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## ***Cordia diffusa* K.C. JACOB, THE KOVAI MANJACK (BORAGINACEAE): A HIGHLY THREATENED STENO-ENDEMIC SPECIES FROM COIMBATORE CITY, TAMIL NADU, INDIA**

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**Abstract:** *Cordia diffusa* K.C. Jacob, belonging to Boraginaceae, discovered in 1938 and named by K.C. Jacob in 1944, is a little-known and the only narrow endemic but neglected plant of Coimbatore City. The lectotype of the steno-endemic is determined and the current status, distribution, potential threats, bioprospecting potential, and suggestions for conservation of the species are discussed. The collection of steno-endemic plant during intensive exploration in its type locality nearly after 90 years is of phytogeographic and conservation significance. The endemic is proposed the category of Critically Endangered (CR) based on criterion D of IUCN (as per versions 3.1 & 13). *C. diffusa* can be protected by promoting awareness of the rarity of native species and mass propagation through vegetative means so as to introduce it in gardens, parks, and avenues, etc. at once in the city.

**Keywords:** Conservation, endemic shrub, lectotypification, status, threats.

Understanding rarity has been an important task among plant ecologists and also vital in conserving biodiversity while the process of rarity has diverse ecological consequences. Steno- or strict endemic species have a small, non-dominant, constantly sparse plant population size and are characterised by their

narrow habitat specificity and geographically restricted in a specific habitat (Rabinowitz 1981). Species with narrow distribution range and/or fewer individuals are considered to be most prone to extinction due to changing climatic conditions and competition from alien species (Chitale et al. 2014). Human-induced perturbations resulting in habitat loss is identified as one of the important causes of rarity, though several intrinsic factors also govern the distribution and survival of species in their natural habitats. The conservation of narrow endemics that are threatened or endangered has become a major concern shared by governments, conservation organisations, and individuals (Kruckeberg & Rabinowitz 1985). Species not collected in herbaria for several decades have been one of the valuable yardsticks for judging the rarity status of the species (Meher-Homji 1995).

Coimbatore, the district headquarters and the third largest city of Tamil Nadu, is located between 11.016°N, and 76.955°E with an approximate altitude of 470m,

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extending over an area of 105km<sup>2</sup>, inhabited by over two million urban population (<https://coimbatore.nic.in/>). Coimbatore City, bounded on the west by the Western Ghats, Noyyal (Noyyil) river running to the south, while the east and the north are covered by vast stretches of fields mainly of black cotton soil (Chandrabose 1981; Chandrabose & Nair 1988). The city limit has expanded as the metropolitan area of the city has increased from 38.28km<sup>2</sup> in 1973 to 62km<sup>2</sup> in 1981 to 274.34km<sup>2</sup> in 2010, owing to the rapid urbanisation and expanding population. It is also one of the most industrialised cities of Tamil Nadu (Anonymous 2015).

Coimbatore City area was botanically sporadically explored since 1826 by renowned botanists such as C.A. Barber, K.C. Jacob, Colonel Cox, J.L. Ellis, and later by M. Chandrabose, Girija Lakshmanan, T.R. Somasundaram, K. Subramanyam, H. Sundanda Kamath, and others. The Flora of Coimbatore published by Chandrabose & Nair (1988) recorded c. 850 taxa by exploring about 258km<sup>2</sup> over a period of 10 years in the city and its environs. Of these, three taxa (*Polygala jacobii* Chandrabose (1968), *Euphorbia hypericifolia* L. var. *coimbatorensis* Chandrabose (1988), and *Cordia diffusa* KC Jacob (1944)) were reported as endemic to the region, but *C. diffusa*, restricted to the city limits, is the only stenoendemic species as of now. *Polygala jacobii*, treated as an unresolved name in the Plant List, is a Indo-Sri Lankan rare endemic herb distributed in Karnataka, Kerala, Madhya Pradesh, Maharashtra, and Tamil Nadu in India (Kulkarni & Singh 1973; <http://florakarnataka.ces.iisc.ac.in/hjcb2/herbsheet.php?id=3666&cat=1>), and *E. hypericifolia* L. var. *coimbatorensis* is now synonymised under *Euphorbia indica* Lam. (Plant List 2019; POWO 2019).

