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Species Recovery Plan for *Phyllanthus Singampattianus* (Sebastine & A.N. Henry) Kumari & Chandrab., – An Endemic, Critically Endangered and Highly Medicinal Shrub of Tropical Riparian Fringing Forests in Southern Western Ghats, India

Phyllanthus singampattianus (Sebastine and A.N. Henry) Kumari and Chandrab is one of the strict endemic and critically endangered woody shrub of Euphorbiaceae family with high ethnobotanic properties. It naturally occurs in Tropical riparian fringing forests of Southern Western Ghats, India. The species has a very narrow endemic zone of distribution in Tirunelveli Hills of Tamil Nadu. The habitats of the species in Kalakad Mundanthurai Tiger Reserve (KMTR) were analysed using GPS and stratified random sampling techniques. Satellite remote sensing data with the aid of GIS were used for site-specific mapping of the threatened species and identification of the status of niches with regard to its growth and degradation. Growth habit, botanical description, silvicultural characters, ethno botanic and other utility of the species are provided with photographs. The places of endemism, precise point-location data on the phytogeographic parameters of the area are illustrated with relevant maps. The immediate need to protect and propagate this strict endemic and critically endangered species is emphasized and its methods of artificial regeneration are elaborated. Finally, Threatened Species Recovery Plan (TSRP) has been suggested to protect, promote and conserve the species using in-situ and ex-situ conservation methods.

Key words: Species Recovery Plan, *Phyllanthus singampattianus,* Strict Endemic, Geoinformatics, Artificial regeneration, *in-situ* and *ex-situ* conservation.

The immediate need to protect and propagate Phyllanthus singampattianus, a strict endemic and critically endangered species is emphasized. Its protection and promotion is also suggested by using in-situ and ex-situ conservation methods.

Introduction

The protection, conservation and management of threatened plants need support of various kinds with systematic short term and long term planning. Priority in planning and dealing with site specific geographic information of their natural habitats is of utmost importance in making appropriate prescription for such threatened species. Precise point-location data on spatial distribution of threatened plant species in their phytogeographic parameters will lead to the correct locality information of the concerned taxa, their population status, and also the factors responsible for their present threat status. The article deals with the above mentioned issues of the threatened species presently known as *Phyllanthus singampattianus* (Sebastine and Henry) Kumari and Chandrab (1987). In synonym it was known as *Reidia singampattiana* Sebastine and Henry (1960, 1978 and 1987) and Henry *et al.* (1978). It was a rare and little-known taxon from Western Ghats (Parthasarathy and Mahadevan, 1987). Locally the plant is known as *Aathuchadai* by Kani tribes found in KMTR and its surroundings (Viswanathan *et al.,* 2006) in Southern Western Ghats, Tamil Nadu and Kerala.

A member of Euphorbiaceae family, it is one of the most interesting and important orders of the tropical region of the Plant Kingdom. The species with very narrow endemic zone of distribution is found in the hills of South Travancore and Tirunelveli Hills (Ahmeddullah and Nayar, 1986). It has been enlisted as one of the critically endangered plant species (PIB, GoI, 2010) and has imminent danger of extinction if appropriate measures are not taken on time.

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The overall objective of Species Recovery Plan is to protect existing population of *Phyllanthus singampattianus* while establishing new sites by improving population stocks through *in-situ* conservation methods and to explore similar bioclimatic zone for its *ex-situ* conservation.

Material and Methods

Study area

Kalakad Mundanthurai Tiger Reserve (KMTR) and its surroundings form part of Agasthyamalai Hills, a Biodiversity Hotspot of global significance (Nayar, 1996). It is the 17th Tiger Reserve in India and located at the southernmost part of the Western Ghats in the districts of Tirunelveli and Kanyakumari in Tamilnadu. Agasthyamalai region has been recognized internationally as not only rich but also priority site for data sheet treatment (WCMC, 1992) and is well known for its species richness and endemicity. The physiography is undulating with elevation ranging from 60 to 1868 m. The reserve lies between latitudes 8°21'27" to 8°53'02" North and between longitudes 77°10'10" to 77°34'28" East covering the total area of 895.39 km^2 with tropical and montane subtropical climatic regimes.

