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SHORT COMMUNICATION

Cyanthillium gracilis, a new combination for the Western Australian endemic *Pleurocarpaea gracilis* (Asteraceae: Vernonieae)

Pleurocarpaea gracilis Lander & P.J.H.Hurter was described to provide a name for a rare species of daisy endemic in the Pilbara region of Western Australia, where it is known only from the summits of mountain peaks on banded ironstones of the Brockman Formation (Lander & Hurter 2013).

At the time of its description, the species was regarded as belonging in tribe Vernonieae Cass. subtribe Linziinae S.C.Keeley & H.Rob, based on its morphology and following the classification of Keeley and Robinson (2009). The mainly tropical tribe Vernonieae is not well-represented in the Australian native flora, with Lander & Hurter (2013) regarding that only one genus, *Pleurocarpaea* Benth., was native (several other genera are introduced). The new species was placed somewhat tentatively in *Pleurocarpaea*, the authors noting that mature achenes were unavailable at the time of publication, and that it 'fits broadly' within that genus 'pending the availability of specimens with fully mature achenes and further research on Australian Vernonieae' (*l.c.* p. 109).

A recent taxonomic treatment of tribe Vernonieae for *Flora of Australia* (Ghafoor 2015) lists ten genera comprising 17 species and infraspecies taxa in Australia. Of the latter, 11 are regarded as introduced and six, *viz Centratherum riparium* (DC.) A.R.Bean, *Pleurocarpaea denticulata* Benth., *P. fasciculata* Dunlop, *P. gracilis*, *Cyanthillium cinereum* (L.) H.Rob. var. *pinnatifidum* Ghafoor and *Vernonia junghuhniana* J.Kost., as native. Only *Pleurocarpaea* is endemic in Australia, the other genera with native species being generally widely distributed in the tropics.

In 2015 one of us (ES) sequenced a recently-collected specimen (*H. Hughes & S. Hitchcock* Opp 3-2; PERTH 07984731) of *P. gracilis* for the internal transcribed spacer (ITS), and conducted a BLAST search against GenBank. The *P. gracilis* sequence most closely matched multiple sequences of *Cyanthillium cinereum* at 97% similarity. Outside *Cyanthillium* Blume the next best match was 93%. Genbank ITS sequences of *Pleurocarpaea denticulata* did not make the top 100 BLAST hits.

This result strongly suggested that *P. gracilis* is incorrectly placed in *Pleurocarpaea*, and should be regarded as a species of *Cyanthillium*. Subsequent phylogenetic analyses based on ITS sequence data confirm this with high support. For this reason, it is here formally transferred to *Cyanthillium*, as *C. gracilis* (Lander & P.J.H.Hurter) K.R.Thiele & E.E.Schill.

Methods

DNA was extracted, amplified, and sequenced following the protocols in Schilling (2011). Briefly, DNA was extracted from leaf material using a DNeasy plant minikit (Qiagen, Valencia, California); ITS amplifications used the ITS-4 and ITS-5 primers (White *et al.* 1990); and sequencing was performed with the ABI Prism BigDye Terminator cycle sequencing ready reaction kit, v. 3.1 (Perkin-Elmer/Applied Biosystems, Foster City, California) and electrophoresed and detected on an ABI Prism 3100 automated sequencer (University of Tennessee Molecular Biology Resource Facility, Knoxville, Tennessee).

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Sequences for the ITS region from other members of Vernonieae were downloaded from GenBank, and aligned using MAFFT (Katoh & Standley 2013). Phylogenetic analyses to assess placement of *P. gracilis* were run using Maximum Likelihood implemented with RAxML v. 7.2.8 (Stamatakis 2014). Sequences from *Helichrysum hamulosum* DC. (Gnaphalieae Lecoq & Juillet) and *Cotula bipinnata* Thunb. (Anthemideae Cass.) were used as the outgroup.

