cheirostylis ovata* (*Broers 412*; CANB): **a** plants showing habit; **b** flower from front; **c** flower from side; **d** labellum from above, flattened out; **e** labellum calli; **f** column from side; **g** column from above; **h** dorsal sepal; **i** synsepalum; **j** petal; **k** pollinarium.

larger perianth parts (dorsal sepal 8 mm long, 4.5 mm wide; synsepalum 8 mm long, 5 mm wide; petals 8 mm long, 2.5 mm wide; labellum 12.5 mm long, 9 mm wide); and, a larger (3.5 mm long) pollinarium with a functional viscidium.

Typification

No type material of *C. ovata* could be found at BRI by either Clements (1989) or myself, and a neotype has therefore been selected using a flowering specimen from a locality close to that of the original collection.

Notes

Rogers and White (1921) described *Zeuxine attenuata* from fragmentary material which lacked a rhizome. Had the specimen been more complete its generic placement would probably have been more obvious to the authors.

As deduced from the floral morphology, well-developed sticky viscidium on the pollinarium and proportion of flowers which set capsules, *C. ovata* is entomogamous but details of the pollinating vector remain unknown.

Etymology

(Latin) *ovatus* = ovate; probably in reference to the ovate leaf lamina.

Specimens Examined

QUEENSLAND: False Moochoopa Ck, upstream of Pack Trail, *Bostock 1488*, 17.ix.1993 (BRI 629409); Upper Parrot Ck, Annan River, *Brass*, 15.ix.1948 (BRI 70113), *Brass*, 19.ix.1948 (BRI 70112); Freshwater Ck, Cairns, *Flecker*, 25.viii.1935 (QRS 44057); Mt Tozer, *Gray 5113*, 16.ix.1989 (QRS 92282); TR 146, Tableland LA, *Gray 1795*, 11.ix.1980 (QRS 61654); Tozers Gap, *Gray 5710*, 29.viii.1993 (QRS 102309); McIlwraith Ra., *Hyland 7626*, 20.ix.1974 (QRS 44059); Layland Holding, Hann Tableland, *Hyland 14741*, 30.iii.1993 (QRS 101747); Lamb Ra., *Johnson*, 16.x.1949 (QRS 44058); Puffdlooney Hill, Iron Ra., *Lavarack*, 8.ix.1975 (BRI 193378); Tozers Gap, *Lavarack 1021*, ix.1976 (BRI 193379); Mackay, *Nugent*, 13.ix.1895 (BRI 312027); Shiptons Flat, near Cooktown, *Roberts (Jones 12980)*, ix.1994 (CBG 9517131 in CANB); mountain NE of Pascoe R. crossing, *Wrigley 210*, 5.ix.1976 (CBG 67961 in CANB); Tozers Gap, Janet Ra., *Wrigley 266*, 7.ix.1976 (CBG 67758 in CANB).

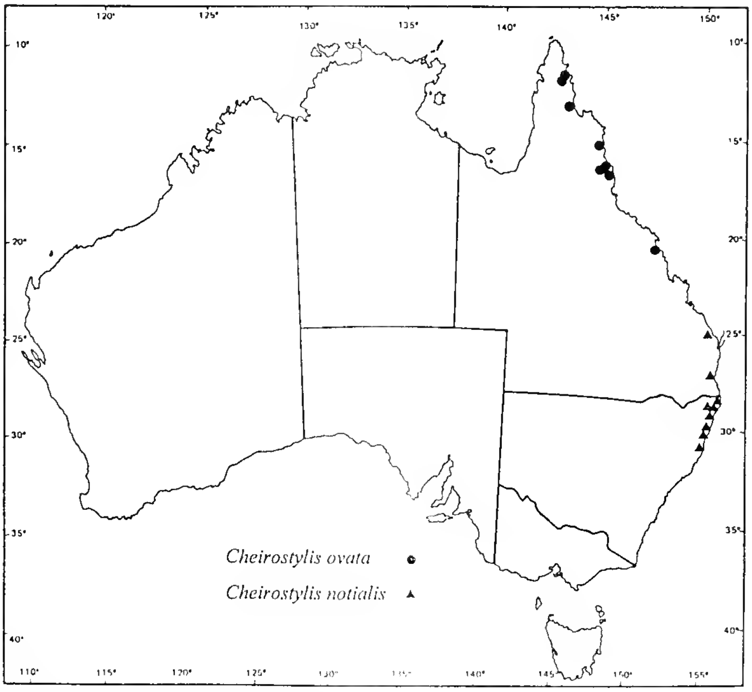

Fig. 2. Distribution of *Cheirostylis* in Australia.

2. *Cheirostylis notialis* D.L. Jones, sp. nov.

Affinis *C. ovatae* (F.M. Bailey) Schltr., foliis minoribus (usque 35 mm x 20 mm) plus distincte ovatis vitta pallida secus nervum medium carenti, ovario trichomatibus in costis praecipue, floribus minoribus (usque 9 mm x 6 mm) plerumque cleistogamis vel si chasmogamis periantho segmentis porrectis remanentibus apici non recurvatis, periantho partibus minoribus (sepalo dorsali 6 mm x 4 mm, synsepali 6 mm x 4.5 mm, petalis 6 mm x 2 mm, labello 8.5 mm x 7 mm), et pollinario minore (2.5 mm longo) viscidio non fungenti differt.

Type: New South Wales, Broken Head, *Jones*, 15.x.1987 (holotype CANB).

Cheirostylis grandiflora sensu J.H. Maiden & E. Betche, *Proc. Linn. Soc. New South Wales* 21: 624–7 (1896), *non* Blume (1825).

Illustrations (both as *C. ovata*): T.D. Stanley and E.M. Ross, *Fl. South-eastern Queensland* 3: 369, fig. 55H (1989); P. Weston, *Fl. New South Wales* 4: pl. 15, bottom centre (1993).

Rhizome 4–11 mm in diameter. *Stem* 1–2 mm in diameter. *Leaves* 3–6; petioles 3–10 mm long, 2–3 mm wide, channelled, sheathing at the base; lamina ovate to ovate-lanceolate, 13–35 mm long, 9–20 mm wide, dark green, dull, apex acute to acuminate. *Inflorescence* 5–18 cm tall, slender, 1–4-flowered. *Sterile bracts* 3 or 4, ovate-lanceolate, 10–16 mm long, 4–5 mm wide, closely sheathing, acuminate. *Fertile bracts* ovate-lanceolate, 3–11 mm long, 3–4 mm wide, closely sheathing, acuminate. *Pedicels* 2–5 mm long, slender, semi-erect, hairy. *Ovaries* narrowly obovoid, 4–8 mm long, 2–4 mm wide, constricted near the apex. *Flowers* white, 6–9 mm long, 5–6 mm wide, often cleistogamous. *Dorsal sepal* ovate, 5–6 mm long, 3.5–4 mm wide, porrect throughout, apex obtuse. *Synsepalum* 5–6 mm long, 4.3–4.5 mm wide, porrect, the lobes obtuse, divaricate, c. 2 mm apart at the tips. *Petals* narrowly linear-oblong to narrowly oblong-obovate, 5–6 mm long, 1.8–2 mm wide, slightly falcate, porrect, slightly divergent, apex obtuse. *Labellum* porrect to obliquely deflexed, often partially twisted, c. 8.5 mm long, c. 7 mm wide; labellum base 4–4.5 mm long, 1.5–2 mm wide, channelled, base saccate, bearing 1–3, irregularly lobed calli, c. 1 mm long; lamina deeply bilobed, each lobe more or less oblong-cuneate, 3–4.5 mm long, 2.6–3 mm wide, divergent, 2–3 mm apart at the apex, the anterior margins irregularly lobed, all margins minutely denticulate. *Callus* elongate. *Column* 3–3.5 mm long, c. 1.8 mm wide. *Stigma arms* c. 2.3 mm long, porrect. Rostellum elongate. *Anther* ovate, c. 1 mm long, c. 1 mm wide, brown, with a short rostrum. *Pollinarium* c. 2.5 mm long; viscidium elliptic, 0.5 mm long; stipe ligulate, c. 9 mm long; pollinia linear clavate, 1—1.3 mm long, white, mealy. Capsules narrowly obovoid, 7–10 mm long, 4–5 mm wide, suberect to erect. (Fig. 3)

Distribution

South-eastern Queensland and north-eastern New South Wales (Miriam Vale to Grassy Head) (Fig. 2).

Ecology

Grows in shady, often moist areas under shrubs in littoral rainforest, rainforest margins and wet sclerophyll forest. Soils are commonly sandy loams, less commonly clay loams. Altitude sea level to 350 m. Flowering period October and November.

Recognition

Differs from *C. ovata* by its smaller (to 35 mm long, 20 mm wide), more distinctly ovate leaves which lack any pale band along the midrib; smaller (to 9 mm long, 6 mm

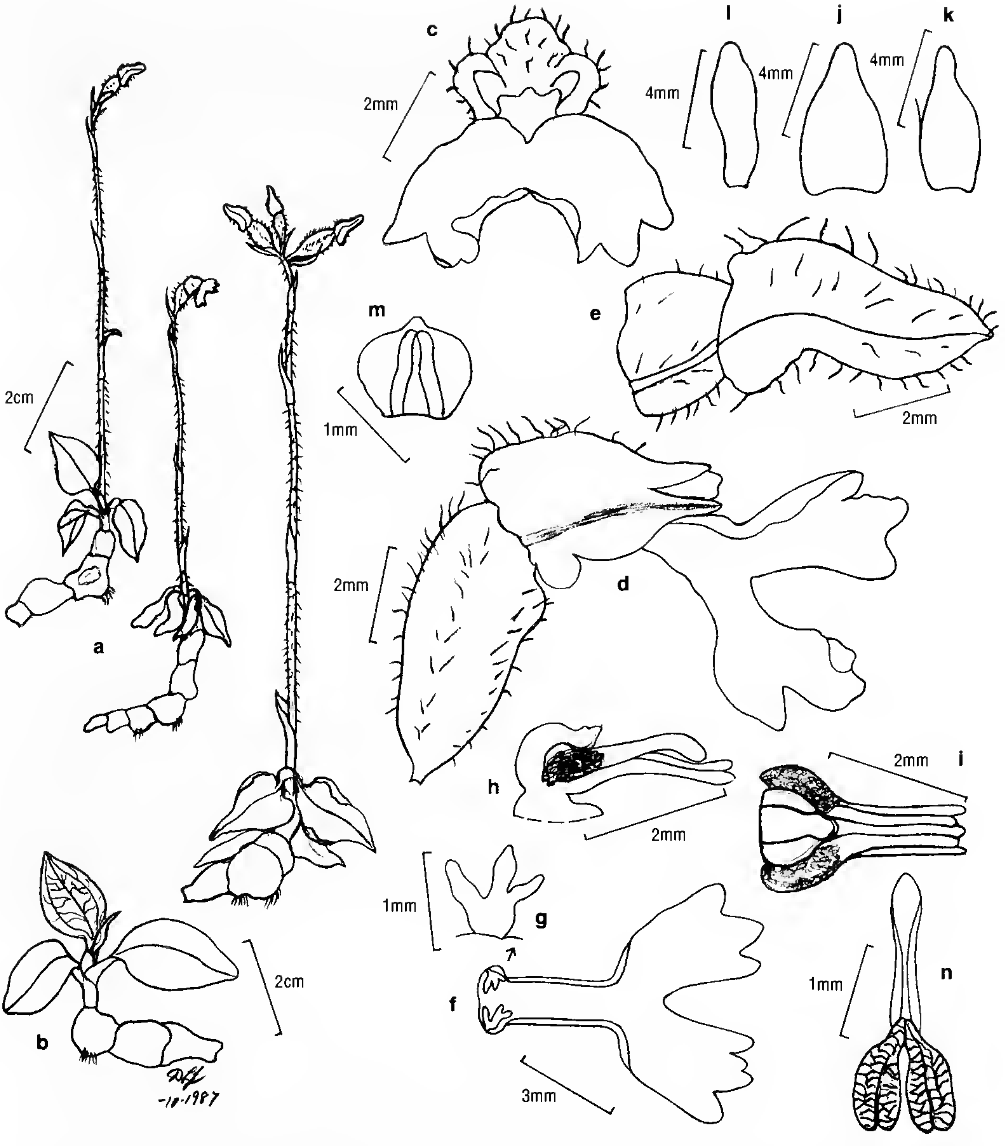

Fig. 3. *Cheirostylis notialis* (Broken Head, *Jones s.n.*; CANB): **a** plants showing habit; **b** non-flowering plant; **c** flower from front; **d** open flower from side; **e** cleistogamous flower from side; **f** labellum from above, flattened out; **g** labellum calli; **h** column from side; **i** column from above; **j** dorsal sepal; **k** lateral sepal; **l** petal; **m** anther, ventral view; **n** pollinarium.

wide) flowers which are commonly cleistogamous or if they open then the perianth segments remaining porrect, with the tips not recurving; smaller perianth parts (dorsal sepal 6 mm long, 4 mm wide); synsepalum 6 mm long, 4.5 mm wide; petals 6 mm long, 2 mm wide; labellum 8.5 mm long, 7 mm wide); and, a smaller (2.5 mm long) pollinarium with a non-functional viscidium.

Notes

The flowers of this species are commonly cleistogamous, with autogamy occurring as the buds develop. In occasional flowers the perianth parts may partially expand, with the labellum protruding, but the sepals do not separate widely and the petals usually remain enclosed within the dorsal sepal. In the few flowers that do open, the labellum is often partially twisted to one side.

Etymology

(Latin) *notialis* = southern; in reference to the southerly distribution of this species.

Specimens Examined

QUEENSLAND: Meres Rd, Bellthorpe, *Crane 991*, 12.xi.1993 (BRI 622463, CANB); Bulburin SF, near Miriam Vale, *Jansen*, 20.xi.1994 (BRI 581822, NSW). NEW SOUTH WALES: 2 km N of Wardell, *Bishop J95/12–18*, 27.ix.1989 (NSW); Woody Head, *Blaxell*, 30.iii.1976 (NSW); Red Rock, N of Woolgoolga, *Clemesha*, 11.iv.1976 (NSW); Brunswick Heads, *Coveny 4380*, 1.ix.1972 (NSW); Lismore, *Fuisellback*, xi.1896 (NSW); near Brunswick Heads, *Hoogland 8599 and Hayes*, 26.x.1962 (NSW); Brunswick Heads, *Hunt*, x.1960 (BRI 435836); Broken Head, *Jones*, 7.xiii.1987 (CANB); 2 km N of Grassy Head, *Metcalfe*, vii.1976 (NSW); Pimlico, near Wardell, Moye, 13.v.1994 (CANB).

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Seven Lichens New to Victoria

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Abstract

Seven lichen taxa collected from cool-temperate rainforest and mixed cool-temperate rainforest/wet sclerophyll forest are recorded from Victoria for the first time: *Menegazzia myriotrema* (Müll. Arg.) P. James, *Parmelia testacea* Stirt., *Parmelinopsis neodamaziana* (Elix & J. Johnst.) Elix & Hale, *Pertusaria novaezelandiae* Szatala, *Placopsis parellina* f. *microphylla* I.M. Lamb, *Pseudocyphellaria ardesiaca* D.J. Galloway and *Trapeliopsis congregans* (Zahlbr.) Brako.

Introduction

Seven lichen species collected from cool-temperate rainforest and mixed cool-temperate rainforest/wet sclerophyll forest are recorded from Victoria for the first time and short morphological and taxonomic notes are provided for each. Although all are listed in Filson's *Checklist of Australian Lichens and allied Fungi* (1996), none were reported from Victoria, nor were they documented from elsewhere in the State. Five of the taxa are also new to mainland Australia: *Menegazzia myriotrema*, *Parmelia testacea*, *Placopsis parellina* f. *microphylla*, *Pseudocyphellaria ardesiaca* and *Trapeliopsis congregans*, while *Parmelinopsis neodamaziana* is known from Queensland and New South Wales and *Pertusaria novaezelandiae* is known from Queensland, New South Wales and Tasmania. The collections were made as part of a larger lichen survey (Louwhoff 1995), covering approximately 50 square km of bushland in the Mt Donna Buang Scenic Reserve in south-eastern Victoria. This area is located within the Yarra Ranges National Park, Central Highlands. The vegetation in the Reserve is of interest as it is a mixture of cool-temperate rainforest and a variety of other, mainly higher altitude, vegetation types. For comparison, brief investigations of rainforest habitats (dominated by *Nothofagus cunninghamii*) near Marysville, Victoria, were also undertaken.

Materials and Methods

Samples were collected with a portion of the substratum and transferred to the laboratory for examination. Herbarium specimens are lodged at the Deakin University Rusden Campus herbarium (DURC) and the National Herbarium of Victoria (MEL). Identifications are based upon relevant literature and representative herbarium specimens; none of the types cited were examined. Chemical spot tests follow methods outlined by Elix (1994*a*). Nomenclature follows that of *Flora of Australia* (1992, 1994), Galloway (1985) and Kantvilas (1990).

Results

1. ***Menegazzia myriotrema*** (Müll. Arg.) P. James, *Fl. Austral.* 54: 313 (1992). *Parmelia myriotrema* Müll. Arg., *Bull. Herb. Boissier* 4: 91 (1896). *Type:* 'without precise locality, Tas., *F.R.M. Wilson 1731* (holotype G)', *fide* P. James, *loc. cit.*

Parmelia retipora Stirt., *Trans. & Proc. New Zealand Inst.* 32: 80 (1900); *Menegazzia retipora* (Stirt.) Bitter, *Hedwigia* 40: 172 (1901). *Type:* 'without precise locality, Tas., *Mrs Heywood McEwen 36* (holotype BM)', *fide* P. James, *loc. cit.*

The genus *Menegazzia* is characterised by the presence of perforations in the upper cortex which are 0.2–2.5 mm in diameter, depending upon the species. *Menegazzia myriotrema* is distinguished from most other members of this genus by the small, delicate lobes of less than 1 mm in width. The ascospores (1-2 per ascus) are simple, broadly ellipsoidal, 45–50(–60; James and Galloway 1992) µm long and 25-35 µm in diameter, with a wall 3.5 µm thick. *Menegazzia myriotrema* was previously thought to be endemic to Tasmania (James and Galloway 1992; Kantvilas 1994). The medulla reacts K+ orange (James and Galloway 1992), but this reaction was not significant in the Victorian specimens. At the study site, *Menegazzia myriotrema* occurred on fallen twigs of *Nothofagus cunninghamii* on the forest floor of cool-temperate rainforest. In Tasmania, the species is common and widespread on canopy twigs in rainforest, but is rare outside the rainforest habitat (James and Galloway, 1992). This is also true for all Victorian specimens observed in the field. *Menegazzia myriotrema* has been treated as a synonym of *M. platytrema* (Kantvilas 1989; McCarthy 1991) but subsequently has been recognised as a separate species (James and Galloway 1992; Kantvilas 1994). It is distinguished from the latter by the thinner lobes with numerous perforations and the generally delicate appearance of the thallus.

Specimens Examined

VICTORIA: The Beeches (loop), Marysville, on small twigs, *Louwhoff 338*, 14.ii.1994 (DURC, MEL), *Louwhoff 353*, 27.iv.1995 (MEL). TASMANIA: Arthur-Pieman Protected Area, 32 km NNE of Savage River, along the pipeline road, on *Cassinia* along margin of mixed rainforest, *J.A. Elix 40109 and G. Kantvilas*, 8.xii.1993 (CANB).

2. ***Parmelia testacea*** Stirt., *Scott. Naturalist (Perth)* 4: 203 (1878). *Type:* 'Tinakora Hill, Wellington, New Zealand, Nov. 1872, *J. Buchanan 42* (holotype BM; isotypes WELT)', *fide* M.E. Hale, *Smithsonian Contr. Bot.* 66: 49 (1987).

Parmelia tenuirima var. *erimis* Nyl., *Flora* 68: 610 (1885); *Parmelia erimis* (Nyl.) Hillmann, *Hedwigia* 78: 259 (1939). *Type:* 'Tinakora Hill, Wellington, New Zealand, 1867, *C. Knight 55* (lectotype H-NYL)', *fide* M.E. Hale, *loc.cit.*

Parmelia rudior Nyl., *Lich. Nov. Zel.* 24 (1888). *Type:* 'Tinakora Hill, Wellington, New Zealand, 1867, *C. Knight 57* (lectotype H-NYL)', *fide* M.E. Hale, *loc. cit.*

Parmelia signifera f. *pallidior* Zahlbr., *Akad. Wiss. Wien Math.-Naturwiss. Kl., Denkschr.* 104: 107 (1941). *Type:* 'Dunedin, South Island, New Zealand, *J.S. Thomson ZA 249* (lectotype W)', *fide* M.E. Hale, *loc. cit.*

Parmelia testacea is morphologically similar to the much more common *P. tenuirima* Hook.f. & Taylor, but is distinguished by the smaller and narrower lobes, the scabrid thalline exciple and the squarrosely branched rhizines which often protrude beyond the lobe margins. In addition, *P. testacea* has predominantly marginal pseudocyphellae, whereas *P. tenuirima* has laminal pseudocyphellae (Elix 1994*a*). The ascospores are ellipsoidal and 13-18 µm long and 8.5-11 µm in diameter (Galloway 1985). Apothecia were not observed in the Victorian specimens. However, pycnidia were numerous, scattered, red brown, immersed and most easily visible when the thallus was hydrated. Many lichens from canopy branches and subalpine scrub at the timberline display a morphology with narrow, branching lobes and copious rhizines as an adaptation to high-light and subalpine environments (Galloway 1985). Specimens collected in Victoria from habitats with plentiful light, also displayed these characteristics. When *P. testacea* grows in the shade (rarely), the lobes are shorter, more rounded and imbricate, and the rhizines are fewer.

In Australia, *P. testacea* was previously reported only for Tasmania (Elix 1994*b*; Filson 1996). At the study site in Victoria, the specimen was collected on *Nothofagus cunninghamii* in mixed forest dominated by *Eucalyptus pauciflora*, at an altitude of 1200 m. In New Zealand, the species is widespread in lowland to subalpine habitats (Galloway 1985). In New Zealand and Tasmania, *P. testacea* frequently occurs on *Nothofagus* species, particularly on trunks along roadsides or riverbanks (Hale 1987).

Specimens Examined

VICTORIA: near summit of Mt Donna Buang, c. 20 km N of Warburton, on *Nothofagus cunninghamii*, *Louwhoff 148*, 12.iv.1993 (DURC, MEL). NEW ZEALAND: Wye Valley, Central Otago, South Island, on rock in *Nothofagus* forest, *Polly*, 30.xii.1991 (WELT).

3. ***Parmelinopsis neodamaziana*** (Elix & J. Johnst.) Elix & M.E. Hale, *Mycotaxon* 29: 243 (1987).

Parmelina neodamaziana Elix & J. Johnst., *Brunonia* 9: 155 (1987). *Type:* '8 km NE of Nerringa, New South Wales, 31 Oct. 1979, *J.A. Elix 5093* (holotype CBG, isotype MEL)', *fide* Elix, *loc. cit.* (but isotype could not be located at MEL).

Parmelia damaziana sensu G.N. Stevens & R.W. Rogers, *Proc. Roy. Soc. Queensland* 90: 39 (1979); J.A. Elix, V.K. Jayanthi & C.C. Leznoff, *Austral. J. Chem.* 34: 1757-1761 (1981); J.A. Elix & H. Streimann, *J. Hattori Bot. Lab.* 51: 84 (1982); *non* (Zahlbr.) Elix & M.E. Hale (1987).

Parmelinopsis neodamaziana bears a superficial resemblance to *P. afrorevoluta* (Taylor) Elix & Hale which also has curled and twisted lobes. However, the former can be distinguished by the smaller ascospores (9–12 µm long and 6–8 µm in diameter cf. 16–20 µm long and 10-14 µm in diameter), in lacking pustular soralia and by the presence of pycnidia. *Parmelinopsis neodamaziana* is endemic to Australia, where it occurs in New South Wales, Tasmania and Queensland (Elix 1994*c*). At the study site in Victoria, *P. neodamaziana* occurs in mixed forest dominated by *Eucalyptus pauciflora* and *Acacia obliquinervia* at an altitude of 1200 m.

Specimens Examined

VICTORIA: near summit of Mt Donna Buang, c. 20 km N of Warburton, Mt Donna Buang Rd, on *Acacia obliquinervia*, *Louwhoff 201*, 16.vi.1994 (DURC, MEL). QUEENSLAND: Bunya Range, Mt Mowbullan, *H.J. Lam 7654*, 24.ix.1954 (J.A. Elix Private Collection).

4. ***Pertusaria novaezelandiae*** Szatala, *Borbàsia* 1: 60 (1939). *Type:* 'Nova Zelandia: North Island: ad lac Waikare-Moana, supra cort. Podocarpi, 1932, *J. Jablonszky* (holotype BP)', *fide* D.J. Galloway, *Fl. of N.Z. Lichens* 377 (1985).

Pertusaria novaezelandiae has very characteristic spores that are large, ellipsoidal, colourless, 1-2 per ascus, with a spore wall frequently ruptured, thereby releasing a dense substance (a condition described as guttulate; Kantvilas 1990). The spores are 100–130 µm long and 37–50 µm in diameter, and with a wall of up to 5 µm thick. The erupting verrucae which contain the apothecia are prominent and wart-like on the pale green to white thallus and are K+ deep purple/scarlet.

