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Two new species of *Pterostylis* (Orchidaceae; Orchidoideae) from the Sunset Country, Victoria, Australia

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Abstract

In northwestern Victoria, Australia, the *Pterostylis* (Orchidaceae) section *Oligochaetochilus* '*rufa* group' comprises several little studied and poorly collected taxa. We surveyed populations of the *rufa* group in the Sunset Country, collecting information on the habitat and vegetation community. Fourteen sites were surveyed for plants with affinities to *P. biseta* and *P. exelsa*. We measured 23 morphological traits for each of 31 field-collected and seven herbarium specimens from this area. Multivariate analyses were undertaken, with cluster analysis and ordination performed on range-standardised data. Three distinct groups were present in both an ordination and dendrogram, with key diagnostic characters relating to the labellum. These groups were compared against other morphologically similar species of *Pterostylis*. Our analyses confirmed one of these groups as *P. biseta*, which is widespread in northwestern Victoria, and two as previously undescribed, putatively rare taxa, described here.

Keywords: multivariate analyses, Pterostylidinae, *Pterostylis biseta, Pterostylis exelsa, Pterostylis jeanesii*, *Pterostylis peakallana,* threatened orchid species

Introduction

Pterostylis Brown (1810: 326) (Pterostylidinae: Cranichideae), as interpreted by the original author and others (Bentham 1873, Janes & Duretto 2010), is a large genus of over 390 terrestrial orchid species found in Australia (Clements *et al.* 2011, Backhouse *et al*. 2019), Papua New Guinea (Williams 1946), New Caledonia (Morat 1993), Indonesia, New Zealand (Jones *et al.* 2002) and East Timor (Silveira *et al*. 2008). The highest species diversity is in southeastern Australia (ALA 2020), likely due to the great variety of habitats found, from alpine environments to desert. Victoria has about 80 recognised species (VicFlora 2020) within eight of the ten sections (Janes & Duretto 2010). Many *Pterostylis* species are threatened in Australia, with 27 listed as critically endangered, endangered or vulnerable (EPBC Act 1999).

Pterostylis species have a pair of underground tubers with an annual dormant period, usually over summer in low rainfall areas. They exhibit a wide variety of flower morphologies, but one of the most recognisable of the ten sections (Janes & Duretto 2010) is the '*rufa* group', originally referred to as the 'rufous group' by Blackmore & Clemesha (1968), which are *Pterostylis* subgen. *Oligochaetochilus* (Szlachetko 2001: 23) Janes & Duretto (2010: 265) and clade C of *Pterostylis* (Clements *et al*. 2011). *Oligochaetochilus* Szlachetko (2001: 23) was accepted by Jones & Clements (2002a,b) in a more restricted form. However, this generic name has not been widely accepted (Janes & Duretto 2010), and thus we refer to the '*rufa* group' as *P*. subg. *Oligochaetochilus* here.

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Pterostylis subg. *Oligochaetochilus* consists of over 100 species across southern and eastern Australia and New Zealand (Janes & Duretto 2010). Recent pollination studies of *Pterostylis* have confirmed that three sections of *Pterostylis* (sections *Pterostylis*, *Oligochaetochilus* and *Urochilus*) are pollinated by sexual deception of fungus gnats, Mycetophilidae and Keroplatidae (Phillips *et al.* 2014, Reiter *et al.* 2019). In *P*. sect. *Oligochaetochilus*, the gnats (Keroplatidae) often copulate with the labellum, suggesting that labellum features may play an important role in distinguishing between taxa (Reiter *et al.* 2019). These plants can be characterised by: a basal rosette of sessile, overlapping leaves that are usually withered at the time of flowering, a galea (fused dorsal sepal and petals) and fused reflexed lateral sepals, a prominent labellum with conspicuous setae and a hinged labellum that rapidly contacts the galea when touched (Jones & Clements 2002a, b, Janes & Duretto 2010).

Currently, *P.* subg. *Oligochaetochilus* in Victoria comprises 18 described species and four undescribed taxa including two with a relationship to *P.* sect. *Oligochaetochilus* (Janes & Duretto 2010): *P. aff. biseta* (Pink Lakes) and *Pterostylis aff. exelsa* (Sunset Country) proposed by Jeff Jeanes (VicFlora 2015). Backhouse *et al.* (2016) have suggested there may be several species in *P.* sect. *Oligochaetochilus* that fit the concepts of *P. aff. biseta* (Pink Lakes) and *P. aff. exelsa* (Sunset Country) scattered through the arid areas of northwestern Victoria, in and around the extensive national park areas of Wyperfeld, Murray Sunset and adjacent smaller reserves. Currently, five species in Victoria in the *rufa* group are listed nationally as either endangered or vulnerable (*Environment Protection Biodiversity and Conservation Act 1999*). Furthermore, many of these putative taxa may be of conservation concern. Therefore, we aim to (1) clarify how many taxa of *P.* sect. *Oligochaetochilus* yet to be formally recognised are present in northwestern Victoria; (2) provide descriptions and conservation assessments of unrecognised species; (3) assign recognised species to collections in northwestern Victoria; and (4) include species in the key to the Flora of Victoria.

Materials and Methods

Field surveys

Fourteen sites within Murray Sunset National Park, Wyperfeld National Park, and surrounding reserves were surveyed for the presence of either *P. aff. biseta* (Pink Lakes), *P. aff. exelsa* (Sunset Country) and other undescribed taxa with similarity to *P. biseta* Blackmore & Clemesha (1968: 150) or *P. excelsa* Clements (1986: 2119). Surveys of parallel transects (every 5–10 m) and tracking using GPS were conducted by Reiter and Kosky in 2017 and Reiter in 2019 during the peak flowering period of these species in October and November. Identification of the dominant species at each site surveyed was undertaken using VicFlora (2020).

