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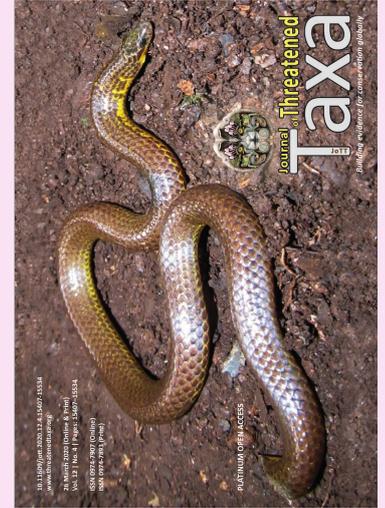
COMMUNICATION

AN ASSESSMENT OF THE CONSERVATION STATUS OF A PRESUMED EXTINCT TREE SPECIES *WENDLANDIA ANGUSTIFOLIA* WIGHT EX. HOOK.F. IN SOUTHERN WESTERN GHATS, INDIA

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An assessment of the conservation status of a presumed extinct tree species *Wendlandia angustifolia* Wight ex. Hook.f. in southern Western Ghats, India

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Abstract: In this study, we carried out an assessment of IUCN conservation status of *Wendlandia angustifolia* Wight ex. Hook.f. (Rubiaceae), based on field data on populations and distribution status of this species that is narrowly endemic to southern Western Ghats. This species was earlier presumed to be extinct, however, our data suggests that it should be assigned to the Endangered (EN) category based on the IUCN Red List criteria.

Keywords: Conservation assessment, endemic plant, endangered category, Rubiaceae, *Wendlandia angustifolia*.

Tamil abstract: மேற்குத்தொடர்ச்சி மலையின் தென்பகுதியில் மட்டுமே அரிதாக காணப்படும் வென்ட்லேண்டியா அங்கஸ்டிபோலியா வைட் எக்ஸ். ஹூக். எஃப். எனும் தாவரம் ரூபியேசி தாவர குடும்பத்தினைச் சார்ந்தது. இப்பகுதியில் மட்டுமே காணப்படும் இந்தத் தாவரம் முற்றிலும் அழிந்து விட்டதாகக் கருதி, இயற்கைப் பாதுகாப்பிற்கான உலகளாவிய ஒன்றிய அமைப்பின் (IUCN) சிவப்புப் பட்டியலிலும் வகைப்படுத்தப்பட்டுள்ளது. களஆய்வின் மூலம் அரியவகை இத்தாவரத்தினை இனங்கண்டு அழிந்துவிட்டதாகக் கருதப்பட்டதை அழிவின் விளிம்பிலுள்ள தாவரவகையாக உறுதிசெய்து, அதன் எண்ணிக்கை மற்றும் பரவலினை இந்த ஆய்வுப் பதிவு செய்கின்றது.

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Author contribution: CM conducted field works, data collection, data analysis, interpretation and prepared the manuscript. PB provided technical inputs and guidance for data collection, LR provided the primary location of the species, herbarium details, and helped in confirming the identity of the species.

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INTRODUCTION

A species unique to a defined geographic unit such as an island/nation or habitat type and not found elsewhere is known as an endemic species. Physical, climatic, and biological factors influence endemism (Chitale et al. 2014). According to Lavergne et al. (2004) some common traits have been observed among the endemic species such as inhabiting microhabitats, producing fewer flowers and seeds, and having lower fecundity than their widespread congeners. Endemic species are poor competitors, and least tolerant to environmental stress (Lavergne et al. 2004). Species with a narrow distribution range and/or fewer individuals are considered to be the most prone to extinction due to changing climatic conditions and competition from alien species (Chitale et al. 2014). Endemic species have long been targets for conservation efforts, because they are not found anywhere else in the world and if lost from their native habitat they are lost forever (Chitale et al. 2014). Myers et al. (2000) opined that conservation of endemic species could result in conservation of species rich landscapes. Assessing present and future distribution of endemic species would form crucial contribution for their conservation planning and management.

