

Deyeuxia gravida (Poaceae: Agrostidae), a newly described species from Victoria, Australia

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Abstract

Deyeuxia gravida C.G.Taylor & N.G.Walsh is described and illustrated from south-west Victoria. Its morphology is compared to *Deyeuxia quadriseta*, with which it has been associated in the past. Its distribution and ecology are discussed.

Keywords: Taxonomy, Poaceae, Cobboboonee National Park, south-west Victoria, *Pentapogon*

Introduction

Deyeuxia (Poaceae, subfamily Pooideae) is the most speciose of the Australian genera of the tribe Aveneae, currently with 35 species recognised in the country, but circumscription varies (see ‘Generic Placement’ below). As conventionally accepted, the genus occurs mainly in the Southern Hemisphere (Australia, South America, southern Malesia, New Guinea, New Zealand) and comprises some 110 species (Weiller et al. 2009). It is characterised by having single-flowered spikelets with the lemma awned (rarely awnless) and somewhat indurated, of firmer texture than the glumes. The ligule is membranous, truncate or obtuse. *Deyeuxia quadriseta* (Labill.) Benth. is the most widespread species of *Deyeuxia* in Australia, occurring in all jurisdictions except the Northern Territory. It has long been known to incorporate a wide range of variation. Vickery (1940) outlined eight informal entities within the species with very brief diagnoses of them, citing a few representative examples and formally naming *D. quadriseta* var. *cylindrica*, restricted to Western Australia. Neither that variety nor any other of Vickery’s other novelties within the species have been upheld to date.

Walsh (1992) drew attention to a ‘noteworthy variant’ with ‘rather weak, slender culms, flaccid leaves and narrow, depauperate panicles with very small spikelets (barely 3 mm)’. This variant was reported to occur on Wilsons Promontory and the far east and south-west of the state. To investigate the validity of this proposed variant, and others previously proposed by Vickery (1940), a phenetic analysis of specimens was made of

Deyeuxia quadriseta from the collection in the National Herbarium of Victoria (MEL).

Methods

Approximately 200 herbarium specimens of *Deyeuxia quadriseta* at the National Herbarium of Victoria (MEL) were selected to cover the geographic range of the species in south-east Australia, with representative specimens from Victoria, Tasmania, New South Wales and South Australia. Vickery's (1940) vouchers for her informal entities were used where represented by specimens at MEL. From specimens cited by Vickery, it seems she had no material of the Walsh (1992) variant at hand.

The initial dataset employed 19 qualitative or quantitative floral and vegetative characters (Table 1). Character choice was informed by those emphasised by Vickery (1940) and those characters most commonly used to distinguish between species of *Deyeuxia* in Australia (e.g., Jacobs & Hastings 2023; Weiller et al. 2009; Walsh 1992). Following scoring of the morphometric characters, incomplete cases were removed from the analysis, reducing the sample size to $n = 163$.

Based on the broad description of the variant outlined by Walsh (1992), a second dataset of character parameters, including qualitative characters less often employed in *Deyeuxia* species demarcation, were applied to a subset ($n = 71$) of the original specimen set, concentrating on fine-leaved and narrow-panicled specimens (Table 1). Although informative, three characters were removed from the analysis due to too many missing cases (Table 1).

All analyses were conducted using R software (R Core Team, 2022). Pairwise dissimilarities using Gower's coefficient were used to construct a dissimilarity matrix (Gower, 1971). The Gower metric is useful for data which contain both binary and numeric variables through range standardisation of the data. Non-metric multidimensional scaling (NMDS) ordination was used to look for patterns in the data using the *vegan* package (Oksanen et al. 2022). Hierarchical cluster analysis was also performed (with the average-linkage method to incorporate outliers) using the *cluster* package (Maechler et al. 2022).

Kruskal Wallis tests were conducted to determine the effect size (H -statistic) of individual variables to

distinguish between the groups determined by cluster analysis in the second data set. The H -statistic indicates the effect size of each character's ability to distinguish between the two groups. Scores closer to 1 indicate more effective characters and are only shown for those found to be significantly different.

