Ninety-three new combinations in *Euploca* for species of *Heliotropium* section *Orthostachys* (Boraginaceae *sensu* APG)

MICHAEL W. FROHLICH¹*, MATS THULIN² & MARK W. CHASE¹

¹Jodrell Laboratory, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3DS, UK; E-mail: m.frohlich@kew.org

²Systematic Biology, Department of Organismal Biology, EBC, Uppsala University, Norbyvägen 18D, SE-75236 Uppsala, Sweden.

Abstract

Many new combinations are needed in *Euploca*, previously regarded as *Heliotropium* section *Orthostachys*, to correspond with results of our forthcoming, world-wide, molecular phylogenetic analysis. We also need these names for our many $\delta^{13}\text{C}$ determinations that identify many *Euploca* species exhibiting C_4 photosynthesis and show that other *Euploca* species are not C_4 . Here we make the many new combinations required to support these results.

Keywords: Australia, Heliotropiaceae, carbon assimilation systems

Introduction

Euploca was erected by Nuttall (1836: 189–190) for *E. convolvulacea* Nuttall (1836: 190) from what is now the western USA and northern Mexico. Subsequently, other authors from Asa Gray (1857: 403) onward placed *Euploca* within *Heliotropium* Linnaeus (1753: 130) section *Orthostachys* Brown (1810: 493) using the key generic character of dry fruit (i.e., nutlets), which distinguishes *Heliotropium* from the related *Tournefortia* Linnaeus (1753: 140), characterized by an indehiscent fleshy fruit.

Molecular studies by Hilger & Diane (2003) included a limited number of exemplars from *Heliotropium* section *Orthostachys* and showed that neither *Heliotropium* nor *Tournefortia* is monophyletic. Their sampled species of *H.* section *Orthostachys* were monophyletic and sister to *Tournefortia* section *Cyphocyema* Johnston (1930: 72–73). Our forthcoming more extensive sampling of *H.* section *Orthostachys* confirms that result.

Lyn A. Craven (now sadly deceased), in his monograph of Australian *Heliotropium* (1996) and subsequent work (Craven 2005a), had named many new species as members of *Heliotropium* section *Orthostachys*. To achieve monophyly of the genus, Craven (2005b) had favoured expanding *Heliotropium* to encompass all of *Tournefortia*, but we agree with Hilger and Diane (2003) that the best solution is to recognize *H.* section *Orthostachys* as the genus *Euploca* (as well as recognizing its sister, *T.* section *Cyphocyema*, as the genus *Myriopus* Small [1933: 1131]). To expand *Heliotropium* to include all of *Tournefortia* would be even more disruptive, resulting in a huge genus that is overly diverse (Hilger & Diane 2003, Diane *et al.* 2016). Most new combinations have already been made for the Americas, but not for Australia. We take this opportunity to make the needed new combinations for all the Australian species recognized as *Heliotropium* section *Orthostachys* in Craven (1996, 2005a), and we make new combinations for some additional species from other parts of the world.

Euploca includes shrubs and herbs, in warm-temperate and tropical climates, primarily in moderately dry to arid climates. It is especially diverse in Australia, North and South America, and the Caribbean. Several species are in the Horn of Africa and adjacent Arabia, but the rest of Africa and southern Asia have few but widespread species.

No single character distinguishes all species of *Euploca* from *Heliotropium* *s.s.* and from *Myriopus*. It is the molecular results that conclusively separates *Euploca* from the other genera (Hilger & Diane 2003). *Euploca* exhibits the following combination of characters, with exceptions in some species: flowers born in scorpioid cymes, and, if the cymes exhibit equal bifurcations, these present only at the base; cymes often with bracts, and bracts sometimes large and functioning as leaves, and then rarely bearing axillary branches that are also cymes. Flowers salverform or funnelform, often with upper ridged epidermal cells elongating into trichomes toward the centre of the disk, and often

grading into moniliform trichomes in the corolla throat. Anther tips sterile and connivent to coherent by their more-or-less bulbous tips. Fruit dry at maturity, rounded or only weakly lobed, breaking into four equal nutlets; the two venter faces of each nutlet large, as long and broad as the nutlet itself, and nearly identical in form, each with a prominent pit. Notable exceptional species are *E. karwinskyi*, which has urceolate corollas, and *E. convolvulacea*, which has strongly bilobed fruits, with each half-fruit nearly spherical, and each half-fruit eventually breaking into nearly hemispherical nutlets, with the nutlets having one large venter face, without a pit, and one small venter face (Frohlich 1976, Craven 1996, Diane *et al.* 2016).