In Victoria, *P. novaezelandiae* commonly occurs on twigs and branches of *Nothofagus cunninghamii*. It has been reported as common and widespread in rainforest canopies in Tasmania, where it occurs on numerous tree species (Kantvilas 1990). In New South Wales, *P. novaezelandiae* is common in *Nothofagus moorei* forests (Kantvilas 1990) and the species is also well known in New Zealand (Galloway 1985; Kantvilas 1990). Additional, previously undocumented specimens from Victoria were found in MEL (see below).

Specimens Examined

VICTORIA: Cement Ck, Acheron Way, on branch collected from forest floor, *Louwhoff 116*, 2.iv.1994 (DURC, MEL); Blue Range, Mount Margaret Saddle, in *Nothofagus* forest, *Filson 17184*, 5.ix.1981 (MEL); Cumberland Falls, c. 19 km E of Marysville, growing in canopy of fallen *Nothofagus*, *Filson 17247*, 17.x.1981 (MEL); East Gippsland, Alfred National Park, summit of Mt Drummer ('1370 ft'), on dead *Eucalyptus* trunks, *Willis*, 17.ii.1965 (MEL); Cathedral Range, 5 km north-east of Buxton, north Jawbone, on rock, *Filson 16631*, 16.ii.1979 (MEL); Otway Range, Turtons Track, near Quarry Glen, on *?A. melanoxylon bark*, *Willis*, 15.viii.1963 (MEL). NEW ZEALAND: Arthurs Pass National Park, Mt Cassidy, common on bark of 'Mountain Nothofagus', *Siseman*, 8.ii.1966 (MEL).

5. ***Placopsis parellina*** f. ***microphylla*** I.M. Lamb, *Lilloa* 13: 149 (1947). *Type:* 'Sine loco (prob. Wellington), *Charles Knight* (WELT), *fide* D.J. Galloway, *Fl. of N.Z. Lichens* 405 (1985).

Placopsis parellina is a very polymorphic species and a number of subspecific taxa have been described (Galloway 1985). *Placopsis parellina* f. *microphylla* differs from the typical, crustose form of *P. parellina* in having a squamulose or microphylline thallus (Galloway 1985). The species has uniseriate ascospores, eight per ascus, often tilted at 45° within the ascus, ellipsoidal, 17–21 µm long and 7–10 µm in diameter, with an undulating wall. In Australia, *P. parellina* f. *microphylla* previously was known only from Tasmania (Kantvilas 1994, Filson 1996). At the study site in Victoria, it occurs on rocks along roadsides in association with *Stereocaulon ramulosum* (Sw.) Räuschel and *Baeomyces heteromorphus* Nyl. ex Bab. & Mitt. and, less commonly, on rocks on the forest floor. The species is widespread in New Zealand (Galloway 1985).

Specimens Examined

VICTORIA: Mt Donna Buang, c. 20 km N of Warburton, on way to summit on Mt Donna Buang Rd, on sandstone along roadside verges, *Louwhoff 105*, iii.1992, (DURC, MEL); Mt Donna Buang, c. 20 km N of Warburton, at 10 Mile Turntable carpark, on roadside cutting, on rock, *Louwhoff 341*, 20.x.1994 (MEL). TASMANIA: Frodshams Gap, near Maydena, on quartzite, *Bratt 83616*, 1.xii.1963 (MEL); Cradle Mountain-Lake St Clair National Park, track between Pine Valley and the Acropolis, *Filson 6934*, 7.1.1965 (MEL).

6. ***Pseudocyphellaria ardesiaca*** D.J.Galloway, *Lichenologist* 15: 141 (1983). *Type:* 'New Zealand, Canterbury, Boyle River, near Lewis Pass, on bark of *Leptospermum* on terrace overlooking Boyle Lodge, *D.J. Galloway*, 9.1.1979 (holotype CHR 343237, isotype BM)', *fide* D.J. Galloway *et al.*, *Lichenologist* 15: 141 (1983).

Pseudocyphellaria ardesiaca is recognised by its purple/grey upper surface and deep, golden yellow medulla and marginal soralia. Although it is similar in appearance to *P. coerulescens*, it differs in the presence of soralia rather than phyllidia. Apothecia have not been reported for either species. Although *P. ardesiaca* contains a blue-green photobiont, it is not tolerant of low light intensities (Galloway 1985), unlike many other species of *Pseudocyphellaria* containing such photobionts. In Australia, *P. ardesiaca* has previously been reported only from Tasmania (Galloway *et al.* 1983, Filson 1996). At the study site in Victoria it occurs in cool-temperate rainforest, in well-lit habitats such as along roadsides. The species also has been reported for New Zealand (Galloway 1985, 1988) where it occurs in cool, moist, humid conditions in montane to subalpine habitats.

Specimens Examined

VICTORIA: Myrtle Gully Reserve, on Mt Donna Buang Rd, on *E. regnans* along roadside, *Louwhoff 003*, 12.i.1994 (DURC, MEL). NEW ZEALAND: Nelson, Wairau Valley, north branch Lees Ck, mountain *Nothofagus* forest on valley floor, growing with *Nephroma australe*, *Glenny 89-026*, 3.i.1989 (WELT).

7. ***Trapeliopsis congregans*** (Zahlbr.) Brako, *New Zealand J. Bot.* 21: 196 (1983).

Phyllopsora congregans (Zahlbr.) D.J. Galloway, *New Zealand J. Bot.* 21: 196 (1983). *Lecidea congregans* Zahlbr., *Akad., Wiss. Wien Math.-Naturwiss. Kl., Denkschr.* 104: 305 (1941). *Type:* New Zealand, Otago, Mt Cargill, on rotten logs, c. 400 m, *J.S. Thomson A96*, May 1935 (lectotype W3424)', *fide* D.J. Galloway *loc. cit.*

Trapeliopsis congregans is a squamulose lichen, recognised by its characteristic red, rusty to brown apothecia, which grow in large, irregular clusters, up to 4 mm wide and become paler (orange) towards the margins. The ascospores (8 per ascus) are ellipsoidal, with narrowly rounded apices, and c. 10 µm long and 3.5-4 µm in diameter. At the study site in Victoria, *T. congregans* is common and occurs mostly on decaying stumps in wet sclerophyll and cool-temperate rainforest, in damp/shaded habitats, often growing together with mosses. *Trapeliopsis congregans* is also known from Tasmania (Kantvilas et al. 1985) and New Zealand (Galloway 1985).

Specimens Examined

VICTORIA: Ben Cairn Reserve, Mt Donna Buang Rd, near car park, on *E. regnans* (base), *Louwhoff 132*, ii.1994 (DURC, MEL). TASMANIA: Mt Wedge, alpine boulder field at 1140 m, on soil, *Kantvilas*, 17.x.1981 (BM); Mt Field National Park, Lake Dobson, soil, *Eucalyptus coccifera*-alpine woodland at 1030 m, *Kantvilas and James*, 13.viii. 1991 (BM).

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Muelleria 10: 91–93 (1997)

SELECTED MYCOLOGICAL PAPERS FROM 'THE 1996 COMMEMORATIVE CONFERENCES', MELBOURNE, 29 SEPTEMBER TO 5 OCTOBER 1996

Introduction

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Baron Ferdinand von Mueller is recognised as Australia's greatest nineteenth century scientist, and it was he who firmly established botanical science on Australian soil. Mueller founded the National Herbarium of Victoria at the Royal Botanic Gardens, Melbourne (Maroske 1995). His interests extended to all groups of plants, including cryptogams. Mueller collected fungi and described some new taxa, and can thus be considered as the first to carry out taxonomic mycology in Australia. More importantly, he played a crucial role as the link between networks of resident collectors and European taxonomic mycologists (May and Pascoe 1996). It was thus appropriate that 'The 1996 Commemorative Conferences' held to mark the centenary of Mueller's death (and the 150th anniversary of the Royal Botanic Gardens Melbourne) comprised sections on Mycology, in addition to Botany ('Beyond the Floras') and History ('The Scientific Savant'), and a symposium on the Proteaceae. Mueller would no doubt have enjoyed, as did the participants, the mix of symposia, receptions, formal dinners and excursions, attended by scientists, media representatives and dignitaries.

The 'Mycology Conference' was the first meeting of the newly inaugurated Australasian Mycological Society. More than 50 mycologists from across Australia and New Zealand, as well as some from further afield, were present to hear papers and view posters on historical, taxonomic and ecological aspects of Australasian mycology. Lack of opportunity for contact among Australasian mycologists with interests in taxonomy and ecology of the indigenous mycota, especially students, has always been a problem. The success of the conference shows that there is now a sufficient amount of interest and enthusiasm to maintain a Society and to organise regular meetings. It was also encouraging that the Society is Australasian in scope rather than Australian, given the similarities in the mycoflora of Gondwanan neighbours such as Australia and New Zealand.

Mueller aimed to produce flora treatments of Australian fungi, at one stage contemplating the production of cryptogamic floras as supplementary volumes to George Bentham's *Flora Australiensis* (Maroske pers. comm.). All that eventuated was the rather unsatisfactory *Handbook of Australian Fungi*. A hundred years after Mueller's death the first two volumes of the new *Fungi of Australia* series were launched during the 'Mycology Conference' by Senator Robert Hill, with additional comments by Professor David Hawksworth (International Mycological Institute).

In this volume of *Muelleria* selected papers from the 'Mycology Conference' and two mycological papers from the session on 'Orphan Groups' in 'Beyond the Floras' are brought together. Further papers from the 'Mycology Conference' will be published in the *Australasian Mycological Society Newsletter*, and other papers presented at 'Beyond the Floras' will appear in *Australian Systematic Botany*.

The term 'orphans' to denote the cryptogams and other neglected groups provoked some debate amongst participants, some of whom felt that it was too negative a term. David Hawksworth uses the term as the starting point for a wide-ranging and thought-provoking analysis which demonstrates convincingly why fungi do share many of the characteristics of orphans, and just as convincingly why more attention must be paid to fungi. Kevin Hyde asks 'Who will look after the orphans?' and shows that there are serious deficiencies in personnel, funding and training in relation to taxonomic research on Australian fungi.

This neglect is despite the fact that fungi are of vital importance in ecosystems as mutualists (mycorrhizae, mycophyllas), as pathogens, as decomposers and recyclers, and also as food for humans and animals, and as sources of medicine. Some of these aspects were explored by participants at the 'Mycology Conference', and Karen Stott and co-workers report on characteristics of Australian strains of the mushroom *Lepista*, which may prove of value in commercial cultivation.

As evidence of an increasing interest in fungi by Australian researchers, Tony Young explores the difficulties of delimiting genera and families in the Hygrophoraceae, while Adrienne Burns and John Conran present intriguing results in the little-studied area of macrofungal phenology and community structure. Kevin Hyde and Teik-Khiang Goh demonstrate that even a specific substrate such as submerged wood in a stream yields a diverse range of fungi, among which are new species or records.

That the fungi are important and extremely numerous but overlooked cannot now be ignored. Several papers presented to the Australian Systematic Botany Society meeting held in 1988 drew attention to these aspects (May 1990; Pascoe 1990), and Pascoe's estimate of the magnitude of fungal biodiversity in Australia (at 250,000 species) was particularly important in emphasising the enormity of the task confronting taxonomic mycologists. The papers presented at 'The 1996 Commemorative Conferences' continue these themes, but the landmark occasions of the first meeting of the Australasian Mycological Society and the launch of the *Fungi of Australia*, along with the evident interest and enthusiasm among Australian mycologists give real hope that substantial progress will now be made on documenting and understanding Australia's mycota.

Mueller embraced fungi as part of the province of the botanist, and fungi continue to be accepted (as they should) within the 'botanical' community — *Muelleria* has always published papers on fungi (lichenised and non-lichenised), the *Fungi of Australia* and *Flora of Australia* are both produced by the botanical section of the Australian Biological Resources Study, and in 1994 the National Herbarium of Victoria created a position for a taxonomic mycologist. This remains, however, the only such position in the Australian state botanical herbaria, and botanical institutions clearly must put more resources into cryptogams, so that one day fungi can be viewed not as orphans, but as just part of the family.

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The Phenology of Macrofungi in Relation to Autumn Rainfall in the Adelaide Hills

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Abstract

Macrofungal species richness and frequency of fruiting was investigated in relation to environmental conditions, early in the rainy season in Cleland Conservation Park in the Adelaide Hills. At two sites: a fern gully and an open woodland, eight permanent 25m^2 quadrats were sampled fifteen times between May and July, 1992. The influence of local temperature, rainfall patterns and soil moisture were assessed. Seventy-three basidiomycete and six ascomycete taxa were collected: the basidiomycete taxa representing five families, dominated by the gilled fungi. There was a strong temporal effect on fruiting pattern which was also correlated with rainfall and temperature during the sampling period. Early in the season there were clear differences between the fungal communities at the two sites, but as the season progressed, they converged towards more similar species compositions.

Introduction

In the dry climate of South Australia, macrofungal fruiting bodies are conspicuous during the cool wet months. Fungi are the major agents of decay, and exist in areas where decomposable material is present. Due to the close association fungi have with their external environment, fungi have been used as generalist organisms in the investigation of ecological processes (Ingold 1984). However, most ecological work on fungi focuses on their hyphal distribution and growth patterns (Park 1968). Fungi are notable for their prolific reproduction and rapid dispersal of large numbers of spores (Ingold 1984). Spore production is important for fungi because of the discontinuous distribution of most fungal substrates (Park 1968). Therefore, to elucidate the survival processes of many fungal species, a knowledge of their fruiting behaviour is required.

Many studies have considered the production of spore producing structures of fungi in Europe (summarised in Wicklow and Carroll 1981; Winterhoff 1992), however, little has been published on the influence of environmental factors on the fruiting of macrofungi in Australia. Chief factors influencing spore production in fungi are temperature and water availability. Temperature effects metabolism and the assimilation of nutrients. Moisture content indirectly controls nutrient availability and subsequently the intensity of spore production (Austwick 1968).

Local environmental gradients in substrate availability and canopy cover influence moisture availability and nutrient supply and therefore species composition. Many ectomycorrhizal basidiomycetes exhibit differences in composition related to forest type (e.g. Bills *et al.* 1985). In Norway, studies have demonstrated that rich fructification is ultimately dependent on the supply of decomposable organic matter after initiation by heavy rain. High yields require high concentrations of soluble nitrogen and phosphorus. Once nutrients have been depleted in one area, production is low in subsequent seasons regardless of rainfall (Mehus 1986).

To investigate the macrofungal species richness and frequency of fruiting in large scale environmental conditions, a study was carried out in the Adelaide Hills. This study investigates the macrofungal species richness and frequency of fruit body production following heavy autumn rainfall in the Adelaide Hills, South Australia. A comparison was made between areas of different canopy cover to investigate whether general environmental factor such as temperature and rainfall had a greater influence on fungal fruit body production than local conditions such as soil moisture and site exposure. Due to the winter wet period in the Adelaide region, the study was initiated prior to the rain season, during late Autumn.

Materials and Methods

Study sites were at Waterfall Gully, in Cleland Conservation Park in the Adelaide region, South Australia (Fig. 1a). A number of creeks flow through this area during winter, and it is well vegetated producing moist sheltered conditions. Following heavy rainfall during May, 1992, regular visits were made to Waterfall Gully to determine the beginning of the fungal fruit body season and the areas where fungi were growing. From late May, formal records of the number and species of fruiting bodies were made.

To demonstrate differences in fruiting between areas with different canopy cover, a fern gully with dense canopy cover, and a more open shrubland area were sampled. Both sites were in close proximity to the creek bed (Fig. 1b). At each site, eight permanent quadrats of 25 m^2 were pegged out around the creek bed, the quadrats at each site covering a range of heavy clay and sandy soils and containing a variety of fungal substrates such as soil, leaf litter and fallen trees. As far as possible, the quadrats were square (5 x 5 m), but in several cases, the quadrat shape had to be altered to allow for local topographic variation.

The total number of the fruit bodies of each macrofungal taxon within each quadrat were recorded every 3–4 days for an eight week period (15 visits). To minimise recounting of thalli on successive visits, only fruit bodies with no signs of decomposition, liquefication or insect damage were recorded, with the total thallus number per quadrat recorded for each species. To gain a measure of relative soil moisture, soil was collected from each quadrat in an airtight container. A pre-weighed No. 48 filter paper was placed in the container and left to equilibrate for 48 hours. The filter paper was brushed of excess soil, weighed, dried to constant weight and reweighed (Greacen 1989). Daily rainfall and temperature measurements were taken from records provided by the Department of Environment and Natural Resources rangers at the Cleland Wildlife Park, 500 m from the sampling sites.

Each time a new taxon was encountered, characteristic morphological features were recorded in the field following the methods of Cole *et al.* (1985), and specimens were later dried at 70°C. For gilled fungi, a spore print was obtained by placing the cap of each specimen on a piece of coloured paper for 6 hours. These prints were then used to assist identification (Cleland 1934–35; Cole, *et al.* 1985). The spores of some specimens were further analysed for size and shape to clarify identification (Young 1986). Following identification, specimens were also compared for verification with the collections in the State Herbarium of South Australia (AD), and the specimens collected in the present study were deposited there.

These data resulted in a matrix of total fruit body frequencies for each fungal species within each quadrat for each sample time (203 samples and 79 species). A multidimensional scaling analysis was performed to summarise changes in the species and frequency of fruiting bodies within each quadrat over time using the SSH module of PATN (Belbin 1992). An association matrix using the Bray-Curtis Association measure, together with a dendrogram created using an unweighted pair group mean association (UPGMA), was used to cluster quadrats of similar fungal composition. Nine environmental parameters and population characteristics were used to assist in the interpretation of associations presented in the ordination: (1) rain24: total rainfall within the previous 24 hours prior to sampling, (2) rain: total rainfall between samples, (3) days since rain: number of days since it had last rained at the time of the sampling visit, (4) temperature: the previous day's maximum temperature, (5) moisture: the relative soil moisture within each quadrat, (6) suction: the relative soil moisture retention capacity (7) richness: species richness, (8) abundance: species abundance of fruit bodies within each quadrat over time, (9) time: sampling time.

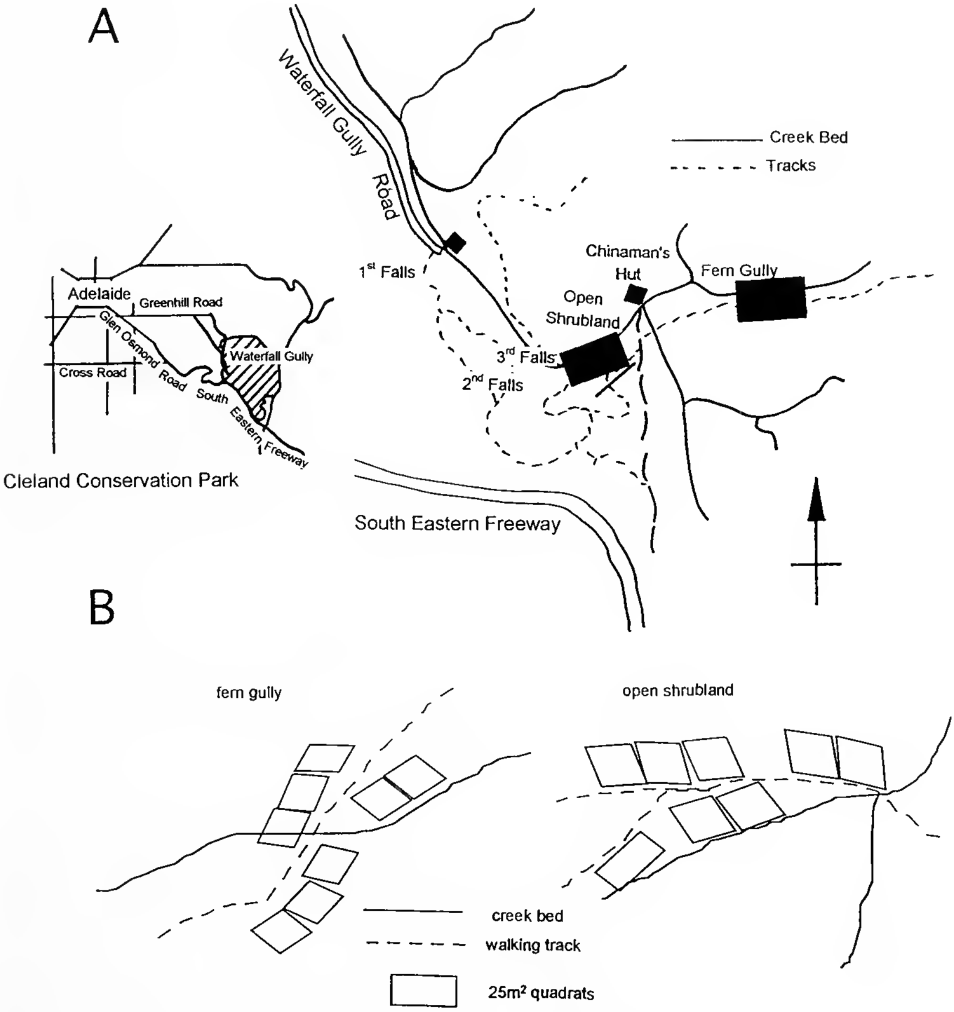

Fig. 1. **a** Map showing the position of Waterfall Gully in the Cleland Conservation Park, Adelaide, South Australia; **b** the position of permanent quadrats in fern gully and a more open shrubland areas. At each site, eight permanent quadrats of 25 m^2 were pegged out around the creek bed.

By multiple linear regression, each of these nine variables is presented as a vector illustrating the direction of increasing effect within the ordination space (Belbin 1991). This was carried out with the Principle Canonical Correlation (PCC) module in PATN.

Results

Site Characteristics

Both the fern gully and the open woodland sites were under a canopy of *Eucalyptus obliqua*, but in the fern gully, the vegetation was much more dense, with *Acacia* and introduced *Ficus* as the understorey, a shrub layer including *Rubus* and *Acrotriche*, with *Gahnia*, *Themeda*, *Pteridium* and *Blechnum* as major components of the ground layer, and large amounts of fallen timber. By comparison, the open woodland had more widely spaced eucalypts (with a few introduced *Pinus* trees), an understorey containing *Banksia*, *Acacia*, *Hakea* and *Exocarpos*, shrub layer of *Epacris*, *Acrotriche* and *Spyridium* and grass layer of mainly *Themeda* and *Danthonia*. In addition, both sites were infested with numerous introduced, weedy shrub, herb and grass species.

Rainfall during the period studied was 137 mm in May, 153.4 mm in June and 133.4 mm in July, with 19, 17 and 18 rain days per month respectively. This compares well with the 1985–1996 twelve year averages of 104.8 mm, 153.9 mm and 169.2 mm, although the May reading was somewhat higher than usual. During the study period the longest time without rain was two periods with no measurable rain for 4–5 days, one each in June and July, although on both occasions trace rainfall was recorded during the period.

Species Patterns

Seventy-three basidiomycete and six ascomycete taxa were collected. The basidiomycete taxa represented five families and were dominated by the gilled fungi. In all, sixteen genera of gilled fungi were identified. A list of those taxa found during the course of the study and their total frequency within each of the main dendrogram groups is presented in Table 1. Species richness for both sites was highest at the start of the study and decreased with time. The fern gully had both higher initial species richness and more variation in the number of species seen on successive visits (Fig. 2). The genera with the highest species richness were *Mycena* (11), *Cortinarius* (11), *Russula* (3) and *Tricholoma* (3).

Table 1. Species present at the Waterfall Gully sites with total number of fruit bodies for each of the seven dendrogram groups (A-G) used for the ordination plot

Numbers in brackets after the dendrogram group are the number of quadrats in the group. Dendrogram groups in which individual species were most commonly present (>20% of the weighted total occurrence) are listed.

