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## Journal of Threatened Taxa

The international journal of conservation and taxonomy

[www.threatenedtaxa.org](http://www.threatenedtaxa.org)

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)

### NOTE

**A NOTE ON THE TAXONOMY, FIELD STATUS AND THREATS TO THREE ENDEMIC SPECIES OF *SYZYGIUM* (MYRTACEAE) FROM THE SOUTHERN WESTERN GHATS, INDIA**

R. Ramasubbu, C. Divya & S. Anjana

26 September 2016 | Vol. 8 | No. 11 | Pp. 9384–9390

10.11609/jott.2682.8.11.9384-9390



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ISSN 0974-7907 (Online)  
ISSN 0974-7893 (Print)

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Myrtaceae, the myrtle family, of the order Myrtales, comprises about 130–150 genera and 5650 species. This family is distributed in tropical and concentrated in America as well as Malesia and Australia. The species of this family are known for their rich volatile oils which are of medicinal importance. Myrtaceae is easily distinguished from the other related families by tanniferous evergreen trees or shrubs with simple and more or less pellucid punctate leaves with oil glands, curving nerves anastomosing distally into intra-marginal nerves; numerous brightly colored and conspicuous epigynous stamens, bisexual flowers with calyprate or non calyprate petals; actinomorphic, ovary inferior or semi-inferior (Vinodkumar 2003).

About 1,100 species of trees and shrubs which have a native range extending from Africa and Madagascar to southern Asia (Raju et al. 2014). The evergreen forests in the high ranges of the southern Western Ghats are a potential region for the distribution of *Syzygium* in India. Most of the species of *Syzygium* are economically important as they are a source of timber, essential oils, spices, edible fruits, fuelwood and also in folk medicine. The leaves and bark of most of the species of this genus have antibacterial (Shyamala & Vasantha 2010), anti-inflammatory (Chaudhuri et al. 1990), antimicrobial (Kiruthiga et al. 2011), antifungal (Park et al. 2007; Ayoola et al. 2008), antitumor (Kiruthiga et al. 2011), antihyperglycemic (Rekha et al. 2010), antihyperlipidemic, antioxidant (Nassar et al. 2007), antidiabetic (Nonaka et al. 1992; Kumar et al. 2008), antigastric and anti-HIV properties (Reen et al. 2006). The bark of the trees is employed in folk medicine for

## A NOTE ON THE TAXONOMY, FIELD STATUS AND THREATS TO THREE ENDEMIC SPECIES OF *SYZYGIUM* (MYRTACEAE) FROM THE SOUTHERN WESTERN GHATS, INDIA

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the treatment of inflammation (Muruganandan et al. 2001).

Being an economically important genus, most species of *Syzygium* are overexploited for their valuable compounds from parts like leaves, bark, and seeds and thereby are under severe threat of extinction. Of the 52 species reported from the Western Ghats, 26 species of *Syzygium* have been listed under the IUCN Red List category. Among them, five species are included under Critically Endangered and eight species are under the Endangered category. Of the species under danger, the following three species, *Syzygium densiflorum* Wall. ex Wight & Arn., *Syzygium myhendrae* (Bedd. ex Brandis) Gamble and *Syzygium travancoricum* Gamble, have not received much attention from conservation perspective. All the tree species have potential biochemical compounds which are used in several indigenous health care systems. Overexploitation, habitat degradation, irregular phenological events, lower productivity and lesser seedling establishment in the natural habitat are the real factors for the vanishing of the population of most of the species of *Syzygium* (Vinodkumar 2003).

DOI: <http://dx.doi.org/10.11609/jott.2682.8.11.9384-9390>

Editor: M.K. Vasudeva Rao, Shiv Ranjani Housing Society, Pune, India.

Date of publication: 26 September 2016 (online & print)

Manuscript details: Ms # 2682 | Received 20 April 2016 | Final received 13 July 2016 | Finally accepted 02 September 2016

Citation: R. Ramasubbu, C. Divya & S. Anjana (2016). A note on the taxonomy, field status and threats to three endemic species of *Syzygium* (Myrtaceae) from the southern Western Ghats, India. *Journal of Threatened Taxa* 8(11): 9384–9390; <http://dx.doi.org/10.11609/jott.2682.8.11.9384-9390>

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Funding: DST-SERB, New Delhi, India (SB/YS/LS-118/ 2013 dated 30.10.2013)

Conflict of Interest: The authors declare no competing interests.