Among our many new combinations, one epithet, “*apertum*,” requires some special explanations. Craven (1996: 628) wrote, regarding *Heliotropium apertum*, “The specific epithet is a reference to the discovery of this species on cleared ground on the edge of the Mitchell Plateau airstrip (L. *aperio*, I open, lay bare).” “*Aperio*” is a verb, so the epithet “*apertum*” must derive from the verb form, that is, the supin (=supine) form, so the epithet is a verbal noun, which does not agree in grammatical gender with the genus. The adjective “*apertus*” does have the neuter nominative form “*apertum*,” which becomes “*aperta*” when feminine. Craven’s use of a verb to explain his epithet means that it must be treated as a verbal noun in apposition.

Three species previously moved to *Euploca* have nomenclatural issues: Melo (2017b) made the new combination *Euploca axillare* (Greenm.) Melo (2017b: 559), based on *Heliotropium axillare* Greenman (1898: 483). This epithet is an adjective, so it must agree in grammatical gender with its genus. *Heliotropium* is neuter, but *Euploca* is feminine, so correcting the epithet to become feminine results in the name *Euploca axillaris*.

In moving *Heliotropium calcicola* Fernald (1907: 62–63) to *Euploca*, as *E. calcicola* (Fernald) Melo (2017a: 125), the author ignored an earlier name for this species: *Antiphytum mexicanum* de Candolle (1846: 121). Two other usages of the epithet *mexicanum* in *Heliotropium* had rendered this epithet unavailable for transfer to *Heliotropium*: *H. mexicanum* Greenman (1898: 484–485) and *H. mexicanum* Sessé & Mociño (1888: 20). There is, however, no *mexicana* in *Euploca*, so that epithet should have been applied to the species when transferred to *Euploca*.

Unfortunately, that could cause confusion. The name *Heliotropium mexicanum* Greenman had been widely used for the species more properly called *Heliotropium ternatum* Vahl (1794: 21), and many herbarium sheets bear this old usage of *Heliotropium mexicanum*. This is in spite of the earlier *Heliotropium mexicanum* Sessé & Mociño, which is a later synonym of *Lithospermum strictum* Lehmann (1818b: 303) as discussed by Johnston (1949: 109). *Heliotropium mexicanum* Greenman is also properly in *Euploca*. To have a different species now called *Euploca mexicana* is unfortunate.

Furthermore, as pointed out by Feuillet (2016: 104), when the new combination *Euploca ternata* (Vahl) Melo & Semir (2009: 289) was made for *H. ternatum*, the authors should have used the earlier epithet based on *Tournefortia humilis* Linnaeus (1753: 141) for this species. Feuillet (2016) did not think *Euploca ternata* could be conserved against a Linnean name, so he made the new combination, *Euploca humilis* (L.) Feuillet (2016: 104).

Both *Euploca ternata* (i.e., *E. humilis*) and *E. calcicola* are widespread, ecologically important species. The name *E. ternata* has continued to be generally used. The complexity of the correct naming for each species adds to the confusion in the naming of the other. Unfortunately, we believe that a proposal to conserve the epithets *ternata* and *calcicola* for *Euploca* would not succeed, so we here make the new combination *Euploca mexicana* for *H. calcicola*. Although this will initially generate confusion, it should result in nomenclatural stability, that, in the long run, will facilitate understanding of the biology of this evolutionarily complex genus. In general, it is better to simply follow priority, rather than trying to determine when a later name should be conserved. In potentially many other specific cases, that would involve personal rather than objective views about the best option.

Taxonomy

Euploca aenigmata (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium aenigmatum* Craven, *Austral. Syst. Bot.* 9: 583 (1996).

Euploca aequorea (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium aequoreum* Craven, *Austral. Syst. Bot.* 12: 929 (1999).

Euploca albrechtii (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium albrechtii* Craven, *Beagle* 21: 19 (2005).

Euploca alcyonium (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium alcyonium* Craven, *Austral. Syst. Bot.* 9: 626 (1996).

Euploca amnis-edith (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium amnis-edith* Craven, *Austral. Syst. Bot.* 9: 584 (1996).

Euploca anderssonii (B.L.Rob.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium anderssonii* B.L.Rob., *Proc. Amer. Acad. Arts and Sci.* 38: 192 (1902).

