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Journal of Threatened Taxa

10.11609/jott.2023.15.2.22559-22770
www.threatenedtaxa.org

26 February 2023 (Online & Print)
15(2): 22559-22770
ISSN 0974-7907 (Online)
ISSN 0974-7893 (Print)

Open Access

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

Publisher
Wildlife Information Liaison Development Society
www.wild.zooreach.org

Host
Zoo Outreach Organization
www.zooreach.org

43/2 Varadarajulu Nagar, 5th Street West, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Registered Office: 3A2 Varadarajulu Nagar, FCI Road, Ganapathy, Coimbatore, Tamil Nadu 641006, India
Ph: +91 9385339863 | www.threatenedtaxa.org
Email: sanjay@threatenedtaxa.org

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Cover: Pseudo-flying animals and wind-dependent seed & spore dispersers – made with digital painting in Krita. © Melito Prinson Pinto

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 February 2023 | 15(2): 22718–22725
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
https://doi.org/10.11609/jott.8271.15.2.22718-22725
#8271 | Received 24 November 2022 | Finally accepted 28 January 2023

COMMUNICATION

Multidimensional time-lapse of a relict species *Canarium strictum* Roxb. from a sacred landscape in Pune District, India

Mukul Mahabaleshwarkar [1], Nivedita Ghayal [2], Supriya Mahabaleshwarkar [3] & Vinaya Ghate [4]

[1,1] A. Kulkarni Department of Biodiversity, MES Abasaheb Garware College, Pune, Maharashtra 411004, India.
[2] Department of Botany, MES Abasaheb Garware College, Karve Road, Pune, Maharashtra 411004, India.
[1,3] Indian National Trust for Art and Cultural Heritage (INTACH), Pune Chapter, Kothrud, Pune, Maharashtra 411038, India.
[4] Former senior scientist, Agharkar Research Institute, C-2, New Friends Society, Paud Road, Kothrud, Pune, Maharashtra 411038, India.
[1] mmukul@gmail.com (corresponding author), [2] gnivedita12@gmail.com, [3] supriya.r.g@gmail.com, [4] vsghate@gmail.com

Abstract: The traditional practice of conservation on religious basis along with commercial linkages at a local level is an interesting system from the point of view of its ecological, economical as well as institutional sustainability. Dhoop-rahat, in the Western Ghats region of Bhor Taluka in Pune District, is possibly the only sacred grove dedicated to a religiously important species *Canarium strictum* Roxb. Dhoop (black dammar resin) is traditionally extracted from *C. strictum*. The present study attempts to assess Dhoop-rahat and its surrounding historic sacred landscape with focus on the rare *C. strictum* individuals in the backdrop of changes in the ecological, geographical, socio-cultural, and economical dimensions associated with it, over time. Field and market surveys were conducted and RS-GIS techniques were used in the study. Community conserved Dhoop-rahat sacred grove has two individuals of *C. strictum* along with seven endemic and one IUCN Red Listed species. Successful regeneration of *C. strictum* is not observed. Once commercially harvested from this location, this species is now used only for ritualistic purposes. The two individuals of *C. strictum* have endured the drastic changes in the surrounding vegetation. In the business-as-usual scenario, there is a high risk of losing the last two individuals of *C. strictum* in the region and eventually the grove itself. Newer approaches of conservation by combining community-based traditional ecological knowledge with modern day scientific methods should be applied for protection of this sacred landscape. Long-term periodic monitoring of sacred groves and their surrounding landscape is essential for ensuring their sustainable existence.

Keywords: Black dammar resin, community conservation, dhoop, Dhoop-Rahat, ecological, economical, natural heritage, sambrani, sacred grove, Western Ghats.

स्थानिक व्यावसायिक संबंधों के साथ-साथ धार्मिक आधार पर प्रकृति संवर्धन की पारंपरिक प्रथा पर्यावरणीय, आर्थिक और संस्थात्मक शाश्वतता के दृष्टिकोण से एक दिलचस्प प्रणाली है। पुणे जिले के पश्चिम घाट क्षेत्र में भोर तालुका में धूप-रहाट संभवतः ऐसा एकमात्र पवित्र उपवन है, जो धार्मिक रूप से महत्वपूर्ण प्रजाति *कैनारियम स्ट्रिक्टम* रॉक्सब. को समर्पित है। धूप (काला दमार) पारंपरिक रूप से *सी. स्ट्रिक्टम* पेड़ से निकाला जाता है। यह अध्ययन समय के साथ जुड़े पर्यावरणीय, भौगोलिक, सामाजिक-सांस्कृतिक और आर्थिक आयामों में होनेवाले परिवर्तन की पृष्ठभूमि में दुर्लभ *सी. स्ट्रिक्टम* पेड़ों के साथ धूप-रहाट और इसके आसपास के ऐतिहासिक पवित्र परिदृश्य (लैन्डस्केप) का आकलन करने का प्रयास करता है। इस अध्ययन में फ़ील्ड और मार्केट सर्वेक्षण किए गए और जी.आय.एस. तकनीकों का उपयोग किया गया। समुदाय-संवर्धित धूप-रहाट में सात स्थानिक और एक आय.यू.सी.एन. रेड लिस्ट में सूचीबद्ध प्रजातियों के साथ *सी. स्ट्रिक्टम* के सिर्फ़ दो पेड़ हैं। धूप-रहाट में *सी. स्ट्रिक्टम* का पुनर्जनन नहीं देखा गया है। इस प्रजाति का उपयोग यहाँ अब व्यावसायिक रूप से नहीं होता और केवल कर्मकांडों के लिए किया जाता है। *सी. स्ट्रिक्टम* के यह दो पेड़ आसपास की परिस्थिति और वनस्पति में होनेवाले भारी परिवर्तन के बावजूद भी अबतक जीवित रहे है। अगर ऐसी ही स्थिति रही तो *सी. स्ट्रिक्टम* के इन अंतिम दो पेड़ को और अंततः पवित्र उपवन नष्ट होने की बड़ी जोखिम है। इस पवित्र परिदृश्य के संवर्धन के लिए समुदाय आधारित पारंपरिक पारिस्थितिक ज्ञान को आधुनिक वैज्ञानिक विधियों के साथ जोड़कर संवर्धन की नई संभावनाओं का उपयोग किया जाना चाहिए। पवित्र उपवनों और उनके आसपास के परिदृश्य की दीर्घकालिन आवर्ती देखरेख उनके शाश्वत अस्तित्व को सुनिश्चित करने के लिए आवश्यक है।

