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A revision of Orchidaceae from the Kimberley region of Western Australia with new species of tropical *Calochilus* and *Dipodium*

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Abstract

Orchidaceae occurring in the Kimberley region of Western Australia are revised. *Calochilus barbarossa* R.L.Barrett, M.D.Barrett & K.W.Dixon, *Calochilus kimberleyensis* R.L.Barrett, M.D.Barrett & M.A.Clem., *Dipodium ammolithum* M.D.Barrett, R.L.Barrett & K.W.Dixon and *Dipodium basalticum* M.D.Barrett, R.L.Barrett & K.W.Dixon are described and illustrated as new species from the Kimberley, one also occurring in the Northern Territory. The genera *Empusa* Lindl., *Habenaria* Willd. *s. str.*, *Phoringopsis* D.L.Jones & M.A.Clem., *Spiranthes* Rich. and *Zeuxine* L. have been added to the Western Australian flora since publication of the *Flora of the Kimberley Region*. The taxonomic status of a number of tropical Australian Orchidaceae is discussed with recommendations for future research. Descriptions and illustrations are provided for twenty orchid species recorded in the Kimberley Region (one without a verified voucher). Keys are presented to all Kimberley orchid species.

Introduction

Orchidaceae is one of the largest families of flowering plants, and naturally represents a significant challenge for classification (Dressler 1993, 2005; Chase *et al.* 2003, 2015; Pridgeon *et al.* 1999, 2001, 2003, 2005, 2009, 2014). Nomenclatural complexity is also a significant hinderance to conservation and trade in orchids (Hinsley *et al.* 2018). Australian Orchidaceae have been reviewed by Jones (1988, 2006, 2021). Clements (1989) provided the first detailed nomenclatural checklist for Australian orchids, providing many important typifications and

clarifying the applications of many doubtful names following the study of type material in European herbaria. Western Australian orchids have been reviewed by Brown *et al*. (2008) and Brown *et al*. (2013). In this context one might expect the taxonomy of Kimberley orchids to be relatively straightforward, however, many questions remain unresolved.

Early notes on Kimberley orchids have been provided by Pate & Dixon (1982), Dixon *et al*. (1989) and Dixon (1994). A history of discovery is documented for species newly recorded from the remote Kimberley region of Western Australia between 1979 and 2016 following a series of targeted wet season field trips. Since the publication of *Flora of the Kimberley Region* (Wilson 1992), fieldwork in the Kimberley region has resulted in the discovery of one new species record for Western Australia from each of the following genera: *Calochilus* R.Br.*, Dipodium* R.Br.*, Empusa* Lindl., *Habenaria* Willd.*, Pecteilis* Raf., *Phoringopsis* D.L.Jones & M.A.Clem. and *Spiranthes* Rich. *Zeuxine oblonga* R.S.Rogers & C.T.White has been collected from near Kununurra by other botanists in the same time period. The four new species described here were previously included as informal taxa in a field guide to the orchids of Western Australia (Brown *et al*. 2013). Twenty species from thirteen genera are now recorded from the Kimberley region. Most of these species occur in the north-west Kimberley, in the highest rainfall zones (Figure 1), and those that also occur in the Northern Territory exhibit large disjunctions.

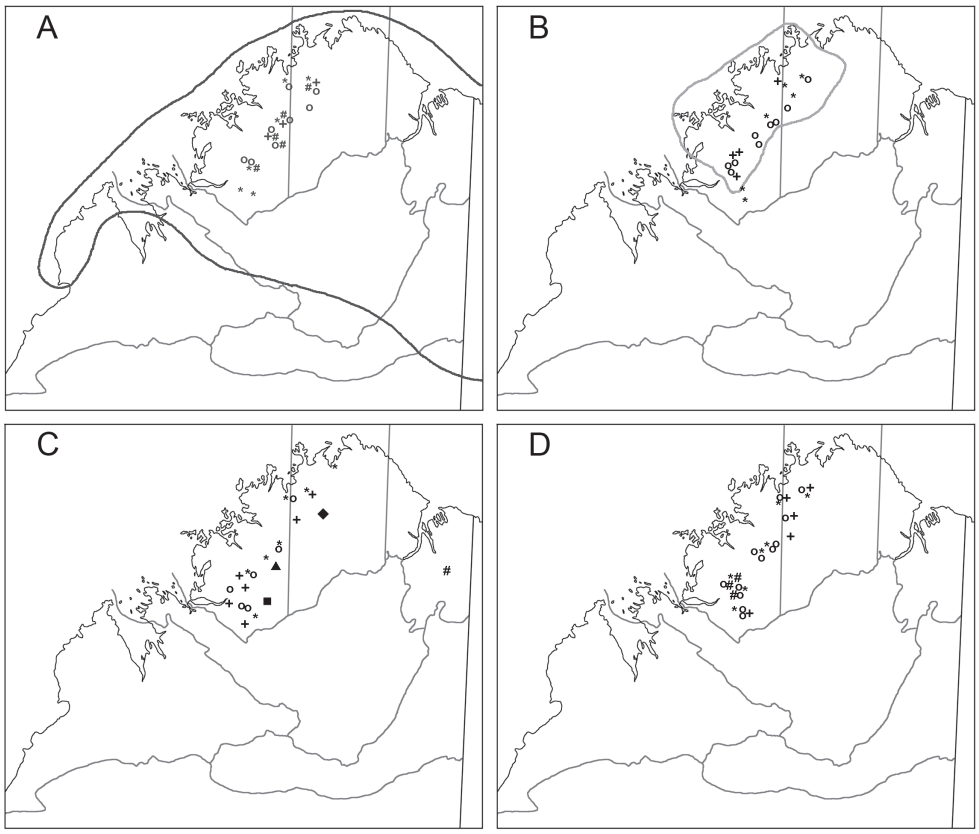

Fig. 1. Distribution of Orchidaceae in the Kimberley Region of Western Australia with the phytogeographic regions of Beard (1990). Map A: *Calochilus barbarossa* (#); *Calochilus kimberleyensis* (o); *Calochilus holtzei* (*); *Cymbidium canaliculatum* (solid line); *Phoringopsis byrnesii* (+). Map B: *Dendrobium dicuphum* (solid line); *Didymoplexis pallens* (+); *Dipodium ammolithum* (o); *Dipodium basalticum* (*). Map C: *Dendrobium foelschei* (♦); *Eulophia bicallosa* (+); *Eulophia picta* (o); *Habenaria hymenophylla* (▲); *Nervilia holochila* (*); *Spiranthes sinensis* (■); *Zeuxine oblonga* (#). Map D: *Empusa habenarina* (#); *Pecteilis elongata* (*); *Pecteilis eurystoma* (o); *Pecteilis ochroleuca* (+).

Three of the species newly described here are considered endemic to the Kimberley region of Western Australia, while *Calochilus barbarossa* R.L.Barrett, M.D.Barrett & K.W.Dixon also occurs around Darwin and on the Tiwi Islands in the Northern Territory. Notes are made on all orchid species recorded for the Kimberley region and keys are presented for these species.

The tropical Kimberley Region of Western Australia covers an area of 300,000 km^2 with habitats ranging from dry monsoon rainforest to arid tropical deserts. The Kimberley has the lowest orchid diversity in Australia after the arid interior. Despite this, it is home to a somewhat remarkable pattern of orchid genera with complex

biogeographic links. Being in relatively close proximity to Indonesia, East Timor and New Guinea, it is not surprising that a number of plant species are shared with that region (Joyce *et al*. 2020; 2021), and some of these shared species are widespread in East and Central Asia. The application of names to many of these widespread orchid species remains problematic as wide-ranging revisions are often required to test species limits. There is also strong representation from Australasian orchid genera such as *Calochilus*, *Dipodium*, *Pecteilis* and *Phoringopsis*, and while much of the orchid flora of this region is considered to be of relatively recent origin, the presence of three endemic orchid species implies a longer evolutionary history for at least some orchid lineages in the region. Aside from the three endemic species, all are found in the Top End of the Northern Territory (NT), except *Spiranthes sinensis* which is absent from the NT but occurs in Cape York.

These biogeographic connections are reflected in the broader flora of the Kimberley region, with a complex mix of biogeographic links. Recent studies have shown that plant populations in the Kimberley often originate from independent dispersal events from Asia relative to populations of the same species in the Northern Territory or Queensland (e.g. Joyce *et al*. 2021).

Methods

Descriptions are based on a combination of fresh and dried material. All relevant orchid specimens at BGPA, CANB, DNA, MEL, NSW and PERTH, along with selected orchid specimens at B, BM, K, and L were examined by at least one the authors. Many species have also been cultivated to flowering in a garden on Beverley Springs (now Charnley River) Station, or in glasshouses at Kings Park & Botanic Garden in Perth, or the Australian National herbarium in Canberra. Orchids were particularly targeted during ecological and taxonomic surveys of the remote north-west Kimberley region of Western Australia over a period of 24 years, at over 100 locations, by the first two authors, in conjunction with Kingsley Dixon, Pat Dundas and Robyn Maher. This included deliberate timing of field work to coincide with maximum flowering times, and specific habitat targeting of both known orchid taxa, and also potential habitats of orchid taxa whose presence was not recorded, but considered possible. This technique identified six additional species for the region over the study period (with a seventh species located by Andrew Mitchell), and location of many previously unknown populations of known orchid species. All orchid species except *Dendrobium foelschei* and *Zeuxine oblonga* have been examined in the field in Western Australia by at least one of the first two authors.

Direct DNA sequencing of endophytes were performed on a single sample of *Dipodium*. Tubers and swollen roots were first washed to remove external dirt, then external surfaces were twice sectioned away with sterile razor blades, to expose a sterile core. DNA was extracted and the Internal Transcribed Spacer (ITS) region amplified using the primers ITS1F and ITS4B, as described in Bougher & Barrett (2020).

Conservation and Ecology

Details of habitats and associated flora of all 20 orchid species recorded from the Kimberley Region are published here for the first time and the specific ecological preferences and related conservation threats are outlined. The region is largely unmanaged wilderness or free-range grazing land, subject to weed invasion, feral animals and high-frequency, broad-scale fires, each of which presents threats to orchid habitats and species. Successful conservation of orchids in the Kimberley region will ultimately rest on habitat conservation as most species are habitat specific. In some cases, specific habitats could be beneficially fenced to protect orchids from damage by feral animals, particularly close to stock watering points. Some habitats may require dedicated weed control to sustain orchid populations.

A third of the 19 extant Kimberley species (no living populations of *Dendrobium foelschei* are known) are considered to be directly threatened in the region and potential threats to the ecological integrity of the region are discussed. Field observations on ecological characteristics were collated between 1992 and 2016 (Table 1; see Barrett 2015 for more background). Many of the 20 orchid species recorded from the Kimberley have only been recorded for this region within this period. Seven species in the region are considered to be of conservation concern (Table 2). This compares to 10 of *c*. 38 orchid species in the neighbouring Northern Territory that are conservation listed (Liddle *et al*. 1994).

Table 1. Number of sites and corresponding habitats for collection of ecological data in the Kimberley Region.

Species	No. of vouchered sites	No. of habitats	Endemic
Calochilus kimberleyensis	10	2	Yes
Calochilus holtzei	12	1	No
Calochilus barbarossa	12	2	No
Cymbidium canaliculatum	10 (90)*	1	No
Dendrobium dicuphum	8 (10)*	1	No
Dendrobium foelschei	(1)*	1	No
Didymoplexis pallens	4	3	No
Dipodium basalticum	6	1	Yes
Dipodium ammolithum	18 (2)*	2	Yes
Empusa habenarina	4	1	No
Eulophia bicallosa	5 (2)*	1	No
Eulophia picta	14 (4)*	1	No
Habenaria hymenophylla	1	1	No
Nervilia holochila	7 (3)*	2	No
Pecteilis elongata	9	1	No
Pecteilis eurystoma	13 (6)*	1	No
Pecteilis ochroleuca	9	1	No
Phoringopsis byrnesii	10	1	No
Spiranthes sinensis	1	1	No
Zeuxine oblonga	1	1	No

* Numbers in parentheses are observations without voucher specimens.

Table 2. Orchid species of conservation concern in the Kimberley region of Western Australia according to FloraBase (Western Australian Herbarium 1998-).

Species	Region*	Conservation Priority	Threats
Didymoplexis pallens	NW	1	Fire, feral ungulates, weeds, small population size
Dipodium basalticum	NW	3	Fire, weeds, small population size
Empusa habenarina	NW	2	Fire, feral ungulates, weeds, small population size
Eulophia bicallosa	NW	3	Fire, feral ungulates
Habenaria hymenophylla	NW	2	Small population size
Spiranthes sinensis	NW	1	Fire, feral ungulates, small population size, altered hydrology
Zeuxine oblonga	NE	2	Fire, weeds, small population size, altered hydrology

*NW corresponds to the North Kimberley and NE corresponds to the Victoria Bonaparte IBRA Bioregions.

Biology

Most orchids found in the Kimberley region are geophytes. Significant geophyte monocot endemism has recently been recognised in the Kimberley with 122 geophytic species now known (out of 701 monocots), with 44 considered endemic to the region (Wheeler 1992; Barrett & Barrett 2015, 2022; Barrett *et al*. 2015; Barrett 2018; M.Barrett & R.Barrett unpubl. data; Table 3). The number of geophytes as a percentage of the total monocot flora is 17%, higher than in southern Australia (7–12%, see Parsons & Hopper 2003) and endemism among Kimberley species of monocot geophytes is just over 36% (Table 3). Geophytes have evolved in response to a number of different environmental factors, including strong seasonality of climate, fire response and aridity of environment (Howard *et al*. 2019). Note that the definition of geophyte adopted by Howard *et al*. (2019) is somewhat broader than many definitions, and most of the grasses listed have thickened rather than fleshy roots.

Table 3. Monocot genera with native geophytic species in the Kimberley, following the definition of geophyte in (Howard *et al.* 2019).

Family	Genus	No. Kimberley species	No. Endemic to Kimberley
Alismataceae	*Caldesia*	1	0
Amaryllidaceae	*Crinum*	3	1
	Proiphys	1	1
Aponogetonaceae	*Aponogeton*	3	3
Araceae	*Amorphophallus*	1	0
	Colocasia	1	0
	Typhonium	8	7
Asparagaceae	*Asparagus*	1	0
	Chlorophytum	1	0
	Lomandra	2	1
	Sowerbaea	1	0
	Thysanotus	2	0
Asphodelaceae	*Caesia*	2	0
	Corynotheca	2	0
	Dianella	1	1
	Tricoryne	1	1
Burmanniaceae	*Burmannia*	1	0
Colchicaceae	*Iphigenia*	1	0
Commelinaceae	*Cartonema*	10	8
	Murdannia	7	4
Cyperaceae	*Cyperus*	5	0
	Eleocharis	3	0
	Scleria	2	0
Dioscoreaceae	*Dioscorea*	2	0
Flagellariaceae	*Flagellaria*	1	0
Haemodoraceae	*Haemodorum*	15	11
Hydrocharitaceae	*Enhalus*	1	0
Hypoxidaceae	*Curculigo*	1	0
	Hypoxis	2	1
Juncaginaceae	*Cycnogeton*	1	0
Orchidaceae	*Calochilus*	3	1
	Didymoplexis	1	0
	Dipodium	2	2
	Empusa	1	0
	Eulophia	2	0
	Habenaria	1	0
	Nervilia	1	0
	Pecteilis	3	0
	Phoringopsis	1	0
	Spiranthes	1	0
	Zeuxine	1	0
Philydraceae	*Philydrum*	1	0
Poaceae	*Eriachne s.l.*	3	2
	Imperata	1	0
	Leersia	1	0
	Neurachne	1	0
	Oryza	2	0
	Pseudochaetochloa	1	0
	Sporobolus	1	0
	Whiteochloa	1	0
Potamogetonaceae	*Potamogeton*	3	0
	Stuckenia	1	0
Smilacaceae	*Smilax*	1	0
Stemonaceae	*Stemona*	1	0
Taccaceae	*Tacca*	2	0
Typhaceae	*Typha*	2	0
Total		**122**	**44**

Of the 17 geophytic species found in the Kimberley Region, 10 species in the genera *Calochilus*, *Habenaria*, *Pecteilis*, *Phoringopsis* and *Spiranthes* all have root tubers which are replaced on an annual basis (Pate & Dixon 1982; Dixon 1991). *Eulophia* species (including former *Geodorum*) produce a series of pseudobulbs, with vegetative material and clonal development arising from the most recent pseudobulb. *Didymoplexis* and most *Dipodium* species are saprophytes with intermittently swollen rhizome segments in *Didymoplexis* or fleshy tuberous roots arising from an abbreviated rhizome in *Dipodium*. *Nervilia* species are highly clonal, with new root tubers ('daughter tuberoids' in Jones 2021) being produced on adventive stems 5–20 cm from the parent plant forming colonies up to three metres in diameter. *Empusa habenarina* is also clonal, with daughter plants being produced adjacent to the parent plant. Jones (2021) suggests that *Pecteilis ochroleuca* and some species of *Calochilus* are semi-obligate saprophytes, with leaves being so reduced as to limit sustenance for plant growth. *Cymbidium canaliculatum* and *Dendrobium dicuphum* are both epiphytic species which produce annual growth of new pseudobulbs. In rare cases, particularly in low light, *Cymbidium canaliculatum* is known to produce elongated rhizomes resulting in new plants.

Dipodium species have limited evidence of chlorophyll and may rely on holomycotrophic systems for growth (Dearnaley & Le Brocque 2006). Jones (2021) records the eastern Australian hyacinth orchid *Dipodium punctatum* as an epiparasite, reliant on fungi that are ectomycorrhizal on root systems of adjacent Myrtaceae species, particularly eucalypts. *Zeuxine oblonga* has a 'fleshy stem' which remains dormant in leaf litter during the dry season, though flowering occurs after the leaves have withered following the end of the wet season (Jones 2021).

Future surveys need to account for the potential presence of geophytic species which are often only observable when flowering. This applies equally to a number of other geophytic taxa in the region (e.g. *Crinum*, *Hypoxis*, *Murdannia*, *Typhonium*).

Pollination

Pollination syndromes are diverse and range from nectar rewards to sexual deception and food mimicry (Stowe 1988). The pollination type also influences flower-life with sexually deceptive flowers remaining open for extended periods (or as in the case of *Phoringopsis*, plants producing blooms over a number of weeks) presumably due to the higher risk associated with non-food pollination systems. *Dendrobium dicuphum* is remarkable in having a bet-hedging system of pollination. This species flowers at the end of the 'wet' season. At least in cultivated plants, early flowers will not self-pollinate, but if open pollination does not occur, the last few flowers that open are autogamously pollinated with these blooms opening for only a few days, ensuring at least some seed set.

Very little literature exists on the pollination of tropical Australian orchids, the available literature summarised by Jones (2021). Pseudocopulation occurs with three species of *Calochilus* and with *Phoringopsis* which is pollinated by thynnid wasps attracted by pheromone production (Mant *et al*. 2002; Jones 2021). *Calochilus barbarossa* is pollinated by scoliid wasps, but may also self-pollinate (R.L. Barrett & M.D. Barrett, pers. obs.). Scoliid wasps are also pollinators of *Dipodium* species (R. Maher, pers. comm.). *Eulophia picta* and *Cymbidium canaliculatum* are apparently pollinated by small native bees (Jones 2021). Australian *Empusa* species are reportedly pollinated by small flies and mosquitos (Jones 2021). Jones (2021) also suggests that the *Habenaria* and *Pecteilis* species in the Kimberley are pollinated by hawkmoths (Sphyngidae). *Spiranthes* species are pollinated by bees in the Apidae and Megachilidae (Bernhardt *et al*. 2017; Kuiter 2018). Pollinators are still unknown for *Didymoplexis* and *Zeuxine*. The authors have observed pollination of two *Calochilus* spp. by scoliid wasps, however actual pollinators in Kimberley region remain unknown for other species. Multiple attempts to locate the pollinators of *Phoringopsis byrnesii* using open flowers as baits were unsuccessful, suggesting its pollinators are rare in the north-west Kimberley, consistent with the observation of very low seed set in this species.

Phenology and seed production

Geophytes have two key drought (or regular dry season) survival processes, either seeds or as bulbs, corms or tubers (sexual and vegetative reproduction). As a strategy for living in the strongly seasonal climate of the Kimberley region, geophytes can be classified as following one of two reproductive strategies. (1) Flower and fruit precociously, dropping seed early in the 'wet' season (Dec/Jan.–Mar/Apr.) so that seedlings can establish and grow during the same 'wet' season, or (2) dropping seed at or after the end of the 'wet' season with seed germinating at the start of the next 'wet' season. Most terrestrial orchids in the Kimberley follow the first pattern, but fertile collections have only been made at the end of the wet season for *Zeuxine* and *Spiranthes* from the Kimberley.

The nature of geophytes with the storage organs described above means that they are not always dependant on rainfall for flowering. In the Kimberley region, *Eulophia bicallosa* and *Nervilia holochila* utilise reserves in

their storage organs to flower precociously (before or at the onset of the 'wet' season) and release seeds with the early rains. This enables establishment of seedlings during the wet season, rather than seeds having to survive the protracted dry season (about 9 months). Most species in the region flower early in the 'wet' season, usually finishing by early February, possibly also avoiding competition with tall grass which reduces visibility for pollinators. *Calochilus holtzei*, a relatively tall species, flowers for an extended period subject to moisture availability. *Eulophia picta* holds its seeds for six months or more, combined with elongation and straightening of the peduncle following fertilization. Fertilization of the flowers also triggers a remarkable elongation of the pedicel in *Didymoplexis pallens* as reported by Hemsley (1884), resulting in up to a trebling in plant height, corresponding somewhat to the height of surrounding grasses as they develop.

Ecology and ecosystem threats

Fire is a pervading force in tropical northern Australia where land is either unmanaged, or managed on a very broad scale (e.g. typical grazing property size in Kimberley is 750,000 acres). Fires are broad and patchy in distribution 'as uncontrolled wildfire' (Russell-Smith *et al*. 2003) or as controlled burns. Approximately one third of the Kimberley region is burnt annually by deliberate 'controlled' burns or wildfire (Fisher *et al*. 2003). One fire in 1994 originated from a tourist's campfire which was not properly extinguished and subsequently burnt for three months and covered almost 100,000 km^2 due to the inaccessibility of the terrain and few local fire-fighters (Peter Saint, pers. comm., R. Barrett pers. obs.). Edwards *et al*. (2003) have observed significant changes in abundance of ground-layer species in a trial savanna woodland site in the Northern Territory subject to frequent fires over a five year period with significant patterns based on life-form, including geophytes such as *Cartonema spicatum* R.Br. Fisher *et al*. (2003), examining patterns of landscape fire and vegetation response in the region, called for 'a thorough appraisal of the status of regional biota in this remote, ostensibly ecologically intact region' and we provide notes on the effects of such fires on orchids in the Kimberley region.

Specific threats to vine thickets and rainforest ecosystems, as key habitats for several Kimberley orchid species, have been documented in recent years with fire and grazing leading to significant increased losses in area over the last 40 years (Kenneally *et al*. 1991, Mangglamarra *et al*. 1991, McKenzie *et al*. 1991, McKenzie & Belbin 1991, Barrett *et al*. 2001).

Grass species richness, an important indicator of habitat quality for the majority of geophytic orchid species in the Kimberley, appears to have changed significantly since the advent of pastoralism in the region (Connor *et al*. 2018). Observations of early botanists and explorers (Fitzgerald 1905, 1918; Easton 1922, Gardner 1923) suggest the presence of large areas of palatable perennial grass species on plains now often dominated by annual *Sorghum* species, which are quick to colonise disturbed areas, but there is little quantified data available to understand what these changes have really been, and their broader implications for landscape changes over time.

Rugged sandstone habitats, where many of the Kimberley orchid species occur, are known refugia for fire-sensitive (obligate seeder) species (Russell-Smith *et al*. 1998, 2002; Yates & Russell-Smith 2003) which are being displaced by current fire regimes (Russell-Smith *et al*. 2002; Fisher *et al*. 2003). Frequent fires have been shown to have a significant impact on obligate seeder species of heath habitats in summer rainfall zones (as experienced in the Kimberley) in the Sydney region, including Banksias (Bradstock *et al*. 1997). Similarly, there is an apparent decline in the Kimberley populations of *Banksia dentata,* an indicator species, when growing with *Pandanus* and *Eucalyptus houseana*, for orchid-rich areas in the region (R. Barrett & M. Barrett pers. obs.). While this species is a resprouter following moderate fire, it is suggested that vigour diminishes with high fire frequency, trees can be killed by high-intensity fires, and seedling recruitment is much reduced, leading to overall population decline. This pattern of decline has been well documented for the resprouter tree species *Callitris intratropica* in the Kimberley and Northern Territory (Bowman *et al*. 2001; Fisher *et al*. 2003).

Epiphytic orchid species are often the most vulnerable with loss of plants and degradation of suitable host trees exposed to fire (Koopowitz *et al*. 2003). However, the effects of burning season on flowering should be examined for the geophytic species in the Kimberley region as flowering is known to be inhibited by summer fires in temperate species of *Calochilus* that are summer-flowering (Jones 2021).

Habitats, distribution, and ecological attributes

The underlying geological formation for the region is the Kimberley Block, largely based on quartz sandstone, with smaller areas of basalt and granite intrusions with laterite interspersed (Gunn & Meixner 1998). The sandstone plateaux of the Kimberley have their greatest similarity with that of the World Heritage listed Kakadu National Park in the Northern Territory, and both have a relatively high number of endemic non-orchid plant taxa (Brennan 1986; M. Barrett and R. Barrett unpubl. data). The majority of the sandstone plateaux receive between 800–1400 mm average annual rainfall, mostly falling from January–March. Each of the habitats described below are found in numerous locations across northern Australia which is probably one of the main factors influencing the low endemism in orchid species in the Kimberley region.

Orchids are generally of restricted distribution in the Kimberley region, with only two species being found outside the wettest region of the Gardner Botanical District, with most species being restricted to the West Gardner subdistrict, which corresponds to the highest rainfall zone in the region (Figure 1; and see Wheeler 1992). There is a general lack of published ecological and geographical data on geophytes, especially those occurring in monsoonal rainforest (e.g. data in Kenneally *et al.* 1991), as some species (*Eulophia picta*) are widespread and common, while others are relatively rare (*Habenaria hymenophylla*, *Nervilia holochila* and *Zeuxine oblonga*).

Orchid habitats

A summary of the key habitat characteristics associated with Kimberley orchids is provided below to assist with conservation planning and further searching for additional populations.

- Eucalyptus alba / E. apodophylla / E. houseana – Banksia dentata – Pandanus spiralis *woodland over closed grassland* (Figure 2A)

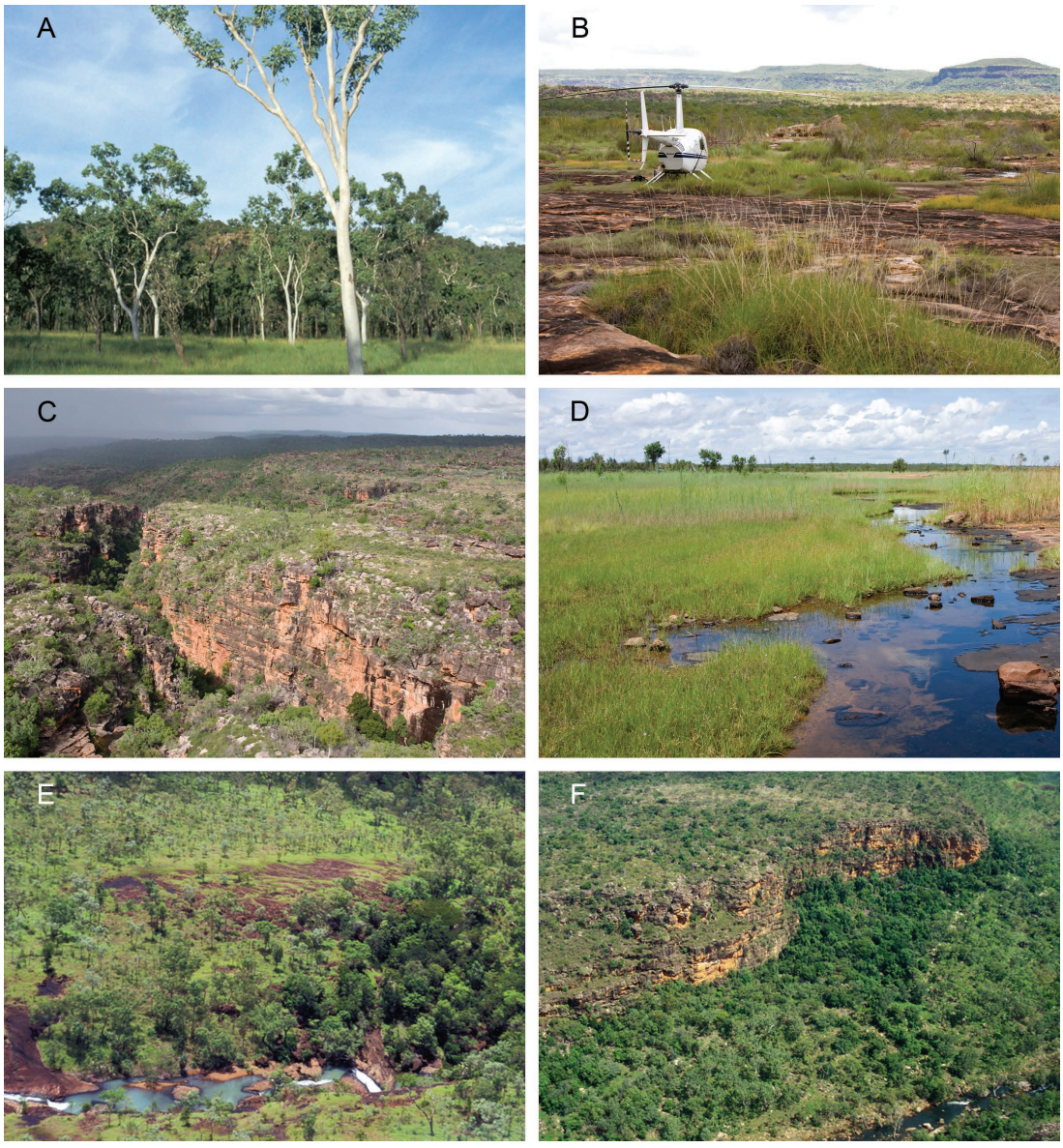

Fig. 2. Habitats of Orchidaceae in the Kimberley Region of Western Australia. A: *Eucalyptus houseana – Banksia dentata* woodland over closed grassland. B: Sandstone pavements. C: Broken sandstone. D: Sand flats derived from sandstone. E: Open woodland on red volcanic clay-loam (with some seasonal waterlogging). F: Vine thickets and rainforest (at base of sandstone cliff).

These open woodlands over dense closed grassland on organic-rich sandy soils are unique assemblages of sporadic occurrence on the sandstone plateaux of the high-rainfall zone of the north-west Kimberley, with similar communities occurring in the Northern Territory. These plant communities occur on seasonally

waterlogged, poorly drained, low-lying flats below sandstone ridges, usually surrounded by either open woodland or open grassland. Higher water tables relative to surrounding areas allow the vegetation to avoid desiccation long into the dry season and early fires are not often carried in these habitats. However, late dry season fire events can be a threat to these habitats when extensive savanna grasses are highly combustible. Most orchid species in this habitat are geophytic, and hence most are not directly threatened by such fires, though fires can be coincident with flowering of *Nervilia holochila* and *Eulophia bicallosa*. Threats come from the risk of post-fire invasion of annual *Sorghum* spp. which are more likely to sustain fire, increasing overall fire frequency, which in turn burns the organic-rich soil surface, over time destroying the orchid habitat (Chen *et al*. 2004).

In some areas these habitats are threatened by feral animals, particularly grazing by cattle and pigs which seek out the root tubers of sedges, grasses and orchids (Figure 3). Uprooting of tubers of *Pecteilis elongata* has been noted on herbarium collections from the Darwin region in the Northern Territory. Feral donkeys and buffalo could also be of concern in some situations. Some orchid habitats with higher stocking rates are known to be churned by cattle hooves and pig wallows (R. Barrett & M. Barrett, pers. obs, R. Maher & B. Maher pers. comm.) and also act as sites for weed invasion.

Fig. 3. Disturbance to orchid-suitable habitat by feral pigs searching for roots and tubers in the Prince Regent National Park.

Overstorey species characterising this habitat type are a combination of *Eucalyptus alba* or *E. houseana*, *Banksia dentata* (a species of restricted distribution that is vulnerable to high frequency or intensity fires with preference for this habitat type), *Eucalyptus apodophylla, Melaleuca viridiflora* and *Pandanus spiralis* (widespread tree or screw palm species common in this habitat type). Orchid species may be more easily located by first locating sites with co-occurring indicator trees.

Understorey species of this habitat vary to some extent, but usually include *Alloteropsis semialata*, *Byblis liniflora*, *Calochilus barbarossa*, *C. kimberleyensis, Clitoria australis*, *Drosera* aff. *paradoxa*, *Eulophia bicallosa* (specific to habitat type), *Haemodorum flaviflorum*, *Lindernia plantaginea, Ludwigia octovalvis*, *Pecteilis eurystoma*, *Scleria brownii, Stylidium pachyrrhizum,* and *Xyris complanata*. Less common understorey species are *Didymoplexis pallens*, *Empusa habenarina* (both restricted to this habitat type), *Hypoxis nervosa, Gonocarpus chinensis, Utricularia kimberleyensis,* and *U. uliginosa*.

- *Grasslands and heaths on sandstone pavements* (Figure 2B)

Sandstone pavements represent a particularly interesting ecological community which for the Kimberley region has only recently been recognised as distinct from the broken quartz sandstone plateaux on which they occur, with many locally endemic species (Barrett & Barrett 2015; Barrett 2018). Pavements are areas of skeletal sands and organic matter over sheet sandstone, usually located on the tops of mesas and plateaux. These habitats also occur on the Kakadu sandstone in the Northern Territory where they often provide habitat for myrtaceous-dominated heath (Brennan 1986, Russell-Smith *et al*. 2002). *Calochilus* spp. and *Phoringopsis byrnesii* are found on these unusual fire-protected sites. The remoteness and fire-protected nature of the pavements indicates they are under little immediate threat. Frequent fire could possibly be a threat on more extensive pavements with higher plant biomass capable of carrying fire (Russell-Smith *et al*. 2002).

Vegetation is often dominated by *Acacia* spp. and *Triodia* spp. with associated vegetation of *Acacia cyclocarpa*, *A. nuperrima*, *Borya subulata*, *Byblis filifolia, B. liniflora*, *Calochilus barbarossa*, *C. kimberleyensis*, *Calytrix gomphrenoides*, *Corymbia torta* subsp. *torta*, *Drosera cucculata, D. glabriscapa, D. paradoxa*, *Eriachne glandulosa*, *Fimbristylis* spp., *Grevillea latifolia*, *G. wickhamii*, *Hypoxis cavernicola, Iphigenia indica, Lechenaultia* aff. *filifolia, Micraira* spp., *Phoringopsis byrnesii*, *Ricinocarpos rosmarinifolius*, *Stylidium ceratophorum*, *Tacca maculata, Thysanotus banksii, Triodia* spp., *Typhonium* aff. *nudibaccatum* and *Utricularia magna*.

- *Woodlands on broken sandstone habitats* (Figure 2C)

A common and widespread habitat type in many areas of northern Australia is broken quartz sandstone and sandstone scree slopes. In the north-west Kimberley, this habitat often includes *Brachychiton viscidulus*, *Corymbia greeniana*, *Corymbia torta* subsp. *torta*, *Cymbopogon procerus*, *Dipodium ammolithum*, *Eucalyptus tetrodonta*, *Ficus platypoda*, *Gardenia* spp., *Goodenia sepalosa*, *Pecteilis elongata*, *Planchonia rupestris*, *Planchonella pohlmaniana*, *Solanum heteropodium*, *Tacca leontopetaloides*, *Terminalia canescens*, *T. ferdinandiana* and *Triodia* spp.

These habitats are in some ways naturally protected from high intensity fire due to the sparse vegetation on the broken sandstone, and the leaf litter between boulders where *Dipodium ammolithum* occurs is largely untouched by fire. Low intensity fires do not appear to have immediate effects on *Dipodium ammolithum* which has been observed flowering readily following fire even where the litter layer has been burnt.