Euploca apertum (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium apertum* Craven, *Austral. Syst. Bot.* 9: 627 (1996).

Euploca applanata (Thulin & Verdc.) Thulin, *comb. nov.*

Basionym: *Heliotropium applanatum* Thulin & Verdc., in Verdc., *Fl. Trop. E. Africa*, Boragin. 119 (1991).

Euploca arenitensis (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium arenitense* Craven, *Beagle* 21: 16 (2005).

Euploca argyrea (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium argyreum* Craven, *Beagle* 21: 13 (2005).

Euploca brachygyne (Benth.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium brachygyne* Benth., *Fl. Austral.* 4: 396 (1869).

Euploca brachythrix (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium brachythrix* Craven, *Austral. Syst. Bot.* 9: 585 (1996).

Euploca bracteata (R.Br.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium bracteatum* R.Br., *Prodr. Fl. Nov. Holland.* 493 (1810).

Euploca calvariavis (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium calvariavis* Craven, *Austral. Syst. Bot.* 9: 586 (1996).

Euploca chalcedonia (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium chalcedonium* Craven, *Austral. Syst. Bot.* 9: 587 (1996).

Euploca chrysocarpa (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium chrysocarpum* Craven, *Austral. Syst. Bot.* 9: 554 (1996).

Euploca collina (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium collinum* Craven, *Austral. Syst. Bot.* 9: 616 (1996).

Euploca conocarpa (F.Muell. ex Benth.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium conocarpum* F.Muell. ex Benth., *Fl. Austral.* 4: 398 (1869).

Euploca consimilis (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium consimile* Craven, *Austral. Syst. Bot.* 9: 629 (1996).

Euploca cracens (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium cracens* Craven, *Austral. Syst. Bot.* 9: 589 (1996).

Euploca cunninghamii (Benth.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium cunninghamii* Benth., *Fl. Austral.* 4: 400 (1869).

Euploca delestangii (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium delestangii* Craven, *Austral. Syst. Bot.* 9: 571 (1996).

Euploca dichotoma (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium dichotomum* Craven, *Austral. Syst. Bot.* 9: 591 (1996).

Euploca dichroa (Urb.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium dichroum* Urb., *Symb. Antill.* [Urban] 5(3): 481 (1908).

Euploca diffusa (Britton) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium diffusum* Britton, *Bull. New York Bot. Gard.* 4: 122 (1905).

Euploca discordis (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium discorde* Craven, *Austral. Syst. Bot.* 9: 593 (1996).

Euploca diversifolia (F.Muell. ex Benth.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium diversifolium* F.Muell. ex Benth., *Fl. Austral.* 4: 400 (1869).

Euploca eggersii (Urb.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium eggersii* Urb., *Symb. Antill.* [Urban] 5(3): 481 (1908).

Euploca epacridea (F.Muell. ex Benth.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium epacrideum* F.Muell. ex Benth., *Fl. Austral.* 4: 396 (1869).

Euploca euodes (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium euodes* Craven, *Austral. Syst. Bot.* 9: 594 (1996).

Euploca fasciculata (R.Br.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium fasciculatum* R.Br., *Prodr. Fl. Nov. Holland.* 494 (1810).

Euploca ferreyrae (I.M.Johnst.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium ferreyrae* I.M.Johnst., *J. Arnold Arbor.* 37: 296 (1956).

Euploca filaginoides (Benth.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium filaginoides* Benth., *Fl. Austral.* 4: 398 (1869).

Euploca flintii (F.Muell. ex A.S.Mitch.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium flintii* F.Muell. ex A.S.Mitch., *J. Adelaide Bot. Gard.* 2: 357 (1980).

Euploca foveolata (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium foveolatum* Craven, *Austral. Syst. Bot.* 9: 595 (1996).

Euploca frohlichii (Craven) M.W.Chase, *comb. nov.*

Basionym: *Heliotropium frohlichii* Craven, *Austral. Syst. Bot.* 9: 574 (1996).

Euploca galioides (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium galioides* Craven, *Austral. Syst. Bot.* 9: 597 (1996).

Euploca geocharis (Domin) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium geocharis* Domin, *Biblioth. Bot.* 89: 547 (1928).

Euploca glabella (R.Br.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium glabellum* R.Br., *Prodr. Fl. Nov. Holland.* 494 (1810).

