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## A Review on *Calophyllum apetalum* Willd., an Endemic Medicinal Tree of Western Ghats.

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### ABSTRACT

Conservation and regeneration of threatened tree species are crucial and it is important to study their ecology, mode of seed dispersal, seed production, to sustain their genetic diversity. *Calophyllum* is a genus having 187 species. But the pitiable fact that only few species are explored and the knowledge of other species are indigent. The *Calophyllum* species which occur in India, especially in Western Ghats are *Calophyllum apetalum*, *C. inophyllum*, *C. astroindicum*, *C. polyanthum* and *C. pascalianum*. As the data provided by IUCN Red list, this medicinally important endemic tree species *C. apetalum* coming under the 'Vulnerable' category. All species have poor conservation efforts (ie, Data Deficient category and Not Evaluated category, and some of the species are Least Concerned). Based on the aspects of conservation of *Calophyllum* species, *C. apetalum* needs an urgent study due to its Vulnerability. Improper utilization and lack of conservation, *C. apetalum* may undergoes endangered in future. There are no detailed studies about their phenology, nature of the seed, developmental and germination aspects, dispersal of the seed, propagation, regeneration and conservation strategies yet. So, it is important to study all these aspects and conserve the whole population. This review focuses on information about *Calophyllum apetalum*, including its ecology, usage, and reasons for the species decline. This will help to identify effective measures for regeneration and conservation (both *In-situ* and *Ex-situ*) by doing this, the genus *Calophyllum* can retain at least one of its species.

**Keywords:** *Calophyllum apetalum*, western ghats, medicinal tree.

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## INTRODUCTION

Over the past thirty years there has been an increase in scientific research concerning the conservation and management of threatened or endangered species [1]. *Calophyllum* is a genus of evergreen trees, distributed in the Tropics of Asia, mainly in the Indo – Malaysian region, Australia, Africa and Tropical America. *C. apetalum* is important for their highly medicinal values [2, 2a, 2b]. According to IUCN *C. apetalum* under ‘Vulnerable’ category. *C. apetalum* Willd., means absence of petals on flowers hence the name ‘apetalum’ [3]. The seed is edible [4]. This species has various ethno - medicinal values [5,5a]. The seed oil of *C. apetalum* is used by traditional practitioners for the treatment of leprosy [6, 7]. The seed oil of *C. apetalum* and *C. soulattri* was also used in the treatment of skin infections (8,6). The infusion of *C. apetalum* mixed with the honey is used for treating scabies [6]. *C. apetalum*, *C. tacamahaca* and *C. inophyllum* are reported to be used in the treatment of rheumatism [9, 6]. Xanthonones have been isolated from the bark and wood of several species of the genus *Calophyllum* [10]. From *C. apetalum* apetalinones A- C, were isolated in which ‘A’ was a novel xanthone isolated from the roots. The bark of *C. apetalum* have a new xanthonoid apetalinone - D were isolated [11]. However, because to various human activities, a changing climate, and other factors, this population has recently begun to drop abruptly. Here in lies the need of protecting this particular tree species. Studies on the regeneration of *C. apetalum* seeds [12] indicates the major propagation tool for this species was seeds. The information about *C. apetalum*, their ecology, usage, and reasons for the species decline are the main topics of this review, which also discusses solutions for their regeneration and conservation (both *In-situ* and *Ex-situ*). Protect at least one species of the genus *Calophyllum*.

## MATERIALS AND METHODS

Available manuscripts like research articles, journals, review papers, books, e-papers, e-books, electronic thesis, dissertations and search engines like Google, Yahoo, Microsoft Bing and herbarium specimens were used for collecting data.

### Results

***Calophyllum apetalum*** [13,14,8,14a]

Synonyms:

- *C. decipiens* Wight [13,15,8,15a]
- *C. wightianum* Wall.ex Planch. & Triana [5, 13,16]
- *C. spurium* Choisy [8, 13]
- *C. burmannii* Wight [13,16]
- *C. calaba* L. [13,17,17a,17b]
- *C. calaboides* G. Don [18]

**Common names [19-25]**

|           |  |
|-----------|--|
| English   | Poon Spar of Travancore, Konkan Leaf Tree                                  |
| Malayalam | Arrupunna, Manjapunna, Valuzhavam, Kattapunna,Attupunna, Manjapunna        |
| Hindi     | Bobbi, Undi, Kal Honne, Kalpoon, Kalpoone, Kirihonne, Kullponne, Shri Hone |
| Marati    | Bobbi, Irai  |
| Sanskrit  | Joshishmathi, Punnagam,  |
| Gujarati  | Sarpuna  |
| Kannada   | Huraluhonne, Irai, Kalohonne   |
| Tamil     | Cherupinnay, Sirubinnai, Valuluvai   |
| Bombay    | Cherupinnai, Sarapunna   |

There has been much disagreement amongst botanists over the correct application of the name *Calophyllum calaba*. Specimens from three different species have at times been confused and given this name. We have followed the treatment of Stevens and applied this name to the Sri Lankan species. This

Indian species is treated here as *Calophyllum apetalum* and the tropical American species as *Calophyllum brasiliense* [26].

