Blumea 64, 2019: 92–95
www.ingentaconnect.com/content/nhn/blumea

RESEARCH ARTICLE

https://doi.org/10.3767/blumea.2019.64.01.03

The *Euploca baclei* complex (*Boraginaceae* subfam. *Heliotropioideae*)

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Key words

Africa
biogeography
Boraginaceae
endozoochory
Euploca
Heliotropiaceae
Heliotropium
key
map

Abstract In order to recognise both taxa previously regarded as varieties of *Heliotropium baclei*, nowadays classified in *Euploca*, a new combination is necessary. As the two varieties are clearly separable in terms of morphology and biogeography, we propose to raise these varieties to the species level, for which the new combination *Euploca katangensis* needs to be created. Moreover, we propose the new combination *Euploca madagascariensis* for *Heliotropium madagascariense*, a species from Madagascar considered by some as conspecific with *H. baclei*, but treated here as distinct. For these three species with beaked fruits, constituting the '*Euploca baclei* complex', a key and a distribution map, based on revised herbarium specimens, is given. Two additional combinations, *Euploca bullockii* and *Euploca sessilistigma* are made to complete the transfer of tropical African *Heliotropium* species that belong in *Euploca*.

Published on 18 March 2019

INTRODUCTION

In the course of the preparation of a manuscript on *Boraginaceae* for the Flore du Gabon, some species of *Heliotropium* in the broad sense of Gabon and other African countries have been studied.

Recently, Hilger & Diane (2003) rearranged the generic delimitation and classification of *Boraginaceae* subfam. *Heliotropioideae* (by some, e.g., Luebert et al. 2016, recognised at family level), based on molecular data of nuclear ITS1 and chloroplast trnLUAA intron sequences, combined with morphological characters. They proposed to merge *Schleidenia* Endl. and *Heliotropium* L. sect. *Orthostachys* R.Br. into *Euploca* Nutt., and resolved *Myriopus* Small as its sister. A later study, based on more markers and outgroups but only two *Euploca* species, indeed resolved these two genera as sisters, that are, together with *Ixorhea* Fenzl, forming the sister clade of the remainder of the subfamily being *Heliotropium* s.str. (Weigend et al. 2014). *Euploca* was published by Nuttall (1836) to accommodate a new North American species (*Euploca convolvulacea* Nutt.) and was until the merger by Hilger & Diane (2003) an exclusively New World taxon.

With the inclusion of *Heliotropium* sect. *Orthostachys* and *Schleidenia*, *Euploca* now is considered to have a pantropical distribution and to contain c. 100 species (Luebert et al. 2011), although currently in *Euploca* only 68 specific names exist (IPNI 2018).

However, a considerable number of recombinations has not yet been made. In their study, Hilger & Diane (2003) not only transfer only a small selection of species, they also only make a single new recombination for a subspecies, while other existing subspecies and varieties of the species they transferred, were not discussed nor transferred. Amongst those Old World specimens they used for their molecular study was an accession from Zambia, *Gilges 685* (M), of *Heliotropium baclei* DC. var. *rostratum* I.M.Johnst. (as *Schleidenia* but that combination is not validly published). Based on the phylogenetic position of this accession, they indeed created *Euploca baclei* (DC.) Diane & Hilger but did not make any new combination for the taxon their accession belonged to, var. *rostratum*. The differences between typical *Euploca baclei* and material of var. *rostratum* seem so large that we wondered if this taxon should not be recognised at species level.

Although our research is focused on continental tropical Africa, we stumbled upon a collection (*J.M. Hildebrandt 3035*) from Madagascar of which the K duplicate, an isolectotype of *Evolvulus madagascariensis* Vatke, was identified as belonging to *H. baclei* var. *rostratum*.

Evolvulus madagascariensis is an older name than *H. katangense*, the oldest available name at species level for var. *rostratum*, and hence the identity of this material is relevant for the name of the continental African material. So, we included material of *Heliotropium madagascariense* (Vatke) I.M.Johnst., as it is currently classified, into our studies, resulting in a complete review of the African *Euploca* species with a widened and elongated beak, the *Euploca baclei* complex.