Field Collections

From the 14 sites surveyed in Victoria, 31 samples were collected from across the following sites: Walpeup South, Weddings Reserve, Milmed Track, Milmed Swamp, Milmed Rock Track, Dattuck, Mossdam, Pink Lakes, Broken Bucket, Anuello, Glenalbyn, Round Swamp, Mopoke and Barraport West (Fig. 1). Samples collected from South Australia included samples from Rockleigh, Pinaroo West and Belair NP in the Blackwood area. Precise localities are withheld due to the rarity of some of the species. Some sites also contained other *P.* sect. *Oligochaetochilus* species including *P. maxima* Clements & Jones (1989: 124) and *P. boormanii* Rupp (1943: 98). However, these species are clearly morphologically distinct from our focal taxa and therefore were not included in our sampling. Samples were kept fresh until measurements were taken and subsequently preserved in 80% ethanol and lodged as spirit collections at the Royal Botanic Gardens Victoria National Herbarium. We recorded latitude and longitude for each specimen in this study and mapped the distribution of each group from the multivariate analysis using ArcGIS (Johnston *et al.* 2001).

Sampling

Because dried herbarium specimens do not retain the fine labellum characters and three-dimensional shapes in this group that are required to distinguish species, we restricted our multi-variate analysis to alcohol-preserved specimens of taxa within *P.* sect. *Oligochaetochilus* (Janes & Duretto 2010) that did not key out to species within the current VicFlora (2020). We supplemented this by *in situ* examination and retained photographs of these alcohol-preserved specimens to establish traits that are lost on preserving such as colour and translucent tissues, i.e., windows around groves on the labellum. We included in our statistical analysis seven previously collected specimens and 31 specimens from our field surveys in 2017 and 2019.

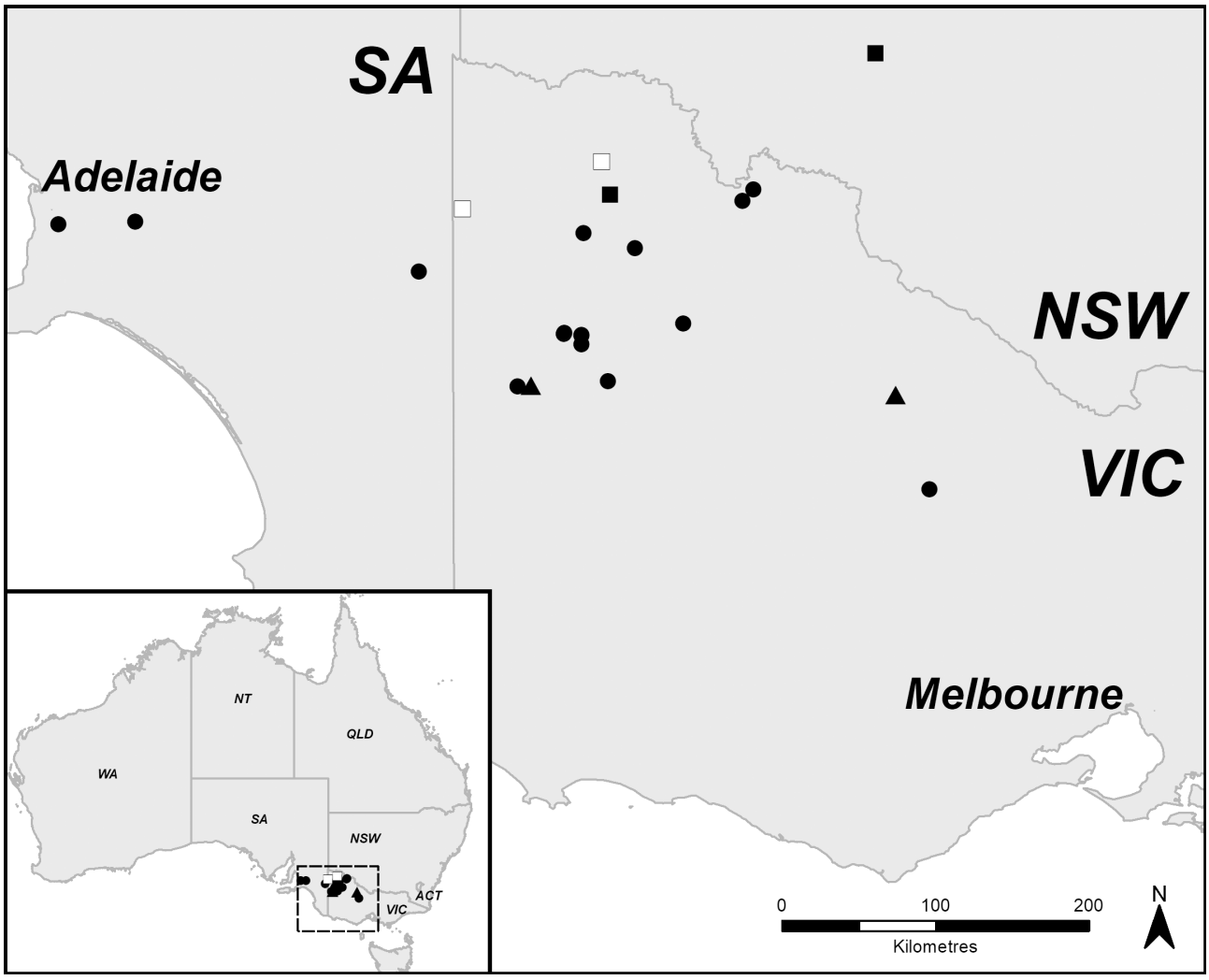

FIGURE 1. Distribution of study sites surveyed: black circles= group 1 (*P. biseta*); black squares = group 2 (*P. jeanesii*); white squares = *P. jeanesii* sites from which there are collected specimens but no plants were found in recent surveys; black triangles = (group 3) *P. peakallana*.

