

## SOUTH PACIFIC CLEISTOCALYX TRANSFERRED TO SYZYGIUM (MYRTACEAE)

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### SUMMARY

Evidence from both morphological and molecular phylogenetic data support the view that the circumscissile calycine calyptra, the sole defining character of *Cleistocalyx*, has multiple origins within *Syzygium* s.l. and is therefore an invalid basis for generic circumscription. Accordingly, the Fijian *Cleistocalyx* are transferred to *Syzygium*, and the new combinations *Syzygium decussatus*, *S. eugenioides* and *S. seemannii*, are made. *Syzygium myrtooides* is reinstated, and *Cleistocalyx ellipticus*, *C. longiflorus*, *C. kasiensis* and *C. seemannii* var. *punctatus* are reduced to the synonymy of *S. seemannii*. The distribution of *S. seemannii* is extended to Vanuatu.

**Key words:** *Acicalyptus*, *Cleistocalyx*, *Syzygium*, Myrtaceae, molecular phylogeny, morphology.

### INTRODUCTION

As part of our ongoing studies into relationships within *Syzygium* Gaertn. s.l., we have had the opportunity to examine members of the group from the south western Pacific region, including Fiji, New Caledonia and Vanuatu. Of particular interest is the status of several Fijian taxa, which are presently referred to Blume's genus *Cleistocalyx* (Smith, 1985). *Cleistocalyx* Blume is one of several proposed, and variously accepted, segregates from *Syzygium* s.l., such as *Acmena* DC., *Acmenosperma* Kausel, *Piliocalyx* Brongn. & Gris and *Waterhousea* B. Hyland. Generic circumscription within *Syzygium* s.l. has long been considered contentious (e.g. Merrill & Perry, 1939; Henderson, 1949; Schmid, 1972; Hyland, 1983; Smith, 1985; Craven, 2001) and this is particularly true with respect to *Cleistocalyx*. Amongst recent treatments, *Cleistocalyx* is accepted by Merrill & Perry (1937), Briggs & Johnson (1979), Kostermans (1981), Smith (1985) and Chantaranothai & Parnell (1994), but not by Schmid (1972), Hyland (1983), Craven (1998) or Dawson (1999).

Given that, of the 500 to 1000 species included in *Syzygium* s.l., somewhere in the vicinity of 5% possess a calycine calyptra, this is clearly a valuable character for taxonomic purposes. However, the *Cleistocalyx* group is not clearly distinguished from *Syzygium* s.str. by floral anatomy (Schmid, 1972), wood anatomy (Ingle & Dadswell, 1953) or pollen morphology (Pike, 1956); nor did Merrill & Perry (1937), Briggs & Johnson (1979) or Smith (1985) mention any vegetative or fruit characters by which

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the group could be consistently distinguished. In the absence of corroborative evidence from related disciplines, the circumscription of *Cleistocalyx* rests entirely upon a single constant character, the possession of a circumscissile calycine calyptra.

In his treatment of the Australian species of *Syzygium* s.l., Hyland (1983) reduced the three Australian *Cleistocalyx* to *Syzygium*, in belief that if the calycine calyptra was excluded from consideration, these plants were not representatives of the same evolutionary lineage. With similar reasoning, Craven (1998) transferred the Lord Howe Island endemic species *Cleistocalyx fullagarii* (F. Muell.) Merr. & L.M. Perry to *Syzygium*. While not specifically stating their position, both Dawson (1999; 4 New Caledonian species) and Takeuchi (2002; 2 Papuasian species) preferred *Syzygium* rather than *Cleistocalyx*, as the correct generic placement for calyptrate syzygioid taxa. Of the remaining calyptrate species in the eastern Malesian region, several have been referred to *Piliocalyx* (which has affinities with *Acmena* rather than *Syzygium*) and will not be further considered here, but the seven Fijian species presently included in *Cleistocalyx*, together with a calyptrate plant from Vanuatu, are discussed below.