METHODS

Herbarium specimens from BR, BRLU, L and WAG, and the Madagascar material of MO have been physically examined, while specimens from E, K and P together with those present on JSTOR-Global Plants (2017) were examined using high resolution images on the internet. All examined specimens were entered in the Naturalis database and georeferenced. For some measurements also the images have been used. For measurements the beak length is measured from the sinus in the fruit-outline to the apex but excluding the style and stigma cap if that is still present and for fruit length the beak was included as well.

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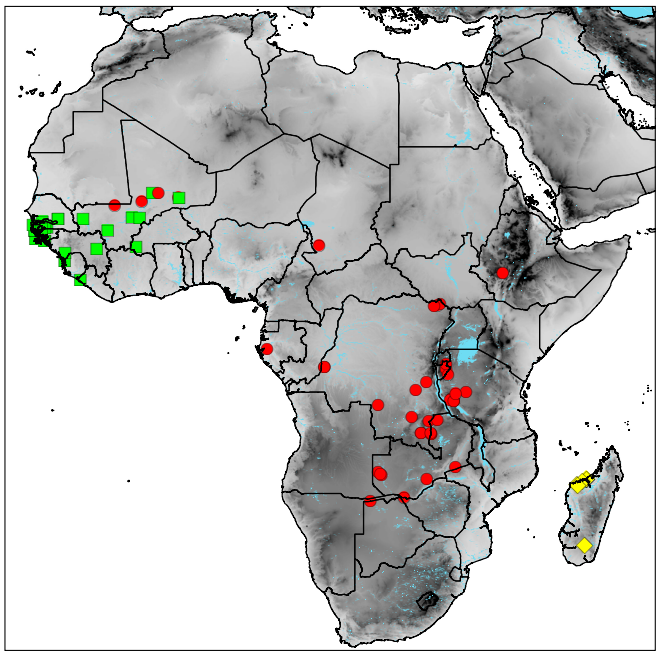
RESULTS

In our opinion, the two varieties of *Heliotropium baclei* are clearly separable based on two characters; length of the rostrum on the ripe fruits and petal colour, as mentioned by Johnston (1930), Heine (1963) and Taton (1971). Using herbarium vouchers from the African continent we evaluated the mentioned morphological characters. We consider these differences to be quite substantial. The long beaks and completely yellow flowers of var. *rostratum* are a striking difference with typical *E. baclei*. Moreover, typical *E. baclei* has in general smaller fruits than the other variety, and there is even a gap in the ranges of the beak proportion of the entire fruit length. Apart from an area along the Niger River in western Mali where they co-occur, the two taxa are geographically separated, as is shown in Map 1.

We therefore want to recognise *Heliotropium baclei* var. *rostratum* at the species level, for which a new combination is proposed: *Euploca katangensis*. Interestingly, the material we examined of *H. madagascariense* seems more closely related to the West-African *E. baclei*, than to the pan-African *E. katangensis*. With *E. baclei* it shares white flowers with a yellow centre, and relatively short beaks. Fruits of *H. madagascariense* are in general slightly smaller than those of *E. baclei*, but their width is slightly larger, resulting in a different length/width ratio with only a slight overlap: *H. madagascariense* fruits are wider than long (ratio 0.6–0.95) where *E. baclei* is about globose to longer than wide (ratio 0.9–1.8). Together with the wide geographical gap between these two entities, we cannot accept this material as belonging to the same species. Hence, we follow Johnston (1930) who considered this as a separate species: *Heliotropium madagascariense*. As *Hildebrandt 3035* and other Malagasy specimens seen by us clearly fit into the former subsection *Axillaria* I.M.Johnst. under the section *Orthostachys* R.Br. and we consider it closely related to *E. baclei*, we think it should be placed in *Euploca* as well, and hereby we propose a new combination. Since in the protologue there is no specimen designated as holotype for the type gathering, and the most likely one, the B sheet, mentioned as holotype by Förther (1998), which should be considered as a lectotypification, is lost, we select the L sheet from the extant isolectotypes.