- *Woodlands on sand flats derived from sandstone* (Figure 2D)

Open sandy flats are common below quartz sandstone ridges and alongside creek-lines over sandstone. These sandflats may form shallow depressions, or be lightly sloping alongside creeks, with a catchment area above them which ensures seasonal waterlogging and soil moisture persisting longer than the surrounding soils. Such sandflats occur with sandstone ranges across northern Australia. In the Kimberley region they are commonly dominated by *Fimbristylis* spp. with *Acacia nuperrima, Alloteropsis semialata, Calochilus barbarossa*, *Calochilus kimberleyensis*, *Crinum joesmithii*, *Drosera caduca, D. ordensis*, *Drosera* aff. *paradoxa*, *Grevillea pteridifolia*, *Haemodorum brevicaule*, *H. flaviflorum*, *Hakea arborescens*, *Lindernia plantaginea, Ludwigia octovalvis*, *Melaleuca viridiflora*, *Pandanus darwinensis*, *P. spiralis*, *Pecteilis eurystoma*, *Platyzoma microphyllum*, *Sorghum stipoideum*, *Stylidium pachyrrhizum, S. prophyllum*, *S. rubriscapum*, *Polygala* sp., *Utricularia chrysantha* and *Xyris complanata*.

In more open woodland over sandstone plateaux, *Calochilus holtzei* occurs in direct association with *Corymbia* spp., particularly *C. latifolia* and *C. greeniana* in Western Australia, and *C. foelscheana* in the Northern Territory.

Eucalyptus alba – Banksia dentata woodlands may occur as small pockets on these more extensive sand flats, but the two habitats are here treated as distinct based on vegetation associations, also reflected in differences in organic matter in the soil, and the orchid species that can be found in them.

- *Open woodland on red volcanic clay-loam* (Figure 2E)

Open Eucalypt woodland with the overstorey dominated by *Eucalyptus tetrodonta* with an associated flora of *Erythrophleum* aff. *chlorostachys*, *E. tectifica*, *Pecteilis ochroleuca*, *Livistona eastonii* (in the Mitchell Plateau area), *Murdannia graminea*, *Planchonia careya*, *Sorghum* spp. and *Terminalia canescens*. *Dipodium basalticum* occurs very patchily in this habitat type. Open eucalypt woodland dominated by a variety of *Corymbia* and/

or *Eucalyptus* species provides habitat for *Cymbidium canaliculatum*, even in more extreme environments on the edge of the Tanami desert. *Habenaria ochroleuca* will occasionally occur in darker alluvial soils which are seasonally waterlogged, where it is most commonly found in association with *Melaleuca minutifolia*.

- *Vine thickets and rainforest* (Figure 2F)

Vine thickets in the Kimberley region vary greatly in composition and dominance (Kenneally *et al*. 1991) with many similarities to corresponding areas of the Northern Territory. It is noteworthy that there are clear distinctions in vegetation composition based on substrate, especially those on basalt versus sandstone, but also for spring-fed communities. Orchids in Kimberley vine thickets and rainforest occur most frequently in areas of high humidity but low flow (usually along small creek lines or at cliff bases), with a relatively dense canopy. Associated species (in very mixed combinations) may be *Carallia brachiata*, *Clematis pickeringii*, *Dendrobium dicuphum*, *Diospyros* spp., *Eulophia picta*, *Lophostemon grandiflorus* subsp. *riparius*, *Myristica insipida*, *Nervilia holochila*, *Stenochlaena palustris*, *Syzygium angophoroides*, *Tournefortia mollis*, and occasionally *Cymbidium canaliculatum, Didymoplexis pallens, Dipodium ammolithum, Ficus hispida, Pandanus spiralis* and *Pouteria sericea*.

- *Spring-based swamp vegetation*

Point Springs represents an unusual habitat in the Kimberley, being a small swamp with tall vegetation, including some species typically occurring in rainforest or vine thickets (Kenneally *et al*. 1991). This swamp sits near the base of a sandstone slope, on the margin of extensive blacksoil flats associated with the Ord River. This habitat is the only known location for *Zeuxine oblonga* in the Kimberley. The single known *Spiranthes sinensis* collection was from a grass and sedge dominated mound spring.

Taxonomy and species ecology

Twenty species of orchid in 13 genera are now recognised as occurring in the Kimberley region of Western Australia. A brief history of recent classifications for these species is presented in Table 4, and information on generic typification partly follows Alrich & Higgins (2011) and Mabberley & Moore (2022). A key to these species is provided below to replace the key in Wilson (1992).

Table 4. Classification of Kimberley orchids by subfamilies, tribes and subtribes according to *Genera Orchidacearum* and subsequent modifications as accepted here indicated with their associated reference.

Genera Orchidacearum subfamilies, tribes, subtribes and genera	Subsequent changes	References
Orchidoideae Eaton.		
Diurideae Endl. ex Butzin		
Drakaeinae Schltr.		
37. *Phoringopsis* D.L.Jones & M.A.Clem.	Separated from *Arthrochilus* F.Muell. in 2002	Pridgeon *et al*. 2001; Jones *et al*. 2002; Miller & Clements 2014
Thelymitrinae Lindl.		
53. *Calochilus* R.Br.		Pridgeon *et al*. 2001; Nargar *et al*. 2018
Orchideae Small		
Orchidinae Reveal		
78. *Habenaria* Willd.	Significant redefinition required, see text	Pridgeon *et al*. 2001; Jin *et al*. 2014, 2017; Clements & Jones 2018
90. *Pecteilis* Raf.	Substantially enlarged to include some species previously in *Habenaria*	Pridgeon *et al*. 2001; Jin *et al*. 2014, 2017; Clements & Jones 2018
Cranchideae Pfeiff.		
Goodyerinae Ridl.		
166. *Zeuxine* Lindl.		Pridgeon *et al*. 2003
Spiranthinae Lindl.		
203. *Spiranthes* Rich.		Pridgeon *et al*. 2003
Epidendroideae Lindl.		
Gastrodieae Lindl.		
368. *Didymoplexis* Griff.		Pridgeon *et al*. 2005
Malaxideae Lindl.		
378. *Liparis* Rich. (including *Empusa* Lindl.)	Significant redefinition required, see text	Pridgeon *et al*. 2005; Su *et al*. 2015; Kumar *et al*. 2022
Nervilieae (Schltr.) Dressler		
Nerviliinae Schltr.		

Genera Orchidacearum subfamilies, tribes, subtribes and genera	Subsequent changes	References
392. *Nervilia* Comm. ex Gaudich.		Pridgeon *et al*. 2005
Cymbidieae Pfeizer		
Cymbidiinae Benth.		
447. *Cymbidium* Sw.		Pridgeon *et al*. 2009
448. *Dipodium* R.Br.		Pridgeon *et al*. 2009
Eulophiinae Benth.		
460. *Eulophia* R.Br. ex Lindl.	Significant redefinition required, see text	Pridgeon *et al*. 2009; Bone *et al*. 2015; Chase *et al*. 2021b
462. *Geodorum* Jacks.	Congeneric with *Eulophia*	Pridgeon *et al*. 2009; Bone *et al*. 2015; Chase *et al*. 2021b
Dendrobieae Lindl. ex Endl.		
622. *Dendrobium* Sw.	Significant redefinition may be required, see text	Pridgeon *et al*. 2014; Nargar, Clements, in. prep.

Key to Orchidaceae species in the Kimberley region of Western Australia

1 Plant a leafy epiphyte 2

1: Plant terrestrial, leafy or not 4

2 Leaves stiff and leathery; flowers yellow and purple or green; labellum not spurred ..... **Cymbidium canaliculatum**

2: Leaves not leathery; labellum spurred ..... **Dendrobium** (3)

3 Flowers with planar tepals, white with a pink or green labellum ..... **Dendrobium dicuphum**

3: Flowers with twisted tepals, white at the base, yellow towards the apex, with a white labellum with prominent red markings ..... **Dendrobium foelschei**

4 Leaves with a winged keel, ± Y-shaped in cross-section; labellum conspicuous, entire, not spurred, densely hairy ..... **Calochilus** (5)

4: Leaves pleated or smooth, not Y-shaped in cross-section, or absent; labellum various, not prominently hairy 7

5 Inflorescence with 10–40+ flowers; flowers 20–25 mm long, 8–12 mm wide; leaves more than 10 mm across (usually fully developed, or nearly so, at anthesis); growing in association with *Corymbia* spp ..... **Calochilus holtzei**

5: Inflorescence with 2–10 flowers; flowers 11.7–21.4 mm long, 5.2–9.2 mm wide; leaves less than 8 mm wide (sometimes absent at anthesis) 6

6 Inflorescences with 2–4 flowers; flowers 11.7–15.6 mm long, 5.2–7.4 mm wide; ovary narrowly ovate (length), labellum tip not concave ..... **Calochilus kimberleyensis**

6: Inflorescences with 6–10 flowers; flowers 18.4–21.4 mm long, 8.1–9.2 mm wide; ovary ovate (length), labellum tip concave ..... **Calochilus barbarossa**

7 Leaves present at time of flowering 8

7: Plant leafless or leaves not present at time of flowering 16

8 Leaves arising on separate stalk from inflorescence, top of flowering spike reflexed in flower, straightening in fruit ..... **Eulophia picta**

8: Leaves arising on same stalk as inflorescence, inflorescence straight 9

9 Leaves pleated ..... **Empusa habenarina**

9: Leaves smooth 10

10 Labellum not or only weakly spurred....11
10: Labellum deeply three-lobed and with a long spur....13
11 Labellum insectiform, column with two lateral horns....**Phoringopsis byrnesii**
11: Labellum not insectiform, column without lateral horns....12
12 Flowers white; inflorescence bracts hairy....**Zeuxine oblonga**
12: Flowers pink; inflorescence bracts glabrous....**Spiranthes sinensis**
13 Lateral petals two-lobed, the lower lobes similar to the labellum lobes....**Habenaria hymenophylla**
13 Lateral petals entire....**Pecteilis** (14)
14 Labellum lobes filiform, up to 25 mm long, nectar spur 20–35 mm long.... **Pecteilis elongata**
14: Labellum lobes less than 20 mm long, nectar spur 8–15 mm long....15
15: Lateral labellum lobes narrowly ovate and recurved…….....**Pecteilis ochroleuca**
15 Labellum lobes filiform, up to 12 mm long, spreading to slightly recurved....**Pecteilis eurystoma**
16 Petals and sepals adnate for almost half their length; plant leafless.... **Didymoplexis pallens**
16: Petals and sepals free; plant leafless, or leaves not present during flowering....17
17 Labellum tubular to convex, not spurred; leaves ovate to broadly ovate, emerging after flowering....**Nervilia holochila**
17: Labellum with or without a small spur at base; leaves narrowly lanceolate or absent....…18
18 Labellum convex, shallowly 3-lobed at the apex, with a small spur at base; leaves present after flowering time, narrowly lanceolate....….**Eulophia bicallosa**
18: Labellum flat, entire, not spurred at the base; plant obligately mycotrophic and leafless....**Dipodium** (19)
19 Petals not spotted; growing on sandstone outcrops....**Dipodium ammolithum**
19: Petals obscurely spotted and streaked; growing in open woodland on basalt soils....**Dipodium basalticum**

Species treatments

Calochilus R.Br., *Prodr*. 320 (1810). *Lectotype*: *C. paludosus* R.Br., designated by M.A.Clements, *Austral. Orchid Res*. 1: 35 (1989).

A predominantly Australian genus comprising some 28 species divided into three subgenera only one of which subgen. *Tropichilus*, is represented in tropical Australia (Nargar *et al*. 2018).

Subgenus **Tropichilus** M.A.Clem., *Australian Systematic Botany* 31: 405-406 (2018). *Type species*: *Calochilus caeruleus* L.O.Williams.

Calochilus sect. *Pulchrichilos* Szlach., *Polish Bot. J*. 46(1): 13 (2001).

Column apex cucullate and bulbous. Labellum with calli that form one or two ridged plates or two prominent tooth-like protrusions, staminodia visible as appendages, stem bracts not covering the ovary. In rare peloric forms flowers cleistogamous and labellum without calli.

Notes: Following the description of the first tropical *Calochilus* species, *C. holtzei* F.Muell. (Mueller 1892), new tropical species have been named by Williams (1946), Jones & Lavarack (1989), Jones & Gray (2002) and Jones & Clements (2004).

The three Kimberley species can be distinguished by the characteristics detailed in Table 5.

Table 5. Comparison of key features in Kimberley *Calochilus* species.

	C. barbarossa	*C. holtzei*	*C. kimberleyensis*
Leaves	narrow, 1.5-3 mm wide	broad, 12-15 mm wide	narrow, 1.5-3 mm wide
No. Flowers	6–10	10–40+	2–4
Flower size	18.4–21.4 mm long, 8.1–9.2 mm wide	20–25 mm long, 8–12 mm wide	11.7–15.6 mm long, 5.2–7.4 mm wide
Capsule size	9–12 mm long, 3–4.5 mm wide	11–16 mm long, 4.8–7.4 mm wide	12–19 mm long, 3.3–4.5 mm wide
Column wing glands	many, minute	many, minute	1, minute
Labellum hair colour	red, lacking purple tints	orange, lacking purple tints	red with vinaceous tints
Labellum lateral hairs	greatly exceeding margin	greatly exceeding margin	scarcely exceeding margin
Labellum base	unequally haired	unequally haired	equally haired
Labellum apex	rounded	triangular	truncate
Lateral sepal markings	*c.* 5 prominent red veins	*c.* 7 prominent red veins	diffuse red, *c.* 3 obscure veins just detectable
Flowering time	mid Dec.–early Feb.	late Jan.–Feb.	late Dec.–early Feb.

Calochilus barbarossa R.L.Barrett, M.D.Barrett and K.W.Dixon, *sp. nov*.

Type: Western Australia: Edkins Range, on Walcott Inlet track, 79 km N of Beverley Springs Station homestead, 10 Jan. 1995, *R.L.Barrett* & *M.D.Barrett RLB 908* (holo: PERTH; iso: CANB, NSW).

Illustrations: A.P.Brown *et al*., *Orchids West. Austr.*, pl. p. 363 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 478, 479, 481 (2013). D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); pl. p 420 (2021), as *C. caeruleus*, NT only.

Erect geophytic *herb*, tubers ovoid, 1.8–2.7 cm long, 0.8–1.5 cm wide, fleshy. *Leaves* usually partially to well-developed at anthesis, linear, triquetrous in cross-section, erect, dark green, fleshy, margins bluntly rounded, apex acute, 15–30 cm long, 1.5–3 mm wide. *Inflorescence* 300–700 mm tall, very slender, dull green or glaucous; sterile bracts 2–5, lanceolate, 7.5–35 mm long, 2.3–4.5 mm wide, closely sheathing, subacute; fertile bracts lanceolate, 6.0–6.9 mm long, 1.4–2.1 mm wide, closely sheathing, acute. *Pedicels c*. 9.1 mm long, slender, obliquely erect. *Flowers* lasting about half a day, (3–)6–10, 18.4–21.4 mm long, 8.1–9.2 mm wide; perianth segments spreading widely at temperatures above *c*. 25ºC, obliquely erect. *Dorsal sepal* obovate, 7.6–8.1 mm long, 4.3–4.8 mm wide, cucullate, concave, gibbous towards base, pale green with dark reddish marks near the base on the anterior surface, acute. *Lateral sepals* asymmetrically broadly lanceolate, 7.2–7.9 mm long, 3.2–3.4 mm wide, widely divergent, slightly carinate, subacute to apiculate. *Petals* narrowly ovate-lanceolate, 7.0–7.2 mm long, 2.3–3.1 mm wide, asymmetrical, obliquely deflexed close to the lateral sepals, tips slightly incurved, with many dark red lines on the anterior surface, obtuse to subacute. *Labellum* projected obliquely downwards, oblong-elliptical, 14.3–16.5 mm long, 5.5–6.0 mm wide, cupped or saccate towards the apex, obscurely 3-lobed, the margins of the lateral lobes with 5–7 pairs of very short, linear teeth, apex sub-acutely apiculate; ventral surface pale yellow-green with reddish spots or streaks, the proximal two-thirds densely adorned with appressed curved, linear-terete, deep reddish to purple calli 1.7–4.0 mm long, the distal third devoid of calli; basal pair of labellum calli only moderately raised, *c*. 1.6 mm long, 0.3 mm wide, fleshy, slightly incurved, pinkish-red, shiny; dorsal surface pale yellow-green. *Column* 4.6–5.3 mm long, 2.9–3.5 mm wide, green, strongly gibbous and glandular-papillate beneath the anther; wings broad, obtuse, protruding, with a few small purple spots. *Anther* 2.7–3.6 mm long, 1.5–2.1 mm wide, green with cream flaps, obliquely erect, surface minutely colliculate. *Pollinia* 2.0–2.3 mm long, curved, cream to white, mealy. *Stigma* oblong, 1.4–1.8 mm across, sunken. *Capsule* narrowly ovoid, 9–12 mm long, 3–4.5 mm wide, ribbed. (Figure 4)

Diagnostic characters: Related to *C. caeruleus*, distinguished by the lateral ridges at base of labellum very pale purplish (*vs* very dark purplish), extending only half-way to free calli (to the start of free calli in *C. caeruleus*), and long, slightly saccate, bare lip on the labellum (bare portion short and not saccate in *C. caeruleus*), with consistently purplish red hairs at the base of the labellum (bluish in *C. caeruleus*). The narrower leaves (1.5–3 vs 6–8 mm wide) are partially to fully developed at anthesis. The inflorescence has generally fewer flowers ((3–)6–10 vs 4–12). Flowers remain open for most of the day.

Fig. 4. *Calochilus barbarossa*. A. Habit. B, C. Flower. D. Capsule. E. Leaves at advanced anthesis. F. Close-up of leaf. G. Inflorescence. H. Close-up of flower. I. Close-up of labellum apex. J. Lateral view of flower showing saccate labellum. Voucher: *R.L.Barrett, M.D.Barrett & M.Maier RLB 6158* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Specimens examined: WESTERN AUSTRALIA: 6 km ENE of junction of Pitta Creek and Prince Regent River, 29 Jan. 2000, *M.D.Barrett* MDB 962 (PERTH); 2.7 km NW of Mt Hann, 31 Jan. 2000, *M.D.Barrett* MDB 1030 (PERTH); Edkins Ra., 79 km N of Beverley Springs Stn Hstd, 10 Jan. 1994, *R.L.Barrett* & *M.D.Barrett* RLB 966 (PERTH); Edkins Ra., 77 km N of Beverley Springs Stn Hstd, 28 Dec. 1995, *R.L.Barrett* & *M.D.Barrett* RLB 674 (PERTH); 1 km NW of Mount Bomford, 5 Jan. 2001, *R.L.Barrett* & *M.D.Barrett* RLB 1538 (CANB, PERTH); *c.* 8.5 km NE of Mount Agnes, 6 Jan. 2001, *R.L.Barrett* RLB 1574 (CANB, PERTH); 1 km NW of 'Leptospermum Falls', Prince Regent Nature Reserve, 10 Jan. 2001, *R.L.Barrett* RLB 1662 (CANB, PERTH); 6.5 km NE of junction of Pitta Creek and Prince Regent River, W of Reserve boundary, 10 Jan. 2001, *R.L.Barrett* RLB 1717 (CANB, PERTH); 26.7 km E of Kings Cascades; 12.4 km NNE of junction of Youwanjela Creek and Prince Regent River, Prince Regent Nature Reserve, 25 Jan. 2007, *R.L.Barrett* & *M.D.Barrett* RLB 3839 (PERTH); 6.5 km NE of junction of Pitta Creek and Prince Regent River, W of Reserve boundary, 28 Jan. 2007, *R.L.Barrett* & *M.D.Barrett* RLB 4026 (PERTH); East Isoetes Pavement 1, Prince Regent Nature Reserve, 16 Jan. 2010, *R.L.Barrett, M.D.Barrett & M.Maier* RLB 6158 (PERTH); Gutter Swamp site, N of Bachsten Gorge, Prince Regent National Park, 13 Mar. 2014, *R.L.Barrett* RLB 9007 (PERTH). NORTHERN TERRITORY: *15 km S of Snake Bay, Melville Island, 31 Jan. 1984, *D.L.Jones 1290* (DNA); Emau Plains, Melville Island, 6 Dec. 1984, *D.L.Jones 1691* (DNA); *Emau Plains, Melville Island, 6 Dec. 1984, *D.L.Jones 1692* (DNA). (* at start of location indicates specimens cited by Jones & Clements 2004 as *C. caesius*).

Distribution: Relatively common in the Prince Regent River to Edkins Range area, also extending north to Theda Station and scattered on Melville Island in the Northern Territory.

Conservation status: Widespread and not immediately threatened, though its habitat is increasingly threatened through disturbance by feral pigs (B. Maher, R.L. & M.D. Barrett, pers. obs.).

Ecology: Grows on seasonally wet, shallow sand lenses over sandstone with *Acacia richardsii*, *Byblis filifolia, Borya subulata*, *Drosera cucullata*, *Drosera fragrans, Lechenaultia* aff. *filiformis, Phoringopsis byrnesii*, *Ricinocarpos rosmarinifolius*, *Stylidium ceratophorum*, *Triodia* spp. and *Utricularia magna*.

Phenology: Flowers December–January.

Etymology: From Holy Roman Emperor Barbarossa (1122–1190), ('red beard' in Italian), in reference to the conspicuous beard of red labellum hairs characteristic of this species.

Notes: Wilson (1992) stated that the type description of *C. caeruleus* records this species as being leafless in habit. Leaves of *C. barbarossa* do not appear until part way through anthesis, and the same appears to be true for *C. caeruleus* (Jones 2006; 2021). The concept of *C. caesius* of Jones (2004) also includes some material of *C. barbarossa* and the figure of *C. caeruleus* from the Northern Territory on page 420 of Jones (2021) also represents *C. barbarossa*. The type of *C. caesius* represents a smaller species more closely allied to *C. kimberleyensis*. *Calochilus caesius* is here considered endemic to the Northern Territory.'

C. barbarossa often grows with *C. kimberleyensis* in the Kimberley, but the flowering season only just overlaps, and no intermediates have ever been found. The number of flowers and capsule length are the best features to use when distinguishing dried or fruiting specimens.

Pseudocopulation by scoliid wasps has been observed for this species (M Barrett and R. Barrett, pers. obs.).

Common name: Red beard orchid.

Calochilus holtzei F.Muell., *Vict. Nat.* 8(2): 180 (Mar. 1892); & *Bot. Centralbl.* 50: 127 (1892). *Type*: Northern Territory: near Port Darwin, 1891, *M.Holtze* 1276 (holo: MEL 615533; iso: K 000827519).

Calochilus holtzei var. *obligacocca* J.Simmonds, *The Orchadian* 6: 85 (1979), *nom. nud*.

?*Calochilus imperiosus* D.L. Jones, *The Orchadian Sci. Suppl.* 14(8): v (2004). *Type*: Queensland, Cook District: Shiptons Flat, S. of Cooktown, 30 Mar. 1993, *C.H.Broers* 406 & *L.J.Roberts* (holo: CBG 9306358).

Illustrations: P.Lavarack & B.Gray, *Trop. Orchids Austr.* pl. 15 (1985); D.L.Jones, *Native Orchids Austr.* 311, fig. p. 311 (1988); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg.* 1005, fig. 303a (1992); A.Dockrill, *Austr. Indig. Orchids* (edn. 2); 1: 162, fig. p. 163 (1992); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 2); 264, pl. (2006); A.P.Brown *et al*., *Orchids West. Austr.*, pl. p. 361 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 475, 480 (2013); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 421 pl., 422, fig. (2021).

Erect geophytic *herb*, tubers ovoid, 3–4 cm long, 1.2–1.5 cm wide, fleshy. *Leaves* well developed at anthesis, linear, triquetrous, Y-shaped in cross-section, erect, dark green, somewhat leathery, margins angular, apex acute, 25–50 cm long, 12–20 mm wide. *Inflorescence* 50–100 cm tall, robust, glaucous or dull green; sterile bracts 2 or 3, lanceolate, 2.4–5 cm long, 10–14 mm wide, closely sheathing, acuminate; fertile bracts lanceolate to obovate, 8.4–13.9 mm long, 2.2–3.9 mm wide, closely sheathing, acute to acuminate. *Pedicels* 10–18 mm long, slender, obliquely erect. *Flowers* lasting all day unless fertilised, 10–40+, 20–25 mm long, 8–12 mm wide; outer tepals pale greenish yellow with brown lateral striping; labellum dark purple-brown at base, calli pale greenish yellow at base, variously green, brown or reddish at the apices; perianth segments spreading widely, obliquely erect. *Dorsal sepal* ovate, 7.3–9.4 mm long, 4.5–5.2 mm wide, cucullate, concave, gibbous towards base, green with a few dark lines on the anterior surface, acute. *Lateral sepals* asymmetrically lanceolate to obovate, 6.7–9.1 mm long, 3.2–3.6 mm wide, widely divergent, slightly carinate, acute. *Petals* oblong to obovate, 6.4–8.2 mm long, 2.7–3.2 mm wide, minutely verrucose on underside, asymmetrical, obliquely deflexed close to the lateral sepals, tips slightly incurved, with a few lines on the anterior surface, obtuse. *Labellum* projected obliquely downwards, ovate to oblong, 15–20 mm long, 7–12 mm wide, undulating, minutely verrucose on distal third, glabrous at base with 2 raised keels 2–4 mm long, densely bearded with hairs up to 3.1 mm long and a band of shorter hairs (up to 0.5 mm long) along centre line, glabrous for 2–3 mm at apex, apex acute and recurved, margins upturned to give a triangular appearance. *Column c*. 4 mm long, *c*. 4.2 mm wide, green, strongly gibbous and glandular-papillate beneath the anther; wings broad, obtuse, protruding, with a few small purple spots. *Anther c*. 3 mm long, *c*. 1.5 mm wide, green with cream flaps, obliquely erect, surface minutely colliculate. *Pollinia c*. 2 mm long, curved, cream to white, mealy. *Stigma* oblong, *c*. 1 mm across, sunken. *Capsule* ovoid to broadly ovoid, 11–16 mm long, 4.8–7.4 mm wide, ribbed. (Figure 5)

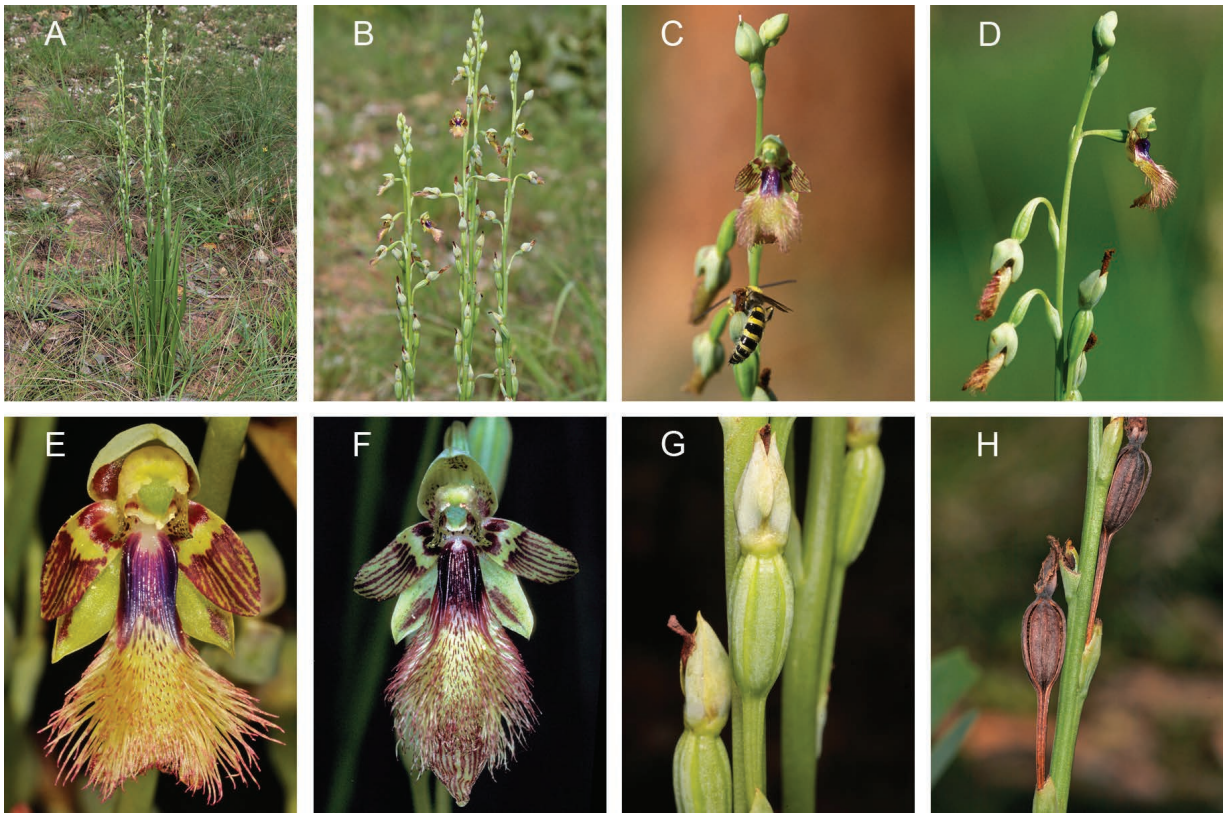

Fig. 5. *Calochilus holtzei*. A. Habit. B. Inflorescences. C. Flower being pollinated by a scoliid wasp (*Radumeris radula*). D. Inflorescence with open flower and developing fruit. E, F. Flowers showing variation in colour between populations. G. Developing fruit. H. Dehisced fruit. Vouchers: A, B, D, E, G, H. *R.L.Barrett, M.D.Barrett & M.Maier RLB 6490* (PERTH). C. *R.L.Barrett RLB 1749* (CANB, PERTH); *F.M.D.Barrett MDB 930* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Specimens examined: WESTERN AUSTRALIA: 15 km N of Junction of Youwanjela Creek and Prince Regent River, 27 Jan. 2000, *M.D.Barrett MDB 922* (PERTH); 3 km SW of Mount Fyfe summit, Drysdale Station, 28 Jan. 2000, *M.D.Barrett MDB 930* (PERTH); 1 km E of Beverley Springs Stn Hstd, 2 Feb. 1995, *R.L.Barrett RLB 976* (PERTH); Synnot Ra., 21 km NW of Beverley Springs Stn Hstd, 7 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 694* (PERTH); Synnot Ra., 32 km NW of Beverley Springs Stn Hstd, 14 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 704* (PERTH); Walgumungun Creek, 1 km E of Beverley Springs Stn Hstd, 31 Jan. 1996, *R.L.Barrett RLB 758* (PERTH); Walgumungun Creek, 1 km E of Beverley Springs Stn Hstd, 2 Feb. 1995, *R.L.Barrett RLB 976* (PERTH); 3 km SW of Mount Fyfe, 11 Jan. 2001, *R.L.Barrett RLB 1749* (CANB, PERTH); 9.8 km ENE of Jameison Arch; 6.6 km SE of Mount Agnes, Mount Elizabeth Station, N of Munja track, 28 Jan. 2007, *R.L.Barrett* & *M.D.Barrett RLB 4044* (PERTH); 2 km S of Bachsten Creek Camp, Edkins Range, 26 Jan. 2010, *R.L.Barrett, M.D.Barrett & M.Maier RLB 6490* (PERTH); cultivated, Botany Dept, UWA, Nedlands ex Mitchell Plateau, N Kimberley, 31 Jan. 1980, *K.W.Dixon s.n.* (PERTH); Mitchell Plateau adjacent to Airfield swamp, NW Kimberley, 5 Feb. 1979, *K.F.Kenneally* 7018 (CANB, K, L, PERTH); NE of Airfield swamp, Mitchell Plateau mining camp, 10 Jan. 1979, *J.Smith s.n.* (PERTH 258458). NORTHERN TERRITORY: Kapalga, 30 Dec. 1983, *C.R.Dunlop 6620* (CANB, DNA, MEL, NSW); Howard River headwaters, 6 Apr. 1984, *D.L.Jones 1568* (DNA); Q213; approx. 17 miles N of Oenpelli Mission, 15 Feb. 1973, *M.Lazarides 7715* (CANB); Hanguana Jungle, Melville Island, 26 Nov. 1989, *E.R.Petherick & J.Russell-Smith 8140* (DNA). QUEENSLAND: Davies Creek Rd, upstream of Davies Creek Falls, Mareeba district, 22 Apr. 1981, *P.D.Hind 2930* (NSW); Shiptons Flat, 8 Feb. 1991, *L.Roberts DLJ 7350* (CBG).

Distribution: From Charnley River (formerly Beverley Springs) Station homestead north to the Mitchell Plateau and Theda Station and east to the Northern Territory and Cooktown in Queensland.

Conservation status: Widespread and common in some areas, though inconspicuous and rarely seen. Not considered threatened. This species is conserved in the Prince Regent National Park.

Ecology: Grows exclusively in association with *Corymbia* spp., particularly *C. latifolia*, *C. foelscheana* and *C. greeniana*, on sand over sandstone, beside creeks and on plateau-top flats, often with *Erythrophleum* aff. *chlorostachys* over *Alloteropsis semialata*, *Bossiaea bossiaeoides*, *Chrysopogon fallax* and *Sorghum plumosum*.

The nature of the association between *C. holtzei* and *Corymbia* deserves further exploration, especially in relation to symbiotic fungi.

Phenology: Flowers December–January, with a longer flowering period than other species due to its robust nature and large number of flowers per inflorescence.

Affinities: A very distinctive, robust species that has some of the tallest inflorescences in the genus, making it more visible among tall grasses when they develop later in the wet season. *Calochilus holtzei* is perhaps morphologically closest to *C. barbarossa*, sharing the elongated ridges on the base of the labellum. Phylogenetic analyses by Nargar *et al*. (2018) recovered *C. holtzei* as sister to *C. caeruleus*, but *C. barbarossa* was not included in that study. Jones in Jones and Clements (2004) named *C. imperiosus* based on Queensland specimens previously included within the concept of *C. holtzei*. The differences given appear slight, and the colour of the labellum hairs is quite variable among Kimberley populations, the variation encompassing Jones' (2004) stated differences between taxa. Results from a recent molecular analyses of *Calochilus* did not separate these two species (Nargar *et al*. 2018). We therefore tentatively synonymise the two species, until such time as definitive differences can be identified.

Notes: The only collection for Western Australia prior to the 1990s was from the Mitchell Plateau. This species is now known to be widespread in WA from Theda Station, Mitchell Plateau, the Edkins Range and Beverley Springs (now Charnley River) Station.

Pseudocopulation has been observed for this species. Graham Brown (pers. comm.) has identified the wasp as *Radumeris radula* (formerly *Campsomeris radula*), Scoliidae. (Figure 2C).

Common names: Tall beard orchid, Ghostly beard orchid.

Calochilus kimberleyensis R.L.Barrett, M.D.Barrett & M.A.Clem., *sp. nov*.

Type: Western Australia: Edkins Range, on Walcott Inlet track, 77 km N of Beverley Springs Station Homestead, 16°01'25"S, 125°18'55"E, 28 Dec. 1995, *R.L.Barrett* & *M.D.Barrett RLB 674* (holo: PERTH; iso: CANB, DNA, NSW).

Calochilus caesius auct. non D.L. Jones: A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 358, 361 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 478, 479 (2013).

Calochilus sp. A Kimberley Flora (K.F. Kenneally 7110), A.J.G.Wilson in J.R.Wheeler (ed.) Fl. Kimb. Reg., 1006, fig. 303b (1992); Western Australian Herbarium. (1998–). FloraBase – The Western Australian Flora. Department of Environment and Conservation. http://florabase.dpaw.wa.gov.au/ [accessed February 2012].

Illustrations: A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 358, 361 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 478, 479 (2013), as *C. caesius*.