Application of geoinformatics supplemented with floristic data collected from sample quadrats of 20m x 20m laid out along with stakeholders' analysis of endemic and threatened plants in KMTR were carried out to make this study more holistic. The further details are as follows:

i) Data were collected from satellite imagery, IRS – P/6 LISS III FCC hard and soft copies of 18th February 2005 of path, 101 and row 67 and 68 for interpretation of endemic species *Phyllanthus singampattianus*. Three different processes were undertaken with the help of ERDAS 9.1 and Arc GIS 9.3 software. GPS locations were registered with proper geo co-ordinates during field verification with the assistance of Survey of India maps (1969,

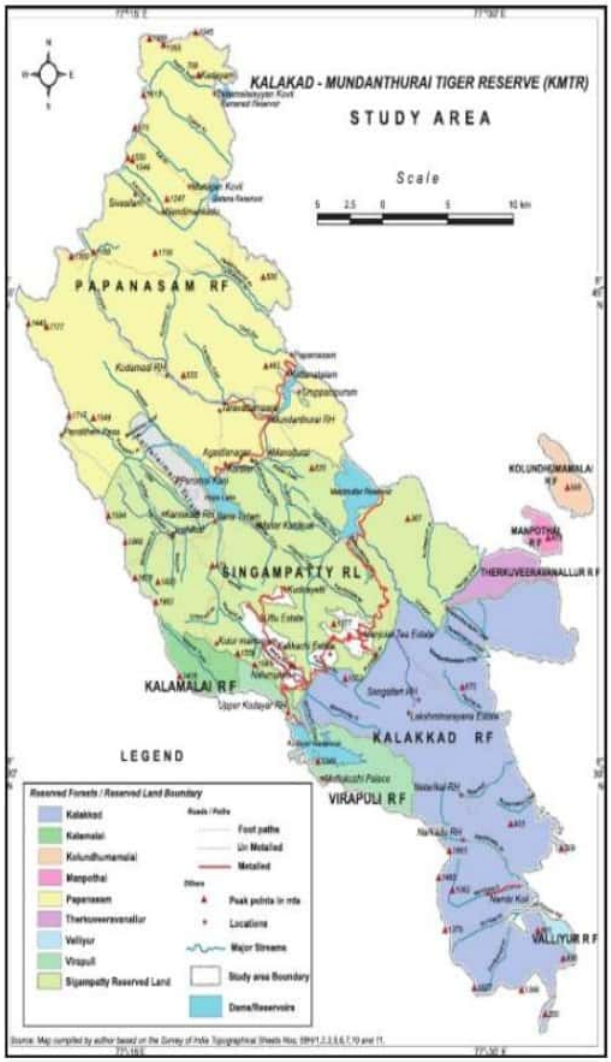

Fig.1: Base map of the study area

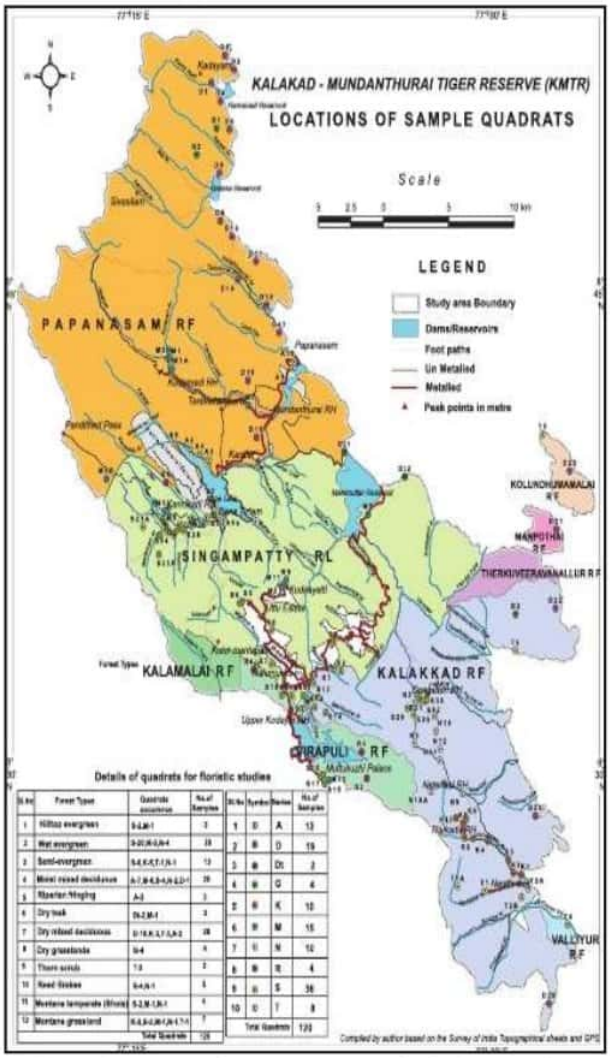

Fig. 2: Locations of sample quadrats for floristic studies

1978). Visual and supervised digital classification techniques were adopted to delineate the habitats in micro level and to analyse the status of each habitat. Frequent field visits were made during 2001 to 2011.