Character selection and analyses

Measurements of 23 floral characters (Table 1) were collected using cellSens standard measurement software (Olympus). Images were taken with a DP74 Olympus colour camera attached to an Olympus dissecting microscope. A hierarchical approach was used to delimit groups. Of the 23 characters measured, we only excluded one, labellum raised midline in basal section (LRMB), from our analysis because it was invariant. In the initial cluster analysis, 22 characters were used, which split the specimens into three main groups. Thereafter, a subset of five of the 22 characters were used, and this refined group of characters were those that were most informative (i.e the range of sample measurements see Appendix 3, did not overlap between at least one of the three groups) and consisted of the following characters: labellum depth (mm), labellum tip (upturned or not), labellum tip shape (pointed or not), two translucent grooves (present or absent) and labellum width (mm). Resulting groupings were compared with descriptions and type specimens of the species morphologically most similar to these groups including: *P. biseta* (SA), *P. petrosa* Jones & Clements (1993: 79; NSW), *P. exelsa* (SA), *P. pedina* (Jones 2009: 214) Janes & Duretto (2010: 262; NSW) and *P. terminalis* (Jones & Bates 2017: 44) Shaw (2019: 46; SA). These comparisons were carried out between our groupings and the types and descriptions of 22 characters for which material or descriptions allowed comparison. Because the types were not preserved in alcohol or only the flowers and not the stem were preserved in alcohol they were not included in the multivariate analysis.

Multivariate analyses were performed using PATN (Belbin 1987). Cluster analysis and ordination were performed on range-standardised data. Distance matrices were calculated using the Gower metric (GM) and cluster analysis was performed using unweighted pair-group method using arithmetic averages (UPGMA) to produce dendrograms. Kruskal Wallis (KW) values were calculated by PATN for groups defined in the dendrogram. Ordinations were performed in

three dimensions using multidimensional scaling (MDS), with 50 random starts and 1,000 iterations. MDS stress values were within acceptable limits (0.1192).

TABLE 1. Morphometric characters, including abbreviations and character state.

Character	Code	Character state
Flowering time (FT)	FT	October (0), November (1)
Flowering plant height (H) cm	H	Continuous (cm)
Number of flowers (NF)	NF	Continuous
Distance on stem between flowers (DBF) cm	DBF	Continuous (cm)
Width of the widest point between lateral sepals (WS) mm	WS	Continuous (mm)
Length of the free points of the sepals (LFPS) mm	LFPS	Continuous (mm)
Length of the solid part lateral sepals (LSS) mm	LSS	Continuous (mm)
Length of free point galea (LFPG) mm	LFPG	Continuous (mm)
Labellum length (LL) mm	LL	Continuous (mm)
Labellum width (LW) mm	LW	Continuous (mm)
Labellum depth (LD) mm	LD	Continuous (mm)
Labellum raised in the midline at the base (LRMB)	LRMB	Absent (0), present(1)
Labellum tip upturned (LTU)	LTU	Absent (0), present (1)
Length of prominent setae (LPS) mm	LPS	Continuous (mm)
Length of labellum setae (LLS) mm	LLS	Continuous (mm)
Height of flower (HF) cm	HF	Continuous (cm)
Depth of flower (not including ovary) (DF) cm	DF	Continuous (cm)
Labellum shape pointed (LP)	LP	Absent (0), present (1)
Height of basal mound from bottom of labellum to top of mound (HBM) mm	HBM	Continuous (mm)
Two see through grooves down length of labellum (TSG)	TSG	Absent (0), present (1)
Length of basal mound (LBM) mm	LBM	Continuous (mm)
Width of basal mound (WBM) mm	WBM	Continuous (mm)
Length of flower stalk including ovaries (LFST) mm	LFST	Continuous (mm)

Results

Analysis of Characters

Cluster analysis of the 22 characters (Appendix 1) from 38 specimens revealed three main groups (1–3) in the UPGMA dendrogram (Fig. 2) with these three groups corresponding to the discrete groups in the ordination (Appendix 2). For each group, we have provided summary statistics for all characters measured (Appendix 3) and mapped their distribution from our sample set in northwestern Victoria (Fig. 1).

KW values were generated for each variable (Appendix 4). The five most-informative characters for discriminating between groups, all with a KW value greater than 18, related to the labellum (Figs 3, 4): labellum depth (mm), labellum tip (upturned or not), labellum tip shape (pointed or not), two translucent grooves (present or absent) and labellum width (mm). Other informative characters included flowering time and height (cm).

When compared to the other two groups formed by the cluster analysis, group 1 specimens (Appendices 2, 3) had a thinner labellum depth, an upturned labellum, a rounded end to the labellum, two translucent groves and a wider labellum. Like group 2, plants generally flowered in October, whereas group 3 was November flowering in our 2017 and 2019 surveys.

The specimens of group 2 (Appendices 2, 3) had labellums that were thicker than in group 1, upturned labellum tip absent, a pointed labellum tip, two translucent groves absent, a narrower labellum than group 1 and a shorter labellum than group 3. In addition, flowering was at the same time as group 1 (peak mid-October), whereas group 3 is a November flowering species in our surveys.

Group 3 specimens had a thicker labellum than group 1 (Appendices 2, 3), upturned labellum tip absent, pointed labellum tip and translucent groves absent, a narrower labellum than group 1 and a longer labellum than group 2. In addition, flowering time was mid-November rather than October. Plants were taller than the range of heights of groups 1 and 2.