Erect geophytic *herb*, tubers ovoid, 1.5–2 cm long, 0.8–1.2 cm wide, fleshy. *Leaves* short or absent at anthesis, linear, triquetrous in cross-section, erect, dark green, fleshy, margins bluntly rounded, apex acute, 10–25 cm long, 2–4 mm wide. *Inflorescence* 200–400 mm tall, very slender, dull green; sterile bracts 2–3, lanceolate, 0.8–2.9 cm long, 1.6–2.6 mm wide, closely sheathing, subacute; fertile bracts lanceolate, 3.6–7.5 mm long, 1.6–2.2 mm wide, closely sheathing, subacute. *Pedicels* 5.5–9.9 mm long, slender, obliquely erect. *Ovaries* 7.3–12.4 mm long, 1.4–1.8 mm wide at flowering. *Flowers* lasting about half a day, 1–3, 11.7–15.6 mm long, 5.2–7.4 mm wide; outer tepals pale yellowish green with purple-brown markings; labellum brownish with deep reddish to purple glossy calli; perianth segments spreading widely at temperatures above *c*. 25ºC, obliquely erect. *Dorsal sepal* ovate, 5.2–6.0 mm long, 3.1–4.2 mm wide, cucullate, concave, gibbous towards base, green with a few dark lines on the anterior surface, acute. *Lateral sepals* asymmetrically broadly lanceolate, 4.8–6.0 mm long, 2.0–2.4 mm wide, widely divergent, slightly carinate, acute to apiculate. *Petals* ovate, 4.4–6.2 mm long, 1.7–2.3 mm wide, asymmetrical, obliquely deflexed close to the lateral sepals, tips slightly incurved, with a few lines on the anterior surface, acute. *Labellum* projected obliquely downwards, obovate to oblong-elliptical, 10.1–14.5 mm long, 4.3–6.7 mm wide, flat, very obscurely 3-lobed, the margins of the lateral lobes with *c*. 10 pairs of very short, linear teeth, apex acute; ventral surface reddish brown, the proximal three-quarters densely adorned with appressed curved, linear-terete, reddish calli 0.4–1.7 mm long, the distal eighth devoid of calli; basal pair of labellum calli prominently raised, tooth-like *c*. 2 mm long, 0.5 mm wide, fleshy, shallowly incurved, reddish, shiny; dorsal surface dark reddish brown, finely glandular-dotted. *Column* 3.2–3.5 mm long, 3.0–3.2 mm wide, green, strongly gibbous and glandular-papillate beneath the anther; wings broad, obtuse, protruding, with a few small purple spots and two small sham-eyes at the base. *Anther c*. 1.4 mm long, *c*. 1.6 mm wide, green with cream flaps, obliquely erect, surface minutely colliculate. *Pollinia c*. 1.6 mm long, curved, cream to white, mealy. *Stigma* oblong, *c*. 1.3 mm across, sunken, appendage bluntly triangular. *Capsule* narrowly ovoid, 12–19 mm long, 3.3–4.5 mm wide, ribbed. (Figure 6)

Fig. 6. *Calochilus kimberleyensis*. A. Habit. B. Inflorescence. C–G. Flowers. H. Fruit. I. Lateral view of flower. J, K. Comparison of flowers of *C. barbarossa* (left) and *C. kimberleyensis* (right). Vouchers: A, B, D, F, G, H, I: *R.L.Barrett, M.Maier & P.Kendrick RLB 6238* (PERTH); C, E: *R.L.Barrett RLB 1718* (PERTH); J, K: *R.L.Barrett, M.D.Barrett & M.Maier RLB 6158* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Diagnostic characters: Related to *C. caesius* D.L.Jones but differs by the overall stronger, bolder red colouration of the labellum with vinaceous tints (pale pink-purple in *C. caesius*); labellum slightly crenulated and jagged margin of the labellum apex (± entire in *C. caesius*), dark red-purple when fresh (green with blue-grey colour sheen of the labellum in the light in *C. caesius*); column broader at the base; ovate rather than narrowly ovate-lanceolate petals. Also related to *C. caeruleus*, differing in the smaller flowers and only 2–4 flowers per inflorescence (4–12 in *C. caeruleus*).

Specimens examined: WESTERN AUSTRALIA: *c.* 1 km E of falls at head of N arm of Bachsten Creek, Prince Regent River Reserve, 30 Jan. 1999, *M.D.Barrett MDB 668A* (PERTH); 1/3 way uphill on jump-up on Beverley Springs–Walcott track, N end of Edkins Range, 5 Feb. 1999, *M.D.Barrett MDB 785* (PERTH); Edge of plateau above upper Prince Regent River, 3.5 km E of Mount Agnes, 2 Feb. 2000, *M.D.Barrett MDB 1038* (PERTH); Edkins Ra., 74 km N of Beverley Springs Stn Hstd, 26 Dec. 1995, *R.L.Barrett* & *M.D.Barrett RLB 638* (CANB, NSW, PERTH); Edkins Ra., 79 km N of Beverley Springs Stn Hstd, 9 Jan. 1995, *R.L.Barrett* & *M.D.Barrett* RLB 906 (PERTH); Edkins Ra., 11 Jan. 1995, *R.L.Barrett* & *M.D.Barrett RLB 907* (PERTH); *c.* 8.5 km ENE of Mount Agnes, 6 Jan. 2001, *R.L.Barrett RLB 1570* (PERTH); *c.* 8 km N of Charnley River Crossing on Walcott Inlet track, Edkins Ra., 8 Jan. 2001, *R.L.Barrett & K.W.Dixon RLB 1657* (PERTH); 6.5 km NE of junction of Pitta

Creek and Prince Regent River, W of Reserve boundary, 10 Jan. 2001, *R.L.Barrett RLB 1718* (PERTH); gutter swamp site, north of Bachsten Creek Falls, Prince Regent Nature Reserve, 18 Jan. 2010, *R.L.Barrett, M.Maier & P.Kendrick RLB 6238* (PERTH); Sandstone pavement E of Mount Brookes, Prince Regent Nature Reserve, 19 Jan. 2010, *R.L.Barrett, M.Maier & P.Kendrick RLB 6273* (PERTH); gutter swamp site, north of Bachsten Creek Falls, Prince Regent Nature Reserve, 13 Mar. 2014, *R.L.Barrett RLB 9006* (PERTH); swamp N of fuel dump which is N of Amax Basecamp, NW Kimberley, 9 Feb. 1979, *K.F.Kenneally 7110* (PERTH).

Distribution: West and Central Gardner districts, Northern Botanical Province (Beard 1990), recorded from the Edkins Range, Prince Regent National Park, Mitchell Plateau, Theda and Doongan (King Edward River) Stations in the Kimberley.

Ecology: Sandy flats over sandstone in seasonally damp areas. Growing in association with *Acacia dunnii*, *A. nuperrima, Banksia dentata*, *Byblis liniflora*, *Calochilus barbarossa*, *Clitoria australis*, *Didymoplexis pallens*, *Drosera caduca, D. ordensis*, *D.* aff. *paradoxa*, *Erythrophleum* aff. *chlorostachys*, *Eucalyptus alba*, *E. apodophylla*, *E. tetrodonta*, *Eulophia bicallosa*, *Grevillea pteridifolia*, *Haemodorum flaviflorum*, *Hakea arborescens*, *Hypoxis nervosa, Lindernia plantaginea, Empusa habenarina*, *Ludwigia octovalvis*, *Melaleuca viridiflora*, *Pandanus spiralis* var. *spiralis, Pecteilis eurystoma*, *Platyzoma microphyllum*, *Stylidium pachyrrhizum, Triodia* sp., *Polygala* sp. and *Xyris complanata*.

Phenology: Flowers December–early February.

Conservation status: This species is widespread in distribution and common in limited populations. It is not considered to be under any threat at present, though some populations are disturbed by pigs. The range of this species includes the Prince Regent National Park.

Etymology: The epithet refers to the Kimberley region where this species is apparently endemic.

Notes: This species was referred to as *Calochilus* sp. A by Wilson (1992). Results from molecular analysis of 80 plastid loci and one nuclear locus (ITS) including, *C. caesius* collected from the Northern Territory and *C. kimberleyensis* from the Kimberley confirmed their sister relationship (Nargar *et al.* 2018). Descriptions and photos of *C. caesius* can be found in Liddle *et al.* (2017) and Jones (2021).

First discovered in the north Kimberley by Kevin Kenneally in February 1979.

Common name: Kimberley beard orchid.

Cymbidium Sw., *Nova Acta Regiae Soc. Sci. Uppsal.* ser. 2, 6: 70 (1799). *Lectotype*: *Cymbidium aloifolium* (L.) Sw., designated by P.F.Hunt, *Kew Bull.* 24(1): 94 (1970).

Jensoa Raf., *Fl. Tellur* 4: 38 (1836). *Lectotype*: *J. ensata* (Thunb.) Raf., *nom. illeg.*, designated by P.F.Hunt, *Kew Bull.*, 24(1): 94 (1970).

Cyperorchis Blume, *Rumphia* 4: 47 (1848). *Type*: *C. elegans* (Lindl.) Blume, designated by P.F.Hunt, *Kew Bull.*, 24(1): 94 (1970).

Iridorchis Blume, *Orchid. Arch. Ind.* 1: 91, t. 26 (1858). *Type*: *Cymbidium giganteum* Wall. ex Lindl.

Arethusantha Finet, *Bull. Soc. Bot. France* 44: 178–180, t. 15 (1897). *Type*: *Arethusantha bletioides* Finet.

× *Cyperocymbidium* A.Hawkes, *Orchid Rev.* 72: 420 (1964). *Type*: Not designated.

Notes: The genus *Cymbidium* is well-defined and two editions of a generic monograph have been published (Du Puy & Cribb 1988, 2007). Some phylogenetic relationships of Cymbidiinae genera have been questioned by Batista *et al.* (2014), but largely clarified by more extensive sampling by Li *et al.* (2016) and Zhang *et al.* (2019). Relationships within *Cymbidium* have been assessed by Zhang *et al.* (2002) who questioned the existing subgeneric classification. Additional sampling by Lan *et al.* (2018) supports the recognition of three subgenera.

Subgen. **Cymbidium**

Section **Cymbidium**

Section *Austrocymbidium* Schltr., *Repert. Sp. Nov. Regni Veg.* 20: 104 (1924). *Lectotype*: *C. canaliculatum* R.Br., designated by P.Hunt, *Kew Bull.* 24(1): 94 (1970).

Section *Austrocymbidium* Schltr. is here listed as a synonym of Sect. *Cymbidium* based on a sister relationships between *C. canaliculatum* and *C. aloifolium* (Zhang *et al.* 2019).

Cymbidium canaliculatum R.Br., *Prodr*. 331 (1810). *Type*: Queensland: Broad Sound, 25 Sept. 1803, *R.Brown* [*Bennett No. 5503*], (lecto: BM 000532695; isolecto: BM 000532696, BM 000532697, E 00686022, E 00686023, K 000891109, K 000891110), designated by M.A.Clements, *Austr. Orchid Res*. 1: 43 (1989).

Cymbidium hillii F.Muell. in Regel, *Gartenflora* 138–9 (1879); *Fragm*. 11: 88 (1880). *Type*: cult. Brisbane Botanic Gardens, ex in coastal forest Mulgrave Mountains, North Queensland, *W.Hill s.n.* (holo: ?MEL, *n.v.*).

Cymbidium sparksii Rendle, *J. Bot*. 36: 221 (1898); *Cymbidium canaliculatum* var. *sparksii* (Rendle) F.M.Bailey, *Compr. Cat. Queensl. Pl*. 845 (1913). *Type*: cult. London, 26 Apr. 1909, *J.Sparks* ex 'North-east Queensland', 20 April 1899, *A.O.Jones s.n.* (holo: BM 000532702; iso: K 000891108).

Cymbidium canaliculatum var. *canaliculatum* forma *inconstans* Rupp, *Proc. Linn. Soc. New S. Wales* 59: 98 (1934), *nom. illeg*.

Cymbidium canaliculatum var. *canaliculatum* forma *aureolum* Rupp, *Proc. Linn. Soc. New S. Wales* 59: 99 (1934). *Lectotype* (here designated): New South Wales: Pilliga, Oct. 1932, *H.M.R.Rupp s.n.* [Herbarium of Australian Orchids No. 387d] (lecto: NSW 596402; isolecto: NSW 596403).

Cymbidium canaliculatum var. *marginatum* Rupp, *Proc. Linn. Soc. New S. Wales* 59: 99 (1934). *Lectotype* (here designated): Queensland: Cairns, Oct. 1933, *W.F.Tierney s.n.* [Herbarium of Australian Orchids No. 387f] (lecto: NSW 807352; isolecto: NSW 807345).

Cymbidium canaliculatum var. *marginatum* forma *fuscum* Rupp, *Proc. Linn. Soc. New S. Wales* 59: 99 (1934). *Lectotype* (here designated): Queensland: Cairns, Oct. 1933, *W.F.Tierney s.n.* [Herbarium of Australian Orchids No. 387f] (lecto: NSW 807352; isolecto: NSW 807345).

?*Cymbidium canaliculatum* var. *marginatum* forma *purpurascens* Rupp, *Proc. Linn. Soc. New S. Wales* 59: 99 (1937). *Type*: Queensland: Proserpine, *C.Macpherson s.n.* (syn: ?NSW, *n.v.*); Head of Brisbane R., *F.A.Weinthal s.n.* (syn: ?MEL, *n.v.*).

Cymbidium canaliculatum var. *barrettii* Nicholls, *Austr. Orchid Rev*. 7: 40 (1942). *Type*: Northern Territory: Groote Eyland, Apr. 1940, *C.Barrett s.n.* (holo: MEL 0647418).

Illustrations: Hook.f., *Bot. Mag*. 96: t. 5851 (1870); Rupp, *Proc. Linn. Soc. New S. Wales* 59: 94–100, figs 1–3 (1934); Dockr., *Austr. Pl*. 3: 293–295, fig. (1966); Nicholls, *Orchids Austr.* 1: 630–632, t. 447 (1969); Brennan, *Wildfl. Kakadu* 59, pl. 98 (1986); M.Clark & S.Traynor, *Pl. Trop. Woodl*. 44, fig. (1987); D.L.Jones, *Native Orchids Austr.* 594, fig. (1988); J.Brock, *Top End Native Pl*. 133, pl. (1988); Du Puy & Cribb, *Genus* Cymbidium 90, pl. 8, 66–67, fig. 21.1 (1988); Dockr., *Austr. Indig. Orchids* (edn. 2); 2: 854, fig. p. 855 (1992); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg.* 1006, fig. 302a (1992); P.H.Weston in G.J.Harden, *Fl. New S. Wales* 4: 240, fig., pl. 17 (1993); Kenneally *et al.*, *Broome & Beyond* 213, pl. (1996); J.Puruntatameri *et al*., *Tiwi Pl. & Animals* 41, pl. (2001); P.Wiynjorrotj *et al*., *Jawoyn Pl. & Animals* 51, pl. (2005); D.L.Jones, *Compl. Guide Austr. Orchids* 466, pls. (2006); R.Melzer & J.Plumb, *Pl. Capricornia* 495, pl. (2007); A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 352, 364, 367 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 470, 475, 482, 483 (2013); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 746 pls (2021).

Robust erect *epiphyte* with crowded stems, pseudobulbs ellipsoidal to obovoid, 30–90 mm long, 15–30 mm wide, with 3–4 large bracts at the base, bracts up to 7 cm long. *Leaves* 3–7 per pseudobulb, distichous, largest at the top of the stem, alternate, dull green, linear to narrowly ovate, tapering to an acute apex, coriaceous and stiff, canaliculate, 80–400 mm long, 10–30 mm wide, disarticulating, 10–30 mm above the base. *Inflorescences* 1–3 per stem, erect to pendulous, arching, usually from the axils of the upper cataphylls, 200–400 mm long; peduncle 100–200 mm long, with 5–8 distant sheaths up to 3.5 cm long; rachis 60–250 mm long, with 15–50+ flowers, bracts 2–4 mm long, triangular, acute to acuminate. *Flowers* 25–50 mm wide, fragrant, usually widely spreading, light green or brown, purple or dull red, usually with lighter coloured margins or markings, labellum usually white with red or purple markings, callus ridges cream to pale green; pedicels 15–30 mm long. *Perianth*: sepals more or less oblong, 16–20 mm long, 4.5–6 mm wide, acute; petals narrowly elliptic, acute, 14–17 mm long, 4.5–5.5 mm wide; labellum 12–17 mm long, 4–7 mm wide when flattened, 3-lobed; lateral lobes crescent-shaped, erect, 1–2.5 mm long, 4–10 mm wide, midlobe usually decurved, 6–15 mm long, 5–10 mm wide; callus of 2, parallel, well-defined, ridges extending to midlobe, slightly hairy to papillose, the hairs extending onto the midlobe. *Column* yellowish-green or green, often blotched with red-brown, paler at the base, anther-cap cream or green to dark red-brown, 6–10 mm long, slightly curved, mottled, winged at apex; pollinia 2, about 1 mm long. *Anther* 1–1.5 mm across, rostrum indistinct. *Capsule* 40–50 mm long, 10–20 mm wide, ribbed, fusiform-ellipsoidal, shortly pedicellate, column persistent. (Figure 7).

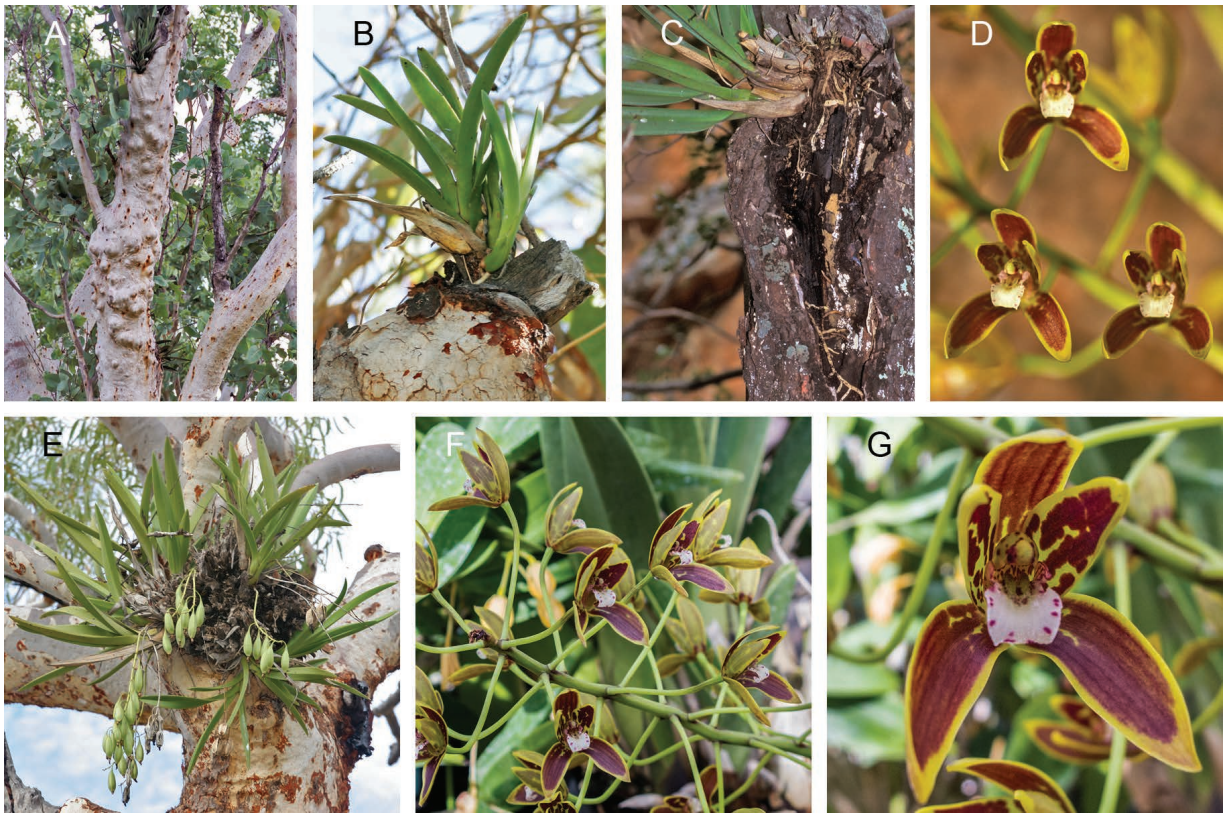

Fig. 7. *Cymbidium canaliculatum*. A–C. Habit and habitat in broken branches of living eucalypts. D. Flowers. E. Fruiting plant. F. Inflorescence. G. Flower. Vouchers: A: not vouchered, from SE of Mt Bomford; B, E: not vouchered, from Ragged Range, SW of Lake Argyle; C, not vouchered, from S side of Mt Bomford; F, G: not vouchered, cultivated at Kings Park & Botanic Garden from S side of Mt Bomford. Photos by R.L. Barrett.

Selected specimens examined: WESTERN AUSTRALIA: Beverley Springs Stn Hstd, 22 Dec. 1991, *R.L.Barrett* 12 (PERTH); Karrakatta Bay, 8 km NW of One Arm Point, N Dampierland, 07 Nov. 1987, *B.J.Carter* 141 (PERTH); Steep Head Island, Admiralty Gulf, N. Kimberley, 18 Nov. 1981, *T.P.Farrell* 976 (PERTH); Mount Herbert, near Inglis Gap, King Leopold Range, 17 May 1905, *W.V.Fitzgerald* 803 (PERTH); W5, Prince Regent River Reserve, 28 Aug. 1974, *K.F.Kenneally* 2170 (PERTH); adjacent to Granny's Soak campsite, edge Gardner Ra., N Tanami Desert, 10 May 1998, *K.F.Kenneally* 12036 (PERTH); Barker River, Sept. 1905, *J.Staer s.n.* (E 00686025*!); Roebuck Bay, Nov. 1891, *J.W.O.Tepper* 150 (PERTH); Roebuck Bay, 1892, *J.W.O.Tepper s.n.* (MEL). NORTHERN TERRITORY: Old Litchfield Road, 9 Sept. 1975, *C.R.Dunlop 3689* (CANB, DNA); Daily River settlement, 15 Jan. 1988, *N.M.Smith 1004* (DNA); Borroloola area, 12 Aug. 1991, *G.M.Wightman 5402* (DNA). QUEENSLAND: Maranoa, 28 miles [45 km] S of Roma on road to Surat, 29 Nov. 1972, *D.F.Blaxell 1049 & L.A.S.Johnson* (NSW); Cook, 19.4 km from Peninsula Development Road to New Dixie Station, 15 Oct. 1980, *J.R.Clarkson 3582* (NSW); NW of Goondiwindi, 1960, *L.Pedley 705* (CANB). NEW SOUTH WALES: 9.8 km N of the Rocky Dam - Wallangra road junction on road to Yetman, 2 Nov. 1983, *R.G.Coveny 11728 & P.G.Wilson* (NSW); cultivated at RBG Sydney [ex Mount Kaputar National Park, Waa Gorge, just upstream from twin pools], 20 Oct. 1987, *K.D.Hill 2775, L.A.S.Johnson & P.H.Weston* (NSW); Mole River, near Darby Creek, *c.* 6.9 km along Mole Station Rd, 9 Nov. 2018, *G.M.Taseski 923 & J.M.Cohen* (NSW).

Distribution: Widespread in the Kimberley region, less common in the northern regions of the Northern Territory and Queensland, but common and widespread in parts of southern Queensland and inland Northern New South Wales as far south as the Hunter River valley.

Conservation status: Widespread and not considered threatened (Du Puy and Cribb 1988, 2007) although an attractive apple-green variety is uncommon and eagerly sought after by collectors. This species may be subject to localised extinction along popular tourist routes where plants are souvenired by passing motorists.

Ecology: Epiphyte on a variety of hosts, mainly eucalypts, but also *Celtis*, *Melaleuca*, *Mimusops* and *Sterculia*. This species establishes on the rotting heartwood and bark of trees and in hollow branches, the roots growing down through the hollowed trunk of the tree and may even reach the ground and thus persist in dead trees and stumps.

Phenology: Flowers May–November, fruits June–December.

Affinities: On the basis of comparative morphological evidence considered to be most closely related to *C. hartinahianum* Comber & Nasution from northern Sumatra, *C. chloranthum* Lindl., from Sumatra, Java, Malaysia, Borneo and Palawan in the Philippines, and possibly *C. elongatum* J.J.Wood, Du Puy & P.S.Shim from Borneo (Du Puy and Cribb 1988). However, in a recent morphological and molecular based study (Zhang *et al*. 2019) revealed that *C. canaliculatum* was deeply embedded in subgenus *Cymbidium*, sister to the type species *C. aloifolium*, which is widespread throughout tropical SE Asia.

Typification: Rupp (1934) does not cite a type for his *Cymbidium canaliculatum* var. *canaliculatum* forma *inconstans* Rupp, but explicitly equates it with the type form of *Cymbidium canaliculatum* R.Br., so the name is illegitimate as he should have named it 'forma *canaliculatum*' (Art. 26.1, Shenzhen Code).

Two sheets of *Cymbidium canaliculatum* var. *canaliculatum* forma *aureolum* Rupp are held at NSW (NSW 596402 and NSW 596403). It is likely that both were originally mounted together, and were separated relatively recently, but this cannot be conclusively demonstrated, so we here designate the larger sheet (NSW 596402) as the lectotype of the name.

We identify two sheets at NSW with *Cymbidium canaliculatum* var. *marginatum* Rupp (NSW 807352 and NSW 807345). It is likely that both were originally mounted together, and were separated relatively recently, but this cannot be conclusively demonstrated, so we here designate the sheet with the original Rupp herbarium label (NSW 807352) as the lectotype of the name.

Rupp (1934) recognised two forms of his var. *marginatum*, but did not specify which was the typical form (which should have been called 'forma *marginatum*'). We here choose a lectotype for *Cymbidium canaliculatum* var. *marginatum* forma *fuscum* Rupp to equate it with that variety.

We have not chosen a lectotype for *Cymbidium canaliculatum* var. *marginatum* forma *purpurascens* Rupp as original material has so far not been located. We have also not located original material of *Cymbidium hillii* F.Muell.

Notes: There are two colour forms recorded for the Kimberley Region. The common form is mottled purple, brown and yellow-green. A rare lime-green form has been observed near Mount Elizabeth Station, King Edward River Crossing and on the Dampier Peninsula. The latter form has been described as *C. canaliculatum* var. *barrettii* Nicholls (1942) based on specimens from Groote Eylandt. This is probably a partially albino form.

In some cases, the colour forms found in *Cymbidium canaliculatum s. lat*. are found in specific geographic areas. The deep red flowers of *C. canaliculatum* var. *sparksii* (Rendle) F.M.Bailey also correspond to inflorescences that are much more floriferous than other forms. Detailed discussions are provided by Rupp (1934) and Du Puy and Cribb (1988). While recent authors decline to recognise any of the named varieties, further investigation of variation in this species is warranted and is the subject of a current investigation by L. Simpson using molecular techniques.

Common names: Channel-leaf Cymbidium, Black orchid.

Dendrobium Sw., *Nov. Acta Reg. Soc. Sci. Upsal.*, ser. 2, 6: 82 (1799), *nom. cons*. *Type species*: *D. moniliforme* (L.) Sw., *type cons*., designated by Pfeiffer, *Nomencl. Bot.*, 1(2): 1030 (1872); and see Holttum *et al*. (1979).

Notes: Delimitation of monophyletic genera within the Dendrobiinae remains in a state of flux at present with alternate classifications providing disparate concepts of how to best treat these orchids (Yukawa *et al*. 2000; Clements & Jones 2002; Clements 2003, 2006; Burke *et al*. 2008; Adams 2011; Pridgeon *et al*. 2014; Jones 2021). Publication of detailed molecular phylogenetic analyses of Dendrobiinae is pending (Nargar, Clements *et al*. in prep.), which will lend significant support to a revised classification. Since the latest results have yet to be published, for the sake of simplicity, a broad generic concept of *Dendrobium* is applied here pending improved resolution of relationships and corresponding taxonomic proposals.

Subgen. **Dendrobium**

Section **Phalaenanthe** Schltr., *Repert. Spec. Nov. Regni Veg. Beih*. 1: 447 (1912). *Type species*: *D. bigibbum* Lindl.

Dendrobium subg. *Pedilonum* sect. *Ceratobium* subsect. *Platypetala* Kraenzl. in Engl., *Pflanzenr*. IV. 50. II. B., 21: 139 (1910). *Type species*: *D. affine* (Decne.) Steud.

Vappodes M.A.Clem. & D.L. Jones, *The Orchadian* 13(11): 492 (2002). *Type species*: *Dendrobium bigibbum* Lindl.

Dendrobium dicuphum F.Muell., *Fragm*. 8: 28 (1873); *Callista dicupha* (F.Muell.) Kuntze, *Gen. Pl.* 2: 654 (1891); *Vappodes dicupha* (F.Muell.) M.A.Clem. & D.L.Jones, *The Orchadian* 13: 492 (2002); *Dendrobium bigibbum sensu* F.Muell., *Fragm.* 6: 119 (1868), *non* Lindl. (1853). *Type*: Northern Territory: Liverpool R., *B.Gulliver s.n.* (holo: MEL 624053; iso: K, MEL 624079, W).

Dendrobium dicuphum var. *grandiflorum* Rupp & T.E.Hunt, *Proc. Linn. Soc. New S. Wales* 72: 241 (1948). *Type*: Northern Territory: near Darwin, 1945, *G.L.Piper* or *R.J.Langdon 318* (lecto: BRI AQ0279506), designated by M.A.Clements, *Austr. Orchid Res*. 1: 46 (1989).

Dendrobium dicuphum var. *album* Hort. ex E.C.Cooper, *Roy. Hort. Soc. Dist. Gard*. 2: 653 (1951), *nom. illeg.*

Dendrobium affine auct. non (Decne.) Steudel: D.L.Jones, *Native Orchids Austral.* 432 (1988); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimberley Region* 1007 (1992); Dockr., *Austral. Indig. Orchids* (edn. 2); 2: 596 (1992).

Illustrations: Nicholls, *Orchids Austral.* 112, t. 415 (1969); N.Lothian, *Austral. Orchids* 47, pl. 49 (1981); Brennan, *Wildfl. Kakadu* 100, pl. 182 (1986); D.L.Jones, *Native Orchids Austral.* 432, fig. (1988), as *D. affine*; J.Brock, *Top End Native Plants* 135, pl. (1988), as *D. affine*; W.Upton, Dendrobium *Orchids Austral.* 19 fig. 10, pl. 7 (1989), as *D. affine*; A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimberley Region* 1007, fig. 302b (1992), as *D. affine*; Dockr., *Austral. Indig. Orchids* (edn. 2); 2: 596, fig. p. 597 (1992), as *D. affine*; Lavarack *et al*., Dendrobium *and its relatives* 242, pl. (2000), as *D. affine*; P.Wiynjorrotj *et al*., *Jawoyn Pl. & Animals* 54, pl. (2005), as *D. affine*; D.L.Jones, *Compl. Guide Austral. Orchids* 417, pl. (2006), as *Vappodes dicupha*; A.P.Brown *et al*., *Orchids West. Austral.*, pls p. 368, 371 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austral.*, pls p. 471, 475, 484, 485 (2013); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 675 pl. (2021), as '*Durabaculum dicuphum*'.

Erect *epiphytic* herb; stems with pseudobulbs 50–350 mm long, *c*. 10 mm wide, slender fusiform. *Leaves* 3–10 at distal end of stem, erect to recurved, linear to narrowly ovate, 60–200 mm long, 10–25 mm wide, coriaceous, base sheathing, disarticulated and deciduous above the sheaths, acuminate. *Inflorescences* 1–4, semi-erect or recurved, 150–400 mm long with (2–)6–10(–20) flowers. *Flowers* spreading, white or cream, sometimes maroon, pink or green on lower part of labellum, 20–50 mm across; pedicels 10–20 mm long. *Dorsal sepal* oblong or narrowly ovate, shortly acute, 10–20 mm long, 4–7 mm wide. *Lateral sepals* narrowly ovate, 14–22 mm long, mentum up to 7 mm long. *Petals* obovate, 14–22 mm long, 5–8 mm wide. *Labellum* 3-lobed, 13–20 mm long, 7–13 mm wide when flattened; lateral lobes obliquely triangular, erect, enclosing the column, 3–5 mm long, 5–8 mm wide; midlobe oblong, 7–11 mm long, 2.5–5 mm wide, mucronate, keels 5, sometimes extending more than halfway along the midlobe, with calli or crested on the distal half. *Column* 3–4 mm long, 3–4 mm wide; foot, which is almost all spur, almost parallel to the body of the column, 4–6 mm long. *Anther c*. 2 mm in diameter; rostrum deflexed or decurved, broadly crescent shaped. *Rostellum* very short, transverse linear or crescentic. *Stigma* shield-shaped. Pollinia subequal, compressed slender falcate-obovoid. *Capsule* up to 20 mm long, 10 mm wide, glabrous, ribbed. (Figure 8)

Selected specimens examined: WESTERN AUSTRALIA: Crusher Vine Thicket, 6 km S of Mitchell Plateau mine camp, 05 June 1987, *J.J.Alford 525* (PERTH); Fiona Elizabeth Falls, Synnot Creek, 35 km NW of Beverley Springs Stn Hstd, 28 May 1995, *R.L.Barrett s.n*. (PERTH); Grevillea Gorge, from below Grevillea Pool to Synnot Creek, Synnot Range, Beverley Springs Station, 9 June 1995, *R.L.Barrett RLB 8639* (PERTH); Source of Calder River, Kimberley, 20 June 1922, *C.A.Gardner 893* [*1393*] (AD, NSW, PERTH); Mount Trafalgar, Prince Regent River Reserve, 26 Aug. 1974, *A.S.George 12705* (PERTH); Site 1, 13.5 km NE of Crystal Head, SW Osborne Island, Gardner Botanical district, 0.1 km to coast, 11 June 1987, *K.F.Kenneally* & *B.P.M.Hyland KFK 10336* (PERTH). NORTHERN TERRITORY: Melville Island, Jump-up Jungle, 1 Feb. 1984, *D.L.Jones 1338* (DNA); Elcho Island, Warangaiyu Lagoon, 4 July 1975, *P.Latz 6093* (DNA); Galiwinku community, Elcho Island, 29 Apr. 1987, *N.M.Smith 598* (DNA).

Distribution: From the Synnot Range and Walcott Inlet, north to the Mitchell Plateau and Bonaparte Archipelago in the north Kimberley. Also widespread in the 'top end' of the Northern Territory, disjunct from the Kimberley distribution.

Conservation status: Relatively widespread within its range and not considered threatened.

Ecology: Epiphytic on a variety of hosts, particularly *Lophostemon grandiflorus* subsp. *riparius* and *Sersalisia sericea*, but also *Eucalyptus*, *Pandanus aquaticus*, and in the Northern Territory, *Cycas*.

Phenology: Flowers May–August, fruits June–December.

