

Euploca Nutt. (Boraginaceae)- A new species record for India reveals Biogeographical link with Gondwana Super Continent

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Abstract

The species *Euploca baclei* (DC.) Diane & Hilger (2003) of *Boraginaceae*, found in tropical Africa, America and Australia, is reported for the first time in India from the lateritic plains of Kannur district in northern Kerala. The discovery is of great phytogeographical significance and further strengthens the theory of "Biotic Ferry" by sharing floristic and faunistic elements common to Africa and Indian subcontinent and also the overall biogeographical link with Gondwana land mass of Mesozoic era belonging to Cretaceous period (approximately 132 - 72 mya).

Keywords: *Euploca*, Boraginaceae, Biotic Ferry, Gondwana, Continental drift.

Introduction

During the course of botanical exploration in the lateritic plains of Kannur district in northern Kerala, an interesting specimen of *Euploca* Nutt. (1836) was collected from a mud-covered open marsh of a drying seasonal pool. Detailed studies of the specimen confirmed it as *Euploca baclei* (DC.) Diane & Hilger, hitherto known from tropical Africa, South America and Australia. Thus, the species is reported from India for the first time which deserves lot of phytogeographical importance and also strengthens the theories of the Continental Drift (Alfred Wegener, 1912) and Biotic Ferry by sharing common genetic stock of plants and animal species in Africa, Madagascar and India (Hedges, 2003). In this case, the

common genetic stock of *Euploca* is spread across continents as a result of breaking away of the Southern Super Continent, the Gondwana into two land masses viz Western Gondwana contains Africa and South America and Eastern Gondwana land with Antarctica, Australia and India with Madagascar (Biju and Bossuyt, 2003; Hedges, 2003). The inferred geological events and subsequent reconstruction of continents may be the possible answers to the present-day distribution of the genus *Euploca* in four continents as mentioned.

The genus *Euploca* was established by Nuttall (1836), but later Gray (1874) reduced it to a synonym of *Heliotropium* L., based on the systematic treatment of De Candolle (1845). Subsequent phylogenetic studies on these two genera by using the ITS1 gene spacer, found that the *Heliotropium* is paraphyletic and *Euploca* constitute a monophyletic clade, including *Heliotropium* sect species such as *Orthostachys* R. Br., *Hilgeria* Förther and *Schleidenia* Endl. (Diane et al., 2002; Hilger and Diane 2003). Based on these findings proposed new combinations and now, the genus *Heliotropium* encompasses only the species incorporated into *Tournefortia* Sect. *Tournefortia* (genus *Tournefortia* s. str.) (Diane et al., 2003 & 2016). Besides the molecular data, *Euploca* and *Heliotropium* are separated based on significant morphological characteristics like presence or absence of bracts, nature of anthers (free or fused), number of nutlets, shape of embryo,

leaf anatomy etc. Thus, *Euploca* is characterised by the presence of bracts in the inflorescence, flowers more rarely solitary, axillary or supra-axillary, long pedicellate, anthers coherent at their apices, four nutlets and curved embryo. However, the genus *Euploca* also shows some similarities with *Heliotropium* in sharing annual or perennial habit, branched stem with appressed bristly hairs, hairy leaves, alternate or rarely pseudo-opposite leaves, dry fruit etc.

The genus *Euploca* Nutt., included about 213 species (Melo and Semir 2006 a & b, 2009) and are mainly distributed in tropical regions of Africa, America, and India and extended to subtropical and temperate regions of Australia (Diane *et al.*, 2002; Frohlich *et al.*, 2020) Fig 1.a.

Euploca baclei (DC.) Diane & Hilger, Bot. Jahrb. Syst. 125(1). 47. 2003; Simon & Wieringa, Blumea 64: 92-95.2019. *Heliotropium baclei* D. C., Prodr. 9:546. 1845; Baker in Thiselton Dyer, Fl. Trop. Africa 4(2): 34. 1905. Fig. 1.b., 2 & 3.

Holotype: Africa (The Gray Herbarium (GH), GH00097797!). This type sheet had additionally mounted with two other fragments of N. M. Thomas 8836 & G. F. Scott- Elliot 5717.