Acknowledgements: We thank DST-SERB, New Delhi, India for providing funds (SB/YS/LS-118/ 2013 dated 30.10.2013) to carry out the research.



To prevent the population reductions, alternative strategies are to be developed to protect these little known important tree species. In order to assess the population density of all the three species of *Syzygium*, extensive field trips were conducted in different forest areas of Western Ghats of Kerala (Agasthyamalai) and Tamil Nadu (Megamalai, Palni hills, Nilgiry) from October 2014 to April 2016. Further, the populations of *S. travancoricum* were also located at Kalasamala Kavu, the sacred grove of Kerala. The distributional status of the species was confirmed through field visit, consultation with herbarium specimens and also through standard literature. All the three species of *Syzygium* were monitored periodically for flowering and fruiting phenology, seed germination in vitro and in vivo, insects or pests, etc.

### *Syzygium densiflorum*

Wall. ex Wight & Arn., Prodr. 329. 1834; Nair & Henry, Fl. Tamil Nadu 1. 1983. Vajr., Fl. Palghat District 199. 1990; Anil Kumar, Fl. Pathanamthitta District 265. 1994; Sasidharan et al. KFRI research report. 99. 8. 1994. Sasidh., Fl. Periyar Tiger Reserve 137. 1998; Sasidh., Fl. Chinnar Wildlife Sanctuary 129. 1999; Mohanan & Sivad., Fl. Agasthyamala 261. 2002. Sasidharan et al. KFRI research report. 282. 2006. Nayar et al. Fl. Plant of Kerala 451.2006; Maridass, Ethnobotanical leaflet. 14: 616. 2010. Bruce, Food plants International. 2014. Ramachandran. Adv. Poll. Spor. Res. 30. 167. 2014. Nayar et al. Fl. The Western Ghats, India, 1:674. 2014. *Syzygium arnottianum* Walp., Rep. 2:180.1843; Gamble, Fl. Pres. Madras 475(338). 1919; Mohanan & Henry, Fl. Thiruvananthapuram Dist. 187. 1994; Subram., Fl. Thenmala Division 134. 1995; Grellier et al. J. South Asian Nat. Hist. 2(2). 165.1997; Swarupandan et al. KFRI Research report 154. 30. 1998; Menon & Balasubramanyan., KFRI Research report 281. 28. 2006; *Eugenia arnottiana* (Walp.) Wight, Ic. t. 999. 1845; Hook. f., Fl. Brit. India 2: 483. 1878.

Large canopy trees, above 15m tall, bark surface blackish-grey, rough; branchlets terete. Leaves aromatic, simple, opposite-decussate, estipulate; petiole 3–20 mm long, slender, grooved above, glabrous; lamina 3.5–9×1.8–3.7 cm, elliptic-lanceolate or elliptic-oblong, base attenuate or acute, apex acuminate or caudate-acuminate, margin entire, glabrous, glandular punctate, coriaceous, olive-green when dry; finely dotted on both sides, main nerves numerous, parallel, slightly ascending, inconspicuous on both sides, secondary nerves numerous, closely parallel, looping at the margin, marginal nerve 0.1mm away from the margin. Flowers

bisexual, white, 10–12 mm long, sessile, in dense clusters forming compact, terminal trichotomous cyme congested; calyx tube 5mm, turbinate; lobes 4; no thick disc; petals free, deciduous; stamens many, free, bent inwards at the middle in bud; ovary inferior, 2-celled, ovules numerous; style 1; stigma simple. Fruits berry, oblong-ovoid, dark purple, fleshy, single-seeded. Stalk and pedicel stout and short.

**Vernacular name:** Malayalam: Ayuri, Karayambuvu, Njaval, Vellanjaval, Ayura; Tamil: Kurunjaval, Kuruthal, Kuruthamaram, Nagay, Naval, Pillanjaval.

**Materials examined:** MH Acc: No: 174906, 14.iv.2008, Naduvattam, coll. M. Mohanan & J.V. Sudhakar; MH Acc: No: 174905, 14.iv.2008, Naduvattam, coll. M. Mohanan & J.V. Sudhakar. MH Acc: No: 174540, 9.iv.2008, Naduvattam, coll. M. Mohanan & J.V. Sudhakar; MH Acc: No: 174541, 9.iv.2008, coll. M. Mohanan & J.V. Sudhakar; GUH 206, 31.xii.2015, Vattakkanal, Kodaikanal, 8°41'01.73"N & 77°11'23.99"E, coll. Felix Irudhyaraj & Ramasubbu; GUH 209, 25.iii.2015, Agasthiyamalai 10°12'29.60"N & 77°28'50.32"E, coll. Manikandan & Ramasubbu; GUH 204, 19.iii.2016, Megamalai, 9°41'56.35"N & 77°23'59.12"E. coll. Mohanraj & Ramasubbu; GUH 216, 18.iii.2016, Vattakkanal, Kodaikanal, 8°41'01.73"N & 77°11'23.99"E, coll. Felix Irudhyaraj & Sasikala.