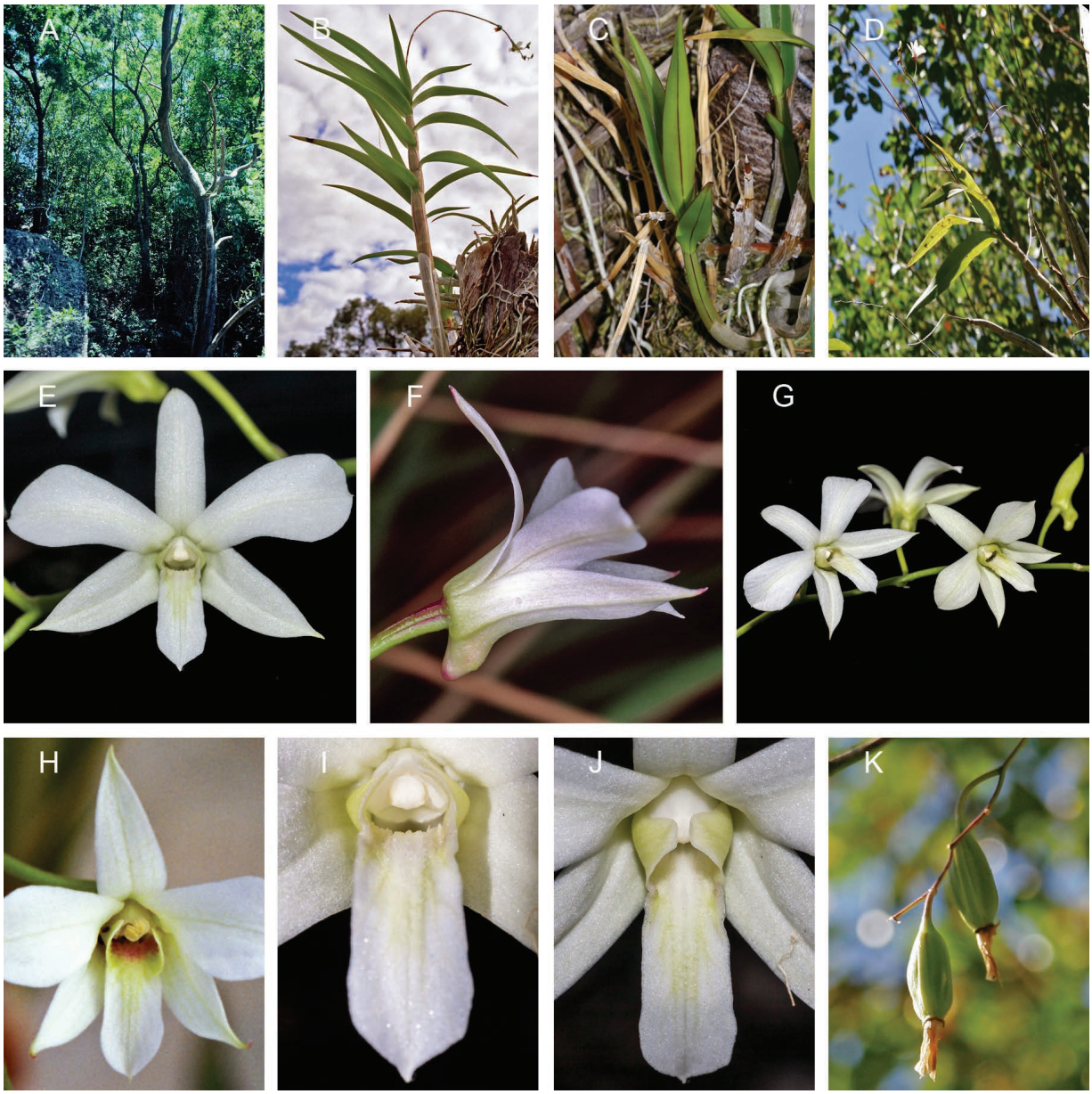

Fig. 8. *Dendrobium dicuphum*. A. Habitat. B–D. Habit. E–H. Flowers. I, J. Close-up of labellum. K. Fruit. Vouchers: A: not vouchered, from below Mount Daglish. B, C, E–J: not vouchered, cultivated at Kings Park & Botanic Garden from Grevillea Gorge, Synnot Range. D, K: not vouchered, from SW Osborne Island. Photos by R.L. Barrett & M.D. Barrett.

Affinities: Related to *D. affine*, a species from Timor, Flores (East Nusa Tenggara), Komodo and West Nusa Tenggara and adjacent small islands. *Dendrobium dicuphum* has often been considered a synonym of *D. affine* in recent decades (e.g. Wheeler 1992; Lavarack *et al*. 2000), however we consider *D. affine* a distinct taxon with longer inflorescences with numerous flowers; flowers with broader lateral petals; narrow side lobes clasping the column, an elongate-rectangular labellum midlobe with acute apex; predominantly white to cream coloured flowers often with a light green column, labellum side lobes and base of petals and sepals, and 3 rows of yellow, green or pink calli; all features not found in *D. dicuphum*. Lavarack *et al*. (2000) also noted the commonly shorter pseudobulbs in north-western Australian populations (as *D. affine*), though this character is variable in *D. dicuphum*.

Notes: Kenneally *et al*. (1991) recorded a *Bulbophyllum* sp. (*K.F. Kenneally* 10453) from rainforest on Neville Creek in the Harding Range. A visit to the site found only protocorms and adult plants of *D. dicuphum*. The material collected by Kenneally subsequently flowered in Canberra and was proven to be *D. dicuphum* (D.L. Jones pers. comm.), but was not vouchered.

Labellum colouration is variable on a seasonal basis. Interestingly, several populations in the vicinity of Beverly Springs (Charnley River) Station were observed to be all lime green one season, and all dark pink the following season (including a plant from the Edkins Range cultivated at Beverley Springs Station Homestead).

Common name: White butterfly orchid.

Dendrobium foelschei F.Muell., *S. Sci. Rec*. 2: 230 (1882); *Dendrobium canaliculatum* var. *foelschei* (F.Muell.) Rupp & Hunt, *Proc. Linn. Soc. New S. Wales* 72: 240 (1948); *Callista foelschei* (F.Muell.) Kuntze, *Revis Gen. Pl*. 2: 654 (1891); *Cepobaculum foelschei* (F.Muell.) M.A.Clem. & D.L.Jones, *The Orchadian* 13: 486 (2002); D.L.Jones, *Compl. Guide Austr. Orchids* 381, pl. (2006). *Type*: Northern Territory: Near Port Darwin; Sept. 1882, *P.Foelsche* (holo: MEL 93793; iso: AD 96945320, K 001085448, MEL 93794, W (Reichenbach Herb. Orchid. No. 40224)).

Illustration: D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 672 pl. (2021), as '*Durabaculum foelschei* (ined.)'.

Erect *epiphytic* herb; stems in small tufts, pseudobulbous *c*. 20–80 mm long, 5–10 mm wide, slender fusiform, those newly formed covered in sheathing bracts that gradually disintegrate as they get older exposing shallowly sulcate bare surface. *Leaves* 2–6, canaliculate, carnose, semi-cylindrical or tapered slightly from the base to the apex, acute or acuminate, lamina 40–170 long, 3–6 mm wide. *Inflorescence* of 1–6 racemes arising from terminal and subterminal nodes, *c*. 80–300 mm long, axis 1–2 mm wide, the peduncle equal to or shorter than the rachis; rachis bearing from 2–20 flowers; pedicels 10–25 mm long, 0.3–0.5 mm wide. *Flowers* 12–35 mm across, patent, porrect, often not opening widely, fragrant, tepals generally twisted to a variable extent, white, cream in the basal half, pale yellow or pale brown in apical half; labellum white or cream, pale yellow or green in basal half, rich pink-purple in apical half. *Dorsal sepal* 9–17 mm long, 1.5–2.5 mm wide, oblong-linear, acute, slightly broader in basal half. *Lateral sepals* similar to dorsal sepal in size and length but also obliquely falcate. *Petals* spreading, slightly longer than the dorsal sepal, 13–23 mm long, 2–2.5 mm wide, narrowly oblong-spatulate with an acute almost obtuse apex. *Labellum* stiffly attached to the apex of the column foot, markedly dissimilar in size and shape to the sepals and petals, calcarate, lamina narrowly triangular, fleshy, strongly trilobed; lateral lobes prominent, obliquely triangular, erect, entire with obtuse apices, incurved embracing the column; midlobe porrect or slightly decurved, narrowly to broadly rhombic or elliptical with distinct narrow base and apiculate or acuminate apex, 9–13 mm long, 4.5–6 mm wide when flattened; calli consisting of 3 narrow parallel ridges, extending along the midlobe for about three-quarters of its length, becoming enlarged, prominent, lamellate, crested and irregular on the midlobe. *Column* 3–4 mm long, fleshy, nearly straight, with highly reduced ventral tooth-like apical stelidia. *Column* foot well developed, similar in length to column, straight or slightly curved, 3–4 mm long, narrowing towards base. *Stigma* entire ovate, concave. *Rostellum* ventral, swollen transverse. *Anther* terminal, incumbent, 2-celled, persistent, attached dorsally by a ligulate claw, smooth, erostrate or with a short rostrum, apex papillate. *Pollinia* 4 in 2 subequal, pairs, obovoid to falcate, yellow, hard waxy.

Selected specimens examined: NORTHERN TERRITORY: Magela Creek, near Island Billabong, 12 Feb. 1984, *I.D.Cowie 181* (DNA); Melville Island; 15 km S of Snake Bay, 31 Jan. 1984, *D.L.Jones 1334* (DNA); Arnhem Land, 8km NE of Maningrida, 17 June 1987, *G.M.Wightman 3863* (DNA). QUEENSLAND: cultivated [ex 4 km S of Elliot Falls], 15 Oct. 1996, *E.Lielkajis ORG327* (CANB).

Distribution: Scattered across the top-end of the northern Territory and disjunct populations near the tip of Cape York in far north Queensland. The single historical population recorded from Western Australia is no longer extant.

Conservation status: Relatively widespread within its range and not considered threatened.

Ecology: Epiphytic on a variety of hosts, particularly *Melaleuca* species and *Barringtonia acutangula*.

Phenology: Flowers July to September.

Affinities: Similar to *D. canaliculatum* R.Br. but the leaf-bearing axes not as swollen and the axes are generally longer in *D. foelschei*; leaves are very slender, almost terete; sepals are slightly narrower and more sharply acute than those of *D. canaliculatum*; petals narrowly oblong-spatulate with a distinctly apiculate or acuminate midlobe with a narrow base.

Notes: *Dendrobium foelschei* has been reported to occur in the north Kimberley region based on living material collected by the late W.H. Butler and cultivated in a glasshouse at the Western Australian Herbarium by A.P. Brown who confirmed the identification when the plant flowered. Unfortunately, no voucher is known to have been made before the plant died, and there are no other records for Western Australia. It seems reasonable to accept the origin of the plant as both A.P. Brown and K.W. Dixon discussed this directly with W.H. Butler and the site was subsequently visited and found to be consistent with verbal descriptions, but a hot fire had recently scorched all canopies in the area and no trace of the species could be found (K.W. Dixon pers. comm.). This record was referred to as *D. canaliculatum* in Wilson (1992). It is not known whether the species still persists in the Kimberley.

Common name: Thin tea tree orchid.

***Dendrobium* species**

Gardner (1923) noted a purple flowered *Dendrobium* sp. observed on *Eucalyptus houseana* in the vicinity of the Prince Regent River. However, no collections were made and the identity remains unknown. The flowers were described as being large and conspicuous. Gardner considered the plant he saw to be distinct from *D. dicuphum* and from *Cymbidium canaliculatum*, which were observed on the same expedition in 1919.

Didymoplexis Griff., *Calcutta J. Nat. Hist*. 4: 383, t. 17 (1843). *Type*: *D. pallens* Griff.

Notes: *Didymoplexis* has been considered to be a fairly small genus of about ten species (Hemsley 1884; Lavarack 1977; Hsu & Chung 2007; Cribb *et al*. 2013; Zhou *et al*. 2016; Gray 2017), but additional taxa have come to light in recent years and it is likely that more will be discovered as they are easily overlooked (Ormerod 2000; Cribb *et al*. 2013; Suddee 2014; Suetsugu *et al*. 2017; Suetsugu & Hsu 2019). It has also been suggested that the circumscription should include *Didymoplexiella* Garay (see Averyanov 2010; Suetsugu & Hsu 2019).

Didymoplexis pallens Griff., *Calcutta J. Nat. Hist*. 4: 383, t. 17 (1843); *Epiphanes pallens* (Griff.) Rchb.f. in Seeman, *Fl. Vit*. 296 (1868); *Gastrodia pallens* (Griff.) F.Muell., *Contr. Phytogr. New Hebrides* 22 (1870). *Type*: India: near bamboo clumps, Serampor, Calcutta, *W.Griffith s.n.* (type: CAL, *n.v*. (possibly lost); icon t. 17).

Leucorchis sylvatica Blume, *Mus. Bot*. 1: 31 (1849); *Didymoplexis sylvatica* (Blume) Ridl., *J. Bot*. 345 (1884). *Type*: Indonesia: Bantam Province, Island of Java, Harriang, *T.Horsfield s.n*. (holo: *n.v*.; iso: BM 000061576).

Apetalum minutum Wight, *Icon. Pl. Ind. Or*. 5: 22, t. 1758 (1851). *Type*: India: Near Sultan's Battery in Coorg, under a clump of Bamboos, *T.Jerdon ex R.Wight s.n.* (holo: K; iso: K).

Arethusa ecristata Griff. in McClell., *Not. Pl. Asia* 5(3): 378-379 (1851). *Type*: (icon t. 343, *Icon. Pl. Asia*. (1847). *Note*: Major components of this plate are taken from Griffith's earlier published illustration of *D. pallens.*

?*Pogonia pachystomoides* F.Muell., *Fragm*. 8: 174 (1874); *Nervilia pachystomoides* (F.Muell.) Schltr., *Bot. Jahrb. Syst*. 45: 404 (1911); *Didymoplexis pachystomoides* (F.Muell.) Garay & W.Kittr., *Bot. Mus. Leafl*. 30(3): 48, 182 (1986). *Type*: Queensland: Ad sinum Rockingham's Bay, *W.Hill* 307 (holo: MEL 677521!).

Arethusa bengalensis Hort. ex Hemsley, *J. Proc. Linn. Soc. Bot*. 20: 311 (1884), *pro syn*.

Cheirostylis kanarensis Blatter & McCann, *J. Bombay Nat. Hist. Soc*. 35: 732–733, fig. 4 (1932). *Type*: Bombay: N. Kanara: Tatwal, June 1912, *T.R.Bell s.n*. (holo: *n.v*.).

Illustrations: Hemsley, *J. Proc. Linn. Soc. Bot*. 20: 308, pl. 28 (1884); King & Pantl., *Ann. Roy. Bot. Gard*. (*Calcutta*) 8: 260, pl. 364 (1898); J.J.Sm., *Orchid Java Fig. Atlas* 1 fig. 51 (1908); Lavarack, *Austrobaileya* 1(1): 63 fig. 2a (1977); Lavarack, *The Orchadian* 5(11): 159, fig. 1 (1978); Lavarack & B.Gray, *Trop. Orchids Austral.* 96, pl. 51 (1985); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimberley Region* 1008, fig. 303c (1992); Dockr., *Austral. Indig. Orchids* 1 (edn. 2): 255, pl. p. 256 (1992); D.L.Jones, *Compl. Guide Austral. Orchids* 368, fig., pl. (2006); A.P.Brown *et al*., *Orchids West. Austral*., pls p. 372, 375 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austral*., pls p. 475, 486, 487 (2013); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 634, 635, pl., fig. (2021).

Leafless, achlorophyllous *mycoheterotroph*, 80–300 mm high at anthesis; stem white or reddish, with a few small, scarious bracts, arising from stem tubers up to 100 mm long. *Inflorescence* a raceme bearing 5–15 flowers. *Flowers* 7–14 mm long, glistening white with a yellow spot at the base of the labellum, short-lived, usually only 1 open at any time, erect; bracts triangular, *c*. 4 mm long; pedicels orange, up to 5 mm long at anthesis, elongating to 40–200 mm long in fruit. *Dorsal sepal c*. 10 mm long, adnate to the petals for *c*. half its length. *Lateral sepals* connate for *c*. half their length and adnate to the petals for a short distance, 6–7 mm long, obtuse. *Petals* 6–7 mm long, obtuse. *Labellum* variable in shape, usually 2-lobed and 4–7 mm long, *c*. 10 mm wide when flattened out, with a longitudinal row of calli almost the entire length of labellum and *c*. 2 mm wide. *Column* 4–6 mm long, curved, dilated laterally towards the apex to form broad wings which terminate as teeth below the anther, foot curved, 2–3 mm long. *Anther c*. 1.5 mm diameter; pollinia with a thick retinaculum. *Stigma* rectangular. *Capsule* orange, finely ribbed, 13–16 mm long, 3.6–4.3 mm wide. (Figure 9).

Specimens examined: WESTERN AUSTRALIA: Gwen's Gorge, off S arm of Bachsten Creek, Edkins Range, 6 Dec. 1994, *R.L.Barrett* & *M.D.Barrett RLB 948* (PERTH); Edkins Range, 62 km N of Beverley Springs Station Homestead, 26 Dec. 1995, *R.L.Barrett* & *M.D.Barrett RLB 633* (PERTH); *loc. cit*., 8 Jan. 2001, *R.L.Barrett* & *K.W.Dixon RLB 1644* (PERTH). NORTHERN TERRITORY: Douglas-Daly Experimental Farm, 5 Dec. 1988, *J.Russell-Smith 6489* (DNA); 19 km N of Mirrngadja, Arnhem Land, 5 Nov. 1987, *C.R.Dunlop & G.J.Leach 1551* (DNA). QUEENSLAND: W of Cairns, 2004, *B.Gray 8888* (CANB); Dauan Island, 1989, *D.L.Jones 3660* (CBG).

Fig. 9. *Didymoplexis pallens*. A. Flowering plant post-fire. B. Fruiting plant on edge of burnt area. C. Whole plant including root system. D–F. Flower. Voucher: *R.L.Barrett & K.W.Dixon RLB 1644* (PERTH). Photos by R.L. Barrett.

Distribution: Scattered in Australia, in the North Kimberley of Western Australia, the 'top end' of the Northern Territory and north Queensland. Widespread outside Australia, including Afghanistan, China, Japan, Taiwan, Assam, Bangladesh, India, Nepal, Myanmar, Thailand, Vietnam, Malaysia, Indonesia, Christmas Island, Papua New Guinea, Vanuatu and New Caledonia.

Conservation Status: This species is very restricted in its habitat in Western Australia, and is possibly under threat from frequent burning at all known locations, since fire is removing critical humus layers required for the survival of tuberoids over the dry season. Listed as Priority One for Western Australian flora (Florabase 1998 onwards). Listed as Data Deficient in the Northern Territory (Franklin & Kerrigan 2005; Woinarski *et al*. 2007).

Ecology: Occurs in dense closed grassland on peaty soils in association with *Banksia dentata*, *Byblis liniflora*, *Calochilus barbarossa*, *C. kimberleyensis, Clitoria australis*, *Empusa habenarina, Drosera paradoxa*, *Eucalyptus apodophylla*, *E. houseana*, *E. alba*, *Eulophia bicallosa*, *Haemodorum flaviflorum*, *Hypoxis nervosa, Lindernia plantaginea, Empusa habenarina*, *Ludwigia octovalvis*, *Melaleuca viridiflora*, *Pandanus spiralis* var. *spiralis, Pecteilis eurystoma*, *Stylidium pachyrrhizum, Utricularia uliginosa* and *Xyris complanata*.

Phenology: Flowers and fruits December–January.

Affinities: Only two species of *Didymoplexis* are known from Australia. *Didymoplexis micradenia* (Rchb.f.) Hemsl. differs in having pinkish-white flowers, a short column foot *c*. 1 mm long, and a finely toothed labellum apex (Gray 2017).

Notes: Hundreds of plants were observed in a single population following fire on one occasion. *Didymoplexis* is reliant on fungal species associated with Poaceae. It is not known whether fire stimulates mass-flowering or if this simply made the plants easier to locate. A return visit to the site three years post-fire found only a few plants, though this was toward the end of the flowering season. It is interesting to note that the Kimberley populations may be the only ones known that are not in direct association with a member of Poaceae subfam. Bambusioideae, growing instead with *Arundinella nepalensis*, *Germainia truncatiglumis* and *Mnesithea rottboellioides*, but any specific associations remain uncertain.

A number of new *Didymoplexis* taxa have been described from Asia in recent years (Averyanov *et al*. 2019; Suetsugu *et al*. 2017; Suetsugu 2019) and further research is required to confirm that the correct name is being applied to the material collected in northern Australia and the status of those species listed as synonyms are conspecific. Comparative study of the types and protologues listed above, including illustrations, suggests that more than one species is included under this concept.

Common names: Potato orchid, Crystal bells.

Dipodium R.Br., *Prodr*. 330 (1810). *Type*: *Dendrobium punctatum* Sm. (= *Dipodium punctatum* (Sm.) R.Br.).

Note: *Dipodium* is phylogenetically related to *Cymbidium*, and is of interest for containing both climbing leafy species and saprophytic species (O'Byrne 2014).

Dipodium ammolithum M.D.Barrett, R.L.Barrett & K.W.Dixon, *sp. nov*.

Type: Western Australia: Edkins Range, 76 km N of Beverley Springs Station Homestead, 16°02'S, 125°23'30"E, 28 December 1995, *R.L.Barrett* & *M.D.Barrett RLB 688* (holo: PERTH 08042101; iso: CANB, DNA, K).

Dipodium sp. Sandstone (R.L. Barrett & K.W. Dixon RLB 1642), Western Australian Herbarium. (1998–). FloraBase – The Western Australian Flora. Department of Environment and Conservation. http://florabase.dpaw.wa.gov.au/ [accessed 14 August 2012].

Illustrations: A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 376, 381 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 472, 475, 488, 489 (2013).

Terrestrial, erect, saprophytic, leafless *herb* with short subterranean *rhizome* covered with imbricate bracts, with an extensive system of thick carnose roots; branches of the rhizome covered with imbricate bracts and terminating in an inflorescence up to 140 cm tall, although generally 50–70 cm tall; *peduncle* longer than or about equal to the rachis, *c*. 3 mm diam. at base of inflorescence, 1.5–2 mm diam. at apex of inflorescence, mostly vinaceous, to pink, purplish brown or dark mauve, straw-coloured in patches, furnished with four to nine sheathing *bracts* 9–17 mm long; *rachis* often completely dark pinkish purple (not flecked or streaked), bearing 15–45 usually well-spread flowers; *floral bracts* small, shortly sheathing, 4.0–5.7 mm long, 0.9–1.2 mm wide; *pedicels* 13–15 mm long in flower, slender, twisted; *ovaries* 6.5–8.7 mm long, 0.7–1.1 mm wide, ribbed, purple, usually slightly curved. *Flowers* erect or pendant, 18–24 mm diam., patent, held at 15–45° to horizontal; *tepals* somewhat recurved, adaxially uniform pale pink with the only markings a slightly darker pink midline and veins, abaxially very faintly speckled. *Dorsal sepal* 12.5–16.4(–20.3) mm long, 1.0–2.5(–3.2) mm wide, *c*. narrowly oblong obovate, obtuse. *Lateral sepals* 11.1–18.2(–20.9) mm long, 1.6–2.6(–2.9) mm wide, narrowly oblong-elliptical to oblong obovate, obtuse, slightly falcate. *Petals* 13.1–18.0(–27.6) mm long, 1.4–1.8(–3.2) mm wide, narrow falcate-oblong, bluntly acute. *Labellum* porrect, slightly upcurved in the distal half, 3-lobed, 7.8–12.6 mm long, 3.1–4.5 mm wide, dark pink; lateral lobes pink, projected forwards, not out-curved when fresh, sometimes spreading when dry, equal to or slightly longer than column, 2.3–3.0 mm long, 0.7–0.8 mm wide, *c*. narrowly oblong, pubescent towards the base; midlobe 7.3–9.0 mm long, 2.6–3.1 mm wide, narrow rhomboid to narrow elliptical, more or less acute, furnished from about three quarters to the apex with a central band (for 3–4.5 mm), which is broadest at the distal end, of hairs which are more or less tangled, 0.4–0.6 mm long and purplish, minutely papillose (papillae *c*. 0.05 mm long) over most of length; *disc* furnished with two sublinear pubescent keels 5.3–8.0 mm long, 0.5–0.7 mm wide which generally diverge at the distal end. *Column* closely parallel to the labellum, 5.8–8.1 mm long, 1.6–2.4 mm wide, dilated in the distal half and narrowly winged at the apex, anterior surface below the middle furnished with a pink pubescent patch; apical margin of column sinuate or incised. *Stigma c*. 1.0 mm diam., depressed ovate to semicircular. *Anther* cap 1.8–2.1 mm long, 0.9–1.4 mm wide, rostrum decurved, large, apex projecting. *Pollinarium* 1.2–1.4 mm long; retinaculum *c*. 0.8 mm long, ovate; stipes *c*. 1.0 mm long; pollinia *c*. 0.6 mm long, obovoid, dark yellow. *Capsule* 14–16 mm long, 7–10 mm wide, prominently ribbed, sometimes cream, usually pale to dark pink or purple. (Figure 10)

Fig. 10. *Dipodium ammolithum*. A. Habit. B, C. Inflorescence. D. Infructescence. E–G. Flower. H. Close-up of labellum from above. I. Close-up of column and labellum base. J. Fruit. Vouchers: A: *R.L.Barrett & M.O'Connor RLB 1572* (PERTH); B–E: *R.L.Barrett* & *M.D.Barrett RLB 1726* (PERTH); F: *M.D.Barrett 1371* (PERTH); G–J: *R.L.Barrett* & *M.D.Barrett RLB 3922* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Diagnostic characters: Similar to *D. basalticum* and *D. stenocheilum*, differing from both in lacking any tepal markings (except sometimes faintly pigmented veins), and habitat on broken sandstone.

Specimens examined: WESTERN AUSTRALIA: 2.6 km NW of Mt Hann, Mt Hann, near Prince Regent Reserve, 26 Jan. 2000, *M.D.Barrett 912* (PERTH); 6 km ENE of junction of Pitta Creek and Prince Regent River, 29 Jan. 2000, *M.D.Barrett 955* (PERTH); 10 km ESE of Mt Agnes near watershed of Drysdale and Prince Regent Rivers, NW Kimberley, 21 Jan. 2003, *M.D.Barrett 1371* (PERTH); Theda Station, 13 Jan. 2016, *M.D.Barrett MDB 4910* (PERTH); Edkins Ra., 81 km NNW of Beverley Springs Stn Hstd, 28 Dec. 1995, *R.L.Barrett* & *M.D.Barrett RLB 663* (PERTH); Edkins Ra., 76 km N of Beverley Springs Stn Hstd, 9 Jan. 1995, *R.L.Barrett* & *M.D.Barrett RLB 967* (PERTH); *c.* 8.5 km NE of Mount Agnes, 6 Jan. 2001, *R.L.Barrett & M.O'Connor RLB 1572* (PERTH); near prospecting camp, *c.* 2 km SW of Mount Fyfe, 6 Jan. 2001, *K.W.Dixon per R.L.Barrett 1642* (CANB, PERTH); 6.5 km NE of junction of Pitta Creek and Prince Regent River, W of Reserve boundary, 10 Jan. 2001, *R.L.Barrett 1719* (PERTH); 1 km S of Mount Fyfe, 11 Jan. 2001, *R.L.Barrett* & *M.D.Barrett RLB 1726* (PERTH); Theda Station, *c.* 3 km SE of homestead, on sandstone ridge behind rubbish dump, 23 Feb. 2006, *R.L.Barrett* & *M.D.Barrett RLB 3288* (PERTH); Large gully, 10.8 km NE of junction of Youwanjela Creek and Prince Regent River, Prince Regent Nature Reserve, 20 Jan. 2007, *R.L.Barrett* & *M.D.Barrett RLB*

3666 (PERTH); 'Shrimp Creek' (informal name), 11.7 km S of Kings Cascades, Prince Regent River Reserve, 22 Jan. 2007, *R.L.Barrett* & *M.D.Barrett RLB 3719* (PERTH); Gwens Gorge south arm, NE of Bachsten Creek Bush Camp, southern boundary of Prince Regent Nature Reserve, 24 Jan. 2007, *R.L.Barrett* & *M.D.Barrett RLB 3810* (PERTH); 'Acacia Flat' (informal name), Princess May Ranges, 21.6 km due N of Kings Cascades, Prince Regent Nature Reserve, 25 Jan. 2007, *R.L.Barrett* & *M.D.Barrett RLB 3922* (PERTH); 'Leptospermum falls' (informal name) pavement 2, E of Prince Regent Nature Reserve boundary, 16 Jan. 2010, *R.L.Barrett, M.D.Barrett & M.Maier RLB 6103* (PERTH); Sandstone pavement E of Mount Brookes, Prince Regent Nature Reserve, 19 Jan. 2010, *R.L.Barrett, M.Maier & P.Kendrick RLB 6265* (PERTH); side arm of Pitta Gorge, Prince Regent Nature Reserve, 23 Jan. 2010, *R.L.Barrett, P.Kendrick & G.Sparkes RLB 6358* (PERTH).

Distribution: Apparently endemic to the sandstone ranges of the north-west Kimberley, from the Edkins Range, north to Theda Station.

Etymology: From the Greek *ammo-* (sand) and *lithos* (stone) in reference to the particular habitat of this species.

Conservation status: This species is common within its limited range and is well represented in the Prince Regent National Park. It is not currently under threat.

Ecology: Occurs in deep leaf litter on sandstone scree or outcrops, often with *Brachychiton viscidulus*, *Ficus* spp., *Gardenia* spp., *Planchonella pohlmaniana* and *Planchonia rupestris* over *Triodia* spp. Occasionally in vine thicket over sandstone with *Blechnum indicum*, *Dioscorea bulbifera*, *Ficus brachypoda, F. racemosa*, *Pavetta kimberleyana*, *Strychnos lucida*, *Syzygium angophoroides, Xanthostemon paradoxus*. Direct sequencing of the Internal Transcribed Spacer (ITS) region from two central tissue samples of root tubers from a specimen of this species from Theda Station (*M.D. Barrett MDB 4910*, PERTH) returned two identical sequences of a *Lactifluus* (Pers.) Roussel (Russulaceae; GenBank record ON819578). This suggests that the primary endophytes of *Dipodium ammolithum* are Russulaceae, in agreement with previous findings (Bougoure & Dearnaley 2005; Dearnaley & Le Brocque 2006; Boddington *et al*. 2016). A third tuber tissue sample (GenBank ON819579) sequenced from this same *Dipodium* specimen belonged to the genus *Clitopilus* (Entolomataceae; e.g 97.4% BLAST match to *Clitopilus prunulus* EU273512). Species of *Clitopilus* are usually considered saprophytes, but *C. hobsonii* (Berk.) P.D.Orton has recently been recorded as a root symbiont of *Liquidambar* (Peng *et al*., 2021). The presence of *Clitopilus* in this *Dipodium* sample is most likely incidental, but the possibility of a symbiotic interaction cannot be excluded.

Phenology: Flowers and fruits December–January.

Common name: Sandstone hyacinth orchid.

Dipodium basalticum M.D.Barrett, R.L.Barrett & K.W.Dixon, *sp. nov*.

Type: Southern tributary of the Roe River, NNW of Mount Fyfe, Western Australia, 11 January 2001, *K.W.Dixon* per *R.L.Barrett RLB 1766* (holo: PERTH 08042136).

Dipodium stenocheilum auct. non O.Schwarz: D.L.Jones, *Native Orchids Austr.* 406 (1988), *p.p*. as to Kimberley; A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg.* 1008, fig. 303d (1992); Dockr., *Austr. Indig. Orchids* (edn. 2): 2: 834 (1992), *p.p*. as to Kimberley.

Dipodium sp. Basalt Woodland (M.D. Barrett 198), Western Australian Herbarium. (1998–). FloraBase – The Western Australian Flora. Department of Environment and Conservation. http://florabase.dpaw.wa.gov.au/ [accessed 14 August 2012].

Illustrations: A.P.Brown *et al*., *Orchids West. Austr.*, pl. p. 379 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 489 (2013).

Terrestrial, erect, saprophytic, leafless *herb* with short subterranean *rhizome* covered with imbricate bracts, with an extensive system of thick carnose roots; branches of the rhizome covered with imbricate bracts and terminating in an inflorescence up to 120 cm, although generally 70–90 cm tall; *peduncle* longer than or about equal to the rachis, 6–8(–9.5) mm diam. at base of inflorescence, 0.8–1.2 mm diam. at apex of inflorescence, generally pale cream to purple, furnished with four to six sheathing *bracts* 1–2 cm long; *rachis* often suffused with pinkish purple, bearing 35–70 rather crowded flowers; *floral bracts* small, sheathing, 6–8.5 mm long, 1 mm wide; *pedicels* 12–16 mm long in flower, slender, twisted; *ovaries* 5.5–7.5 mm long, 1–1.5 mm wide, ribbed, cream, straight to slightly curved. *Flowers* erect (rarely slightly pendant), 24–30 mm diam., patent, usually held at 15–45° to horizontal; *tepals* somewhat recurved, adaxially generally pale pink to white, usually with some small flecks and stripes of a darker shade, abaxially darker pink with scattered flecks of a darker shade, more prominent at the distal end. *Dorsal sepal* 11.2–14.8 mm long, 2.2–3.2 mm wide, *c*. narrowly oblong obovate, bluntly acute. *Lateral sepals* 11–18 mm long, 2.3–3.0 mm wide, narrowly oblong-elliptical to oblong obovate,

bluntly acute, sometimes slightly falcate. *Petals* 12.2–15.8 mm long, 2.4–2.8 mm wide, narrow falcate-oblong, bluntly acute. *Labellum* porrect, slightly upcurved in the distal half, 3-lobed, 12.3–20.5 mm long, 2.9–5.7 mm wide, pale to dark pink; lateral lobes lighter in colour than the midlobe, projected forwards, not out-curved when fresh, often spreading when dry, equal to or slightly longer than column, 3.4–3.8 mm long, 0.7–0.8 mm wide, *c*. narrowly oblong, pubescent towards the base; midlobe 10–13 mm long, 2.4–3.0 mm wide, narrow rhomboid to narrow elliptical, more or less acute, furnished from about two thirds to the apex with a central band, which is broadest at the distal end, of hairs which are more or less tangled, 0.2–0.4 mm long and generally mauve, with another patch of dense hairs at the base of the lobes; *disc* furnished with two sublinear pubescent keels 5.2–8.6 mm long, 0.6–0.9 mm wide which generally diverge at the distal end. *Column* closely parallel to the labellum, 6.2–6.9 mm long, 1.3–1.8 mm wide, dilated in the distal half and narrowly winged at the apex, anterior surface below the middle furnished with a pink pubescent patch; apical margin of column sinuate or incised. *Stigma c*. 1.1 mm diam., depressed ovate to semicircular. *Anther* cap 1.3–1.5 mm long, 0.6–0.7 mm wide, rostrum decurved, small, apex projecting. *Pollinarium* 1.5–1.8 mm long; retinaculum *c*. 0.8 mm long, ovate; stipes *c*. 1.1 mm long; pollinia *c*. 0.7 mm long, obovoid, dark yellow. *Capsule* 11–15 mm long, 6–7 mm wide, prominently ribbed, cream to mauve or pale pink. (Figure 11)

Fig. 11. *Dipodium basalticum*. A–C. Habit. D. Inflorescence. E. Unidentified scoliid wasp pollinating flower. F–I. Flowers. J. Close-up of column and labellum base. K. close-up of labellum apex and column apex. Vouchers: A, D, I, J: *R.L.Barrett & M.D.Barrett RLB 748* (PERTH), B, C, E–I: not vouchered, from near Charnley River Station homestead. Photos by R.L. Barrett & M.D. Barrett (A, D, J, K); R. Maher (B, C, E–I).

Diagnostic characters: Allied to *D. stenocheilum*, differing in the smaller flowers with flecks and stripes and robust stem. Similar in appearance to *D. elegantulum*, differing in the tepals having obtuse rather than acute apices and a narrower (narrow rhomboid to narrow elliptical), more or less acute labellum.

Specimens examined: WESTERN AUSTRALIA: 0.5 km ESE of Beverley Springs Stn Hstd, 10 Feb. 1993, *M.D.Barrett 198* (PERTH); 0.5 km ESE of Beverley Springs Station Homestead, 16°43'10"S, 125°27'40"E, 29 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 748* (CANB, DNA, K, PERTH (2 sheets)); Airfield swamp, 4 km N of mining campsite, Mitchell Plateau N Kimberley, 7 Dec. 1982, *K.F.Kenneally 8663* (PERTH); Mitchell Plateau mining camp, 10 Dec. 1978, *J.Smith s.n.* (PERTH).

Distribution: Endemic to the Kimberley, first discovered on the Mitchell Plateau, and now known to be widely distributed from Theda and King Edward River Stations south to Beverley Springs (Charnley River) Station, but rarely seen and number of populations is difficult to assess. Known populations range from 5–50 plants.

Conservation status: Relatively poorly known, but difficult to locate, and given the range of distribution, probably more common than current collections indicate. Conservation Codes for Western Australian Flora: Priority 3 recommended.

Ecology: Occurs in open Eucalypt woodland dominated by *Eucalyptus tetrodonta* with *Erythrophleum* aff. *chlorostachys*, *Planchonia careya*, *Sorghum* sp. and *Terminalia canescens*.

Phenology: Flowering and fruiting December–February.

Etymology: The name is derived from the basalt-derived substrates the species grows on.

Notes: Previously confused with *D. stenocheilum* O.Schwarz. Differs from *D. elegantulum* in that the column hairs are restricted to the apical half of the column, not scattered along the entire length. Table 6 presents key data to distinguish the two Kimberley species from the two most morphologically similar species.

Common name: Flecked hyacinth orchid.