Results

In the RAxML ITS tree (Figure 1), *P. gracilis* is weakly supported (BS=62%) as sister to the Sri Lankan *Cyanthillium hookerianum* (Arn.) H.Rob., with *P. gracilis*+*C. hookerianum* sister to *C. cinereum* and *C. montanum* (C.B.Clarke) Bunwong, Chantar. & S.C.Keeley with moderate support (BS=80%). These species together comprise a monophyletic *Cyanthillium*. This clade in turn is part of a well-supported clade comprising species of *Hilliardiella* H.Rob., *Polydora* Fenzl, *Parapolydora* H.Rob and *Vernonia* Schreb. (further species of the latter genus are widely scattered in the tree, indicating that it may not be monophyletic). *Pleurocarpaea denticulata* is distant, placed with poor support in a clade with species of *Linzia* Sch.Bip. ex Walp.

Discussion

While the analysis above should not be regarded as a definitive outline of generic relationships in tribe Vernonieae, it strongly indicates that *P. gracilis* is only distantly related to *P. denticulata* and should be transferred to *Cyanthillium*.

Comparison with specimens held at PERTH and with species and genus descriptions in Ghafoor (2015) indicates that *P. gracilis* is also morphologically better placed in *Cyanthillium* than in *Pleurocarpaea*. It shares with the former epaleate receptacles (paleate in *Pleurocarpaea*) and achenes with a prominent pappus of numerous capillary bristles 4–5 mm long (pappus absent or of few, stout bristles <1 mm long in *Pleurocarpaea*).

Accordingly, *P. gracilis* is recombined below into *Cyanthillium* as *C. gracilis*.

Key to species of *Cyanthillium* in Australia

The following key is amended from that provided in Ghafoor (2015).

1. Perennial, suffruticose herb to 40 cm high; leaves < 10 mm long, ≤ 5 mm wide ..... **C. gracilis**

1: Annual, erect herbs to 1.25 m; leaves 10–100 mm long, to 50 mm wide

2. Involucre cylindrico-campanulate, 2.5–3.5 mm wide; florets 15–20 per capitulum; achenes ±ribless, densely setulose; pappus biseriate, inner longer bristles about as long as corolla, outer shorter bristles persistent ..... **C. cinereum**

2: Involucre hemispherical to depressed-subglobose, 5–10 mm wide; florets 75–90 per capitulum; achenes 4- or 5-ribbed, glabrous and glandular; pappus uniseriate, delicate, with bristles much shorter than corolla ..... **C. patulum**