Results

No clearly demarcated clusters, reflecting any of the eight informal groups within *Deyeuxia quadriseta* outlined by Vickery (1940), were apparent from the first dataset ordination or cluster analysis (results not shown).

The second dataset analysis retrieved a distinct group of specimens, consistent with Walsh's (1992) variant (Figure 1). Qualitative characters better distinguished between the two groups with all quantitative characters yielding a H -statistic of <0.5 .

Discussion

Walsh's variant was virtually restricted to a small area of far south-west Victoria with one outlier in the Otway Ranges (Figure 2). The most important characters in separating Walsh's variant from the remaining specimens were a strongly 2-keeled palea that was equal to or longer than the lemma, shorter callus hairs, a plumper caryopsis that caused the palea to bulge somewhat ventrally, and the lemma having strongly raised nerves either side of the midline (Figure 3). The separation of these specimens was primarily based on these binary qualitative characters. Quantitative characters were less informative as Walsh's variant typically sat within the range of *D. quadriseta* due to this species' highly variable form (Table 2). Qualitative characters related to seed morphology are also more likely to be taxonomically informative as they are conserved in species across different environments, whereas differences in vegetative characters likely reflect phenotypic plasticity in response to differing environments (Frazee & Marquis, 1994; Villellas et al., 2021).

Subsequent fieldwork in Cobboboonee National Park showed Walsh's variant to be locally common, but highly ecologically restricted to the margins of seasonally wet depressions (Figure 4). 'Typical' *Deyeuxia quadriseta* (including some relatively fine-leaved and narrow-panicled forms) was sometimes encountered in

the same general area but occupying a broader range of habitats than the variant. Specimens collected in the course of this fieldwork were lodged at MEL and included in the analyses.

On the basis of morphological characters and a very distinctive ecology, Walsh's variant is here circumscribed at species rank as *Deyeuxia gravida*. Although only 13 of the more than 300 *Deyeuxia quadrisseta* specimens

housed at MEL conform to *D. gravida*, it is likely that this species is more widely distributed than currently known. Despite their superficial similarity (mainly in habit and inflorescence structure), specimens from Wilsons Promontory and a few other near-coastal sites proved not to be *D. gravida* but rather depauperate individuals of *D. quadrisseta* with floral morphology typical of that species. Whether this development is

Table 1. Qualitative (Ql) and quantitative (Qn) characters scored for phenetic analyses of the second dataset. *H* statistics approaching 1 indicate greater cluster differentiation. Characters added in the second round of scoring are indicated by †. Characters excluded from analysis due to poor coverage indicated by *.

Character definitions	Variable type	<i>H</i> statistic
Vegetative characters		
Maximum width of last or penultimate flag leaf (mm)	Qn.	0.311
Length of last or penultimate flag leaf (mm)	Qn.	...
Panicle width at widest point (mm)	Qn.	0.452
Panicle length (mm)	Qn.	...
Culm diameter in last internode (mm)	Qn.	0.461
Length of last or penultimate ligule (mm)	Qn.	0.304
*Plant height (cm)	Qn.
Inflorescence and seed characters		
Awn attachment point on lemma, measured from tip of callus (mm)	Qn.	0.341
Total length of awn (mm)	Qn.	0.307
*Anther length (mm)	Qn.
Lower glume length (mm)	Qn.	0.447
Length of lemma, measured from tip of callus to the lemma apex, inclusive lemma teeth (mm)	Qn.	0.406
Maximum callus hair length (mm)	Qn.	0.459
Panicle interrupted (0) or completely continuous (1)	Ql.	0.241
†Many overlapping spikelets tightly condensed into panicle (0) or panicle sparse (1)	Ql.	0.827
†Lemma nerves raised (0) or lemma surface uniform (1)	Ql.	1
†Lemma scabrous along nerves (0) or not evident, lemma surface may be scabrous all over (1)	Ql.	1
†Callus hairs prominent (0) or inconspicuous and seemingly appressed to lemma (1)	Ql.	1
†Palea exceeding or subequal to lemma (0) or palea shorter than lemma (1)	Ql.	1
†Palea nerves raised either side of the midline (0) or evident but not raised (1)	Ql.	1
†Palea scabrous along nerves (0) or not, palea nerves may not visible (1)	Ql.	1
*Caryopsis deeply grooved along whole length (hilar groove) (0) or not (1)	Ql.
Ratios		
Ratio of callus hair length to lemma length	Qn.	0.369
Ratio of awn length to lemma length	Qn.	...
Ratio of awn attachment point to lemma length	Qn.	...
Ratio of glume length to lemma length	Qn.	...
Ratio of panicle width to length	Qn.	0.413

