Rehabilitation approach for *Eugenia singampattiana* Beddome – an endemic and critically endangered tree species of southern tropical evergreen forests in India

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***Eugenia singampattiana* Beddome is one of the endemic and threatened tree species of southern Western Ghats in Peninsular India with medicinal value. After more than 112 years since Beddome's collection, the species could be recollected from the same locality in evergreen forests of Singampatti and Papanasam Reserved Forests in Tamil Nadu. The endemic zone of this species is located in the surroundings of the Hope lake at Kalakad Mudandurai Tiger Reserve (17th Tiger Project of India) in Tirunelveli district, Tamil Nadu. The threatened status of *E. singampattina* is reassessed in this article. Botanical description, growth habit, phenology, morphological features, silvicultural characters and medicinal properties are provided. Its natural distribution zone, places of endemism, the phytogeographic parameters of the area of provenance are described with related maps. Immediate need to protect and propagate this critically endangered species is emphasized and its methods of artificial reproduction are elaborated. Finally, conservation measures recommended to stop further erosional process of the species are discussed.**

Keywords: Artificial regeneration, critically endangered, endemism, *Eugenia singampattiana*, evergreen forest.

EUGENIA singampattiana Beddome (Myrtaceae), locally known as 'Korandi' by Kanni tribes in Tirunelveli district, Tamil Nadu is one of the endemic and threatened tree species of the southern Western Ghats in Peninsular India with medicinal value. Lushington[1] described it as 'Eugene Myrtle of the Singampatty Hills of Tinnelvelly'. The species is categorized as Endangered or Possibly Extinct by the Botanical Survey of India[2].

The species is endemic to the tail end of southern Western Ghats in Peninsular India. Earlier records related to its natural distribution are few and found only from Singampatti and Papanasam hills at Kalakad Mundandurai Tiger Reserve Forest (KMTR – 17th Tiger Project of India) in Tirunelveli district, Tamil Nadu. The species is known from the two collections made by Beddome from the above-mentioned areas[3–7] between 1864 and 1874. It had not been collected or reported again during the last 112 years till a collection was made by Daniel in 1986 and 1987 from Papanasam hills near Hope lake[8].

Subsequently, Rajendran collected samples from Checkkalamoodu[8], on the way to Kannikatti from Tulukka mottai in 1988. Gopalan collected samples during 1990–92 from Ambalam river bank, Inchikuli, Kannikatti and from Ullar to Inchikuli, respectively[8].

Sarcar *et al.*[9] collected the species with flower and ripe fruits on the western side of Hope lake between Kavathalai Ar and Tulukka mottai along the road (lower side) leading to Kannikatti from Kariar in September 1999 and again from the southern side of Hope lake near Banathirtham during February and July 2000 (Figure 1).

Sarcar[10] again collected various parts of the species and phytogeographic parameters related to its growth from places adjacent to the Banathirtham waterfalls, Kariar to Kannikatti forest rest house, Inchikuli, Pambar and Mallar river bank during 1999–2001 and assessed the population of matured trees in the above areas.

Gopalan and Henry[8] in their book *Endemic Plants of India*, have revised the present status of the species as 'Endangered' based on availability of more than 500 mature trees of the species in two isolated fragmented populations. After a comprehensive study of the total population of the species and considering its narrow zone of endemism in the world, its status is required to be revised as a plant of 'Critically Endangered' order according to the norms of IUCN Guidelines[11].

Material and methods

After more than 112 years since Beddome's collection, the species has been recollected in the watershed of Tambraparni, Pambar, Maller, Ullar, around the western,

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southern and eastern sides of Hope lake in the western Ghats area, Tirunelveli district, Tamil Nadu. For further studies, locations of fragmented populations were marked on the Survey of India Maps (1969, 1978)[12] and then their geographical co-ordinates were confirmed by the hand-held GPS (Global Positioning System). Different parts on the plants, viz. leaf, stem, flower, seeds, bark and wood sample were collected in addition to the various phytogeographic parameters, e.g. rock, soil, climatic elements and species assemblage in which this plant grows.

For confirmation of species, vegetative parts collected from its endemic zone were compared with the existing herbarium document available at the Southern Regional Office, Botanical Survey of India, Coimbatore, Tamil Nadu. Herbarium of the species collected is deposited in the Survey of Medicinal Plants Unit, Siddha (Field No. 6925 dated 22 February 2000) under Central Council for Research in Ayurveda and Siddha, Palayamkottai, Tirunelveli for maintenance.

Soil samples were collected from the places of endemism of the species and analysed in 2001.

Bark, leaf and roots of the plant were collected during the field survey and the sample was sent to Foundation for Revitalization of Local Health Tradition (FRLHT), Bangalore in April 2003 to obtain its phytochemical parameters.