## Morphology

*Calophyllum apetalum* are evergreen moderate sized Tree [27] straight – and cylindrical stemmed, evergreen tree with a girth of up to 2.1 m, distributed in the evergreen forests of Western Ghats up to 1350 m, often found along the banks of rivers and streams. Bark pale yellow with characteristic boat shaped furrows; leaves obovate to elliptic, coriaceous, 4–10 cm long; Flowers bisexual, white, petals absent, about 1-2.5 cm across, pedicel slender, glabrous, about 7-15 mm long, bracts ovate, deciduous, about 4 mm long, perianth lobes 4-8, imbricate, sepals 4 rarely 3, decussate in pairs, obovate-ovate, deflexed, biseriate, veined prominently, membranous, outer 2, broadly ovate-orbicular about 3.5-6 x 3.3-5.5 mm across, inner 2, obovate-elliptic, white, petaloid, about 6-9 x 3.5-5 mm across, , rarely 2-5, but deciduous before anthesis. Stamens 45-85, obscurely fascicled, free, filaments slender, connate at the base, about 5 mm long, anthers basifixed, oblong, yellow or reddish, about 1.5-2.5 mm across, dehiscing longitudinally. Ovary superior, globose, unilocular, about 1.5 mm across, ovule single anatropous, style slender, longer than the stamens, about 3.5 mm long, stigma peltate, margins entire or crenulate, about 1-1.5 mm across. Fruit indehiscent drupe, ovoid-subglobose, about 1-2 cm across, with thin smooth exocarp, dry mesocarp and stony or spongy endocarp, red when ripe, Seeds 1, ovoid-globose, about 7.5-12 x 5-7 mm across, smooth with large cotyledons, exalbuminous, with oil content [28].

## Ecology

The tree is found along the foothills from Maharashtra and Goa southward through the forests of Karnataka and Kerala. It is often found growing along the rivers which flow down the Western Ghats to the sea. The tree attains large size in Kerala, particularly in the interior of evergreen forests, often away from streams; elsewhere it is medium - sized, mostly along the streams. In its natural habitat, the absolute maximum shade – temperature ranges from 32 to 38°C or more, the absolute minimum being from 4 to 16°C and the rainfall ranges between 125 and 825 cm [29]. The tree is a strong shade demander especially in the early stages but is capable thriving in the open later. It prefers very moisture situations, found along the perennial and semi perennial streams of evergreen forests but cannot tolerate flooding for long periods. It however, avoids stagnant water. The root system is mainly superficial and spreads rapidly from the base of the stem in all directions and it is highly lenticular surface permits respiration. It is sensitive to fire, even superficial scorching often proving fatal; also, its coppicing power is poor. Species are receptive to various virus, fungi, insect pests that affects the leaves, roots, and the fruits. Associated plants are *C. polyanthum* Wall.ex Choisy, *Carallia brachiata* (Lour.) Merrill, *Dipterocarpus indicus* Bedd., *Dysoxylum malabaricum* Bedd., *Hopea parviflora* Bedd., *Kingiodendron pinnatum* (Roxb.) Harms, *Vateria indica* Linn., *Ixora nigricans* R.Br.ex Wight & Arn., *Syzygium zeylanicum* (L.) DC., *Uvaria narum* (Dunal) Wall., *Holgarna arnottiana* Hook.f., *Sesamum indicum* L. etc. in Karnataka, Kerala and Tamil Nadu.

## Uses

### Timber

The timber is good for construction. It is used for construction of boats, oil mills, bridges and for cabinet work [8, 30]. It is suitable for manufacture of match boxes and poles. The timber is suitable for plywood. It is a good fuel [31]. The sapwood is pale reddish white; heartwood is reddish brown with darker streaks and without characteristic odour, lustrous, with smooth feel, moderately heavy (wt.689 kg/m<sup>3</sup>), moderately hard and strong, somewhat irregularly grained, medium – textured and durable. The timber works to smooth surface with careful planning. The timber is liable to splitting, surface cracking and cupping during seasoning. The heartwood is very refractory to treatment, side and end – penetration being practically nil. The preservative – treated wood is slightly more durable. The tree is susceptible to gall formation. The edges of the leaves are often transformed in to large hollow, irregularly shaped, winged galls. The disease is very common in the districts of Uttara Kannada. The stem and petiole - galls are also recorded. Galls are produced by an unidentified *Psyllid* (Hemiptera) [32]. Graveyard tests on the natural durability of wood showed that its average life is 59–65 months. The data for the comparative suitability of timber, expressed as percentages of the same properties of teak, are: wt, 100: strength as beam, 80: stiffness as a beam, 80: suitability as a post, 80: shock resisting ability, 90; retention of shape, 65; shear, 110; and hardness, 110 [5, 33]