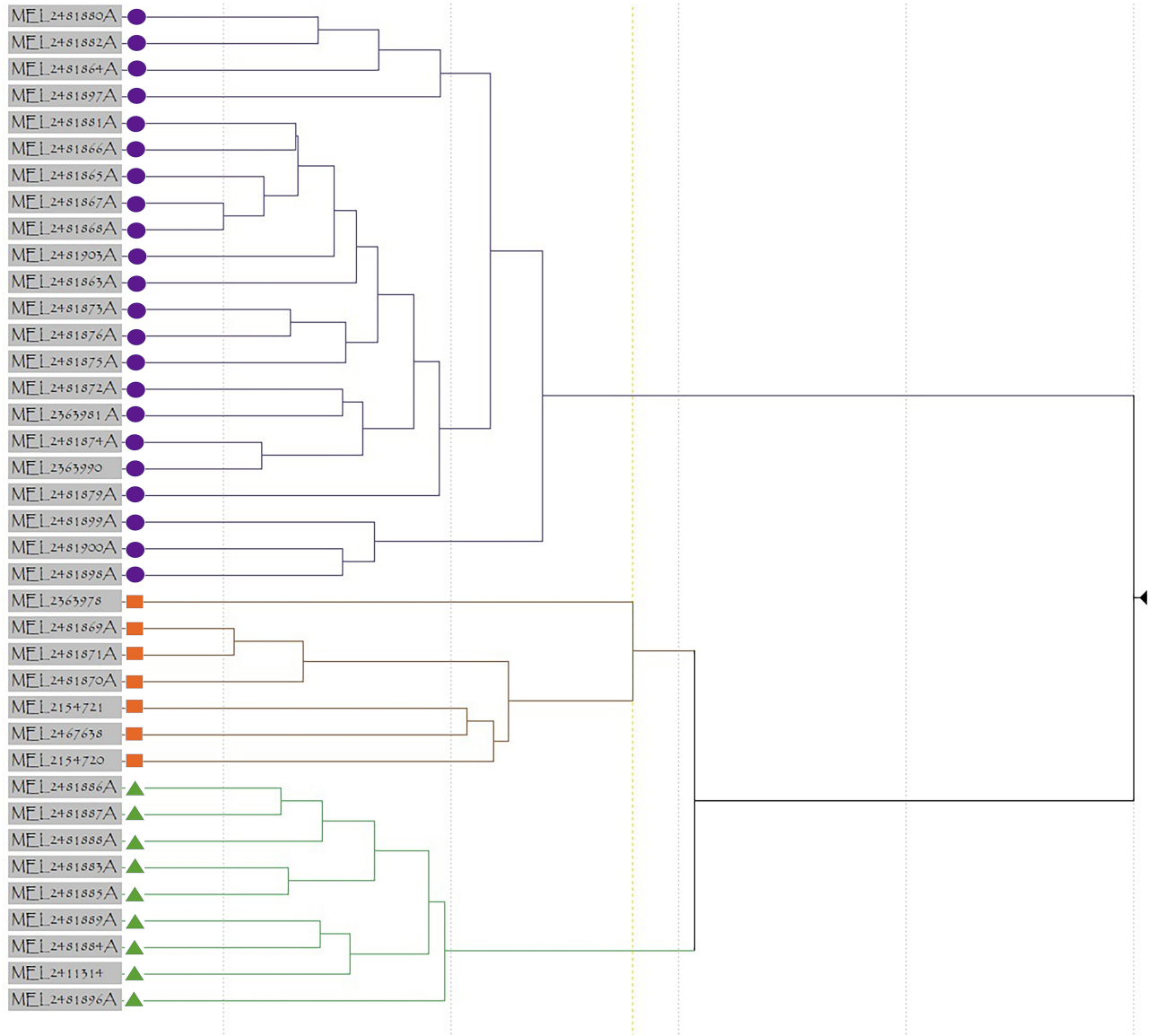

FIGURE 2. Dendrogram of group 1 (*P. biseta*)= purple circle, group 2 (*P. jeanesii*)= brown square and group 3 (*P. peakallana*)= green triangle. Dendrogram based on cluster analysis of morphometric measurements of the top 5 Kruskal Wallis characters with a value greater than 18. Distance matrices were calculated using the Gower metric (GM) and cluster analysis was performed using unweighted pair-group method using arithmetic averages (UPGMA) to produce dendrograms.

FIGURE 3. Comparison between labellums side on of group 2 (*P. jeanesii*) (A), group 1 (*P. biseta*) (B) and group 3 (*P. peakallana*) (C). Scale = 1.1mm.

FIGURE 4. Comparison of labella from above of group 2 (*P. jeanesii*) (A), group 1 (*P. biseta*) (B) and group 3 (*P. peakallana*) (C). Scale = 1 mm.

Vegetation

Groups 1 and 2 largely occurred in different vegetation types but did overlap in their distribution when found in the semi-arid woodland ecological vegetation class (EVC) 97 (DSE 2004a), with group 2 exclusive to this vegetation class. Groups 1 and 3 overlapped in distribution and vegetation types. Groups 2 and 3 did not overlap in vegetation types, with the former being found in semi arid woodland EVC 97 (DSE 2004a) and the later red swale mallee EVC 95 (DSE 2004b) and low rises woodland EVC 66 (DSE 2004c).

Pterostylis group 1 species occurred among a variety of ecological vegetation classes, including red swale mallee EVC 95 (DSE 2004b), semi arid woodland EVC 97 (DSE 2004a) and semi arid parilla woodland EVC 828 (DSE 2004d), with no clear preference for habitat, across the 11 sites occupied (Appendix 5). Prominent overstory species differed between sites from those dominated by *Eucalyptus calycogona* subsp. *trachybasis* Nicolle (2000: 307) and *Eucalyptus socialis* Mueller in Miquel (1859: 132) subsp. *socialis,* to those dominated by *Eucalyptus largiflorens* Mueller (1855: 34) or even *Casuarina pauper* Mueller in Miquel (1859: 100). Likewise, the understorey differed between sites from a largely chenopod understorey dominated by *Disphyma crassifolium* subsp. *clavellatum* (Haworth 1803: 79) Chinnock (1986: 194) to a diverse understorey of more than 14 common species.