Detailed study about nursery techniques both from seed origin and vegetative parts was made at Tirunelveli after collecting seeds and stem-cuttings. Frequent field visits were made to the above forest areas during 1999–2001. Natural regenerations as well as floral compositions and phenological characters of the species were studied during these field visits. The various primary and secondary data on phytogeographic parameters were collected during field visits in the locality.

Figure 1. *Eugenia singampattiana* Bedd. ***a***, Twig with fruits; ***b***, Striking orange colour fruits with dark green leaves ***c***, Mature seeds.

Results and discussions

Various characters of the plant

A small, dense, evergreen tree grows in semi-evergreen to evergreen forests in the Singampatti hills of southern Western Ghats. Under favourable situation, it attains a height of about 6–9 m with 40 cm girth. It has distinct morphological and silvicultural characters along with specific properties of medicinal value.

Morphological characters: Bark grey, smooth; branchlets ferete. Leaves opposite, simple 6–12 × 3–8 cm, dark green above, light beneath. Ovate or elliptic–oblong, acute at apex, rounded at base, nerves and intramarginal nerves prominent; petiole short. Inflorence terminal, racemes. Flowers white, crowded, actinomorphic, bisexual. Sepals four, oval–orbicular; petals four, nerved ovate. Bracts and bracteoles pubescent; calyx tube 3 mm long (Figure 2).

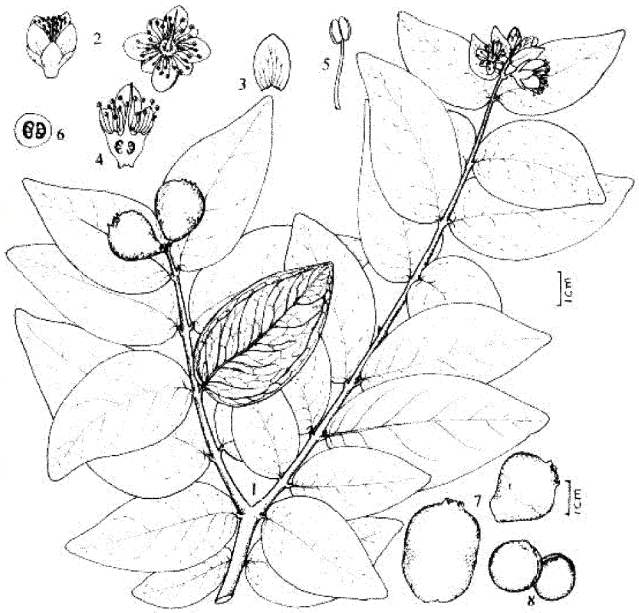

Figure 2. *E. singampattiana* Bedd[9]. 1, Flowering and fruiting twig; 2, Flower; 3, Petal; 4, Calyx with stamens; 5, Stamen; 6, Cross section of ovary; 7, Fruits; 8, Seeds.

Table 1. *Eugenia singampattiana* – phytochemical parameters

	Visible	Long UV	Short UV	Anisaldehyde
TLC Profile				
Syzigium cumini	Nil	0.41, 0.506, 0.58	Nil	0.072, 0.228, 0.337, 0.578, 0.686, 0.891
Eugenia singampattiana	Nil	0.41, 0.506, 0.58	Nil	0.072, 0.18, 0.265, 0.337, 0.42, 0.578

	S. cumini	*E. singampattiana*
Foreign organic matter	Nil	Nil
Moisture content	8.8	10.2
Total ash (%)	4.97	8.19
Acid insol. ash (%)	0.2650	0.3563
Alcohol sol. ext (%)	14.77	4.08
Water sol. ext (%)	11.89	3.66
Reducing sugars (%)	+	+
Hydrolizable sugars	+	+
Phenolics	+	+

Bark from *E. singampattiana* are scrapings from a young and immature plant, whereas bark from *S. cumini* is from a matured tree. These are the preliminary observations from a single sample. TLC profile shows some common bands both in the UV light and on spraying with anisaldehyde. +, Present.

Fruit is almost spherical in shape (1.5–1.75 cm diameter and 5.5–6.5 cm circumference). Persistent calyx. Riped fruit is yellowish-orange to crimson-red with fleshy pericarp. Seeds 2–3, planoconvex, 1.5–1.5 × 1.3 cm stony black.

The plant starts flowering from middle of February, it continues up to end of July and fruiting starts from July and fruits ripen in September–October.

Silvicultural characters: *E. singampattiana* is a shade-bearer, specially during young stage; seedlings and saplings are found under shade of second and first-storied high forest. Species is frost-tender in early stages and hardier later. It is fire and drought-tender. It grows well where soil moisture is ensured with good drainage. The species is not readily browsed by cattle.

Like *Syzygium cumini* (Troups, 1920)[13], *E. singampattiana* possesses excellent coppicing power. Large number of shoots are produced, particularly round the periphery of the cut surface of the stump. Stumps and also branch-cuttings produce stools as a rule. Figure 3 shows the appearance of pure coppice shoots.