ii) The matrix of geographic parameters of provenance area where this species grows such as, forest type and floristic association, geological formations, landform with slope pattern and altitudinal zone, hydro-geomorphologic set up, climatic conditions, soil types, all in common Geo reference were studied in GIS domain (Sarcar, 2010). Soil samples and other floristic samples were collected mainly from places of endemism identified from the sample quadrats as found in Fig. 2. For confirmation of species, the vegetative parts were compared with the existing herbarium available in Southern Regional Office, Botanical Survey of India (BSI), Coimbatore, Tamil Nadu.

iii) Phytochemical analysis by Gas Chromatograph - Mass detector (GC-MS) was used for analysing the biochemical properties of *Phyllanthus singampattianus (*at Indian Institute of Crop Processing Technology, (IICPT), Thanjavur, Tamil Nadu by Sarcar (2009).

iv) A detailed study on Nursery techniques from seed origin were made at Tamil Nadu Forestry Training College, Vaigai Dam. The natural regenerations, floral compositions, phenological and silvicultural characters of the species were studied.

v) Data collection on existing conservation and management practices, the various Acts, Rules and Policies in managing the flora particularly the threatened plants of the study area were done from the various stakeholders of endemic and threatened plants using Questionnaire and Interview method.

Results and Discussion

Various characters of the plant

A woody shrub up to 3.5 m high; it has distinct morphological and silvicultural characters along with large ethnobotanic properties and other potential utility. The species has biannual flowering period as follows: Flowering Period: November-January; April-June; Seeding Period: December-February to July-September

Morphological characters: Stems and Branch esterete, lenticellate, woody; leaf scars persistent. Leaflets alternate, obliquely elliptic to falcate, 3-9x2-4 mm, cuneate at base, revolute at margin, acute at apex, coriaceous, tomentose beneath, glabrous above, pale beneath, dark green above; nerves 3-4 pairs; petioles *c.* 1x0.5 mm, brown; stipules ovate-lanceolate, *c.* 2x0.5 mm. **Flowers** monoecious, axillary. **Male** flowers: 1-4 together on lower side of branches; pedicels up to 5 mm long; bracts *c.* 1x0.5 mm. **Sepals** 4, 2+2, ovate, *c.* 2x1 mm, fimbriate above middle, acute-acuminate at apex, pellucid; disc glands 4, large, alternate to sepals. **Stamens** 4 filamental column around pistillode. **Female** flowers larger than male ones; pedicels up to 6 mm long; bracts oblong, *c.* 1.5x0.5 mm. **Tepals** 6, 3+3, ovate, *c.* 2.3x1 mm, rounded at base, setae or fringed above middle. **Ovary** obovoid, *c.* 1x1 mm; **Styles** 3, each 2-fid; **Capsules** globose, *c.* 3x3 mm; cocci 3, thin-valved. **Seeds** brown, triangular, *c.* 1x0.5 mm.

Silvicultural Characters: *Phyllanthus singampattianus*is a strong light demanding woody shrub. It is sensitive both to frost and drought. The shrub coppices well and coppice-shoots in particular grow vigorously. It is a good colonizer and grows gregariously with very restricted distribution in river bed areas occupied by boulders. It is very sensitive species in its regeneration process and prefers to grow in open places. The species occur well in shallow, porous sandy soil with good drainage where continuous soil moisture regime is ensured. It has a very strong netlike root system forming colonized pure crop of the species which holdfast the bedrock of boulders even in the swift flowing rocky streams. The stems of the species are woody and very strong. Its leaves are not readily browsed by cattle (Fig. 3).

Ethno botanic characters and other potential value

The species has medicinal value. Its parts are used in Folk and Siddha under Indian system of medicine (Viswanathan *et al.*, 2006). The local people use the leaf paste for curing Jaundice. So far, no detailed phytochemical and ethno botanical study was made. The scholars carried out detail study of the leaf dust and also dust of stem bark observed that plant is extraordinarily rich in medicinal properties (Sarcar, 2009). The activity of components identified in *Phyllanthus singampattianus* (Leaf Dust and Stem Dust) is given below in Table 1 (a) and (b).

Natural distribution zone

India: Southern Western Ghats, 600-900m, KMTR in Tirunelveli District, Tamil Nadu, Endemic.

Geographical range in KMTR

Name originated from the place of endemism *i.e.* Singampatti R.L; Along Tamairabarani River from Banatirtham to Inchikuzhi, scattered up to Paiar, Pambar, Servalar, Valayar and also at Papanasam, Upper Kodayar and Kakachi (Gopalan and Henry, 2000).

Only a single specific habitat with compact distribution of *Phyllanthus singampattianus* could be identified in the river bed of Tambraparani at Inchikuzhi otherwise the species has very sporadic and scattered distribution in the study area (Sarcar, 2010).

