

MALESIAN AND AUSTRALIAN TOURNEFORTIA TRANSFERRED TO HELIOTROPIMUM AND NOTES ON DELIMITATION OF BORAGINACEAE

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SUMMARY

Boraginaceae is expanded to comprise seven subfamilies, two of which are based on Hydrophyllaceae and Lennoaceae, respectively. The type species of *Tournefortia* sect. *Tournefortia* is transferred to *Heliotropium*, as are its Malesian–Australian representatives.

Key words: *Heliotropium*, *Tournefortia*, Boraginaceae, Lennoaceae, Malesia, Australia.

INTRODUCTION

The Flora of Australia account of Boraginaceae is planned for publication in 2005 (A. Wilson, pers. comm.). As the present author is contributing the treatment for *Heliotropium* L. to that series, it has been necessary to consider some recent publications on the family.

LIMITS OF THE FAMILY BORAGINACEAE

A starting point may conveniently be made with Melchior (1964) who grouped Boraginaceae with Hydrophyllaceae and Lennoaceae in the suborder ('Unterreihe') Boraginineae in the order ('Reihe') Tubiflorae. Boraginaceae is a widespread family and has about 2300 species and about 130 genera assigned to five subfamilies: Boraginoideae, Cordioideae, Ehretioideae, Heliotropioideae and Wellstedioideae (Mabberley, 1997). Hydrophyllaceae is also widespread and has about 270 species in 18 genera (Mabberley, 1997). Lennoaceae is a family restricted to the New World and consists of four species of root parasites assigned to two genera (Mabberley, 1997). Flora of Australia uses the Cronquist (1981) classification of flowering plants as the basis for family recognition and treatment, albeit with some minor departures in recent years (A. Orchard, pers. comm.). Insofar as Boraginaceae is concerned, Cronquist (1981) adopted a fairly traditional circumscription, with Hydrophyllaceae assigned to Solanales and Boraginaceae and Lennoaceae to the closely related Lamiales. However, despite placing them in separate orders, he acknowledged the existence of a relationship between Boraginaceae and Hydrophyllaceae (Cronquist, 1981: 908) but did not provide details. A useful and concise enumeration of the diagnostic morphological features of Boraginaceae (including the five subfamilies), Hydrophyllaceae and Lennoaceae is given in Mabberley (1997).

Taking advantage of an accumulation of information in recent years, derived from analysis of genome data and the more traditional sources of data such as morphology and anatomy, the Angiosperm Phylogeny Group (APG) in 1998 published a suprafamilial classification of flowering plants (APG, 1998). In this classification, the Boraginaceae were placed in the informal group Euasterids I (a group including the orders with which the Boraginaceae previously have been associated, i.e. Lamiales and Solanales) but were not assigned to an order. The families Hydrophyllaceae and Lennoaceae were referred by the APG (1998) to Boraginaceae. In a subsequent paper, the APG (2003) repeated their 1998 placement of the Boraginaceae (incl. Hydrophyllaceae and Lennoaceae) with the comment that there was still no clear placement of Boraginaceae in spite of several independent analyses of sizeable data sets. Nor did Soltis et al. (2000) find in their studies that Boraginaceae grouped unequivocally. Ferguson (1999) studied the relationships of Hydrophyllaceae using *ndhF* sequence data and found that the 'core' Hydrophyllaceae nested into Boraginaceae s.l. with one species, *Codon schenckii* Schinz, nesting separately from the core Hydrophyllaceae and with the position of *Hydrolea* L. being unresolved. *Hydrolea* is now placed in a distinct family, Hydroleaceae Bercht. & J. Presl, in the Solanales (APG, 2003).

Not all contemporary workers have accepted the combining of Hydrophyllaceae and Lennoaceae with Boraginaceae, however, and not all have accepted a broad circumscription of the latter family, instead treating it as consisting of five families, i.e. Boraginaceae s.s., Cordiaceae, Ehretiaceae, Heliotropiaceae and Wellstediaceae. Gottschling et al. (2001) utilised ITS1 data in a phylogenetic study of Boraginaceae s.l. plus Hydrophyllaceae and Lennoaceae (but not including *Wellstedia* Balf.f. as material was not available). In their results, Lennoaceae is the sister taxon to Ehretiaceae, and Hydrophyllaceae is the sister taxon to a clade comprising Heliotropiaceae, Cordiaceae, Ehretiaceae and Lennoaceae. The last five taxa form a clade sister to Boraginaceae s.s. Based upon the results of Gottschling et al. (2001), it seems that Hydrophyllaceae and Lennoaceae are appropriately placed with the four elements traditionally included in Boraginaceae.