Medicinal properties: Comparative profile of bark of *S. cumini* and *E. singampattiana* is given in Table 1 based on biochemical tests conducted by Shastry at FRLHT. The results show that the phytochemical parameters of *E. singampatiana* have similar medicinal properties as *S. cumini*.

Natural distribution zone

The species is endemic to the tail end of the southern Western Ghats, Agasthiyamalai area, Tirunelveli district, Tamil Nadu of Peninsular India. This has also been reported by Ramesh and Pascal[14].

Figure 3. *E. singampattiana* Bedd. A tree near Banathirtham (southern bank of Thamiraparani) showing excellent coppicing power.

Beddome made two collections, one from Singampatti hills[3–7] and the other from Papanasam hills at an altitudinal range of 300–900 m.

The species was relocated time to time from almost the same geographical area of southern, western and eastern side of Hope lake in KMTR area.

Occurrence of the species is strictly restricted to a narrow zone of micro watersheds of Tambraparni river and its tributaries around Hope lake within the altitudinal range of 280–900 m, mainly in semi-evergreen forest type, the upper portion of which merges from wet evergreen forest and the lower portion joins a moist mixed deciduous forest types of the Western Ghats. The natural distribution zone of the species is located between lat. 8°33′N to 8°42′46″N and between long. 77°17′55″E to 77°21′37″E. Figure 4 shows the general distribution locality, while Figure 5 shows the natural distribution zone with places of endemism. The places of occurrence of the

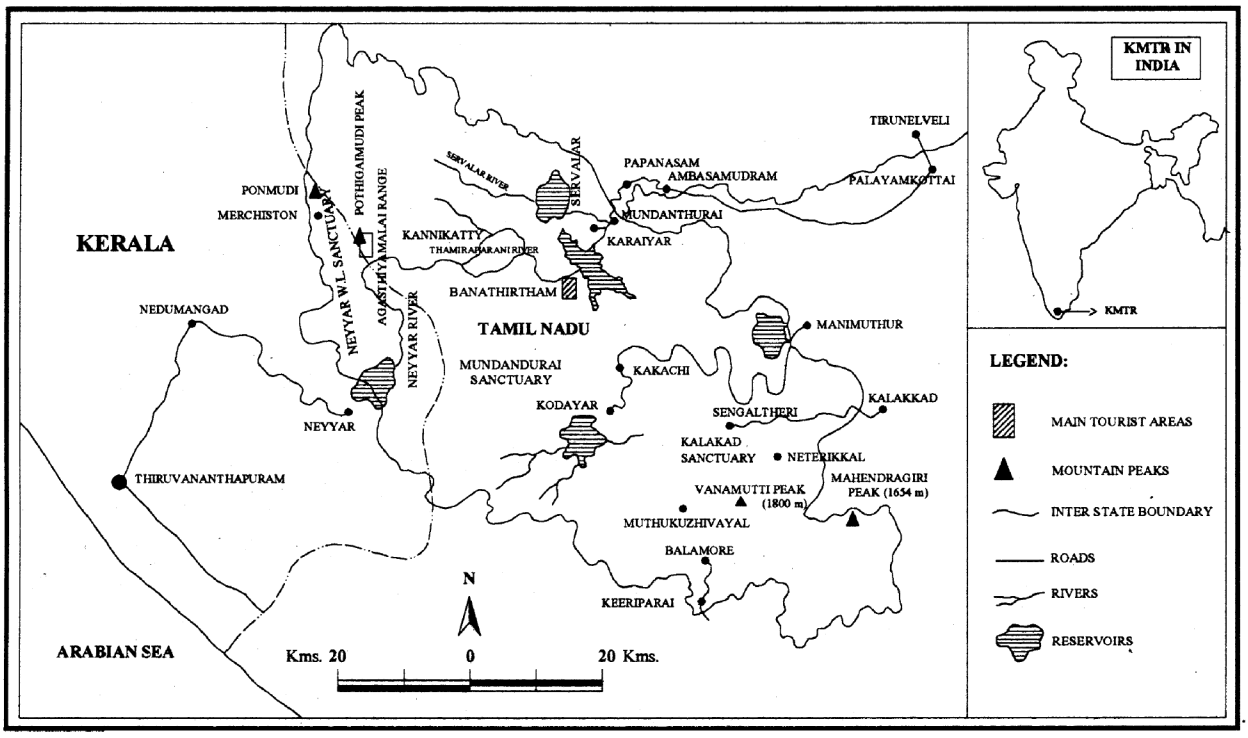

Figure 4. *E. singampattiana* Bedd. General distribution area (KMTR and its surroundings).

species reported from time to time are also shown in Figure 5.

Phytogeographic conditions of the area of provenance

The species could be relocated in the semi-evergreen to evergreen forest types of KMTR, where the milieu of various phytogeographic factors has played a key role in its endemism, growth and also for its present 'Endangered status'. A study of this background may help in identifying its other locations and to take up appropriate measures to protect the existing populations and also for further propagation efforts.