Taxon	Group (No. of quadrats)	A (15)	B (23)	C (38)	D (7)	E (39)	F (65)	G (20)
Amauroderma rude (Berk.) Torrend	E,G	—	—	—	1	8	1	5
Campanella sp. A	B	—	41	—	—	—	2	—
Clavaria cinera	F,G	—	—	—	—	—	2	2
Clavaria sp. A	D,E,G	—	—	2	1	5	2	2
Clavulina rugosa Bull.	C,F,G	—	—	10	—	2	35	8
Clavulinopsis amoena (Zoll. & Mooritzi) Corner	C	—	—	38	—	—	13	3

Table 1. Continued

Taxon	Group (No. of quadrats)	A (15)	B (23)	C (38)	D (7)	E (39)	F (65)	G (20)
Clitocybe sp. A	C,D	1	1	—	—	—	—	—
Cortinarius (Dermocybe) clelandii A.H. Sm.	F,G	3	2	3	3	37	5	1
Cortinarius (Myxanicium) lavendulensis Cleland	A	6	1	1	—	4	—	1
Cortinarius (Myxamicum) archeri Berk.	E	—	—	1	—	5	—	—
Cortinarius (Phlegmacium) castaneofulvus Cleland	G	1	3	3	—	3	—	10
Cortinarius (Phlegmacium) microarcheri Cleland	B,F	—	1	—	—	—	10	—
Cortinarius (Telemonia) fibrillosus Cleland	A,D	7	4	4	6	10	3	1
Cortinarius sp. A	C	—	1	5	—	2	—	1
Cortinarius sp. B	G	—	1	3	—	—	—	13
Cortinarius sp. C	A–C	1	4	3	—	—	1	—
Cortinarius sp. D	D	—	—	7	5	—	8	1
Cortinarius sp. E	F,G	—	—	—	—	—	8	3
Crepidotus variabilis (Pers.: Fr.) P. Kumm.	C,F	—	—	4	—	—	7	—
Crepidotus sp. A	A	6	—	—	—	—	—	—
Crepidotus sp. B	B,E,F	—	36	—	—	47	55	—
Discinella terrestris (Berk. & Broome) Dennis	E,G	—	4	21	8	79	72	50
Entoloma lampropum (Fr.: Fr.) Hesler	C	—	—	1	—	—	—	—
Entoloma prostratum (Cleland) E. Horak	C,D	—	—	4	1	—	1	—
Galerina sp. A	B,E	—	2	—	—	1	—	—
Galerina sp. B	F	—	—	—	—	—	2	—
Hebeloma mesophaeum (Pers.) Quél.	F	—	—	—	—	—	2	—
Hydnum repandum L.: Fr	B,F	—	2	—	—	—	15	—
Inocybe sp. A	A,B	13	64	6	—	—	2	—
Inocybe sp. B	B,D,F	—	10	—	4	5	18	—
Laccaria laccata (Scop.: Fr.) Cooke	B,D	2	37	13	23	18	13	1
Lactarius eucalypti O.K. Mill. & R.N. Hilton	F	—	—	—	—	—	1	—
Leotia lubrica Pers.	E	—	—	—	—	7	—	—
Leptonia albida Cleland	A,F	5	2	1	—	3	—	3
Mycena australiana Cleland	B,C,E	—	108	230	—	136	140	3
Mycena cunninghamiana Cleland	E,F,G	—	—	—	—	2	2	1
Mycena fusca Cleland	A	13	10	14	1	16	10	2
Mycena pullata (Berk. et Cooke) Sacc.	C	3	5	42	—	14	4	1
Mycena subgalericulata Cleland	C,D,E	2	53	115	19	139	13	2
Mycena sp. A	D,G	—	1	—	8	4	27	58

Table 1. Continued

Taxon	Group (No. of quadrats	A (15)	B (23)	C (38)	D (7)	E (39)	F (65)	G (20)
Mycena sp. B	G	—	1	7	—	17	22	58
Mycena sp. C	B,E,G	—	1	—	—	2	—	1
Mycena sp. D	F	—	—	—	—	—	1	—
Mycena sp. E	B	—	2	—	—	—	1	—
Mycena sp. F	D	1	106	32	316	75	154	10
Oudemasiella radicata (Relhan: Fr.) Singer	B	—	2	—	—	—	—	—
Omphalina chromacea (Cleland) T.W. May & A.E. Wood	B	1	24	—	—	16	4	—
Panaeolus paludosus Cleland	B	—	2	—	—	—	—	—
Panus lecomptei (Fr.: Fr.) Corner	F	—	—	—	—	—	17	—
Paxillus infundibuliformis Cleland	A	1	—	—	—	—	—	—
Pluteus lutescens (Fr.) Bres.	E	—	—	—	—	205	—	—
Pluteus sp. A	A,C	1	—	1	—	—	—	—
Podoserpula pusio (Berk.) D.A. Reid	F	—	—	—	—	—	1	—
Ramaria ochraceosalmonicolor (Cleland) Corner	C,E,F	—	—	3	—	2	8	—
Rhodocybe reticulata (Cleland) E. Horak	B,E	—	1	—	—	1	1	—
Rickenella fibula (Bull.: Fr.) Raithelh.	D	—	—	—	3	—	1	1
Russula mariae Peck	A,C	1	—	1	—	—	—	—
Russula pectinata Peck	D	—	—	1	1	—	—	—
Russula persanguinea Cleland	B,C,E	—	1	2	—	5	—	—
Stereum sp. A	D	—	—	—	16	2	6	—
Thelephoraceae sp. A	F	—	—	—	—	—	9	—
Tremella mesenterica Retz.: Fr.	E,G	—	—	—	—	8	—	11
Tricholoma sp. A	B,E	—	2	—	—	1	—	—
Tricholoma sp. B	D	—	—	—	1	—	—	—
Tricholoma sp. C	E	—	—	—	—	1	—	—
Tricholomopsis rutilans (Schaeff.: Fr.) Singer	B,D	—	2	3	2	—	—	—
Xylobolus illudens (Berk.) Boidin	G	—	—	—	—	2	—	5
Ascomycota sp. A	C	—	—	6	—	—	—	—
Ascomycota sp. B	E,G	—	—	—	—	6	—	2
Ascomycota sp. C	B,E	—	85	11	—	68	16	9
Ascomycota sp. D	C	—	—	25	—	—	—	—
Basidiomycota sp. A	E	—	—	—	—	4	—	—
Basidiomycota sp. B	E	—	—	—	—	1	—	—
Basidiomycota sp. C	C	—	—	1	—	—	—	—
Basidiomycota sp. D	C	—	—	1	—	—	—	—
Basidiomycota sp. E	G	—	—	—	—	—	—	9
Basidiomycota sp. F	F,G	—	—	—	—	—	1	1
Basidiomycota sp. G	C,F	—	—	4	—	1	12	—

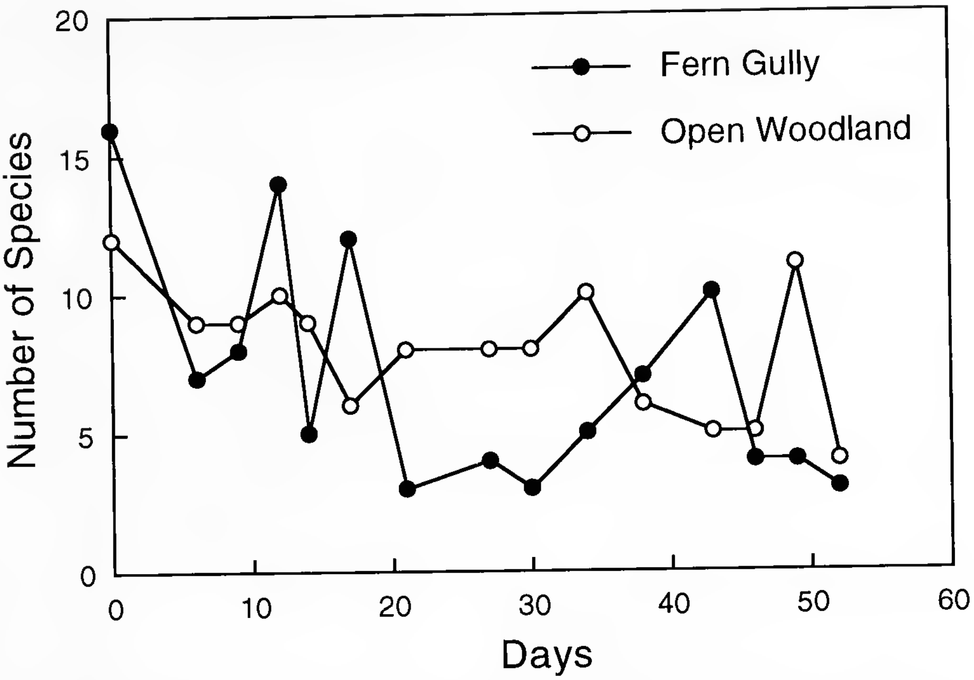

Fig. 2. Total species richness for the Fern Gully and open Woodland sites throughout the study period.

There were four major trends in the frequency of fruiting of those taxa which had a high occurrence of fruit production.

(1) Related species which occurred on similar substrates demonstrated an inverse pattern of high frequencies. For example, *Mycena australiana* and *M. subgalericulata* which grew on large woody substrata exhibited an inverse pattern of abundance: when the number of fruiting bodies of one was low the other was high (Fig. 3a). A similar relationship was observed between two species on *Inocybe* (Fig. 3b), a genus with mycorrhizal taxa (Aberdeen 1979).

(2) Taxa which had a high frequency of fruiting over a short period of time. This was observed in *Pluteus lutescens* which has a short lived peak in number of fruiting bodies. This peak fell off rapidly and the species did not occur again during the sampling period (Fig. 3c).

(3) Some genera were present in low or variable frequencies but were observed both throughout the sampling period and at both sites. For example, Laccaria laccata and several *Cortinarius* and *Mycena* spp. were observed throughout quadrats at both sites for the duration of sampling (Fig. 4a), although *Laccaria* does peak noticeably in the open shrubland.

For all three of these trends there was a general decline in the overall frequency of fruiting over the sampling period, with peaks in abundance being in the first 30 days of sampling.

(4) There was one ascomycete, *Discinella terrestris*, which increased in fruit frequency throughout the sampling period. This trend was observed at both of the sites, although this taxon appeared later within the quadrats in the wetter fern gully site than at the open shrubland site (Fig. 4b).

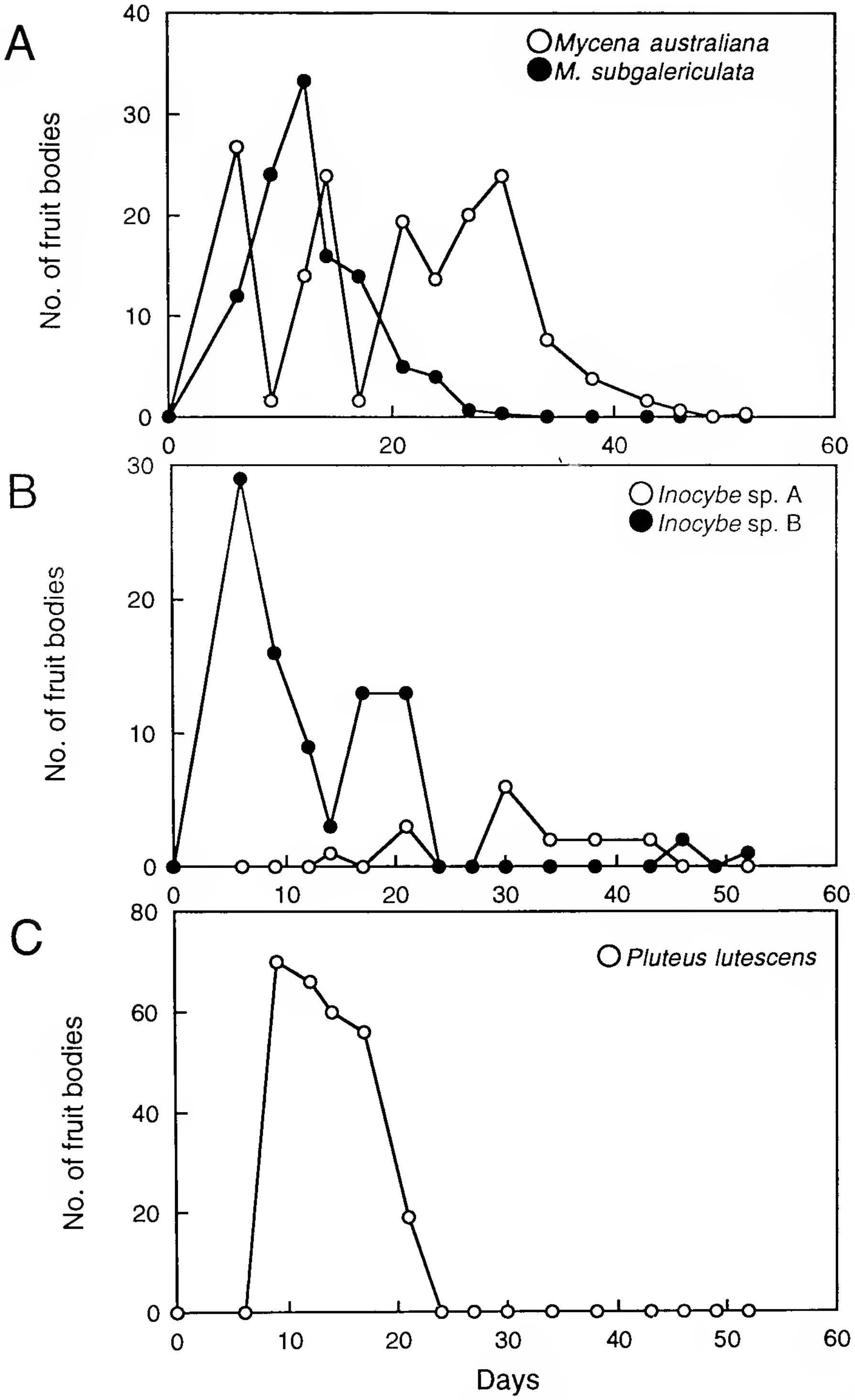

Fig. 3. a–c Examples of some of the phenology patterns exhibited by widespread species. Data represent totals for each species across all sites for each sample: **a** two common species of *Mycena* which grew on large woody substrata and exhibited an inverse pattern of abundance; **b** two species on *Inocybe* which also exhibited an inverse pattern of abundance; **c** *Pluteus lutescens* which showed a high frequency of fruiting over a short period of time.

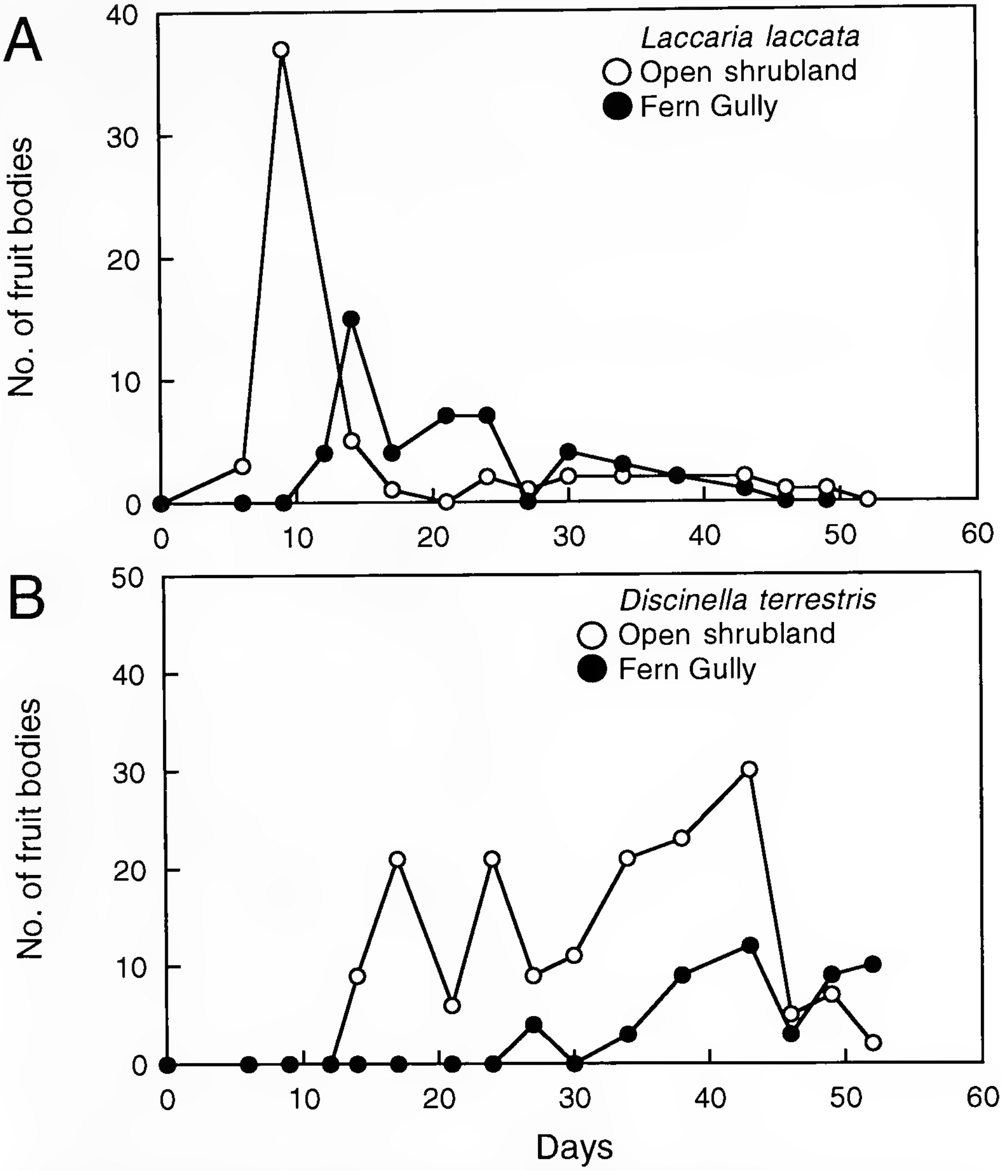

Fig. 4. **a**–**b** Examples of the patterns of phenology seen between the fern gully and the drier more open forest sites: **a** *Laccaria laccata* was observed at low frequencies throughout quadrats at both sites for the duration of sampling; **b** *Discanella terrestris*, increased in fruit frequency throughout the sampling period at both of the sites. This taxon appeared later within the quadrats in the wetter fern gully site than at the open shrubland site.

Cluster Analysis

The dendrogram was truncated at the seven group level. The relationships of these groups to each other are summarised in the inset in Fig. 5. The dendrogram can also be divided into three supergroups, the first (Groups A–D) representing quadrats predominantly from the first nine sample times: Group A represented quadrats 1 and 2 from the fern gully; Group B was quadrats 3, 4 and 5 of the fern gully; Group C was quadrat 6 from the fern gully and quadrats 1, 2 and 4 from the more open woodland; and Group D represents quadrat 5 from the open woodland. The second supergroup (Group E) consists of a mixture of quadrats 1 and 2 from the fern gully (times 10–15) and open woodland quadrats 6–8, times 1–9. The third supergroup (Groups E–F) represents quadrats from times 10–15. Group F is made up of fern gully quadrats 3–8 and open woodland quadrats 1–5; Group G, open woodland quadrats 6–8 only.

The species found in the survey which were found to be either restricted to or most common in particular dendrogram groups, were as follows:

Group A: *Cortinarius lavandulensis*, *Crepidotus* sp. A and *Paxillus infundibuliformis*.

Group B: *Campanella* sp. A, *Oudemansiella radicata*, *Omphalina chromacea* and *Panaeolus paludosus*.

Group C: *Clavinulopsis amoena*, *Cortinarius sp.* A, *Entoloma lampromum*, *Mycena pullata*, Ascomoycota spp. A & D and Basidiomycota sp. D.

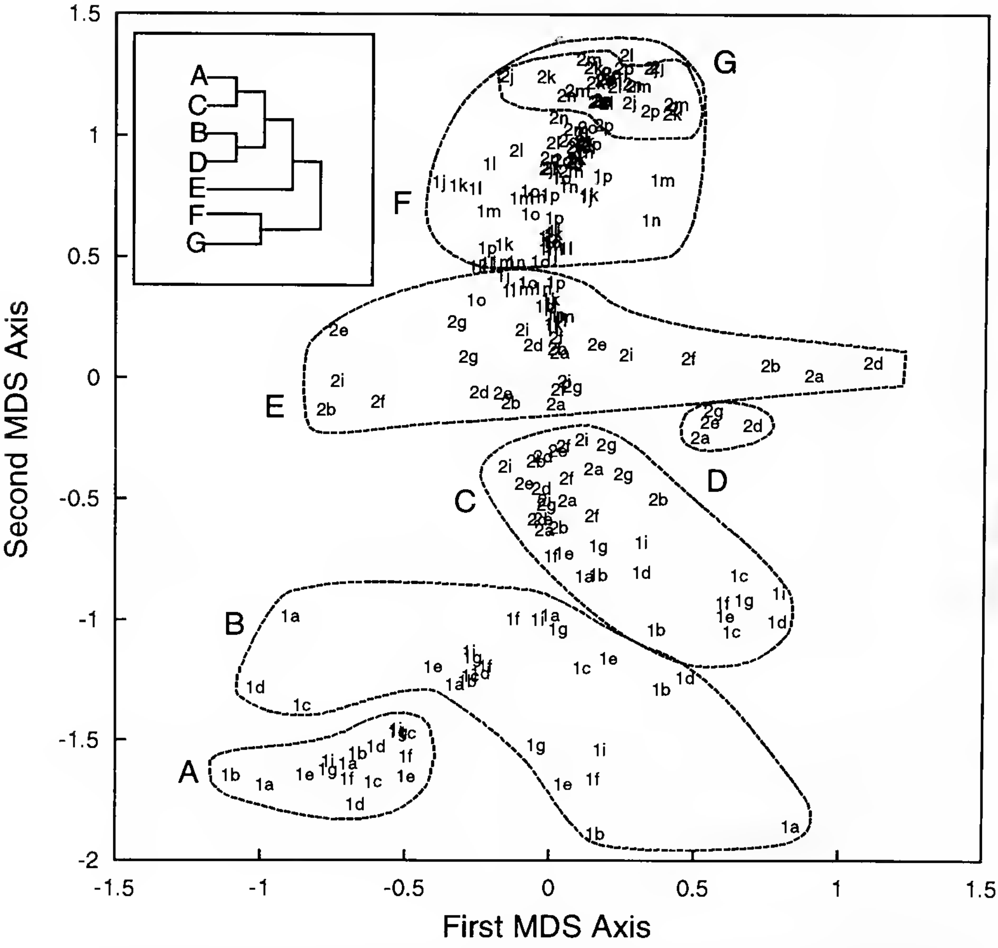

Fig. 5. MDS Ordination of the quadrats sampled through time with seven equally dissimilar dendrogram quadrat groups (A–G) identified from Bray-Curtis, UPGMA clustering (inset). Within the groups, 1 and 2 represent quadrats from fern gully and open forest sites respectively, lower case a-p represent the repeated observations through time for each site from earliest to latest.

Group D: *Cortinarius* sp. D, *Mycena* sp. F, *Rickenella fibula*, *Russula pectinata*, *Stereum* sp. A and *Tricholoma* sp. B.

Group E: *Cortinarius archeri*, *Leotia lubrica*, *Pluteus lutescens*, *Tricholoma* sp. C and Basidiomycota spp. B & E.

Group F: *Galerina* sp. B, *Hebeloma mesophaeum*, *Mycena* sp. D, *Panus lecomptei*, *Podoserpula pusio* and Thelophoraceae sp. A.

Group G: *Cortinarius* sp. B, *Mycena* sp. B, *Xylobus illudens* and Basidiomycota sp. E.

Ordination

The MDS ordination restricted to two dimensions produced a stress value of 0.12. This stress value is considered to represent an acceptably small degree of distortion of the inter-OTU (operational taxonomic units) distances. MDS (unlike Principal Component Analysis) does not partition the variance along the principal axes and all axes contribute equally, so alignment or greater spread along the 'second' axis is not a concern (Belbin 1992).

When the dendrogram groups were overlaid on a plot of these two ordination dimensions (Fig. 5), five groups (A–F) were discrete, with two groups (F and G) overlapping. The ordination groups aligned mostly along the second MDS axis, with the lower quadrants representing the early season samples, when conditions were generally wetter and warmer. When the dendrogram groups were compared with the PCC vectors for the environmental features measured (Fig. 6), Groups A and B were associated with recent rainfall events, whereas quadrat Groups C and D were related more with the amount of rain and higher temperatures. Rainfall, and temperature show a similar second MDS axis response, decreasing in intensity, with Group F representing drier and cooler (and later) sites. However, this relationship is inversely related to sampling time which increases across Groups B, C, D to F, and therefore rainfall, temperature, and time of sampling are confounded and cannot be distinguished uniquely as discrete factors underlying community structure. The number of days since last rain increased in the direction of Group A to F and G, indicating that fungi in Group A, and to a lesser extent Group B, tended to be associated with recent rainfall while other Groups did not.

The quadrats in Group E were aligned along the first MDS axis and were not clearly associated with the most of environmental features measured. There was a tendency for the soil moisture and species richness features to align with this axis, but they represent non-significant trends only.

In summary, five patterns of quadrats were seen in relation to environmental variables: (1) those occurring early during sampling, which corresponds to wet warmer conditions (dendrogram Groups A–D), (2) those occurring late during sampling corresponding to drier cooler conditions (Groups F–G), (3) those occurring after recent rainfall (Groups A and B), (4) those occurring without recent rainfall (Group G), and (5) quadrats which were not correlated significantly with any of the environmental variables measured (Group E).

Group D was unique in that it only contained representative temporal samples of a single quadrat from the shrubland site for the first 33 days of sampling. It was observed that this quadrat had a homogeneous species richness and high abundance throughout the first half of the sampling period. Although there were no significant relationships between species richness, abundance or soil moisture within the ordination space, these factors showed a general trend of increasing influence in the direction of group D (Fig. 5).