Table 6. Comparison of distinguishing morphological characters for *Dipodium ammolithum*, *D. stenocheilum*, *D. basalticum* and *D. elegantulum*.

	D. ammolithum	*D. stenocheilum s.l.*	*D. basalticum*	*D. elegantulum*
Stems	uniformly cream to purple vinaceous, to pink, purplish brown or dark mauve, straw-coloured in patches, dark pinkish purple (not flecked or streaked)	uniformly greenish or cream to pale pink (not flecked or streaked)	pale cream to purple, often suffused and flecked or streaked with pinkish purple	creamy white to greenish or sometimes dark pinkish purple (not flecked or streaked)
Tepals	adaxially uniform pale pink with the only markings a slightly darker pink midline and veins, abaxially very faintly speckled	white or pale pink to dark pink with darker small spots and striae outside, lighter pink inside with a few scattered spots	adaxially generally pale pink to white, usually with some small flecks and stripes of a darker shade, abaxially darker pink with scattered flecks of a darker shade, more prominent at the distal end	pale pink to dark pink with darker small spots and striae outside, lighter pink inside with a few large spots near the apex of the tepals
Dorsal sepal	12.5–16.4(–20.3) mm long, 1.0–2.5(–3.2) mm wide	20–22.5 mm long, 4.5–5.0 mm wide	11.2–14.8 mm long, 2.2–3.2 mm wide	(14–)15.5–23 mm long, (3.0–)4.0–6.0 mm wide
Lateral sepals	*Lateral sepals* 11.1–18.2(–20.9) mm long, 1.6–2.6(–2.9) mm wide	19.5–22.3 mm long, 4.3–4.8 mm wide	11–18 mm long, 2.3–3.0 mm wide	(15.0–)16.3–26 mm long, (2.5–)4.3–6.0 mm wide
Lateral petals	13.1–18.0(–27.6) mm long, 1.4–1.8(–3.2) mm wide	19.3–20.2 mm long, 3.8–5.2 mm wide	12.2–15.8 mm long, 2.4–2.8 mm wide	(13–)15.5–24 mm long, (2.5–)3.8–5.6 mm wide
Labellum	slightly incurved in the distal half, 7.8–12.6 mm long, 3.1–4.5 mm wide, dark pink	strongly recurved, appearing much narrower than it is: 17.8–18.2 mm long, 7.3–7.7 mm wide, dark pink	slightly incurved in the distal half, 12.3–20.5 mm long, 2.9–5 .7 mm wide, pale to dark pink	slightly incurved in the distal half, (14–)16.0–22.8 mm long, (4–)5.2–7.3 mm wide, dark pink
Labellum lateral lobes	pink, projected forwards, not out-curved when fresh, sometimes spreading when dry, equal to or slightly longer than column, 2.3–3.0 mm long, 0.7–0.8 mm wide, *c.* narrowly oblong	projected forwards, not out-curved when fresh, 3.2–3.8 mm long, oblong with rounded apex	lighter in colour than the midlobe, projected forwards, not out-curved when fresh, often spreading when dry, equal to or slightly longer than column, 3.4–3.8 mm long, 0.7–0.8 mm wide, *c.* narrowly oblong	projected forwards, upcurved when fresh, distinctly longer than column, 3.7–3.9(–6.0) mm long, 1.3–1.5(–2.0) mm wide, linear-spathulate

	D. ammolithum	*D. stenocheilum s.l.*	*D. basalticum*	*D. elegantulum*
Labellum midlobe	7.3–9.0 mm long, 2.6–3.1 mm wide, narrow rhomboid to narrow elliptical, more or less acute, furnished from about three quarters to the apex with a central band (for 3–4.5 mm), which is broadest at the distal end, of hairs which are more or less tangled, 0.4–0.6 mm long and purplish, minutely papillose (papillae *c*. 0.05 mm long) over most of length	*c*. 6–7 mm long, *c*. 4 mm wide, hairy along midline, held diagonally forward at *c*. 60° to margin, elsewhere glabrous or a few hairs near column along midline; longest hairs 0.6–0.8 mm long; also hairy in throat for last 4–5 mm	10–13 mm long, 2.4–3.0 mm wide, furnished from about two thirds to the apex with a central band, which is broadest at the distal end, of hairs which are more or less tangled, 0.2–0.4 mm long and generally mauve, with another patch of dense hairs at the base of the lobes	8.0–10.0 mm long, 4.0–5.0 mm wide, hairs on labellum in a band along central part with weak ridges, hairs sparse over middle portion between larger hairs and bumps, dense behind and around bumps, hairs extending onto lower margins of lateral lobes
Column	closely parallel to the labellum, 5.8–8.1 mm long, 1.6–2.4 mm wide, dilated in the distal half and narrowly winged at the apex, anterior surface below the middle furnished with a pink pubescent patch; apical margin of column sinuate or incised	closely parallel to the labellum, 8.1–9.5 mm long, 3.4–4.2 mm wide, dilated in the distal half and narrowly winged at the apex	closely parallel to the labellum, 6.2–6.9 mm long, 1.3–1.8 mm wide, dilated in the distal half and narrowly winged at the apex, anterior surface below the middle furnished with a pink pubescent patch; apical margin of column sinuate or incised	closely parallel to the labellum, 7.4–10.0 mm long, 3.3–3.3 mm wide, dilated in the distal half and narrowly winged at the apex, anterior surface below the middle furnished with a pink pubescent patch; apical margin of column with a few crenations
Disc [throat]	furnished with two sublinear pubescent keels 5.3–8.0 mm long, 0.5–0.7 mm wide which generally diverge at the distal end	furnished with two sublinear pubescent keels *c*. 1.2 mm long, firmly attached, only existing as raised ridges, or tips free for *c*. 0.35 mm	furnished with two sublinear pubescent keels 5.2–8.6 mm long, 0.6–0.9 mm wide which generally diverge at the distal end	furnished with two sublinear pubescent keels *c*. 7 mm long, *c*. 1 mm wide, firmly attached, only existing as raised ridges
Pollinia	*c*. 0.6 mm long, obovoid	not examined	*c*. 0.7 mm long, obovoid	0.8–1.0 mm long, obovoid
Vouchers	See specimens cited	*Cowie 8016* (DNA D136624)	See specimens cited	*B.Gray* 4940 (CNS); *Maslin* (CNS 12717)

Empusa Lindl., *Bot. Reg.* 10: sub t. 825 (1824). *Type*: *E. paradoxa* Lindl.

Notes: We here use Lindley's generic name *Empusa* as the definition of *Liparis* Rich. remains problematic. That genus has been widely demonstrated to be paraphyletic (Cameron 2005; Pridgeon *et al*. 2005; Tsutsumi *et al*. 2007; Li *et al*. 2013, 2020; Su *et al*. 2015; Tang *et al.* 2015; Kumar *et al*. 2022). Cameron (2005) in the first molecular phylogenetic analysis of Malaxideae demonstrated that the traditional interpretations of *Liparis* and *Malaxis* Sol. ex Sw. are both polyphyletic assemblages. While global sampling still has many gaps, it is clear that taxa currently included in *Liparis s. lat*. (sensu Ridley 1886), including in Australia, belong in multiple segregate genera (as proposed by Margońska & Szlachetko 2001, 2004; Margońska 2006; Li *et al*. 2020), though some authors still advocate for broad concepts of varying circumscription (Smith 1909; Blaxell 1978; Gray 1992; Seidenfaden 1992; Comber 2001; Schuiteman *et al*. 2001–2010; Jones & Clements 2004, 2005; Jones 2006, 2021; Jones *et al*. 2006, 2010; Bostock 2008; Chen *et al*. 2009; Li & Yan 2013; Zhou *et al*. 2016; Li *et al*. 2019; Aung *et al*. 2020; Gray *et al*. 2021).

Su *et al.* (2015), in a more detailed study based on analysis of 74 species of Malaxideae that included material of *Empusa habenarina*, reaffirmed the earlier work of Cameron (2005, demonstrating the paraphyly of *Liparis s. lat*.. Studies by Su *et al.* (2015) and Kumar *et al*. (2022) also revealed that *E. habenarina* does not align with *Liparis sens. str.*, rather it falls within a highly supported and well isolated group sister to and part of a major clade that includes genera such as *Crepidium* Blume, *Dienia* Lindl. and *Empusa* Lindl. This renders the name *Liparis s. str.* inapplicable to *E. habenarina* and to its relatives with similar general vegetative and floral morphology. However, a workable classification is yet to be achieved for the terrestrial clade of Malaxideae, which includes the types of *Crepidium*, *Dienia*, *Empusa* and *Liparis*. While the genus *Empusa* has been accepted in some recent publications, *Dienia* is an equally competing name for this clade, which also includes the later name *Crepidium*. *Empusa* is therefore the earliest available generic name applied to this taxon, though further changes can be expected to establish acceptable generic boundaries in tribe Malaxideae.

Empusa habenarina (F.Muell.) D.L.Jones & M.A.Clem., *The Orchadian* 14(8): xiv (2004). *Sturmia habenarina* F.Muell., *Fragm*. 4: 131 (1864). *Liparis habenarina* (F.Muell.) Benth., *Fl. Austral*. 6: 273 (1873). *Leptorchis habenarina* (F.Muell.) Kuntze, *Revis Gen. Pl*. 2: 671 (1891). *Type*: 'In pratis humidis ad sinum Rockingham's Bay', *J.Dallachy* s.n. (holo: K; iso BM 00090085!).

Illustrations: Nicholls, *Orchids Austr*. 100, t. 363 (1969), as *Liparis habenarina*; Dockr., *Austr. Indig. Orchids* 1 (edn. 2): 350, pl. p. 351 (1992), as *Liparis habenarina*; P.H.Weston in G.J.Harden, *Fl. New S. Wales* 4: 226, fig. (1993), as *Liparis habenarina*; T.Bishop, *Field guide orchids New S. Wales Vict.* 183, fig. 436 (1996), as *Liparis habenarina*; D.L.Jones, *Compl. Guide Austr. Orchids* 274, fig., pl. (2006); A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 394, 397 (2008), as *Liparis habenarina*; A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 475, 499 (2013), as *Liparis habenarina*; Liddle *et al*., *Field Guide Pl. Darwin Sandsheet Heath* [20], pl. (2017); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 643 pl., fig. (2021).

Terrestrial *herb* to 50(60) cm tall, with a few clustered, subterranean pseudobulbs usually 2, 2–3 cm long, 1.5–2.5 cm wide, obovoid. *Leaves* usually three, 10–25 cm long, 2–4 cm wide, ovate, oblong or obovate, acute or obtuse, usually distinctly plicate, sometimes scarcely plicate, with (usually 5) prominent veins, bases sheathing stem. *Inflorescence* a terminal raceme, stiffly erect, 15–50(–60) cm tall; peduncle equal to or greatly exceeding the rachis, distinctly 4–6 angular and narrowly winged, usually a solitary bract at the base; rachis 8–22-flowered, bracts 3–4 mm long, pedicels, including ovary, 5–10 mm long. *Flowers* resupinate, 10–12 mm wide, greenish yellow or sometimes purple with a green column. *Dorsal sepal* deflexed, 5–10 mm long, 1–2 mm wide, more or less linear or lorate with the margins revolute. *Lateral sepals* deflexed, connate towards the base, sub-porrect in the proximal third then revolute, closely subtending labellum, oblong to cuneate, 6–8 mm long, *c*. 3 mm wide when flattened. *Petals* deflexed, 8–10 mm, *c*. 1 mm wide, linear to falcate-lorate. *Labellum* semierect to decurved through about 90°, 4–6 mm long 3–4 mm wide, oblong to obovate, shallowly canaliculate, sometimes bifid in the distal third, the lobes rounded and slightly serrulate or sinuate; disc with two narrow, slightly raised keels converging towards apex. *Column* prominent above sepals and petals, 4–5 mm long, curved through about 90° past the middle; wings rather large, more or less bluntly depressed triangular. *Stigma* transverse sub-oblong. *Rostellum* small and not very prominent. *Anther* subquadrate, with a long decurved deltoid rostrum. *Pollinia* sub-reniform in lateral view. *Capsule* erect, dehiscent, 10–12 mm long. (Figure 12).

Specimens examined: WESTERN AUSTRALIA: near falls at head of north arm of Bachsten Creek Gorge, Prince Regent River Reserve, 30 Jan. 1999, *M.D.Barrett, W.Maher & K.W.Dixon MDB 691* (PERTH); Edkins Ra., 78 km NNW of Beverley Springs Stn Hstd, 11 Jan. 1995, *R.L.Barrett* & *M.D.Barrett RLB 956* (PERTH); *c*. 8 km N of Charnley River Crossing on Walcott Inlet track, Edkins Range, 8 Jan. 2001, *R.L.Barrett & K.W.Dixon RLB 1660* (PERTH); 'Shrimp Creek' (informal name), 11.7 km S of Kings Cascades, Prince Regent River Reserve, 22 Jan. 2007, *R.L.Barrett & M.D.Barrett RLB 3745* (PERTH). NORTHERN TERRITORY: Melville Island, 15 km south of Snake Bay, 31 Jan. 1984, *D.L.Jones 1286* (CANB, DNA). QUEENSLAND: Moa Island, 1989, *D.L.Jones 3625* (CBG); near Herberton, 2002, *D.L.Jones 18321* (CANB). NEW SOUTH WALES: Woolgoolga, 23 Apr. 1992, *S.C.Clemesha s.n.* (NSW 429775); Brunswick Heads, Mar. 1935, *H.M.R.Rupp s.n.* (NSW 379241).

Distribution: Recorded from a relatively small area in the Edkins Range and upper Prince Regent River in the North Kimberley. Also occurs on Melville Island and the northern mainland in the Northern Territory, more widespread in Queensland, from Cape York southwards, extending to Coffs Harbour in New South Wales. Possibly also in Asia (see notes).

Conservation status: Known only from four sites within the Edkins Range, at least two of which are subject to disturbance by feral pigs, and two on the Gardner Plateau, and it remains poorly known in Western Australia. Conservation Codes for Western Australian Flora: Priority 2 (Western Australian Herbarium 1998 onwards). Listed as Data Deficient in the Northern Territory.

Ecology: Grows in seasonally wet, sandy / peaty soils in association with *Banksia dentata*, *Byblis liniflora*, *Calochilus barbarossa*, *C. kimberleyensis, Clitoria australis*, *Didymoplexis pallens*, *Drosera paradoxa*, *Eucalyptus apodophylla*, *E. houseana*, *E. alba*, *Eulophia bicallosa*, *Haemodorum flaviflorum*, *Hypoxis nervosa, Lindernia plantaginea, Ludwigia octovalvis*, *Melaleuca viridiflora*, *Pandanus spiralis* var. *spiralis, Pecteilis eurystoma*, *Stylidium pachyrrhizum, Utricularia uliginosa* and *Xyris complanata*.

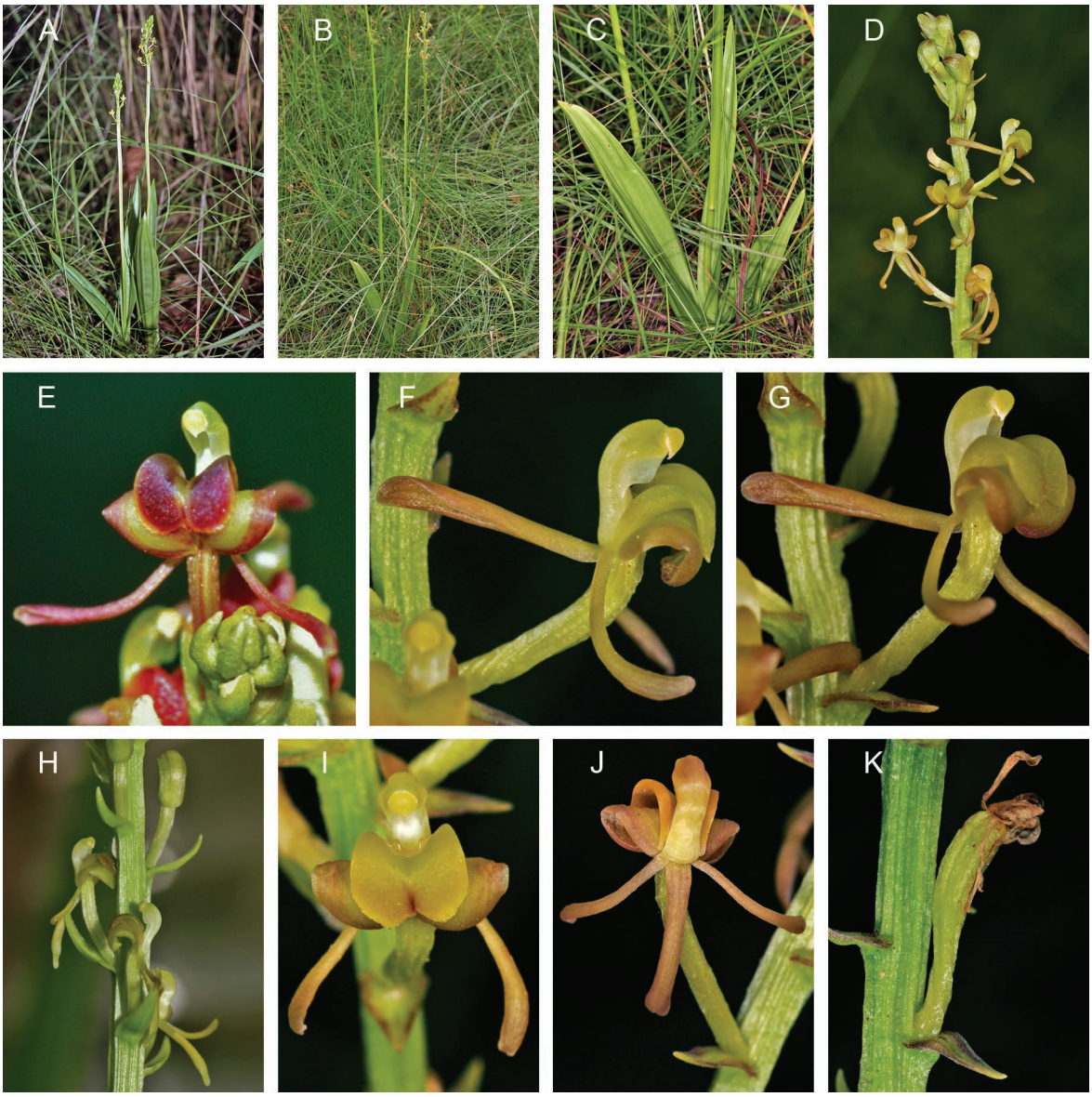

Fig. 12. *Empusa habenarina*. A, B. Habit. C. Pleated leaves. D. Inflorescence. E–J. Flowers. K. Fruit. Vouchers: A: *R.L.Barrett & M.D.Barrett RLB 956* (PERTH); B–K: *R.L.Barrett & M.D.Barrett RLB 3745* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Phenology: Flowers and fruits recorded for January (to April in the Northern Territory and Queensland).

Affinities: Closely related to *Liparis wenshanensis* Y.Y.Su, Y.L.Huang & G.Q.Zhang, *L. ferruginea* Lindl. and possibly *L. sootenzanensis* Fukuyama (Su *et al.* 2015). *Liparis wenshanensis* differs in having 45–55 flowers; white sepals, petals and column; strongly recurved lateral sepals and a cordate lip. *Liparis ferruginea* is morphologically very similar, but the wings on the column are much broader in *Empusa habenarina*. *Liparis sootenzanensis* differs in having broader dorsal sepals, filiform petals and a denticulate apex to the lip.

Notes: This species may extend to Asia, in which case there may be an earlier name available. The illustration of *Liparis odorata* Lindl. in Smith (1908; fig. 201) from Java appears to be a good match for this taxon, but Smith's concept does not match *L. odorata*, a species described from India. Smith's illustration could otherwise represent *L. ferruginea* Lindl.

Common names: Hobgoblin orchid, Kimberley mosquito orchid.

Eulophia R.Br., *Bot. Reg.* 7: ad t. 573 (Oct. 1821), (as '*Eulophus*'), *nom. et orth. cons. Type*: *E. guineensis* Lindl., *typ. cons.*, designated by W.Greuter, *Regnum Veg.* 118: (1988).

Geodorum Jackson in Andrews, *Bot. Repos.* 10: t. 626 (1811), *nom. rej. prop. Type*: *G. citrinum* Jackson.

Eulophia R.Br. ex Lindl., *Bot. Reg.* 8: t. 686 (1822). *Type*: *E. guineensis* Lindl.

Graphorkis Thouars, *Nouv. Bull. Sci. Soc. Philom Paris* 1: 318 (1809), *nom. rej*. *Type*: not designated.

Wolfia Dennst., *Schlüssel Hortus Malab*. 38 (1818), *non* Schreb. (1791), *nom. illeg*. *Type*: *W. spectabilis* Dennst.

Eulophia C.Agardh, *Aphor. Bot*. 109 (1822) (Musci), *nom. rej*.

Lissochilus R.Br., *Bot. Reg*. 7: sub t. 573 (1821), *nom. rej*. *Type*: *L. speciosus* R.Br.

Cyrtopera Lindl., *Gen. Sp. Orchid. Pl*. 189 (1833). *Lectotype*: *C. woodfordii* (Sims) Lindl., designated by A.Richard, *Orbigny, Dict. Univ. Hist. Nat*. 4: 561 (1844).

Thysanochilus Falc., *Proc. Linn. Soc. London* 1: 14 (1839). *Type*: not designated.

Hypodematium A.Rich., *Tent. Fl. Abyss*. 2: 286 (1850), *non* Kunze (1833) *nec* A.Rich. (1848), *nom. illeg*. *Type*: *H. abyssinicum* A.Rich.

Platypus Small & Nash in Small, *Fl. S.E. U.S*.: 329 (1903). *Type*: *P. papilliferus* Small & Nash.

Donacopsis Gagnep., *Bull. Mus. Natl. Hist. Nat.,* sér. 2, 4: 593 (1932). *Type*: *D. laotica* Gagnep.

Semiphajus Gagnep., *Bull. Mus. Natl. Hist. Nat.,* sér. 2, 4: 598 (1932). *Type*: not designated.

Notes: Since its description by Brown (1821), definition of the genus *Eulophia* has remained problematic, and much work is still required at regional levels (e.g. Ortúñez *et al*. 2020). The best circumscription is still a matter of debate, but molecular data clearly demonstrate the need to combine *Eulophia s str*. with the earlier name *Geodorum* Jackson as the type species of both genera are resolved in the same clade (Batista *et al*. 2014; Martos *et al*. 2014; Bone *et al*. 2015). This combination of the two genera was foreshadowed by Schlechter (1914 [transl. 1982]) who stated that '..there is no characteristic by means of which it is possible to separate *Geodorum* from *Eulophia* R. Br., yet it has not occurred to any botanist to unite these two genera.'

Chase *et al*. (2021a) have provided new combinations for former *Geodorum* species in *Eulophia*, but many species circumscriptions remain problematic and a detailed revision is required. While *Geodorum* is the earlier name, Chase *et al*. (2021b) formally proposed conservation of *Eulophia* as there are many more species currently included in that genus. Ormerod (2017) had anticipated such a proposal, and provided the new combination *Eulophia picta* (R.Br.) Ormerod. With the exception of *Eulophia picta*, other Australian species are relatively poorly collected, in part due to the flowers and leaves emerging at different times, and flowering prior to or early in the wet season when few other species are in flower, and weather is inhospitable for field work. Some vegetative characters of Australian species are discussed by Holttum (1952), but further work is required.

Eulophia bicallosa (D.Don) P.Hunt & Summerh., *Kew Bull*. 20: 60 (1966); *Bletia bicallosa* D.Don, *Prodr. Fl. Nepal*. 30 (1825); *Limodorum bicallosum* Buch.-Ham. ex D.Don, *Prodr. Fl. Nepal*. 30 (1825), *nom. inval., pro. syn*.; *Graphorkis bicallosa* (D.Don) Kuntze, *Revis. Gen. Pl*. 2: 662 (1891); *Liparis bicallosa* (D.Don) Schltr., *Repert. Spec. Nov. Regni Veg. Beih*. 4: 196 (1922). *Type*: Terriany Forest, lower Nepal, 30 Mar. 1802, *F.Buchanan-Hamilton s.n*. (lecto: BM 000525392; isolecto: LINN 1402.8; K 000852989), designated by Ormerod, *Checkl. Papuasian Orch*. 292 (2017).

Epipactis bicarinata Buch.-Ham. ex Wall., *Numer. List* 7363 (1831), *nom. nud*.; *Cyrtopera bicarinata* Lindl., *Gen. Spec. Orchid. Pl.* 190 (1833); *Eulophia bicarinata* (Lindl.) Hook., *Fl. Brit. India* 6: 6 (1890); Lindl., *Gen. Sp. Orchid. Pl*. 190 (1833); *Graphorkis bicarinata* (Lindl.) Kuntze, *Revis. Gen. Pl*. 2: 622 (1891). *Type*: Nepal: Patgang, 23 Mar. 1809, *F.Buchanan-Hamilton s.n.* (holo: K-Wall.; iso: K-Lindl.).

Cyrtopera candida Lindl., *J. Proc. Linn. Soc., Bot*. 3: 31 (1864); *Eulophia candida* (Lindl.) Hook.f. in J.D.Hooker, *Fl. Brit. India* 6: 6 (1892); *Graphorkis candida* (Lindl.) Kuntze, *Revis. Gen. Pl*. 2: 662 (1891). *Type*: Sikkim, *Cathcart*, *J.D.Hooker 241* (holo: K 000078326).

Eulophia fitzalanii F.Muell. ex Benth., *Fl. Austr.* 6: 300 (1873); *Graphorkis fitzalanii* (Benth.) Kuntze, Revis. Gen. Pl. 2: 622 (1891). *Type*: Queensland: Mount Dryander, Jan. 1871, *E.F.A.Fitzalan s.n*. (holo: K 000078348; iso: MEL 677527).

Cyrtopodium parkinsonii F.Muell. ex Kraenzl., *Oesterr. Bot*. Z. 44: 256 (1894). *Type*: Papua New Guinea: Bismarck Archipelago, New Britain, near Ralum, 1885, *R.Parkinson 56* (holo: B†; iso: MEL 2420356, MEL2420357).

Cyrtopera formosana Rolfe, *Bull. Misc. Inform*. 1896: 198 (1896); *Eulophia formosana* (Rolfe) Rolfe in Forbes & Hemsley, *Enum. Pl. China, Orchids* 28 (1903). *Type*: China: South Cape, Formosa, *A.Henry 1947* (holo: NY00008694, image seen, iso: K 000078314).

Eulophia bicarinata var. *major* King & Pantl., *Ann. Roy. Bot. Gard.* (*Calcutta*) 8: 181 (1896); *Eulophia bicallosa* var. *major* (King & Pantl.) Pradhan, *Indian Orchids: Guide Identif. & Cult*. 2: 461 (1979). *Type*: n.v.

Eulophia versteegii J.J.Sm., *Bull. Dept. Agric. Indes Neerl*. 19: 24 (1908). *Type*: New Guinea: pre 1908, *G.M.Versteeg* 1952 (holo: *n.v.* iso: K 000078345 (ex BO), L 0063896, images seen).

Eulophia neopommeranica J.J.Sm., *Nova Guinea* 8(1): 26 (1909). *Eulophia papuana* (Kraenzl.) Schltr. in K.Schum. & Lauterb., *Nachtr. Fl. Deutsch. Schutzgeb. Südsee* 148 (1905); *Cyrtopera papuana* Kraenzl., *Notizbl. Bot. Gart. Berlin-Dahlem* 2: 104 (1898), *nom. illeg.*, *non* Ridl. (1886). *Type*: Papua New Guinea: Ralum, im Grasfeld auf vulkanischem Boden 100 m ü. M., Oct. 1896, *Dahl 90* (holo: B†).

Eulophia brachycentra Hayata, *Icon. Pl. Formosa*. 4: 72, fig. 36a (1914). *Type*: Formosa [Taiwan]: Taitō: Shinkögai, June 1906, *Z.Kobayashi s.n.* (holo: TAI, *n.v.*).

Eulophia vanoverberghii Ames, *Philipp. J. Sci*. ser. C, 7: 13 (1914). *Type*: Philippines: Bontoc subprovince, Luzon, April 1910, *M.Vanoverbergh* 336 (holo: AMES ; iso: K 000078344, images seen).

Eulophia merrillii Ames, *Orchidaceae* 5: 104 (1922). *Type*: Philippines: Caraga, Surigao Province, Mindanao Island, 6 October 1906, *E.D.Merrill* 5452 (holo: AMES 00099460, image seen).

Eulophia venosa auct. non (F.Muell.) Rchb.f. ex Benth.: W.Fitzg., *J. & Proc. Roy. Soc. West. Austr.* 3: 129 (1918); A.S.George, *Nuytsia* 1: 182 (1971).

Illustrations: ?D.L.Jones, *Native Orchids Austr.* 362, fig. (1988); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg.* 1010, fig. 303e (1992); Dockr., *Austr. Indig. Orchids* (edn. 2): 2: 812, fig. p. 813 (1992); A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 382, 385, 386, 389 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 472, 490, 491 (2013); ?D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 624 pl., fig. (2021); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 628, pl. (2021).

Terrestrial, geophytic *herb*, deciduous, tuberous rhizoids up to 10 cm long, to 3 cm diam., forming chains of up to 5, each representing a year's growth, whitish. Leaf-bearing *stem* 150–250 mm long, usually with 3 large sheathing bracts, the upper bract large and leaf-like. *Leaf* solitary, lanceolate to very narrowly ovate, finely plicate, 250–400 mm long, 10–25 mm wide. *inflorescence* a terminal raceme with 5–22 flowers, 60–80(–120) cm high, the peduncle generally much longer than the rachis. *Flowers* 20–30 mm diam., pale green or whitish with variable purple, red or brownish dusting or striping; with a green or deep purple or red column foot; pedicels including the ovary 10–30 mm long. *Dorsal sepal* narrowly ovate, acute, 10–15 mm long, 2.5–4 mm wide. *Lateral sepals* adnate with column foot, widely spreading, oblong, 13–19 mm long, 3.5–5 mm wide, apex decurved, sometimes twisted in distal half. *Petals* projected forward, obovate to broadly lanceolate, 10–15 mm long, 5–6 mm wide, often apiculate. *Labellum* distinctly 3-lobed, up to 15 mm long, 10 mm wide, keels *c.* 5 mm long, glabrous; spur *c.* 3 mm long, subconical, obtuse lateral lobes 2–3 mm long, 7–9 mm wide, with raised purple or red veins; midlobe more or less truncate, recurved, 6–8 mm long, 7–10 mm wide, with fine purple or red veins, the central basal portion rugose, margins undulate and suberect. *Column* 6–7 mm long, projected forward, curved; foot *c.* 4 mm long. *Stigma* sub-reniform. *Anther* with a deflexed, truncate rostrum. *Pollinia* obovate, stipe short, narrow. *Rostellum* small, truncate. *Capsule c.* 15 mm long, 8 mm wide. (Figure 13).

Specimens examined: WESTERN AUSTRALIA: Edkins Ra., 62 km N of Beverley Springs Stn Hstd, 26 Dec. 1995, *R.L.Barrett* & *M.D.Barrett RLB 634* (PERTH); Edkins Ra., 78 km NNW of Beverley Springs Stn Hstd, 11 Jan. 1995, *R.L.Barrett* & *M.D.Barrett RLB 957* (PERTH); Edkins Ra., 62 km N of Beverley Springs Stn Hstd, 8 Jan. 2001, *R.L.Barrett & K.W.Dixon RLB 1649* (CANB, PERTH); between Isdell and Precipice Ranges, 21 Sept. 1905, *W.V.Fitzgerald 1498* (PERTH); Artesian Range, 30 Sept. 1921, *C.A.Gardner 1365 / 1865* (PERTH).

PAPUA NEW GUINEA: near Horanda airstrip, Northern Division, Territory of Papua, 4 Sept. 1953, *R.D.Hoogland 3808* (CANB); Milne Bay: Near Medino village, N coast of Cape vogel Peninsula, 6 Sept. 1954, *R.D.Hoogland 4645* (CANB).

Distribution: North Kimberley, Isdell, Precipice and Edkins Range, Mt Fyfe and Theda Station in Western Australia, and from Cape Tribulation south to Mackay in North Queensland. Possibly also in the Northern Territory but those records probably represent a distinct taxon (see Jones 2021). As currently broadly defined, this species is widespread outside Australia from New Guinea to the Philippines, China, Nepal and India.

Conservation status: In the Kimberley, restricted in distribution, and potentially threatened by grazing and burning pressures. Locally abundant at some locations and probably not under immediate threat, however, individual habitats are quite small and thus increasing pig numbers are having a direct impact and pose an increasing threat to most known populations. Frequent fire will also likely shrink habitat availability through the loss of soil organic matter. This species may become threatened if habitat modification by feral animals and fire is not abated. Loss of organic matter through burning, resulting in habitat loss, is likely to be a medium-term (10–20 years) threat to the species. Conservation codes for Western Australian flora: Priority 3 recommended.

Fig. 13. *Eulophia bicallosa*. A, B. Habit. C. Pseudobulbs. D. Habitat and habit. E–H. Inflorescence. I–K. Flowers. Vouchers: A–C: near Charnely River *R.L.Barrett & K.W.Dixon RLB 1649* (PERTH); D, F–H, J, K: not vouchered, same site as A–C. E, I: not vouchered, Theda Station. Photos by R.L. Barrett (A–C) & R. Maher (D–K).

Ecology: Occurs in peaty, humus-rich, otherwise sandy and seasonally waterlogged soil amongst long grass.

Phenology: Flowers August–December (predominantly seen following fire when plants are more easily located).

Affinities: Similar to *E. venosa* F.Muell. from adjacent areas of the Northern Territory which differs in the prominently veined sepals and petals, and the labellum being longer than wide. As some recent collections from the Kimberley are sterile, their identity is not proven and they may be referrable to *E. venosa*.

Notes: Collected by W.V. Fitzgerald from between the Isdell and Precipice Range in 1905 (Fitzgerald 1918) and by C.A. Gardner from the Artesian Range in 1919 (Gardner 1923), only three other specimens had been collected from Theda Station, until January 1995 when plants in the leaf stage were found in their thousands on sandflats in the Edkins Range, Theda and Doongan (King Edward River) Stations. There are two flower forms known in the Kimberley region, one with a predominantly green labellum and one with a predominantly pink labellum, but there are too few specimens available to know if they represent discrete taxa or local or seasonal variation.

The application of names in *Eulophia* is still problematic and further assessment across the range of the genus is still required (Bone *et al.* 2015; Ormerod 2017; Ortúñez *et al.* 2020). There are still few flowering specimens from Australia available in herbaria as flowering occurs with the first monsoon rains, when little collecting effort occurs. High levels of clonality within populations may also lead to high levels of localised variation

that could create false impressions of speciation. It is still quite possible that the name *E. bicallosa* (*sensu* Hunt & Summerhayes 1966) should not be applied to Australian populations (see Gogoi *et al*. 2012 for photos from Assam, India), but further study is required. Likewise, the Kimberley and Queensland populations may represent independent dispersals from Asia, and may not be conspecific.

The apparent disjunct distributions in the Kimberley and in Queensland may suggest independent dispersal events from south-east Asia.

Common name: Tropical grass orchid, Frilled lip orchid.

Eulophia picta (R.Br.) Ormerod, *Checkl. Papuasian Orch*. 293 (2017); *Cymbidium pictum* R.Br., *Prodr*. 331 (1810); *Geodorum pictum* (R.Br.) Lindl., *Gen. Sp. Orchid. Pl*. 175 (1833), *nom. illeg. non* Link & Otto (1821). *Type*: Australia: Northern Territory: Dec. 1802, *R.Brown* [*Bennett No. 5507*] (lecto: BM 000525343, designated by Hallé, *Fl. Nouv. Caledonie* 8: 250 (1977), (as 'holo'); isolecto K 000890997).

Geodorum semicristatum Lindl., *Fol. Orchid*. 6: 2 (1854). *Type*: Philippines: 1841, *H.Cuming* 2107 (holo: K-LINDL; iso: BM 000525330; K 000890999, K 000891000).

Tropidia grandis Hance, *J. Linn. Soc., Bot.* 13: 128 (1873). *Type*: China: Guangdong: Hong Kong, in the Happy Valley woods, July 1866, *H.F.Hance* 13343 (holo: BM 000525308).