merely a phenotypic response or has some genetic basis was not explored during the current study. The occurrence of *D. gravida* in the Otway Ranges is disjunct from the 'core' area of occurrence, inviting further survey of similar sites in the Otways and any intervening areas of apparently suitable ecology.

Taxonomy

Deyeuxia gravida C.G.Taylor & N.G.Walsh sp. nov.

Type: Australia. VICTORIA, Cobboboonee National Park, beside Mt Deception Rd, c. 300 m E of its junction with Wrights Swamp Rd, 16 km W of Drumborg, C.G. Taylor 2 and N.G. Walsh, 17 Feb. 2022. Holo: MEL 2518109; Iso AD, CANB, HO, K, NSW, US (Figure 5).

Weakly caespitose annual (perhaps more long-lived through sequential wet years), culms decumbent to ascending, to c. 60 cm long. Leaves soft-textured, rather flaccid, ±smooth to slightly scabrous; blade flat or weakly channelled, to c. 20 cm long and 3 mm wide; ligule obtuse, 1–3 mm long. Inflorescence a slender, contracted panicle with ±appressed branches, c. 2–15 cm long, 1.5–6 mm wide, often slightly interrupted. Spikelets 2.3–3.4 mm long, green at anthesis; glumes acute, sub-equal, scabrous along the keel, gaping about the lemma; lemma shorter or subequal to glumes, 1.9–2.9 mm long, ovoid, minutely to strongly scabrous along whole length and the nerves, hardly thickened, but the 5 nerves prominently raised, entire or microscopically 4-toothed at the apex, awned just above the callus; callus hairs not uniform with some reflexed, less than a quarter the length of the lemma; rachilla bristle absent. Awn 2.5–3.8 mm long, geniculate, twisted in lower part and typically exceeding lemma; palea 1.8–2.5 mm long, sub-equal to the or sometimes exceeding the lemma or, strongly 2-keeled and visible between lemma margins at maturity.

Specimens examined: VICTORIA. Cobboboonee State Forest, beside Coffeys Lane c. 1.6 km SE from its junction with Jackeys Swamp Rd, 9.5 km SW of Heywood, N.G. Walsh 9289 & C.G. Taylor, 17.ii.2022 (MEL). Cobboboonee Forest Park, beside Coffeys Lane c. 1.5 km ESE from its junction with Jackeys Swamp Rd, 9.5 km SW of Heywood, C.G. Taylor 1 & N.G. Walsh, 17.ii.2022 (AD, CANB, HO, MEL). Cobboboonee National Park, beside T&W Rd, 2.1 km S of Baggate Rd, 6.4 km WNW of Lyons, C.G. Taylor 3, N.G. Walsh & D. Pitts, 17.ii.2022 (AD, CANB, MEL, NSW). Lower Glenelg National Park, Cordover Swamp, c. 500 m

Figure 1. Dendrogram from hierarchical cluster analysis of the second data set: *Deyeuxia gravida* (grey highlight); *Deyeuxia quadriseta* (no highlight).