### Taxonomic History & Phytogeography

The genus *Cordia* L. (Boraginaceae sensu lato and Cordiaceae sensu stricto), native to tropical and subtropical regions, is diverse with c. 250–350 widespread species (Mabberley 2008; Balachandran & Rajendiran 2016). In India, the genus is represented by about 20 species, of which 13 species have been recorded so far from Tamil Nadu (Ramamurthy 1987; Balachandran & Rajendiran 2016) including three endemics, viz., *Cordia diffusa* K.C. Jacob, *C. domestica* Roth, and *C. ramanujamii* Balachandran & Rajendiran, all are shrubs or small trees. *C. domestica* is distributed in Western Ghats of Madurai and Nilgiris districts and also reported to be cultivated (Ramamurthy 1987), while *C. ramanujamii* is a recently discovered endemic species from the Pakaam Malai Reserve Forest, Ginjee, Eastern

Ghats, Tamil Nadu, at an altitude of 350m (Balachandran & Rajendiran 2016).

A new *Cordia* species was discovered by Dr. K. Cherian Jacob on 02 May 1938, based on the collections from Nanjundapuram, about 8km south of Coimbatore, and was later named as *Cordia diffusa* K.C. Jacob (1944). This species was included in the enumeration of rare and threatened plants of southern India by Henry et al. (1978), and it was determined as Indeterminate on the IUCN Red List of Threatened Plants (Rao et al. 2003). Based on the specimens available at MH, it was revealed that this rare narrow endemic species was collected by K. Subramanyam in 1959 (MH: 7784) and was last collected by Chandrabose in 1968 from nearby the type locality, as well as from the Forest College compound, R.S. Puram, Coimbatore. The steno-endemic, however, has not been collected or recorded since 1968. It was stated by Chandrabose & Nair (1988) that *Cordia diffusa*, is also on the verge of extinction due to rapid urbanisation, industrialisation and other anthropogenic activities. They further reiterated that conservation of the species in this highly disturbed area would be a challenge. In the light of these facts, we made thorough explorations in and around the type locality to determine the current status of the species. Prabhu et al. (in press) report the collection of the species from the Forest College Campus, Institute of Forest Genetics and Tree Breeding (IFGTB), Coimbatore, in their phytochemical screening and bioactivity studies. There is, however, no extant population of the plant in the Forest College, IFGTB Compound. The bush from which the collection was reportedly made was found cleared from the garden of IFGTB. A few stem cuttings of the removed plant are being kept now for propagation of the species (Fig. 1G). Hence, the authors made intensive surveys for the plant in its type locality for about one year and could recollect the species in flowers and fruits from the dry open wastelands along the railway track, Nanjundapuram area, Coimbatore, in May 2018. A population of just 10 individuals were observed in the type locality, and the plant was straggling in the dry open wasteland with black cotton soil and almost always associated with *Capparis* sp., besides *Calotropis gigantea*, *Morinda tinctoria*, etc. The habitat of the endemic plant was highly disturbed by human interferences particularly plastics, polythene, bottles and other garbage found strewn around the habitat. From the pertinent literature, it was revealed that this species was not collected from its type locality after the type collection by K.C. Jacob in 1938. Hence, the present collection of *C. diffusa* from its type locality, nearly after 90 years is of phytogeographic and

conservation significance of this little-known species. There are, however, collections from nearby areas along Vaalankulam Lake in western Coimbatore (see specimens examined). The species was supposedly recently recorded from the Gulf of Mannar, eastern coast, by Daniel & Umamaheswari (2001). The rare occurrence of the endemic species from the mainland coast as well as from the Karaichalli Island, Thoothukudi (Tuticorin) District, Gulf of Mannar Biosphere Reserve, is intriguing and is the only record of *C. diffusa* from the coast and far away from its type locality. Nevertheless, the cited specimens in the Flora (P. Daniel & P. Umamaheswari 103325, 107301; S.A. Muthukumar 104746) could not be traced at MH. Hence, the disjunct distribution of this narrow endemic is intriguing and needs further investigations.