In Smith's (1971, 1985) treatments of the Fijian *Syzygium* s.l., he notes that while sterile and fruiting specimens of *Cleistocalyx* require close scrutiny for correct identification, the buds and flowers are strikingly distinct, and that we may equally question the distinctiveness of *Syzygium* (from *Eugenia* L.) and *Acmena* (from *Syzygium* s.str.) as *Cleistocalyx*. The Fijian *Cleistocalyx*, along with the Vanuatu collections, are reasonably distinctive, and are almost certainly closely related, and this distinctiveness presumably prompted Gray's erection of the genus *Acicalyptus* to accommodate two Fijian species (Gray, 1854, 1862), and Merrill & Perry's (1937) maintenance of *Acicalyptus* as a section of *Cleistocalyx* for 5 Fijian taxa. Even with respect to floral morphology, however, the Fijian taxa share little in common with other calyptrate species within the region. For example, the Fijian *Cleistocalyx* have a condensed axile-central placenta, on which the ovules are 'scattered', basally attached and radiating to ascending. The calyptrate species from New Caledonia, and *S. fullagarii*, have considerably larger flowers, with pendulous, laterally attached, biseriate ovules. The Australian calyptrate species *S. gustavioides* B. Hyland has an axile-central placenta on which the ovules are pendulous and laterally attached. Variation in ovule orientation and placental structure has been considered phylogenetically significant in *Syzygium* s.l. (e.g. Hyland, 1983; Craven, 2001) and other fleshy fruited Myrtaceae (e.g. *Eugenia* L., Van Wyk & Botha, 1984) and may be more indicative of relationships in *Syzygium* s.l. than is the presence/absence of a calycine calyptra. The shape of the ovules per se may also be significant and this is currently being evaluated.

Recent molecular systematic studies have provided additional insight into the status of *Cleistocalyx*. Harrington & Gadek (2004) sampled 66 Australasian species of *Syzygium* s.l., including the calyptrate taxa *S. gustavioides* (F.M. Bailey) B. Hyland, *S. nervosum* DC., *S. canicortex* B. Hyland and *S. fullagarii* (F. Muell.) Craven, for sequences of the ITS and ETS regions of nuclear ribosomal DNA. With respect to *Cleistocalyx*, the results of this study are consistent with the views of Hyland (1983) and Craven (1998). *Syzygium canicortex* and *S. fullagarii* are resolved (but not as sister taxa) in a strongly supported group along with several *Syzygium* species and *Acmenosperma* (*A. claviflorum* (Roxb.) Kausel), *S. nervosum* occurs in a separate, strongly supported clade of predominantly syzygioid taxa, and the relationships of *S. gustavioides* are unresolved.

Using DNA sequences from the chloroplast regions *matK*, *ndhF* and the *rpl16* intron, Biffin et al. (in review) have developed a molecular data set for a geographically broad sample of *Syzygium* s.l. In addition to the species mentioned above, these data include representatives of the Fijian *Cleistocalyx* group (*C. longiflorus* (A.C. Sm.) Merr. & L.M. Perry, *C. ellipticus* (A.C. Sm.) Merr. & L.M. Perry, *C. decussatus* A.C. Sm.) and the New Caledonian calyptrate taxon *S. kuebiniense* J.W. Dawson. These data provide strong support (i.e. bootstrap = 90%) for 4 major lineages within *Syzygium* s.l., three of which include taxa that are referable to *Cleistocalyx*. Even within these groups, there is evidence for multiple origins of the calycine calyptra, and while the Fijian *Cleistocalyx* form a robust, monophyletic group, their close relationships appear to rest with typically syzygioid species rather than other calyptrate taxa. Their analyses include other Fijian *Syzygium* species (*S. amplifolium* L.M. Perry, *S. brackenridgei* (A. Gray) C. Muell., *S. gracilipes* (A. Gray) Merr. & L.M. Perry, *S. purpureum* (L.M. Perry) A.C. Sm., *S. seemanianum* Merr. & L.M. Perry) which are resolved in the same major clade as the three Fijian *Cleistocalyx* although not as sister taxa (Biffin et al., in review). From this we conclude that the Fijian syzygioid species probably have diverse evolutionary origins.