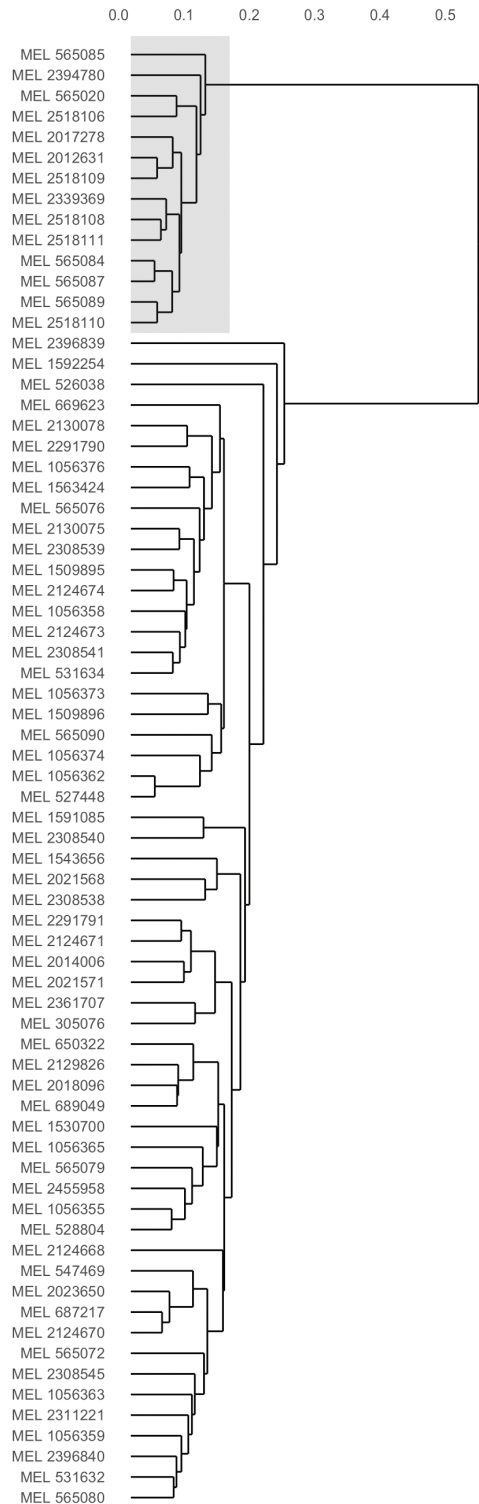




Figure 2. Currently known distribution of *Deyeuxia gravida*.

SE from junction of Baggate Rd and Liddles Lane, c. 4 km SE of Drik Drik, *C.G. Taylor 4, N.G. Walsh & D. Pitts*, 17.ii.2022 (AD, MEL). Off Westwoods Tk, c. 300 m E of Barongarook-Gerangamete Rd, and 200 m south of the track. 5.2 km SE of Barongarook, *N.G. Walsh 6948 & G.W. Carr*, 7.i.2010 (BRI, MEL). Cobboboonee National Park, Cut out Dam Rd, c. 1.2 km W of Jackys Swamp Rd, *A. Messina 957, N.G. Walsh & D. Pitts*, 7.i.2016 (K, MEL). Connover

[Cordover] Swamp (also known as Red Gum Swamp), SE of Drik Drik, *D.E. Albrecht 5160, I.C. Clarke & S.A. Day*, 3.xii.1992 (MEL, NSW). Unnamed circular swamp c. 5.5 km due SE of Greenwald, *D.E. Albrecht 4729*, 15.ii.1991 (MEL). Portland, off Portland-Nelson Road, c. 6 miles from Portland P.O., *A.C. Beauglehole 1725*, 1949 (MEL, NSW). Portland area, Gorae, south of Holmes' property, *A.C. Beauglehole 1569*, 15.i.1950 (MEL, NSW). Lower