Topographic matrix: The watersheds of Tambraparni and its tributeris around Hope lake in which the endemic zone of the species could be noticed is topographically located on the northeastern aspects of the southern Western Ghats, having the altitudinal range of 280–900 m. Except the adjacent areas of Hope lake up to 600 m, the remaining areas have steep slope[12].

The area is drained by river Tambraparni and its tributaries like Pambar, Mallar odai and Kavatalaiar. Melakkosu odai, Karaiar which contribute to the Hope lake from the west, northwest, south, east, southeast sides respectively (vide Figure 5).

Climatic conditions: The natural distribution area of the species is located in the transit zone and enjoys both tropical monsoon rainforest climate (Am) and tropical wet and dry climate or monsoon savana (Aw), according to climatic zones classified by W. koppen[15].

Climate of the locality above 500 m, i.e. in the upper reaches of watersheds around the Agasthiswaram and other peaks like Naga Pothigai, and Aintalai Pothigai, remains cool and temperature does not fall below 16.2°C in the coldest month. April and May are the hottest months. Normal mean maximum temperature in these months remains in the neighborhood of 32.7°C. Its mean monthly temperature remains around 22.9°C.

Rainfall is seasonal and above 200 cm per year. Banathirtham (300 m) receives 323 cm and Kannikatti (777 m) 330 cm of annual rainfall. The area gets the benefit of both the southwest and the northeast monsoons. The southwest monsoon begins in June and continues up to the end of August with irregular intervals, while the northeastern monsoon is from October to December. The bulk of rainfall is derived from northeast monsoon. The monthwise rainfall details of four centres of the locality are given in Table 2 (1962, 1978)[16,17].

Soil properties: The soil consists mostly of a dark clayey loam – the argillaceous nature being probably due to the disintegration of feldspar aided by plentiful supply of humus[18].