**Distribution and ecology:** It is a native tree which grows in the riparian/marshy area of evergreen forest at higher elevations between 1,500–2,300 m (Image 1), reported from Maharashtra, Karnataka, Kerala (Thiruvananthapuram, Eravikulam, Pathanamthitta, Kottayam, Idukki, Palakkad, Kozhikode, Kasargod) and Tamil Nadu (Palni Hills, Aanamalai and Nilgiri Hills (Vinodkumar 2003).

**Economic importance:** The local tribes of the Nilgiris have been using the leaves of *S. densiflorum* for the treatment of diabetes mellitus from ancient times. Clinical investigators working in India have also confirmed the effectiveness of *S. densiflorum* against diabetes mellitus. Trace elements from this plant make a good daily supplement for people suffering from bone and anaemic disorders (Subramanian et al. 2012). The oil extracted from the leaves possesses a higher anti-oxidant capacity (Saranya et al. 2013). It has potential phytochemical compounds such as tannin, saponins, flavonoids, alkaloids, quinine, cardiac glycosides, terpenoids, phenols and carbohydrates (Nasrin & Pandian 2015).

**Field status:** The large number of mature individuals of *Syzygium densiflorum* has been already exploited from the Palni Hills only a very meager number of mature



Image 1. Flowers of *Syzygium densiflorum*

individuals and seedlings exist. The mean number of mature individuals observed at different shola forests of Palni Hills was only  $36 \pm 0.9$ . *S. densiflorum* is closely associated with other shola arboreals like *Eleocarpus recurvatus*, *E. variabilis*, *Rhododendron arboreum*, *Rhodomyrtus tomentosa*, *Litsea coriacea* and several *Eucalyptus* species. The tree growing shola forests have regular phenoevents, but flowering is not observed as a regular event in most of the individuals of *Syzygium densiflorum*. A very few mature individuals only flowered once in two years and the period of flowering was also unpredictable. However, a major percentage of the flowers and fruits withered away prematurely. The fruits are edible and also the food source for many birds, insects, Malabar Giant Squirrel and Nilgiri Langur. The shelf life of seeds has been observed to be a maximum of one year, but it is best to be sowed within 4–6 months. Fresh fruits were brought to the nursery, depulped manually, dried for some days and sown in artificial beds (1x1 m plots) prepared in the forest land and germination was noticed. The seeds showed a maximum 60% of germination and the least percentage (13%) of seedlings alone emerged as viable seedlings. According to the previous literature and recent field survey, *S. densiflorum* is distributed in selected forest areas of the southern Western Ghats. Due to the lack of updated information, the species being included under Vulnerable category by IUCN, and authenticated survey reports have to be communicated to IUCN to include under the endangered category. During January–March, five foliicolous fungi viz., *Asterina* sp., *Lambosia hosagoudari*, *Meliola syzygii-benthamiani*, *Meliola densa*, *Trichothyrium asterophorum* can be commonly seen on the most part of leaves. The fungal infestation

has also been retarding the growth and reproduction of the trees.

### *Syzygium myhendrae*

(Bedd. ex Brandis) Gamble, Fl. Pres. Madras 478 (338). 1919 [1: 338. 1957 (Repr.)]; V. Chitra in N.C. Nair & A.N. Henry (Eds), Fl. Tamilnadu Anal. 1: 157. 1983; Gopalan & Henry, End. Pl. India SW Ghats 398. 2000; Sasidh. et al. J. Econ. Tax. Bot. 26: 609. 2002. Sasidharan et al. KFRI research report. 282. 2006. Sasidh., Biod. Doc. Kerala pt. 6, Fl. Pl.: 178. 2004; Nayar et al. Fl. Pl. Kerala-Handb.: 451. 2006. Nayar et al. Fl. Plant of Kerala. 452. 2006; Nayar et al. Fl. The Western Ghats, India, 1: 677. 2014. *Eugenia myhendrae* Bedd. ex Brandis, Indian Trees 325. 1906; Bourd., Forest Trees Travancore 189. 1908; Rama Rao, Fl. Pl. Travancore. 171. 1914.