Pterostylis group 2 species were found in a *Casuarina pauper* woodland (Appendix 5) with the following common species: *Casuarina cristata* Miquel (1848: 70), *Sclerolaena diacantha* Bentham (1870: 194), *Chenopodium ulicinum* Gandoger (1919: 224), *Enchylaena tomentosa* Brown (1810: 408), *Maireana brevifolia* (Brown 1810: 409) Wilson (1975: 22), *Olearia pimeleoides* (Candolle 1836: 268) Bentham (1867: 479), *Atriplex vesicaria* Heward in Bentham (1870: 172), *Beyeria viscosa* Miquel (1844: 350) and *Eremophila* sp. Although surveys were conducted at Rocket Lake with a similar *Casuarina pauper* woodland, no plants were found. In addition, although herbarium spirit collections existed, no plants were found during surveys at Berook, which was of a different vegetation type.

Pterostylis group 3 species were found in two vegetation types with no apparent similarities: *Eucalyptus phenax* Brooker & Slee (1996: 77), *Eucalyptus calycogona* subsp. *trachybasis* woodland with a depauperate understory largely being a winter wet, grey clay soak without groundcover, and a *Eucalyptus largiflorens* grassy woodland with cracking clays and a diverse understorey of geophytes, succulents and daisies (Appendix 5).

Discussion

Comparison with similar described species

We assessed if each of our groups corresponded to those named species that were morphologically most similar to our groupings. These are: *P. biseta* and *P. petrosa*, most similar to group 1; *P. exelsa* and *P. pedina*, most similar to group 2; and *P. exelsa* and *P. terminalis*, most similar to group 3.

Pterostylis biseta was described by Blackmore & Clemesha (1968), the holotype *Rogers s.n.* (NSW 99356), consists of a sheet of three pressed flowers. The species is is not currently recognised from Victoria (Vicflora 2020). We included several samples of *P. biseta* from South Australia in our analysis including from Blackwood (MEL 2481899A), Rockleigh and Pinaroo. These samples clustered with all the Victorian samples in our analysis in group 1.

We compared the range of measurements with the holotype of *P. biseta* and found these overlapped with the range in group 1 in the following characters: height (group 1 10–30 cm; holotype 15–22 cm), number of flowers (group 1

2–5; holotype 4–5), distance between flowers (group 1 r 1.5–3.4 cm; holotype 2.0–3.0 cm), length of the free points of the sepals (group 1 10–25 mm; holotype 16–21 cm), length of the labellum (group 1 4.7–8.2 mm; holotype 5.0–6.0 mm), labellum tip upturned (group 1 present; holotype present), depth of the flower (group 1 2.0–3.5 cm; holotype 2.5 cm), and length of the free point of the galea (group 1 3–15 mm; holotype 10–12 mm). Furthermore, we compared the type description by Blackmore & Clemesha (1968) with the range in group 1 (see Appendices 1, 3) and found that in all cases the measurements in the description of *P. biseta* overlapped with those in group 1. This included plant height, number of flowers, width of the sepals, length of the sepals, length of the free points of the galea, length of the labellum, and depth of the flower. In addition, the description refers to the tip of the labellum being upturned and the species being widespread and scattered across Victoria and South Australia. Within Victoria, this species occurs in four distinct vegetation types including red swale mallee EVC 95 (DSE 2004b), semi arid woodland EVC 97 (DSE 2004a) and semi arid parilla woodland EVC 828 (DSE , 2004d; Appendix 5).

Pterostylis petrosa was described by Jones & Clements (1993). We compared the holotype, *Logan s.n* (a floral card consisting of two dissected flowers) and nine specimens from the following sheet and spirit collections of *P. petrosa*: CANB 663617.2 , CBG8605640.1, CBG8605640.3, CANB663617.1, CBG8605640 to our samples of group 1 '*P. biseta'* (Appendix 6). Comparisons were limited due to the condition of the specimens and the type not consisting of a whole plant. There were discrepencies between the description (Jones & Clements 1993) and the type specimen, namely: flowering time in the description is September–November (holotype collected 7 December 1988), width of lateral sepals description 14–16 mm (holotype 12–13 mm), length of solid part of lateral sepals description 6–8 mm (holotype 12.5 mm) and length of labellum description 7–9 mm (holotype 5.5–6.5 mm). We found that there was no difference in the range of values measured on those samples examined of *P. petrosa* including the holotype from *P. biseta* or group 1 in our study, except for the holotype of *P. petrosa*, which had wider lateral sepals (Appendix 6). However, the description (but not the holotype or samples examined) of *P. petrosa* from The Rock clearly differs from *P. biseta* with a wider galea, shorter free points on the sepals and a longer labellum, and thus we conclude that group 1 is not *P. petrosa*. Further collections are required to clearly define the concept of *P. petrosa* and the co-occurance of *P. biseta*.

Pterostylis excelsa was described by Clements (Jessop & Toelken 1986) with the holotype *Clements 1600E* (CBG), a cultivated plant. Although this species has similarities to groups 2 and 3, *P. exelsa* can be easily distinguished by a crest of small setae on the labellum mound. In addition, plants of *P. excelsa* are generally taller with a scape up to 80 cm in height and 20 flowers. The two closest morphological fits of described species to groups 2 and 3 are *P. pedina* and *P. terminalis*, and thus we compare these below.

Pterostylis pedina was described by Jones (2009; as *Oligochaetochilus pedinus*) from two plants. The holotype was from a plant cultivated by Nita Wheeler in Yass, *Jones 19177* (CANB 664862), consisting of a pressed specimen of the aerial parts of one plant, including rosette and two intact flowers and a dissected flower in spirit (CANB 664862.2). There are no other specimens of this species lodged in herbaria. At first glance, this species is superficially similar to groups 2 and 3. The holotype measurements of *P. pedina* differed and was smaller than the range of measurements in groups 2 and 3 specimens in all the following characters: width of sepals, length of free points of the sepals, length of the labellum, labellum width, length prominent setae on the labellum, height of flower, height of basal mound (HBM) and width of basal mound (WBM; Appendix 3). Thus, we conclude that *P. pedina*, although morphologically similar, cannot be ascribed to groups 2 and 3 due to these substanial differences.