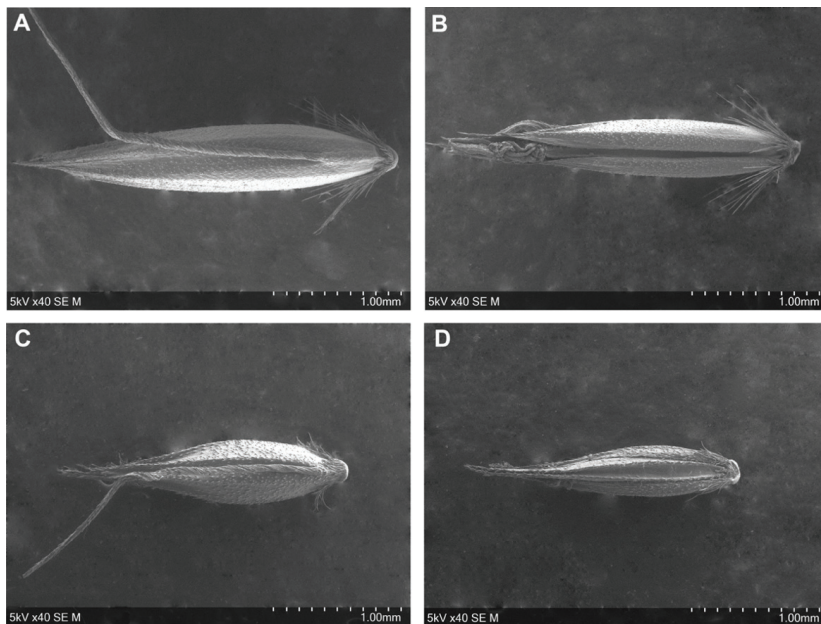


Figure 3. Scanning electron microscope images of typical *Deyeuxia quadriseta*. A. dorsal view of lemma with awn attachment; B. ventral view of lemma. *Deyeuxia gravida*. C. dorsal view of lemma with awn attachment; D. ventral view of lemma.

Glenelg National Park, Red Gum Flat, south of Greenwald. A.C. *Beaglehole* 42570, 28.xii.1964 (MEL). Far South West district. Lower Glenelg River area, Tremaine Swamp, A.C. *Beaglehole* 42482, xii.1954 (MEL, NSW).

Habitat: Margins of seasonally inundated pools and swamps (Figure 4). Soil mostly sandy with a high organic component. Typically, associated species include *Eucalyptus ovata* Labill., *Acacia melanoxylon* R.Br., *Coprosma quadrifida* (Labill.) B.L.Rob, *Gratiola peruviana* L., *Lobelia beagleholei* Albr., *L. pedunculata* R.Br., *Ornduffia umbricola* (Aston) Tippery & Les, *Hookerchloa hookeriana* (F.Muell. ex Hook.f.) E.Alexeev, *Juncus procerus* E.Mey., *Carex appressa* R.Br., *Cyperus lucidus* R.Br., *Lepidosperma laterale* R.Br., *L. longitudinale* Labill. Soils are primarily derived from Quaternary sands of varying depth overlying basalt of the newer volcanics. At the Cordover Swamp site (Figure 4b), the plant community is dominated by *Eucalyptus camaldulensis* Dehnh. rather than *E. ovata* and the soils are less freely draining with apparently shallower sand, promoting a dense ground layer of *Sphagnum novozelandicum* Mitt.

Distribution: Known with certainty only from far south-western Victoria in the Cobbooboonee and Lower Glenelg National Parks, with an outlying easterly occurrence in the Otway Ranges near Barongarook. The species is likely to occur in South Australia, but it is currently not known from there. A review of specimens held at AD did not identify any immediate matches for *D. gravida* (P. Lang pers. comm.).

Conservation Status: It is likely that there are numerous populations yet to be discovered within the Cobbooboonee National Park—there is limited access by road to areas that contain what seems to be preferred habitat. For an assessment of the species’ conservation status (IUCN 2012), we conservatively estimated the number of populations to be ~ 50, with the number of individuals estimated at 5500 (based on a midpoint of between 20 and 200 individuals per population). Population size and extent are likely prone to fluctuation as a consequence of poor survivorship in dry years where the depressions do not hold water for sufficient time or of sufficient depth. The generation length is

Table 2. Character table outlining morphological features most useful in distinguishing *Deyeuxia gravida* from *D. quadriseta*. All measurements are in mm unless stated otherwise.