Geodorum pacificum Rolfe, *Bull. Misc. Inform. Kew* 1908: 71 (1908). *Type*: Polynesia: Vaua, Tonga Islands, Jan. 1892, *C.S.Crosby 246* (syn: K 000890995); Solomon Islands, Jan. 1907, *C.M.Woodford s.n*. (syn: K 000890996, L, *n.v*.).

Geodorum neocaledonicum Kraenzl., *Vierteljahrsschr. Naturf. Ges. Zurich* 74: 82 (1929). *Type*: New Caledonia, pentes du Tiebaghi, Paagoumene, 12 Mar. 1925, *A.Ü.Däniker 1384* (holo: Z; iso: Z).

Geodorum neocaledonicum Schltr. *nom. nud., nom. illeg. non* Kraenzl.: D.L.Jones, *Native Orchids Austr.* 364 (1988); E.M.Ross in T.D.Standley & E.M.Ross, *Fl. S.E. Queensl*. 3: 371 (1989); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg*. 1010 (1992); T.Bishop, *Field guide orchids New S. Wales Vict*. 196 (1996).

Geodorum terrestre auct. non (L.) Garay: Garay, *Harvard Pap. Botany* 2: 47 (1997).

Illustrations: R.Schlechter, *Orchidac. German New Guinea* 492, fig. (1914 [transl. 1982]), as *Geodorum pictum*; N.Hallé, *Fl. Nouv. Caledonie* 8: 224, pl. 106 (1977), as *Geodorum pictum*; D.L.Jones, *Native Orchids Austr.* 364, pl. p. 40, pl., fig. (1988), as *Geodorum neocaledonicum*; E.M.Ross in T.D.Standley & E.M.Ross, *Fl. S.E. Queensl*. 3: 371, fig. 56b (1989), as *Geodorum neocaledonicum*; A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg*. 1010, fig. 303f (1992), as *Geodorum neocaledonicum*; P.H.Weston in G.Harden, Fl. New S. Wales 4: 238, fig. (1993), as *Geodorum densiflorum*; T.Bishop, *Field guide orchids New S. Wales Vict*. 196, fig. 477 (1996), as *Geodorum neocaledonicum*; D.L.Jones, *Compl. Guide Austr. Orchids* 360, fig., pl. (2006); A.P.Brown *et al. Orchids West. Austr.,* figs p. 388, (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 470, 475, 492, 493 (2013), all as *Geodorum terrestre*; D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 630 pls, fig. (2021), as *Geodorum densiflorum*.

Terrestrial, geophytic *herb*, deciduous, often forming small vegetative clumps; pseudobulbs crowded, broadly ovoid, half or completely buried in ground, 2.5–4.5 cm diam. *Leaves* 3–5, petioles 2–8 cm long; lamina ovate to obovate 150–370(–450) mm long, 40–60(–90) mm wide, plicate, with distinct ribs and veins, attenuate, margins sometimes undulate, acuminate; leaves and inflorescences developing simultaneously. *Inflorescence* an axillary raceme, up to 400 mm high at anthesis, erect while developing, rachis reflexed 180° as flowers mature then straightening and elongating up to 700 mm long after fertilisation; peduncle with several bracts, the lower ones large and sheathing. *Flowers* 8–20, crowded, resupinate, depressed tubular, only partially open at the orifice only, 10–20 mm long, pink or purplish, with prominent dark red to purple veins and spots inside; pedicels short, 3–10 mm long, subtending bracts 5–15 mm long, 3–4 mm wide, narrowly triangular. *Dorsal sepal* 11–18 mm long, 3–5 mm wide, lanceolate. *Lateral sepals* free, 11–18 mm long, 2.5–4 mm wide, lanceolate, cymbiform at the apex, keeled on the outside. *Petals* 11–18 mm long, 2.5–4 mm wide, oblong or obovate, acute. *Labellum* obscurely 3-lobed, pink with red or purple veining, 10–15 mm long, 6–8 mm wide, saccate, emarginate; lateral lobes 5 mm long, 1 mm wide, recurved around the column; midlobe 2–3 mm long, 4 mm wide, margins slightly recurved and sinuate; keel extending onto the midlobe, *c*. 1 mm wide. *Column* 3–6 mm long, 2.5–3.5 mm wide, wings rudimentary, column foot 1–2 mm long. *Anther* hemispheric; pollinia large, grooved, stipe very short. *Rostellum* very small, narrow ovate. *Capsule* pendulous, somewhat fleshy when green, thickly ribbed, 25–50 mm long, 15–25 mm wide, obovoid, dehiscent. (Figure 14).

Fig. 14. *Eulophia picta*. A, B. Habit. C. Pleated leaf. D. Infructescence. E–H. Inflorescence. I–K. Flower. Vouchers: A–D: *R.L.Barrett RLB 4658* (PERTH); E–K: not vouchered, cultivated at Kings Park & Botanic Garden, from Synnot Range. *R.L.Barrett & M.D.Barrett RLB 699* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Specimens examined: WESTERN AUSTRALIA: Grevillea Gorge, 30 km NW of Beverley Springs Hstd, 7 June 1992, *M.D.Barrett 22* (PERTH); Gwen's Gorge, Edkins Ra., 85 km N of Beverley Springs Stn Hstd, 11 Jan. 1993, *R.L.Barrett* & *M.D.Barrett RLB 449* (PERTH); Grevillea Gorge, Synnot Ra., 32 km NW of Beverley Springs Stn Hstd, 14 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 699* (PERTH); Synnot Ra., 25 km NW of Beverley Springs Stn Hstd, 14 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 715* (PERTH); 'Skull Creek' camp and trap site, Doongan Station, 24 Apr. 2008, *R.L.Barrett RLB 4658* (PERTH); South Bachsten Creek, NW of falls on N side of creek in small gully, Prince Regent Nature Reserve, 21 Jan. 2010, *R.L.Barrett & V.Kessner RLB 6311* (PERTH); N side of Synnot Range, NW of Potts Camp, Charnley River Station, 28 Jan. 2010, *R.L.Barrett, M.Maier & P.Kendrick RLB 6568* (PERTH); near homestead, Charnley River Station [introduced from Synnot Range], 29 Jan. 2010, *R.L.Barrett RLB 6586* (PERTH); Mount Daglish Vine Thicket in Harding Range, W Kimberley, June 1987, *G.J.Keighery* & *J.J.Alford s.n.* (PERTH); Camp Creek, Mitchell Plateau, NW Kimberley, 03 Feb. 1979, *K.F.Kenneally 6972* (PERTH); 6 km S of Mining Camp in Crusher Vine thicket, Mitchell Plateau, N Kimberley, 25 Jan. 1989, *K.F.Kenneally* & *B.P.M.Hyland KFK 10843* (PERTH); 6 km N of Lake Gilbert near Beverley Springs, Kimberley, 01 Feb. 1989, *K.F.Kenneally* & *B.P.M.Hyland KFK 10938* (PERTH); SE of Mitchell Plateau mining camp, 7 Jan. 1979, *J.Smith s.n.* (PERTH 251925). NORTHERN TERRITORY: 13 km S of Gove Airport Terminal, 25 Feb. 1994, *K.Brennan 2686* (DNA); Melville Island, 'The Pines', 2 km past Taracumbie Falls turnoff, 31 Jan. 1984, *D.L.Jones 1289* (CANB, DNA); Angalarri River, 14 May 1994, *P.Latz 10002* (DNA); 10 km S of Maningrida, 18 June 1987, *D.Lucas 2608 & J.Russell-Smith* (DNA); Nightcliff, 14 Dec. 1964, *A.N.Rodd 19*

(NSW). QUEENSLAND: near Caloundra, 1997, *G.N.Batianoff 970115* (BRI, NSW); Bells Creek, near Golden Beach, S of Caloundra, Jan. 1985, *D.L.Jones s.n.* (CANB 665203); NW of Miram Vale, 1990, *P.H.Weston 1538 & P.G.Richards* (NSW). NEW SOUTH WALES: near Brunswick Heads, 1934, *F.Fordham 329* (NSW).

NEW CALEDONIA: *c.* 7 km from top of range on road from coast to Ouegoa, 24 Aug. 1992, *M.A.Clements 7925* (CBG); track from Baie d'Upi to Baie d'Oro, Ile des Pins, 10 Feb. 1991, *K.L.Wilson 7830 & P.H.Weston* (NSW).

Distribution: Widespread in vine thickets and rainforest in the North Kimberley, from Charnley River (Beverley Springs) and Pantijan Stations north to the Mitchell Plateau and Theda Stations. Widespread across the top end of the Northern Territory, north and eastern Queensland, and south as far as the north east coast of New South Wales. Also widespread in tropical Asia, New Guinea, Philippines, Japan and many Pacific islands including Solomon Islands, Samoa, Tonga, Vanuatu and New Caledonia.

Conservation status: Common in vine thickets over sandstone in the north-west Kimberley and not under threat.

Ecology: Occurs in vine thickets over sandstone or basalt, preferring damp areas with a thick litter layer in the Kimberley, more, rarely among ferns and grass near creeks with *Syzygium eucalyptoides*, *Typhonium peltandroides*, *Glycosmis sapindoides* and *Diospyros* sp. Also in open forests, woodlands, heathlands and grasslands in higher rainfall zones elsewhere in Australia.

Phenology: Flowers December–February, fruits January–March.

Affinities: Species limits in the clade formerly called *Geodorum* remain poorly understood. We accept the taxon first described as *Cymbidium pictum* R.Br. (Brown 1810) as the earliest available name for the widespread Australasian and Pacific species (e.g. Lewis & Cribb 1991). *Eulophia picta* may be most closely related to *E. cernua* (Willd.) T.C.Hsu (formerly *Geodorum densiflorum* (Lam.) Schltr.) from Asia, a species with more open flowers and few distinct internal markings, and *E. picta* is here regarded as a distinct species.

Notes: Incorrectly cited by Jones (1988), Ross (1989) and Wilson (1992) as '*G. neocaledonicum* Schltr.' [= *G. neocaledonicum* Kraenzl.].

While the name *Geodorum terrestre* (Linnaeus) Garay has been used in Australia following Garay (1997), the name was misapplied as the type of that name applies to *G. citrinum* Jackson (see Ormerod 1994, 2017; Chen *et al*. 2009; Averyanov *et al*. 2018; Chase *et al*. 2021b).

Hallé (1977) cited a holotype for *Geodorum pictum*, however this is to be corrected to lectotype, as it is the first designation of a single specimen from the original material. Many additional synonyms are listed by Naive *et al*. (2022), however this group of species requires significant additional work to determine the correct application of each of these names.

Common names: Shepherds crook orchid, Pink nodding orchid, Bent orchid.

Habenaria Willd., *Sp. Pl.* 4(1): 5, 44 (1805); *Habenorkis* Du Petit-Thouars, *Nouv. Bull. Sci. Soc. Philom. Paris* 1: 317 (1809), *nom. inval. Type*: *Orchis habenaria* L. (= *Habenaria macroceratilis* Willd.), designated by Kraenzl., *Bot. Jahrb. Syst*. 16: 58 (1892).

Mesicera Raf., *Neogenyton* 4 (1825). *Type*: *M. quinqueseta* Raf.

Nemuranthes Raf., *Fl. Tellur*. 2: 61 (1837), *nom. superfl. Type*: *N. habenaria* (L.) Raf.

Notes: Generic boundaries in subtribe *Habenarinae* remain problematic as current sampling in molecular phylogenies remains patchy for this highly diverse and pantropical clade of Orchids (Jones 1997; Bateman *et al*. 2003; Szlachetko *et al*. 2003; Szlachetko & Kras-Lapinska 2003a, 2003b, 2003c; Szlachetko & Sawicka 2003; Szlachetko 2003, 2005, 2012; Szlachetko & Kras 2006; Chen *et al*. 2009; Kurzweil 2009; Batista *et al*. 2013, 2014; Ngugi *et al*. 2020; Kolanowska *et al*. 2021). For Australia, only *H. hymenophylla* and *H. maccraithii* Lavarack are likely to remain in *Habenaria*, and possibly even these may be removed at a later date. Most Australian species are now placed in *Pecteilis* Raf. following recent resolution of relationships among Asian and Australian species using molecular data (Jin *et al*. 2014, 2017; see Clements & Jones 2018; Jones & Clements 2019).

Habenaria hymenophylla Schltr., *Repert. Spec. Nov. Regni Veg. Beih*. 9: 212 (1911). *Type*: Northern Territory: Near Port Darwin, 1888, *M.Holtze 799* (holo: B†; iso MEL 108305).

Habenaria trinervia auct. non Wight: Benth., *Fl. Austral*. 6: 394 (1873).

Illustrations: Dockr., *Austr. Indig. Orchids* 1: 28, fig. (1969); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 475, 495 (2013); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 603 pl., fig. (2021).

Erect, geophytic *herb* to 45 cm tall, glabrous. *Tuberoids* cylindrical to ovoid to obovoid. *Stems* with 5–8 scattered leaves and 2 or 3 sheathing bracts near the base. *Leaves* suberect, lamina 30–60 mm long, 30–35 mm wide, ovate or elliptical, thin-textured, margins entire to undulate, base sheathing the stem, acute or apiculate. *Inflorescence* a terminal raceme, erect, 10–25 cm long, 20–30-flowered although the flowers not crowded; bracts *c.* 15 mm long, ovate, shortly acuminate; ovaries *c.* 15 mm long, twisted, fusiform. *Flowers* resupinate, spreading-erect, hooded, 15–18 mm long, 10-13 mm wide, green and white. *Dorsal sepal* erect, incurved, hooded, 4.5–5 mm long, 4.5–5 mm wide, broadly ovate. *Lateral sepals* free, deflexed from the base, oblique, 4.5–5 mm long, 3.5–4 mm wide, margins incurved, ovate to oblong, apiculate. *Petals* suberect, divided into 2 lobes; posterior (upper) lobe oblique or out-curved, *c.* 6 mm long, 1.5 mm wide, linear, obtuse; anterior (lower) lobe incurved erect, *c.* 4.5 mm long, *c.* 1 mm wide, narrow linear. *Labellum* deeply 3-lobed; lateral lobes spreading or divergent at *c.* 30° to midlobe, variously curved, 4.5–7 mm long, 0.5 mm wide, narrow linear; midlobe incurved, 6–7.5 mm long, 1 mm wide, broad linear, obtuse; spur 11–15 mm long, somewhat curved forwards, ± cylindrical but dilated in distal third. *Column*, including the anther, *c.* 3.5 mm long, 2.5 mm wide; auricles *c.* 1 mm long. *Stigmatophores c.* 2 mm long, canaliculate dorsally. *Rostellum* triangular, carnose. *Thecal tubes* slightly shorter than the stigmatophores. *Pollinia* concave-cylindrical. *Capsule* erect, dehiscent. (Figure 15)

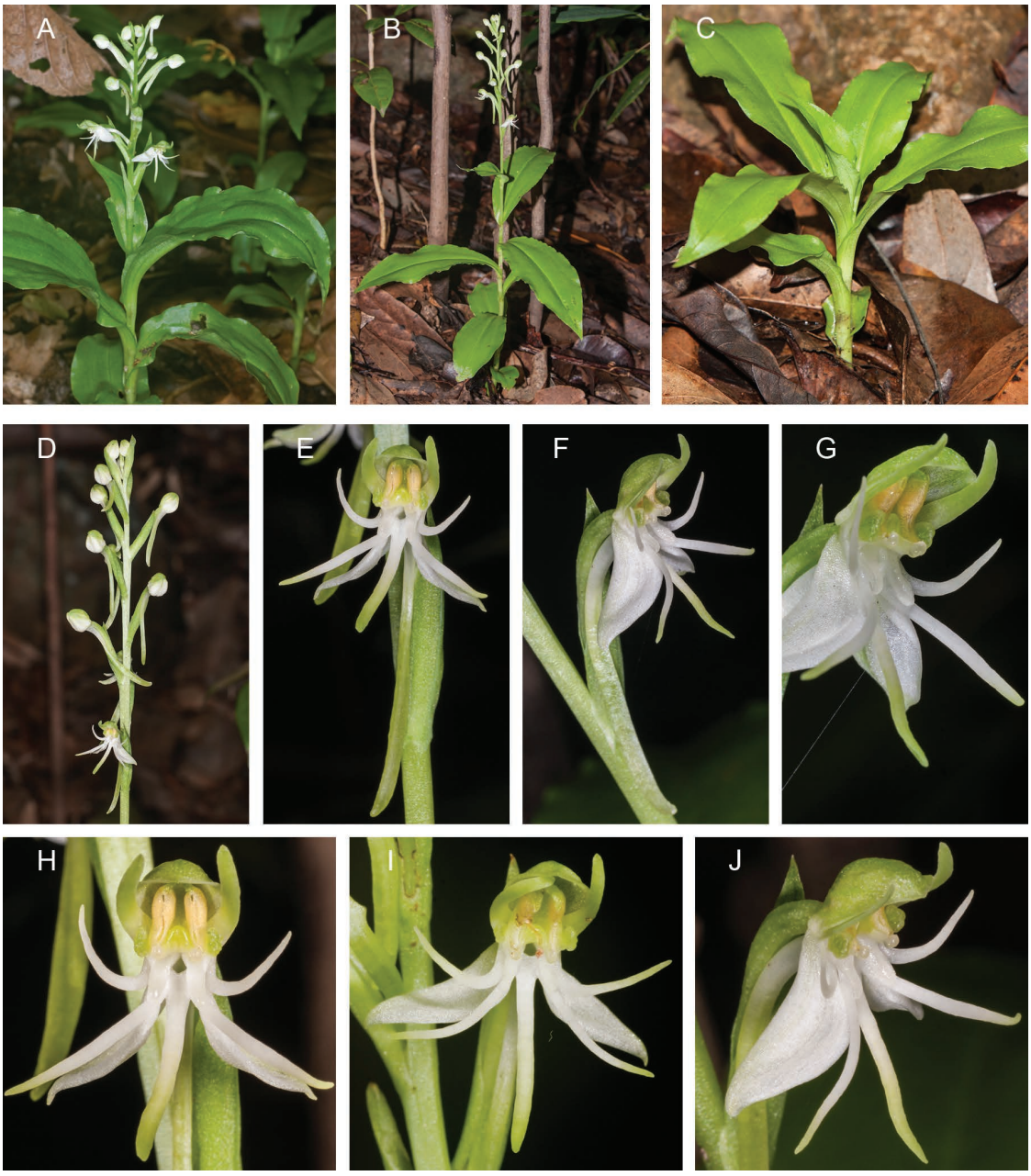

Fig. 15. *Habenaria hymenophylla*. A, B. Habit. C. Aerial rosette of leaves. D. Budding inflorescence. E–J. Flowers. Voucher: *R.L.Barrett, P.Kendrick & G.Sparkes RLB 6350* (PERTH). Photos by R.L. Barrett.

Specimens examined: WESTERN AUSTRALIA: Pitta Gorge, Prince Regent Nature Reserve [precise locality withheld], 23 Jan. 2010, *R.L.Barrett, P.Kendrick & G.Sparkes RLB 6350* (CANB, DNA, PERTH). NORTHERN TERRITORY: Arnhem Land district; Elcho Island: '10-mile area', on coast N of Wurrpan, 4 Feb. 1978, *M.A.Clements 1162* (CBG); Melville Island, 5 km W Snake Bay, 17 Apr. 1987, *J.Russell-Smith 2093* (DNA); Milingimbi, Arnhem Land, 18 Mar. 1987, *N.M.Smith 3474* (DNA); 1.5 km W of Humpty Doo, 6 June 1991, *S.Taylor 70* (DNA).

Distribution: In Western Australia, this species is only known from a single location in the north Kimberley, from a deep gorge near the Prince Regent River, very disjunct from the closest known populations in the Northern Territory. Its primary distribution is on Melville Island and near Darwin in the Northern Territory and from the Iron Range south to Rockhampton in Queensland.

Conservation status: The single known location in Western Australia is within the Prince Regent National Park. Recommended for listing as Priority two for Western Australian flora as the known locality is within a conservation reserve and not immediately threatened. Only about 30 plants have been observed over a distance of about 200 m. Listed as Data Deficient in the Northern Territory. http://eflora.nt.gov.au/factsheet?id=4082

Ecology: In the Kimberley, found growing in deep leaf litter under gallery forest dominated by *Myristica insipida*. In the Northern Territory, it grows in monsoon forests, often near the coast, forming vegetative colonies.

Phenology: Flowers January–February in the Kimberley, October–April elsewhere.

Affinities: The only other Australian species that remains in *Habenaria s. str*. is *H. maccraithii* Lavarack, which differs in its bright green leaves, brownish flowers and petals with two similar, slender lobes.

Notes: Known as the smelly socks orchid as the flowers develop an unpleasant odour which grows stronger during the day.

Common names: Coastal rein orchid, Smelly socks orchid.

Nervilia Comm. ex Gaudich. in Freycinet, *Voy. Uranie* 4: 5, t. 35 ([13 June] 1827) & 421 ([18 Sep.] 1829), *nom. cons*. *Type*: *N. aragoana* Gaudich., *type cons*.

Stellorkis Thouars, *Nouv. Bull. Sci. Soc. Philom. Paris* 1: 317 (1809), *nom. rej*. *Type*: *Arethusa simplex* Thouars *nom. rej.* vs. *Nervilia* Comm. ex Gaudich. (1829), *nom. cons.*

Cordyla Blume, *Bijdr. Fl. Ned. Ind.*: 416 (1825), *nom. illeg*., *non* Lour. (1790). *Type*: not designated

Aplostellis A.Rich., *Mém. Soc. Hist. Nat. Paris* 4: 36 (1828); *Haplostellis* Endl., *Gen. Pl.*: 219 (1837), *orth. var*. *Type*: *A. ambigua* A.Rich., *nom. illeg.* (*Arethusa simplex* Thouars) ≡ *Stellorkis* Thouars (1809).

Roptrostemon Blume, *Fl. Javae, Praef.*: vi (1828); *Rophostemon* Endl., *Gen. Pl.*: 216 (1837), *orth. var*. *Type*: not designated (substitute name for *Cordyla* Blume).

Bolborchis Zoll. & Moritzi in A.Moritzi, *Syst. Verz. Java*: 89 (1846). *Type*: *B. crociformis* Zoll. & Moritzi.

Nervilia holochila (F.Muell.) Schltr., *Bot. Jahrb. Syst*. 39: 48 (1907); *Pogonia holochila* F.Muell., *Fragm*. 5: 200 (1866). *Type*: Queensland: 'Ad sinum Rockingham's Bay', 4 Dec. 1865, *J.Dallachy s.n*. (holo: MEL 677533; iso: K 000942700, MO 3343587).

Illustrations: Nicholls, *Orchids Austr.* 76, t. 284 (1969); D.L.Jones, *Native Orchids Austr.* 419, fig. (1988); J.Brock, *Top End Native Pl.* 265, pl. (1988); Dockr., *Austr. Indig. Orchids* 1 (edn. 2): 246, fig. p. 247 (1992); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg.* 1012, fig. 303i (1992); D.L.Jones, *Compl. Guide Austr. Orchids* 282, pl. (2006); A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 398, 401 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 475, 500, 501 (2013); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 646 pl. (2021).

Erect, terrestrial, geophytic *herb* to 35 cm, forming clonal colonies, tubers 12–30 mm diam. *Leaves* solitary, developing post-anthesis or independent of anthesis; petiole 20–60 mm long; lamina erect, 50–180 mm long, 40–80 mm wide, pale green, ovate to broadly ovate, strongly plicate, commonly with 7 prominent veins, glabrous, apex acute. *Inflorescence* a terminal raceme, fleshy, 15–25 cm high, elongating in fruit, with large sheathing bract below flowers. *Flowers* (1–)3–6, resupinate, lax, widely spreading, fragrant, tepals mauve, pink. cream or pale green, short-lived; pedicels 6–8 mm long. *Perianth*: sepals linear to lanceolate or narrowly obovate, 15–26 mm long, 3–4.5 mm wide, acuminate; petals 13–22 mm long, 3.5–5.5 mm wide, less acuminate than sepals; labellum 3-lobed, concave, 14–25 mm long, 12–18 mm wide when flattened, usually white at the base, grading to pink at the apex sometimes entirely pink or white, lateral lobes more or less erect and encircling the whole column, or oblong or rounded, 12–16 mm long, midlobe almost square to semicircular, 4–6 mm long, 5–7 mm wide, margins undulate, keel a raised, linear to oblong, hirsute ridge extending almost the entire length of the labellum. *Column*

erect, 10–12 mm long, dilated and very shortly winged at apex, with a hump behind the anther. *Anther* with a small bifid rostrum. *Pollinia* shallowly grooved. *Stigma* semicircular. *Capsule* pendulous, dehiscent. (Figure 16).

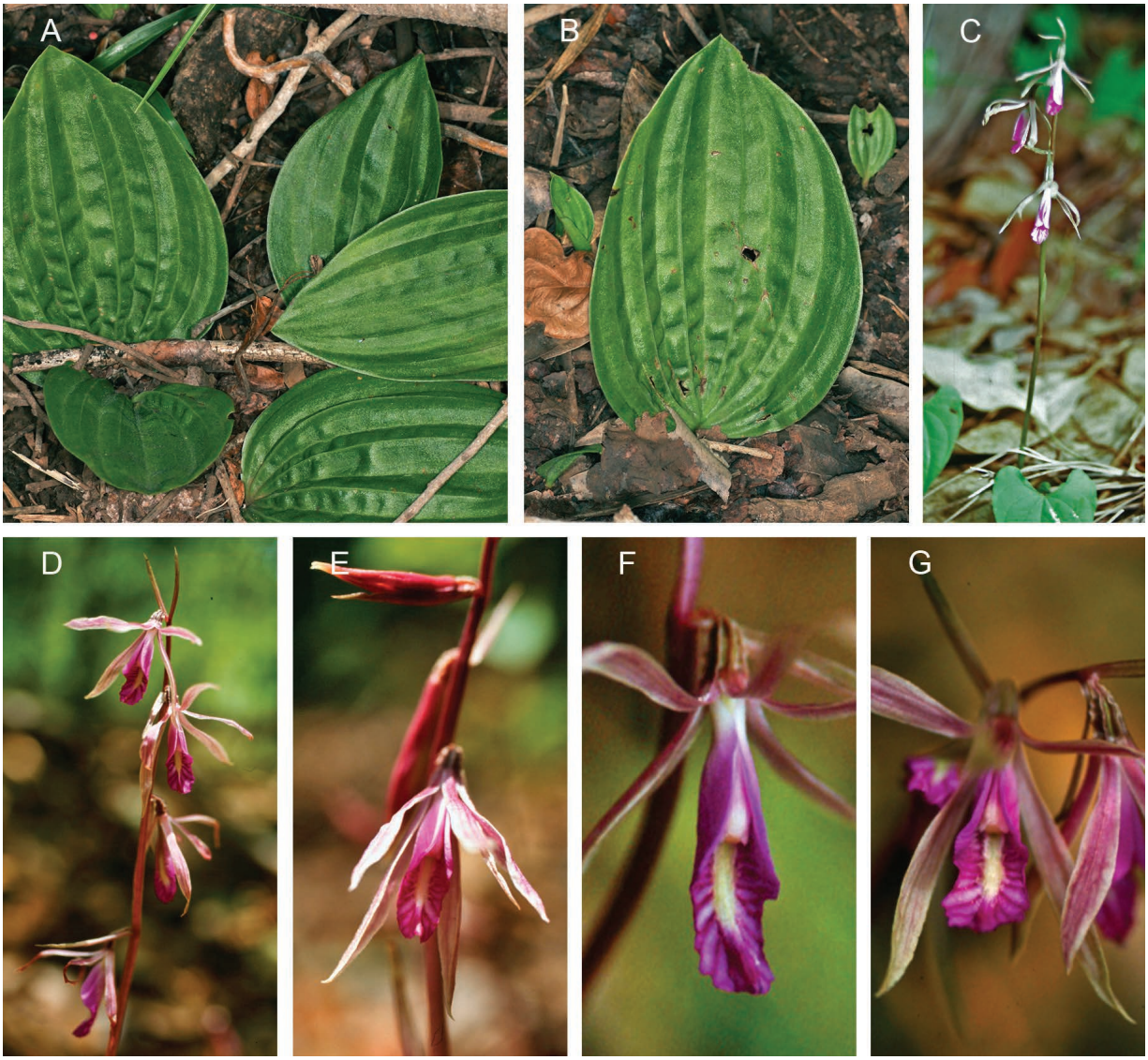

Fig. 16. *Nervilia holochila*. A, B. Pleated leaves. C, D. Inflorescence. E–G. Flowers. Vouchers: A, B: *R.L.Barrett* & *M.D.Barrett RLB 3190* (PERTH); C: *R.L.Barrett & M.D.Barrett RLB 949* (PERTH); D–G: not vouchered, from near Charnley River Station homestead. Photos by R.L. Barrett (A–C) & R. Maher (D–G).

Specimens examined: WESTERN AUSTRALIA: N side of wide gorge on S arm of Bachsten Creek, S border of Prince Regent River Reserve, 1 Feb. 1999, *M.D.Barrett & K.W. Dixon MDB 705* (PERTH); Gwen's Gorge, Edkins Ra., 6 Dec. 1994, *R.L.Barrett* & *M.D.Barrett RLB 949* (PERTH); beside small basalt hill, 2 km SW of Mount Fyfe, 04 Jan. 2001, *R.L.Barrett & M.D.Barrett RLB 1535A* (PERTH); *c.* 8.5 km NE of Mount Agnes, 6 Jan. 2001, *R.L.Barrett & M. O'Connor RLB 1573* (CANB, PERTH); Theda Station, *c.* 2 km S of homestead beside Kalumburu Road, 19 Feb. 2006, *R.L.Barrett* & *M.D.Barrett RLB 3190* (PERTH); Mission Station, Napier Broome Bay, 10 Dec. 1904, *G.F.Hill 21* (PERTH). NORTHERN TERRITORY: Kakadu National Park, Ranger Uranium Lease, 22 Apr. 1991, *K.Brennan 1418* (DNA); Berry Springs, *c.* 60 km S of Darwin, 24 Jan. 1978, *M.A.Clements 1044* (CANB); near Mt Howship, East Alligator River area, Arnhem Land, 18 Feb. 1984, *D.L.Jones 1438* (DNA); 15 km N Gray's Bay, NE Arnhem Land, 28 Feb. 1988, *D.Lucas & J.Russell-Smith 5076* (DNA). QUEENSLAND: Thursday Island, 1989, *J.R.Clarkson 7745* (CBG); near Port Curtis, 1981, *P.D.Hind 2893* (NSW); Thursday Island, hill near hospital, Feb. 1989, *D.L.Jones 3702* (CBG, NSW); Keats Island, 1999, *B.S.Wannan 1463* (NSW).

Distribution: North Kimberley, from Beverley Springs Station homestead, Prince Regent River, Mount Fyfe, Mitchell Plateau and Theda Station, also occurs in the Northern Territory, Queensland and Papua New Guinea.

Conservation status: Rarely seen in flower due to the brief flowering period (*c.* 1 week) and scattered occurrence, however the species is relatively widespread and not under immediate overall threat. Frequent fire may, however, be threatening some individual populations due to destruction of vine thicket habitats that maintain vital leaf litter and soil moisture levels.

Ecology: Occurs in a variety of habitats, usually in dark, peaty soils, from open Eucalypt woodland dominated by *Eucalyptus miniata, E. obconica* and *E. tetrodonta* with *Murdannia nudiflora*, *Premna herbacea*, *Sorghum* sp. to dense vine thicket with *Antidesma ghaesembila*, *Dioscorea bulbifera*, *Dipodium ammolithum* and *Ficus virens*.

It appears that clonal populations may persist for some time in habitats which are not their preferred ecological niche. In several instances, populations have been observed in relatively open woodland, usually beside creeks. Jones (2021) also reports this species from swamp margins. It is possible that minor recruitment can occur into open woodland, however the potential for successful sexual reproduction and long-term persistence of such populations is unknown.

Phenology: Flowers November–December.

Affinities: Perhaps closest to *N. aragoana* Gaudich., differing from it and all other Australian species in having ovate rather than cordate, circular or peltate leaves.

Notes: A rarely collected species in Western Australia, only one flowering specimen, collected in 1904, was known until December 1994 when it was found flowering in the Edkins Range, on the Mitchell Plateau and on Theda Station and more recently beside Beverley Springs (Charnley River) Station Homestead (R. Maher pers. comm.). In the Edkins Range, one gorge supports three large and several small colonies on rainforest slopes, the largest of which contains over five hundred plants, most of which are probably clonal. Flowering occurs soon after the first heavy wet-season rains.

Common name: Ribbed shield orchid.

Pecteilis Raf., *Fl. Tellur*. 2: 37 (1836 [1837]). *Lectotype*: *P. susannae* (L.) Raf., designated by Schlechter, *Repert. Sp. Nov. Regni Veg*. 4: 120 (1919).

Synmeria Nimmo in J.Graham, *Cat. Pl. Bombay, Add.*: s.p. (1839). *Type*: *S. schizochilus* Nimmo.

Centrochilus Schauer, *Nov. Actorum Acad. Caes. Leop.-Carol. Nat. Cur.* 19(Suppl. 1): 435 (1843). *Type*: *C. gracilis* Schauer.

Kraenzlinorchis Szlach., *Orchidee* (*Hamburg*) 55: 57 (2004). *Type*: *Kraenzlinorchis mandersii* (Collett & Hemsl.) Szlach.

Smithanthe Szlach. & Marg., *Orchidee* (*Hamburg*) 55: 172 (2004). *Type*: *Smithanthe rhodocheila* (Hance) Szlach. & Marg.

Plantaginorchis Szlach., *Richardiana* 4: 61 (2004). *Type*: *P. plantaginea* (Lindl.) Szlach.

[*Fimbrorchis* Szlach., *Orchidee* (*Hamburg*) 55: 489 (2004), *p.p.* as to *Pecteilis medioflexa* (Turrill) M.A.Clem. & D.L.Jones.]

Pecteilis elongata (R.Br.) M.A.Clem. & D.L.Jones, *Austral. Orchid Review* 83(6): 51 (2018); *Habenaria elongata* R.Br., *Prodr*. 313 (1810).

Lectotype: Northern Territory: Arnhem South [Caledon] Bay, Point U1, 6 Feb. 1803, *R.Brown* [*Bennett* No. 5540] (lecto: BM 000032259, designated by M.A.Clements, *Austr. Orchid Res.* 1: 85 (1989); isolecto: BM 000032260, E 00373992, ?E 00373993, ?K-LINDL K000061930, K 000827069, ?K 000827070).

Residual syntypes: Carpentaria, 1802/3, *R.Brown s.n.* (syn: AMES, K 000827068).

Habenaria millari F.M.Bailey, *Bot. Bull. Dept. Agric. Queensl.* 3: 18 (1891). *Type*: Queensland: Walsh River, *T.Barclay-Millar* (holo: BRI AQ0279604).

Habenaria triplonema Schltr., *Repert. Sp. Nov. Regni Veg.* 9: 435 (1911); *Pecteilis triplonema* (Schltr.) M.A.Clem. & D.L.Jones, *Austral. Orchid Review* 83(6): 51 (2018). *Type*: Northern Territory: Near Port Darwin, 1889, *M.Holtze* 979 (holo: B†; iso: MEL 108319).

Illustrations: Lavarack & B.Gray, *Trop. Orchids Austr.* pl. 10 & 12 (1985), as *H. triplonema*; D.L.Jones, *Native Orchids Austr.* 340, fig. (1988), as *H. triplonema*; Dockr. *Austr. Indig. Orchids* 1 (edn. 2): 218, 220, figs (1992), as both *P. elongata* and *P. triplonema*; A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg.* 1011, fig. 303g (1992), as *H. elongata*; Mabb. & D.T.Moore, *Bull. Nat. Hist. Mus. London, Bot. ser*. 190, pl. (1999), as *H. elongata*; D.L.Jones,

Compl. Guide Austr. Orchids (edn 2); 341, 344, pls (2006), as both *P. elongata* and *P. triplonema*; A.P.Brown *et al. Orchids West. Austr.,* pls p. 390, 393 (2008), as *H. triplonema*; A.P.Brown *et al.*, *Field Guide Orchids West. Austr.,* pls p. 473, 494 (2013), as *H. elongata*; D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 609 pl., fig. (2021), as both *P. elongata* and *P. triplonema*.