Pterostylis terminalis was described by Jones & Bates (2017, as *Oligochaetochilus terminalis*) with the holotype, *Bates 94577* (AD), lodged somewhat later than the description in early 2020 and consisting of three pressed plants. The labellum is described as thick textured except for its apex which is "thin textured upturned with a vague median ridge, obtuse, with a terminal cluster of shorter upturned bristles." As noted above the labella of groups 2 and 3 plants are consistently thick including their pointed (acute) apices, which are not upturned. The flowers of *P. terminalis* were recognized as having "prominent green bands and lines in the first few days after opening these marks changing color to reddish-brown or pink and finally red when dry". Groups 1, 2 and 3 plants do not exhibit this trait. There were discrepancies between the holotype and the description of *P. terminalis* including: length of the free points sepals (holotype 11–16 mm; description 20–30 mm) and length of free point of the galea (holotype 11 mm; description 5–7 mm). A comparison of the range of measurements in the description of *P. terminalis* and holotype (where possible due to the nature of pressed specimens) with that in groups 2 and 3 (Appendices 1, 3) found that *P. terminalis* had a narrower lateral sepals than group 3 (unable to measure on type), smaller prominent setae (LPS) than group 3 (unable to measure on type), longer labellum than group 2 (ranges did not overlap) and a wider labellum than group 2 (ranges did not overlap, unable to measure on type). Although flowering time for *P. terminalis* based on the type is October unlike that in Group 3 which is generally November, environmental conditions may not make this a reliable character.

Thus, we conclude that although *P. terminalis* is superficially similar to groups 2 and 3, the above characters clearly distinguish this species from our groups.

Taxonomy

Pterostylis jeanesii N.Reiter, B.Kosky & M.A.Clem., *spec. nov.* (Fig. 6)

Type:—AUSTRALIA. Victoria: Murray Sunset National Park, Mopoke, 44 m, 22 Oct 2019, *Reiter 407* (holotype: MEL2481870A).

Pterostylis jeanesii (Fig. 5, revised key to Vicflora Appendix 7) has similarities to *P. exelsa* but differs from that species by way of lacking a crest of small dense setae on the labellum mound, shorter scape 9–20 cm (versus 80 cm), 2–5 flowers (versus up to 20). *Pterostylis jeanesii* is similar to *P. pedina* but differs from this species in the following: wider lateral sepals, longer free points of the sepals, longer labellum, wider labellum, longer prominent setae, taller flower, taller basal mound and wider basal mound. *Pterostylis jeansii* corresponds to the following illustrations: Backhouse (2019: 358; as *P.* species 'Sunset Country') and Jeanes & Backhouse (2006: 140; as *P.* sp. *aff. excelsa*).

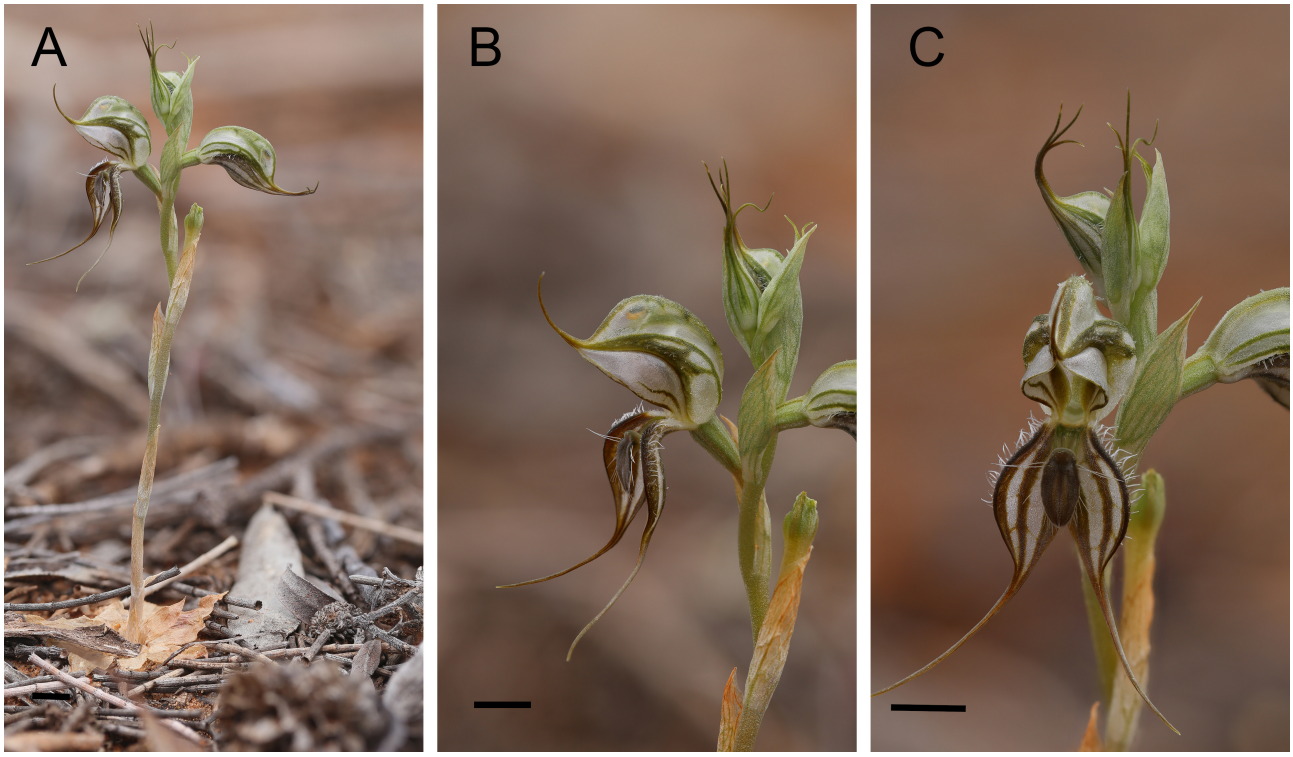

FIGURE 5. A. *Pterostylis jeanesii* habitat. B. Inflorescence, side view. C. Inflorescence, front view. Photographer: June Niejalke.