## Fruit

*Calophyllum apetalum* yield edible fruits. They contain a cream – coloured kernel, (average weight 2.5 g) which is eaten; it is enclosed in a hard shell (average weight 6.4g). The fruits are collected and sold. The kernels contain apetalolide and  $\beta$  – sitosterol-  $\beta$  – D - glucoside. The sun - dried kernels yield a greenish yellow fatty oil (45-50 %), having a characteristic odour and a bitter taste. The process of collection of kernels, extraction of oil and its utilization are almost like those of *C. inophyllum*. The fatty acid composition of the oil is as follows; palmitic,8; stearic,14; oleic, 48; and linoleic, 30%. The unsaponifiable matter contains  $\beta$  - sitosterol. The oil is used as an illuminant, lubricant, and in soap making and leather – treating. The oil is used in rheumatism, leprosy, scabies and other cutaneous affections, and as a septic poison.

## Dispersal of seed

Seeds may be dispersed by autochory i.e., self-dispersal, zoochory i.e., dispersal by birds or animals, anthropochory i.e., dispersal by humans [28]. The yellow stem bark exudes a translucent resinous fluid when injured. It is reported to be used as vulnerary, resolute and anodyne. The tender leaf juice with bark juice of *Erythrina indica* Lam. is given internally for gastric trouble. The paste of seed kernel is applied externally for skin diseases. The oil cake is a good manure [34,43a,34b]. The bark and stem contain friedelin and  $\beta$  – amyrlathrate composedin. The bark also contains betulinic acid, apetalic acid and  $\beta$  - sitosterol. The wood yields  $\beta$  – sitosterol and mesoinositol. The heartwood yields a clathrate composed of wightianone, and fatty acids, mainly palmitic. From the leaves friedelin, apetalactone and canophyllol have been isolated. The roots contain friedelin,  $\beta$  – amyrlin, jacareubin, 1-methoxy-3,5,6- trihydroxyxanthone, 2-(3'3; - dimethylallyl)-1,3,5,6-tetrahydroxyxanthone and 1,3,5,6 – tetrahydroxyxanthone [35,35a].

## Xanthonones

Three new xanthonoids, apetalinones A-C, were isolated from the roots of *Calophyllum apetalum*, as well as the known compounds, calozeyloxanthone and zeyloxanthone. The stem bark of this species yielded a new xanthonoid, apetalinone D, and another known xanthonoid, tomentonone. Five known xanthonones (3,8-dihydroxy-1,2-dimethoxy-, 1,3-dihydroxy-2,5-dimethoxy-, 1,5-dihydroxy-, 1,3,5-trihydroxy-2-methoxy- and 1,3,5-trihydroxyxanthone) and two flavonoids ((-)-epiafzelechin and (-)-epicatechin) were also characterized as constituents in the stem wood. Among them, apetalinone A was a novel xanthonone with 1,1-dimethylallyl ether moiety, which indicated a new biosynthetic pathway including Claisen rearrangement and Diels-Alder reaction. Four new prenylated xanthonoids, apetalinones A-D, were isolated from *C. apetalum* in addition to five known xanthonones [11].

## Regeneration

Natural regeneration is generally adequate under the parent tree. The seedlings thrive in the dense shade of the heavy undergrowth, found along the streams and continue to grow slowly until they emerge into the open. Afterwards the crown assumes a round shape. In Karnataka, transplanting of the species was successful in Dandeli and Telgeri – Kans division. The percentage of survival is reported to be 60 – 70. Growth of the tree is slow in the early years. The tree starts bearing between 3 to 4 years after planting and continues to fruit up to 30 years. It usually flowers between December and April. The fruits ripen during the rainy season from June onwards and are dispersed by the floods or by birds. An average adult tree may yield c 12,000 fruits in each season i.e., Feb – May and Sep - Nov. Germinative capacity of the seed is probably poor. The oily seeds lose their viability quickly [36,36a].

## Cultivation details

A plant of the moist to wet tropics, where it is found at elevations up to 1,735 metres. It grows best in areas where annual day time temperatures are within the range 30 - 35°C, but can tolerate 12 - 38°C. It can be killed by temperatures of 4°C or lower. It prefers a mean annual rainfall in the range 3,000 - 6,000 mm but tolerates 1,300 - 8,000 mm. Grows best in full sun, tolerating light shade prefers a medium-textured soil of moderate fertility prefers a pH in the range 5 - 6, tolerating 4.5 – 7 [37].