Medium sized trees, upto 12m high, bark greyish pink; branchlets tetragonous. Leaves aromatic, simple, opposite, estipulate; petiole 2–5 mm long, slender, glabrous; lamina 3–7 x 2–2.5 cm, oblanceolate or obovate, base cuneate, apex obtusely acuminate, tip of acumen obtuse, margin entire, glabrous, coriaceous; lateral nerves many, slender, close, parallel, obscure, looped at the margin forming intramarginal nerves; intercostae reticulate, obscure. Flowers; petals free, bisexual, small, white, sessile in terminal corymbose cymes of umbellules, branches of inflorescence quadrangular; calyx tube 3mm, turbinate; lobes 4, round, petals 4, caducous; stamens many, regularly folded at middle in bud, 5mm long; ovary inferior, 2-celled, ovules many; style filiform, shorter than the stamens; stigma simple, acute. Fruit sessile, 7–8 mm across, globose, pink-purple, crowned by persistent calyx limb (Images 2 & 3).

**Materials Examined:** GUH 231, 07.vi.2014, Kardana Estate, Megamalai,  $9^{\circ}30' - 10^{\circ}30'N$  &  $77^{\circ} - 78^{\circ}30'E$ , coll. Anjana & Ramasubbu; GUH 211, 26.ii.2015, Agasthiyamalai,  $10^{\circ}12'29.60''N$  &  $77^{\circ}28'50.32''E$ , coll. Ramasubbu & Manikandan; GUH 212, 19.iii.2016, Megamalai,  $9^{\circ}30' - 11^{\circ}32'N$  &  $77^{\circ} - 79^{\circ}32'E$ , coll. Ramasubbu & Mohanraj; GUH 203, 28.vi.2015, Megamalai,  $9^{\circ}30' - 10^{\circ}30'N$  &  $77^{\circ} - 78^{\circ}30'E$ , coll. Divya & Ramasubbu; GUH 219, 20.iii.2016, Megamalai,  $9^{\circ}30' - 10^{\circ}30'N$  &  $77^{\circ} - 78^{\circ}30'E$ , coll. Anjana & Felix Iruthyaraj.

**Distribution and ecology:** *Syzygium myhendrae* is mainly distributed in Karnataka, Kerala (Idukki, Kollam, Thiruvananthapuram) and Tamil Nadu (Mutukuzhivayal, Tirunelveli) (Shareef & Rasiya 2015). Recently, it has been collected from the Megamalai Hills, Theni District, Tamil Nadu.

**Phenology:** Flowers in June and fruit set in September.



Image 2. Flowering branch of *Syzygium myhendrae*

**Economic importance:** The color and ornamentation of young leaves are highly attractive and many taxonomists recommend that it can be introduced as an ornamental. Fruits are edible, sweet cum acidic taste with a tinge of mango flavour (Shareef & Rasiya 2015).

**Field status:** R.H. Beddome collected this species initially from Mahendragiri Hills of Agasthyamalai, Tamil Nadu and identified as *Eugenia*. Later Brandis (1906) described it scientifically and published validly as *Eugenia myhendrae* without the type material. Bourdillon (1908) had also collected a similar specimen from Peermadu (Idukki) of Kerala and Muthukuzhivayal (Tirunelveli) of Tamil Nadu. After a few decades, the species had been declared as extinct and no single specimen had been collected by taxonomists and field biologists from the above said localities. Several floristic explorations conducted by many researchers (Mohanan & Henry 1994; Manickum et al. 2008) also confirmed the non-availability of this little known endemic species. After a few decades, Sasidharan et al. (2002) rediscovered the species from Shenduruny Wildlife Sanctuary and Periyar Tiger Reserve, Kerala. Shareef et al. (2015) have also collected the specimens from its type locality. During our field exploration at Megamalai Hills, a few flowering individuals of *Syzygium myhendrae* were collected at an altitude of 2000m. There were 11±03 mature individuals along with approximately 29 (3–4 years old) seedlings observed from the ≥6km<sup>2</sup> radius. Unfortunately, most of the mature individuals were observed in and around tea estates on private land and only very few (3–5) mature individuals in the protected forest areas. Being a semi-evergreen tree, it exhibits severe oscillation in the events on vegetative and following phenology. The flowering period of mature individuals was reported to be from June–August. The field studies at different time periods indicated that the tree flowers regularly at the onset of the monsoon. But most percentages of flowers emerged