India is one of the mega diversity countries with a wide range of topography, climate and habitat. India has a total of 18,532 flowering plant species of which 23.2% are endemic (Singh & Dash 2017). The Western Ghats (along with Sri Lanka) is one of the four designated biodiversity hotspots in India on account of its high degree of endemism and loss of primary forest cover. Of the 2,116 endemic flowering plants recorded in the Western Ghats, 410 are distributed in the state of Tamil Nadu (Singh et al. 2015). Many of these species are rapidly disappearing due to increases in human population, urbanization, habitat fragmentation and the increased dependency of the world's population on limited natural resources (Woodruff 2001). Accordingly global, regional, national and local lists of threatened species have proliferated over the past four decades (Burton 2003). The first step to initiate conservation action for endangered organisms is to identify the populations of species that are in decline or are facing the risk of extinction (Caughley 1994; Brook et al. 2006). The present study was carried out to assess the population status of *Wendlandia angustifolia*, a narrow endemic and extinct category (IUCN 2012; version 3.1) tree species distributed in the southern Western Ghats, India.

MATERIALS AND METHODS

Study area

The study was conducted in Kalakad-Mundanthurai Tiger Reserve (KMTR), in the southern Western Ghats which is part of the Agasthiyamalai Biosphere Reserve. KMTR represents a wide variation in the topographical, geo-morphological, edaphic and climatic features, and thus supports a wide range of forest types. The vegetation type varies from thorny shrub jungle to lush evergreen forests and montane grass-lands. Eleven major forest types are present here, out of which the Tirunelveli semi-evergreen forests are unique in the area. KMTR partly comprises a large contiguous tract of around 400km² of wet evergreen forest.

Sampling and assessment

The population status and distribution of *Wendlandia angustifolia* in the stream habitat of Tamirabarani River basin was ascertained along Karaiyar, Servalar and Manimuthar rivers. Field surveys were carried out in Mundanthurai range that lies between 8.566–8.716 °N and 77.266–77.433 °E. Quadrats measuring 0.1ha area (31.7×31.7m) were established along the river banks to assess the population of this species. Contiguous plots (each includes five number of quadrats) were established along 1.5km stretch for each stream. The number of individuals in each quadrat was enumerated along with their location, height, girth, phenological status and associated species. Geographical coordinates were recorded using Global Positioning System (Garmin eTrex 30x). Height and girth were measured by a measuring tape. Phenological status such as presence of flowers and fruits were observed by periodic field visits. Various growth categories were fixed based on the height and girth classes. A majority of the individuals are less than minimum measurable threshold of 1.3m height from the rooting point. Hence height classes have been incorporated to include those plant individuals which are less than 1.3m height. Individuals which have grown less than 1m height are capable of producing flowers and fruits and hence considered as adults. Girth class was categorised as saplings (<10cm gbh), recruits (10–20 cm gbh) and established (>20cm gbh) individuals. In the height categories, the above mentioned saplings were further classified into seedlings (<1m) and saplings (1–2 m), the corresponding girth classes are mentioned as height class ranges between 1.2–3.5 m as recruits and 1.3–6.5 m as established individuals.

The species was further evaluated as per IUCN Red List criteria, version 3.1 (IUCN 2012). We used the

minimum convex polygon method to calculate the range size as an estimate of its extent of occurrence (EOO). Area of occupancy (AOO) of the species within the grid is studied taking into account of the terrain features with respect to altitude. The EOO and AOO values were calculated by using the GEOCAT software developed by Kew with the standard cell width of 2km (Bachman et al. 2011). Formal thresholds based on population size and geographic range were used for categorization.