It is my belief that recognition of a single family, i.e. Boraginaceae, as was adopted by the APG (1998, 2003), will serve the producers and users of botanical information better than recognising seven families. To reflect their respective identities and maintain comparability with the other subfamilies of Boraginaceae, Hydrophyllaceae and Lennoaceae should be treated at the rank of subfamily within Boraginaceae. The evolutionary position of Wellstedioideae needs to be determined by analysis of molecular sequence data; its continued taxonomic acceptance is conditional upon its being supported as a comparably distinct clade within Boraginaceae. With this caveat in mind, the seven subfamilies of Boraginaceae are as follows: Boraginoideae Arn. (1832) 122. Type: *Borago* L. — Cordioideae Link (1829) 569. Type: *Cordia* L. — Ehretioideae (Mart. ex Lindl.) Arn. (1832) 122. Type: *Ehretia* P. Browne. — Heliotropioideae (Schrad.) Arn. (1832) 122. Type: *Heliotropium* L. — Hydrophyllloideae (R.Br.) Burnett (1835) 1005–1007, 1095, 1105. Type: *Hydrophyllum* L. — Lennooideae (Solms) Craven (see below). Type: *Lennoa* La Llave & Lex. — Wellstedioideae Pilg. (1912). Type: *Wellstedia* Balf.f.

THE STATUS OF TOURNEFORTIA

The conventional circumscription of *Heliotropium* follows Johnston (1928) whose thorough studies of Boraginaceae have provided a foundation for its subsequent students. [Johnston's publications, and the many taxa he treated, recently have been indexed by Hilger & Zippel (2001).] The most recent comprehensive account of *Heliotropium* is that of Förther who treated the sections in detail, and enumerated the species of the genus as he defined it (Förther, 1998). Förther essentially maintained the traditional circumscription of *Heliotropium* with the excision of several species into three small genera, i.e. *Hilgeria* Förther, *Nogalia* Verdc. and *Schleidenia* Endl. These are characterised as follows: *Hilgeria*: mat-forming herb, single-flowered, peduncle elongating in fruit to exceed the subtending leaf, fruit splitting into mericarps; *Nogalia*: weak succulent herb or subshrub, branchlets densely leaved, calyx lobes broad and rounded, fruit entire and drupaceous; *Schleidenia*: decumbent annual or short-lived perennial, anthers apically hairy, fruit entire and drupaceous. In Förther's (1998) classification of Heliotropioideae, the subfamily comprised eight genera: *Argusia* Boehm., *Ceballosia* G. Kunkel ex Förther, *Heliotropium* L., *Hilgeria* Förther, *Ixorhea* Fenzl, *Nogalia* Verdc., *Schleidenia* Endl. and *Tournefortia* L.

Förther's schema has been challenged by analysis of *trnL* and ITS1 sequence data (Diane et al., 2002; Diane, 2003; Hilger & Diane, 2003). In particular, Diane (2003) and Hilger & Diane (2003) effectively demonstrated that *Argusia*, *Ceballosia*, *Nogalia* and most of *Tournefortia* nested in a well-supported clade (comprising clades HELIOTHAMNUS, HELIOTROPIUM I, HELIOTROPIUM II) that included the nomenclatural type of *Heliotropium* (i.e. *H. europaeum* L.). *Hilgeria* and *Schleidenia* nested into a well-supported clade (EUPLOCA) based on *Heliotropium* sect. *Orthostachys* sensu Johnston (1928) and most contemporary authors. Clade EUPLOCA was sister to a clade (MYRIOPUS) that equates to *Tournefortia* sect. *Cyphocyema* I.M. Johnst., and *Ixorhea* (clade IXORHEA) was sister to the clade EUPLOCA–MYRIOPUS. Diane (2003) and Hilger & Diane (2003) proposed that Boraginaceae subfam. Heliotropioideae (as Heliotropiaceae) be redefined to comprise five genera: *Euploca* Nutt., *Heliotropium* L., *Ixorhea* Fenzl, *Myriopus* Small, and *Tournefortia* L.