Both morphological and molecular evidence supports the view that *Cleistocalyx*, as presently circumscribed, is a polyphyletic assemblage and should not be maintained at generic level. The Fijian *Cleistocalyx*, and the material from Vanuatu, are best included in *Syzygium*, consistent with the treatment of other calyptrate syzygioid taxa within the eastern Malesian region. Ultimately, if recent arguments for an inclusive concept of *Syzygium* s.l. (Craven, 2001, 2003; Craven & Biffin, 2005) are borne out by accumulating morphological and molecular evidence, this placement is in the interest of taxonomic stability of the group. Accordingly, the Fijian *Cleistocalyx* species below are transferred to *Syzygium*.

Insofar as the tree flora of Fiji is concerned, *Syzygium* (incl. *Cleistocalyx*) provides particular difficulties for those conducting biodiversity and floristic studies. Contemporarily collected specimens are difficult to equate to the species as Smith (1985) delimited them. Because *Syzygium* species are common components of the Fijian rainforests, it is important that unambiguous identifications are made. The opportunity has been taken to consider the species limits of the Fijian representatives of *Cleistocalyx* as part of the present investigations into their generic affiliations. We suggest that four species only should be recognised in lieu of the seven accepted by Smith (1985), and in the enumeration below several novel reductions have been effected.

### 1. *Syzygium decussatum* (A.C. Sm.) Biffin & Craven, *comb. nov.*

Basionym: *Cleistocalyx decussatus* A.C. Sm. (1971) 495. — Type: *DF 310 (I. Bola 108)* (holo BISH n.v.; iso K, SUVA), Fiji, Viti Levu, Naitasiri Province, Colo-i-suva, 22 Feb. 1962.

### 2. *Syzygium eugenioides* (Merr. & L.M. Perry) Biffin & Craven, *comb. nov.*

Basionym: *Cleistocalyx eugenioides* Merr. & L.M. Perry (1937) 330. — *Calyptranthes eugenioides* Seem. (1866) 81, nom illeg., non Cambess. (1833). — Type: *Seemann 156* (holo K; iso GH), Fiji, Viti Levu, without further locality, 1860.

### 3. *Syzygium myrtooides* (A. Gray) R. Schmid

*Syzygium myrtooides* (A. Gray) R. Schmid (1972) 478. — *Acicalyptus myrtooides* A. Gray (1854) 551, t. 67. — *Calyptanthus myrtooides* (A. Gray) Seem. (1866) 81. — *Cleistocalyx myrtooides* (A. Gray) Merr. & L.M. Perry (1937) 329. — Type: *U.S. Expl. Exped. 1838-42* (holo US n.v., image seen; iso GH, K), Fiji, Vanua Levu, mountains of Macuata Province, 1840.

### 4. *Syzygium seemannii* (A. Gray) Biffin & Craven, *comb. nov.*

Basionym: *Acicalyptus seemanni* A. Gray (1862) 317. — *Calyptanthus seemanni* (A. Gray) Seem. (1866) 81. — *Cleistocalyx seemanni* (A. Gray) Merr. & L.M. Perry (1937) 330. — Type: *Seemann 168* (holo GH; iso BM n.v., K), Fiji, Vanua Levu, the coast of Macuata Province, 1860. (See note 3.)

*Eugenia prora* Burkill (1906) 4. — Type: *Yeoward 41* (lecto (fide Smith (1985) 363) K), Fiji, without further locality, Nov. 1894.

*Cleistocalyx seemanni* (A. Gray) Merr. & L.M. Perry var. *punctatus* Merr. & L.M. Perry (1937) 330. — Type: *Graeffe* (holo GH; iso K), Macuata Province, Mt Tana Lailai, Ovalau, Dec. 1864.