Deciduous terrestrial, solitary, tuberous herbs. Leaves sessile 2–10 in a rosette, imbricate, green, or withered at anthesis; lamina narrowly elliptical, margins entire, acute to acuminate to 2.0 × 1.1 cm. Scape 9–20 cm tall, 0.4 cm diam. Flowers 2–5, 2.0–4.0 cm tall, 1.0–2.1 cm thick. Sterile leafy bracts 2–5, ensheathing stem, lanceolate, acuminate, withered at flowering, 0.5–2.5 cm long. Floral bracts ovate-lanceolate, not overlapping at base of scape, clasping stem, apex acute to acuminate, 20–45 × 3–10 mm. Pedicels slender 2.1–2.9 cm long, enclosed within the floral bract. Ovaries narrowly cylindrical, 4.0–7.0 × 1.5–3.0 mm. Flowers porrect; galea bulbous, mostly glabrous or with few short bristles along the apical and lateral ridges, gibbous at base, shallowly curved throughout, narrowing to a filiform, decurved apical point,translucent white with predominantly green to brown stripes and markings; petals mostly translucent white with small green or brown suffusions, margins incurved with well-developed basal flanges, usually not touching; lateral sepals usually translucent white with brown or green outline and striping, free points usually brown occasionally green, basal half of lateral margins covered with prominent short, white bristles. Dorsal sepal cucullate, broadest near the base 1.0–2.1 cm long, tapering to an apical filiform, decurved point 0.2–1.0 cm long. Lateral sepals deflexed, narrow at base and conjoined in basal half, shallowly concave with thickened lateral margins, sparsely ciliate, conjoined part 7–11 × 5–12 mm; free points curved forward, filiform, 11–19 mm long, slightly spreading. Petals asymmetrical oblong-lancolate, falcate, 1.0–2.1 × 4.0–5.0 mm, dorsal margin prominently

thickened, glaborus, anterior margin curved, glabrous, proximal flange brown prominent, apex acuminate. Labellum insectiform on a visible claw, articulate, highly sensitive to touch, nested between conjoined part of the lateral sepals when exposed and in set position; 4.8–5.7 × 1.2–2.1 mm, 0.3–0.4 mm deep, usually solid brown or green; laminar obovate to elliptical with basal lobe: 1.4–1.6 mm tall, 0.5–1.6 × 0.6–2.1 mm; distal margins with a series of spreading, short white setae, largest nearest the base, smaller towards apex, 0.4–2.7 mm long, with twin pairs of prominent long setae, 1.8–4.0 mm long on the labellum below the basal lobe. Column porrect, incurved, extending most of the length of the bulbous part of the galea, partly visible through translucent parts of the galea; column wings rectangular, distal margins covered in a series of fine, dense setae. Anther obtuse, green, c. 1.0 mm long. Pollinia linear, c. 1.0–1.5 mm long, yellow.

FIGURE 6. A. *Pterostylis peakallana* habitat. B. Inflorescence, side view. Photographer: Russell Stanley.

Flowering:—October

Habitat:—Red soils in a low-lying *Casuarina pauper* woodland with the following commonly occurring species: *Casuarina cristata, Sclerolaena diacantha, Chenopodium ulicinum, Enchylaena tomentosa, Maireana brevifolia, Olearia pimeleoides, Atriplex vesicaria, Beyeria viscosa* and *Eremophila* sp. At Borree Plains (NSW) the single herbarium specimen occurred in *Casuarina pauper* woodland. The Berook site is open *Eucalyptus* woodland.

Distribution:—Herbarium specimens from four locations (Figure 1) between Murray Sunset National Park and Boree Plains in NSW. However, surveys in 2018 and 2019 only located this species at a single site within the Murray Sunset National Park, Victoria. Road works appear to have destroyed the plants at Berook, and no plants were found near Rocket Lake despite extensive surveys. The plants are likely to still be extant in Boree Plains NSW but were not seen in a survey by Kosky in 2019.

Conservation status:—IUCN criteria CR C2ai (IUCN, 2012) for critically endangered with observed documented decline, less than 250 individuals known and less than 50 individuals in any known population. The remaining population in Victoria is in a national park.

Etymology:—Named after the Victorian botanist Jeff Jeanes, who discovered the first specimens of this species and has made a significant contribution to the taxonomy of the Orchidaceae and other plant families.

Additional specimens examined:—AUSTRALIA. Victoria: Murray Sunset National Park, Mopoke, 44 m, 24 Oct 2017, *Reiter 218* (MEL2467638A); Murray Sunset National Park, Mopoke, 44 m, 22 Oct 2019, *Reiter 406* (MEL2481869A); Murray Sunset National Park, Mopoke, 44 m, 22 Oct 2019, *Reiter 408* (MEL2481871A); Murray Sunset National Park, Berrook, 52 m, 1 Oct 1991, *Jeanes s.n* (MEL2154721); Murray Sunset National Park, Berrook, 52 m, 20 Oct 1992, *Jeanes s.n* (MEL2154720A); Murray Sunset National Park, Rocket Lake, 45 m, 22 Oct 1996, *Fletcher 360* (MEL2034851A). New South Wales: Boree Plains Station, 108 m, 27 Oct 2016, *Sluiter 16* (MEL2387265).

Pterostylis peakallana N.Reiter, B.Kosky & M.A.Clem., *spec. nov.* (Fig. 7)

Type:—Australia. Victoria: Wyperfeld National Park, Brocken Bucket, 130 m, 9 Nov 2019, *Reiter 425* (holotype: MEL2481888A).