RESULTS AND DISCUSSION

History and characteristic features of endemic tree species

Wendlandia angustifolia is a small tree belonging to the family Rubiaceae. This plant species usually grows on rock crevices at low to medium altitude in riparian forests. It was first collected from the Courtalam Hills, Western Ghats by Robert Wight and described by Hooker (1882) in his Flora of British India. The species was re-collected from Kannikatti area in 1917 by Rangachari and after that no collection was made for about 81 years. Viswanathan et al. (2000) re-collected the species from Inchikuzhi area of KMTR in 1988. Gamble (1921) stated that this species was found in the Deccan forests of Kadapa and Western Ghats of Tinnevely. The distribution in Kadapa forest, however, was reported by Gamble based on the Beddome collections (Coll. No. RHB 1880) available at Madras Herbarium (MH). The distribution of this species in Kadapa forest seems doubtful, as there is no re-collection from the Kadapa forests since Beddome's collection. Beddome has extensively explored the Western Ghats during the period 1880. We presume that the location details could be wrongly labeled as Kadapa forests with collection number 1880 and it could have been collected from Western Ghats in the year 1880. This species is assessed as Extinct (Ex) in the Red List Assessment by the World Conservation Monitoring Centre (1998). Deb & Maiti in Nayar & Sastry (1987) analyzed the species and suggested that this species is presumed extinct. They also suggested that efforts should be made to relocate the species from the river beds at low altitudes and introduce in botanic gardens for its conservation.

Nomenclature

Wendlandia angustifolia Wight ex. Hook.f., Fl. Brit. India. 3: 40. 1880. Gamble, Fl. Madras 588. 1921 (repr. ed. 2. 415. 1957); Deb & Maiti in Nayar & Sastry, Red Data Book Indian Pl. 1: 348. 1987.

Specimens examined: Tamil Nadu: Tirunelveli District:

Courtallum, R. Wight, s.n., (Barcode No. K000030922); Courtallum, R. Wight 1334 (Barcode No. K000030921) both are at Kew Herbarium (K); Mundanthurai, 16.iii.1917, Rangachari 14623; Kannikatti, 19.iii.1917, Rangachari 14663 (MH); Inchikuzhi, 1000 m, 16.ii.1998, M.B. Viswanathan, E. Harrison Premkumar & N. Ramesh 1641; Inchikuzhi, 1,000m, 24.v.1998, M.B. Viswanathan, E. Harrison Premkumar & N. Ramesh 2010 (SPKCESH); Ambalam, Aruvipuram River bank, 29.iv.1990, R. Gopalan 93319 (MH); Papanasam, Near Sorimithu Ayyanar Temple, 04.iii.2011, L. Rasingam, 3101 (BSID).Karaiyar 224m, 05.xii.2016, C. Muthumperumal 3201; Servalar, 218m, 07.xii.2016, C. Muthumperumal 3202; Inchikuzhi, 625m, 19.i.2017, C. Muthumperumal 3203; Kandamparai, 283m, 22.ii.2017, C. Muthumperumal 3204; Inchikuzhi, 617m 01.iii.2017, C. Muthumperumal 3205 (SACONH-Herbarium of Sálím Ali Centre for Ornithology and Natural History).

Species description

Wendlandia angustifolia is a small tree with slender branches, growing up to 5m height. Leaves are ternately whorled; linear-lanceolate, attenuate at base, entire at margin, acute at apex, 4–11 x 0.5–1.8 cm, coriaceous; lateral nerves 6–8 pairs; petioles up to 1cm long; stipules triangular-ovate, subulate or cuspidate at apex. Inflorescence at terminal branches in panicles; panicles slender, pyramidal, leafy below; flowers densely crowded; bracts ligulate, hastate at base, acuminate at apex. Calyx tube turbinate, glabrous, about 1.5mm long, lobes cuspidate, about 1mm long, subulate. Corolla tube slender, about 5mm long; lobes almost orbicular, small. Stamens exserted, filaments short; anthers dorsifixed, linear, about 1mm long. Style about 6mm long, exserted; stigma bifid. Fruits globose, 2mm across, rugose and many seeded; seeds brown, irregular, oblong-trigonal.

This species is distinct from other known species by its glabrous stem, ternately-whorled, linear-lanceolate leaves and glabrous calyx tube with subulate lobes. Further, the habitat of the species is very distinct, as it grows only on rocky riverbeds, whereas be congeners grows along the stream banks as well as other forest types.