Herbs, erect or prostrate, ca. 15 cm long. Stem single or branched, base woody, densely pubescent to strigose. Leaves simple, alternate, petiolate; petiole 1- 1.5 mm long; lamina elliptic-oblongate, obtuse at apex, greenish, ca. 7 x 3 mm; 1 nerved, central nerve prominent below and canaliculate above, strigose-pubescent with adpressed tubercle based hairs, 0.75 - 1 mm long, margins entire. Flowers solitary, 5- merous, 5-7 mm long, pedicelate; pedicel pubescent; bracts leafy, pubescent on both surfaces. Calyx ciliated, cilia 1.5 mm long, lobes 5, unequal with three length classes (major, intermediate and minor), ovate – linear lanceolate, acute; major 4- 3.2 x 1-1.75 mm, ovate – linear lanceolate, intermediate 2.8- 3 x 1-2 mm, ovate lanceolate; minor 1-1.5 x 0.9-1 mm, linear lanceolate. Corolla white with a yellow throat or bright yellow, glabrous inside, sparsely pubescent outside, main lobes ca. 1.5 x 1 mm, triangular with obtuse; 5 minute lobes alternating with main lobes, ca. 0.75 mm long; infundibuliform, tube 2 mm long. Stamens 5, inserted; anthers 0.5-0.6 mm long, dithecous, sagittate, pubescent only at the apex, anthers apically coherent, connectives protracted. Ovary superior, bicarpellary, ovoid, sparsely pubescent, surrounded by copuliform disc, tetralocular, one ovule in each loculus; style 0.2-0.3 mm. long, simple; stigma capitate, stigmatic ring well marked, apex pubescent. Fruit ovoid, 5-3 x 2 mm.

(including 0.5- 1 mm. long terminal beak), sparsely pubescent with rigid hairs; nutlets 4; embryo 1.3 mm long, curved.

Flowering & Fruiting: December -March

Habitat & Ecology: *Euploca baclei* has been collected from Koram, a laterite area in Kannur District of Kerala state, India. Significantly small population occurs in marshy sediment substratum of a seasonal pool. There were less than 50 individuals growing in three pools in association with species of semi aquatic community such as *Pogostemon deccanensis* (Panigrahi) Press, *Lindernia tenuifolia* (Colsm.) Alston var. *tenuifolia*, *Rhynchospora wightiana* (Nees) Steud., *Eriocaulon cuspidatum* Dalzell, *Drosera burmannii* Vahl etc. It is possibly surviving in very fragmented populations of a narrow range of distribution on the coastal lateritic plateau. The species is being subjected to the pressure of habitat modifications/ destruction due to nearby mining activities.

Distribution: Tropical Africa including Madagascar, America, Australia and now in India (Kerala).

Phytogeographical Significance:

i) The present record of the *Euploca baclei* from Kerala, particularly in the lowland lateritic plateau near coastal belt assumes biogeographical significance as its counter parts are distributed in Australia, Africa, Madagascar and South America. The disjunct distribution clearly connects with theory of continental drift, particularly the Gondwana land movement happened some 160 million years ago. The species was described first from Africa, which implies that the original genetic stock got separated with the formation of West and East Gondwana as a result of breaking away where, western continent contains Africa and South America and the Eastern continent with Antarctica, Australia, Madagascar, Seychelles and India. As per the estimated geological time scale the Eastern Gondwana land mass continued to break apart losing Antarctica- Australia (130 mys ago), Madagascar (90 mys ago), Seychelles (65 mys ago) and finally India's collision with Asia (55 mys ago) created the present day land configurations (Stephen McLoughlin, 2001; Hedges, 2003). Thus, the species became isolated and surviving in Kerala is basically from Gondwana stock.

ii) The species *Euploca baclei* is growing in Southern India in a narrow coastal lateritic plain having peculiar climatic conditions alternate with heavy monsoon and followed by 6-7 months dry period where the seasonal pools become dry. The species appears at the end of the monsoon when

water level recedes and complete the life cycle at the end of the summer. The flowering phenology in comparison with the population of this species is more or less corroborated to the populations of its counterparts growing in Australia, Africa, and South America that were once part of Gondwana land. The seeds remain in the pool beds and crevices expecting next monsoon to survive. In spite of heavy anthropogenic pressure, the species is thriving and unfortunately it has been overlooked for more than 225 years of botanical history of India (Pandey, 2012). We have searched the herbaria of Southern India especially the CALI, KFRI, MH and TBGT and found no specimen of this species is housed at. The present findings, therefore, emphasizes Biologists, particularly Taxonomists, continue to survey and document the species before they disappear.

iii) The genus *Euploca* was first recorded in North America (Nuttall, 1836), even though the genetic stock is from Southern Continents as per the reorganization of Gondwana land mass. The occurrence of the genus *Euploca* in Northern America could be explained as the result of plant movement by Amphitropical Relationships through a narrow strip of land connecting both

South and North America (Raven, 1963; Simpson *et. al.*, 2017).

Specimen examined: India, Kerala: Kannur District, Koram Lateritic area, 12° 08' 45.4" N, 75° 14' 44.6 E, ± 60 m, February 2017, T. Shaju, M.P. Rijuraj & A.G. Pandurangan, 90306 (TBGT); India, Kerala: Kannur District, Koram Lateritic area, 12° 08' 45.4" N, 75° 14' 44.6 E, ± 60 m, February 2018, T. Shaju & M.P. Rijuraj 92101 (TBGT); India, Kerala: Kannur District, Koram Lateritic area, 12° 08' 45.4" N, 75° 14' 44.6 E, ± 60 m, March 2019, T. Shaju, M.P. Rijuraj & A.G. Pandurangan, 96071 (TBGT).