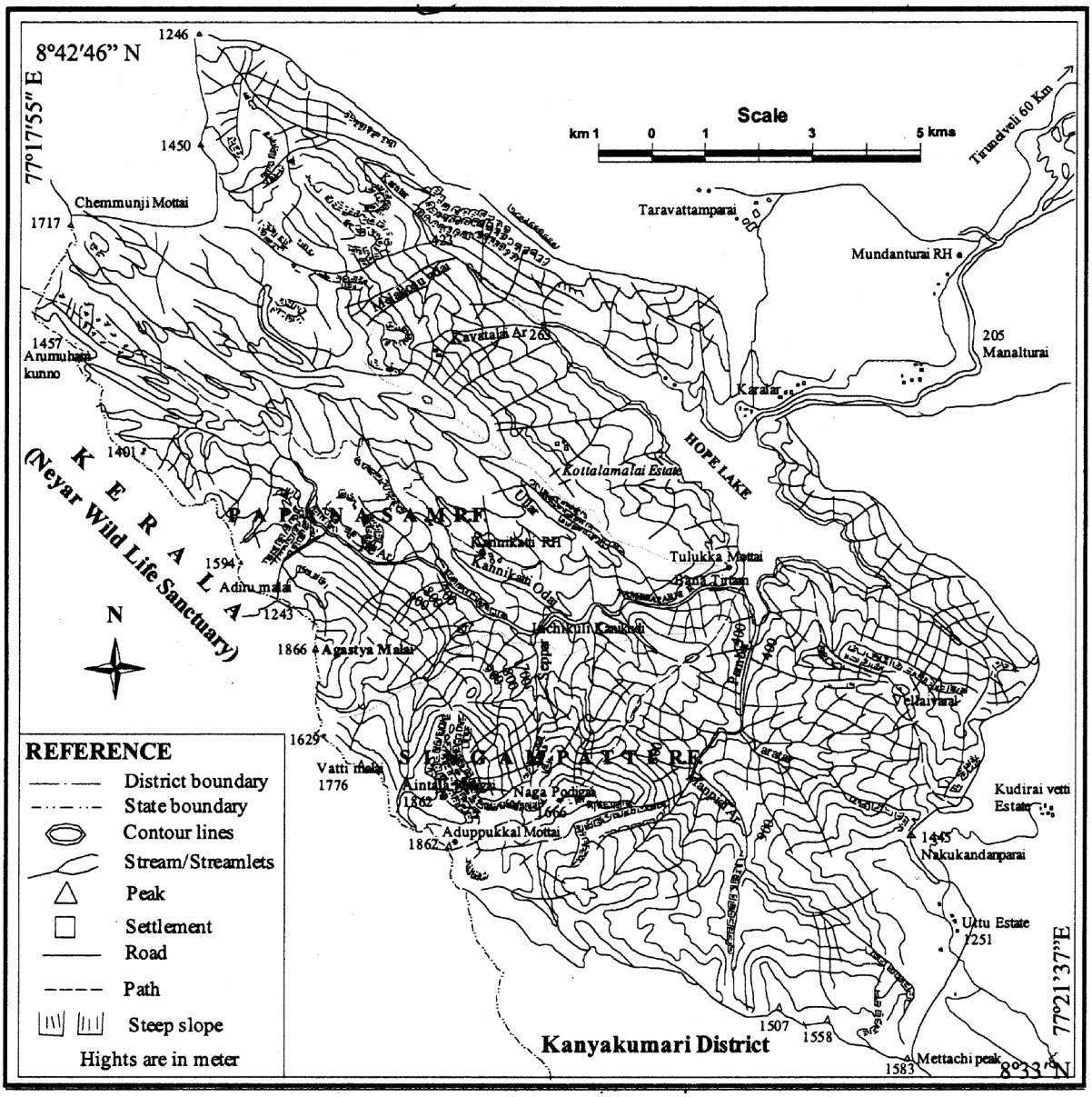

Figure 5. *E. singampattiana* Beddome – zone of natural distribution with places of endemism.

Soil samples were collected from places adjacent to the standing trees of the species identified from the western, southern and eastern sides of Hope lake in Singampatti and Papanasam RFs. These soil samples were analysed at the Soil Testing Laboratory, Tamil Nadu Agricultural Department, Tirunelveli (see Table 3).

Habitat and ecological situations: The resultant effect of various phytogeographic conditions, namely topography, geology and soil, mixed effect of low latitudinal and high altitudinal extent, climatic conditions and past treatment, including biotic pressure has developed typical transitional forest types between southern tropical wet evergreen (rain) forest (IA/C4) and Tirunelveli semi-evergreen forest (2A/C3) of the revised classification of forest types by Champion and Seth[19].

The species under study, i.e. *E. singampattiana* is basically an evergreen species available in this transitional zone of evergreen forest area to semi-evergreen forest. Southern tropical wet evergreen forest is a climax type of rainforest which occurs between 700 and 1500 m through a series of transitions from moist deciduous to evergreen form.

Floristic structure, composition and association of the species: The top canopy or the first layer is extremely dense, represented by gigantic trees like *Artocarpus hirsutus*, *Canarium strictum*, *Cullenia exarillata*, *Diospyros*

Table 2. Monthly rainfall of the tract (average of 10 years rainfall data)

Month	Upper dam Karaiyar, 262 m	Banathirtham 300 m	Upper Tambraparni	Kannikatti 777 m
January	19.54	14.7	11.7	29.7
February	7.62	15.1	8.0	10.2
March	6.43	8.1	7.8	6.8
April	11.04	10.6	11.5	12.2
May	11.44	13.4	10.8	21.0
June	19.08	45.4	34.5	62.0
July	13.13	39.0	34.4	50.3
August	6.25	28.5	14.1	27.0
September	7.01	18.6	18.3	26.9
October	24.07	51.4	44.1	50.3
November	34.19	39.2	35.5	50.5
December	18.27	44.2	35.3	–
Total	178.08	322.8	266.0	356.9

Table 3. Results of soil samples* collected from places of endemism

Soil details	Laboratory no.	Texture and colour	Lime status	pH	EC (ds/m)	Available nutrients (kg/acre) Nitrogen N	Phosphorus P	Potash K	Micronutrient content (in ppm) Zinc	Copper	Iron	Manganese
ES/ Banathirtham 1	16644 16667	Yellowish brown Sandy clay	No effervescence No calcareousness	4.9	0.04	106	2.0	175	0.03	0.08	5.24	5.64
ES/ Banathirtham 2	16645 16668	Yellowish brown Sandy clay	No effervescence No calcareousness	6.0	0.06	109	2.0	250	0.15	0.08	6.16	12.86
ES/ Banathirtham 3	16646 16669	Yellowish brown Sandy clay	No effervescence No calcareousness	6.6	0.06	104	2.5	215	0.15	0.14	5.33	12.92

*Soil samples analysed by R. Gandhi, Soil Testing Laboratory, T.N. Agricultural Department, Tirunelveli.

ebenum, *Elaeocarpus serratus*, *E. tuberculatus*, *Gluta travancorica*, *Holigarna arnottiana*, *Hopea parviflora*, *H. utilis*, *Mesua ferrea*, *Palaquium ellipticum*, *P. bourdillonii*, *Poeciloneuron pauciflorum* and *Vepris bilocularis*.

The second layer is composed of shade-loving trees such as *Cinnamomum iners*, *Nageia wallichianus*, *Eugenia mundagam*, *Garcinia echinocarpa* var. *monticola*, *G. travancorica*, *Homalium jainii*, *Isonandra lanceolata*, *Kingiodendron pinnatum*, *Symplocos cochinchinensis* subsp. *laurina*, *Syzygium caryophyllatum* and *S. jambos*.