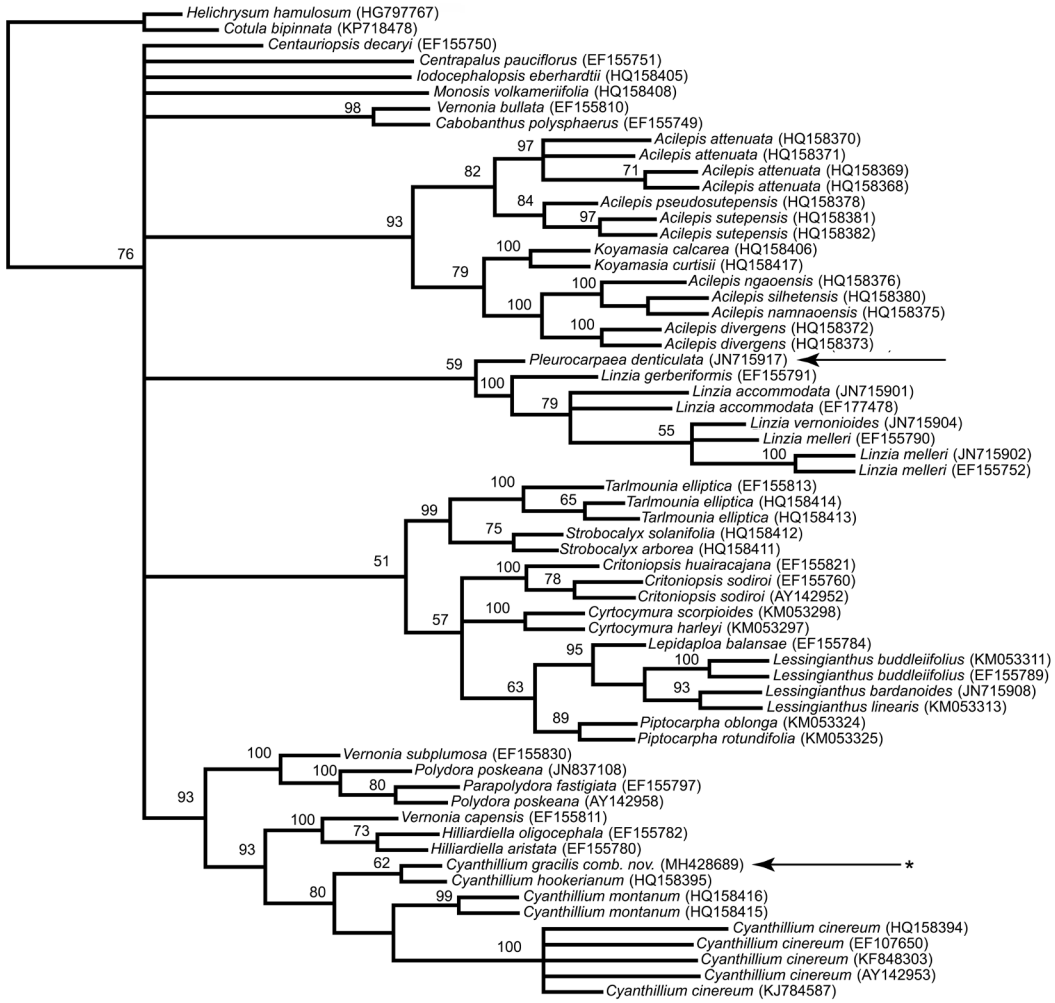

Figure 1. Tree showing relationships of *Cyanthillium gracilis comb. nov.* (arrowed, asterisked) and its clear separation from *Pleurocarpaea*, represented by *P. denticulata* (arrowed), within tribe Vernonieae based on RAxML analysis of DNA sequence data from the nuclear ribosomal internal transcribed spacer (ITS) region. Bootstrap values shown above branches. Genbank reference numbers in parentheses following species names.

Taxonomy

Cyanthillium gracilis (Lander & P.J.H.Hurter) K.R.Thiele & E.E.Schill., *comb. nov.*

Basionym: *Pleurocarpaea gracilis* Lander & P.J.H.Hurter, *Nuytsia* 23: 110–114.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 June 2012, *H. Hughes & S. Hitchcock* Opp 3-2 (PERTH); 5 June 2012, *S. Kern* Opp 59 (PERTH); 9 May 2012, *S. Kern & M. Mikli* Opp 07 (PERTH); 9 May 2012, *S. Kern & M. Mikli* WH 12125-05 (PERTH); 14 May 2012, *S. Kern & M. Mikli* Opp 22 (PERTH); 16 May 2012, *S. Kern & M. Mikli* Opp 31 (PERTH); 4 June 2012, *S. Kern & M. Mikli* Opp 28 (PERTH); 15 Oct. 1998, *S. van Leeuwen* 4387 (PERTH); 14 Oct. 1998, *S. van Leeuwen* 4345 (PERTH); 7 July 2011, *E. Thoma* 1596 (PERTH); 18 Apr. 2013, *B. Watkins & E. Thoma* ET 1633 (PERTH).

Conservation status. *Cyanthillium gracilis* is listed by Smith and Jones (2018), under *P. gracilis*, as Priority Three under the Conservation Codes for Western Australian Flora.

Notes. In the protologue description, *P. gracilis* is described as a perennial suffruticose herb. Under the heading *Distinguishing features*, however, it is described as annual, like *P. fasciculata*. Specimen notes usually describe it as a 'rounded subshrub' with no indication of longevity. It is likely that *C. gracilis* is a short-lived perennial. The other species of *Cyanthillium* occurring in Australia (*C. cinereum*, *C. patulum*) are erect annuals; however, some non-Australian species are perennial and ±shrubby (Ghafoor 2015).

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