*Acicalyptus elliptica* A.C. Sm. (1936) 107, f. 57a, c. — *Cleistocalyx ellipticus* (A.C. Sm.) Merr. & L.M. Perry (1937) 330. — Type: *Smith 1567* (holo BISH n.v.; iso GH, K), Fiji, Vanua Levu, Bua Province, Seatovo Range, 20 Apr. 1934.

*Acicalyptus longiflora* A.C. Sm. (1936) 109, f. 57d. — *Cleistocalyx longiflorus* (A.C. Sm.) Merr. & L.M. Perry (1937) 329. — Type: *Storck XXV or XXVI* (holo K; iso GH), Fiji, without further locality, June 1883.

*Cleistocalyx kasiensis* A.C. Sm. (1971) 495. — Type: *DA 15740* (*leg. E. Damanu*) (holo BISH n.v.; iso K), Fiji, Vanua Levu, Cakaudrove Province, Mt Kasi area, 7 June 1968.

Notes — 1. Smith (1985) chose to recognise *C. ellipticus*, *C. longiflorus* and *C. kasiensis* at specific level and, ‘without much conviction’ (p. 364), maintained Merrill & Perry’s (1937) var. *punctatus* within *C. seemannii*. With respect to the latter, we note that some specimens (e.g. *Gillespie 2866*, *Horne 774*, *Yeoward 41*) are intermediate in terms of prominence, and density of glands, reducing the value of this separation. In rejecting Gray’s genus *Acicalyptus*, Smith (1985: 359) notes that flower size, elongate calycine calyptra, and bud- and fruit- angularity are characters usable only at specific level, and there, *not easily* (emphasis added). He then uses bud- and fruit-angularity and flower size to separate *C. ellipticus* and *C. longiflorus*, although there are no marked discontinuities in the characters above. In our opinion, these characters represent a continuum, as does leaf size, and the development of an acumen. If these are excluded from consideration, *C. ellipticus* may be distinguished (but not consistently) from *C. longiflorus* by its ultimate inflorescence branchlets, with flowers in triads, compared with usually solitary flowers, but not from *C. seemannii* or *C. kasiensis*, in which the former condition predominates. *Cleistocalyx kasiensis*, known only from the type collection, is distinguished only by its shortly petiolate leaves, which again may be regarded as an outlier in what is essentially a continuum. The petiole in *C. seemannii*, *C. longiflorus* and *C. ellipticus* is 2–11, 3–10 and 6–15 mm long, respectively, whereas in *C. kasiensis* it is 2 mm long. Given that the leaf blades (including acumen) of *C. kasiensis* in shape are consistent with the variation occurring in the three former taxa, the differences in petiole length between *C. kasiensis* and *C. longiflorus* and *C. ellipticus* are an inadequate foundation upon which to base a species.

2. Several specimens from Vanuatu also fall within our concept of *S. seemannii*. We note that just prior to anthesis, the buds of the Vanuatuan plant are larger (5–7 mm

long) than in the Fijian material we have seen, and the hypanthium is swollen at the apex beyond that which is typical for *S. seemannii*. In other respects, the specimens from Vanuatu are a good match for *C. seemannii* sensu Smith, and key out to this taxon in his flora (Smith, 1985). These specimens thus extend the range of *S. seemannii* to Vanuatu. The relevant details of the Vanuatuan collections are: *Morrison* s.n., Aneityum, peak S of Ithumu, tree c. 19 ft., 30 June 1890 (K); *Morrison* s.n., Aneityum, peak S of Ithumu, alt. 1835 ft., tree c. 20 ft., 30 June 1890 (K); *Morrison* s.n., Aneityum, summit of peak (2300 ft.) between Anumu and Ithug, 26 June 1896 (K, 2 sheets).

3. It appears that the locality from which the type collection of *A. seemanni*, *Seemann 168*, was made is uncertain. Smith drew attention to the fact that the locality, Port Kinnaird, Ovalau, [Lomaiviti Province,] is given on the isotype material at K (Smith, 1985). Seemann, however, cites the Macuata locality given above (Seemann, 1866).

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