Below the second layer, innumerable shrubs and small trees such as *Agrostistachys borneensis*, *A. indica*, *Antidesma menasu*, *Callicarpa tomentosa*, *Elaeocarpus munronii*, *Eugenia singampattiana*, *Eurya nitida*, *Litsea deccanensis*, *Mallotus distans* and *Tabernaemontana gamblei* are found.

E. singampattiana is found below the second layer as small tree.

Semi-evergreen forest type is the major group which is distributed all around Hope lake, particularly 300–700 m between wet evergreen forest above and the moist deciduous forest below.

These forests are distributed in patches and belts wherever moisture availability is adequate to support a semi-evergreen forest, but at the same time inadequate for an evergreen climax formation. In the western side of Katalamalai Estate and in the eastern side of Mallar basin exposed easily to biotic pressure, moist mixed deciduous forest type could be noticed.

Plant propagation practices

There is no recorded information on natural regeneration of the species, but during field study it was noticed that many natural regenerations were available below the tree shade near the streams, where the soil has sufficient humus and moisture content. Artificial reproduction methods were attempted both from seed origin and by stem cuttings[10].

Propagation from seed origin: The ripened light yellowish to orange colour fruits was collected during September and October (Figure 6). These were kept in a heap under shade for 2–3 days. This helps the pericarp to rot and then pulp is

removed by rubbing and washing in water. The seeds were dried in shade. The number of fruits and seeds per kg was found to be ca 440 and 360–870 respectively. The seeds have a germination capacity of 87% and plant survival of 61%. Seeds appear to have a dormancy period of a few months. Seeds were collected from fresh, ripened fruits in the Banathirtham area at the end of September and dibbled soon after the removal of pulp at Palayamkottai forest campus. Germination could be noticed only in January, indicating that the dormancy period could run for a few months. About 514 plants were obtained from 1 kg of seeds. Seed viability could be retained maximum for a period of 7–8 months, after which the endosperm of the seeds gets dried-up and the seeds lose their germination capacity.

Seedlings of *E. singampattiana* have been raised for experimental purposes by sowing seeds in the nursery. No specific problems were faced during raising of the plant in the nursery. However, the growth pattern was slow in the early stages. Raised bed nursery of forest soil with sufficient leaf litter and humus content helps in better and early germination, while in ordinary soils the result is not encouraging. Covering the mother bed with about 1.0–1.5 cm thick straw gives better results as it provides required warmth to the seeds. Water is supplied in the morning and evening. When seedlings become 3–4 cm, they are dibbled in 16 × 30 cm or 15 × 25 cm polythene bags. Details of seed weight, germination percentage, etc. are given in Table 4.

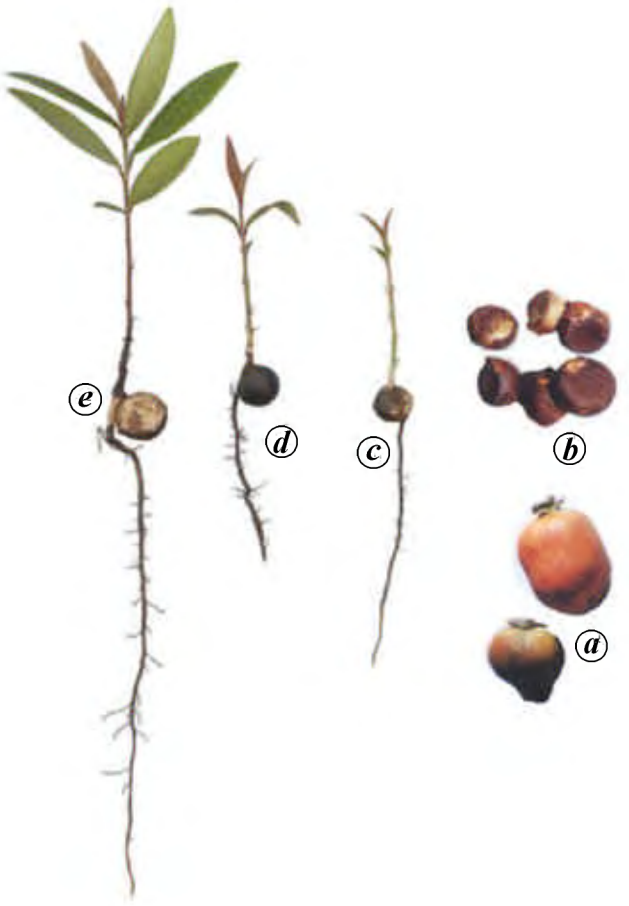

Figure 6. *E. singampattiana* Bedd. seedling. ***a***, Fruits; ***b***, Seeds; ***c–d***, Stages of germination; ***e***, Six-month-old seedling.