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Fig 1. a. Type of Genus *Euploca* Nutt. -*Euploca convolvulacea* Nutt. (Natural History Museum (BM), BM 000799721!), b. Holotype of *Euploca baclei* (DC.) Diane & Hilger Africa (The Gray Herbarium (GH), GH00097797!). (Sheets Courtesy Natural History Museum, London & The Gray Herbarium, Harvard University, Cambridge)



Fig 2. *Euploca baclei* (DC.) Diane & Hilger: a. Habitat; b. Habit; c. Single plant; d. Flowers; e. Calyx; f. Corolla split open; g. Anther; g¹. Protracted connective with pubescent (inset); h. Beaked fruit; h¹. Mericarp (inset); i. C.S. of fruit with four nutlets; j. Curved embryo.

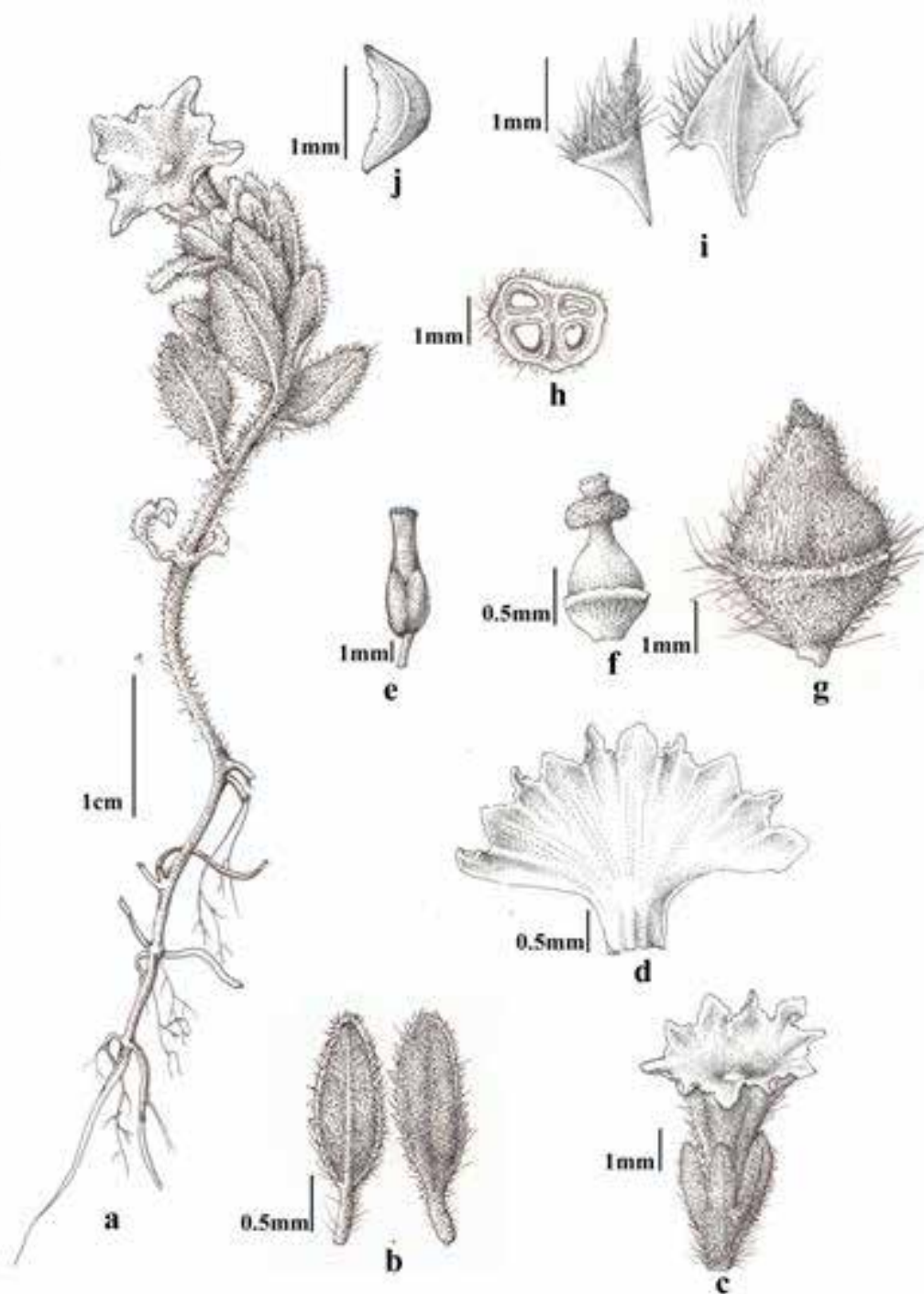


Fig 3. *Euploca baclei* (DC.) Diane & Hilger a. Habit, b. Bract (dorsal & ventral view), c. Flower, d. Corolla split open, e. stamen, f. Pistil, g. Beaked fruit, h. C.S. of fruit with four mericarps(nutlets), i. Mericarps (side view & lower view), j. Curved embryo.

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