The reported distribution of *C. diffusa* K.C. Jacob in Chengalpattu District (Ramamurthy 1987; Nayar 1996; Singh et al. 2015), and in the Deccan (Ahmedullah & Nayar 1987) is doubtful as there are no specimens from these regions available in MH. Daniel & Umamaheswari (2001) also concluded that the endemic species was earlier reported from Coimbatore only.

### Systematic Treatment

#### *Cordia diffusa*

K.C. Jacob in J. Bombay Nat. Hist. Soc. 45: 78. 1944; A.N. Henry et al. in J. Bombay Nat. Hist. Soc. 75: 692. 1978; K. Ramamurthy in A.N. Henry et al., Fl. Tamil Nadu 2: 97. 1987; M. Chandrabose & N.C. Nair in Fl. Coimbatore 190. 1988; P. Daniel & P. Umamaheswari in Fl. Gulf of Mannar 279, t.37. 2001. *Gerascanthus diffusus* (K.C. Jacob) Borhidi, Acta Bot. Hung. 34: 404. 1988 (Image 1).

**Lectotype:** INDIA, Tamil Nadu, Coimbatore District, near Nanjundapuram, 1,330ft (c. 400m), railwayline, 02 May 1938, K.C. Jacob 86237A, MH Acc. No. 175500! designated here; Isolectotypes: K.C. Jacob 86237 B, C, D & E, MH Acc. Nos. 175501!–175504! Paratype: Tank Road, near Railway station, c. 400m, 23 March 1942, K.C. Jacob s.n., MH 175505!

**Specimens examined:** India, Tamil Nadu, Coimbatore District, Vaalankulam, along railway line, 467m, K. Subramanyam 7784, 10 February 1959, MH Acc. Nos. 15269!, 15270!; Ramanathapuram, 469m, M. Chandrabose 28852, 21 November 1965, MH 55200!, 55201!; Forest College Compound, R.S. Puram, 468m, M. Chandrabose 29876, 07 May 1968, MH Acc. Nos. 57090!, 570901!; Vaalankulam side, 467m, M. Chandrabose 30292, 02 July 1968, MH Acc. Nos. 57455!, 57456!; M. Chandrabose 30577, 02 August 1968, MH Acc. Nos.

57601!, 57602!; R.S. Puram, Botanical Garden, IFGTB Campus, Gurudev Singh & C.K. Jeyachandran 17681, 13 October 1987, FRC (n.v.); Near Nanjundapuram, c. 410m, along railway line, K. Sampath Kumar 997, 29 April 2018, MH (Image 2).

Shrubs, straggling, spreading, c. 1m high; branches many, woody, spreading in all directions, lenticellate; younger parts tawny pubescent. Leaves 3–7 x 2.0–3.5 cm, simple, alternate or opposite, exstipulate, broadly elliptic-oblong, acute or obtuse at apex, shortly mucronate, rough, coriaceous, dentate, scalloped along margins, dark green above, pale beneath; midrib prominent beneath, nerves prominent, 6–8 pairs; rough hairy on both surfaces, petiole c. 0.3–0.5 cm long, pubescent. Inflorescences in terminal 8–12 flowered umbellate cymes; peduncle simple, c. 2cm long. Flowers ebracteate, pedicels 2–4 mm long. Calyx tubular, brown, tomentose, c. 5mm long; fruiting calyx saucer-shaped, margins brown, tomentose. Corolla white, tubular, c. 8mm long, lobes 4, linear-oblong, prominent and reflexed, fragrant. Stamens 4, antisepalous, epipetalous, exerted; anthers pale brownish, sagittate; filaments adnate to the base, free at the top, white, glabrous. Style terminal, simple below, bipartite, branches again bipartite, pale yellow; stigma simple, white. Ovary 4-loculed, c. 2mm long, greenish. Drupes ovoid-acute, mucronate, 1–1.5 x 0.8–1.2 cm, greenish when young, bright orange when ripe, edible, pulp sugary, viscid, with cup-shaped, fulvous pubescent, irregularly many lobed persistent calyx; 1-seeded; seeds globose, orange, shiny, 5–8 x 4–6 mm.