Character	Species	
	<i>Deyeuxia gravida</i>	<i>Deyeuxia quadriseta</i>
Leaf width	0.7–2.9	0.6–7.8
Panicle width	1.5–6	2.5–35
Culm diameter	0.4–1	0.4–4.6
Ligule length	1.1–2.8	1–7.2
Awn attachment point	0.3–0.5	0.3–1.6
Awn length	2.5–3.8	1.5–6.9
Anther length	0.3–0.5	0.2–2.1
Lower glume length	2.3–3.4	2.6–6.3
Lemma length	1.9–2.9	2–4.9
Callus hair length	0.3–0.5	0.5–1.5
Ratio of callus hair length to lemma length	15–20 %	15–40 %
Ratio of panicle width to length	5 %	5–40 %
Panicle	Sparse	Dense with many overlapping spikelets
Lemma	Raised scabrous nerves	Lemma surface uniform
Palea	Palea bulging at maturity to expose raised and scabrous keels between lemma margins	Palea hardly visible between lemma margins

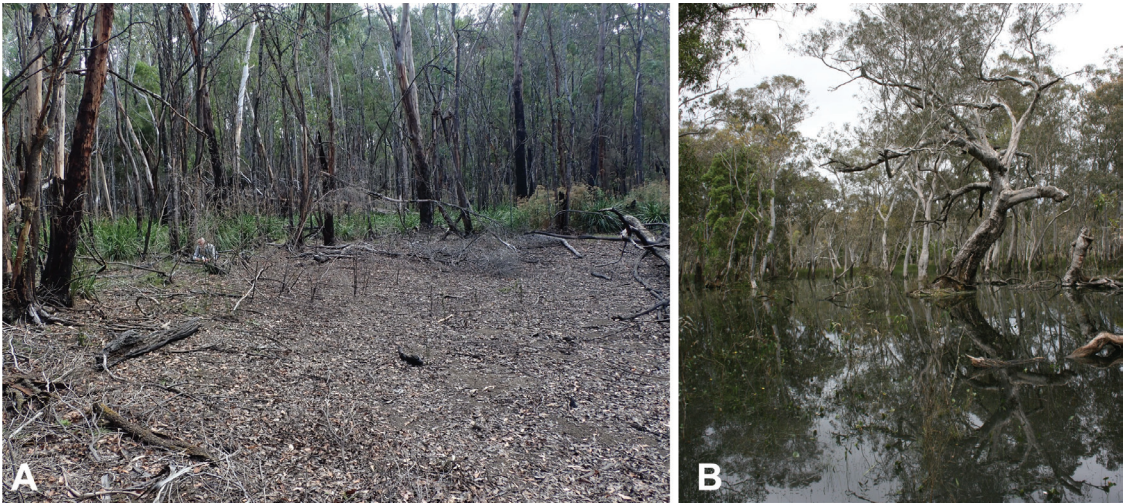


Figure 4. Habitat of *Deyeuxia gravida*. A. occurring at the margins of seasonally inundated pools dominated by *Eucalyptus ovata*; B. *Eucalyptus camaldulensis* swamp with *Sphagnum novozelandicum* dominating the ground cover (Photo David Pitts).

one year, although in consecutive wet years this could be higher. Extent of Occurrence was calculated at c. 150 km² for the Cobboboonee NP and Cordover Swamp sites, but, if the single Otways site is included, it expands to c. 1600 km². The Area of Occupancy is estimated to be 100 km² applying IUCN recommended 2 km grid size per occupied site.

The quality of habitat is likely to decline over time as a consequence of climate change, with projections suggesting reduced winter and spring rainfall in the order of 5 % and increased annual temperature of 1.9 °C by 2050 (CSIRO and Bureau of Meteorology, 2022).

Applying these mostly conservative assumptions, *Deyeuxia gravida* satisfies the IUCN 3.1 Red List EN (Endangered) Criteria B1bc (ii, iii, iv, v) + B2 bc (ii,iii,iv), i.e. the species has an estimated Extent of Occurrence (EEO) of <5000 km² and Area of Occupation (AOO) of <500 km² and a projected reduction in EEO, AOO, quality of habitat, number of subpopulations and number of individuals.

Etymology: The epithet is a Latin term meaning heavy or pregnant, a reference to the plump caryopsis that gives a ventrally distended appearance to the floret when ripe, a feature that distinguishes it from similar species like *Deyeuxia quadriseta*.