Table 1 (a): Activity of Components identified in *Phyllanthus singampattianus* [Leaf Dust] 124 [GC MS study]

S.No.	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
1	9.98	3-O-Benzyl-d-glucose	$C_{13}H_{18}O_6$	270	1.97	Sugar compound	Preservative
2	11.17	Dodecanoic acid	$C_{12}H_{24}O_2$	200	1.14	Lauric acid	Antioxidant, Antibacterial, COX-1 & COX-2 inhibitor, Antiviral, Candidicide. Hypocholesterolemic
3	12.13	Megastigmatrienone	$C_{13}H_{18}O$	190	0.26	Ketone compound	Sweetener
4	12.32	2-Cyclohexen-1-one, 4-(3-hydroxy-1-butenyl)-3,5, 5-trimethyl-, [R-[R*,R*-(E)]]-	$C_{13}H_{20}O_2$	208	0.51	Ketone compound	No activity reported
5	13.70	Tetradecanoic acid	$C_{14}H_{28}O_2$	228	2.11	Myristic acid	Antioxidant, Nematicide, Cancer preventive, Lubricant Hypocholesterolemic
6	14.22	5H-Inden-5-one, octahydro-1-hydroxy-7a-methyl-	$C_{10}H_{16}O_2$	168	1.21	Ketone compound	No activity reported
7	14.78	3,7,11,15-Tetramethyl-2-hexadecen-1-ol	$C_{20}H_{40}O$	296	1.11	Terpene alcohol	Antimicrobial Antiinflammatory
8	16.62	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	12.07	Palmitic acid	Antioxidant, Hypocholesterolemic Nematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic 5-Alpha reductase inhibitor
9	16.86	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284	0.93	Fatty acid ester	-do-
10	18.84	Phytol	$C_{20}H_{40}O$	296	1.30	Diterpene	Antimicrobial, Anti-inflammatory Anticancer, Diuretic
11	19.36	9,12,15-Octadecatrienoic acid, (Z,Z,Z)-	$C_{18}H_{30}O_2$	278	14.21	Linolenic acid	Anti-inflammatory, Hypocholesterolemic, Cancer preventive Hepatoprotective, Nematicide, Insectifuge, Antihistaminic, Antieczemic, Anti-acne, 5-Alpha reductase inhibitor Antiandrogenic, Antiarthritic, Anti-coronary, Insectifuge
12	19.61	Octadecanoic acid	$C_{18}H_{36}O_2$	284	1.57	Stearic acid	No activity reported
13	24.57	Heptadecane, 9-hexyl-	$C_{23}H_{48}$	324	0.73	Alkane compound	No activity reported
14	24.72	1-Phenanthrenemethanol, 1,2,3,4,4a,9,10,10a-octahydro -6-methoxy-1,4a-dimethyl-, [1S-(1à,4aà,10aá)]-	$C_{18}H_{26}O_2$	274	0.56	Alcoholic compound	Antimicrobial
15	26.01	Tetracosane	$C_{24}H_{50}$	338	0.50	Alkane	No activity reported
16	29.64	Squalene	$C_{30}H_{50}$	410	53.79	Triterpene	Antibacterial, Antioxidant, Antitumor, Cancer preventive, Immunostimulant, Chemo preventive, Lipoxygenase inhibitor, Pesticide
17	35.12	à-Amyrin	$C_{30}H_{50}O$	426	6.02	Triterpenoid	Antimicrobial Cancer preventive

**Source: Dr. Duke's Phytochemical and Ethnobotanical Databases

Phytogeographic conditions of the area of provenance

The occurrence of species could be located in the **Southern Tropical Riparian fringing** forest type in KMTR, where the milieu of phytogeographic factors has played a key role in its endemism, growth and also for its present 'threat status'. The study of the phytogeographic parameters helps in protecting the existing populations and its further propagation efforts.

The summary of abiotic factors for *Phyllanthus singampattianus* is shown in Table 2 and the characteristics of provenance area of the single distribution Zone at Inchikuzhi is furnished in Table 3.

i) ***Geology***

The species occurrence could be observed mainly in Garnet-Sillimanite - Graphite gneiss of Khondalite group of rocks.

ii) ***Topographic Matrix***

The major area of distribution of the species could be observed mainly between 600 to 900 m and

Table1 (b): Activity of Components identified in *Phyllanthus singampattianus* [Stem Dust] 125 [GC MS study]