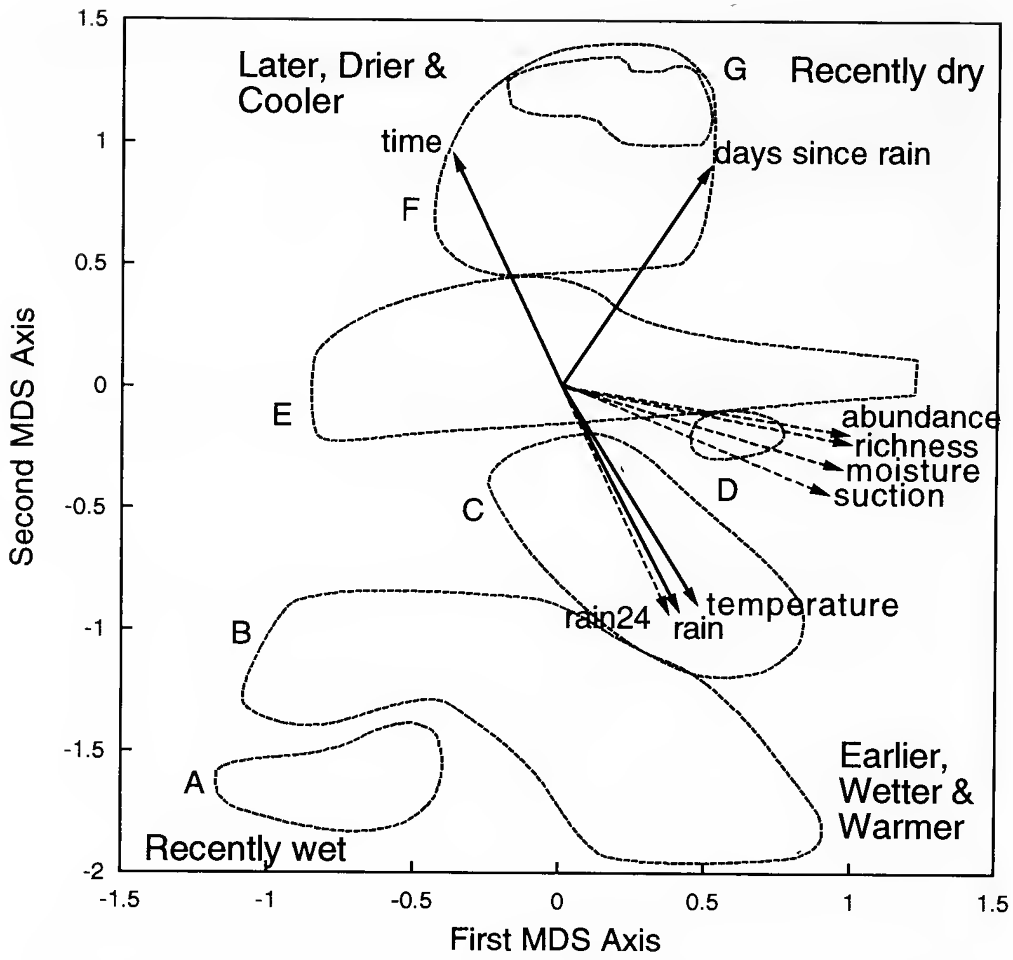

Fig. 6. The relationships between the quadrats and the measured environmental variables are shown as PCC vectors; significant correlations are indicated by solid vector lines, non-significant trends by dashed lines; vector directions indicate the direction of increasing effect within the ordination space. Group positions and letters are those from Fig. 4.

Discussion

A large number of fungal species were found in Waterfall Gully from late autumn to mid winter of 1992. Although most species were present throughout large parts of the sampling period, many species only produced one or two fruiting bodies during this time, with only a few taxa both common in number and through time. This pattern of a few major taxa accounting for most biomass has also been documented for ectomycorrhizal basidiomycetes (Bills *et al.* 1985).

There was a strong temporal influence on the fruiting pattern which correlated with the rainfall and temperature fluctuations during the sampling period. Early in the season there were differences in the fungal composition between the sites, but their composition converged during mid-winter. Due to the relationship between rainfall, temperature and time, these factors could not be distinguished in isolation as having the greatest influence on the structure of the fungal community. The temporal pattern may have resulted from ambient conditions as other studies have related the intensity of fruiting to ambient temperature and moisture availability (e.g. Austwick 1968; Blackwell and Gilbertson 1984). A full seasonal study would be required to elucidate the latter, and studies often require several years to isolate environmental factors from temporal patterns (Peterson 1977; Mehus 1986).

For example, in the basidiomycete *Dermocybe uliginosa* the onset of fruit body production was found to be initiated by soil temperature at 0.05m and the daily minimum temperature above the soil surface whereas the abundance of fruiting bodies may also be determined by the soil water vapour pressure (Kotilová-Kubicová *et al.* 1990). Initiation of spore production in the ascomycete *Venturia inaequalis* (St-Arnaud *et al.* 1985) and fruit body production of the basidiomycete *Lactarius mexicanus* (Luz and Torres 1994) were also strongly correlated with minimum ambient temperature and specific sustained levels of precipitation. Similarly, individual myxomycete species demonstrated resource partitioning through temporal variation in sporulation along moisture and canopy cover gradients (Stephenson 1988).

It is interesting that as conditions at Waterfall Gully became cooler, albeit slightly drier, there was convergence in the fungal floras across the open and closed forest-type quadrats. Mehus (1986) found that in good fungal seasons in Scandinavia (equivalent to cool and wet winters in South Australian terms) there is more similarity in the fungal species composition between different sites than in dry years. Salo (1994) working in Finnish forests also found that their communities were dominated (as were ours) by *Cortinarius*, *Mycena*, *Tricholoma* and *Russula* spp. and that species diversity was higher in the more mesic environments sampled, especially for mycorrhizal and saprophytic macrofungi. Similarly, G'osheva and Bogoev (1990) in Bulgarian pine forests found that phenology was strongly controlled by humidity and microclimate.

Holownia (1986) observed that within apparently 'uniform' ecological communities, there were different patterns of fungal fruit body emergence, with the same species behaving differently in different, but closely spaced areas sampled, concluding that this was the result of edaphic responses. In that four year study, several species were found to be reliably predictable in their fruiting rhythms, whereas other taxa exhibited two- or three-phase fruiting appearances which were considered to be responses to temperature and moisture rather than species-specific characteristics. In contrast, Fedora and Boobook (1986) found that *Armillariella mellea* was only capable of fruiting once per season on the same substrate, although the environment and climate also influenced the timing of the fruiting.

We found that at Waterfall Gully as conditions became generally drier, there was convergence in the fruit body types emerging at the sites, but as this was associated with a general reduction in total species numbers, it possibly represents convergence through all sites becoming sufficiently dry that only those species which can produce fruit bodies under lower moisture levels were observed. This was further seen in the split into those quadrats sampled before and after time 9 of the study. These later samples were drier and generally more similar floristically. The earlier sampled quadrats were wetter and there was patchiness not only between the fern gully and shrubland sites, but also between different quadrats within these sites. This suggests that there are microclimatic or at least microecological features which are influencing the appearance of the fruit bodies. Nevertheless, as with the studies of Mehus (1986), Stephenson (1988) and Salo (1994) the highest species diversity, richness and total abundance were in the more mesic sites at the wettest times.

The quantitative effects of cover were not measured in this study, and should be the subject of further studies to determine how exposure influences not only fruit body production, but also the other environmental parameters which themselves can affect fungal phenology. Similarly, the potentially differential phenology responses to the environment by soil-living mycorrhizal versus wood-rotting fungi need more careful investigation. Nevertheless, there were both mycorrhizal (e.g. *Cortinarius* and *Russula*) and wood-rotting taxa (*Mycena* and *Pluteus*) present as key species in several of the dendrogram groups, suggesting that the responses were not necessarily substrate specific.

Soil moisture was not a good indicator of water availability to the fungi, as many species grew on other substrata. Methods of quantifying the moisture content of substrata other than soil, such as leaf litter and logs would allow for a better evaluation of the importance of moisture in fungal fruiting. The moisture holding capacity of substrata can influence the persistence time of the fruiting structure (Ingold 1984). The water content of leaf litter and fine twigs is primarily a function of daily temperature and relative humidity. In contrast, branches, logs and stumps take longer to dry after being saturated by heavy rains. Larger substrata also provide greater organic carbon supplies than smaller substrata (Mehus 1986). These larger substrata may form a suitable surface for continuous fruit production and lead to more competitive influences structuring the community. Relationships between different species of *Mycena* and *Inocybe* which grew on logs and stumps may have resulted from this.

There are also many fungal species which may have mycorrhizal associations, and in a number of studies it has been observed that the interaction between the host and the symbiont is also important in fungal phenology (Bentivenga and Hetrick 1992; Johnson-Green *et al.* 1995), thus the mycorrhizal status of the fungal taxa observed in the present study requires clarification. The fungal response to the mycorrhizal partner, site location and substrate age and condition were all considered to interact in determining the ecology of the taxa observed by Holec (1993), and careful experimental design will be needed as well as longer-term observations to unconfound the effects of the parameters affecting fruiting phenology at Cleland.

In the Waterfall Gully area, there are indications of relationships between environmental factors and the patchy distribution of many macrofungal species. Further investigations are required in particular, long term studies or permanent sites, combined with more detailed measurement of ecological parameters and potential mycorrhizal interactions before the observed patterns can be explained adequately.

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Orphans in 'Botanical' Diversity

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Abstract

The range of organisms included in 'botany' has included ones now placed in five different kingdoms of Life (*Bacteria*, *Chromista*, *Fungi*, *Plantae* and *Protozoa*). The hypothesis that 'botanical' organisms other than in the kingdom *Plantae* should be viewed as 'orphans' within botany is tested in relation to different attributes of human orphans: these lack close relatives, are misunderstood, excluded from 'family' events, unnamed, ignored or overlooked, have few carers, and are inadequately provided for. No data contrary to the hypothesis was discovered. 'Botanical' orphans are to be valued for their crucial ecological roles, potential as bioindicators, and as a source of exploitable attributes. The 'botanical' orphans merit human attention from both altruistic and selfish motives, and resourcing commensurate with their importance.

Introduction

In this contribution I endeavour to highlight the issue that some groups of organisms, many of importance to humankind and the environment, are not being investigated to an extent commensurate with their significance. They have become 'orphans' within their discipline.

Orphans by definition lack parents, but in addition to familial isolation 'botanical' orphans share other characteristics found in human orphans: they often lack known close relatives, are misunderstood, excluded from 'family' events, unnamed, ignored or overlooked, have few carers, and are inadequately provided for. Data are presented to test the hypothesis that there are 'botanical' orphans relating to each of these criteria.

What is Botany?

The first step in this enquiry must be to define 'botany'. The word derives from one used in ancient Greece to mean grass, fodder or pasture. The first book title using the word in a classificatory sense appears to be the *Pinax Theatri Botanici* (Bauhin 1623) which included algae, mushrooms and lichens as well as vascular plants, bryophytes and ferns. The first usage in English recorded in the *Oxford English Dictionary* (1971) is by Ray in a letter dated 1696 (Dereham 1718), and the definition of botany in that *Dictionary* is 'the science which treats of plants'. *Collins Reference Dictionary of Biology* (1988) has 'the scientific study of the plant kingdom, usually including microorganisms'. Surprisingly, or perhaps intentionally, *The Penguin Dictionary of Botany* (Blackmore and Tootill 1984) fails to define 'botany', although its Preface indicates pure and applied plant sciences and the work includes algae, fungi and even some prokaryotes.

Evidence for a definition in practice is seen in the scope of botanical gardens and other institutions, botany departments, botanical meetings, societies, journals, and textbooks of botany. These are invariably found to include, to a greater or lesser extent, algae, bryophytes, ferns, and fungi (including lichens) in addition to flowering plants. The number of possible examples is overwhelming, but indicative are the contents of reference collections listed in *Index Herbariorum* (Holmgren *et al.* 1990), the subjects of papers in journals such as the *Canadian Journal of Botany*, symposium titles at International Botanical Congresses, and papers commemorating botanical anniversaries (e.g. Wagner 1974; Short 1990). That not all 'botanical' departments, institutions, meetings, journals and books hold or treat organisms other than vascular plants is an observation pertinent to the 'orphan' hypothesis.

Bacteria (and often also viruses) were regularly to be found in textbooks of botany into the 1960s (e.g. Brimble 1964). This tradition has even been maintained in at least one influential text (Raven *et al.* 1992), but in general bacteria and viruses are now almost exclusively confined to departments, societies, journals, textbooks and meetings labelled 'microbiology', a not entirely appropriate term (Cowan 1978). A complication is that microbiology as currently interpreted in practice encompasses some groups still also treated in 'botanical' fora, notably algae, cyanobacteria, and fungi (Hawksworth 1992). Interestingly, in universities with no microbiological departments or microbiologists, prokaryote teaching invariably reverts to departments of botany or other botanists on the faculty.

The *International Code of Botanical Nomenclature* (Greuter *et al.* 1994: Pre. 7) covers 'all organisms traditionally treated as plants ... e.g., blue-green algae (*Cyanobacteria*); fungi including chytrids, oomycetes and slime moulds; photosynthetic protists and taxonomically related non-photosynthetic groups' and not only those referred to the kingdom *Plantae*. 'Fungi' in the sense of the Code are defined as 'including slime moulds and lichen-forming fungi' (Art. 13.1*d*).

What are the 'Botanical' Orphans?

For the purposes of the subsequent analysis in this contribution, I posit that the algae, cyanobacteria, fungi (including lichens) and photosynthetic protists are all treated as putative 'botanical' orphans. In my discussions, I will emphasise the non-photosynthetic heterotrophic groups, as the photosynthetic ones were considered in depth separately by other contributors to the 'Beyond the Floras' Conference, with the exception of the ecological units termed 'lichens'.

The Characteristics of 'Botanical' Orphans

The evidence to test the hypothesis that the organism groups cited above merit the appellation 'orphans', can be presented by each of the characteristics encountered amongst orphaned humans.

(a) Lacking Close Relatives

It has been recognised for many generations that Life on Earth cannot be simply divided into two kingdoms, *Animalia* and *Plantae*. A five-kingdom system has been widely used since promulgated by Whittaker (1969), which also distinguished the *Fungi*, *Monera* and *Protista* at the same rank; all but *Animalia* included organisms historically studied by botanists. Molecular work has shown that systems based on ultrastructural differences, ciliation, cell-wall composition, chlorophylls, phycobilins and lysine synthesis were not only robust but merit further higher categories — especially as an enormous molecular diversity amongst uncultured bacterial groups has become apparent. There is now general agreement that two domains or superkingdoms should be recognised, *Prokarya* and *Eukarya*. The former includes the *Archaea* and *Bacteria* (including *Cyanobacteria*) and the latter *Animalia*, *Chromista*, *Fungi*, *Plantae* and *Protozoa* (Cavalier-Smith 1993; Corliss 1994). A few authors still unite *Chromista* and *Protozoa* into the *Protoctista* (or *Protista*; e.g. Margulis 1996), but this can now be justified only by pragmatic rather than phylogenetic arguments.

As molecular data accumulate, evidence that more higher categories merit recognition is emerging. Sogin *et al.* (1996) suggest that at least two main categories in *Eukaryka* should be recognised within what others have termed *Chromista*; they informally refer to these as 'alveolates' (including dinoflagellates) and 'stramenopiles' (including diatoms, oomycetes, labyrinthulids, brown algae, and chrysophytes).

The data now available suggests that the *Fungi* are more closely allied to the *Animalia* than to the *Plantae* (Wainright *et al.* 1993), and that some of the organisms formerly regarded as fungi belong not in the kingdom *Fungi*, but in the *Chromista* (or 'straminopiles'; i.e. the labyrinthulids and oomycetes) or *Protozoa* (i.e. the slime moulds). The term 'fungi' is consequently now best used in the colloquial sense of organisms traditionally studied by mycologists (Christensen 1990; Hawksworth 1991; Barr 1992; Hawksworth *et al.* 1995). A parallel argument exists for the use of the term 'algae' (Christensen 1990), which are now dispersed not only within different kingdoms of *Eukarya*, but also even extending into *Prokarya* for the cyanobacteria.

The cyanobacteria provide the most extreme case of distant relatives amongst the 'orphans'. These organisms were historically treated as blue-green algae, but molecular data accumulated from 1980 has established beyond doubt that they are true bacteria and belong in the kingdom *Bacteria* in the domain *Prokaryota* (Margulis 1996; Whitton 1992). The cyanobacteria are consequently now starting to receive increased attention from bacteriologists, although still studied by 'algologists', and their nomenclature remains subject to the *International Code of Botanical Nomenclature* (see above).

It is clear that orphan 'botanical' groups, other than bryophytes, do not have close relatives in *Plantae*.

(b) Misunderstood

Misunderstandings about some of the 'orphans' are of long-standing. For example, the genus *Mucor* as treated by Linnaeus (1753) also incorporated species of at least *Aspergillus*, *Calicium*, *Chaenotheca*, *Erysiphe* and *Penicillium*; Linnaeus also included four lichenised species in the 'algal' genus *Byssus*, and the cyanobacterial lichen *Leptogium lichenoides* lay hidden in the jelly-fungal genus *Tremella*.

It was not appreciated that lichens were composite structures formed of a fungus and(or) algae or cyanobacteria until 1867, and the nature and definition of lichens has been continuously and sometimes acrimoniously debated since that time (Hawksworth 1988; Hawksworth and Honegger 1994). Although since 1959 the *International Code of Botanical Nomenclature* has explicitly stated that names given to lichens refer to the fungal component, they were treated as if a separate class *Lichenes* until after the Thirteenth International Botanical Congress in Sydney in 1981. What was and was not considered a 'lichen' at least in part stemmed from what Acharius (1810) had treated in the *Lichenographia Universalis*; Fries held Acharius in the highest regard as the last pupil to defend his thesis in the presence of Linnaeus, and included in the *Systema Mycologicum* (Fries 1821–32) only fungi not considered to be lichens by Linnaeus. Indeed, there is evidence for occasional correspondence between them on this topic.

This has meant that some non-lichenised fungi continue to this day to be studied by lichenologists (e.g. *Chaenothecopsis*, *Leptorhaphis*, *Stenocybe*). In practice single genera can even include both lichenised and non-lichenised species, or have different biological strategies according to the stage in their life life-histories (e.g. *Caloplaca*, *Diploschistes*, *Mycomicrothelia*, *Rhizocarpon*, *Toninia*). The polyphyletic origin of lichens has been generally accepted by ascomycete systematists since the mid-1970s, and is now indisputably confirmed by molecular data (Gargas *et al.* 1995). Lichen-forming fungi are now being routinely included in overall classification systems, check-lists, and mycological text-books (e.g. Hawksworth *et al.*, 1995; Alexopoulos *et al.*, 1996). As in the case of other ecological groups of fungi, such as entomopathogens, mycorrhizas, or plant pathogens, this does not preclude pragmatic accounts of fungi with biological strategies held in common.

Yet lichens continue to be misunderstood. A separate phylum name, *Mycophycophyta*, was used by Margulis (1993) including basidiomycete and ascomycete lichens with algae and cyanobacteria — a 'phylum' polyphyletic to the extent of including elements from three kingdoms. Lichens have even being included in the *Flora of Australia* from 1992, rather than the *Fungi of Australia* series started in 1996; an anachronistic situation that perhaps merits a revisit.

(c) Unnamed

There has been considerable debate generated on the issue of estimating the numbers of known and undescribed species on Earth. The various estimates proposed have been assessed in the UNEP *Global Biodiversity Assessment* (Heywood 1995) and working figures recommended (Table 1). Accepting that there are wide margins for potential error in these calculations, the differences in the percentages of the known *vs* estimated species for the different 'botanical' groups are, nevertheless, striking. Whereas 84.4% of the Earth's plants have been described, the proportions for algae, bacteria and fungi are 10, 0.04 and 4.8% respectively. Ninety percent or more of the orphans remain unnamed.

The date by which the inventory for each group will be completed at current rates of species description (where available) are also staggeringly divergent. The year 2024 seems not unreasonable for vascular plants, but contrasts markedly with 2888 for fungi, and even more dramatically with 10295 for bacteria. This pattern is mirrored at the national level. For example, in the British Isles (where for this purpose the native plants can be considered 100% known) those changes that occur are largely from revisions in taxonomy, and the total has remained at around 2,100 for the last 40 years. In the case of the fungi, the British list has increased by 100% over this same period (Hawksworth 1991). It is still not too difficult to find fungi new to science in the British Isles, mycologically the world's best-studied country; on average 46 species of fungi new to science are still described from the country every year (Hawksworth 1993).

Table 1. Known and estimated global species numbers (in thousands) for selected 'botanical' groups, with rates of species description and the estimated year of completion of the inventory (based on data in Heywood 1995)

Group	Known species	Estimated species	Percentage known	Described per year	Estimated year of completion
Algae	40	400	10.0	unknown	unknown
Bacteria	4	1,000	0.04	120	10295
Fungi	72	1,500	4.8	1,600	2888
Plants	270	320	84.4	1,700	2024

Against this background, the task of completing the inventory of Australian fungi is especially daunting as so little exploration has yet been carried out. In the five years 1991–95, 405 species of fungi (including lichen-forming species) were catalogued as newly described from Australia in the *Index of Fungi*. Pascoe (1990) argued that the number of fungi in Australia could be 10 times the number of Australian plants, i.e. 250,000. The actual number of fungi already known in the country is unlikely to be more than 5,000 (including lichen-forming groups), suggesting 245,000 may await discovery. If all were new for science, at the rate of description seen in the last five years it would take another 3,025 years to complete the task. In practice, many will have been described from other regions, but even assuming that 50% were new, the task would take until the year 3508 at current levels of resourcing. The *Fungi of Australia* will require careful long-range planning and megascience scale financing.

The extent of novelty in all 'orphan' groups challenges us to adopt new methods of working and to determine priority groups for systematic research (Hawksworth and Ritchie 1993; Rossman 1995; Cannon 1997; Hawksworth *et al.* 1997; Hyde and Hawksworth 1997).

(d) Excluded from Family Events

Orphans can be expected to be excluded from or marginalised at family events. Few botanists working on orphan groups belong to general botanical societies, especially where there are active national or international bodies catering for their specialities. For example, the Botanical Society of the British Isles (BSBI) specifically advertises itself as 'the major source of information on the status and distribution of British and Irish flowering plants and ferns'; since 1836 the Society and its forerunners only had vascular plant specialists as President's, although two also 'straying' into bryophytes were accepted (Allen 1986). The International Association for Plant Taxonomy (IAPT), is 'concerned with botany in the traditional broad sense [and] embraces all organisms within the mandate of the *International Code of Botanical Nomenclature*, regardless of their current disposition in particular kingdoms'; it had 91 mycologists (including lichenologists) as personal members in 1994, 10.3% of the 808 membership.

This same pattern of no or minimal representation at 'botanical' parties, is seen in congresses, workshops and symposia. The most recent International Botanical Congress (IBC) is illustrative. The Fifteenth IBC, held in Yokohama, Japan in 1993, included 211 symposia; only 8 (3.8%) concerned algae and 11 (5.2%) fungi. The 'orphans' now largely have their own international congresses, for example the International Mycological Congress series initiated in 1971.

(e) Ignored or Overlooked

Many 'botanical' and 'plant' texts ignore the 'orphans'. While this can be justified where 'plant' is used in the sense of *Plantae*, this is hardly defensible for 'botany' in its traditional interpretation. In works that do mention them at all, the treatments tend to be disproportionate to the extent of diversity in the 'orphan' groups. An analysis of the contents of five tertiary-level texts which have appeared over the last four decades revealed that while not less than 38% of the pages were devoted to vascular plants, no 'orphan' group attained more than 8% (Table 2).

The coverage in five 'botanical' journals for the 10 years 1985–95 was analysed and found to be in a similar mould (Table 3). Not more than 15% of the total pages were devoted to any 'orphan' group in any of these journals, compared with 77–90% allocated to vascular plants. The complete runs of two Australian 'botanical' journals, the *Australian Journal of Botany* and *Muelleria*, were then assessed to determine if the pattern had changed over the last 40 years (Table 4); it had not.

Table 2. Space allocations (% pages) botany textbooks

Textbooks	General	Bacteria & Viruses	Algae	Fungi	Bryophytes	Vascular Plants
McLean and Ivimey-Cook (1951–73)	16.5	0.5	4	4.5	0.5	74
Brimble *et al.* (1960)	39	0.5	4	7	2	48
Weier *et al.* (1982)	39	5	6.5	8	3.5	38
Sitle *et al.* (1991)	34.5	1.5	6	6	2.5	50
Raven *et al.* (1992)	32.5	4.5	6	6	2.5	48

Table 3. Space allocations (% pages) in botanical journals 1985–1995

Journal	Bacteria & Viruses	Algae	Fungi	Bryophytes	Vascular Plants
Australian Journal of Botany	0.5	2	11	0.5	86
Muelleria	—	3	15	—	82
Nordic Journal of Botany	0.1	12.5	10	—	77.4
Plant Systematics and Evolution	0.05	4.6	4.6	0.15	90.6
Taxon	—	4.0	4.5	6.5	85

Table 4. Space allocations (% pages) in two Australian botanical journals

Volume (Year)	Bacteria & Viruses	Algae	Fungi	Bryophytes	Vascular Plants
Australian Journal of Botany					
1-5 (1953–57)	—	3.	3.5	1	92.5
6-10 (1958–62)	—	6.5	1.5	2	90
11-15 (1963–67)	—	10	13.5	—	76.5
16-20 (1968–72)	0.5	12	11	—	76.5
21-25 (1973–77)	1.5	18	14	2	64.5
26-30 (1978–82)	0.5	6	14.5	—	79
31-35 (1983–87)	0.5	3.5	14	0.5	81.5
36-40 (1988–92)	0.25	—	10	0.25	89.5
41-43 (1993–95)	—	—	8.5	—	91.5
Mean	0.5	6.5	10	0.5	82.5
Muelleria					
1 (1955–67)	—	9	22	4	65
2 (1969–73)	—	1	4	11	84
3 (1974–77)	—	—	26	5	69
4 (1978–81)	—	1.25	8	1.25	89.5
5 (1982–84)	—	—	4	—	96
6 (1985–88)	—	—	13.5	—	86.5
7 (1989–92)	—	4	13.5	—	82.5
8 (1993–95)	—	5	18.5	—	76.5
Mean	—	2.5	13.5	3	81

(f) With Few Carers

The issue of the shortage of systematists world-wide has been widely publicised; the total number of scientists describing new organisms world-wide stands at around 7,000 (Heywood 1995). The issue entered the intergovernmental arena at the second meeting of the Subsidiary Body on Scientific, Technological and Technical Advice (SBSTTA) to the Convention on Biological Diversity in Montreal in September 1996; the recommendations from that meeting were subsequently endorsed at the Third Conference of the Parties to the Convention in Buenos Aires in November 1996. Nations are realising that systematic services are necessary to enable them to meet their obligations under the Convention.