Pterostylis peakallana (Fig. 6, revised key to Vicflora Appendix 7) has affinities to *P. exelsa* but differs from that species in lacking a crest of small dense setae and a scape 18–58 cm tall (versus up to 80 cm) with 1–8 flowers (versus up to 20). *Pterostylis peakallana* is similar to *P. terminalis* but differs in labellum tip not upturned, wider lateral sepals and longer prominent setae. *Pterostylis peakallana* corresponds to the following illustrations: Backhouse (2019: 357; as *P.* species 'north west plains'); Backhouse *et al*. (2016: 714; as *P.* 'north west mallee' - Yanac photos only).

Deciduous terrestrial, solitary, tuberous herbs. Leaves sessile 2–10 in a rosette, imbricate, green, or withered at anthesis; lamina narrowly elliptical, margins entire, acute to acuminate, 0.5–3.5 × 0.5–1.0 cm. Scape 18–58 cm tall, 0.2–0.3 cm diam., generally 1–8 flowers, 3.0–4.5 cm tall, 2.0–2.5 cm thick. Sterile leafy bracts 4–7, ensheathing stem, lanceolate, acute, withered at flowering, 0.5–3.0 cm long. Floral bracts ovate-lanceolate, not overlapping at base of scape or at apex, clasping stem, apex acute, 2.0–3.5 × 0.3–1.0 cm. Pedicels erect, glabrous, slender 2–4 cm long, partially enclosed within the floral bract, appressed against the stem. Ovaries erect to slightly porrect, near but not usually against the stem, glabrous, narrowly cylindrical, 4.0–7.0 mm × 1.5–2.0 mm. Flowers porrect; galea bulbous, glabrous, gibbous at base, shallowly curved throughout, narrowing to a filiform, apical point; translucent white with predominantly green to light brown stripes and markings; petals mostly translucent white with small light green or brown suffusions, margins incurved with well-developed basal flanges, usually not touching; lateral sepals usually translucent white with light brown or green outline and striping, free points usually light brown-green, basal half of lateral margins covered with prominent white trichomes. Dorsal sepal cucullate, glabrous, broadest nearest the base, 2.0–2.5 cm long, tapering to an apical filiform, straight to decurved point, 10-14 mm long. Lateral sepals deflexed, narrow at base and conjoined in basal half, flat to shallowly concave lateral margins, sparsely ciliate, conjoined part 8–11 mm long, 7–10 mm wide; free points curved forward, filiform, 11–23 mm long, spreading. Petals asymmetrical obong-lancolate, falcate, 0.8–1.2 × 4.2–6.2 mm, dorsal margin prominently thickened, glaborus, anterior margin curved, glabrous, proximal flange brown prominent, apex acuminate. Labellum insectiform on a visible claw, articulate, highly sensitive to touch, nested between conjoined part of the lateral sepals when exposed and in set position; 6.2–7.9 × 1.7–2.9 mm, 0.3–0.4 mm deep, usually solid green or brown, laminar oblanceolate with basal lobe: 1.6–2.5 × 0.7–1.3 mm, 1.4–2.0 mm wide; distal margins slightly uneven with a series of spreading white setae, largest nearest the base, smaller towards apex, 1.1–2.5 mm long, with twin pairs of prominent long setae, 2.6–4.6 mm long below the basal lobe, occasionally a set of hairs, 1.0–1.5 mm, extending from the basal mound, not always present. Column porrect, incurved, extending most of the length of the bulbous part of the galea, partly visible through translucent parts of the galea; column wings rectangular, distal margins covered in a series of fine, dense setae. Anther obtuse, green, c. 1 mm long. Pollinia linear, yellow.

Flowering:—Peak flowering November.

Habitat:—Different semi-arid habitats, the first a floristically depauperate, low-lying, seasonally inundated open *Eucalyptus* woodland on cracking clays dominated by *Eucalyptus calycogona* subsp. *trachybasis* and *Eucalyptus phenax* subsp. *phenax*, and the second site a diverse open eucalypt woodland dominated by *Eucalyptus largiflorens*, *Bursaria spinosa* Cavanilles (1797: 30), *Chrysocephalum semipapposum* Steetz in Lehman (1845: 474), *Rhodanthe corymbiflora* (Schlechtendal 1848: 448) Wilson (1992: 391) with a diverse understory community of grasses and geophytes.

Distribution:—Currently known from two widely disjunct populations (Fig. 1) within Wyperfeld National Park and a reserve near Boort, with unconfirmed reports from one further location within Wyperfeld National Park.

Conservation status:—Endangered, *P. peakallana* meets the IUCN criteria (IUCN, 2012) EN D for endangered with less than 250 individuals known. However, considering the large area of similar habitat within Wyperfeld, Murray

Sunset and surrounding reserved areas, adequate surveys for this species in mid-November in years of high rainfall are required to accurately determine its status.

Etymology:—Named in honour of Rod Peakall in recognition of his role in elucidating the pollination mechanisms of many Australian orchids and his contributions to understanding evolution of pollination by sexual deception.

Additional specimens examined:—Australia. Victoria: Wyperfeld National Park, Brocken Bucket, 130 m, 9 Nov 2019, *Reiter 426* (MEL2481889A); Wyperfeld National Park, Brocken Bucket, 130 m, 9 Nov 2019, *Reiter 423* (MEL2481886A); Wyperfeld National Park, Brocken Bucket, 130 m, 9 Nov 2019, *Reiter 424* (MEL2481887A); Marmal NCR, 9 Nov 2019, *Reiter 420* (MEL2481883A); Marmal NCR, 9 Nov 2019, *Reiter 422* (MEL2481885A); Marmal NCR, 104 m, 9 Nov 2019, *Reiter 421* (MEL2481884A); Marmal NCR, 104 m, 3 Nov 2016, *Radford s.n.* (MEL2411314); Marmal NCR, 104 m, 9 Nov 2019, *Reiter 433* (MEL2481896A).

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