S.No.	RT	Name of the compound	Molecular Formula	MW	Peak Area %	Compound Nature	**Activity
1	3.94	Benzene, 1-ethyl-4-methyl-	C_9H_{12}	120	0.15	Aromatic compound	No activity reported
2	11.17	Dodecanoic acid	$C_{12}H_{24}O_2$	200	0.41	Lauric acid	Antioxidant, Antibacterial, COX-1 & COX-2 inhibitor, Antiviral, Candidicide. Hypocholesterolemic,
3	13.68	Tetradecanoic acid	$C_{14}H_{28}O_2$	228	0.26	Myristic acid	Antioxidant, Cancerpreventive, Nematicide, Lubricant Hypocholesterolemic
4	16.55	n-Hexadecanoic acid	$C_{16}H_{32}O_2$	256	1.55	Palmitic acid	Antioxidant, Hypocholesterolemic Nematicide, Pesticide, Lubricant, Antiandrogenic, Flavor, Hemolytic 5-Alpha reductase inhibitor
5	16.85	Hexadecanoic acid, ethyl ester	$C_{18}H_{36}O_2$	284	0.11	Fatty acid ester	-do-
6	18.65	Vitamin E	$C_{29}H_{50}O_2$	430	5.31	Vitamin	Anti-ageing, Analgesic, Anti-diabatic, Anti-inflammatory, Antioxidant, Antidermatitic, Antileukemic, Antitumor, Anticancer, Hepatoprotective, Hypocholesterolemic, Antiulcerogenic, Vasodilator, Antispasmodic, Antibronchitic, Anti-coronary
7	19.23	Oleic Acid	$C_{18}H_{34}O_2$	282	1.59	Un saturated Fatty acid	Anti-inflammatory, Antiandrogenic, Cancerpreventive, Dermatitigenic, Hypocholesterolemic, 5-Alphareductase inhibitor, Anemiagenic, Insectifuge, Flavor
8	19.56	Octadecanoic acid	$C_{18}H_{36}O_2$	284	0.43	Stearic acid	No activity reported
9	22.79	12-Oleanen-3-yl acetate, (3à)-	$C_{32}H_{52}O_2$	468	12.10	Acetate compound	No activity reported
10	24.55	Heptacosane	$C_{27}H_{56}$	380	0.73	Alkane	No activity reported
11	25.98	Tetracosane	$C_{24}H_{50}$	338	0.91	Alkane	No activity reported
12	28.05	Lup-20(29)-en-3-ol, acetate, (3á)-	$C_{32}H_{52}O_2$	468	68.75	Lupeol acetate	Antiarthritic
13	29.46	2,6,10,14,18,22-Tetracosahexaene, 2,6,10, 15,19,23-hexamethyl-, (all-E)- (Synonyms: All-trans-Squalene)	$C_{30}H_{50}$	410	1.00	Triterpene	Antibacterial, Antioxidant, Antitumor, Cancer preventive, Immunostimulant, Chemo preventive, Lipoxygenase -inhibitor, Pesticide
14	35.03	Lanosterol	$C_{30}H_{50}O$	426	6.71	Sterol compound	Antimicrobial Anti- inflammatory

**Source: Dr. Duke's Phytochemical and Ethnobotanical Databases

occupying nearly 88% area in part of *Lower and middle plateau* typically in river bed area. However, general distribution extends its limit between 575-925 m. Similarly, the species mainly could be seen in gentle slope.

iii) *Climatic Conditions*

The natural distribution area of the species is located in the Tropical monsoon rain forest climates (Am) as per climatic zones classified by W. Koppen (Trewartha, 1954). Normal mean maximum temperature in these months remains 26^{0}C. A major portion of the semi-evergreen forest - the home of the species is mainly located in *medium rainfall zone* (1200-2000 mm annually). The moisture regime of 6 months wet season prevails here.

iv) *Soil Types and Properties*

The major occurrence of the species could be observed in 2 types of Soil series namely Puncholai, (*Typic Haplustepts*), Ergangalli, (*Typic Haplustepts*). These soil series are generally with very shallow soil depths as found in Table 4 below.

v) *Habitat and Ecological Situations*

The resultant effect of various phytogeographic conditions and past treatment including biotic pressure have developed typical transitional forest types as Tropical Riparian fringing forests between Southern Tropical Wet Evergreen (rain) Forest (IA/C4), Tirunelveli semi-evergreen forest (2A/C3) as per Champion and Seth (1968) which supports the growth of the species.