The situation is particularly acute in the species-rich groups, especially the putative 'orphans'. In the case of Australia, Pascoe (1990) noted that only 26 taxonomic mycologists were present in the country, 11 of whom were lichenologists. As a result of a questionnaire, Grgurinovic and Hyde (1993) reported that there were 32 researchers in Australia spending some time on taxonomic mycology; half devoted less than 20 h each month on research, and five were concerned with only three economically important genera. These authors list 55 orders of fungi on which there have been no publications by Australian authors in the years 1988–91. This issue is returned to in the contribution by Hyde (1997).

The level of 'carers', both researchers and curators, can also be reflected in institutional structures. Zoologists learnt long ago that the recognition of more departments was a key to gaining more curators and researchers. In many cases, botany is a single department whereas zoology is distributed through several. For example, in the Royal Ontario Museum in Toronto, zoology is represented by seven departments and has 67 staff; botany is a single department with seven staff, yet encompasses organisms from five and not part of one kingdom (Royal Ontario Museum 1993; Table 5). In such structures, 'orphans' are proportionately disadvantaged; within botany at the ROM, mycology is represented by one research fellow and half of a technician.

(g) Inadequately Provided for

The numbers of botanical institutions which hold reference material of the 'orphan' groups are considerable world-wide, but the collections are generally small, restricted in scope, and lack specialist staff. Data collected by Walker (1980) indicated that in Australia there were then about 244,000 fungal (including lichen) specimens and cultures distributed through 62 institutions, eight of those institutions accounting for 150,000 of the collections. The figure of 244,000 constitutes 4.6% of the 5.3 million

Table 5. Structure of the biological departments and numbers of personnel in the Royal Ontario Museum, Toronto in 1993 (Royal Ontario Museum 1993)

Department	Personnel
Botany	7
Entomology	6
Ichthyology and Herpetology	11
Invertebrate Palaeontology	10
Invertebrate Zoology	7
Mammology	12
Ornithology	12
Vertebrate Palaeontology	9

botanical specimens housed in 38 Australian collections (Holmgren *et al.* 1990; Heywood 1995). The situation for algae is similar, 204,000 collections, 3.8% of the total, being contained in seven collections (Richardson and McKenzie 1992).

The situation is similar in the case of other genetic resource collections in Australia. There are 101,000 vascular plants in Australia's botanical gardens and 94,000 accessions in seed banks, yet a mere 2,202 fungi are maintained in culture in the country (Heywood 1995).

Inadequate in-country capacity has implications for where specialists will deposit critical material. Of the 405 species of fungi described as new from Australia in the period 1991–95, the name-bearing types of 136 (33%) were deposited in reference collections outside the country. While this percentage is not exceptional and conforms to the general pattern (Hawksworth and Kirk 1995), the absence of key reference material in the country will constrain the speed with which Australian mycologists can progress their systematic work.

Some Australian botanists have questioned the value of reference collections (Clifford *et al.* 1990). Acquisitions and curatorial policies certainly need to be kept under review, but reference collections of all kinds are a major facility required for diverse purposes. Grgurinovic and Walker (1993) stress the crucial role of fungal collections in identification, determination of host and geographic ranges, quarantine, and biocontrol. With so few mycological systematists, and with so many fungi being either unnamed or belonging to groups yet to be critically revised, collections are the key reference point for validating published reports of all kinds. Collections also have largely untapped potential; preserved material of lichenised and other fungi can aid bioprospecting for secondary metabolites (Paterson and Hawksworth 1985; Elix 1992). DNA can also be extracted and amplified from both dried cultures and specimens for use in systematic and other investigations (Wingfield and Wingfield 1993). I have recently addressed the importance of microbial genetic resource collections to biodiversity and biosystematics elsewhere (Hawksworth 1996).

The decision to close the Biological and Chemical Research Institute (BCRI) at Rydalmere and relocate the fungal collections to new facilities in Orange was confirmed in August 1996. This action has concerned mycologists world-wide as the Rydalmere collection is the most important for mycology in the continent. Careful planning and adequate resourcing will be needed if the effectiveness of the collection is to be not only maintained but enhanced. An independent review of the effects of the break-up of BCRI is recommended after 3–5 years (Standing Committee on State Development 1996); if that is not positive it will record a major set-back to Australian mycology.

Why 'Botanical' Orphans Should be Valued

There are multifarious reasons why 'botanical' orphans should be valued, and three are introduced here as indicative.

(a) Ecological Processes

The various 'orphan' groups are responsible for a variety of crucial roles in ecosystem functioning and plant health. Their significance is becoming increasingly apparent as ecological processes are examined in depth. Organisms forming mutualistic associations with plants are of especial significance, notably mycorrhizal and endophytic fungi. Mycorrhizas can bind together communities and translocate nutrients that limit plant growth (Read 1996), influencing the quality and quantity of below-ground carbon (Rygiewicz and Andersen 1994), and endophytes produce metabolites inhibiting insect pests (Clay 1990).

Photosynthetic 'orphan' groups fix substantial amounts of carbon dioxide at the global scale. They constitute up to 80% of the primary productivity and biomass in open oceans (Andersen 1992).

Others, mainly fungi, are crucial to the cycling of nutrients from dead and waste biotic materials of all kinds; fungi are essential to lignin breakdown. It is also becoming apparent that lichens and other rock microbiota have a significant role in rock weathering and contribute to global carbon sequestration (Schwartzman 1993), and that lichens cannot be ignored in studies of nitrogen fixation and nutrient fluxes in forests. In one oak wood in California, the lichen litter was almost twice as rich in nitrogen as fallen leaves, and contributed substantially more nitrogen deposition than would be inferred from the mass of the litter alone (Nash 1996). Fungi are also emerging as a key source of food for insects in the tropics; one study in Sulawesi, based on 1.1 million beetle specimens, revealed that 23.4% of the species were fungivores (Hammond 1990).

The extent of soil surface stabilisation by both free-living cyanobacteria and lichens is also not always appreciated. The communities often involve rather few species, are fragile, and are particularly vulnerable to trampling or driving. Once lost, the surfaces are exposed and subject to heightened erosion, but fast-growing microscopic algae and cyanobacteria also have potential for halting or reversing desert encroachment (Painter 1993). Soil surface stabilisation is a significant role for the 'orphans' in desert regions throughout the world (Kappen 1988), and is a topic meriting particular attention in Australia (Rogers 1982).

For supplemental information see Andersen (1992), Dix and Webster (1995), Heywood (1995), Rayner (1995), and Lodge *et al.* (1996).

(b) Bioindicators of Ecosystem Health

Many of the 'orphans' live in intimate associations with their environment and are therefore particularly vulnerable to changes in ecological conditions. This is especially so for lichens which, because of their longevity, are well-established and widely used as bioindicators of certain gaseous air pollutants, and as bioaccumulators for heavy metals and radionuclides (Gilbert 1992; Richardson 1992; Huckaby 1993). There is also a correlation between the frequency of mycorrhizal fungi and tree health under the influence of acid rain, and these fungi can serve as early bioindicators of impending forest damage before symptoms are visible in the trees (Arnolds 1991).

The 'orphans' can also serve as bioindicators of other types of environmental perturbations. Certain lichens have restricted powers of dispersal and require a continuity of trees to persist, and the proportion of these present in a site is indicative of the extent to which ecological continuity has been maintained (Rose 1992). In the tropics leaf-surface mosaics of algae, superficial microfungi, hepatics, and lichens have similar values. Lücking (1995) has elegantly demonstrated the relationship between forest disturbance and foliicolous lichens in Costa Rica.

The application of lichens on rocks at the sides and in rivers and lakes as indicators of water levels also merits attention. The pioneering work of Gregory (1976) near Armidale in New South Wales is noteworthy in this respect.

(c) Source of Exploitable Attributes

The commercial value of pharmaceuticals obtained from fungi is widely appreciated, and bioprospecting has been an element in the drug discovery programmes of major pharmaceutical companies for the last 50–60 years (Nisbet and Fox 1991). Wonder-drugs are few and far between, but surprises can come from unexpected sources; global sales of cyclosporin, the drug from *Tolypocladium inflatum* routinely used to reduce organ rejection in human organ transplant surgery, reached US $ 1.29 billion in 1995 —

substantially exceeding that even of paracetamol. Taxol, the anti-tumor drug obtained from the bark of the Pacific yew in the USA, has also now been found to be produced by a new endophytic fungus *Taxomyces andreanae* (Stierle *et al.* 1993).

Conclusion

The data presented here support the hypothesis that algae and fungi meet the criteria which justify their designation as orphans in 'botanical' diversity. No data to negate this contention were found. It is also evident that 'botanical' orphans merit human attention from both altruistic and selfish motives: altruism from other biologists because of their actual and potential importance to the environment and human well-being, and selfishness from their underresourced practitioners.

Orphans must be wary of too much special pleading. The flagrant beggar pulling at the sleeves of a more affluent passer-by may be less successful than one in obvious need crouched in doorway. Mycologists have been pressing their case for decades. The pamphlet *The Need for Encouraging the Study of Systematic Mycology in England and Wales*, prepared by a committee of the British Mycological Society, was distributed to Government departments in 1944 (British Mycological Society 1949); it had no marked impact. Any demands must be perceived as reasonable, and I submit that it is not unreasonable to request a level of support commensurate with their importance and that received by the 'nuclear family'.

In order to progress, a heightened awareness of the importance of the orphans is essential. I have previously argued that each mycologist needs to be involved in asserting the identity of their subject, have a shared and personal mission, and create a segment of his or her time to act for this cause (Hawksworth 1995). If each scientist working with an orphan group also became an active chauvinist, the lobby could not continue to be unheeded. The climate is already starting to change, as evidenced by the coverage of orphans in UNEP's *Global Biodiversity Assessment* (Heywood 1995), and the vision of launching the *Fungi of Australia*. These signals should not occasion complacency, but encourage us to build further so that the level of our knowledge of the different orphan groups will be more appropriate to their numbers and relevance by the time of the bicentennial of the Royal Botanic Gardens in Melbourne.

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Observations on Morphology and the Response of Hyphae to Temperature by Australian and French Isolates of *Lepista*

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Abstract

The development of viable commercial cultivation techniques for the edible fungus *Lepista nuda* (Bull.: Fr.) Cooke is necessary to expand the range of species available to the exotic/wild mushroom growing industry in Australia. This study provides new data on the effect of temperature on hyphal growth of Australian isolates of *Lepista*. Wild *Lepista* were collected from selected cool (4–25°C during growing season) and warm (8–35°C during growing season) climatic regions in Australia and pure vegetative cultures isolated. These collections differed morphologically from overseas isolates but whether these are new species or varieties or the result of environment and habitat has yet to be determined. The optimum temperature parameters for hyphal growth were determined and comparisons made with French cool (average day temperature 11°C) and warm (average day temperature 14°C) climatic region isolates. The range of temperatures for the mycelial growth of Australian and French isolates *in vitro* was 5–35°C and 5–30°C respectively. The growth rate of Australian isolates was more than double that of French isolates at the optimum temperatures.

Introduction

There are 20–25 species of fungi suitable for amateur or extensive small scale commercial production and four species suitable for intensive commercial production (Olivier 1991). In Australia, amongst the gilled fungi, there are a number of edible species in the families Agaricaceae, Bolbitiaceae and Tricholomataceae. The mushroom *Lepista nuda* (Bull. : Fr.) Cooke (= *Tricholoma nudum* (Bull. : Fr.) P. Kumm.; *Rhodopaxillus nudus* (Bull. : Fr.) Maire; *Clitocybe nuda* (Bull. : Fr.) H.E. Bigelow & A.H. Sm.), of the family Tricholomataceae, commonly known as Wood Blewitt, is well known in Europe and Britain where it has an international gastronomic reputation (Krieger 1967, Dickinson and Lucas 1979, Jordan 1989). It has a slightly aromatic smell and sweetish taste (Jordan 1995) and is better cooked, fried or baked, than eaten raw (Dickinson and Lucas 1979, Jordan 1989). *Lepista nuda* deserves research into methods of cultivation because of its eating characteristics and the need for new wild/exotic species of fungi by the Australian mushroom industry.

A study of the morphology and growing characteristics of Australian *Lepista nuda* is required to select isolates attractive for consumption and commercial production. The optimum temperature for hyphal growth is an important factor for colonisation of substrate and shorter cropping times.

Materials and methods

Isolates

Basidiocarps were collected from cool and warm climatic regions in eastern Australia and their genera and species identified. Axenic cultures were then prepared from the basidiocarp. These isolates were identified as *Lepista nuda* and then further groupings were determined on the basis of macroscopic and microscopic characteristics. Isolates from different groups, habitats and environments were then selected for further study into the response of hyphae to temperature. Vegetative cultures of *Lepista nuda* from cool and warm climate regions of France were supplied by the Centre de Champignons, Institut National Research Agronomique, Bordeaux.

Temperature

A 4 mm disc of hyphae was cut from the growing edge of an 8 day old culture and placed with the hyphal surface in contact with the agar at the centre of a petri dish containing malt extract agar plus 2% yeast extract (MEAY). Five replicates of each isolate were placed at ten temperatures ranging from 5–40°C and incubated in the dark for 8 days. Radial growth was measured between the outer edge of the colony and the inoculum along two axes at 90° to each other. This figure was averaged to determine the radial growth of hyphae from the edge of the inoculum.

Results

Isolates

Australian isolates were collected from a variety of habitats: leaf litter under shrubs (*Rhododendron* and *Camellia*); leaf litter under trees (*Cedrus deodara* and *Quercus suber*); and on open grassland (*Poa pratensis*, *Pennisetum* sp. and *Cynodon dactylon*).

All basidiocarps of the Australian isolates were either violet, lilac or bluish overall and all were assigned to the section *Genuinae* Konrad and Maublanc. The spore colour of all isolates was salmon pink, the shape ellipsoid and the surface minutely warty. Using the dichotomous keys of Pegler (1977), Moser (1978) and Breitenbach and Kranzlin (1991) and descriptions from Guinberteau *et al.* (1989) isolates were keyed out to the species *Lepista nuda*, with four subgroups identified (Table 1) using macroscopic characteristics. These may be taxonomic subgroups but they are also useful for identification of isolates attractive to the market place.

Temperature

The optimum temperature for hyphal growth of the Australian and French isolates was found to be 25–30°C and 20–24°C respectively with no growth at 40°C. Significant differences (using ANOVA) were found in the radial growth of hyphae between Australian and French isolates (Table 2).

Discussion

Species of *Lepista* are widely distributed in different ecosystems throughout the world. *Lepista nuda* has been collected in Switzerland, Britain and France in late summer-autumn, rarely spring (Breitenbach and Kranzlin 1991); autumn to early winter (Phillips 1985); and late autumn-winter (Guinberteau *et al.* 1989). The growth habit of this genus is variable being found in groups, rings and caespitose, but it is rarely found

Table 1. Subgroups of Australian *Lepista nuda*, on the basis of macroscopic characteristics

Characteristic		Sub group A	 B	 C	 D
Basidiocarp	shape and form	robust and fleshy	less robust than A but fleshy	bends easily having stipe: pileus ratio smaller than B	similar to form B but often with umbo
	height (mm)	70–110	70	95	75
Pileus	colour	lilaceous brown and shiny	lilac to lilaceous brown and shiny	lilac	bright or deep lilac or lilaceous brown
	diameter (mm)	65–132	35–40	75	50–75
	shape	convex to shallow convex with age	shallow convex	convex to plane	shallow convex or plane and with/without umbo
Stipe	colour	lilac to lilac purple, darker at base	lilac	lilac	lilac to lilaceous brown
	size (mm)	50–78 x 25–33	60 x 11	75 x 8	45–65 x 7–11
Lamellae colour		lilac purple to deep lilac	lilac	lilac	lilac or lilaceous pink or deep lilac
Habitat		leaf litter under *Rhododendron*, *Camellia*, *Cedrus deodara*, *Quercus suber*	lawns — *Poa pratensis*	pasture — *Pennisetum*	roadsides, pasture, gardens — *Pennisetum*, *Cynodon dactylon*
Habit	group	ring	group	group	ring or group
Climate[1]		cool	cool	warm	warm

Table 2. Hyphal growth of Australian and French isolates of *Lepista nuda* in response to temperature

Group[1]	Optimum temperature (°C)[2]	Radial growth of hyphae (mm)[2]
A	25	17.98
B	25	24.59
C	30	24.68
D	25	29.97
FW	24	11.38
FC	20	12.46

[1] Groups A,B,C,D are Australian subgroup isolates with A and B being cool climate and C and D warm climate; FW are French warm climate isolates; FC are French cool climate isolates.

[2] Respresentative mean of all isolates within the subgroup.

solitary. It grows in coniferous and deciduous woods, pasture, roadsides, gardens, compost heaps and under shrubs. The habitats and season of growth of Australian isolates appear similar to that of the European ones. Australian isolates differ morphologically from overseas isolates but whether they are new species, varieties or the result of environmental differences and habitat has yet to be determined. Therefore an unequivocal resolution of isolates was not possible but four sub groups were identified.

The optimum growing temperature for Australian and French isolates growing on MEAY are 30 and 25°C respectively. In addition the hyphal growth rates of Australian isolates are almost double that of French for both warm and cool isolates. This has significant implications on the rate of growth of hyphae through substrate and it is expected to lead to reduced time for colonisation of substrate and a shorter growing period. The maximum temperatures tolerated by Australian isolates are higher than French isolates at 35°C and 30°C respectively with Australian isolates having less growth at 5°C than French isolates. This may indicate that the process of basidiocarp induction could be encouraged to occur at higher temperatures than are currently accepted in Europe. Research into this next phase of commercialisation is currently being undertaken.

The four Australian subgroups could be the result of nutrition, age and/or weather. Alternatively, the combination of morphological and temperature response data may indicate that the Australian isolates are new strains, varieties or species. This information on morphology and effect of temperature on hyphal growth of Australian *Lepista* isolates will form the basis for the development of a viable commercial cultivation technique for this edible fungus.

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Preliminary Observations on the Limitations of the Australian Hygrophoraceae (Fungi, Agaricales)

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Abstract

Initial studies of the Australian Hygrophoraceae have demonstrated 57 taxa of which five are also found in Europe, two in North America, nine in New Zealand, with the remaining 41 species so far known only from Australia. Only the genera *Hygrophorus*, *Hygrocybe* and *Camarophyllopsis* are recognised with *Hygrocybe* here including *Bertrandia, Gliophorus, Humidicutis, Camarophyllus* and *Aeruginospora*. *Camarophyllopsis* here includes *Hygrotrama*. The waxy lamellae criterion used for placing species into the Hygrophoraceae is discussed and retained as a valid taxonomic character. The family Hygrophoraceae is retained with tribes Hygrophoreae and Hygrocybeae.

Introduction

Fifty-seven taxa have been recorded during initial studies on the Australian Hygrophoraceae (Young 1996) and the total number for the family in Australia is estimated to lie between 150 and 200 species. Further details of the study methodology, taxa and proposed systematic structure for the Australian species are contained in Young and Wood (1997) but the purpose of this paper is to explore some of the difficulties in deciding whether various fungal taxa should be placed or retained within the Hygrophoraceae, or even whether the Hygrophoraceae should be retained as a useful taxonomic unit within the Agaricales.

Australia has numerous species of genus *Hygrocybe* but relatively few species of other genera within the family Hygrophoraceae. Genera so far undiscovered in Australia include *Hygroaster* and *Neohygrophorus*. This study recognises only one species for each of the genera *Camarophyllopsis* and *Hygrophorus* although more are likely to be assigned to these two genera when the tropical and Tasmanian species are better known. Only seven of the Australian taxa also occur in Europe and North America [e.g. *Hygrocybe cantharellus* (Schwein. : Fr.) Murrill, *H. conica* (Schaeff. : Fr.) P. Kumm. and *H. miniata* (Fr. : Fr.) P. Kumm.] while *H. astatogala* (R. Heim ex R. Heim) Heinem. is also known from Africa. The remainder of the Australian taxa are either indigenous to Australia (41 species) or previously described from New Zealand (9 species) (Horak 1971, 1990).

The validity of the Hygrophoraceae as a natural family within the Agaricales is currently under debate. Horak (1973) described the family as 'a mixture of several heterogenous groups held together by means of more or less unimportant taxonomic characters' and there is no doubt that use of this family (as defined by the characters of waxy lamellae and very long basidia) is being challenged. Both Arnolds (1990) and Bas

(1990) placed the tribes of the Hygrophoraceae within the Tricholomataceae and Bas (1990) stated the intention to propose the latter family for conservation against the earlier name. While their lead has not yet been widely adopted, there is reason to believe that their structure may eventually be found to be correct and the present family Hygrophoraceae of no value other than filing taxa in a convenient pigeon hole.

Studies of the Australian Hygrophoraceae have not resolved the above problems to any great extent, although they do confirm the need for re-appraisal of the validity of the Hygrophoraceae as a natural family and they have shed some light on relationships within its tribes. Because of this fluid situation, the Hygrophoraceae is retained for the Australian taxa while recognising that the family may eventually be discarded as a suitable unit for these taxa. The following discussion considers the limits of the Hygrophoraceae as defined traditionally by the waxy lamellae, the basidial length and the general morphology.

Family Limitations

Waxy Lamellae and Basidial Lengths

The waxy lamellae criterion still remains the critical test for assigning a fungal species to the Hygrophoraceae based on fresh material, and despite its subjective nature, it is still easily distinguished and applied very effectively. If the basidiome has waxy lamellae then they appear translucent, have a brittle texture, and look similar to polished paraffin wax. There is no doubt the character exists despite its unusual nature: the ability to determine a member of the Hygrophoraceae by this test is rapidly learnt by the novice and is reasonably accurate. Once dried, the waxy appearance is lost and herbarium material can be readily assigned to the Tricholomataceae rather than the Hygrophoraceae. Accurate, complete field notes and (if possible) colour images are essential when dealing with herbarium material believed to be within the Hygrophoraceae. Boertmann (1995) similarly commented on the difficulty of identifying dried material suspected to be within the Hygrophoraceae without accurate colour descriptions.

The waxy appearance of the lamellae has been linked to the ‘unusual lengths of the basidia’ (Singer 1986, Largent 1985), however measurements of basidial mean dimensions for the Australian taxa of this study do not support this concept (Fig. 1). Forty-six of these taxa (82%) have basidia with mean lengths in the interval 24–44 µm; by comparison, taxa of the Tricholomataceae (a family of white spored agarics in which the waxy character is infrequent, and which may be considered to have basidia of ‘normal length’) have basidia that are generally 20–45 µm, rarely 80 µm. Although one of that family's taxa, *Xerula radicata* (Rehlan : Fr.) Dörfelt (syn. *Oudemansiella radicata* (Rehl. : Fr.) Singer), has very long basidia (70–80 µm), that species as found in Australia does not have waxy lamellae. Further, the greatest basidial length so far recorded for an Australian species of the Hygrophoraceae (59 µm) is far less than that recorded for *X. radicata*.