Euploca glandulifera (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium glanduliferum* Craven, *Austral. Syst. Bot.* 9: 557 (1996).

Euploca haesum (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium haesum* Craven, *Austral. Syst. Bot.* 9: 600 (1996).

Euploca haitiensis (Urb.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium haitiense* Urb., *Symb. Antill.* [Urban] 5(3): 482 (1908).

Euploca heterantha (F.Muell.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium filaginoides* Benth. var. *heteranthum* F.Muell., *Trans. Roy. Soc. South Australia* 13: 171 (1890).

Euploca hintonii (I.M.Johnst.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium fallax* I.M.Johnst. var. *hintonii* I.M.Johnst., *J. Arnold Arbor.* 18: 15 (1937).

Euploca imbricata (Griseb.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium imbricatum* Griseb., *Cat. Pl. Cub.* [Grisebach] 211 (1866).

Euploca inexplicita (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium inexplicitum* Craven, *Austral. Syst. Bot.* 9: 617 (1996).

Euploca lapidicola (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium lapidicola* Craven, *Beagle* 21: 16 (2005).

Euploca laxa (Thulin) Thulin, *comb. nov.*

Basionym: *Heliotropium laxum* Thulin, *Nordic J. Bot.* 23: 529 (2005).

Euploca leptalea (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium leptaleum* Craven, *Austral. Syst. Bot.* 9: 601 (1996).

Euploca maxima (Chodat & Hassl.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium maximum* Chodat & Hassl., *Bull. Herb. Boissier* ser. 2, 5: 482 (1905).

Euploca mexicana (DC.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Antiphytum mexicanum* DC., *Prodr.* 10: 121 (1846).

= *Euploca calcicola* (Fernald) J.I.M.Melo, *Harvard Pap. Bot.* 22: 125 (2017a).

= *Heliotropium calcicola* Fernald, *Proc. Amer. Acad. Arts and Sci.* 43: 62 (1907).

Euploca melanopedii (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium melanopedii* Craven, *Austral. Syst. Bot.* 9: 603 (1996).

Euploca microsalsoloides (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium microsalsoloides* Craven, *Beagle* 21: 19 (2005).

Euploca mitchellii (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium mitchellii* Craven, *Beagle* 21: 13 (2005).

Euploca moorei (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium moorei* Craven, *Austral. Syst. Bot.* 9: 604 (1996).

Euploca mutica (Domin) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium muticum* Domin, *Biblioth. Bot.* 89: 544 (1928).

- Euploca myriophylla*** (Urb.) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium myriophyllum* Urb., *Repert. Spec. Nov. Regni Veg.* 13: 473 (1915).
- Euploca nana*** (Northr.) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium nanum* Northr., *Mem. Torrey Bot. Club* 12: 61 (1902).
- Euploca nashii*** (Mills.) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium nashii* Mills., *Publ. Field Columb. Mus., Bot. Ser.* 2: 309 (1909).
- Euploca nesopelyda*** (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium nesopelydum* Craven, *Austral. Syst. Bot.* 9: 623 (1996).
- Euploca nexosa*** (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium nexosum* Craven, *Austral. Syst. Bot.* 9: 576 (1996).
- Euploca nigricans*** (Balf.f.) M.W.Frohl., M.W.Chase & Thulin, *comb. nov.*
 Basionym: *Heliotropium nigricans* Balf.f., *Proc. Roy. Soc. Edinb.* 12: 81 (1884).
- Euploca ottoni*** (Lehm.) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium ottoni* Lehm., *Pl. Asperif. Nucif.* 1: 59 (1818a).
- Euploca pachyphylla*** (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium pachyphyllum* Craven, *Austral. Syst. Bot.* 9: 560 (1996).
- Euploca paniculata*** (R.Br.) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium paniculatum* R.Br., *Prodr. Fl. Nov. Holland.* 494 (1810).
- Euploca parviantrum*** (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium parviantrum* (Craven), *Austral. Syst. Bot.* 9: 562 (1996).
- Euploca pauciflora*** (R.Br.) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium pauciflorum* R.Br., *Prodr. Fl. Nov. Holland.* 493 (1810).
- Euploca peckhamii*** (Craven) M.W.Froh. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium peckhamii* Craven, *Austral. Syst. Bot.* 9: 624 (1996).
- Euploca peninsularis*** (Craven) M.W.Froh. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium peninsularis* Craven, *Austral. Syst. Bot.* 9: 619 (1996).
- Euploca personata*** (Thulin) Thulin, *comb. nov.*
 Basionym: *Heliotropium personatum* Thulin, *Nordic J. Bot.* 23: 530 (2005).
- Euploca plumosa*** (Craven) M.W.Froh. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium plumosum* Craven, *Austral. Syst. Bot.* 9: 605 (1996).
- Euploca prostrata*** (R.Br.) M.W.Froh. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium prostratum* R.Br., *Prodr. Fl. Nov. Holland.* 494 (1810).
- Euploca protensa*** (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium protensum* Craven, *Austral. Syst. Bot.* 9: 608 (1996).
- Euploca ramulipatens*** (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*
 Basionym: *Heliotropium ramulipatens* Craven, *Austral. Syst. Bot.* 9: 621 (1996).