Erect geophytic *herb*, 30–80 cm tall, slender or moderately robust. *Leaves* 2–6, basal or one may be low down on the stem, 60–120(–150) mm long, 5–15(–20) mm wide, narrowly ovate to obovate, acute, often canaliculate, glabrous. *Inflorescence* a raceme of 10–25(–40) flowers, each flower subtended by a bract 5–7 mm long, tapered to a fine point; a few larger bracts on the rachis below the first flower, up to 24 mm long. *Pedicels* 2–5 mm long. *Ovaries* 10–14 mm long at anthesis, straight to slightly curved. *Flowers* white or cream; dorsal sepal and petals forming an erect galea; dorsal sepal 4–6 mm long, 3–4 mm wide, ovate, obtuse; lateral sepals spreading, 5–7 mm long, 2.5–3 mm wide, narrowly ovate and curved, acute; petals when flattened 5–7 mm long, 2.5–3 mm wide, falcate-triangular, obtuse, often with a small tooth-like lobe near the base of the anterior margin; labellum with three long, filiform lobes, the lateral lobes curved or twisted, usually asymmetrical, 15–25 mm long, the central lobe straight, 5–8 mm long, spur 20–35 mm long, 0.5–1.5 mm diam., dilated in the distal third, curved or even curled; column *c.* 1.5 mm long, auricles claviform, *c.* 0.5 mm long; anther thecae widely separated, parallel, thecal tubes one-third to as long as, but much more slender than the stigmatophores; stigmatophores *c.* 3 mm long, subcylindrical. *Capsule* 14–18 mm long, *c.* 3 mm wide. (Figure 17).

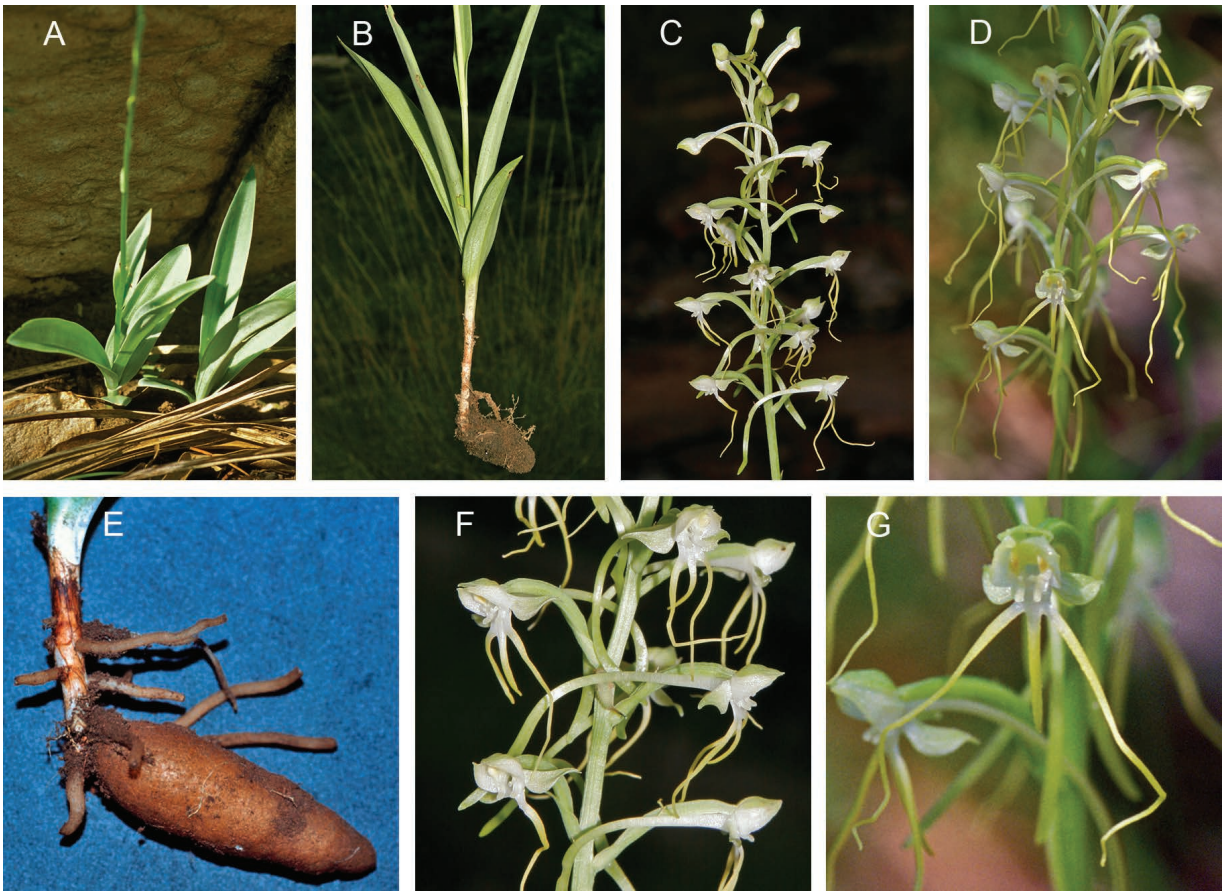

Fig. 17. *Pecteilis elongata*. A. Habit. B. Leaves and tuber. C, D. Inflorescence. E. Fleshy roots and tuber. F, G. Flowers. Vouchers: A, D, E, G: *R.L.Barrett RLB 1751* (PERTH); B, C, F: *R.L.Barrett, M.D.Barrett & M.Maier RLB 6489* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Specimens examined: WESTERN AUSTRALIA: 5 km due E of junction of Pitta Creek and Prince Regent River, 11 Jan. 2001, *M.D.Barrett & R.L. Barrett MDB 1193* (PERTH); 5.2 km SW of junction of Pitta Creek and Prince Regent River, 28 Jan. 2007, *M.D.Barrett & R.L.Barrett MDB 1836* (PERTH); Edkins Range, on Walcott Inlet track, 80 km N of Beverley Springs Station Homestead, 26 Dec. 1995, *R.L.Barrett & M.D.Barrett RLB 646* (PERTH); Synnot Ra., 25 km NW of Beverley Springs Stn Hstd, 14 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 709* (PERTH); cultivated at Beverley Springs Stn Hstd ex Edkins Ra., 80 km N of Beverley Springs Stn Hstd, 24 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 743* (PERTH); cultivated at Beverley Springs Stn Hstd ex

Edkins Ra., 63 km N of Beverley Springs Stn Hstd, 4 Feb. 1996, *R.L.Barrett* & *M.D.Barrett RLB 795* (PERTH); 'Leptospermum Falls', Prince Regent River Reserve, 10 Jan. 2001, *R.L.Barrett* & *M.D.Barrett RLB 1699* (CANB, PERTH); 3 km SW of Mount Fyfe, 11 Jan. 2001, *R.L.Barrett RLB 1751* (CANB, PERTH); 2 km S of Bachsten Creek Camp, in Edkins Range, 26 Jan. 2010, *R.L.Barrett, M.D.Barrett & M.Maier RLB 6489* (PERTH); 15 km S of Mitchell River Station Road turn-off, from King Edward [River], Mitchell Plateau Road, Mitchell Plateau, NW Kimberley, 07 Feb. 1979, *K.F.Kenneally 7071* (PERTH); Mitchell Plateau Mining Camp, 17 Jan. 1979, *J.Smith s.n.* (PERTH). NORTHERN TERRITORY: Kapalga; Kakadu National Park, 25 Jan. 1994, *J.Egan 3057* (DNA); Port Darwin, *n.d.* [?1889], *M.W.Holtze 1058* (MEL); Kapalga gate dividing buffalo and non-buffalo plots, 15 Feb. 1984, *D.L.Jones 1415* (DNA); 2 km W of Bankas Jungle, 10 Mar. 1994, *S.Taylor 162* (DNA); Milingimbi; Arnhem Land, 19 Mar. 1987, *G.M.Wightman 3509* (CANB, DNA). QUEENSLAND: near Bamaga, 1986, *B.Gray 4291* (CANB); Fly Point, Albany Passage, northern end of Newcastle Bay, Cape York Peninsula, 15 Feb. 1986, *D.L.Jones 2300* (CANB); Moa Island, *c.* 1 km NW of Kubin, near airstrip, 14 Feb. 1989, *D.L.Jones 3623* (CBG, NSW); Moa Island, *c.* 1 km NW of Kubin, near airstrip, 15 Feb. 1989, *D.L.Jones 3641* (CBG).

Distribution: North Kimberley, from the Synnot Range, north to the Mitchell Plateau and Theda Station, east to the north-west Northern Territory, Walsh River in Queensland and recorded in the Western Province of Papua New Guinea by Renz (1987) and Kolanowska *et al.* (2021).

Conservation status: Relatively widespread, and relatively common in the Prince Regent National Park. Not considered threatened.

Ecology: Occurs on shallow sand amongst sandstone with *Triodia* spp., recorded with *Corymbia torta* ssp. *torta*, *Corymbia* ?*greeniana*, *Cymbopogon procerus*, *Eucalyptus tetrodonta*, *Gardenia* spp., *Goodenia sepalosa*, *Terminalia canescens*, *T. ferdinandiana*. Usually in dryer locations than other terrestrial orchids in the Kimberley.

Phenology: Flowers January–February.

Affinities: Probably most closely allied to *P. mutica* (Span.) M.A.Clem. & D.L.Jones, which has narrow, erect leaves and very thin lateral labellum lobes, and *P. leptophylla* (Renz) M.A.Clem. & D.L.Jones, which also has narrow, grass-like leaves.

Notes: Original collections of *Habenaria elongata* were made by Brown at five different locations in the Gulf of Carpentaria (Mabberley & Moore 2022), but it is not always possible to link duplicates to particular locations, so some duplicates are listed above with '?' as they may be syntypes for other locations.

There has been long-standing confusion as to the putative differences between *Pecteilis elongata* and *P. triplonema*. Each author treating these two taxa provides differing, subtle characters on which to separate them, but the differences observed may only be regional variation within a single taxon. Dockrill (1969) considered *P. elongata* to have lateral labellum lobes of unequal length, equal in *P. triplonema*. This character is variable for *P. elongata*, notably, the lobes on the type specimen being equal in length. Renz (1987) studied material of *P. elongata* from New Guinea, and in examining descriptions of *P. triplonema*, considered it likely that the two names were conspecific. Wilson (1992) noted that *P. elongata* was very similar to *P. triplonema*, but gave no differences between the taxa. Jones (2002) considered *P. elongata* and *P. triplonema* to be distinguishable based on flower colour and twisting of the lateral lobes of the labellum. Jones (2006) considered the lateral lobes of the labellum to diverge at different angles from the midlobe, 50–80° for *P. elongata* and 30–40° for *P. triplonema*, but these differences are not consistent between populations assigned to either taxon. Jones (2021) provides comparative illustrations which highlight potential differences in the length of the lateral lobes of the labellum, and in the shape of the column, raising the possibility that a second entity should be recognised.

Examination of the original description of *P. triplonema* by Schlechter (1911) showed that he did not compare his new species with *P. elongata* directly, rather with the Indonesian species *P. mutica* Span. Given that the holotype of *P. triplonema* was destroyed, previous authors have been unable to determine if there are reliable differences between these two taxa. There are a large number of Schlechter duplicates extant at NSW (Blaxell 1973), but no material of *P. triplonema* has been found there. Christenson (1987) has documented Schlechter material at PR and S. Steudel *et al.* (2012) recently identified a large number of duplicates of Schlechter Orchidaceae type specimens at Z and ZT that had not previously been recognised as isotypes, but duplicates of *P. triplonema* were not found. However, authentic isotype material has recently been recognised at MEL and after examination of this specimen we here consider *P. triplonema* to be a synonym of *P. elongata*. Further study of variation in this taxon, and the application of the name *Habenaria millari* F.M.Bailey is encouraged.

Common names: White rein orchid, Twisted rein orchid, Three-lobed butterfly orchid.

Pecteilis eurystoma (Schltr.) M.A.Clem. & D.L.Jones, *Austral. Orchid Review* 83(6): 51 (2018); *Habenaria eurystoma* Schltr., *Repert. Spec. Nov. Reg. Veg. Beih*. 10: 248 (1912). *Lectotype*: Queensland: Newcastle Range, 1875, *W.E. de M.Armit* 390 (syn: B†; lecto: MEL 108303), designated by M.A.Clements, *Austr. Orchid Res.* 1: 86 (1989).

Residual syntype: Northern Territory: Port Darwin, 1886, *M.Holtze* 651 (syn: B†; MEL 108304).

Habenaria praecox Lavarack & Dockrill, *Austrobaileya* 5(2): 331, f. 1 (1999); *Pecteilis praecox* (Lavarack & Dockrill) M.A.Clem. & D.L.Jones, *Austral. Orchid Review* 83(6): 51 (2018). *Type*: Queensland. North Kennedy District: about 12 km south of Cardwell, 18 23'S, 146 05'E, 6 Feb. 1997, *P.S.Lavarack PSL 4001* (holo: BRI-AQ0716327; iso: CANB 523191, NSW 503587).

Habenaria halata D.L.Jones, *The Orchadian* 13: 518 (2002); D.L.Jones, *Compl. Guide Austr. Orchids* 342, pl. (2006); *Pecteilis halata* (D.L.Jones) D.L.Jones, *Austral. Orchid Review* 84(1): 19 (2019). *Type*: Northern Territory: Yarrawonga Swamp, 20 km E of Darwin, 15 Dec. 1984, *D.L.Jones 1740* (holo: DNA D0025719).

Habenaria sp. Beverley Springs Station (M.D. Barrett MDB 185), Western Australian Herbarium. (1998–). FloraBase – The Western Australian Flora. Department of Environment and Conservation. http://florabase.dpaw.wa.gov.au/ [accessed 14 August 2012].

Habenaria ochroleuca auct. non R.Br.: Dockrill, *Austr. Indig. Orchids* (edn. 1); 1: 38, pl. 28 (1969), *p.p.* as to Kimberley.

Habenaria joesmithii K.W.Dixon, R.L.Barrett & M.D.Barrett in A.P.Brown *et al.*, *Field Guide Orchids West. Austr.,* pls p. 496–497 (2013), *nom. inval.*

Illustrations: A.P.Brown *et al*. *Orchids West. Austr.,* pl. p. 393 (2008); A.P.Brown *et al.*, *Field Guide Orchids West. Austr.,* pls p. 494, 496, 497 (2013), both as *H. joesmithii* ms; ?Liddle *et al.*, *Field Guide Pl. Darwin Sandsheet Heath* [27], pl. (2017).

Tuberous terrestrial *herb* growing in loose groups. *Tubers* broadly ovoid, 3.5–4.6 cm long, 1–2.2 cm wide, fleshy. *Leaves* obliquely erect, 3 or 4, radical, blade flat to somewhat conduplicate or canaliculate, linear-lanceolate, 2.5–11(–15) cm long (short at anthesis, elongating with age), 6–11(–18) mm wide, dark to dull green, acute to apiculate. *Inflorescence* 12–39 cm tall, slender, *c.* 4 mm diam. near base, *c.* 2.7 mm diam. below the first flower, smooth until just below flowers when becoming ribbed, 11–30-flowered; sterile bracts 3–9, lanceolate, 3.5–14(–23) mm long, 1.5–2.4(–3.5) mm wide, sheathing at the base, long-acuminate; fertile bracts lanceolate, 3–13 mm long, 1–2.5 mm wide, base sheathing. *Pedicels* slender, *c*. 3 mm long, straight or slightly curved. *Ovary* linear to very narrowly ovate, becoming curved, 7–12.5(–21) mm long, 1–1.5(–2.4) mm wide, curved near the apex. *Flowers* 7–12 mm diam., white to very slightly greenish, sweetly fragrant in the morning, moderately spaced, 30–60% overlap between flowers. *Dorsal sepal* pale to dark green, erect, broadly ovate, 2.4–4.7 mm long, 1.8–4.0 mm wide, slightly cucullate, faintly 3-nerved. *Lateral sepals* widely divergent, ovate, 4–6 mm long, 1.7–2.2(–4.0) mm wide, slightly asymmetric to somewhat deltoid, faintly 3-nerved, apex acute. *Petals* erect, ovate to broadly ovate, 3.7–5.4 mm long, 1.7–3.2 mm wide, anterior margin near base with a shallow, rounded flange, apex shallowly acute. *Labellum* obliquely deflexed, 6.2–9.2 mm long, 10–19.1 mm wide when flattened, deeply trilobate; base 2.7–4.6 mm long, 2.2–3.8 mm wide; lateral lobes widely divergent, straight to curved upwards near the tips, narrowly linear, 4.5–9.1 mm long, 0.75–1.8 mm wide, distal margins slightly erose, apex obtuse; mid-lobe almost straight to slightly obliquely deflexed, very narrowly triangular, 4.0–6.9 mm long, 0.8–2.0 mm wide, margins slightly irregular, apex usually obtuse. *Spur* shallowly recurved in distal half, 7.9–9.3(–10.3) mm long, 1.8–2.1 mm wide near mouth, gradually tapering to a constriction 1.0–1.1 mm wide, then expanding to a maximum width of 1.8 mm near tip, slightly curved; throat inside diam. 1.3–1.6 mm. *Column* bluntly porrect, 1.8–2.7 mm long, 2.0–2.5 mm wide, 1.3–1.9 mm thick; auricles linear-cylindrical, *c*. 2.1 mm long, obtuse; stigmatophores cylindrical, 0.8–1.5 mm long. *Anthers* 1.1-1.3 mm long, *c.* 0.6 mm wide, oblong, yellow turning spotted brown in age, apex acute, the anther sacs widely separated; anther channels clavate, 0.3–0.5 mm long. *Rostellum* vestigial. *Pollinia* narrowly ovoid, *c*. 1.2 mm long, 0.7 mm wide, yellow, sectile; pollinia stalks *c.* 0.5 mm long, cream, attachment pads *c.* 0.3 mm across. *Capsules* erect, narrowly obovoid, 9.4–12.9(–21) mm long, 2.0–4.2 mm wide. (Figure 18)

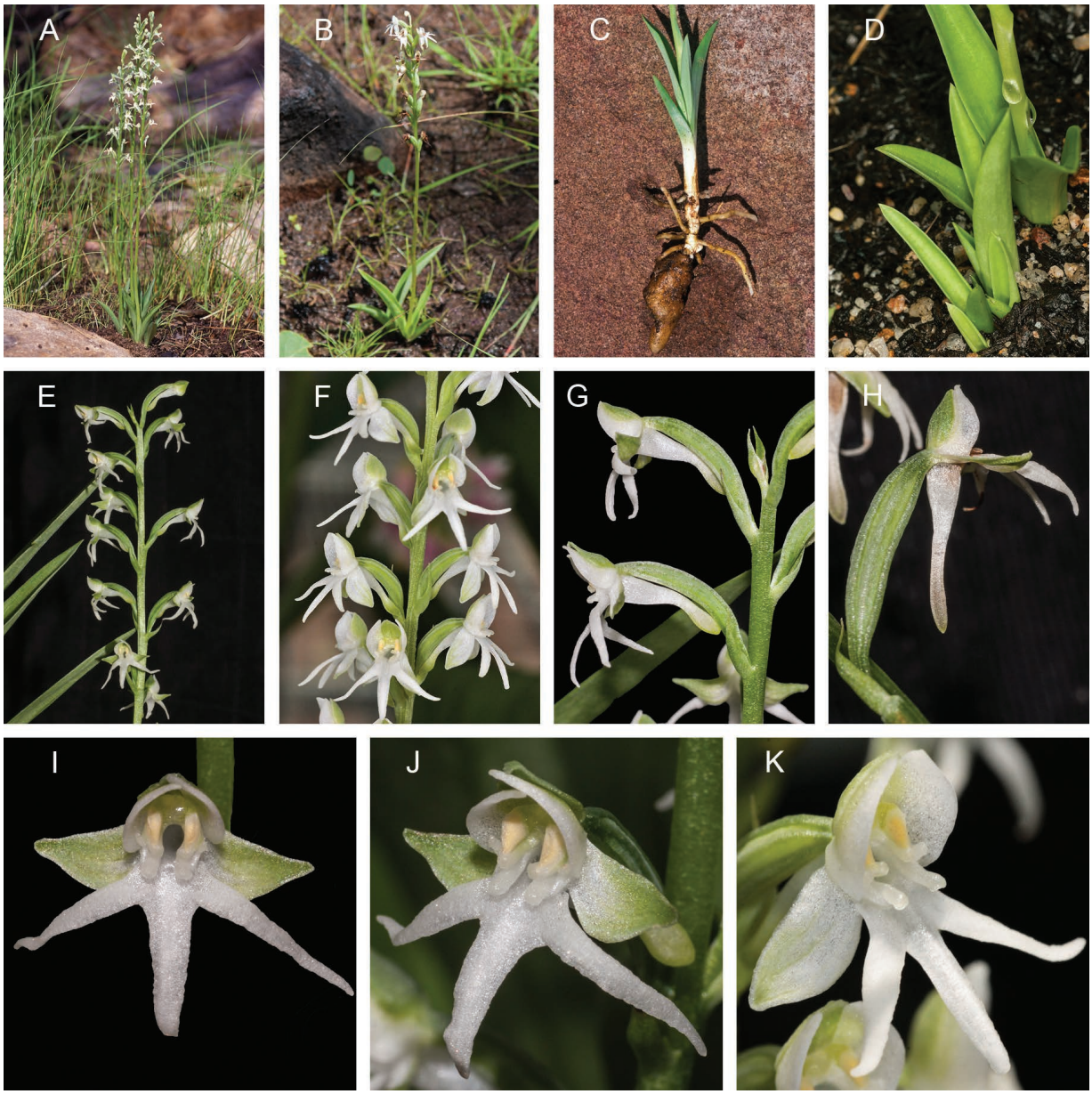

Fig. 18. *Pecteilis eurystoma*. A, B. Habit. C. Leaves, roots and tuber. D. Leaves. E, F. Inflorescence. G–J. Flowers. Vouchers: A–C: *R.L.Barrett & K.W.Dixon RLB 1648* (PERTH); (D–K): not vouchered, cultivated at Kings Park & Botanic Garden, from Edkins Range. Photos by R.L. Barrett & M.D. Barrett.

Diagnostic characters: Differs from *P. ochroleuca* in the forward-projecting lateral labellum lobes. Differs from *P. vatia* in the lateral labellum lobes not recurved towards the apex.

Specimens examined: WESTERN AUSTRALIA: 0.5 km NW of Beverley Springs Station Homestead, W Kimberley, 10 Feb. 1993, *M.D.Barrett 185* (PERTH); Theda Station access gate, SE of homestead, north Kimberley region, 15 January 2016, *M.D.Barrett MDB 4918* (PERTH); *c.* 5 km SW of Mt Fyfe, Drysdale River Station 30 Jan. 2000, *M.D.Barrett & K.W.Dixon MDB 983* (PERTH); 3.5 km NW of Mt Agnes, near Prince Regent River, 9 Jan. 2001, *M.D.Barrett 1172* (PERTH); 18.8 km WNW of Munja Airstrip, Harding Range plateau, Harding Range, N of Walcott Inlet, W Kimberley, 19 Jan. 2007, *M.D.Barrett & R.L.Barrett MDB 1799* (CANB, PERTH); beside Long Creek, 15 km NW of Beverley Springs Stn Hstd, 7 Jan. 1996, *R.L.Barrett & M.D.Barrett RLB 696* (PERTH!); Edkins Ra., 78 km NNW of Beverley Springs Stn Hstd, 11 Jan. 1995, *R.L.Barrett & M.D.Barrett RLB 955* (PERTH); *c.* 3 km SE of Mount Fyfe, 7 Jan. 2001, *R.L.Barrett & K.W.Dixon RLB 1632* (PERTH); *c.* 8 km N of Charnley River crossing on Walcott Inlet track, Edkins Range, 8 Jan. 2001, *R.L.Barrett & K.W.Dixon RLB 1648* (PERTH); Theda Station, *c.* 2 km SE of homestead S. of rubbish dump, beside Kalumburu Road, 21 Feb. 2006, *R.L.Barrett & M.D.Barrett RLB 3252* (PERTH); 'Isoetes Creek' (informal name), W of Quail Creek, 15.9 km SSE of Kings Cascades, Prince Regent River Reserve, 22 Jan. 2007, *R.L.Barrett & M.D.Barrett RLB 3760* (PERTH); Youwanjela pavement 1, 26.7 km E of Kings Cascades; 12.4 km

NNE of junction of Youwanjela Creek and Prince Regent River, Prince Regent Nature Reserve, 25 Jan. 2007, *R.L.Barrett* & *M.D.Barrett RLB 3842* (PERTH); Track S of Airfield, Mitchell Plateau, N Kimberley, 26 Jan. 1982, *K.F.Kenneally 7995* (PERTH 00250988); Airfield Swamp, Mitchell Plateau mining camp, 15 Jan. 1979, *J.Smith s.n*. (PERTH). NORTHERN TERRITORY: Arnhem land: *c*. 22 km NE of Oenpelli Mission, 17 Feb. 1973, *L.G.Adams 2994* (CANB); Kakadu National Park, Ranger Uranium Mine, 19 Dec. 1991, *K.Brennan 1705* (DNA); Cobourg Peninsula; N of track to Raffles Bay pearl farm, 1 Feb. 2005, *I.D.Cowie 10408* (CANB); Jabiru, swamp N airport, 11 Dec. 1984, *D.L.Jones 1715* (CANB, DNA); Djapididjapin about 12 miles [19 km] from Nangalala, 15 Jan. 1973, *H.Reeve 583* (CANB); Nhulunbuy, East Woody Beach, 12 Feb. 1988, *J.Russell-Smith 4704* (DNA). QUEENSLAND: Iron Range, 19 Dec. 1988, *L.Lawler 144* (CANB); McIlwraith Range, 1999, *B.S.Wannan & R.Jago 1110* (NSW).

Distribution: From Beverley Springs [Charnley River] Station, Mt Elizabeth Station, and Edkins Range, north to the Mitchell Plateau and Theda Station in the north Kimberley region of Western Australia. As broadly defined here, also in the top end of the Northern Territory, and far north Queensland.

Etymology: From the Latin *eurys* (broad) and *stoma* (mouth), in reference to the mouth of the spur.

Conservation status: Very common on seasonally wet sand flats over sandstone in the north-west Kimberley and not under threat.

Ecology: Occurs on sand flats over laterite and sandstone. Recorded in association with *Acacia nuperrima, Calochilus barbarossa*, *Calochilus kimberleyensis*, *Crinum uniflorum*, *Drosera* aff. *paradoxa*, *Empusa habenarina*, *Eucalyptus apodophylla*, *Eulophia bicallosa*, *Fimbristylis* spp., *Grevillea pteridifolia, Haemodorum brevicaule*, *H. flaviflorum*, *Pandanus darwinensis*, *P. spiralis*, *Stylidium prophyllum*, *S. rubriscapum*, *Utricularia chrysantha* and *Xyris complanata*.

Phenology: Flowers and fruits December–February.

Notes: In WA first recorded from the Mitchell Plateau (Dixon *et al*. 1989) and mentioned in Wilson (1992) as a form of *P. ochroleuca*, this species is now known from Theda and Doongan [King Edward River] Stations in the northern Kimberley, south to Beverley Springs Station in the north-west Kimberley. *Pecteilis eurystoma* is perhaps the most numerous orchid species in the Kimberley and individual sand flats can support thousands of plants in suitable habitats.

The first author has searched at B for any traces of the syntypes of *Habenaria eurystoma* and none could be located. A duplicate at MEL was designated as lectotype by Clements (1989).

Pecteilis eurystoma is here broadly defined to include *P. praecox* (Lavarack & Dockrill) M.A.Clem. & D.L.Jones (see Lavarack and Dockrill, 1999), *P. halata* (D.L.Jones) D.L.Jones and *Habenaria* sp. Beverley Springs Station (M.D. Barrett MDB 185). Jones (2021) maintained *P. eurystoma*, *P. halata* and *P. praecox* as distinct species, but if this status is justified, the distinction between each remains to be clearly defined. We remain open to the idea that some or all of these taxa represent distinct entities, especially given significantly disjunct distributions, however each is sufficiently morphologically variable that we have been unable to identify consistent morphological differences between them at present. Molecular data will likely be required to test species limits in this complex. *Pecteilis eurystoma* may also be related to *P. ochroleuca*. The description above is based entirely on WA material, so that any future changes to concepts will not necessitate re-description for this region.

The taxon illustrated by Renz (1987) as *Habenaria ochroleuca* is actually more closely allied to *P. propinquior*.

The flowers of this species are sweetly fragrant.

Common names. Western Butterfly orchid, Sweet Rein Orchid, Early rein orchid.

Pecteilis ochroleuca (R.Br.) M.A.Clem. & D.L.Jones, *Austral. Orchid Review* 83(6): 51 (2018); *Habenaria ochroleuca* R.Br., *Prodr*. 313 (1810). *Type*: Northern Territory: [Pobassoo] Island (Y2), [Arnhem Land], 18 Feb. 1803, *R.Brown* [*Bennett* No. 5539] (lecto: BM 000032261, designated by Clements, *Austral. Orchid. Res.* 1: 86 (1989); isolecto: K 000827061, K 000827062, K 000827063; K-LINDL 000061931).

Syntypes: North Coast, Islands Y1, Z1, Z2, Feb. 1803, *R.Brown s.n.* (syn: BM, K, L, *n.v.*).

Illustrations: D.L.Jones, *Native Orchids Austr.* 339, pl., fig. (1988); Dockr. *Austr. Indig. Orchids* 1 (edn. 2): 216, fig. p. 217 (1992); A.J.G.Wilson in J.R.Wheeler (ed.) *Fl. Kimb. Reg.* 1011, fig. 303h (1992); Mabb & D.T.Moore, *Bull. Nat. Hist. Mus. London, Bot. ser*. 190, pl. (1999); D.L.Jones, *Compl. Guide Austr. Orchids* 343, pl. (2006); A.P.Brown *et al*., *Orchids West. Austr.*, pl. p. 393 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 496 (2013), all as *Habenaria ochroleuca*; D.L.Jones, *Compl. Guide Native Austr. Orchids* (edn 3); 607, pl., fig. (2021).

Erect, geophytic *herb* to 40 cm tall. *Leaves* 3 or 4, 1 or 2 near the base, reducing to sheathing bracts up the stem, oblong or ovate, 20–40 mm long, 12–20 mm wide, acute or acuminate. *Inflorescence* a raceme with 10–25 flowers. *Flowers* white, *c*. 10–14 mm diam., the dorsal sepal and labellum spur often green; pedicels up to 3 mm long. *Perianth*: dorsal sepal erect, 4–5 mm long, 3–4 mm wide, ovate; lateral sepals 4–5 mm long, *c*. 3 mm wide, falcate to narrowly ovate, widely spreading and upcurved; petals forming a galea with the dorsal sepal, 3–4 mm long, *c*. 2 mm wide, falcate-elliptical; labellum deeply 3-lobed and spurred; lateral lobes 7–8 mm long, *c*. 3 mm wide, narrowly falcate-triangular to narrow falcate-subovate, widely spreading and apical third curved up towards the dorsal sepal; midlobe recurved, 5.5–6 mm long, 0.7–1.0 mm wide, linear, obtuse; spur 10–15 mm long, 1.5–2 mm wide, contiguous with the ovary in the proximal third then curved forwards, dilated near apex. *Column c*. 2.5 mm high, auricles *c*. 1 mm long, erect, bluntly conical. *Anther* emarginate or truncate on top, anther locules parallel, 2.5–3 mm long, *c*. 1 mm apart; thecal tubes about 1.5–2 mm long; stigmatophores almost twice as long as the thecal tubes. *Capsule c*. 12 mm long, 4 mm wide. (Figure 19).

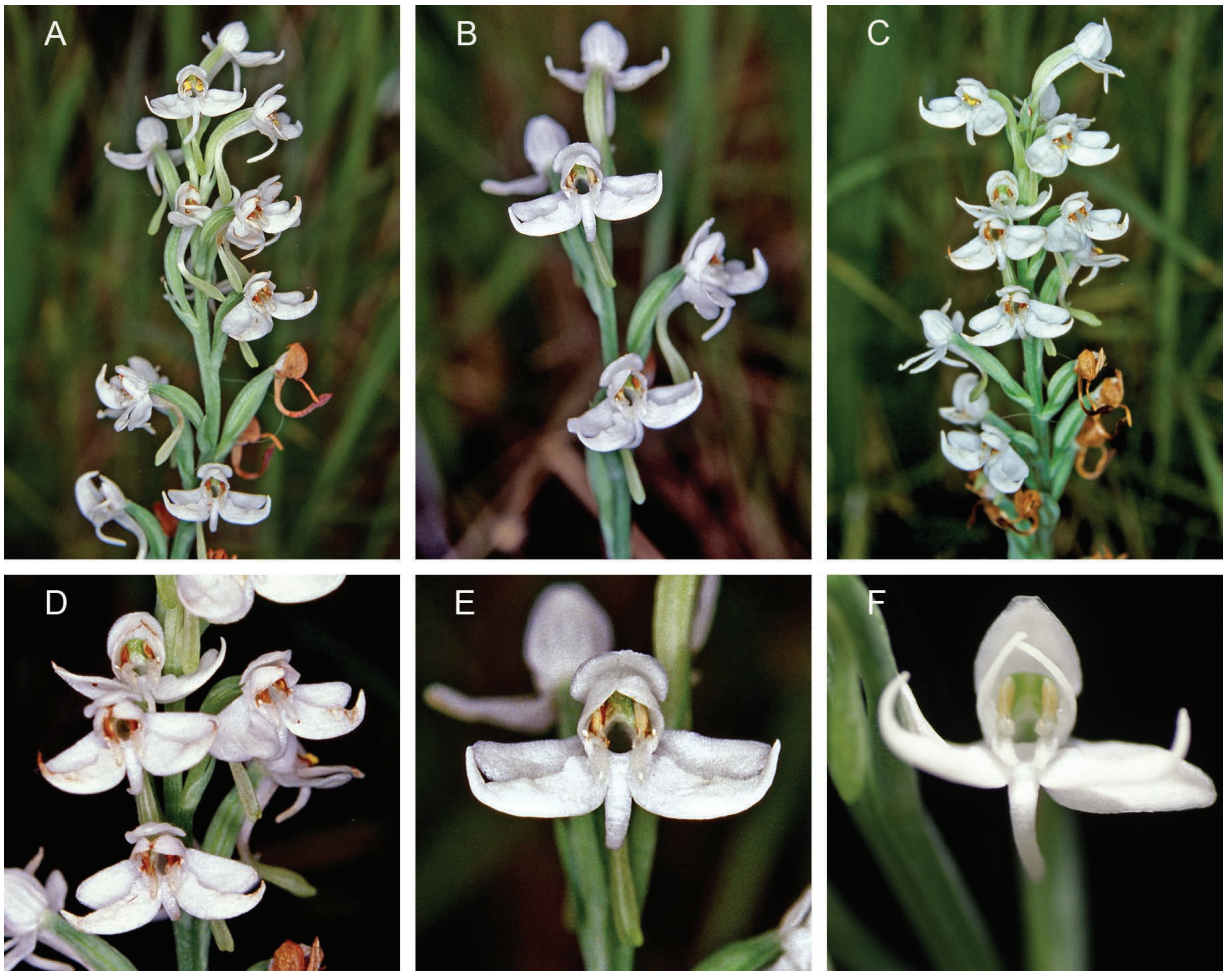

Fig. 19. *Pecteilis ochroleuca*. A–C. Inflorescence. D–F. Flowers. Vouchers: *R.L.Barrett & M.D.Barrett RLB 3209* (PERTH); F: *R.L.Barrett* & *M.D.Barrett RLB 742* (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Specimens examined: WESTERN AUSTRALIA: *c*. 1 km SE of Theda Station Homestead, 30 Jan. 2003, *M.D.Barrett MDB 1445* (PERTH); Theda Station access gate, SE of homestead, north Kimberley region, 15 Jan. 2016, *M.D.Barrett MDB 4919* (PERTH); Synnot Ra., 22 km NW of Beverley Springs Stn Hstd, 12 Mar. 1995, *R.L.Barrett RLB 1028* (PERTH); 0.5 km SSW of Beverley Springs Station Homestead, 05 Apr. 1995, *R.L.Barrett RLB 1069* (PERTH); 0.5 km SSW of Beverley Springs Stn Hstd, 23 Jan. 1996, *R.L.Barrett* & *M.D.Barrett RLB 742* (PERTH); Theda Station, homestead gate at N. end of airstrip, beside Kalumburu Road, 19 Feb. 2006, *R.L.Barrett* & *M.D.Barrett RLB 3209* (PERTH); 6.3 km ESE of old base camp site (Camp Creek Crossing) on Mitchell Plateau–King Edward River Road, 1.3 km N of road at base of low basaltic outcrop, Feb. 1986, *K.W.Dixon 680* (PERTH); Mitchell River, 22 Feb. 1980, *C.R.Dunlop 5232* (PERTH); Mitchell Plateau, near Amax Basecamp, 03 Feb. 1979, *K.F.Kenneally 6968* (CANB, K, PERTH); Adjacent to Amax Basecamp, Mitchell Plateau, 04 Feb. 1979, *K.F.Kenneally 6996* (PERTH). NORTHERN TERRITORY: Arnhem Land district: Elcho

Island: along road from Gali Winku township to mouth of Wurrmalmirr Creek, 4 Feb. 1978, *M.A.Clements 1165* (CBG); Cobourg Peninsula; just south of Danger Point, 30 Jan. 2005, *I.D.Cowie 10373* (CANB); *c*. 44 km directly ~NNW of Oenpelli, or *c*. 56 km by road, 15 Mar. 1973, *L.A.Craven 2271* (CANB); Angularli Creek, Murganella–Oenpelli Road, 9 Feb. 1984, *D.L.Jones 1359* (CANB); Latram River, NE Arnhem Land, 14 Feb. 1987, *G.M.Wightman 4161* (CANB, DNA).