These results suggest that the basidial length is not the main reason for the waxy appearance of the lamellae which is probably determined by the physical and chemical structures of the basidial wall and possibly also by basidial and hyphal turgor pressure. Cibula (1979) showed that the optical qualities of the pileus of an American species, *Hygrophorus chameleon* Cibula, altered with the amount of water present in the tissues and there is tentative support for the turgor pressure concept. Many Australian species of the Hygrophoraceae have very thin hyphal walls and the high water content of the fungal basidiome has already been noted (Arnolds 1981). High turgor pressure and

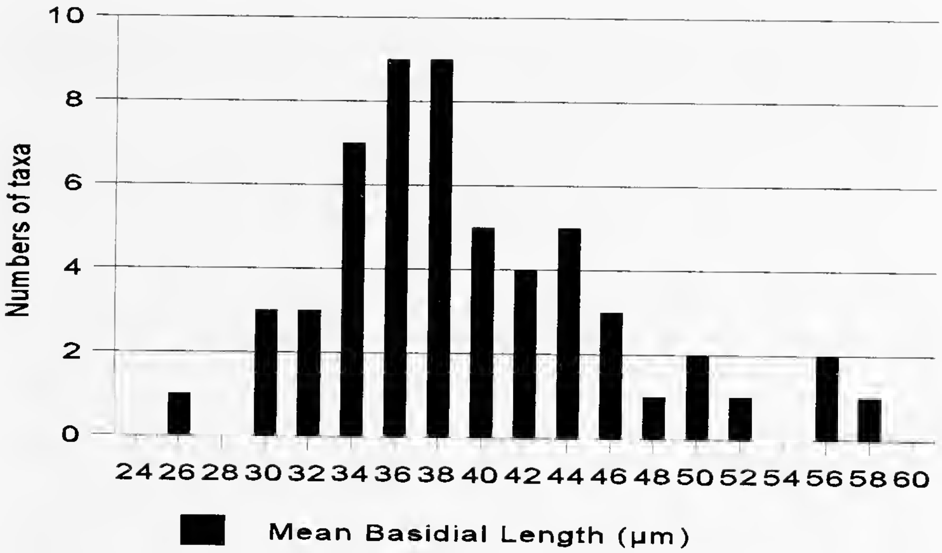

Fig. 1. Numbers of taxa of the Australian Hygrophoraceae according to each taxon's basidial mean length; interval 2 μm.

water content coupled with the thin hyphal walls, already observed as a character in this family, could account for the brittle nature of the lamellae, while the high turgor pressure is suggested by the tendency of some species to 'weep' watery latex from the tissues when cut.

Morphological Comparisons with Other Taxa

(a) Family Tricholomataceae and the Hygrophoraceae

The Tricholomataceae is the closest family to the Hygrophoraceae. An inspection of Singer's (1986) definitions of the two families shows so much similarity between the two sets of characters, that the presence of waxy lamellae becomes the criterion for separation of the two families. Australian data appears to confirm this family proximity for it shows that the mean basidial lengths of the taxa of the Australian Hygrophoraceae are similar to those of the Tricholomataceae and members of the two families are separated only by the waxy lamellae character. Since European species also showed this similarity, Arnolds (1990) placed tribes Hygrocybeae and Hygrophoreae in the Tricholomataceae. This combination is still to be completly accepted (e.g. Hansen and Knudsen 1992) and it is not applied in this study. It is important to note that when defining generic limits, the genera whose species are most likely to be confused with those of the Hygrophoraceae are all within the Tricholomataceae: *Mycena*, *Hemimycena*, *Dermoloma*, *Omphalina*, *Gerronema*, *Clitocybe*, *Porpoloma*, and *Omphaliaster*.

Within the Hygrophoraceae the tribe Hygrophoreae is well defined by the presence of a divergent hymenophoral trama. Genus Hygroaster (tribe Hygrocybeae) approaches this divergent structure at the sides of the trama but differs by being irregular at the centre (Singer 1986). Since tribe Hygrophoreae combines the divergent trama with a filamentous pileipellis, broadly adnate to decurrent lamellae, a frequently occurring viscid universal veil and a mycorrhizal habit, the tribe forms a very natural group of taxa within the Hygrophoraceae. (Divergent tramas do occur in other white spored genera, e.g. *Amanita*, but other characters present clearly separate those taxa from the Hygrophoraceae.) The sole Australian taxon currently ascribed to the Hygrophoreae, *Hygrophorus involutus* G. Stev., can only be accorded provisional membership until the trama of fresh material can be examined.

For tribe Hygrocybeae, only the genera *Hygrocybe* and *Camarophyllopsis* have been recorded for Australia. Provided the waxy lamellae character is apparent, *Camarophyllopsis* is defined by its hymenidermic pileipellis, often decurrent lamellae and dull colours in greys or browns. The genus *Hygrocybe* is more difficult to define as the species within the genus have characters that are more varied. If the basidiomes are large, brightly coloured and exhibit waxy lamellae, little difficulty is experienced; most problems occur when the basidiomes are small, dull coloured and the normally distinctive features of the family may be overlooked, a point also made by Hesler and Smith (1963). Frequently, the species are assigned to genus *Hygrocybe* on a group of characters taken together, rather than a single definitive character. For example, species within *Hygrocybe* generally have lamellae that are distant and thick in addition to their waxy appearance, and their habit of growing on mossy soil or humus is an additional ecological character that may be used. At the microscopic level, hymenophoral trama and pileipellis structures are extremely useful, but additionally, the thin hyphal walls and the presence or absence of clamps, together with clamp structure, can be added to the overall character assemblage. Subgenus *Hygrocybe* is well defined by the very long, aseptate, tubular elements of the lamellae trama. Although there are some members in which the elements are shorter, the lack of tramal clamps, the presence of lactifers and the conical, often brightly coloured, radially splitting pilei are very distinctive and permit their easy recognition. No Australian taxon has been found which is intermediate between subgenera *Hygrocybe* and *Pseudohygrocybe*, nor has a member of the Tricholomataceae been encountered where the lamellae trama contain tubular elements similar to those in subgenus *Hygrocybe*.

(b) Genus Mycena

Most problems of delimitation against other genera occur within subgenus *Pseudohygrocybe* because the variations at the limits of sectional ranges can be extreme. *Gliophorus pallidus* E. Horak, which belongs in this subgenus, might be confused with some small, whitish and glutinous taxa of *Mycena* such as *Mycena austrororida* Singer, however the amploid spores of that species — abundant and sinuous cheilocystidia, cellulodermic pileipellis and caespitose habit on wood — immediately distinguish it. Taxa of *Mycena* are usually readily identified when several of its defining characters are apparent: amyloid spores, diverticulate hyphae in the pileipellis, pileocystidia and abundant and varied cheilocystidia. Other useful characters are the presence of pleurocystidia or (when it occurs) a lignicolous substrate (logs, twigs or branches in forest litter). Where the hyphae of the pileipellis are not diverticulate, they may be globose (as in *Mycena austrororida*) or smooth but in these taxa other characters typical of the genus will be present. Again, it is the lack of these fundamental characters that so often characterises the Hygrophoraceae.

(c) Genus Hemimycena

Hemimycena is closely related to *Mycena*. It comprises mostly small, white and delicate taxa which in the past have been mistakenly placed in *Hygrocybe*. Arnolds (1985) described the species *Hygrocybe griseopallida*, but later synonomised this with *Hemimycena mairei* (E.J. Gilb.) Singer after re-examination revealed the characteristic diverticulate hyphae in the pileipellis. The sub-regular trama and decurrent lamellae in

Hemimycena suggest subgenus *Cuphophyllus*, but the diverticulate hyphae usually present in the pileipellis, the cheilocystidia and pleurocystidia usually present and the extremely small basidiomes that are gregarious on litter all serve to separate the genus. *Hemimycena* is not yet known for Australia but it is present in New Zealand (Horak and Desjardin 1994). This fact, together with the abundance of small, white agarics in Australian tropical and temperate rainforests, suggests Australian species of *Hemimycena* will be found.

(d) Genus Clitocybe

The genus *Clitocybe* and its relationships to other genera have been extensively discussed (Bigelow 1982; Singer 1975, 1986) and only *Hygroaster* was suggested as having any delimitation difficulties with *Clitocybe*, however the unique trama and the stellate spores of Hygroaster separate it immediately. Only taxa in subgenus *Cuphophyllus* (subdued colours and decurrent lamellae) might be confused with *Clitocybe*, however the thick, widely spaced lamellae of the Hygrophoraceae bear little resemblance to the narrow, crowded lamellae found in *Clitocybe*. Species of *Cupophyllus* are also separated by the more robust basidiomes of *Clitocybe*. Basidiomes of *Pseudohygrocybe* which approach the overall morphology of *Clitocybe* are also readily separated from *Clitocybe* because they are either highly glutinous with either (or both) cheilocystidia and caulocystidia (unknown in *Clitocybe*) or are highly coloured in reds, oranges or greens. Such colours are generally absent from *Clitocybe*. No Australian taxa are yet known which would cause difficulties in separating a species of *Clitocybe* from the Hygrophoraceae.

(e) Genera Gerronema *and* Omphalina

Two genera of the Tricholomataceae, *Gerronema* and *Omphalina*, are separated from each other by their different pigmentation structures in the pileipellis (Singer 1975, 1986). The bright pigments present in certain small taxa within these two genera initially suggest the species *Hygrocybe cantharellus* because they display the decurrent lamellae and habit of that taxon. Separation is usually on a group of characters not present in one or other of the genera. Basidiomes of *Omphalina* and *Gerronema* are always quite small, dry and invariably have decurrent lamellae. When semi-decayed logs form the substrate for the basidiome, *Gerronema* and *Omphalina* are indicated while *Hygrocybe* is virtually eliminated. Similarly the presence of abundant, bristling cystidia especially where they occur on the pileal surface is also an indicator of the Tricholomataceae since such structures are not present in the Hygrophoraceae. Spores in *Omphalina* and *Gerronema* tend towards cylindric or tilda (~) shapes, rather than the ovoid to globose shapes in the Hygrophoraceae, and the trama is always irregular (or if regular, then only at the very centre with the sides irregular) while the taxa close to *H. cantharellus* have regular tramas. Arnolds (1985) discussed the omphaloid taxon *Hygrocybe viola* J. Geesink & Bas and noted its apparent proximity to *Omphalina*. He considered it well separated because of its intracellular or parietal pigments rather than strongly encrusting pigments found on the hyphae of the pileipellis, the presence of medallion clamps and lactifers, and the long basidia rather than the shorter basidia found in *Omphalina* and taxa close to *Omphalina*. Medallion clamps are absent from *Omphalina* (Arnolds 1986), but they occur extensively in the Hygrophoraceae. The presence of encrusting pigment on the cuticular hyphae would also serve to separate species of *Hygrocybe* as the taxa around *H. cantharellus* have intracellular pigments. Although the lamellae in *Omphalina* and *Gerronema* may be thick and decurrent, they are never waxy in appearance.

(f) Genus Dermoloma

The genus *Dermoloma* (J.E. Lange) Singer has been variously placed in the Hygrophoraceae and the Tricholomataceae. Arnolds (1990) placed it in the Tricholomateae *sensu* Arnolds; Arnolds (1992) revised his position and argued that the genus should be placed within the Hygrocybeae. Singer (1975, 1986) has consistently maintained its position in the Tricholomataceae, a position also taken by Pegler (1983, 1986) and Hansen and Knudsen (1992). Corner (1994) discussed the Malesian species of *Dermoloma* at length and with reference to the European taxon *D. cuneifolium* (Fr. : Fr.) Bon, the taxon upon which Arnolds (1992) based his assumptions. Corner found that the amyloid spore character in *D. cuneifolium* is extremely variable in basidiomes growing side by side, some being amyloid and others inamyloid. Corner also noted that the characters present in the 13 Malesian species referrable to *Dermoloma* 'so extended the idea of the genus ... [that they] ... nullify its use.' On the basis of his investigations, Corner reduced *Dermoloma* to synonymy with *Tricholoma* (Fr.) Staude and hence placed the Malesian taxa within the Tricholomataceae.

Assuming the genus is retained, *Dermoloma* seems close to *Camarophyllopsis*, but the holotype species, *D. cuneifolium* (Fr. : Fr.) Bon has very short basidia (mean 26.5 x 6.3 µm) while the sole Australian taxon so far known for *Camarophyllopsis* has basidia with a mean of 40 x 6.7 µm. The spores also differ: in *Dermoloma* they are usually elliptical although they may approach subglobose and they may be amyloid; in *Camarophyllopsis* they are generally distinctly subglobose and inamyloid. The pileipellis also differs: species of *Camarophyllus* have an hymenoderm (which may be reduced to a layer of pyriform to more or less globose elements) rather than the densely packed regular cutis of *Dermoloma*. The position of *Dermoloma* thus remains controversial with very different family relationships proposed. While it is agreed that *Dermoloma* does approach *Camarophyllopsis*, the two genera are here retained in separate families (or tribes) until more conclusive evidence is produced.

(g) Genus Porpoloma

Porpoloma Singer presents similar problems to those of *Dermoloma*. During the study of the Hygrophoraceae, material was collected of an undescribed taxon in the Bunya Mountains (Queensland) which on field characters was at first assigned to the brown pigmented group of taxa within *Pseudohygrocybe*. The strong amyloid reaction of the spores and basidial length (mean 36.5 x 7 µm), indicated the genus *Porpoloma*. Singer (1975, 1986) also agreed that *Porpoloma* approached the brown group of taxa within *Hygrocybe* but considered that the short basidia and amyloid spores were sufficient to separate them. Whilst the amyloid spore argument is still undoubtedly valid, the basidial length criterion is not. The only taxon with amyloid spores widely accepted as being in the Hygrophoraceae and apparently close to subgenus *Cuphophyllus* is *Neohygrophorus angelesianus* (A.H. Sm. & Hesler) Singer with its irregular trama, decurrent lamellae and intracellular cuticular pigments. Singer (1962) detailed his studies of the holotype to see if it could be moved to the Tricholomataceae but the long basidia, the waxy lamellae and the obvious proximity to *Cuphophyllus* convinced him that it was correctly retained in the Hygrophoraceae. Singer maintained this position in all future publications. The intense amyloid spore reaction in *Porpoloma* together with its 'hygrophoraceous' macrocharacters make family allocation of this taxon difficult to resolve, but the amyloid reaction seems sufficient to separate it from the brown pigmented taxa within the Hygrophoraceae.

(h) Genus Omphaliaster

Most authors do not consider *Omphaliaster* to be within the Hygrophoraceae and Bas (1990) placed the genus in Tribe *Clitocybe* with *Omphalina*. Hansen and Knudsen (1992) retained *Omphaliaster* in the Tricholomataceae, while Moser and Jülich (1988) also placed *Omphaliaster* outside the Hygrophoraceae. Singer (1975, 1986) regarded *Omphaliaster* as a synonym of *Hygroaster* but the analysis by Baroni (1982) is very clear and leaves no doubt that *Omphaliaster* is quite separate from *Hygroaster* on the basis of hymenial structure and pileal pigmentation. The separation of *Omphaliaster* from subgenus *Cuphophyllus* is defined on a group of characters rather than a single one: the habit of *Omphaliaster* is omphaloid and is somewhat similar to those genera that fit within subgenus *Cuphophyllus*, however species of *Omphaliaster* have a regular to sub-regular trama in the lamellae rather than the irregular trama in *Cuphophyllus*, have lamellae faces with abundant pseudocystidia which are absent in *Cuphophyllus* and frequently have encrusted pigments in the pileipellis while the pigments are intracellular in *Cuphophyllus*. Dennis (1953) and Pegler (1983) describe the waxy nature of the lamellae of *Hygroaster* but there is no suggestion of the same waxy nature in the lamellae of *Omphaliaster*.

Conclusions

Despite the apparent similarity between the Tricholomataceae and the Hygrophoraceae, on balance, it is argued that as far as the known Australian taxa of the Hygrocybeae are concerned, the two families should not yet be combined. The waxy character of the Hygrocybeae is likely to be caused by physical and chemical factors within the basidiome which do not seem to occur widely in the Tricholomataceae and it is so distinctive and consistent in these taxa that it does define a unique species aggregate within the Agaricales. With the waxy character come a series of supporting characters for many species (bright colours, extremely watery context, tramal and pileipellis structures etc.) that add weight to the separation. Only a single taxon within the Hygrophoreae is partially known for Australia and its possible relationships to the Tricholomataceae or the Hygrocybeae remain uncertain.

Family Tricholomataceae is already a very large, complex aggregate of white spored species. The transfer of the tribes of the Hygrophoraceae into the Tricholomataceae has some merit as far as morphology is concerned, but it does not resolve the questions of why these waxy gilled taxa have their peculiar physical characteristics and whether their origins are similar to those of the Tricholomataceae. Resolution of the Hygrophoraceae and Tricholomataceae problem will probably remain until comprehensive genetic studies are completed, but despite the present use of a separate Hygrophoraceae, it would not be a surprise to discover that at least the Hygrophoreae (and possibly also the Hygrocybeae) should be placed within the Tricholomataceae.

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Who will Look After the Orphans?

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Abstract

The status of current taxonomic research in mycology in Australia is analysed. The returns of a questionnaire, and an analysis of 1076 publications incorporating the key words 'Fungi' and 'Australia' listed in *Biological Abstracts* from 1991–95, indicate the unfortunate state of taxonomic mycology in Australia. Although 131 publications are of a taxonomic nature only 61 of these are by Australian researchers on Australian fungi and, of these, 29 are co-authored by a mycologist who is now employed outside Australia. Besides this, 32 of the 61 are taxonomic publications in plant pathology. Only seven publications in taxonomic mycology were published by Australian universities from 1991–95. Most of the remaining publications are by mycologists in government institutions. This indicates the poor state of funding in taxonomic mycology in Australia. The methods used by the Australian Biological Resources Study to direct funds to research on fungi are examined and discussed. Targeting families or habitats are possible ways forward. But who will carry out the investigations needed to complete the *Fungi of Australia* series? Training of mycologists and employment of trained mycologists is of paramount importance and should be carried out in Australian universities. There are very few mycologists in Australian universities and most of these have only a peripheral interest in systematics. Therefore training will need to be carried out in collaboration with Government institutions or with overseas universities or institutions. The need for the promotion of mycology by mycologists, and the need for an organised and coherent approach to this promotion is essential for the future of mycology in Australia.

Introduction

Grgurinovic and Hyde (1993) highlighted the poor state of taxonomic mycology in Australia in 1991. At that time the situation was critical as there was very little undergraduate or postgraduate training in taxonomic mycology in Australian universities and very few university lecturers devoted any of their time to taxonomic mycology. In 1996 the question still remains as to whether or not the situation has improved? In this paper the status of training of taxonomic mycologists is investigated. A questionnaire was published in the *Australasian Mycological Newsletter* in June 1996 and the returns to this survey are presented. Since publications reflect research efforts in government institutions and universities, *Biological Abstracts* from 1991–1995 has been analysed to give a clear picture of what mycological research is being carried out in Australia.

The *Fungi of Australia* series was launched in October 1996 with the publication of Volume 1a and b. The inaugural annual general meeting of the Australasian Mycological Society was also held at this time. This is promising for the future of taxonomic mycology in Australia. The future direction of the *Fungi of Australia* is discussed and recommendations are proposed in order to promote healthy debate. The future of mycology in Australia lies in the hands of its mycologists. There is a need for mycologists to promote their subject, to articulate its importance, and to make mycology of interest to the general public. Mycologists must have an organised and coherent approach to promoting their passion.

Results of the Survey into Taxonomic Projects in Mycology in Australia in 1996

A questionnaire was published in the *Australasian Mycological Newsletter* in June 1996 asking for information concerning projects in taxonomic mycology in Australia. A total of 10 returns were received and illustrate the nature and extent of work on taxonomic mycology in Australia (Tables 1, 2). The questionnaires were often incomplete, and the author has filled in omissions where the researcher and their work are personally known to him. However, the information provided here provides a reasonably accurate assessment of training and taxonomic research presently being carried out in mycology in Australia.

Besides the startling (but expected) small number of research projects the following observations need raising.

1. There are very few replies from Australian universities.
2. There is no research project with a major taxonomic component being carried out in Australian universities.
3. Several of the researchers are retired and working with minimal or no funding.
4. There is only one fully funded higher degree student being trained in taxonomic mycology in Australia and this student is partially supervised outside Australia. Two other students are receiving their funding and training outside Australia.
5. In most cases few hours are designated to the projects or funding for the projects is minimal.

Table 1. Australians in full time training in taxonomic mycology

Institute	Fungal group	Funding
Hong Kong University	Fungi on palms	Hong Kong University
Department of Primary Industries, Mareeba, Queensland	Phyllachoraceae	Australian Biological Resources Study
Oregon State University	Truffle-like relatives of *Russula* species	National Science Foundation (USA)

Table 2. Taxonomic mycologists in full time employment in Australia

Institution	Fungal group	Employer
Department of Primary Industries, Indooroopilly, Queensland	Plant pathogens	Queensland Government
Institute for Horticultural Development, Melbourne, Vic	Plant pathogens	Victorian Government
Agricultural Research and Veterinary Centre, Orange, NSW	Plan pathogens	New South Wales Government
Royal Botanic Gardens Melbourne	Basidiomycetes	Victorian Government
University of Tasmania	Basidiomycetes	University of Tasmania

Tables 1 and 2 do not include those taxonomic mycologists who have retired and are working unfunded, or those who carry out taxonomic mycology in their own time. To most mycologists the results should be of no surprise and these returns indicate a worsening trend compared to the results of Grgurinovic and Hyde (1993).

Publications in Mycology from 1991 to 1995

Publications, rather than surveys, are more likely to provide an accurate appraisal of the type of mycological research being carried out in Australia. Although publications will be biased towards active researchers this should balance out across the range of mycological subjects. The key words 'Fungi' and 'Australia' were used to extract publications of a mycological nature involving Australia in *Biological Abstracts* from 1991 to 1995. A total of 1076 publications were abstracted and sorted into subject areas (Table 3).

There were problems in sorting as there is an overlap of subject areas in some papers. Some plant pathology papers have a cell biology component and these are categorised as plant pathology only. Some publications categorised under biological control could have been included under Plant Pathology, and many publications categorised as taxonomic, describe plant pathogens. There are obviously places where it was difficult to decide on a category for a particular publication, and other scientists may have chosen differently from the author. Some publications describing a small number of Australian fungi in taxonomic monographs by non-Australian mycologists may not have been abstracted. However, the results provide an overall picture of the nature of mycological research in Australia between 1991 and 1995.

The results, with respect to taxonomy, are quite surprising. The majority of publications (460) are of a plant pathological nature, while taxonomic mycology scored second highest with 131 publications. Subject areas which seem relatively healthy are cell biology/genetics (118), human mycology (80), biological control (58), mycorrhizae (48), biotechnology (45) and fungal ecology (37). Nearly all of the publications, with the exception of the taxonomic publications, are written by Australian mycologists describing research carried out in Australia, and reflect the industrial or human importance of these subject areas. One surprisingly well-published (presumably well-funded) area is fungi and diet in mammals. This is a prime example of funding being available for research on cuddly furry large animals (politically nice) with little human or industrial value, while insufficient money is available for research into potentially important, but tiny (and therefore supposedly irrelevant) fungi. Areas such as biodeterioration and food microbiology can consider themselves relatively poorly funded.

Table 3. Publications in mycology (from *Biological Abstracts* 1991 to 1995, using the key words 'Fungi' and 'Australia')

Subject	No.	Subject	No.
Magic mushrooms	2	Fungal ecology	37
Mushroom production	2	Biotechnology	45
General microbiology	9	Mycorrhizae	48
Biodeterioration	12	Biological control	58
Food microbiology	13	Human mycology	80
Nothing to do with fungi	18	Genetics/cell biology	118
Medical (animals)	20	Taxonomy	131
Diet and dung	21	Plant pathology	460

A breakdown of the 131 taxonomic publications is given in Table 4. Twenty-seven publications are by non-Australian mycologists discussing Australian fungi. In contrast only 11 publications by a single Australian mycologist discuss mainly non-Australian fungi. Of the remaining 72 papers written by Australian mycologists, 4 are of a general nature, 7 describe lichens, and the remaining 61 discuss Australian fungi. A breakdown of these 61 publications is provided in Table 5. The most startling conclusion is that nearly 50% of these 61 publications are written by a single mycologist who is no longer in Australia. Thirty-two of these publications also discuss or describe plant pathogens and only 18 of these publications describe non-pathogenic microfungi. In 5 years only 7 publications in taxonomic mycology have been produced by Australian universities. Since publications reflect research (and funding), this is not a criticism of the work of mycologists, but clearly reflects the poor funding and employment opportunities for taxonomic mycological research in our Government institutions and in particular the critical situation in our universities.

Who will Do the Research and How Will it be Funded?

To date topics of research for the *Fungi of Australia* have involved mostly visible target groups, often related to the interests of Australian mycologists. There is merit to this approach as who can tackle groups where Australian mycologists have no interest or little expertise? Although these fungi are often easily seen on account of their large size or striking symptoms, they account for less than about 1 in 30 of all fungi, the less visible fungi making up the majority. It is therefore important that the microfungi are given considerable funding in the next decade. It is also important that non-economic groups are given priority over economic groups, since the latter groups could obtain funding from elsewhere.

Table 4. Breakdown of the 131 publications from 1991–1995 in taxonomic mycology

Category	Mycologist Non-Australian	Mycologist Australian
General paper		4
Lichens	6	7
Non-Australian fungi	15	11[1]
Australian fungi	27	61(29[1])
Total	48	83

[1] Co-authored by a single researcher who is presently employed outside Australia.

Table 5. Breakdown of 61 publications in taxonomic mycology between 1991 and 1995 by Australian mycologists on Australian fungi

Category	Number	University	Non-university
Macrofungi	11	2	9
Plant pathogens	32	4	28(13[1])
Non pathogenic macrofungi	18	1	17(16[1])
Total	61	7	54(29[1])

[1] By a single researcher who is presently employed outside Australia.