Euploca rhadinostachya (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium rhadinostachyum* Craven, *Austral. Syst. Bot.* 9: 632 (1996).

Euploca scabra (Retz.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium scabrum* Retz., *Observ. Bot.* [Retzius] 2: 8 (1781).

Euploca skeleton (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium skeleton* Craven, *Austral. Syst. Bot.* 9: 578 (1996).

Euploca sphaerica (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium sphaericum* Craven, *Austral. Syst. Bot.* 9: 609 (1996).

Euploca sphaerococca (Urb.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium sphaerococcum* Urb., *Symb. Antill.* [Urban] 5(3): 483 (1908).

Euploca subreniformis (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium subreniforme* Craven, *Austral. Syst. Bot.* 9: 610 (1996).

Euploca synaimon (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium synaimon* Craven, *Austral. Syst. Bot.* 9: 625 (1996).

Euploca tabuliplagae (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium tabuliplagae* Craven, *Austral. Syst. Bot.* 9: 567 (1996).

Euploca tachyglossoides (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium tachyglossoides* Craven, *Austral. Syst. Bot.* 9: 563 (1996).

Euploca tanythrix (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium tanythrix* Craven, *Austral. Syst. Bot.* 9: 611 (1996).

Euploca texana (I.M.Johnst.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium texanum* I.M.Johnst., *J. Arnold Arbor.* 29: 231 (1948).

Euploca transformis (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium transforme* Craven, *Austral. Syst. Bot.* 9: 581 (1996).

Euploca tytoides (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium tytoides* Craven, *Austral. Syst. Bot.* 9: 568 (1996).

Euploca uniflora (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium uniflorum* Craven, *Austral. Syst. Bot.* 9: 569 (1996).

Euploca uninervis (Urb.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium uninerve* Urb., *Ark. Bot.* 17, no. 7: 51 (1922).

Euploca vaga (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium vagum* Craven, *Austral. Syst. Bot.* 9: 614 (1996).

Euploca ventricosa (R.Br.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium ventricosum* R.Br., *Prodr. Fl. Nov. Holland.* 494 (1810).

Euploca vestita (Benth.) M.W.Frohl. & M.W.Chase, *comb. nov.*

Basionym: *Heliotropium vestitum* Benth., *Fl. Austral.* 4: 395 (1869).

Euploca viator (Craven) M.W.Frohl. & M.W.Chase, *comb. nov.*
Basionym: *Heliotropium viator* Craven, *Beagle* 21: 23 (2005).