Map 1 Distribution of *Euploca katangensis* (Gürke ex De Wild.) E.L.A.N. Simons & Wieringa (●), *E. baclei* (DC.) Diane & Hilger (■) and *E. madagascariensis* (Vatke) E.L.A.N.Simons & Wieringa (◆).

NOTES ON ECOLOGY, MORPHOLOGY AND KEY TO THE 'EUPLOCA BACLEI GROUP'

Euploca can clearly be separated from *Heliotropium* s.str. but the characters are not easily recognised in the field. *Euploca* is characterised by mericarpid or endocarpid structures with surface sculpturings described as 'pits', kranz-chlorenchyma organisation in leaves of almost all species and the exclusive occurrence of characteristic trichomes on a pedestal of distinctly enlarged foliar epidermis cells (Hilger & Diane 2003).

No comprehensive treatment of African *Heliotropium* has been written yet. However, following Johnston (1928, 1930), Förther (1998) and Hilger & Diane (2003), most African species nowadays classified in *Euploca* formerly belonged to subsections *Axillaria* and *Bracteata* I.M.Johnst. of section *Orthostachys*. The only exception is *E. ovalifolia* (Forssk.) Diane & Hilger that belonged to subsection *Ebracteata* I.M.Johnst. Species belonging to former subsection *Bracteata* are quite easily recognised by its bracteate solitary inflorescence and its pointed corolla lobes. Species belonging to former subsection *Axillaria* have flowers borne along a leafy stem, not aggregated into a definite spike or raceme and have drupaceous, beaked fruits. Thus, apart from *E. ovalifolia*, African species of *Euploca* are easily distinctive from 'true' *Heliotropium* s.str., like the pantropical species *H. indicum* L. and its type species *H. europaeum* L. that have ebracteate, leafless, dichotomous spiciform inflorescences. *Euploca ovalifolia* has ebracteate spiciform, often dichotomous inflorescences too, but differs in some micromorphological characters, typical for *Euploca*; having a one-layered endocarpid with surface sculpturings and having trichomes of the leaves on a pedestal of enlarged epidermal cells (Förther 1998, Hilger & Diane 2003).

Euploca baclei s.str. is a sub-Saharan, Upper Guinean taxon, probably not occurring east of Mali (Map 1). *Euploca katangensis* is widespread in Africa south of the Sahara and east of eastern Mali. *Euploca madagascariensis* is endemic to Madagascar. Our map does not present all herbarium specimens. Taton (1971) mentions some collections from Central Africa that have not been seen by us, as is the case for *Gilges 685* (M) from Zambia used in the study by Hilger & Diane (2003). It is also likely more material from Madagascar will exist in herbaria we did not visit.

The three taxa occur at muddy, sandy or gravelly shores of lakes and river beds and other temporarily inundated areas, sometimes in roadside verges, ditches, or even on tracks. *Euploca baclei* has been collected in rice paddies several times. Rees (1978) mentions *H. baclei* var. *rostratum* co-dominating dry lagoon bottoms of the Kafue river in Zambia during the dry season, together with *Cynodon dactylon* (L.) Pers. They seem to be pioneer species of open or almost absent vegetation, being able to quickly cover shores that have recently fallen dry or even while they are still inundated. In Gabon, *E. katangensis* was collected (*Lachenaud 2024*) at the stony shores of a lake in the sedimentary basin of the Ogooué river. At least the type species of the genus (*E. convolvulacea*) seems to have a similar ecology (Nuttall 1836). Dispersal of the fruits could possibly occur by means of endozoochory as is the case with many plant species in aquatic habitats (Soons et al. 2016). And indeed, fruits of *E. katangensis* have been found in the guts of birds, at least in knob-billed geese (*Sarkidiornis melanotos*) an inter-tropical migrant species (Douthwaite 1978).