Unfortunately, it would be very difficult to investigate families of microfungi as the researcher would need to examine numerous microhabitats in numerous regions, if more than a cursory monograph is to be written. The research and proposed volumes (Volumes 4a–x) on habitat based taxonomy are therefore the obvious research approach that should be taken. This would provide many advantages:

1. The investigator would receive a wide training in mycology and would not become a specialist in any particular Order or Family. Australia cannot afford to train mycologists with a narrow expertise as it is unlikely they would find future employment.
2. Collections of a wide range of fungi would be made and placed into Australian herbaria. These can then be the basis for later taxonomic studies of Orders and Families of microfungi.
3. Information on the particular habitat for the *Fungi of Australia* volume would be available.

The lack of taxonomic mycologists in Australia has already been mentioned and therefore who will work on the future volumes of the Fungi of Australia? The answer lies in those students presently being trained. It is essential that funding is provided to these fresh graduates so that they can develop their mycological expertise in Australia and write future volumes of the *Fungi of Australia*.

Training of Future Taxonomic Mycologists

The training of future mycologists is problematical since there is very little mycology taught at Australian universities and there are very few lecturers with more than a peripheral interest in taxonomic mycology. It is unlikely that these lecturers will go out of their way to get funding for taxonomic projects, although there are good students in Australian universities with a strong interest in mycology (Guest, pers. comm.). There are presently three students being trained in taxonomic mycology, although only one of these is funded and working in Australia. Other students of mycology being trained in Australian universities have projects which involve a minor taxonomic component or are only partially funded. This situation is far from ideal and must be changed.

The best way forward is for mycologists in Australian universities to collaborate with taxonomic mycologists in Government institutions or overseas universities and institutions in training young Australians. The mycologists in universities must realise that most of the burden is with them. They must actively encourage students to take an interest in taxonomic mycology. They must seek support for taxonomic research in the form of research funds from the various grant-awarding bodies. The Government institution mycologists must also play a role. They must actively seek collaborative projects with university mycologists in order to train students together.

Finally a balanced approach must be taken. The students should receive training in a wide range of taxonomic groups so that they can more easily find employment following graduation and can tackle future volumes of the *Fungi of Australia*.

The Future of Mycology in Australia

The poor state of mycology in Australia is obvious, yet what can be done in order to improve this situation? Unfortunately, nothing will happen unless the few remaining Australian mycologists fight back. Recent grant applications to the Wet Tropics Rain Forest Management Authority have been unsuccessful, despite the fact that one of their reviewers for world heritage listing have indicated that they had omitted any mention on how they were to address the role and speciation of fungi (Young, personal communication). There is also frustration as requests for funding for mycological research falls on 'deaf ears' (Young, 1988, 1994). The report on a national workshop on *Taxonomy in Crisis* held in Canberra in October 1995 (Visher, 1996) deals with the Australian Biological Resources Study (ABRS) strategies for increasing numbers of taxonomists in Australia, and the amount of taxonomic work being carried out in Australia. No mycologist was invited to the workshop which took no note of Grgurinovic and Hyde (1993). Therefore, although the need for the training of experts and the need for research into lower plants is addressed, the message that the need for funding in mycological research, the largest and probably the most important kingdom (both ecologically and in potential usefulness to mankind) is critical, has been sadly missed.

The incorporation of the Australasian Mycological Society finally provides mycologists with a voice. All Australian mycologists have a role to play in promoting taxonomic mycology. All mycologists must stand as a strong coherent group and educate the Government and the public of the importance of mycology to industry, to agriculture, and the potential benefits of taxonomic mycological research.

For its part, ABRS must support training of mycologists in universities in collaboration with Government institutes or overseas universities. Other funding bodies, in particular the Co-operative Research Centre for Tropical Rainforest Ecology and Management and the Australian Research Council, must be made aware of the critical situation of taxonomic mycology in Australia and begin to fund training and ongoing employment. It is only then that the decrease in fungal systematists in Australia can be halted.

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Fungi on Submerged Wood in a Small Stream on Mt Lewis, North Queensland, Australia

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Abstract

Results of an investigation into the fungi associated with submerged wood in a small stream on Mt Lewis, North Queensland, Australia is reported. Forty-two fungi were identified including 20 ascomycetes and 22 deuteromycetes. The frequency of occurrence of these fungi is discussed in this paper. A new species, *Didymostilbe australiensis*, and some other notable species, are described and illustrated.

Introduction

We are investigating the fungi causing the decay of wood in streams and rivers in the subtropics and tropics and have discovered a number of interesting microfungi (Goh 1997; Goh and Hyde 1996a; Hyde *et al.* 1996; Ho *et al.* 1997). These fungi are mainly ascomycetes (Hyde *et al.* 1996) and hyphomycetes (Goh 1996). In this study 100 submerged wood samples were collected from a small stream on Mt Lewis in north Queensland and examined for the presence of lignicolous fungi. This paper presents the first report of our continuing studies of freshwater microfungi from Australia. A species list, which also includes data on the frequency of occurrence of the fungi, is presented (Table 1) and discussed. Recent illustrations and the herbarium numbers are also provided here. Notes and illustrations of selected species, including one new species of *Didymostilbe*, are then given.

Materials and Methods

One hundred submerged wood samples were collected from a 100 m section of a small, unnamed stream on Mt Lewis in north Queensland and placed in plastic bags. They were returned to the laboratory in Hong Kong within 2 days where they were incubated collectively in plastic boxes on moist tissue paper at room temperature under normal light conditions. The samples were periodically examined over the next 21 days and any fungi present were identified and where possible isolated. The material was then air dried and is held in HKU and/or BRIP. In all cases the collection details are Australia, north Queensland, Mt Lewis, on wood submerged in a small stream, June 1995, Tamsin M. and Kevin D. Hyde. The HKU (M) herbarium number is provided in Table 1. Some duplicates and the type material of the new species are also lodged at BRIP. The cultures are held in the Hong Kong University Culture Collection (HKUCC).

Table 1. Frequency of occurrence of fungi on submerged wood samples in a small stream on Mt Lewis
Organised in decending order of frequency and then alphabetically by groups.

Species	Frequency of occurrence %	Herb. No.	New to Australia	Illustrations
Verticillium sp.	8	2279, 2293	*	
Helicomyces roseus Link	6	2243	*	This paper
Jahnula bipolaris (K.D. Hyde) K.D. Hyde	6	2260, 2296		Hyde 1992*a*, Hyde and Wong 1997
Massarina bipolaris K.D. Hyde	5	2266, 2295		Hyde 1995
Clohiesia corticola K.D. Hyde	4	2245		Hyde 1995
Savoryella lignicola E.B.G. Jones & R.A. Eaton	4	2992		Ho *et al.* 1997
Annulatascus sp. 3.	3	2293	*	
Dactylaria sp. 1	3	2235	*	
Dactylella sp.	3	2251	*	
Didymosphaeria sp.	3	2231	*	
Massarina australiensis K.D. Hyde	3	2278, 2294		Hyde 1992*a*; Hyde and Aptroot 1997
Monotosporella setosa var. *macrospora* S. Hughes	3	2279	*	This paper
Ascomycete sp. 2	3	2255, 2276	*	
Anthostomella sp.	2	2265, 2294	*	
Candelabrum brocchiatum Tubaki	2	2262	*	Tubaki 1975
Lasiosphaeria sp.	2	2226	*	
Massarina thalassiensis K.D. Hyde & Aptroot	2	2266, 2276		Hyde and Aptroot 1997
Sporochisma saccardoi E.W. Mason & S. Hughes	2	2314	*	
Tricladium indicum Sati & N. Tiwari	2	2311	*	Sati and Tiwari 1992
Xylomyces chlamydosporis Goos, R.D. Brooks & Lamore	2	3188	*	Goos *et al.* 1977
Annulatascus velatispora K.D. Hyde	1	2225		Hyde 1992*b*
Annulatascus sp. 1.	1	2274	*	
Annulatascus sp. 2.	1	2233	*	
Aquaphila albicans Goh, K.D. Hyde & W.H. Ho	1	2349	*	Goh, Hyde & Ho 1997
Ascotaiwania palmicola K.D. Hyde	1	2285	*	Hyde 1996
Iodosphaeria aquatica K.D. Hyde	1	2308		Hyde 1995
Brachydesmiella anthostomelloidea Goh & K.D. Hyde	1	2293		Goh and Hyde 1996*a*
Cancellidium applanatum Tubaki	1	BRIP 23200		Tubaki 1975; Goh and Hyde 1996*b*

Table 1. Continued

Species	Frequency of occurrence %	Herb. No.	New to Australia	Illustrations
Cryptophiale multiseptata Goh & K.D. Hyde	1	BRIP 23150		Goh and Hyde 1996*c*
Dactylaria sp. 2	1	2249	*	
Dictyochaeta subfuscospora Kuthub. & Nawawi	1	3188	*	This paper
Dictyochaeta sp.	1	3188	*	
Didymostilbe australiensis Goh & K.D. Hyde	1	BRIP	*	This paper
Exserticlava vasiformis (Matsush.) S. Hughes	1	2232	*	This paper
Helicoon gigantisporum Goh & K.D. Hyde	1	BRIP 23200		Goh and Hyde 1996*d*
Kionochaeta sp.	1	2308	*	
Massarina peeralia K.D. Hyde & Aptroot	1	2234		Hyde and Aptroot 1997
Massarina sp.	1	2273	*	
Ophioceras dolichostomum (Berk. & M.A. Curtis) Sacc.	1	2271		Conway and Barr 1977, Hyde 1992*c*
Spadicoides cordanoides Goh & K.D. Hyde	1	BRIP 23201		Goh and Hyde 1996*e*
Verticicladiella sp.	1	2264	*	
Ascomycete sp. 1	1	2244	*	

Frequency of occurrence is calculated by the following formula:

$$\frac{\text{Number of samples species occurred on}}{\text{Number of samples examined}} \times 100$$

Notes on Selected Species

ASCOMYCOTINA

Ascotaiwania palmicola K.D. Hyde

Notes

Ascotaiwania palmicola was orginally described from a palm rachis collected in Ecuador. This is the first record from Australia and from submerged wood.

HYPHOMYCETES

Dictyochaeta subfuscospora Kuthub. & Nawawi (Fig. 1)

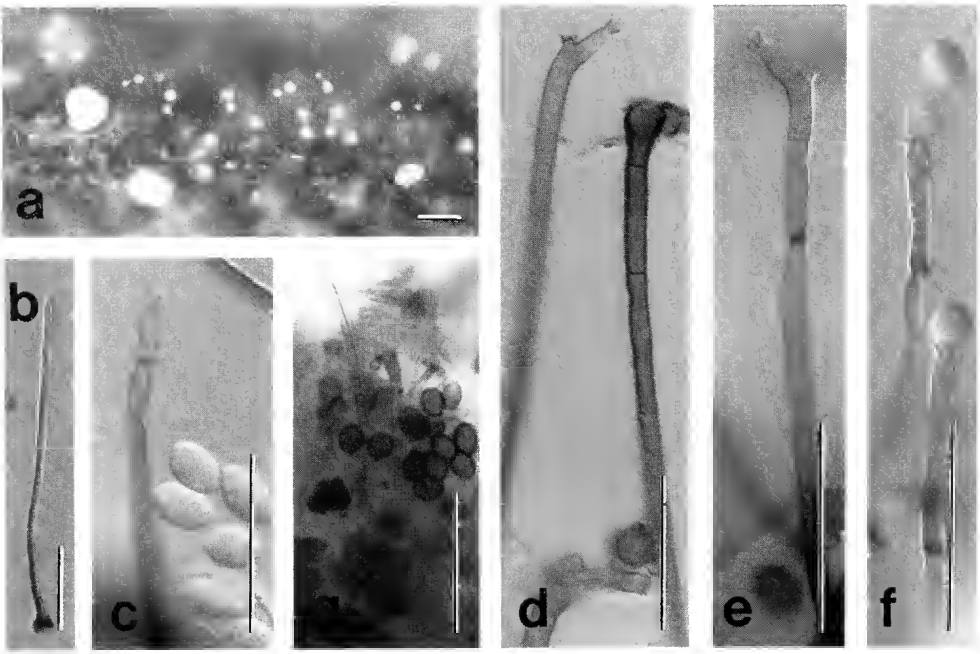

Fig. 1. *Dictyochaeta subfuscospora:* **a** representative portion of colonies on submerged wood; **b** conidiophore; **c–f** apical portion of conidiophores showing percurrent proliferations, phialides with collarettes, and developing conidia; **g** mature conidia that have become pigmented. Scales: **a** 200 µm, **b–g** 50 µm.

Notes

Dictyochaeta subfuscospora was originally described from submerged decaying branches of an unknown angiosperm from Malaysia (Kuthubutheen and Nawawi 1991). This is the first record from Australia, also occurring on submerged wood. This collection of *D. subfuscospora* has pigmented, percurrently and sympodially proliferating, polyphialidic conidiophores with flared collarettes. The shorter, sympodially proliferating, monophialidic to polyphialidic, pigmented conidiophores found close to the substratum by Kuthubutheen and Nawawi (1991) were not seen in our collection. The conidia are ovate, non-septate, non-setulate, initially hyaline to subhyaline, later becoming pale brown, 17–22 x 6–8.5 μm, and form in slimy masses.

Didymostilbe australiensis Goh & K.D. Hyde, sp. nov.

Conidiomata synnematosae, solitariae, subulato-capitatae, non-ramosae, determinatae, cremeae, 250–500 μm altae, ad basim 30–50 μm latae, apicem versus attenuatae usque 15–50 μm latae. Hyphae stipitis ad basim intricatae, superne parellelibus, septatae, laeves, simpliciae, ca. 1 μm latae. Conidiophora non-ramosa, cellulae conidiogenae 13–25 x 1.5–2 μm, phialidicae, anguste cylindricae, apicem versus attenuata, hyalinae, laeves. Conidiorum massa hemisphaerica vel subglobosa, mucoidea, terminalia, cremea vel albolutescens. Conidia enteroblastica, 0–1-septata, interdum ad septa leniter constricta, cylindrica vel leniter clavata, apicem late rotundata, ad basim subtruncata vel obconico truncata, crassitunicata, laevia, hyalina, (8–)9–13(–15) x (2.5–)3–4 μm.

Type: Queensland, Cape Tribulation, Mt Lewis, on decaying wood submerged in a stream, *T.M. and K.D. Hyde ML 28*, vi.1995 (holotype BRIP).

Conidiomata synnematous, solitary, subulate-capitate, unbranched, determinate, creamy white, 250–500 μm tall, 30–50 μm wide at the base, tapered to 15–50 μm wide near the apex, conidiogenous head 40–150 μm wide. *Hyphae of stipe* interweaving at base, parallel throughout stipe, septate, smooth, simple, ca. 1 μm wide. *Conidiophore* unbranched, conidiogenous cells 13–25 x 1.5–2 μm, phialidic, narrowly cylindrical, tapering at the apex, hyaline, smooth. *Conidial mass* hemisphaerical to subglobose, mucoid, terminal, creamy white to pale yellowish. *Conidia* enteroblastic, 0–1-septate, sometimes slightly constricted at the septum, cylindrical to slightly clavate, broadly rounded at the apex, subtruncate to obconically truncate at the base, thick-walled, smooth, hyaline, (8–)9–13(–15) μm long, (2.5–)3–4 μm in diameter. (Figs 2, 3)

Notes

This differs from other *Didymostilbe* species (*sensu* Seifert 1985) in its conidial shape and size. In other species the conidia are larger (14 μm or more in length, 4 μm or more in width) and are mostly ellipsoidal to fusiform in shape.

Exserticlava vasiformis (Matsush.) S. Hughes (Fig. 4)

Notes

Exserticlava vasiformis was originally isolated from wood in Japan by Matsushima (1975) (as *Cordana vasiformis* Matsush.). This species produces solitary, erect, thick-walled, dark conidiophores, each with a terminal funnel-shaped conidiogenous apex, which gives rise to 10–15 distoseptate conidia. The hyaline inner wall of the conidiogenous cell usually expands to 20 μm wide and finally grows upwards as a hyaline, thick-walled, septate, subulate structure, up to 120 μm long. This characteristic extension of the conidiophore is a readily identifiable feature. *Exserticlava* species have also been reported from New Zealand (Hughes 1978), North America (Crane and

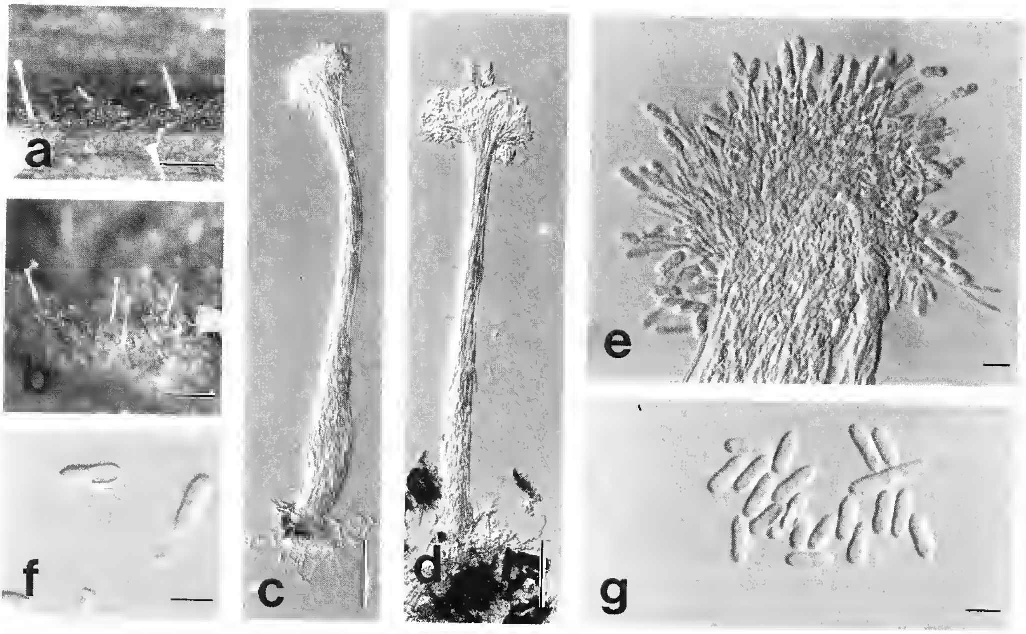

Fig. 2. *Didymostilbe australiensis*: **a–b** synnemata on submerged wood; **c–d** synnemata; **e** close-up of conidiogenous head of a synnema; **f–g** conidia. Scales: **a–b** 500 µm, **c–d** 100 µm, **e–g** 10 µm.

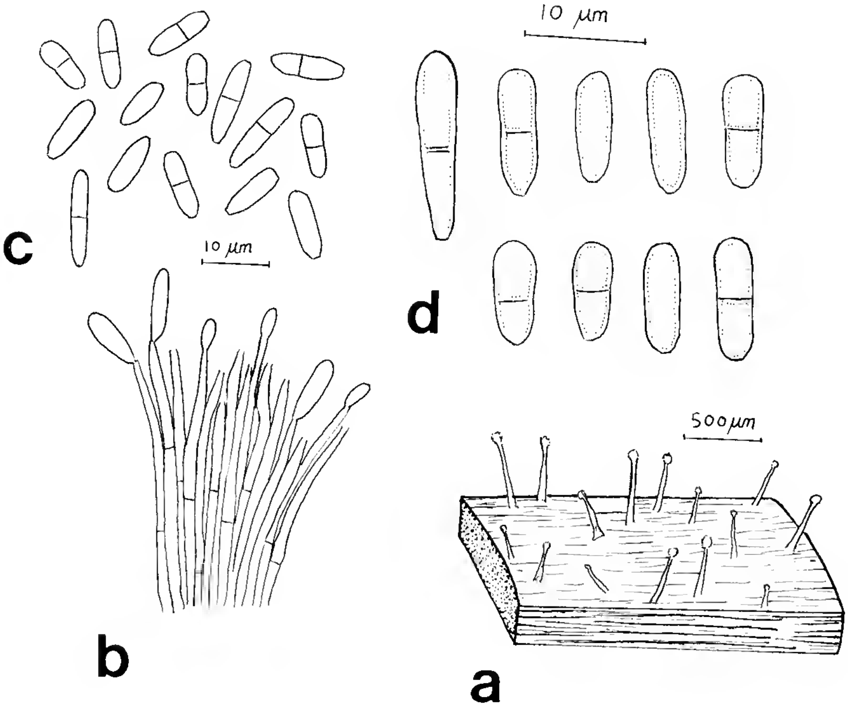

Fig. 3. *Didymostilbe australiensis*, diagramatic representation: **a** synnemata on submerged wood; **b** phialides and developing conidia; **c** conidia; **d** close-up of conidia showing thick walls.

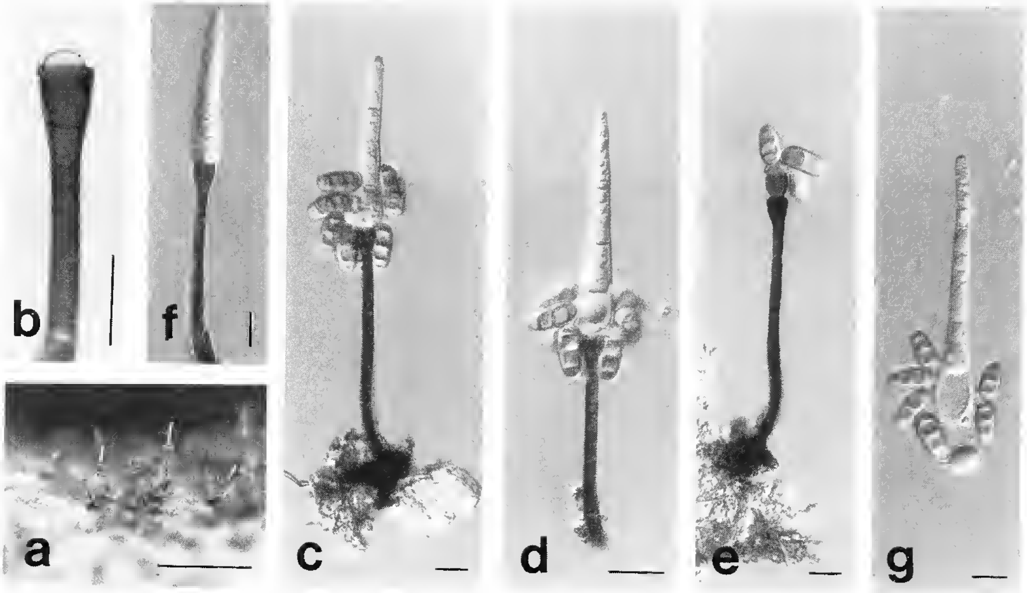

Fig. 4. *Exserticlava vasiformis:* **a** representative portion of colonies on submerged wood; **b–e** conidiophores and conidia (note the subulate, hyaline, multiseptate extension of the conidiophores); **f** apical portion of a conidiophore showing funnel-shaped conidiogenous cell; **g** subulate, septate, and hyaline appendage of the conidiophore and conidia. Scales: **a** 500 μm, **b–g** 20 μm.

Schoknecht 1982), Ethiopia (Bhat and Sutton 1985), Kenya (Kirk 1985), India (Rao and de Hoog 1986) and Malaysia (Kuthubutheen and Nawawi 1994). This is the first record from Australia.

Helicomyces roseus Link (Figs 5, 6)

Notes

This species is characterised by the formation of effuse, thin, flocculose, white to pinkish colonies on natural substrata. The conidiophores are short, hyaline to very pale brown, and arise as short lateral branches of the repent mycelium. The conidiogenous cells are mono- or sympodially polyblastic, developing as denticles on the repent hyphae or as the terminal cells of the conidiophores. The conidia are hyaline and have a basal cell which is obliquely flattened, slightly swollen and attached eccentrically to the conidiogenous denticles. It is commonly found on dead wood, palm litter and other decaying vegetation. This species is widespread and has been reported from many countries (Goos 1985). However, this is the first record from Australia.

Monotosporella setosa **var.** ***macrospora*** S. Hughes (Figs 7, 8)

Notes

This species is characterised by having 2-septate, obovoid to obpyriform, versicoloured conidia. The terminal cell is large, black, and the lower two cells short, brown to dark brown, to almost black. It was originally reported from New Zealand (Hughes 1978) and this is the first record of its occurrence in Australia.