Because of the lack of resolution of clade HELIOTROPIUM I, i.e. the clade including *T.* sect. *Tournefortia*, Diane (2003) and Hilger & Diane (2003) advocated retaining *Tournefortia* s.s. until the situation is clarified. They did state, however, that "the species of *Tournefortia* sect. *Tournefortia* warrant incorporation into the genus *Heliotropium*" (Hilger & Diane, 2003: 45). *Tournefortia* is well represented in Central and South America but there is no recent taxonomic revision of the many species that occur there and an 'automatic' transfer of the American species to *Heliotropium* should not occur before at least a review of their taxonomy. For regions for which recent revisions or reviews of *T.* sect. *Tournefortia* exist, on the other hand, there seems to be no valid reason preventing new combinations being made in *Heliotropium*. This is the case in Malesia (Riedl, 1997) and Australia (Randell & Craven, in press) where the species concerned have been recently revised. Relatively few species of *Tournefortia* occur in the Malesian–Australian region and the lack of a formal infrageneric classification to accommodate them is not an impediment to making the necessary alignment to their generic nomenclature. In the case of American species of *Tournefortia* sect. *Tournefortia*, until the necessary species level revision had been conducted, there will not be names

available in *Heliotropium*. In the interim, authors can either continue to use the name in *Tournefortia* or they can adopt an informal format such as citing “*Heliotropium* sp. (*Tournefortia* [epithet authority])”. Of greater concern is the taxonomic status of clade EUPLOCA. During my ongoing investigations of the Australian indigenous and naturalised species of *Heliotropium* as the genus is traditionally circumscribed (Craven, 1996, in press), I have formed the view that they are appropriately placed in the same genus. Rather than split what is, relative to the rest of Boraginaceae, a very natural group, I prefer to recognise a single genus for these species, i.e. *Heliotropium*. The studies of Diane et al. (2002), Diane (2003) and Hilger and Diane (2003) now lead me to the conclusion that *Heliotropium* should be expanded to include all members of Heliotropioideae.

The species treated by Riedl (1997) as *Tournefortia* in the Flora Malesiana account are enumerated below as species of *Heliotropium*; this includes the three Australian species as they also occur in Malesia. To preserve the name *Heliotropium* against the less speciose *Tournefortia*, the formal transfers of the latter genus and its type species to *Heliotropium* are also effected.

Boraginaceae subfam. **Lennooideae** (Solms) Craven, *comb. nov.*

Basionym: Lennoaceae Solms (1870) 174. — Type: *Lennoa* La Llave & Lex.

HELIOTROPIUM

Heliotropium L. (1753) 130. — Type (fide Britton & Brown (1913) 73): *Heliotropium europaeum* L. *Tournefortia* L. (1753) 140. — Type (fide Britton & Millspaugh (1920) 361): *Tournefortia hirsutissima* L. (*Heliotropium verdcourtii* Craven), typ. cons. prop.

Note — The names *Heliotropium* and *Tournefortia* were published by Linnaeus (1753) in the same work and hence have equal priority. The formal transfer of *Tournefortia* into the synonymy of *Heliotropium* is effected here to maximise nomenclatural stability, given that the latter genus is more speciose and more widely distributed than *Tournefortia* and least disruption will occur by accepting the name *Heliotropium* over *Tournefortia*.

1. *Heliotropium verdcourtii* Craven, *nom. nov.*

Replaced synonym: *Tournefortia hirsutissima* L. (1753) 140. — Type (fide Johnston (1949) 133): “*Tournefortia caule hirsuto*”, Plumier in Burman, *Pl. Amer.* (1760) t. 229, typ. cons. prop.

Notes — 1. This New World species, the nomenclatural type of *Tournefortia*, is formally transferred to *Heliotropium* and a name made available for it in the latter genus now that *Tournefortia* is placed in subordinate synonymy.

2. The lectotypification by Johnston (1949) has been accepted by Jarvis et al. (1993) and is followed here.

3. A new epithet is required in *Heliotropium* due to the prior name *H. hirsutissimum* Grauer (1784). The new epithet has been selected to commemorate Bernard Verdcourt whose prolific published research (Verdcourt, 1997, 2002) includes several contributions on Boraginaceae, notably the account of the family for Flora of Tropical East Africa (Verdcourt, 1991).

2. *Heliotropium biblianum* Craven, *nom. nov.*

Replaced synonym: *Tournefortia tetrandra* Blume (1826) 845. — Type: *Blume s.n.* (holo L n.v.), Java.