Euploca baclei occurs in West-African plains of 0–200 m above sea level, *E. katangensis* is frequent in south- and eastern African highlands at about 1 000 m elevation, reaching up to 1 690 m in Ethiopia, but in Gabon it has been collected at elevations of only 0–20 m. Most records we saw of *E. madagas-*

cariensis come from the lowland but one record from an area at c. 800 m elevation.

All three species grow decumbent to ascendant, often starting in rosettes. The leaves are a bit coriaceous, dark green and a bit glossy, covered with white appressed hairs on both sides. The corolla is trumpet-shaped, 4–7 mm long, the dry fruits are beaked. De Candolle (1845) does not mention whether *H. baclei* is a perennial or an annual; neither does De Wildeman (1903) for *H. katangense*, while Taton (1971) explicitly refers to *H. baclei* var. *rostratum* as perennial. Indeed some of the plants are becoming quite woody at base. In only four of the specimens examined by us the habit was explicitly mentioned: *J. Chillou 1357* and *J.V.G. do Espirito Santo 2005* regarded *E. baclei* as annual, as is the case with collections of *E. katangensis* (*Drummond 6264*, *6762*) from Zambia. We think both species could be annual or perennial, depending on ecological circumstances.

Key to the species in the Euploca baclei complex

1. Flowers yellow to orange-yellow. Fruits with long (1.6–4.2 mm) beak, longer than remainder of fruit: beak/fruit length ratio 0.5–0.7 . . . . . *E. katangensis*
1. Flowers white with a yellow centre. Fruits with a shorter (0.2–1.1 mm) beak, shorter than remainder of fruit: beak/fruit length ratio 0.2–0.4 2
2. Fruits wider than long, length/width ratio 0.6–0.95. — Madagascar . . . . . *E. madagascariensis*
2. Fruits about as wide as long or longer, length/width ratio 0.9–1.8. — West Africa . . . . . *E. baclei*

CONSERVATION ASSESSMENT

Since both continental species according to our data occur at over 10 locations over a fair range, and without imminent threats we consider both species as Least Concern (LC). *Euploca madagascariensis* seems more restricted with fewer locations and might be endangered, but since we have only seen a part of the available material, we refrain from making a full assessment for this species.

NOMENCLATURE AND NEW COMBINATIONS

Euploca katangensis (Gürke ex De Wild.) E.L.A.N.Simons & Wieringa, *comb. nov.* — Fig. 1; Map 1

Heliotropium katangense Gürke ex De Wild., Ann. Mus. Congo Belge, Bot. sér. 4, [1(3)] (1903) 223. — *Heliotropium baclei* DC. var. *rostratum* I.M.Johnst. (1930) 91. — Type: *E. Verdick 141* (BR) (lecto, designated by Förther 1998), Congo (Kinshasa), Katanga, Lukafu, Oct. 1899.

Heliotropium nigerinum A.Chev. (1920) 45. — Syntypes: *A.J.B. Chevalier 1168* (P), Mali, Sebi, 11 July 1899, *A.J.B. Chevalier 1365* (P), Mali, sur les bords du marigot de Day, 3 Aug. 1899. [Note: often considered as *nomen nudum*, but since Chevalier gives a description, we consider this name validly published.]

Heliotropium marifolium auct. non Retz: Baker & Wright (1905) 40.

Note — The authorship of *H. katangense* is rather unclear. The name is published with as sole author Gürke, but in a paper written by De Wildeman, where the introduction (at page vii) thanks several workers in Berlin, including Gürke, for their help, but only of K. Schumann it is explicitly mentioned he made the descriptions for his new species. We therefore have to assume only the name was coined by Gürke and the description is by De Wildeman.

Fig. 1 *Euploca katangensis* (Gürke ex De Wild.) E.L.A.N.Simons & Wieringa in Zimbabwe Zambezi River, Zambezi National Park 18-01-2016. — Photo: Bart Wursten.

Euploca madagascariensis (Vatke) E.L.A.N.Simons & Wieringa, *comb. nov.* — Map 1

Evolvulus madagascariensis Vatke, Linnaea 43 (7) (1882) 522. — *Heliotropium madagascariense* (Vatke) I.M.Johnst. — Type: *J.M. Hildebrandt 3035* (lecto L, designated here, barcode L0004002; iso BM, BREM, GH, GOET, JE, K, LE, M, P, W).