Image 3. Fruiting branch of *Syzygium myhendrae*

in the first two months were not setting the fruits. This may be due to the absence of pollinating agents and heavy wind (app. 47km/hour) which was reported in the field during the monsoon period. Based upon the preliminary study conducted on the field, we confirmed that the reproductive efficiency of the tree was also limited in general and seed viability in particular. The fruit took 18–34 days to attain maturity. The fruit is very small, 7–8 mm with 1–2 mm thickness of fruit pulp. The fruit is edible and many birds, insects, Malabar squirrel, common bonnet monkey and Nilgiri Langur are attracted during the fruiting period. The viability of the seeds was identified as very less (13%). The trees grow mostly in the hills slopes and nearby streams and most part of the seeds was washed away from the soil nearby the tree to streams and waterfalls. The in vitro seed germination studies conducted at mist house (The Gandhigram Rural Institute, Gandhigram, Dindigul) did not yield a positive result. Further, seed germination studies continued on the field and 18% of the seeds only developed as seedlings.

#### *Syzygium travancoricum*

Gamble, Bull. Misc. Inform. Kew. 1918 et. Fl. Pres. Madras 1:480. 1919; Nair & Mohanan, J. Econ. Tax. Bot. 2:234. 1981; Mohanan, Fl. Quilon Dist. 182. 1984; Ahmedulla & Nayar, End. Pl. Ind. Reg. 1: 108. 1987; Nayar & Sastry, Red Data Book of Indian Plants 1:217. 1987; Anil Kumar, Fl. Pathanamthitta Dist. 267. 1994; Mohanan & Henry, Fl. Thiruvananthapuram Dist. 192. 1994; Sasidh. & Sivar., Fl. Pl. Thrissur For. 185. 1996; Sasidh., Fl. Shenduruny Wildlife Sanctuary 125. 1997; Sunil, Fl.

Pl. Alappuzha Dist. 333. 2000; Balasubramaniam et al. J. Econ. Tax. Bot. 29 (2): 382. 2005; Nayar et al. Fl. Plant of Kerala.453. 2006; Krishnakumar & Shenoy J. Econ. Taxon. Bot. 30(4): 900. 2006; Subash et al. The open Conservation Biology Journal. 2:1. 2008; Udhayavani et al. NeBIO. 4(5).68. 2013. Ramachandran. Adv. Poll. Spor. Res. 30: 167. 2014; Nayar et al. Fl. The Western Ghats, India, 1:674. 2014.

Medium sized to large trees, upto 25m high, bark grayish brown; branchlets distinctly four angled, glabrous, longitudinally fissured, peeling off in thin irregular flakes, inner bark grey. Leaves simple, opposite, exstipulate, ovate to elliptic, lamina 10–17×5–10 cm, base narrowed and decurrent, apex bluntly acuminate, papery, hairless, obtuse, margin entire, chartaceous, shiny; lateral nerves 10–15 pairs, parallel, distantly arranged, prominent, looped near the margin forming indistinct intramarginal nerve, intercostae reticulate, faint, joining near margin; petioles 2cm long. Flower small, bisexual, about 3mm across, white, mildly fragrant, arranged in 8–15 cm long axillary corymbose cymes, 5–8 cm long, peduncle 4.5–8 cm long, their branches also long, ascending; calyx tube short, 1mm across, lobes 4, very short; no thickened staminal disc; petals white, calyptrate; stamens numerous, free, bent inwards at middle when in bud; ovary inferior, 2- celled, ovules many; style 1; stigma simple. Fruit, a berry, smooth, hairless, oblong-obtuse on both sides, 1x0.5 cm, deep violet, pericarp juicy; seed one, white (Image 4).

Vernacular name: Malayalam: Poriyal, Vathamkollimaram, Kulirmavu, Thenmavu; Tamil: Kattunaval, Neernaival.