Species distribution

A total of 1,091 individuals were enumerated in 9.3ha area (93 quadrats of 0.1ha) sampled. This species was present in seven out of 11 streams surveyed (Figure 1). Among the seven streams explored, Inchikuli had a higher number of individuals (398), followed by Moolakasam (190), Baana tirtam (178), Kandamparai (139), Pambar

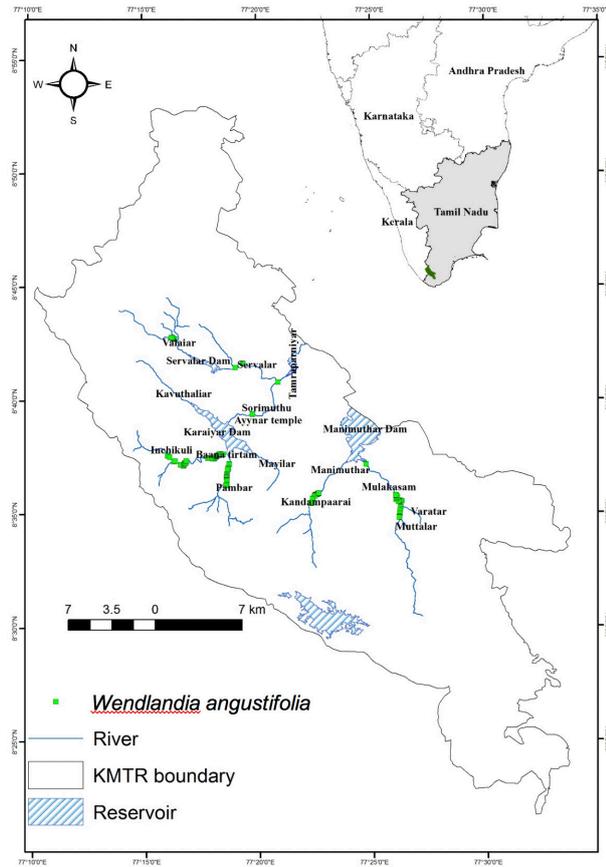


Figure 1. The distribution of *Wendlandia angustifolia* in different streams of Thairabarani River basin, Kalakad-Mundanthurai Tiger Reserve, southern Western Ghats.

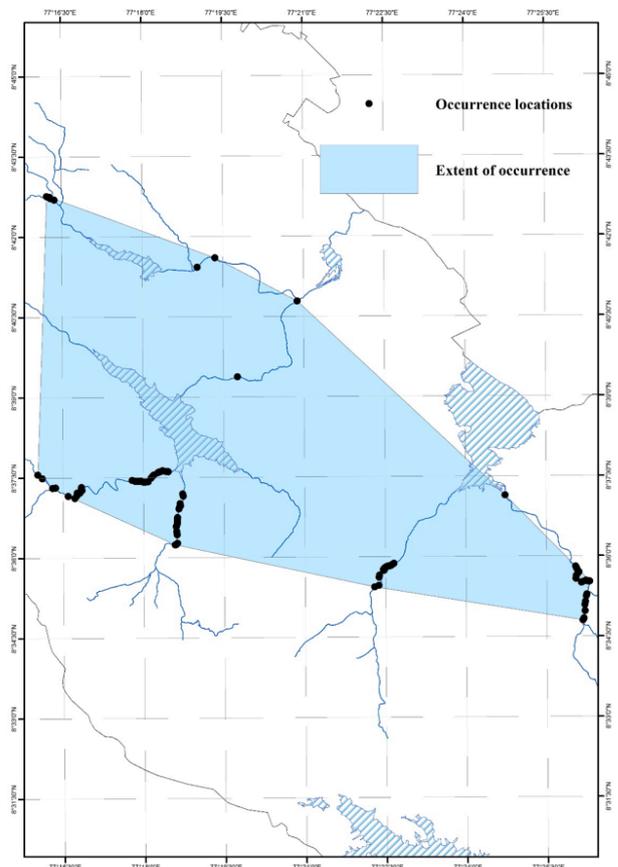


Figure 2. Minimum convex polygon of *Wendlandia angustifolia* in Kalakad-Mundanthurai Tiger Reserve, southern Western Ghats.

(105) and less number of individuals were recorded in Varattar (47) and Servalar (34) (Table 1; Figure 3). The major associating taxa are *Syzygium zeylanicum* var. *lineare*, *Syzygium cumini*, *Garcinia gummi-gutta*, *Pongamia pinnata*, and *Phyllanthus singampattianus*.