As stated in the introduction, many taxa, especially from South America, that belong in *Euploca* have not yet been transferred. Since we have no opinion on the status of many names from the New World we will not deal with those, but for tropical Africa there are only two accepted taxa that have not yet been combined in *Euploca*, so by making these combinations at least this part of the world will have been dealt with. Therefore we propose the next two combinations:

Euploca bullockii (Verdc.) E.L.A.N.Simons & Wieringa, *comb. nov.*

Basionym. *Heliotropium bullockii* Verdc., Fl. Trop. E. Africa, Boragin. (1991) 75. — Type: *A.A. Bullock 2284* (holo K).

Euploca sessilistigma (Hutch. & E.A.Bruce) E.L.A.N.Simons & Wieringa, *comb. nov.*

Basionym. *Heliotropium sessilistigma* Hutch. & E.A.Bruce, Bull. Misc. Inform. Kew 1941 (2) (1942) 160. — Type: *J.B. Gillett 4107* (holo K).

Acknowledgements We thank Bart Wursten for his permission to reproduce the photograph of Fig. 1, and we thank two anonymous reviewers for reviewing the manuscript. We thank the curator of Missouri Botanical Garden for sending us their specimens from Madagascar.'

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IDENTIFICATION LIST

Collector names (initials only added when relevant for Africa) and collection numbers, followed by the herbarium at which the specimen is present (acronyms following Thiers 2017). Collections marked with * have been investigated based on digital specimens only (MNHN 2016, JSTOR-Global Plants 2017, Royal Botanical Garden Edinburgh Herbarium Catalogue 2017). Records marked with ** are reliable records with photo material in observation or photo databases, but with no exsiccate specimens. All records have been georeferenced and entered in the Naturalis database.

Euploca baclei (DC.) Diane & Hilger

Adam 13646 (WAG); 14866* (P).

Bacle* (G-DC, GH) – Berhaut 1690 (BR, P); 4084* (P); 7172* (P) – Breman 268 (WAG).

Champluvier S101 (BR, LG, WAG) – Chevalier 1148* (P) – Chillou 1357 (IFAN, P, WAG) – A. Cissé 135 (WAG).

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Hagerup 309 (BR).

Lécard 42 (BR, WAG) – Lejoly 87/10 (BRLU) – Lisowski 56428 (BR).

Morton SL 1357 (FHI, GC, IFAN, K, SL, WAG).

J. Raynal 7787* (P).

C. Vanden Berghen 1966 (BR); 2041 (BR); 4292 (BR, P); 5339 (BR, WAG) – Verdellen s.n. Gambia 1972 (L.2747523).

Wailly 5154* (P).

Euploca katangensis (Gürke ex De Wild.) E.L.A.N.Simons & Wieringa

Achten 634 (BR) – Auquier 4352 (L, LG, WAG).

Bidgood 6060 (BR) – Bingham 10741 (MRSC, SRGH, WAG) – A.A. Bullock 1198 (BR); 2331 (BR).

Chevalier 1168* (P); 1365* (P) – Christiaensen 701 (BR, WAG).

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Troupin 246 (BR); 702 (BR, WAG).

Vanderyst 4591 (BR); 4629 (BR) – Verdcourt 3447 (BR) – Verdick 141 (BR); 182 (BR).

Wailly 5078* (P) – Witte 5271 (BR) – Wursten** (N/A).

Euploca madagascariensis (Vatke) E.L.A.N.Simons & Wieringa

Bardot-Vaucoulon 1858* (P).

J.M. Hildebrandt 3035* (BM, BREM, GH, GOET, JE, K, L, LE, M, P, W) – Humbert 2079 (MO, P); 4086 (MO).

Rakoto 1377 (MO) – Rakotovao RN 5785 (MO) – Randrianaivo 962 (CNARP, MO, P, TAN).