Vegetative propagation: The species is an excellent coppicer. Keeping this character in mind, ten stump cuttings of a small root portion of pencil thickness were kept in mud pots. All ten stumps started giving shoots within 25 to 30 days. Small stump with root portion were collected from its habitat and at the time of collection itself, a handful of local moist soil was kept with the collected stump to avoid dehydration of the root portion. The stumps and soil were kept in small bags before they were transplanted into the mud pots. The root portion of the stump was carefully kept in the mud pot. Mixed soil, sand and green leaf manure (2 : 1 : 1) was tightly packed around the stump. Then a cylindrical mud pot having a small hole on the top was kept on the mother mud pot (vide Figure 7). Water was sparingly sprinkled once in two days through this hole without opening the cylindrical mud jar. The jar should not be opened frequently. Keeping an empty mud jar on the mother pot creates a natural greenhouse effect, stimulating early and ensured shoot formation. Within 25–30 days new shoots appeared with red-coloured young leaves. The plant was allowed to continue in such confinement for two months. Then the jar was opened in the evening and again closed in morning without allowing direct sunlight. Slowly, the exposure period was extended. This led to the formation of chlorophyll in the plant, which will change its colour from red to light green. After the third month, plants were kept in shade and normal care was taken. To produce large number of plants from stump cuttings, mist chamber methods by Silpaulin sheets can be used economically.

Artificial reproduction methods were attempted both from seed origin and also by stem cuttings by the authors at Tirunelveli. About 46 seedlings of seed origin and 9 plants from stem cuttings were raised as a preliminary experiment.

Conservation efforts and methods

The species with narrow endemic zone of distribution is in imminent danger of extinction. 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 from further anthropogenic pressure.

Measures taken: The species and its habitat get general protection under various Acts and Rules of Tamil Nadu Forest Department, as the area comes under Reserved Forest Category (Papanasam and Singampatti RFs). Further, this habitat also possesses general protection provisions

Table 4. *E. singampattiana* – seed weight, germinative capacity and plant per cent

Data source	No. of seeds per kg	Germinative capacity (%)	Plant (%)	No. of days for germination	Plants per kg
Sarcar *et al.*[9]	857	84	60	65–85 days	514
Sarcar *et al.*[9]	556	87	57	70–95 days	–
Shivasankar	363	89	65	60–85 days	–

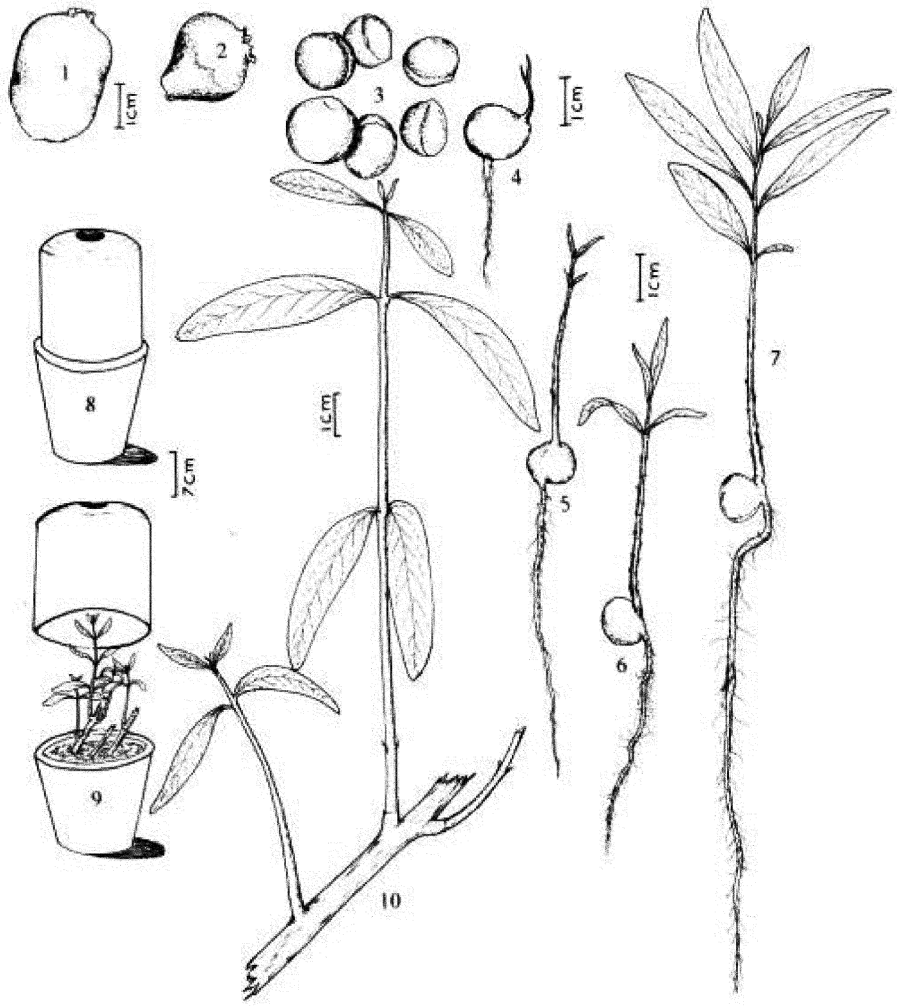

Figure 7. *E. singampattiana* Bedd. – seedling/coppice/shoots. 1, 2, Fruits; 3, Seeds; 4–6, Germination stages; 7, Development of seedling in four months; 8, Mudpot with cylindrical cover (mud pot) on the top with small hole (for filtered light); 9, Development of coppice shoots from branch cuttings; 10, Young coppice shoots.