Growth category

Growth categories of tree individuals were classified into both girth and height classes. Among the 1,091 individuals recorded in the study site, the girth categories show the occurrence of 862 saplings (<10cm gbh), 175 recruits (10-20cm gbh) and 54 established >20cm gbh) individuals (Figure 4a). In the height class categories, saplings were further classified into seedlings 648 (<1m) and saplings 214 (1m-2m). About 175 recruits fall in the ranges of 1.2–3.5 m height class whereas 54 established individuals fall between the ranges of 1.3–6.5 m height (Figure 4b). Almost all individuals growing along the water course area are impacted by water flow. Hence, even the matured individuals were recognized in stunted growth form. Individuals recorded on river banks attained a

reasonable girth. Individuals that attained height $\geq 1.3\text{m}$ and girth $\geq 5\text{cm}$ gbh were considered as adults. They are matured enough to produce flowers and fruits even in the dwarf condition. This species produced new leaves in December, flower buds in January, full blooming in February–March and seeds developed during April–May (Image 1).

Assessment of conservation status

This is the first attempt to assess the population of *W. angustifolia*, a narrow endemic tree species which has been presumed Extinct from the original distribution range in southern Western Ghats, India as per the recent IUCN category (Ver. 3.1; 2012). This species is distributed in the eastern slopes of southern most Western Ghats and grow in gentle rocky beds in rivers and river banks. Moreover this species is found in semi-shade condition and distributed between the elevation ranges of 250m to 720m. As this species occurs in river course area, we observed the flood force impacting the growth of the individuals leaving only a stunted growth.

Table 1. Population assessment of *Wendlandia angustifolia* in different stream habitats in Tamirabarani River basin, Kalakad-Mundanthurai Tiger Reserve, southern Western Ghats.

Name of the reservoir	Name of the stream	Elevation range (m)	Number of quadrats sampled	Area sampled (ha)	Number of individuals recorded
Karaiyar dam	Inchikuliar	617–717	15	1.5	398
	Baanatirtam	354–439	18	1.8	178
	Pambar	286–424	15	1.5	105
	Varattar	436–452	03	0.3	47
Servalar dam	Vaalaiyar	268–309	05	0.5	34
Manimuthar dam	Kandamparaaiar	250–390	17	1.7	139
	Moolakasamar	380–453	20	2.0	190
Total			93	9.3	1091

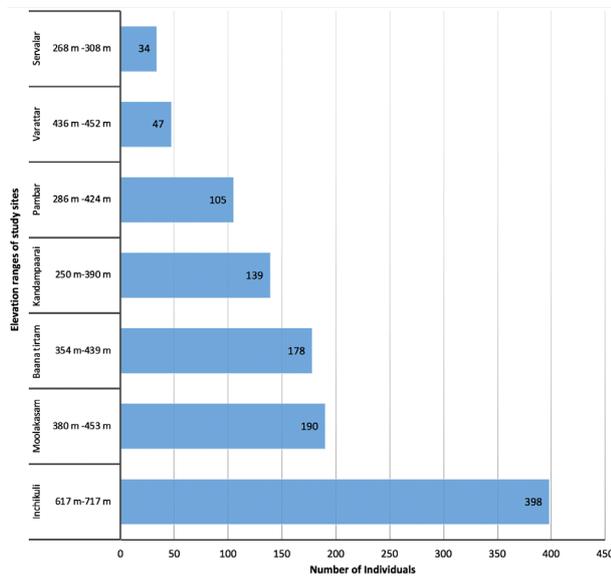


Figure 3. Population distribution of *Wendlandia angustifolia* in different streams (elevation ranges in meter) in Tamirabarani River basin, Kalakad-Mundanthurai Tiger Reserve, southern Western Ghats.