Flowering and fruiting: Almost throughout the year.

#### Current Status

Based on the field surveys, consultation of herbarium specimens of earlier collections including types at MH, review of pertinent literature (Jacob 1944; Henry et al. 1978; Ramamurthy 1987; Ahmedullah & Nayar 1987; Chandrabose & Nair 1988; Daniel & Umamaheswari 2001), it is inferred that the extant population of the steno-endemic may not exceed 50 mature individuals and the area of occupancy is very small and restricted covering less than 5km<sup>2</sup>. Owing to the small and inferred continued declining population size, and the number of mature individuals in the extant population being less than 50, it is proposed that the species be categorized as Critically Endangered (CR) based on criterion D for restricted number of mature individuals as per the guidelines of the IUCN Red List Categories & Criteria (versions 3.1 & 13; IUCN 2001, 2017). Hence, conservation of the species requires immediate and



Image 1. *Cordia diffusa* K.C.Jacob: A—habit of the steno-endemic shrub | B—leaf morphology | C—close-up of inflorescence | D—a twig with immature and mature fruits | E—branch with flowers and fruits | F—close-up of a mature fruit and a seed (inset) | G—sapling from stem cutting. © A–F - K. Sampath Kumar | G - S. Arumugam.

inevitable actions to avoid the possible extinction in the near future.

#### Threat Factors and Conservation Strategies

Human interference with the environment in recent times has greatly accelerated the pace of extinction, though extinctions have also taken place in the past mainly due to natural causes. But, endangered plant

species, compared with endangered animals, attract rather little public attention (Sivarajan 1991). As per the recent estimates, the extinction rate of seed-bearing plant species is 500 times faster than in other species (Ledford 2019).

The flora of Coimbatore and its environs obviously is much disturbed due to regular biotic interferences. The populations of *C. diffusa* in its type locality are found

rare and becoming endangered, and conserving this species in such a highly disturbed area would be really a challenge (Chandrabose 1981; Chandrabose & Nair 1988). During the present survey in the type locality, it was identified that the human interference has been the major threat factor, and dumping of used polythenes, plastics, glasswares, waste materials, debris of buildings, and persistent clearing of vegetation along the tracks by the railway all leading to the habitat destruction and degradation, besides the increasing pollution, rapid urbanisation and industrialisation in the city area. The lack of awareness about the endemic plant of the city also results in the removal of the stands in the wild.

As the plant is shrubby and can be easily propagated by stem cuttings (Fig. 1G), it can be mass propagated at the earliest and introduced in city gardens and in other suitable habitats in and around the city so as to conserve the species. Awareness of the steno-endemic should be created among the public particularly among the school children and college students; and vegetative propagules may be distributed by the concerned agencies or through local 'plant protection' societies and environment / nature clubs to save the plant in peril. The micropropagation studies on the highly threatened endemic plant must be given high priority. The in vitro repository of plant propagules may be deposited at the National Bureau of Plant Genetic Resources (NBPGR) towards long-term ex situ conservation of the species.

Ex situ conservation through seed, pollen, gene and germplasm banks may also be considered to preserve the species outside its natural habitats. Reproductive biological studies may provide important perspectives to help preserve the genetic potential which are crucial for restoration and reintroduction.

### Potential Uses/ Bioprospecting

There are lesser chances to collect and name the missing species before they become extinct and the information about potential uses or unique properties of such native plants need to be passed on (Sharp 1964; Raven 1976). With the scanty literature and the limited herbarium collections, *Cordia diffusa* remains a poorly known plant.