available under the Wild Life (Protection) Act, 1972, 2002, as it comes under KMTR (17th Tiger Reserve of India). However, species-specific conservation measures are yet to be taken up.

Measures proposed: (i) As importance is given for protection of wild fauna under the Wild Life (Protection) Act, 1972, 2002 in India, similar importance has to be given to such threatened plants. A specific and comprehensive Plant Schedule, including this species may be brought under Wild Life Protection (Amendment) Act 2002 or in the Biological Diversity Act 2002, so that all the threatened plant species, particularly critical ones get immediate attention and legal support. (ii) The sole surviving population of the species in the wild in hilly areas of Singampatti and Papanasam, Tirunelveli district, Tamil Nadu

should be accorded full protection by declaring the specific locality and its vicinity as a 'plant sanctuary'[20]. Intensive species inventory is to be conducted in its distribution range so that more niches, if available, can be identified and made as plant sanctuaries and protected. (iii) High-resolution satellite data and GIS can be used to find the actual ecological parameters of the niches of this species, so that the controlling elements and favourable habitat can be taken care of and species-specific zonation maps can be prepared for intensive care and management. Similarly, an atlas showing the spatial distribution of each endemic and threatened plant according to IUCN Guidelines[11] has to be prepared to make species-specific future management plan for such imperilled plant species. (iv) Efforts should be taken to raise forest nurseries by collecting mature seeds during September–October. After getting seedlings of height more than 30–40 cm, they can be planted in their natural habitat to increase the stock density of the species as *in situ* conservation. For *ex situ* conservation, healthy seedlings of the species can also be planted in other parts of the Western Ghats having similar phytogeographic and ecological conditions. (v) Efforts to raise stocks artificially through application of tissue culture techniques and vegetative propagation by stem/root cuttings should also be attempted.

Conclusion and perspectives

E. singampattiana was first collected and reported by Beddome[3] during 1864–74. Subsequently, after more than 112 years, this species was recollected and reported. However, these efforts were mainly taxonomic exercises, except a brief report by the Botanical Survey of India (1987)[2] and by Gopalan and Henry[8] on different facets about the species.

The present study attempted to focus on species-specific information like field identification characters, maps of the natural distribution zone in addition to the phytogeographic parameters and ecological conditions under which this plant grows. Further, species recovery plan, with plant propagation practices, including photographs and line diagrams are provided. Besides, conservation measures to be taken up for this plant have also been recommended for the natural resources managers to make specific programmes for further stock improvement of the species. Thus, the comprehensive report about this critically endangered species may be used as an effective tool for implementation in the field.

However, all the scientific and technical information can only be effectively implemented when protection and management of such natural resources is supported by the required regulations, institutional mechanism and strong legislation in the country.

In this context it is relevant to mention here that we have the Wildlife (Protection) Act 1972 and Wildlife (Protection) Amendment Act 2002, under which only six plants received such protection (under Schedule VI), while many species of wild fauna including insects and beetles are listed as protected species (Schedule I–V). Besides, there is a list of 28 plants (including the abovementioned six plants) which the Ministry of Trade and Commerce prohibits trade under CITES. Further, in the Biological Diversity Act 2002, there is no special protection provision for imperilled plants, except one section which speaks only about empowerment of the Central Government to notify any plant species as threatened and make regulations on the same[21].

Therefore, it is a matter of concern that when more than 7 to 10% of plants[11] suffer from various degrees of threat in the country, we are yet to frame any specific policy/guideline in this sector of plant protection, except for six plants. In the absence of such legal acts or policies for flora, illegally collected plants from the KMTR or Reserved Forests could neither be identified (physically or by biochemical tests in a forensic laboratory due to lack of skill, expertise and policies) nor booked outside the forest boundary under any offence, as it is not legally supported by court of law. Hence, scheduling of the threatened plants community should separately to be taken up with equal strength like fauna, since according to Raven[22] 'it is likely that as a quarter of all species of Indian plants may be either extinct or on their way to extinction within 25 years, the great majority of the species present now are likely to be extinct within a century if proper conservation efforts are not in place in time.'

Thus the natural resource managers, administrators and legislators should re-look into the existing policy framework, management strategies and make a comprehensive species-specific recovery plan for all the imperilled plant resources of the country to protect them for the present and future heritage of mankind.

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