Table 2: Summary of Abiotic factors for- *Phyllanthus singampattianus*

Geology	:	Mainly in Garnet-Sillimanite - Graphite gneiss of Khondalite group of rocks.
Elevation & landform	:	600-800 m, River valley in Lower and Middle plateau
Slope	:	Below 8° (Gentle to Moderate Gentle <15%)
Rainfall	:	120-200 cm
Temperature	:	18°- 28°c
Dry Season Length	:	4 months
Drainage density	:	Very High
Geomorphology	:	River Bed/River Bottom
Soil Type	:	Puncholai and Erganhalli series under Typic Haplustepts, with very shallow
Soil pH	:	Mildly acidic to near Neutral (5.6 - 6.5)

Table 3: *Phyllanthus singampattianus* - Matrix of phytogeographic parameters of the provenance area

Map no	Zone of Endemism (RF/RL)	Forest Types	Geomorphologic features	Slope in Degrees	Temperature in °c	Rain fall in cm	Elevation Zone in m (above MSL)	Soil Series	Soil P^H	Soil depth in cm	Extent of Area in Ha (in %)
Fig.1	*Singampatty R L*	Semi Evergreen	River/ Stream bed	Below 8°(Gentle to Moderate Gentle <15%)		120-200	600 to 800	Puncholai, Ergangalli	Mildly acidic to near Neutral (5.6 - 6.5)	36-105	69.68 (6.41)

***vi) Floristic Structure, Composition and Species Association*:**

Trees: *Isonandra lanceolata, Popowia beddomeana, Syzygium zeylanicum* var. *lineare, Wendlandia angustifolia*; **Shrubs:** *Hedyotis purpurascens* var. *purpurascens, Hedyotis viscida, Impatiens grandis, Psychotria connata*; **Undershrub**: *Hedyotis travancorica*;

Herbs: *Sonerila tinnevelliensis, Stropanthes wightianus, Vernonia ramaswamii.*

Conservation Assessment Management Plan (CAMP)

Phyllanthus singampattianus (Sebastine and A.N. Henry) Kumari and Chandrab could not find place in any of the three Red Data Books on Indian Plants published by the Botanical Survey of India, Calcutta (1987, 1988 and 1990). The World Conservation Monitoring Centre (1996) has also not considered the species in any of the threat category of IUCN. Only recently *Phyllanthus singampattianus* (Sebastine and A.N. Henry) Kumari and Chandrab is enlisted as critically endangered plants of family Euphorbiaceae by Press Information Bureau, Government of India, Ministry of Environment and Forests on July 14, 2010. The recent field survey by the authors find as Extent of occurrence (Km^2): < 75; Area of occupancy (Km^2): <10; Number of subpopulations / locations: < 15 locations; Habitat status: Decrease in area due to construction of Karayar Dam < 20%; Threat status: Damming, washing

Table 4: *Phyllanthus singampattianus* - Results of soil samples* collected from the places of endemism in KANNIKATTI - INCHIKUZHI zone

Soil Details	LAB. No.	Texture & Color	Lime Status ($CaCO_3$)	pH	Available nutrients (Kg/Acre)				Micronutrient available Content			
					EC (ds/m)	Nitrogen N	Phosphorus P	Potash K	Zinc	Copper	Iron	Manganese
Kannikatti slope of tambra parni	1021/19/SP20	Black, clay	**Nil**	**4.85**	**0.14**	67.2	10.0	237.0	0.74	0.64	7.29	9.80
Kannikatti near TAM .bank	1022/20/SP21	Black, clay	**Nil**	**4.99**	**0.07**	71.4	4.5	252	0.82	0.79	7.86	12.41
Before Inchikuzhi, slope, land	1025/23/SP24A	Black, clay	**Nil**	**4.95**	**0.06**	70.0	6.0	232.5	0.79	0.83	7.62	12.79
Before Inchikuzhi flat land, cane	1026/24/SP24B	Black, clay	**Nil**	**5.67**	**0.11**	67.2	4.5	242	0.63	0.82	7.68	12.82
Inchikuzhi near hamlet, *Tricho. Zeylan*	1027/25/SP25	Black, clay	**Nil**	**5.04**	**0.07**	54.6	6.0	215	0.71	0.70	7.45	12.46
Inchikuzhi near hamlet, *Tricho.*	1028/26/SP26	Black, clay	**Nil**	**5.09**	**0.11**	78.4	7.0	185.0	0.65	0.74	7.69	12.59

(*Soil samples analysed from Soil Testing Laboratory, Tamil Nadu Agricultural Department, Tiruchirapalli- 620020).

away by Flash floods. Floods play a role as controlling factor in limiting the number of individuals of their population. Habitat Loss, Habitat Fragmentation; Numbers/Generations studied: >3 generations/10 years; Data quality: Literature, herbarium and field study; IUCN Status: Critically Endangered **(CR)-A1C, B2a, bi, ii, iii E**.