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References

- Balfour, B. (1884) Diagnoses plantarum novarum phanerogamarum Socotrensium, etc.; quas elaboravit Bayley Balfour, scientiae doctor et in Universitate Glascuensi rerum botanicarum regius professor, pars tertia. *Proceedings of the Royal Society of Edinburgh* 12: 76–98.
<https://doi.org/10.1017/S0370164600000195>
- Bentham, G. & Mueller, F. (1869) *Flora Australiensis: a description of the plants of the Australian Territory*. Reeve, London, 576 pp.
- Britton, N.L. (1905) Contributions to the flora of the Bahama Islands II. *Bulletin of the New York Botanical Garden* 4: 115–143.
- Brown, R. (1810) *Prodromus Florae Novae Hollandae et Insulae Van-Diemen*, vol. 1. Taylor, London, 592 pp.
- de Candolle, A. (1846) *Prodromus systematis naturalis regni vegetabilis, sive, enumeratio contracta ordinum generum specierumque plantarum huc usque cognitarum, juxta methodi naturalis, normas digesta*, vol. 10. Treuttel et Würtz, Paris, 679 pp.
- Chodat, R. & Hassler, E. (1905) Plantae hasslerianae soit enumeration des plantes récoltées au Paraguay par le Dr. Emile Hassler, d'Aarau (Suisse) de 1885 à 1902. *Bulletin de l'Herbier Boissier* Ser. 2, 5: 481–506.
- Craven, L.A. (1996) A taxonomic revision of *Heliotropium* (Boraginaceae) in Australia. *Australian Systematic Botany* 9: 521–657.
<https://doi.org/10.1071/SB9960521>
- Craven, L.A. (2005a) Seven new species of *Heliotropium* (Boraginaceae) from the monsoon and arid zones of Australia. *The Beagle* 21: 11–25.
- Craven, L.A. (2005b) Malesian and Australian *Tournefortia* transferred to *Heliotropium* and notes on delimitation of Boraginaceae. *Blumea* 50: 375–381.
<https://doi.org/10.3767/000651905X623049>
- Diane, N., Hilger, H.H., Förther, H., Weigend, M. & Luebert, F. (2016) Heliotropiaceae. In: Kadereit, J.W. & Bittrich, V. (Eds.) *The families and genera of vascular plants*, vol. XIV. Springer, New York, pp. 203–211.
https://doi.org/10.1007/978-3-319-28534-4_17
- Domin, K. (1921–1929) Beiträge zur Flora und Pflanzengeographie Australiens [part 2] Dicotyledoneae. *Bibliotheca Botanica* 89: 1–763.
- Fernald, M.L. (1907) Diagnoses of new spermatophytes from Mexico. *Proceedings of the American Academy of Arts and Sciences* 43: 61–68.
<https://doi.org/10.2307/20022302>
- Feuillet, C. (2016) Two new combinations in *Euploca* Nutt. (Heliotropiaceae, Boraginales) and a conspectus of the species of the Guiana Shield area. *PhytoKeys* 61: 101–124.
<https://doi.org/10.3897/phytokeys.61.6260>
- Frohlisch, M.W. (1978) *Systematics of Heliotropium section Orthostachys in Mexico*. PhD thesis. Harvard University, 277 pp.
- Gray, A. (1857) Diagnostic characters of new species of phaenogamous plants, collected in Japan by Charles Wright, botanist of the U. S. North Pacific Exploring Expedition. (Published by Request of Captain John Rodgers, Commander of the Expedition.) With observations upon the relations of the Japanese flora to that of North America, and of other parts of the Northern Temperate zone. *Memoirs of the American Academy of Arts and Sciences* 6 (2): 377–452.
<https://doi.org/10.2307/25057953>
- Greenman, J.M. (1898) Diagnoses of new and critical Mexican phanerogams. *Proceedings of the American Academy of Arts and Sciences* 33: 471–489. [<https://www.jstor.org/stable/20020833>]
- Grisebach, A. (1866) *Catalogus plantarum Cubensium exhibens collectionem Wrightianam aliasque minores ex insula Cuba missas Wrightianam aliasque minores ex insula Cuba missas*. Engelmann, Leipzig, 301 pp.
<https://doi.org/10.5962/bhl.title.177>
- Hilger, H.H. & Diane, N. (2003) A systematic analysis of Heliotropiaceae (Boraginales) based on *trnL* and ITS1 sequence data. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 125: 19–51.