## Reproduction

*Calophyllum apetalum* flowers are bisexual, i.e., with functional male (androecium) and female (gynoecium), including stamens, carpels, and ovary, rarely polygamous (male & bisexual). Pollination is entomophilous i.e., by insects, or cleistogamy i.e., by self or allogamy i.e., by cross pollination. Flowering/Fruiting: September—May [28].

## Related works

- Three new xanthonoids, apetalinones A-C, in which A was a novel xanthone were isolated from the roots of *C. apetalum*. The bark of *C. apetalum* have a new xanthonoid, apetalinone-D [11].
- *In-vitro* multiplication of *C. apetalum* were carried out. Out of 345 plants restored to their native habitat in the forest at three locations 293 plants survived and showed uniform growth free of morphological defects [38].
- The acetone extract of leaves of *C. apetalum* records the isolation and structure determination of a dipyrano-coumarin  $\alpha$ -hydroxytomentolide-A along with known friedelin, triterpenoids apetalactone, calophyllol and inophyllum C [39].
- Pollination biology and breeding systems of *C. apetalum* shows flowers are pollinated by both anemophily (through wind) and entomophily (through insects) gives effective pollination results and in successful fruit set. The manual cross and self-pollinations are significantly different. It depicts the importance of naturally mediated cross-pollination by pollinators [40].
- The formation of silver nanoparticles by the extract of *Alternaria* sp. obtained from bark part of *C. apetalum* Willd. [41].
- *Myrothecium* sp. isolate M1-CA-102 was the most promising among the 16 *Myrothecium* isolates screened. '*C. apetalum* is a potential source of natural metabolites of pharmaceutical importance [42].
- *Calophyllum apetalum* and *Garcinia morella*, medicinal plants are endemic to Western Ghats, Karnataka, India. Sixteen *Myrothecium* isolates were obtained from the tissues of bark and twigs of these plants. One isolate (JX862206) amongst the 16 *Myrothecium* isolates exhibited potent antibacterial and as well as anti-*Candida* activity [43].
- A work with silver nanoparticles by the concentrate of *Penicillium* sp. disconnected from *C. apetalum*. This strategy is one of the basic, proficient and quick strategies to combine silver nanoparticles at surrounding temperature without utilization of lethal chemicals [44].
- Synthesis of silver nanoparticles by the extract of *Calophyllum apetalum*. Findings: 94 nm silver nanoparticles were synthesized. Improvements/Application: As antibacterial agents, *C. apetalum* interceded blend of silver nanoparticles and their antimicrobial impact [45].
- Studies on *Calophyllum apetalum* roots [46].

## Conservation

Botanical Survey of India took an initiative for *Ex-situ* conservation programme through its chain of eleven Botanic gardens established in different regional centres. All the gardens are designed for collection, introduction, multiplication and maintenance of germplasms of orchids, bamboos, medicinal plants, palms, ferns, legumes, wild edible plants, insectivorous plants, gymnosperms and RET plants. National Orchidarium and Experimental Garden Yercaud took Conservation of Rare, Endangered and Economically important plants collected and detailed conservation initiations multiplied and are being conserved in Experimental Garden. One of the species is *C. apetalum* [47]. Seed bank estimation and regeneration studies of *C. apetalum* Willd., from Western Ghats of Karnataka, *C. apetalum* Willd., from Western Ghats of Karnataka. Studies on the seed production, modes of dispersal and regeneration patterns of threatened tree species are crucial for the management of their genetic diversity. The results revealed that the seeds are dispersed by hydrochory and mammalochory. The *In-situ* regeneration studies revealed, an insignificant relationship between the mean regeneration among the forest ranges and the distances. Also, the *Ex-situ* regeneration studies resulted in an insignificant relationship among forest ranges and the distances from which the seeds were collected. The highest seed germination through *Ex-situ* regeneration suggested it, as a best suitable method of conservation of this species [12]. For a sustainable environment we should focus on conservation, restoration and rehabilitation of this species that makes a significant difference in their population [48].

## CONCLUSION

The present study intended that *Calophyllum apetalum* is a riverine species narrow endemism makes this species vulnerable to extinction. From the genus *Calophyllum*, *C. apetalum* species have more medicinal properties hence there is urgent need for conservation. The propagation of this tree species is majorly through seeds other regeneration practices are also under consideration (Tissue culture methods). Reviews suggests that the proper way of conservation is *Ex-situ* mode. Thus, seed physiological studies may require for the proper conservation and regeneration.

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