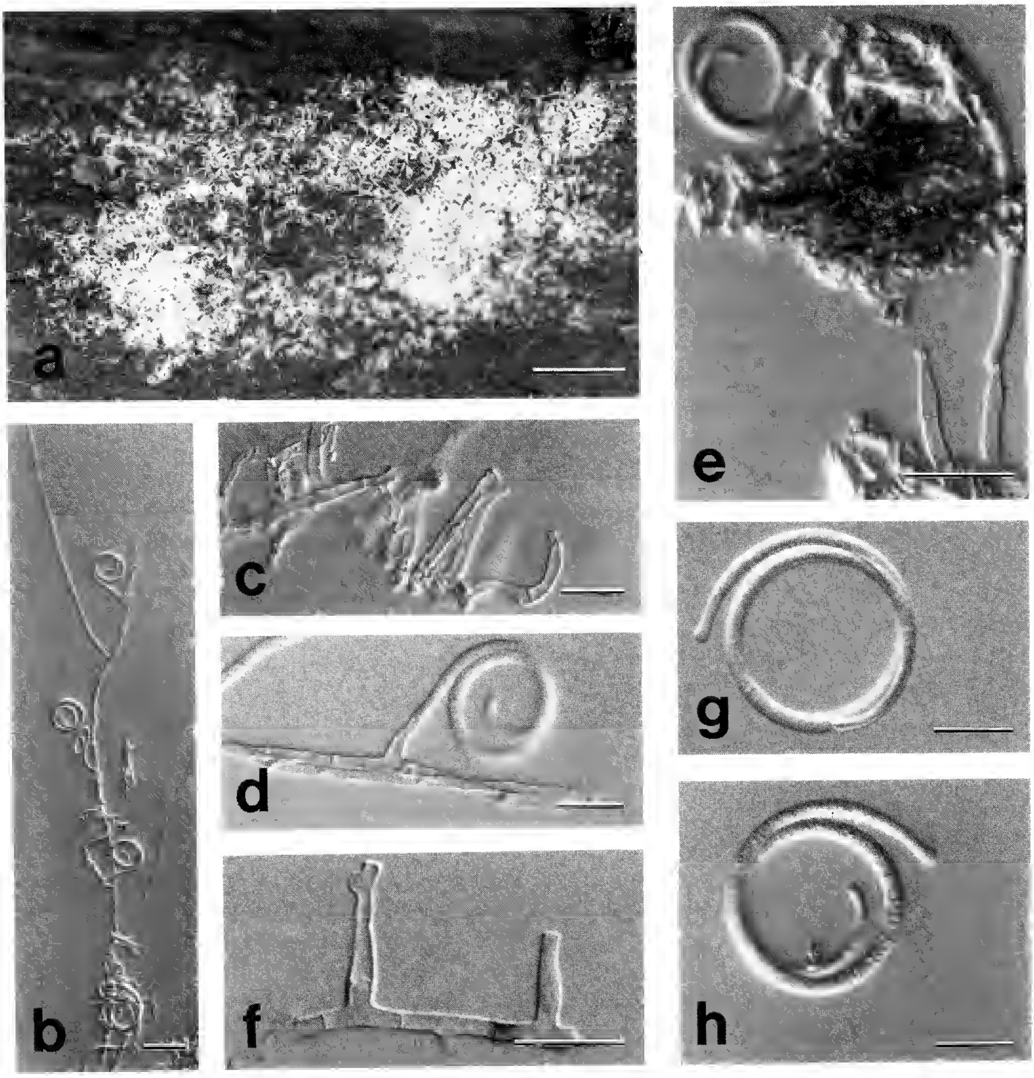

Fig. 5. *Helicomyces roseus:* **a** colonies on submerged wood; **b–e** conidiophores arising from superficial procumbent hyphae and developing conidia; **f** close-up of conidiophores; **g–h** conidia. Scales: **a** 500 µm, **b–h** 20 µm.

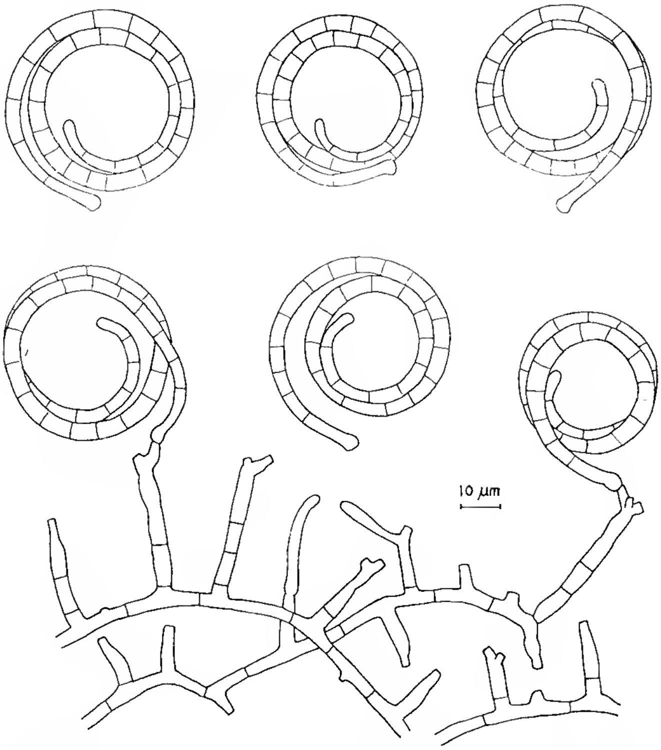

Fig. 6. *Helicomyces roseus*, diagramatic representation of conidiophores arising from hyphae and conidia.

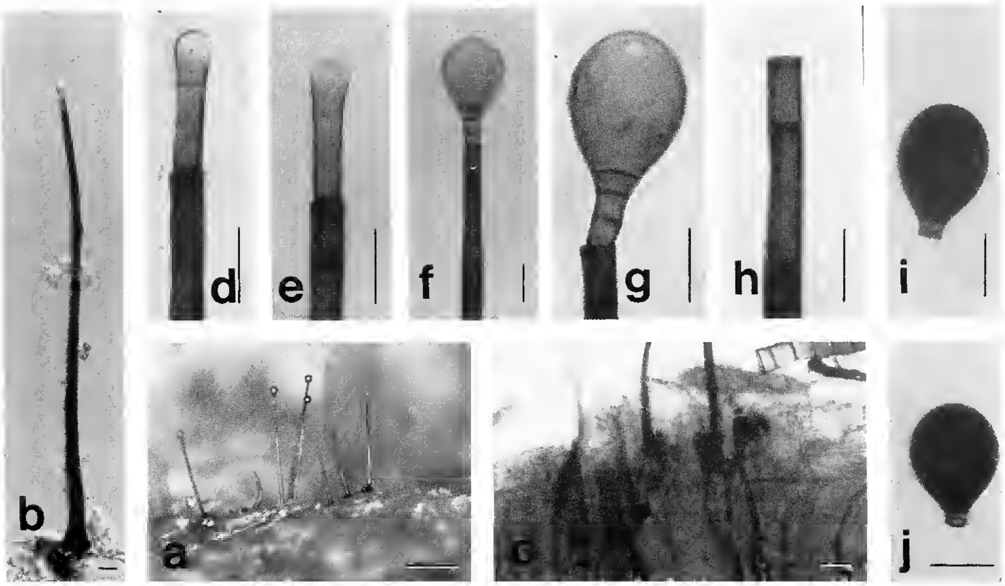

Fig. 7. *Monotosporella setosa* var. *macrospora*: **a** representative portion of colonies on submerged wood; **b** conidiophore; **c** basal portion of conidiophores showing pigmented, branched, septate hyphae immersed im substratum; **d–h** apical portion of conidiophores and developing conidia; **i–j** conidia. Scale: **a** = 200 μm, **b** = 20 μm, **c–j** = 10 μm.

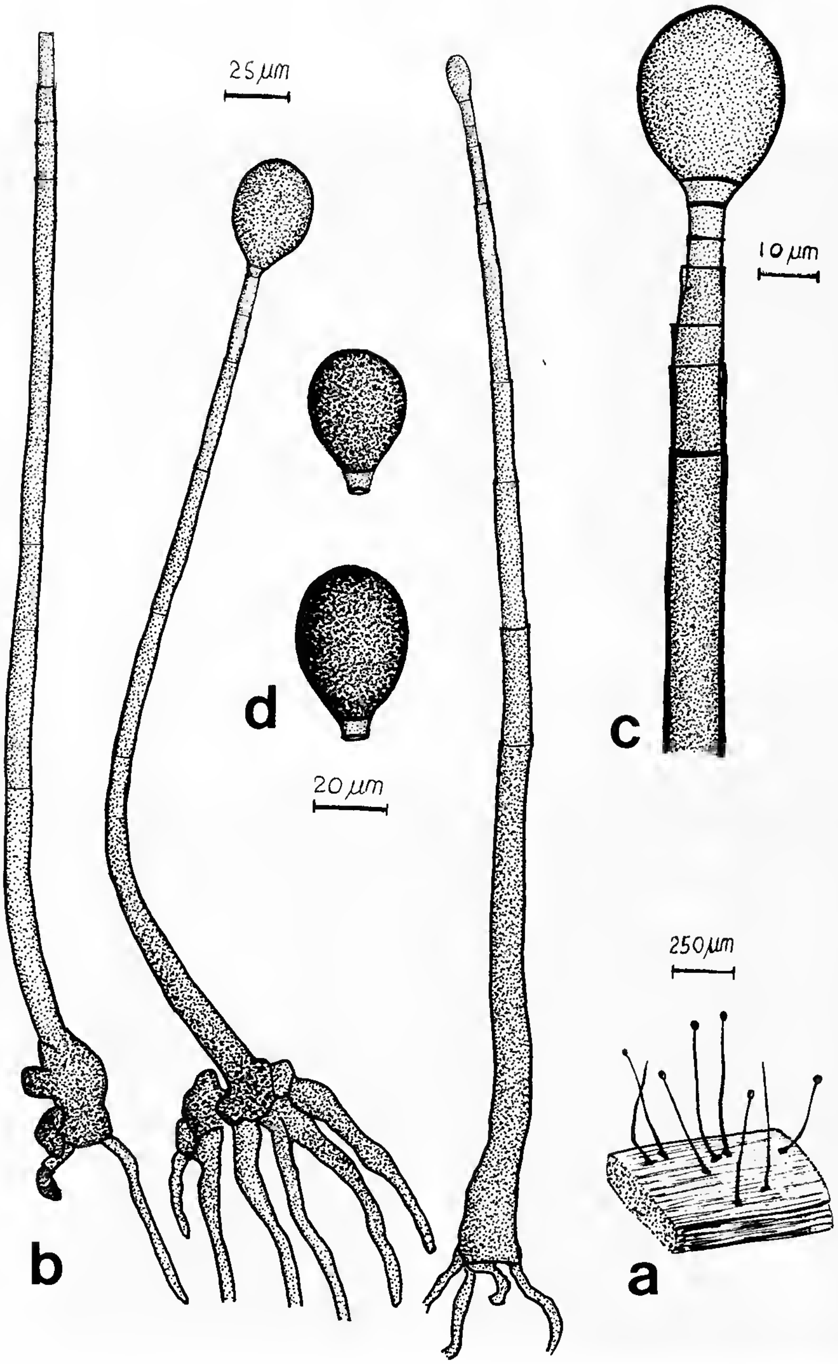

Fig. 8. *Monotosporella setosa* var. *macrospora*, diagramatic representation: **a** representative portion of colonies on submerged wood; **b** conidiophores with percurrent proliferation and developing conidia; **c** apical portion of conidiophore showing percurrent proliferation and developing conidia; **d** conidia.

Notes

This differs from other *Didymostilbe* species (*sensu* Seifert 1985) in its conidial shape and size. In other species the conidia are larger (14 µm or more in length, 4 µm or more in width) and are mostly ellipsoidal to fusiform in shape.

Exserticlava vasiformis (Matsush.) S. Hughes (Fig. 4)

Notes

Exserticlava vasiformis was originally isolated from wood in Japan by Matsushima (1975) (as *Cordana vasiformis* Matsush.). This species produces solitary, erect, thick-walled, dark conidiophores, each with a terminal funnel-shaped conidiogenous apex, which gives rise to 10–15 distoseptate conidia. The hyaline inner wall of the conidiogenous cell usually expands to 20 µm wide and finally grows upwards as a hyaline, thick-walled, septate, subulate structure, up to 120 µm long. This characteristic extension of the conidiophore is a readily identifiable feature. *Exserticlava* species have also been reported from New Zealand (Hughes 1978), North America (Crane and Schoknecht 1982), Ethiopia (Bhat and Sutton 1985), Kenya (Kirk 1985), India (Rao and de Hoog 1986) and Malaysia (Kuthubutheen and Nawawi 1994). This is the first record from Australia.

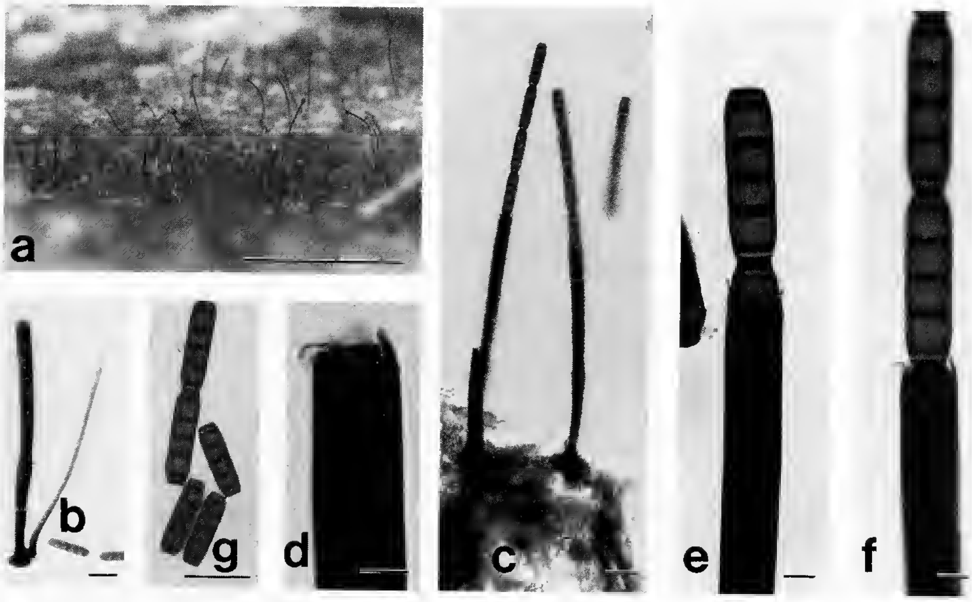

Fig. 9. *Sporoschisma saccardoi:* **a** representative portion of colonies on submerged wood; **b** a conidiophore with a basal capitate seta; **c** conidiophores producing chains of conidia from philaides; **d** close up of the apical portion of a phialide showing the frayed opening; **e–f** upper portion of phialides showing endogenous conidial productions; g conidia. Scales: a 500 µm, **b–c**, **g** 40 µm, **d–f** 10 µm.

Helicomyces roseus (6%), *Jahnula bipolaris* (6%), *Massarina bipolaris* (5%), *Clohiesia corticola* (4%) and *Savoryella lignicola* (4%). There were 22 species recorded on one occasion each. The number of fungi identified on each sample is low, with an average of 0.9 species per sample. The fungi occurring on these wood samples were characteristic aquatic species and not indicative of aerial contamination.

There are no similar published results for comparison in the tropics, although somewhat comparable studies have been conducted in North America and United Kingdom. Shearer and Webster (1991) have listed the frequency of hyphomycetes occurring on submerged twigs in the river Teign in Devon, United Kingdom. They identified 39 species and found 0.4–1.57 species per twig (H' diversity). The numbers of fungi found per sample in this study, falls in the middle of this range, but caution is needed in comparisons, as the methods used in this study differ from those of Shearer and Webster (1991). Shearer and Von Bodman (1983) also investigated the frequency of occurrence of ascomycetes on packs of baited twigs in Jordan Creek in east central Illinois, United States of America. Thirty three ascomycetes were collected, although many were new and identified to genus only. The frequencies of occurrence ranged from 1–20% depending on the length of submergence and wood species. Only one species (*Savoryella lignicola*) occurred in the stream on Mt Lewis and Jordan Creek. This is an indication of the high diversity of fungi yet to be located on submerged wood in tropical rivers.

The results presented here go some way towards determining the assemblage of fungi occurring on submerged wood in the tropics. Direct incubation has been shown to yield more ascomycetes and less aquatic hyphomycetes when compared to bubble chamber incubation (Shearer and Webster 1991) and therefore our techniques may exclude certain Ingoldian fungi.

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BOOK REVIEW

Wildflowers of Southern Western Australia. Margaret G. Corrick, Bruce A. Fuhrer, edited by Alexander S. George. Published by Five Mile Press in association with Monash University, Noble Park, Victoria. 1996. 244 pp. ISBN 1 87597 149 1. Price $A39.95 (hardcover).

Within a couple of months of its release for sale, stocks of this book have been taken up by an enthusiastic public to such an extent that as I write, it is unlikely that any copies are available for sale. A review therefore may seem redundant. However, this is a new work and a second edition is promised for 1997.

The book is introduced with an overview by Alex George of the physical attributes of the land, geological history and dominant vegetation types represented in Western Australia (divided into the Kimberley, the North-West, the Deserts, the Nullarbor, the Transitional Zone, and the South-West). A more detailed discussion of the vegetation is given for the South-West, the focus of the book. Phytogeographic maps, based on Beard (1980), are also provided and these are used to describe the distribution of the plants treated in the main body of the work. I would like to have seen reference to Beard's classification (in which 4 Botanical Provinces are recognised) in George's overview (in which 6 regions are discussed). There is undoubtedly a fair degree of overlap between the 2 treatments, and without justification for the departure from a widely accepted subdivision of the State (i.e. Beard's), one does wonder why a single system could not have been used throughout.

The main text is rightly devoted to depicting and describing the 755 species (in 53 families) selected to represent the flora of this exceptionally rich area. Rather than follow the trend of many recent guides to group plants of particular regions together, the authors have preferred a listing by family (in alphabetic order) and alphabetically arranged genera and species. This arrangement certainly facilitates the finding of known species in the book, and for the many who have an inkling of the affinities of an encountered plant, gives a good chance of identification by comparison with likely related species. Another justification given by the authors for such an arrangement is to allow an appreciation of the diversity contained within the families treated. Their aim is admirably met. The regional, or ecological approach to arrangement of plants in field guides suffers in its inability to deal with species that are widespread or characteristically occur in more than one region or plant association. This shortcoming is avoided by the more systematic approach adopted in this book.

The photographs, mostly by Bruce Fuhrer, vary in quality from superb to excellent, generally allowing appreciation of fine floral detail and beauty, but also providing enough indication of the habit of the plant to allow a confident attempt at identification. Some of the photographs are smaller than I would have liked. Their clarity is such that many could be enlarged considerably without loss of definition. This is undoubtedly a consequence of the inevitable compromise between extent and cost. There is certainly no wasted space that would enable the images to be enlarged without considerable reformatting of the book.

The selection of species portrayed in the book seems nearly perfect. From my admittedly limited experience, it covers those eyecatching species that are encountered along roadsides and in the various reserves that are visited by travellers generally, but particularly by the many who visit southern Western Australia to experience its diverse and sometimes bizarre botany.

The accompanying descriptions, prepared by Margaret Corrick, are concise without being off-puttingly (for the lay-person) technical. They provide information on the habit and size of the plant, the size and shape of leaves, nature of indumentum when significant, dimensions of flowers, habitat and distribution. Where two or more species are likely to be confused, diagnostic characteristics are given. Each family is introduced by a summary of its attributes, relationships, global distribution and 'titbits' of general interest. Large and/or structurally diverse genera are described individually.

Understandably, there is a rich representation of those families for which the area is well known — Asteraceae, Fabaceae, Myrtaceae, Orchidaceae, Proteaceae — whereas less showy groups — such as Cyperaceae, Poaceae and Restionaceae — seem slightly underdone. This is perhaps forgivable given the difficulty in distinguishing many members of these groups without dissecting spikelets, but I felt at least the very rich Restionaceae flora of the region probably could have received more exposure.

The inclusion of a glossary is to be applauded. Too many non-specialist books ignore the value of a glossary, and must then rely on descriptive terms in the everyday lexicon and in so doing lose precision, or include scientific terminology that is at the one time accurate but baffling to the lay-reader. Some further attention could be devoted to the glossary for the second edition however. It gets off to a bad start with a simple spacing error, causing 'achene' to read as 'achenea'. A loss of comma confuses the definition of 'c.' to 'circa about'. A carpel is, not incorrectly perhaps but incompletely, defined as a 'female reproductive organ'. The term 'malesia' for the region that includes the Philippines (not 'Philipines') warrants capitalisation. 'Trifoliate' (rather than 'trifoliolate') is defined as 'a compound leaf with three leaflets'.

I could find very few errors or inconsistencies, but to justify my searching, I feel duty-bound to note them. The introduction to the Philydraceae misspells the family as the Phylidraceae (p. 148). In the discussion of the Rhamnaceae, the genus *Ceanothus* is misspelt '*Ceonothus*' (p. 188). The caption to figure 637 should read *Pomaderris* (not '*Pomoderris*') *forrestiana* (p. 189). The distribution of *Microcybe multiflora* var. *multiflora* should include Victoria (p. 196). There is some inconsistency in the provision of authors to all epithets where infraspecific taxa are described, e.g. *Banksia sphaerocarpa* var. *caesia* A.S. George (p. 159), but *Conospermum acerosum* Lindley subsp. *hirsutum* E..M Bennett (p. 160).

These are minor quibbles, and I proffer them with reluctance, but they do detract slightly from a work that in other respects is reassuringly authoritative. It is hoped that a second edition will allow for corrections. Despite these minor gripes, I thoroughly recommend Wildflowers of Southern Western Australia, and believe it to be among the best, if not the best, of works of the genre (reviewers are obliged to use this term) in this country. I believe it admirably achieves its aim of being a 'valuable reference for professional botanists and amateur enthusiasts alike'. Further, at $39.95 (for the first edition at least) it represents exceptional value. But pages of praise pale into insignificance compared to the most resounding acknowledgment of the book's quality, that is, the purchase of the entire print run within 3 months of its publication! If you're not among the many who purchased the first edition, keep on the lookout for the second later this year or early 1998.

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PUBLICATIONS RECEIVED

Flora of Australia Volume 28, Gentianales. CSIRO Australia, Melbourne. 1996. 335 pp. ISBN 0 643 05884 2 (hardcover). Price $A79.95 (hardcover), $69.95 (softcover).

The latest volume on vascular plants includes the 4 families, 62 genera and 326 species of Gentianales in Australia. Two new genera are described in the Loganiaceae (by B.J. Conn, E.A. Brown and C.R. Dunlop), a mainly tropical and subtropical family. In the Gentianaceae (by L.G. Adams) the montane taxa are now distributed between *Gentiana* and *Chionogentias*. The Apocynaceae (by P.I. Forster and J.B. Williams) and Asclepiadaceae (by P.I. Forster, D.J. Liddle and A. Nicholas) include many ornamental species from tropical and subtropical regions: e.g. *Mandevilla*, *Vinca*, *Nerium*, *Hoya*, *Asclepias*, *Dischidia*.

Fungi of Australia Volume 1A, Introduction — Classification. CSIRO Australia, Melbourne. 1996. 435 pp. ISBN 0 643 05802 8 (hardcover). Price $69.95 (hardcover), $54.95 (softcover).

The *Fungi of Australia* series, comprising 60 volumes (many in multiple parts), will ultimately provide descriptions in a style similar to that of the *Flora of Australia* of all fungi found in Australia. Volume 1A is the first of two introductory books. It includes a major chapter on the classification of fungi, including a new classification system and keys (of world-wide scope) to all orders. The volume also includes chapters on the biology of the fungi, the history of mycology in Australia, biogeography and fossils, and an extensive glossary to mycological terms. Sixteen authors contributed to the volume.

Fungi of Australia Volume 1B, Introduction — Fungi in the Environment. CSIRO Australia, Melbourne. 1996. 405 pp. ISBN 0 643 05935 0 (hardcover). Price $69.95 (hardcover), $54.95 (softcover).

This second introductory volume includes essays on freshwater fungi, marine fungi; plant parasitic fungi; wood decay fungi; associations between arthropods and fungi; gut-inhabiting fungi of Australian herbivores; mycoses and macrofungal poisonings of domestic and native animals; fungal toxins and animals; fungi as a food resource for mammals in Australia; Aboriginal knowledge and use of fungi; macrofungi toxic to humans; fungi and mycotoxins in foods; and human mycoses. It represents the work of 40 contributors (including illustrators and photographers).

Adventrop Doc: Les Adventices d'Adrique soudano-sahélienne. Un système multimédia: flore + CD-ROM. Centre de Coopération Internationale en Recherche Agronimique pour le Développement, Départment de Cultures Annueles (CIRAD-CA), Montpellier. 2000 FF (CD-ROM and book).

The CD-ROM identification key, as demonstrated recently at the *Beyond the Floras* conference in Melbourne by Pierre Grard, provides an innovative and practical approach to identifying crop weeds. Although tailored for tropical Africa, it should have applications in northern Australia. It provides an example of a Flora prepared for farmers and other land managers, rather than for botanists and their friends. Although the text is entirely in French, an anglophile can readily navigate his or her way to any species: this is clearly a user-friendly program.

CORRIGENDUM

Muelleria 9: 67–73 (1996)
Miscellaneous Notes on *Genoplesium ciliatum* (Ewart & B. Rees) D.L. Jones & M.A. Clem. (Orchidaceae).
— *David L. Jones and Jeffrey A. Jeanes*

The fifth couplet in the key on p. 72 should read:

5 Plant 20–40 cm tall; flowers in an open spike, light reddish with a contrasting reddish black labellum; lowland north Queensland only .... ***G. tectum***

5: Plant 6–15 cm tall; flowers in a dense spike, dark purplish red; sub-alpine New South Wales only ....***G. turfosum***

CONTENTS

Volume 10 1997

Page

Vascular Plant Systematics

Lichenology

Selected Mycological Papers from 'The 1996 Commemorative Conferences', Melbourne, 29 September to 5 October 1996

Book Review