The geographic range of *W. angustifolia* was quantified using two metrics, extent of occurrence (EOO) and area of occupancy (AOO), both of which can be used for assessments under criterion B (restricted range species) as recommended by IUCN. EOO which is calculated by constructing the minimum convex polygon (convex hull) around known occurrences using the GEOCAT software developed by Kew with the standard cell width of 2km (Bachman et al. 2011). AOO is also calculated with the same tools by overlaying a grid and interpreting known occurrences as occupied grid cells. The sum of occupied grid cells equates to the AOO value. The EOO of *W. angustifolia* was estimated to be 143 km² and distributed in five major streams indicated in Figure 1 and 2. As per IUCN Sub-criteria “B1-a” the species qualifies to

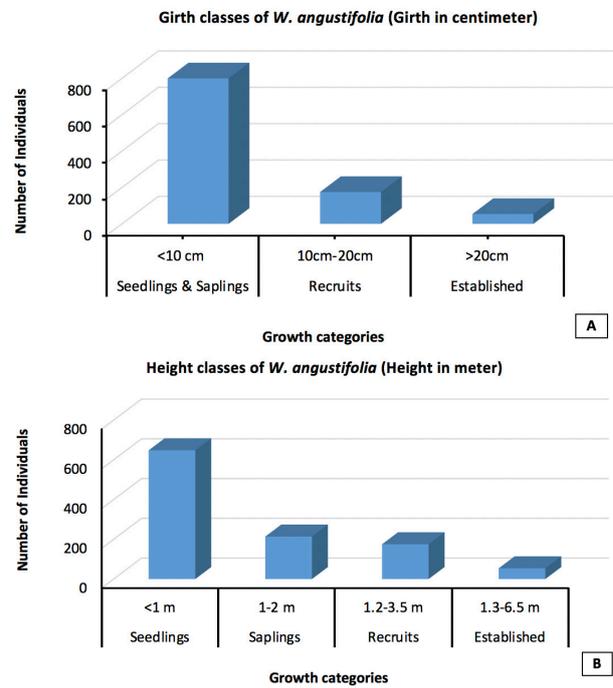


Figure 4. Different growth categories on (A) girth classes and (B) corresponding height class ranges of *Wendlandia angustifolia* in Tamirabarani river basin, Kalakad-Mundanthurai Tiger Reserve, southern Western Ghats.

Endangered category, as this species is distributed in ≤ 5 locations. Among the 7 localities assessed the number of individuals had extreme fluctuation which is clearly indicated in table 1. Hence the Sub-criteria “B1-c” also supporting that this plant under endangered category. The AOO of *W. angustifolia* was 60 km² (Figure 2) and since this estimate is less than 500 km² and hence this species qualifies for Endangered category (B2). Among the 1,091 individuals recorded during the present study, 293 were adults. Individuals which have grown ≥1.3m height and girth ≥ 5cm gbh were considered as adults.

<i>Wendlandia angustifolia</i> Wight ex Hook.f. [Rubiaceae]							
NOT EVALUATED	DATA DEFICIENT	LEAST CONCERN	NEAR THREATENED	VULNERABLE	ENDANGERED	CRITICALLY ENDANGERED	EXTINCT IN THE WILD
NE	DD	LC	NT	VU	EN	CR	EW
							< EXTINCT > EX

Source: **The IUCN Red List of Threatened Species™**



Image 1. Population assessment of *Wendlandia angustifolia* in Inchikuli at Kalakad-Mundanthurai Tiger Reserve, southern Western Ghats. Phenology: a—leafing in December | b—flower buds in January | c—full blooming in February–March | d—fruiting in April–May.

These individuals are capable of producing flowers and fruits in appropriate season of the year. Hence the number of adult individuals is less than 2500, the species qualifies for Endangered category. Moreover number of mature individuals in majority of subpopulations were ≤ 250 individuals [C2 (ai)] and percentage of mature individuals in one subpopulation is 95–100 % [C2 (aii)] also fit for Endangered category.

Final assessment: Based on field observations and population assessment of *W. angustifolia* it is stated that this species is Endangered [EN B1ac(i–iv)+2ac(i–iv); C2a(i,ii)] and not Extinct.

CONCLUSION

W. angustifolia is a habitat and altitude specific species which is reported from seven tributaries of the river Tamirabarani, Kalakad-Mundanthurai Tiger Reserve, southern Western Ghats, India. The current assessment shows that this narrow endemic tree species qualifies for the Endangered (EN) category. It is recommended that this species should be regularly monitored in all the tributaries of river Tamirabarani and further explorations in the neighborhood habitats are suggested. There is an immense need to implement a restoration program to conserve this narrow endemic tree species.

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