Materials examined: K000821398, 6.iii.1995, coll. T. F. Bourdillon; MH Acc No. 113361, 1.iii.1979, Sacred grove Kodumon, coll. C.N Mohanan; 113360, 1.iii.1979, Sacred grove Kodumon, coll. C.N. Mohanan; 113362, 4.iv.1980, sacred grove Kodumon, coll. C.N Mohanan; 113363, 4.iv.1980, sacred grove Kodumon, coll. C.N. Mohanan; 113358, 4.iv.1980, AickadAdoor, coll. C.N. Mohanan; GUH 221, 18.vii.2015, Keel Nadugani, 11°27'181N & 76°22'451E, coll. Mohanraj & Manikandan; GUH 226, 25.iii.2016, Kalasamala, 10°40'27.8N & 76°5'27.1E, coll. Manikandan & Mohan; GUH 228, 08.iii.2016, Nadukani, 11°28'183N & 76°24'458E, Felix Iruthyaraj; GUH 234, 09.iii.2016, Nadukani, 11°28'183N & 76°24'458E, coll. Mohanraj & Ramasubbu; GUH 227, 07.ii.2016, Palode, Thiruvananthapuram, coll. Ramasubbu & Mohanraj.

Distribution: *Syzygium travancoricum* distributed in Kerala (Thiruvananthapuram, Pathanamthitta, Kollam, Thrissur, Kulathupuzha, Wayanad and Idukki) and Tamil Nadu (Nadukani, Nilgiri Hills) and exclusively



Image 4. Flowering branch of *Syzygium travancoricum*



Image 5. Adult mature individual of *S. travancoricum* protected at Kalasa mala Kavu, Kerala

found in such swampy area of evergreen forest in higher elevation between 500–1,200 m (Vinodkumar 2003). But most of the individuals are protected under Kalasamala sacred groves at Kerala (Image 5). These species also occur in Uttara Kannada, Kumaradhara river riparian forest (Karnataka). The dominated populations of *S. travancoricum* also exist in Thirthahalli, Shimoga District.

Phenology: The flowering and fruiting period of the species recorded from April–February. However, the

flowering and fruiting periods were not regular events and severe oscillations were observed during the study period.

**Economic importance:** *Syzygium travancoricum* is known for its astringent, bactericidal, hypoglycemic, and neuropsychopharmacological effects and for their significant odors (Jirovetz et al. 2001; Radha et al. 2002). The antimicrobial activity of essential oil was found to be more effective on yeasts than on bacteria. It has some major compounds such as trans  $\beta$ -ocemene, trans  $\beta$ -aryophyllene,  $\alpha$ -humulene and  $\alpha$ -farnesene (Shafi et al. 2002).

**Field status:** Bourdillon collected the species in March 1895 in Swampy places of Travancore, Kerala and it was described by Gamble in 1981. The tree was said to be extinct once, but it was rediscovered by Krishnakumar & Shenoy (2006) from the forests of Dakshina Kannada, mainly Netravathi basin. Recently this species has been included in the Flora of Tamil Nadu (Thomas & Ramachandran (2014). In Kerala, very few individuals have been reported from a sacred grove at Kundumon and Aikad of Quilon (Nair & Mohanan 1981).

According to the IUCN list, this tree is considered as critically endangered and grows partially in the interior area of Kumaradhara. These species are associated with some endangered species such as *Hopea ponga*, *Veteria indica* and some vulnerable species such as *Ochreinauclea missionis* and *Gymnacranthera canarica* (Ramachandran et al. 2013).

Several factors are responsible for the reduction of the population of these tree species in the natural habitats. Some insects such as *Bracon fletcheri* Silvestri and *Ophiorrhabad* sp. are reported as major infestation agent on fruits of *S. travancoricum* which is the major casual factor affecting natural regeneration of the species (Hussain & Anilkumar 2015). The seed pest incidence, therefore, is responsible and predicts the endangerment of the species in the near future and warrants conservation measures for posterity.

Further, in vitro seed germination confirms its viability upto 76% and healthy seedlings were developed at mist house, GRI. A plant tissue culture technique has been adapted to propagate in large number. Very few explants responded and the research work in progress. Saplings of *S. travancoricum* were established through vegetative cuttings of roots and stems.

*Syzygium densiflorum*, *S. myhendrae* and *S. travancoricum* face severe problems due to low seed viability, the incursion of exotic trees into the forest area, an extension of agricultural land, illegal timber trading, forest degradation and depletion by human

invasion. It has a direct effect on the reduction of this tree population in the natural habitat. Their rarity in the Western Ghats indicates thinner population status and therefore warrants immediate action for its conservation and restoration. A proper conservation measure has to be taken for their effective conservation and regeneration.

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ISSN 0974-7907 (Online); ISSN 0974-7893 (Print)

September 2016 | Vol. 8 | No. 11 | Pages: 9289–9396  
Date of Publication: 26 September 2016 (Online & Print)

DOI: 10.11609/jott.2016.8.11.9289-9396

[www.threatenedtaxa.org](http://www.threatenedtaxa.org)

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