Species Recovery Plan and Management Options

Conservation efforts and methods

The main threats to *Phyllanthus singampattianus* are habitat disturbance mainly because of Karayar Dam, forest enclosure like Katalamalai Estate, Tribal hamlet at Inchikuzhi, Hope Lake formation and the subsequent tourist pressure in Hope Lake and clearing of neighbouring places etc., Besides, flash floods in rivers with huge boulders often suppress the plants and also cause injuries to the stems and entire plants (Fig. 3). Due to the fragmented nature of the populations, their small size and recent anthropogenic activities the species is susceptible to catastrophic events of further erosion unless time bound special care is taken for this plant across the site.

Measures taken

There is no recorded information on natural regeneration of this species. The species is only enlisted as a threatened plant recently. No significant efforts have been made so far.

Plant Propagation Practices

Seed collection and propagation

The flowering and seed maturation periods of the species have been provided above. Regular inspections of populations across the site are needed to determine the period of seed collection. Mature globose capsules of brown colour were collected from Inchikuzhi in the month of February 2008, from the branchlets by striping the capsules along with leaves. They were dried under shade in aerated place for two - three days. Brown colour triangular shaped seeds (1x0.5 mm) are then separated from the leaflets and leaf stems. One kilogram

Fig. 3: *Phyllanthus singampattianus* (Seb. & Henry) Kim. & Chandrab.; a. Gregarious growth of species in river bed; b. A twig in natural habitat with fruits, c. Natural habitat of the species; d. Injured stems and roots;

comprises of 4600- 5000 seeds with 2-3 months viability. Before sowing in mother bed, seeds were soaked in water for 3-4 hours. Seeds can also be directly dibbled in the mother bed already prepared with forest soil and sand from in and around the place of endemism like Inchikuzhi. The germinative capacity is 85% and the plant survival ranges to 80%. The seeds take 36-60 days for germination. Germination is quicker and more in the open than under shade. A kilogram of seeds typically yields 3600 to 4000 usable seedlings. Temporary nurseries in / near the zones of endemism with source of water is preferable than the permanent nursery outside. Fig. 4 shows a. Whorl arrangement of the leaves – a typical twig of *P. singampattiana*; b. A twig in natural habitat with flowers; c. Matured seeds of the species; d. A twig in natural habitat with seeds of the mentioned species, *Phyllanthus singampattianus*.

Vegetative propagation

There are several proven methods for vegetative propagation including division, cuttings and tissue culture but was not attempted for this species during the present study. A research laboratory at Forest Research Institute / Universities or any other reputed Institutions can be equipped to achieve plant production through tissue culture.

The plant is included in the proposed Plant Schedule (Sarcar, 2010).

Habitat protection

The locations of *Phyllanthus singampattianus* across the site have previously been recorded. Habitat loss across the site through degradation and development is a key threat to the long-term survival of the species and the Site populations. By utilising the information accumulated for these species specific to the site, the Forest Department field staff and management can incorporate this knowledge into decision making towards the conservation and management plans and proposals to be implemented in the field at the earliest.

Measures proposed

Appropriate conservation measures are immediately to be taken up to ensure its survival in the wild by protecting the existing known population of the species and its rare habitat.

The habitat area possesses only the general protection provisions available under the Indian Wild Life (Protection) Act; (1972, 2002) as it comes under Protected Area (KMTR- 17thTiger Reserve of India). The species does not get specific protection support under any Act, legislation or policy except above general protection. It is not in any Schedule of I WPA (1972, 2002) nor included in CITES list.

Following Species-specific conservation measures are proposed for immediate action:

Fig. 4: *Phyllanthus singampattianus* (Seb. & Henry) Kim. & Chandrab.; **a.** Whorl arrangement of the leaves - a typical twig of *P. singampattiana*; **b.** A twig in natural habitat with flowers, **c.** Matured seeds of the species; **d.** At wig in natural habitat with seeds.

1) A specific and comprehensive *Plant Schedule* including this species may be brought under Wild life Protection (Amendment) Act.
2) The sole surviving population of the species studied in KMTR and in its surroundings should be accorded full protection by declaring the specific locality and its vicinity as a "Plant Sanctuary" (Sarcar, 2006). Intensive species inventory needs to be conducted in its distribution range.
3) High resolution satellite data and geoinformatics to prepare ***species specific zonation maps*** for intensive care and management. Similarly, an Atlas showing the spatial distribution of each endemic and threatened plant as per IUCN Guidelines (2001) needs to be prepared to make *species specific future management plan*.

4) Efforts should be taken to raise forest nurseries at convenient place in or around its habitat by collecting mature seeds during September - October. After growing healthy seedlings, they can be planted in its natural habitat to increase the stock density of the species as *in-situ* conservation.