Distribution: North west Kimberley, Mitchell Plateau, Theda, Doongan (King Edward River), Drysdale River and Charnley River (Beverley Springs) Stations and in the Northern Territory.

Conservation status: This species has a poorly known and scattered distribution, but it is relatively widespread and probably not under threat.

Ecology: Recorded from seasonally wet clay soils in association with *Dipodium basalticum*, *Erythrophleum* aff. *chlorostachys*, *Eucalyptus tectifica*, *Melaleuca minutifolia*, *Murdannia* aff. *graminea*, and *Terminalia canescens*.

Phenology: Flowers January–February(–April).

Affinities: Similar to *P. eurystoma* (including *P. halata* and *P. praecox*), each of which have previously been included in *P. ochroleuca*. *Pecteilis ochroleuca* differs in its lateral lobes being strongly reflexed, and having short, semi-cauline leaves.

Notes: While rarely seen in the Kimberley, it is not uncommon in suitable habitats and may be more widespread that current collections indicate.

Common names: Sickle orchid, Bent-lobed butterfly orchid, Moustache orchid.

Phoringopsis D.L.Jones & M.A.Clem., *The Orchadian* 13(10): 457 (2002). *Arthrochilus* subgen. *Phoringopsis* (D.L.Jones & M.A.Clem.) Szlach., *Richardiana* 3(2): 97 (2003). *Type*: *P. byrnesii* (Blaxell) D.L.Jones & M.A.Clem.

Notes: Since the inclusion of tropical species in *Arthrochilus* F.Muell. by Blaxell (1972), and the subsequent segregation of *Phoringopsis* D.L.Jones & M.A.Clem. and *Thynninorchis* D.L.Jones & M.A.Clem. (Jones *et al*. 2002) there has been debate about the recognition of these taxa at generic level, with Australian herbaria differing in their acceptance. The two species groups separated from *Arthrochilus s. str.* each have a set of morphological distinctions detailed by Jones *et al*. (2002; 2006). where *Phoringopsis* is distinguished from its nearest sister genus, *Arthrochilus* F.Muell., by 1 or 2 elongate, distichous basal leaves, inflorescence emerging with the leaves, smooth, non-papillate column foot and sepal bases, labellum attached basally (not via a peltate stalk), and the callus reduced-insectiform and ornamented with penicillate calli in *Phoringopsis*, compared to solitary leaves, inflorescences arising separately from leaves, attached by a peltate stalk, and labellum with an intricately insectiform callus. Miller & Clements (2014) confirmed that each genus was phylogenetically distinct and we therefore here follow the Australian Plant Census and maintain them as separate genera.

Phoringopsis byrnesii (Blaxell) D.L.Jones & M.A.Clem., *The Orchadian* 13(10): 457 (2002). *Arthrochilus byrnesii* Blaxell, *Contr. New South Wales Natl. Herb*. 4: 278–279, pl. 25, fig. D1–2 (1972). *Type*: Northern Territory: Waterfall Creek, South Alligator R., 2 April 1969, *N.Byrnes 1530* (holo: NSW 88430; iso: DNA D0002669*; NT D0002669*).

Illustrations: A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 354, 357 (2008); A.P.Brown *et al*., *Field Guide Orchids West. Austr.*, pls p. 475–477 (2013), both as *Arthrochilus byrnesii*.

Plants terrestrial, tuberous, solitary or growing in small clusters, possibly clonal. *Leaves* 2–3, radical, one much longer than others; the largest leaf linear-lanceolate, to 25 cm long, 8–15 mm broad, narrowed tapered to the base, enclosing the peduncle, mid-green. *Inflorescence* many-flowered, 10–50 cm long, usually exceeding the leaves. *Flowers* widely spaced, lowermost about halfway along the peduncle. *Inflorescence* bract central on peduncle, *c*. 7 mm long, 3 mm wide, ovate-lanceolate, sheathing. Floral bracts similar to inflorescence bract. *Flowers* greenish, 12–20 mm long, on slender pedicels *c*. 5 mm long (excluding ovary). *Ovary* 5 mm long at anthesis. *Dorsal sepal* narrowly spathulate, margins incurved, not enclosing the column, 8–10 mm long, 2.5–3 mm wide. *Lateral sepals* obtuse, falcate, triangular, 6–8 mm long, 1.5–2.5 mm wide. *Petals* 6–9 mm long, 0.5–1.5 mm wide, linear, slightly falcate, obtuse. *Labellum* hinged on foot of column with a short claw, ovate-lanceolate, lamina apex notched; lamina 5–7 mm long, 2.0–2.5 mm wide; top of labellum with a large mushroom-shaped callus *c*. 2 mm high, 2 mm wide, densely covered with hair-like processes, 0.5–1.0 mm long, the apices minutely hairy, a few processes also scattered on the lamina towards the claw. *Callus head* with a sigmoid appendage 2–3 mm long, apex bifid, covered in hair-like processes and warty protuberances, projecting towards the base of the column. *Column* curved, slightly shorter than the dorsal sepal, its base almost at right angles to the ovary and prolonged to form a column "foot" 3 mm long, flattened dorsiventrally

and also at right angles to the ovary. Two pairs of "wings" or auricles are present, the larger pair attached on the sides of the dorsiventrally flattened column about halfway between the ovary and stigma, falcate-triangular, 4 mm long, 1 mm wide at the base which is decurrent on the edge of the column; the smaller pair of auricles attached behind the anther, triangular, 0.5–1 mm long. *Anther* terminal on column. *Stigma* below the anther, cup-shaped, 1–1.5 mm wide, margins crenulate. *Pollinia* 4 clavate, flat, mealy, yellow. *Capsule* glabrous, erect, 8–12.5 mm long, 3–5.5 mm wide. (Figure 20).

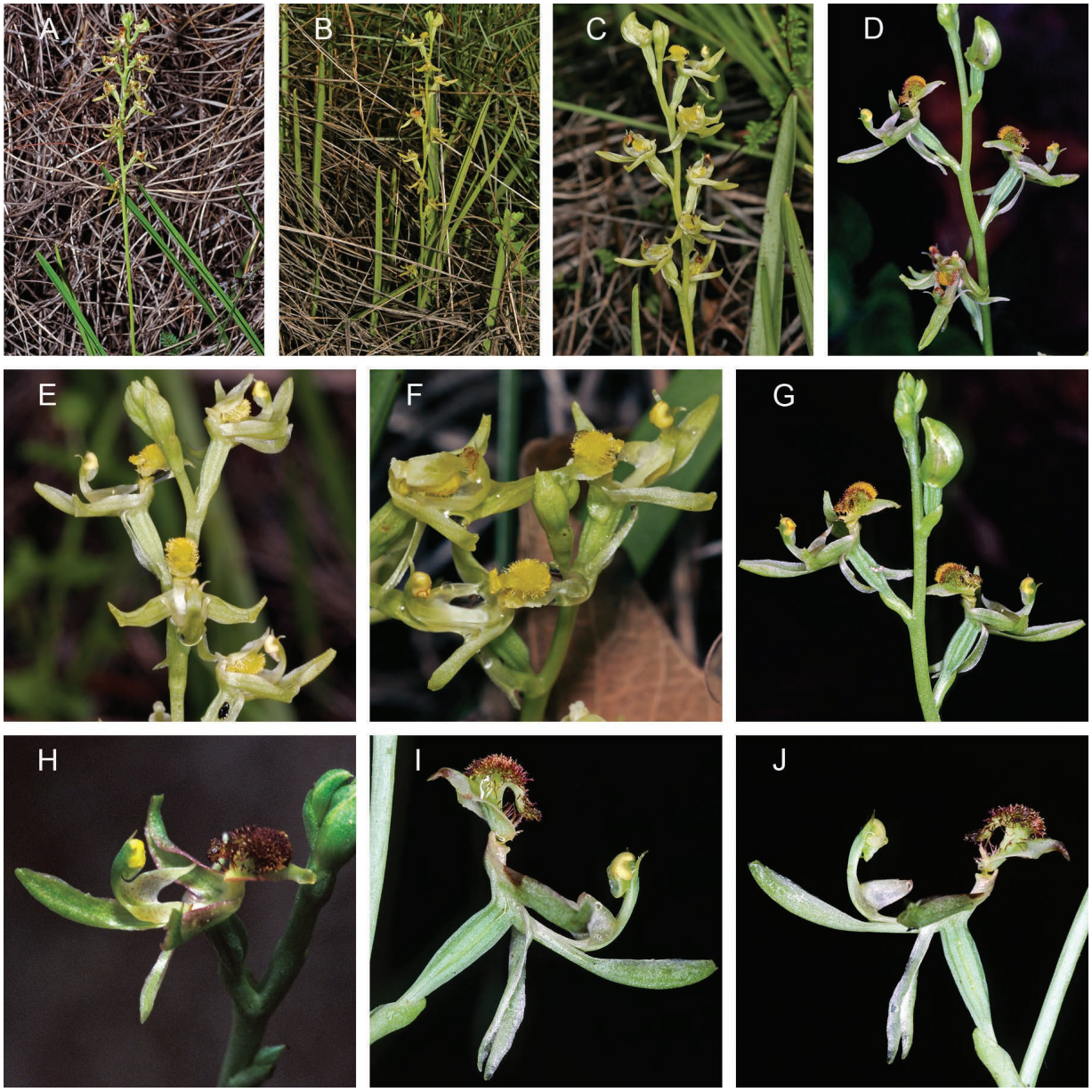

Fig. 20. *Phoringopsis byrnesii*. A, B. Habit and habitat in *Triodia* clumps. C–G. Inflorescences. H–J. Flowers. Vouchers: A–C, E, F: *R.L.Barrett & M.D.Barrett RLB 4025* (PERTH); D, G, I, J: *R.L.Barrett* & *M.D.Barrett RLB 1715* (PERTH); H: *M.D.Barrett* 859 (PERTH). Photos by R.L. Barrett & M.D. Barrett.

Specimens examined: WESTERN AUSTRALIA: 200 m E of summit of Mount Bomford, Drysdale River Station, 25 Jan. 2000, *M.D.Barrett* 859 (PERTH 06347819); 1.2 km E of summit of Mount Bomford, Drysdale Station, 30 Jan. 2000, *M.D.Barrett 991* (PERTH 06347827); edge of Plateau above upper Prince Regent River, 3.5 km E of Mount Agnes, 2 Feb. 2000, *M.D.Barrett 1037* (PERTH 06348696); above narrow gorge off S side of upper Prince Regent River, 4 km NE of N of Mount Agnes, 2 Feb. 2000, *M.D.Barrett 1051* (PERTH 06347835); on massive sheeting sandstone beside Morgan River near Cypress Valley, 2.7 km SE of Theda Station homestead, 23 Feb. 2005, *M.D.Barrett MDB 1694* (PERTH); sandstone pavement, 6.5 km NE of junction of Pitta Creek and Prince Regent River, W of Reserve boundary, 10 Jan. 2001, *R.L.Barrett* & *M.D.Barrett RLB 1715* (PERTH 08042284); sandstone pavement near the headwaters of the Prince Regent River, E of reserve, 21 Jan. 2003,

R.L.Barrett & *M.D.Barrett RLB 2617* (PERTH 08042527); 6.5 km NE of junction of Pitta Creek and Prince Regent River, just outside (E of) Prince Regent Nature Reserve, 28 Jan. 2007, *R.L.Barrett* & *M.D.Barrett RLB 4025* (CANB; PERTH 08042292); sandstone pavement (MP1-2010), Mitchell Plateau, 5 km NW of Surveyors Falls, 24 Jan. 2010, *R.L.Barrett & M.D.Barrett RLB 6408* (PERTH); sandstone pavement on W side of King Edward River, WNW of Theda Station Homestead, 12 Mar. 2014, *R.L.Barrett RLB 8969* (PERTH). NORTHERN TERRITORY: Bradshaw Station, mouth of Victoria River, 6 Apr. 2002, *I.Morris ORG3984* (CANB); upper East Alligator River area, Arnhem Land, 20 Feb. 1991, *J.Russell-Smith 8437* (CANB); Mitmiluk National Park; eastern edge of Marrawal Plateau, 7 Feb. 1996, *J.Russell-Smith 10510* (CANB).

Distribution: In Western Australia, disjunct populations occur from the Prince Regent River north to Theda Station in the north Kimberley region. Also known from disjunct populations on Bradshaw Station and the South Alligator River region of Kakadu National Park in the Northern Territory. This species has recently been identified from the Northwest Highlands of Queensland, adjacent to the Northern Territory border (M.T.Mathieson, pers. comm.)

Conservation status: Restricted in distribution, but locally common in the upper Prince Regent River area, north to Mount Bomford and the King Edward River in Western Australia where it is not considered threatened. Conserved in the Prince Regent National Park and Mitchell River National Park. Listed as Data Deficient in the Northern Territory and Least Concern in Queensland.

Ecology: Grows in shallow sand or rich humus soils, often amongst *Triodia* tussocks on rough sandstone and sandstone pavements on plateaux. In the Kimberley, often growing with *Micraira brevis, M. dunlopii* and *M. lazaridis* and also associated with *Acacia richardsii*, *A. cyclocarpa*, *Borya subulata*, *Byblis filifolia, Calochilus barbarossa*, *C. kimberleyensis*, *Cymbopogon ambiguus*, *Cyperus pygmaeus*, *Dicliptera armata*, *Drosera cucullata*, *D. subtilis*, *Eriocaulon* sp., *Eucalyptus rupestris*, *Fimbristylis* sp., *Gompholobium subulatum*, *Gomphrena affinis*, *Grevillea wickhamii*, *Hibiscus leptocladus*, *Ipomoea eriocarpa*, *Lechenaultia* aff. *filiformis, Mitrasacme laricifolia*, *Murdannia graminea*, *Ricinocarpos rosmarinifolius*, *Rhynchospora* sp., *Stackhousia intermedia*, *Stylidium ceratophorum*, *S.* aff. *osculum*, *S. notabile*, *S.* aff. *quadrifurcatum*, *Thysanotus chinensis*, *Triodia* spp., *Trithuria lanterna*, *Typhonium* sp. Prince Regent River (R.L. Barrett & M.D. Barrett RLB 1716), *Utricularia chrysantha*, *U. magna* and *U. quinquedentata*.

Phenology: Flowers and fruits mainly December–February, but sometimes as late as early April under ideal conditions.

Affinities: Similar to *P. dockrillii* but differs by possession reflexed lateral sepals appressed to the ovary, erect not curved dorsal sepal, labellum insectiform with oblanceolate laminar broadly obtuse and beak-like at apex, central callus ridge beset with lateral accessory penicillate and spiky red calli; column slightly curved forward and lateral spreading, bluntly acute appendages. *Phoringopsis byrnesii* is also similar to but differs from *P. lavarackianum* by possession of glaucous leaf, and labellum callus much more densely covered with penicillate accessory calli.

Also similar to *Arthrochilus latipes*, differing in possession of 1 or 2 erect, elongate, lanceolate leaves, much longer than wide; resupinate flowers, smooth tepal bases; labellum hinge attached in centre of column foot, lacking a peltately attached supporting stalk and the strongly fungiform callus ornamented with long, thin penicillate glands (Jones *et al.* 2006; Jones 2021).

Notes: This species is unusual in its habitat preferences, growing amongst sandstone or on pavement margins dominated by *Triodia* spp.

Common names: Spinifex orchid, Sandstone truffle orchid.

Spiranthes Rich., *Orchid. Europ. Annot.* 20, 28, 36 (1817), *nom. cons*. *Lectotype*: *Spiranthes spiralis* (L.) Chevall., *typ. cons*., designated by M.L.Greene, *Prop. Brit. Bot.* 100 (1929).

Orchiastrum Ség., *Pl. Veron.* 3: 252 (1754), *nom. rej. Type*: not designated.

Triorchis Millán, *Jac. Pet. Opera*: t. 68, f. 7 (1765), *nom. inval.*

Helictonia Ehrh., *Beitr. Naturk*. 4: 148 (1789), *nom. nud. Type*: *Ophrys spiralis* L.

Aristotelea Lour., *Fl. Cochinch*.: 522 (1790), *non* L'Heret (1784). *Type*: *Aristotelea spiralis* Lour. (*non Ophrys spiralis* L.).

Gyrostachis Pers., *Syn. Pl.* 2: 511 (1807), *nom. provis*.

Tussacia Raf. Sch. ex Desv., *Observ. Pl. Angers*: 91 (1818). *Type*: not designated.

Gyrostachys Pers. ex Dumort., *Fl. Belg.*: 134 (1827). *Type*: *G. spiralis* (L.) Pers. ex Blume, selected by Kuntze, *Rev. Gen. Pl.* 2: 663 (1891).

Monustes Raf., *Fl. Tellur.* 2: 87 (1837). *Type*: *Monustes australis* (R.Br.) Raf.

Triorchis Petiver ex Nieuwl., *Amer. Midl. Naturalist* 3: 122 (1913), *nom. superfl.*

Notes: Delimitation of species within *Spiranthes* has been difficult to achieve due to widespread distributions, local variation, high phenotypic plasticity (Pierce & Cribb 2002; Chen *et al*. 2009; Jones & Bates 2015; Pace & Cameron 2017; Tao *et al*. 2018; Pace *et al*. 2019) and hybridisation (Suetsugu *et al*. (2020). Some species complexes are now being resolved using molecular data (Dueck *et al*. 2014; Surveswaran *et al*. 2017, 2018; Frericks *et al*. 2018; Fan & Huang 2019; Pace *et al*. 2019). There has been particular confusion over the application of the name *Spiranthes sinensis* (Pers.) Ames, a matter hopefully now settled by Pace *et al.* (2019).

Spiranthes sinensis (Pers.) Ames, *Orchidaceae* 2: 53 (1908). *Neottia sinensis* Pers., *Syn. Pl.* 2(2): 511 (1807). *Aristotelea spiralis* Lour., *Fl. Cochinch.* (edn 1); 2: 522 (1790). *Epidendrum aristotelia* Raeusch., *Nom. Bot.* (edn. 3); 265 (1797), *nom. superfl. Ibidium spirale* (Lour.) Makino, *J. Jap. Bot.* 3(7): 37 (1926). *Spiranthes aristotelia* (Raeusch.) Merr., *Philippine J. Sci.* 15(3): 230 (1919). *Spiranthes indica* Lindl. ex Steud., *Nom. Bot.* (edn 2); 2: 625 (1841), *nom. inval. Spiranthes spiralis* (Lour.) Makino, *J. Jap. Bot.* 3(7): 25 (1926), *nom. illeg.* *Type*: China: Guangdong: 'Canton' [Guangzhou], *s.d*., *Loureiro 522-1* (holo: P).

Neottia australis var. *chinensis* Ker Gawl., *Bot. Reg.* 7: pl. 602 (1821). *Type*: China: cultivated in England, Mr. Griffin's conservatory at Lambeth, *s.d*., *collector unknown* (holo: Illustration: Bot. Reg. 7: pl. 602 (1821)).

Spiranthes pudica Lindl., *Collect. Bot.* t. 30 (1821). *Type*: China: Cultivated in England, July, *collector unknown* (holo: K).

Spiranthes neocaledonica Schltr., *Bot. Jahrb. Syst., Pflanzen. Pflanzengeog.* 39: 51 (1906). *Type*: New Caledonia: North Province: Ou-Hinna, Jan 1903, *R.Schlechter 15594* (holo: B†).

Spiranthes papuana Schltr. in F.W.L.Kraenzlin (ed.), *Repert. Spec. Nov. Regni Veg. Beih.* 1: 46–47 (1911). *Type*: Papua New Guinea: on flats near the Kenejia Base, *c.* 150 m, Oct. 1908, *R.Schlechter 18338* (holo: B†).

Illustration: N.Hallé, *Fl. Nouv. Caledonie* 8: 478, pl. 190 (1977); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 613 pl., fig. (2021), as *S. papuana*.

Terrestrial *herbs* with perennating rhizome, 10–40 cm tall. *Rhizome c.* 3 mm diam.; roots many, thickened and fleshy, 22-45 mm long, *c.* 2 mm diam., tubers absent. *Stem* erect, leaves clustered towards the base. *Leaves* 2–4 per plant, linear, 40–125 mm long, 5–7 mm wide, pale green, 1-veined, weakly canaliculate in section, apex broadly acute. *Inflorescence* up to 40 cm tall, terete, glabrous, with 2 or 3 sterile bracts sheathing the peduncle, 8–9 mm long, subulate and long-acute, green; flowers *c.* 33, spirally arranged, clustered towards the upper one-fourth of the peduncle with flowers opening from the base, many at anthesis simultaneously. *Flowers* curving forward from the ovary apex, widely open, *c.* 2.8 mm wide, *c.* 3.4 mm long, upper 3 tepals fused except for slight apical notches, and fused at base with lower 2 tepals, pink with a white labellum, glabrous. *Bracts* green, subequal to or slightly shorter than ovary, +/- narrowly cymbiform, 4–6 mm long, *c.* 2 mm wide, attenuate, thin-fleshy, glabrous, sheathing the base of flower, margin white. *Dorsal sepal* conjoined with 2 petals into a 3-toothed structure, pale at the base, grading to dark pink, glabrous, lanceolate, 1.5–1.7 mm long, *c.* 0.8 mm wide, obtuse. *Lateral sepals* fused at base to each other and to petals, pale at the base, grading dark pink, glabrous, lanceolate, 1.5–1.7 mm long, *c.* 0.7 mm wide, obtuse. *Petals* pale at the base, grading dark pink, glabrous, irregular in shape, 1.5–1.7 mm long, *c.* 0.7 mm wide, apex obtuse. *Labellum* white, exceeding tepals, concave, distinctly divided into hypochile and epichile with a constriction in the middle, glabrous on the outer surface, *c.* 3.5 mm long; hypochile dilated at the base, concave, ovate, *c.* 3.0 mm long, 2.0–2.8 mm wide, attached at the base of short foot below the column, with one semi-globular gland on each side, lobes suborbicular with entire margins, raised upwards till the constriction; epichile semi-tunicate, slightly flabellate, *c.* 1.3 mm long, *c.* 1.0 mm wide, margin undulate, slightly crenulate to denticulate or almost fimbriate with some papillose hairs on the front semi-tunicate part, apex abruptly broadly rounded. *Column* green-white, obconical, *c.* 1.5 mm long, 0.3 mm at the base, 0.5 mm wide towards the apex, base cordate, *c.* 0.5 mm long, glabrous, *c.* 1/3 the length of the labellum; stigma at the apex on the lower side, green in colour. *Rostellum* well developed. *Pollinarium* yellow, long clavate, with a deep cleft. *Ovary* +/- sessile, glabrous, green, short ellipsoid, slightly curved at apex 2.0–2.8 mm long, 1.2–1.6 mm wide. *Capsule* short-ellipsoid, 4.2–5(–6) mm long, 1.8–2.8(–3.3) mm wide, glabrous. (Figure 21)

Selected specimens examined: WESTERN AUSTRALIA: Mount Elizabeth Station [precise locality withheld], 15 June 2016, *M.D.Barrett & V.English MDB 5294* (PERTH). QUEENSLAND: near Blencoe Falls, 1979, *B.Gray 1311* (CNS).

Fig. 21. *Spiranthes sinensis*. A. Inflorescence. B, C. Close-up of inflorescence and flowers. Voucher: *M.D.Barrett & V.English MDB 5294* (PERTH). Photos by M.D. Barrett.

PAPUA NEW GUINEA: Kaindi, 2000 m, 12 May 1959, *L.J.Brass 29513* (CANB); Boridi, 4500 ft, 13 Sept. 1935, *C.E.Carr 10299* (BM, CANB); Finesterre Range, Tep Tep to Nokopo track, 27 Mar. 1990, *M.A. Clements 6302* (CBG); Oro Province, Nyola dry lake, Owen Stanley Ranges near Kokoda Trail, 2200 m, 22 Apr. 1990, *M.A.Clements 6948*, *P.Ziesing*, *D.Benzing* & *E.Dauncey* (CBG); Lake Kutaba, between Ridge Camp and Moro Camp, Iagifu Ridge, 29 June 2000, *M.A.Clements 10012* (CANB); Moro base camp grounds, 4 July 2000, *M.A.Clements 10252* (CANB); eastern side Lake Myola No. 1. Subdistrict. Kokoda District, 22 July 1974, *J.R.Croft et al. LAE 61950* (A, BRI, CANB, E, K, L, MU, NSW); Boana, Morobe District, 3000 ft, 6 Oct. 1959, *E.E.Henty N.G.F. 11572* (CANB, LAE); Mannasat, Cromwell Mountains, Huon Peninsula, Morobe District, 7500 ft, 21 July 1964, *R.D.Hoogland 9403* (CANB); Kindi, Wau, 2200 m, 14 May 1979, *A.Kaire 58* (A, BFC, CANB, K, L, LAE); Bonenau Village, Baniara subdistrict, Milne Bay District, 1000 m, 19 Aug. 1969, *R.Pullen 8089* (CANB, LAE); Keribiya-Tambil Road, Kaugel Valley, Hagen subdistrict, 7100 ft, 16 July 1957, *R.G.Robbins 450* (CANB); near Ebenda, Anga Valley, Southern Highlands District, 6600 ft, 16 July 1961, *R.Schodde 1464* (CANB).

Distribution: North Kimberley, Queensland, New Guinea, New Caledonia, China, Lao, Vietnam, Japan, Malaysia, Indonesia.

Conservation status: In Western Australia, known only from a single plant at one location on a pastoral station in the north-west Kimberley, in a swamp, potentially threatened by grazing pressures and/or water extraction. Only one collection is known from Queensland. Conservation Codes for Western Australian Flora: Priority 1. Further survey is required to determine whether the single plant seen was the result of adventitious dispersal, or is part of a persistent population.

Ecology: The single known specimen from Western Australia was growing in a permanently wet, perched mound spring, with Poaceae, Cyperaceae and *Utricularia* spp. Collections from New Guinea are mostly from peaty sedge swamps.

Phenology: Flowering in July in the Kimberley, May to August in New Guinea.

Affinities: Related to *S. australis*, which differs most obviously in the moderately to densely pubescent inflorescence rachis (Pace *et al*. 2019).

Notes: In a recently published paper, Frericks *et al.* (2018) highlighted the difficulties in determining the status and application of names in the *S. sinensis* complex. They revealed that significant molecular differentiation exist between plants collected and determined as this species from across the range from Nepal, China, Japan, Malaysia and Australia. The delimitation of *S. sinensis* has been highly problematic, but a combined morphological and molecular study has refined the concept of this species (Pace *et al*. 2019).

Common names: Chinese Spiranthes, Tiny spiral orchid.

Zeuxine Lindl., *Collect. Bot. App*. no. 18: 1 (1826) (as '*Zeuxina*'); *Orth. Scelet*., 9 (1826) (as '*Zeuxina*'), *nom. cons*. *Lectotype*: *Z. strateumatica* (L.) Schltr., designated by P.J.Cribb, *Taxon* 48: 49 (1999).

Adenostylis Blume, *Bijdr. Fl. Ned. Ind.:* 414 (1825). *Type*: not designated.

Psychechilos Breda, *Gen. Sp. Orchid. Asclep*. 2: t. 9 (1829). *Type*: *P. gracilis* Breda.

Tripleura Lindl., *Edwards's Bot. Reg.* 19: t. 1618 (1833). *Type*: *T. pallida* Lindl.

Strateuma Raf., *Fl. Tellur.* 2: 89 (1837), *nom. illeg*. *Type*: *S. zeylanica* Raf., *nom. illeg*. (= *Orchis strateumatica* L.)

Monochilus Wall. ex Lindl., *Gen. Sp. Orchid. Pl.*: 486 (1840), *nom. illeg*. *non* F.E.L.Fischer & C.A.Meyer (1835); *Haplochilus* Endl., *Ench. Bot*.: 113 (1841). *Type*: not designated.

Heterozeuxine T.Hashim., *Ann. Tsukuba Bot. Gard*. 5: 21 (1986). *Type*: *H. odorata* (N.Fukuyama) T.Hashim.

Zeuxinella Aver., *Updated Checkl. Orchids Vietnam*: 96 (2003). *Type*: *Zeuxine vietnamica* Aver.

Notes: The circumscription of *Zeuxine* has been reduced to exclude *Rhomboda* Lindl. (Ormerod 1995), a position supported by Pridgeon *et al.* 2003).

Zeuxine oblonga R.S.Rogers & C.T.White, *Proc. Roy. Soc. Queensland* 32: 120, fig. 2 (1921). *Lectotype*: Queensland: Kamerunga (Barron R.), *E.Cowley s.n*. (lecto: AD!), designated by M.A.Clements, *Austr. Orchid Res.* 1: 147 (1989).

Residual syntypes: MacKay, *L.J. Nugent s.n.* (syn: AD 97720146A, *n.v.*); Daintree R., *G. Rosenstrom s.n.* (syn: AD 97720146B, *n.v*.).

Illustrations: Nicholls, *Orchids Austr.* 97, t. 53 (1969); D.L.Jones, *Native Orchids Austr*. 352, pl., fig. (1988); G.Wightman, *The Orchadian* 9(12): 281, f. 2 (1990); Dockr., *Austr. Indig. Orchids*. vol. 1; 46, fig. (1992); P.H.Weston in G.J.Harden, *Fl. New S. Wales* 4: 222, fig., pl. 15 (1993); T.Bishop, *Field guide orchids New S. Wales Vict.* 178, fig. 426 (1996); D.L.Jones, *Compl. Guide Austr. Orchids* 351, fig., pl. (2006); J.Woinarski *et al*., *Lost from our landscape* 100, pl. (2007); A.P.Brown *et al*., *Orchids West. Austr.*, pls p. 402, 405 (2008); K.Stephens & D.Sharp, *Fl. N. Stradbroke Isl*. 239, pl. (2009); Brown *et al*., *Field Guide Orchids of Western Australia*, pls p. 475, 503 (2013); D.L.Jones, *Compl. Guide Austr. Orchids* (edn 3); 472 pl., fig. (2021).

Rhizomatous *herb*, 10–35 cm tall, deciduous, forming loose colonies, *Rhizome* prostrate, 2–4 mm thick, fleshy, with wiry roots. Leaf-bearing stems fleshy, 5–15 cm tall, bearing 3–7 scattered leaves with a terminal rosette above; cauline leaves drying first, generally all leaves dry at anthesis. *Leaves* sessile, sheathing at the base, lamina 30–80 mm long, 12–30 mm long, ovate to elliptical, often oblique, acute, thin textured, glabrous, margins often undulate, pale green. *Inflorescence* a terminal spike, 5–30 cm tall, the peduncle greatly exceeding the rachis, 1–2 mm diam, pinkish, subtended by 2 or 3 small sheathing bracts; peduncle, rachis, bracts, ovaries and sepals hirsute. *Ovaries* erect, elongate, asymmetric, 8–12 mm long, *c.* 1 mm diam.; floral bracts 4–12 mm long. *Flowers* 2–30, dense along spike, resupinate, 4–6 mm long; sepals dull green, hairy; petals white, labellum white; dorsal sepal hooded, 4–6 mm long, 1.5–2 mm wide, ovate; lateral sepals 3–4 mm long, 1–1.5 mm wide, narrow triangular or subovate, acute; petals 3.5–6 mm long, 1.5–2.5 mm wide, oblong; labellum 4–6 mm long, 3–4 mm wide, deeply saccate, with two rounded, linear or reniform calli *c.* 0.5 mm long; lower lip divided, lobes *c.* 2 mm long, 2 mm wide, oblong, margins often irregular; column *c.* 1 mm long, stout; stigmatic lobes ovoid, sacs containing a viscid substance; rostellum inclined forwards, *c.* 1.5 mm long, with two widely separated subtriangular lobes exceeding the rostrum apex; anther dorsal, 2-celled, *c.* 1 mm long. Pollinia 2, clavate, elongate, yellow. *Capsule* erect, hirsute, dehiscent; peduncle not elongated in fruit. (Figure 22).

Specimens examined: WESTERN AUSTRALIA: Point Spring, Ord River plains, 43 km ENE of Kununurra on Leguna access track, 26 Jul. 1996, *A.A.Mitchell 4031* (Broome Ag. Dept.; CANB); Point Springs, 43.34 km from Kununurra Post Office on a bearing of 21 degrees, 30 Aug. 2004, *A.A.Mitchell 7825* (CANB, PERTH); Point Spring, Ord River plains, 43 km ENE of Kununurra, 7 Sept. 2003, *G. & N. Sankowsky Sanko 2181* (PERTH).

Distribution: Endemic to Australia. Recorded near Kununurra in the North Kimberley, from the Keep River to the Adelaide River in the Northern Territory and scattered from Cape York Peninsula in north Queensland south to Coffs Harbour in New South Wales.

Conservation status: In Western Australia, known only from one location in a nature reserve in the north-east Kimberley which is potentially threatened by weeds, disturbance from cattle and pigs, and expansion of adjacent agriculture. Considered Vulnerable in the Northern Territory (Woinarski *et al*. 2007). Conservation Priority for Western Australia Flora: Priority 2 (Western Australian Herbarium 1998 onwards).

Fig. 22. *Zeuxine oblonga*. A. Habit. B. Leaf rosette. *c.* Base of stem and leaves. D. Inflorescence. E, F. Flowers. Vouchers: A: *A.A.Mitchell 4031* (Broome Ag. Dept.); B–F: *G. & N. Sankowsky Sanko 2181* (PERTH). Photos by R.L. Barrett (A); G. Sankowsky (B–F).

Ecology: Grows around springs in evergreen rainforest habitats, in deep leaf litter.

Phenology: Flowers July–September in the Kimberley.

Affinities: The only other species recorded for mainland Australia is *Z. polygonoides* (F.Muell.) P.J.Cribb which has since been transferred to the genus *Rhomboda* Lindl. *Zeuxine oblonga* is very similar to material collected from across the Pacific in Fiji and Samoa and where the earliest names appears to be *Z. samoensis* Schltr. (1906) which predates *Z. oblonga* by 14 years. However, it is premature to make any changes as all species are very close and it is essential that DNA be employed in delimiting species concepts.

Notes: Further investigation of species boundaries is required in the genus *Zeuxine*. It is possible that the material from Western Australia should be referred to the name *Z. gracilis* (Breda) Blume which was first described in 1829 from material collection in Java where is common and widespread, however Ormerod (2018) applies the name *Z. gracilis* to a different taxon than the one found in Australia. This species is also very similar as the recently re-discovered *Zeuxine exilis* Ridl., from Christmas Island (Du Puy *et al.* 1993).

A comparative molecular analysis is required to establish the true nature of the relationships between these species before undertaking any taxonomic changes.

Common name: Common jewel orchid.

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