Notes — 1. A new name is required in *Heliotropium* due to the prior name *H. tetrandrum* Lour. (1790). The new epithet is derived arbitrarily from the Greek, *biblion*, a diminutive of *biblos*, book, scroll, paper, and is intended to honour botanical bibliographers. When conducting systematic research, I am often reminded of the enormous debt we owe to those persons who prepare bibliographies of plant names, collectors, publications, etc. and it is high time I acknowledged this in a more enduring manner.

2. See Riedl (1997) for additional taxonomic synonyms.

3. *Heliotropium buruense* Craven, *nom. nov.*

Replaced synonym: *Tournefortia oppositifolia* Riedl (1996) 444. — Type: *Van Balgooy 4885* (holo L n.v.), Indonesia, Maluku, Buru, NW Buru, SE from Bara, Waeduna.

Note — A new epithet is required in *Heliotropium* due to the prior name *H. oppositifolium* Ruiz & Pav. (1799). The epithet selected is derived from the name of the island Buru, the only region in which this species is known to occur.

4. *Heliotropium foertherianum* Diane & Hilger

Heliotropium foertherianum Diane & Hilger in Hilger & Diane (2003) 46. — *Tournefortia argentea* L.f. (1781) 133. — Type: *Koenig s.n.* (holo LINN n.v.), Sri Lanka.

Notes — 1. This common shrub or small tree species of the Indo-western Pacific region is sometimes treated under *Argusia* Boehm. or *Messerschmidia* L. ex Hebenstr. As *H. argenteum* is pre-empted in *Heliotropium* by *H. argenteum* Lehm. (1818), Hilger & Diane (2003) provided a new name for the species.

2. See Riedl (1997) for additional taxonomic synonyms.

5. *Heliotropium luzonicum* (I.M. Johnst.) Craven, *comb. nov.*

Basionym: *Tournefortia luzonica* I.M. Johnst. (1935) 156. — Type: *Adduru 237* (holo A; iso K, both n.v.), Luzon, Cagayan Province, vicinity of Peñaflanca.

a. subsp. *luzonicum*

b. subsp. *angustissimum* (Riedl) Craven, *comb. nov.*

Basionym: *Tournefortia luzonica* subsp. *angustissima* Riedl (1996) 443. — Type: *Ridsdale 1477* (holo L n.v.), Philippines, Luzon, Zambales Province, Santa Cruz, Acoje Mine concession area.

c. subsp. *sublucens* (I.M. Johnst.) Craven, *comb. nov.*

Basionym: *Tournefortia luzonica* var. *sublucens* I.M. Johnst. (1935) 157. — *Tournefortia luzonica* subsp. *sublucens* (I.M. Johnst.) Riedl (1996) 443. — Type: *Ramos & Edaño 44553* (holo A; iso B, BM, K, all n.v.), Luzon, Zambales Province, Anuling.

6. *Heliotropium muelleri* (I. M. Johnst.) Craven, *comb. nov.*

Basionym: *Tournefortia muelleri* I. M. Johnst. (1935) 157. — *Tournefortia mollis* F. Muell. (1858) 59, nom. illeg., non Bertoloni (1851) 186. — Type: *Mueller s.n.* (holo MEL; iso K n.v.), Australia, ad ripas fluvii Burdekin.

7. *Heliotropium riedlii* Craven, *nom. nov.*

Replaced synonym: *Tournefortia minutiflora* Riedl (1996) 443. — Type: *Ivalaoa UPNG 7752* (holo L; iso K, LAE, UPNG, all n.v.), Papua New Guinea, Gulf Province, near Lelefiru, Miaru Mareka Point near Meporo River.

Note — A new epithet is required in *Heliotropium* due to the prior name *H. minutiflorum* Bunge (Von Bunge, 1869). The new epithet honours Harald Udo von Riedl (1936–), a student of Boraginaceae and author of the Flora Malesiana account of this family (Riedl, 1997).

8. *Heliotropium sarmentosum* (Lam.) Craven, *comb. nov.*

Basionym: *Tournefortia sarmentosa* Lam. (1792) 416. — Type: *leg. ign. s.n.* (holo P n.v.), the type, fide Johnston (1935), is labelled “colitur in horto regio insulae Franciae” and “de M. Sonnerat”, and represents a Malesian form of the species.

Note — See Riedl (1997) for additional taxonomic synonyms.

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