5) For *ex-situ* conservation, healthy seedlings of the species can also be planted in other parts of Western Ghats having similar Phyto-geographic and ecological conditions.

6) Efforts to raise stocks artificially through application of tissue culture techniques should also be attempted.

Conclusion

The plant is extraordinarily rich in Medicinal properties (Sarkar, 2009) and has other potential value. The activity of components identified in *Phyllanthus singampattianus* (Leaf dust and Stem dust) has been elaborated in detail as given below in Table1 (a) & 1 (b).

The present study has been attempted to focus on *species- specific information* along with phytogeographic parameters and ecological situations where this plant grows. Further, S*pecies Recovery Plan*, with plant propagation practices and conservation measures are provided for further stock improvement of the species. However, all the above scientific and technical information can only be effectively implemented when protection, conservation and management of such natural resources are supported by the required regulations, institutional mechanism and strong legislation for all the imperilled plant resources of the country (Sarcar, 2005). Presently more than 7 to 10 per cent plants (IUCN 1997, 1998) suffer from various degrees of threats in the country, but specific policy / guidelines are yet to be framed in this sector of plant protection except six plants already in scheduled list. Hence, it is suggested that all Threatened plants be covered under separate Plant Schedules as already proposed (Sarcar, 2010) including *Phyllanthus singampattianus* at the earliest to protect them from further degradation. Understanding the seriousness of the issues, the Department of Environment, Government of Tamil Nadu, published a Comprehensive book (2012) and the National Biodiversity Authority, Government of India published abridged version book on Biodiversity (2012). The present threat status of the species is "Critically Endangered" and it may lead to next stage of threat as "Extinct in wild" soon if proper species recovery plan is not implemented at an early date. Therefore, efforts have to be continued in order to protect, promote and conserve this critically endangered plant which provides us the lifesaving drugs.

दक्षिणी पश्चिम घाट, भारत में उष्णकटिबंधीय तटवर्ती सीमावर्ती वनों की एक स्थानिक, क्रान्तिक रूप से संकटापन्न और अत्यधिक औषधीय झाड़ी *फाइलेन्थस सिंगेम्पेटिएनस* (सैबेस्टाइन एवं ए.एन. हैनरी) कुमारी एवं चन्द्राब के लिए प्रजाति पुनरप्राप्ति योजना

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फाइलेन्थस सिंगेम्पेटिएनस (सैवेस्टाइन एवं ए.एन. हैनरी) कुमारी एवं चन्द्राव उच्च मानव वानस्पतिक गुणों के साथ यूफोर्बिएसीया कुल की एक स्थानिक और क्रान्तिक रूप से संकटापन्न काष्ठीय झाड़ी में से एक है। यह दक्षिणी पश्चिमी घाट, भारत के उष्णकटिबंधीय तटवर्ती सीमावर्ती वनों में प्राकृतिक तौर पर पाई जाती है। प्रजाति का तमिलनाडु की तिरूनेलवेली पहाड़ियों में प्राप्ति का एक बहुत ही हल्का स्थानिक जोन है। कलकड़ मुन्डेन्थुराई बाघ रिजर्व में प्रजाति के आवासों का जी पी एस और स्तरीकृत बेतरतीब प्रतिचयन तकनीकों का उपयोग करके विश्लेषण किया गया। इसकी वृद्धि और निम्नीकरण के संबंध में आलों के स्तर की पहचान तथा संकटस्थ प्रजाति के स्थल-विशेष मानचित्रण के लिए जी पी एस सहायता-प्राप्त सैटेलाइट सूदूर संवेदी आँकड़ों का उपयोग किया गया। प्रजाति की वृद्धि आदत, वानस्पतिक विवरण, वन संवर्धनिक अभिलक्षण, मानव वानस्पतिक एवं अन्य उपयोग छायाचित्रों के साथ उपलब्ध कराए गए हैं। क्षेत्र के पादप भौगोलिक पैरामीटरों पर विशुद्ध प्वाइन्ट-लोकेशन आँकड़े, स्थानिकता के स्थानों को सम्बद्ध मानचित्रों के साथ चित्रित किया गया है। इस स्थानिक और क्रान्तिक रूप से संकटापन्न प्रजाति की सुरक्षा एवं प्रवर्धान की तत्काल आवश्यकता पर जोर दिया गया है और कृत्रि पुनर्जनन के विषय में इसकी विधियों का वर्णन किया गया है। अंत में स्व-स्थाने और पर-स्थाने संरक्षण विधियों का उपयोग करके प्रजाति पुनरप्राप्ति की सुरक्षा, प्रोत्साहन तथा संरक्षण के लिए संकटस्थ प्रजाति पुनरप्राप्ति योजना का सुझाव दिया गया है।

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