<https://doi.org/10.1127/0006-8152/2003/0125-0019>

- Johnston, I.M. (1930) Studies in the Boraginaceae 8. *Contributions from the Gray Herbarium* 92: 3–95.
- Johnston, I.M. (1937) Studies in the Boraginaceae 12. *Journal of the Arnold Arboretum* 18: 1–25.
- Johnston, I.M. (1948) Studies in the Boraginaceae 16. *Journal of the Arnold Arboretum* 29: 227–241.
<https://doi.org/10.5962/bhl.part.26200>
- Johnston, I.M. (1949) Studies in the Boraginaceae 17 B: The identity of species proposed by Sessé and Mociño. *Journal of the Arnold Arboretum* 30: 104–110.
<https://doi.org/10.5962/bhl.part.18048>
- Johnston, I.M. (1956) Studies in the Boraginaceae 28. *Journal of the Arnold Arboretum* 37: 288–306.
- Lehmann, J.G.C. (1818a) *Plantae e familiae Asperifoliarum nuciferae descripsit*. Part 1. Dümmler, Berlin, 250 pp.
- Lehmann, J.G.C. (1818b) *Plantae e familiae Asperifoliarum nuciferae descripsit*. Part 2. Dümmler, Berlin, 235 pp. [pp. 252–478 & I–IX]
- Linnaeus, C. (1753) *Species plantarum*, tomus 1. Salvius, Stockholm, 560 pp.
- Melo, J.I.M. (2017a) New combinations in *Euploca* Nutt. (Heliotropiaceae) from Mexico and Central America. *Harvard Papers in Botany* 22: 125–126.
<https://doi.org/10.3100/hpib.v22iss2.2017.n5>
- Melo, J.I.M. (2017b) Nuevas combinaciones en *Euploca* (Heliotropiaceae) de México. *Revista Mexicana de Biodiversidad* 88: 759–760.
<https://dx.doi.org/10.1016/j.rmb.2017.04.002>
- Melo, J.I.M. & Semir, J. 2009. Two new Brazilian species and new combinations in *Euploca* (Heliotropiaceae). *Kew Bulletin* 64: 285–289.
<https://doi.org/10.1007/s12225-009-9109-3>
- Millspaugh, C.F. (1909) Praenunciae Bahamenses-II. Contributions to a flora of the Bahamian Archipelago. *Publications of the Field Museum of Natural History Botanical Series* 2: 289–321.
<https://doi.org/10.5962/bhl.title.95452>
- Mitchell, A.S. (1980) A new species of *Heliotropium* (Boraginaceae) and a new combination in *Abutilon* (Malvaceae). *Journal of the Adelaide Botanic Garden* 2: 357–359. [<https://www.jstor.org/stable/23872368>]
- Mueller, F. [baron von] (1890) Supplemental notes to the list of plants, collected in central Australia. *Transactions and Proceedings and Report of the Royal Society of South Australia* 13: 170–171.
- Northrop, A.R. (1902) Flora of New Providence and Andros (Bahama Islands). *Memoirs of the Torrey Botanical Club* 12: 1–98, plates 1–19.
- Nuttall, T. (1837) Collections toward a flora of the territory of Arkansas. *Transactions of the American Philosophical Society Ser. 2*, 5: 139–204.
<https://doi.org/10.2307/1004943>
- Retzius, A.J. (1781) *Observationes botanicae sex fasciculis comprehensae*, vol. 2. Crusium, Leipzig, 33 pp. [in fasc 2]
<https://doi.org/10.5962/bhl.title.11760>
- Robinson, B.L. (1902) Flora of the Galapagos Islands. *Proceedings of the American Academy of Arts and Sciences* 38: 77–270.
<https://doi.org/10.2307/20021744>
- Sessé, M. & Mociño, I.M. (1887–1890) *Plantae Nouae Hispaniae*. Naturaleza, Mexico City, 184 pp.
- Small, J.K. (1933) *Manual of the southeastern flora. Being descriptions of the seed plants growing naturally in Florida, Alabama, Mississippi, eastern Louisiana, Tennessee, North Carolina, South Carolina and Georgia*. University of North Carolina Press, Chapel Hill, 1574 pp.
<https://doi.org/10.5962/bhl.title.696>
- Thulin, M. (2005) Three new species of *Heliotropium* (Boraginaceae) from the Horn of Africa region. *Nordic Journal of Botany* 23: 527–532.
<https://doi.org/10.1111/j.1756-1051.2003.tb00428.x>
- Urban, I. (1904–1908) *Symbolae Antillanae, seu, fundamenta florae Indiae Occidentalis*. Borntraeger, Leipzig, 555 pp.
- Urban, I. (1915) Sertum antillanum II. *Repertorium Specierum Novarum Regni Vegetabilis* 13: 465–484.
<https://doi.org/10.1002/fedr.19150133002>
- Urban, I. (1922) *Plantae Haitienses novae vel rariores a cl. Er. L. Ekman 1917 lectae*. *Arkiv för Botanik* 17 (7): 1–72.
- Vahl, M. (1794) *Symbolae botanicae sive plantarum, tam earum, quas in itinere, iprimis orientali, collegit Petrus Forskål, quam aliarum recentius detectarum, exactiores descriptiones, nec non observationes circa quasdam plantas dudum cognitae*, part 3. Möller, Copenhagen, 106 pp.
- Verdcourt, B. (1991) Boraginaceae. In: Polhill, R.M. (Ed.) *Flora of Tropical East Africa*. Balkema, Rotterdam, 124 pp.