Notes: *Deyeuxia gravida* appears most closely related to *D. quadriseta* with which it shares characters of more or less cylindrical inflorescence, florets lacking an obvious rachilla extension and an awn inserted

in the lower one-third of the lemma. It differs from *D. quadriseta* most significantly in the strongly nerved lemma and palea, and in the plump caryopsis that causes the palea to protrude as the caryopsis ripens. It differs further in the palea being often longer than the lemma, the more strongly scabrous surface of the lemma, and the non-uniform callus hairs. The lemma apex of *D. quadriseta* is typically 4-toothed, and sometimes conspicuously so with teeth approaching 1 mm long. It is this characteristic to which the epithet ‘quadriseta’ (= four bristles) refers. The lemma apex of *D. gravida* is either entire or microscopically 4-toothed. While there is some overlap in overall spikelet size, *D. gravida* (2.3–3.4 mm) overlaps the lower end of spikelet size range for *D. quadriseta* (2.6–6.3 mm). While the inflorescences are generally shorter and finer than those of *D. quadriseta*, there is overlap in this character. Even with the separation of *D. gravida* from *D. quadriseta*, the latter remains a very variable species. In overall shape and texture, the lemma somewhat resembles that of *D. minor*, but that species has the lemma longer than the palea, the awn inserted at or above 1/3 from the lemma base, and has the lemma scabrous only below midway.

Generic Placement: Saarela et al. (2017), using analysis of ITS sequence data, included most *Deyeuxia* species, including all Australasian ones, within a broadly circumscribed *Calamagrostis*. Subsequently, Peterson et al. (2022), employing a refined analysis of ITS and plastid sequences, reconsidered the speciose



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MEL 2518109

Deyeuxia Adans.

Det.: Taylor, C.G., 17 Feb. 2022

Coll.: Taylor, C.G. 2 Date: 17 Feb. 2022

Addit. Coll.: Walsh, N.G.

Australia: Victoria

Loc.: Cobboonee National Park, beside Mt Deception Rd, c. 300 m E of its junction with Wrights Swamp Rd, 16 km W of Drumburg.

38° 04' 56" S 141° 24' 41" E. Alt.: 100 m.

Habitat: Small, more or less circular, seasonal open swamp, now dry. Sandy soil with high organic content.

Associated taxa: *Eucalyptus ovata*, *Acacia melanoxylon*, *Amphibromus neesii*, *Lepidosperma laterale* 'majus', *Juncus procerus*, *Centipeda minima*, *Gratiola pumilo*, *Senecio minimus*

Descriptive notes: Weakly caespitose annual (?sometimes perennial); culms decumbent to erect, to c. 90 cm high.

Collecting notes: Locally common, occurring mainly around perimeter of swamp and on elevated mounds nearer centre of swamp.

Dupl.: AD, CANB, HO, K, NSW, US

353 Poaceae – M. Monocots – Main collection (5 Australasia)
Printed from MELISR, 24 Feb. 2022

Figure 5. Holotype of *Deyeuxia gravida* (MEL 2518109).

genus *Calamagrostis sens. lat.*, placing Australasian species (*sensu Saarela et al.*) in a distinct subtribe (Echinopogoninae) and including Australasian *Deyeuxia* (and *Dichelachne*) species into an expanded *Pentapogon*. They recognised a distinct, largely Northern Hemisphere subtribe (Agrostidinae) that included the bulk of *Calamagrostis* (as well as *Agrostis* and other closely related genera, e.g., *Lachnagrostis*). New combinations in *Pentapogon* were made for species of *Deyeuxia* and *Dichelachne* included in their molecular analysis, but not for the majority of species, as the authors preferred to leave this task to Australasian botanists. In New Zealand, de Lange and Schmid (2022) have made the necessary combinations into *Pentapogon* for relevant taxa in that country. The transfer of Australian species of *Deyeuxia* and *Dichelachne* into *Pentapogon* may follow, but to date, there has been resistance to this change by Australian botanists, and the Australian Plant Census (2024) has yet to take up the new combinations already published in *Pentapogon*. Without consensus amongst Australian agrostologists, it is beyond the scope of the current study to make the combinations required for the residue of Australian *Deyeuxia* as currently accepted.

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