The traditional uses, phytochemistry and pharmacology of the 36 medicinal species of the genus *Cordia* have been reviewed recently (Oza & Kulkarni 2017), wherein c. 300 phytochemical compounds of various classes present in the 36 species has been documented. The traditional uses, diversity of phytochemicals, pharmacological properties, and biological activities of *C. dichotoma* discussed in the

review by Jamkhande et al. (2013); and the presence of apigenin in the bark of *C. dichotoma* showed significant healing and reduction in inflammatory enzymes of ulcerative colitis (Ganjare et al. 2011). The protective effect of bark extract of *C. macleodii* against Naja venom poisoning was reported by Soni & Bodakhe (2014). The reputed use of bark from *C. rothii* in heart ailments in Gujarat has also been recorded (Chauhan & Chavan 2009). Similarly, the leaves *C. diffusa* has been studied recently for its antioxidant activity and phytochemical constituents (Prabu et al. in press). Thus, *C. diffusa* has the potential for further bioprospection studies using vegetatively propagated materials or in vitro raised plant parts to avoid collecting from the wild.

### Conclusions

Ex situ conservation measures for the narrow endemic plant of Coimbatore City, *Cordia diffusa* K.C. Jacob, must be initiated immediately. In situ conservation of the wild populations will be most challenging in the light of serious habitat loss owing to the burgeoning population, ever-increasing pollution, rapid urbanisation

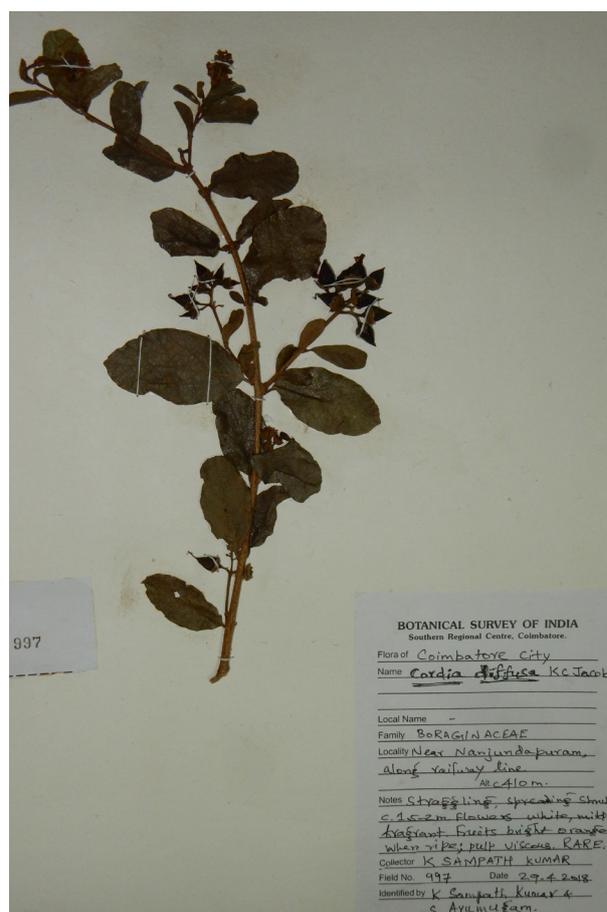


Image 2. Herbarium of *Cordia diffusa* K.C. Jacob: (KSK 997).

and industrialisation, besides possible impacts of global climate change. Hence, effective steps to promote awareness of the rarity and conservation significance of the unique shrub of the city among the public and particularly students are the need of the hour. As the shrub seems to establish easily by asexual mode, multiplication through stem cuttings in nurseries and distribution of vegetatively propagated plant saplings to gardeners may be given top priority, besides introducing it in public and private gardens. Further studies on bioprospection and in vitro clonal propagation are vital. The disjunct distribution of the endemic plant in the region needs further research. Field explorations and regular monitoring of the extant populations in the fragile habitats of the city environs may reveal the current status of other native taxa.

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