Editor: Anonymity requested. **Date of publication:** 26 February 2023 (online & print)

Citation: Mahabaleshwarkar, M., N. Ghayal, S. Mahabaleshwarkar & V. Ghate (2023). Multidimensional time-lapse of a relict species *Canarium strictum* Roxb. from a sacred landscape in Pune District, India. *Journal of Threatened Taxa* 15(2): 22718–22725. https://doi.org/10.11609/jott.8271.15.2.22718-22725

Funding: This research is part of self-funded doctoral research of Mukul Mahabaleshwarkar.

Competing interests: The authors declare no competing interests.

Author details & Author contributions: See end of this article.

Acknowledgements: Authors are thankful to villagers of Shirgaon and Abhepuri, Dr. Utkarsh Ghate, Dr. Ankur Patwardhan, Prof. Dr. P.B. Buchade, Forest Department (MS) Bhor Division for their support.

INTRODUCTION

In many parts of the world, belief in sacred nature underpins people's land and resource use whilst in pursuit of livelihoods; moreover, traditional cultural and spiritual values provide the context in which environmental stewardship can be nurtured (Robson & Berkes 2010). Nature conservation is an ancient tradition in India. One such significant tradition is of dedicating patches of forests to some deities as sacred groves (Gadgil & Vartak 1981). Similar to tradition of sacred landscapes and sacred forests, worshipping individual species of trees has also been an ancient tradition. The cult of tree worship depicting tree as a representative of gods on earth has its roots deep in the history of mankind (Sane & Ghate 2006). The traditional practice of conservation on religious basis along with commercial linkages at a local level is an interesting system from the point of view of its ecological, economical as well as institutional sustainability (Goturkar-Mahabaleshwarkar & Mahabaleshwarkar 2007).

Dhoop-rahat sacred grove situated in the Western Ghats region of Bhor Taluka in Pune District gets its name from the Sanskrit word 'Dhoop', which refers to offering of incense. Dhoop-rahat is possibly the only sacred grove dedicated to a religiously important species *Canarium strictum* Roxb. *Canarium strictum* is unevenly distributed in Western Ghats and southeastern Asia. It is an indigenous plant species of Eastern and Western Ghats of India (Meena et al. 2012) and is endemic to the western peninsula (Gadgil & Vartak 1976). It occurs as a canopy tree in the moist deciduous and evergreen forests. Information about its conservation status nationally or globally is lacking, though at the level of the region, *C. strictum* has been reported to be a species of conservation concern (Ravikumar & Ved 2000). In Maharashtra it shows a serious population bottleneck (Patwardhan & Vasudeva 2010). The geographical distribution of *C. strictum* in Maharashtra was wider in the past as compared to the present observations. The earlier reports show that the species was distributed in Konkan, hills of Pen, the then Pant Sachiv's country that included present talukas of Maval, Mulshi, Velhe, and Bhor (Dalzell & Gibson 1861) and Matheran (Cooke 1903). In Maharashtra, presently, the species has been recorded from Satara, Kolhapur, Pune and Raigad Districts (Singh & Karthikeyan 2000; Patwardhan & Vasudeva 2010) with Dhoop-rahat sacred grove being the northernmost known location of *C. strictum* in the northern Western Ghats (Kulkarni et al. 2014).

C. strictum has common names such as Black Dammar, Raal Dhoop, Black Dhoop, and Sambrani Dhoop. It is a representative of Burseraceae family, which is known as incense trees family. It exudes a resin called Sambrani or Dammar, which has medicinal and spiritual importance. It is harvested for resin by several indigenous communities in the Indian subcontinent (Varghese 2014). Dhoop has medicinal applications in tribal communities as well as in Siddha and Ayurvedic systems of medicine in treatment of respiratory ailments and rheumatism. Dhoop is also burnt for its insect repellent properties. The species also has commercial use in varnish (Langenheim 2003) and timber.

The only two individuals of *C. strictum* surviving in the Dhoop-rahat were reported first in early 1970s (Gadgil & Vartak 1976). Their unique presence is the only reason for survival of this sacred grove. This species has not shown regeneration in grove as well as in the region. Dhoop-rahat sacred grove, along with three other sacred groves, is part of sacred landscape formed near the origin of River Nira. Ownership and management of these sacred groves are in the hands of different agencies including local community and government departments. An ancient trade route, now a state highway, known as *Varandha Ghat*, connecting Bhor and Mahad in Raigad District of Konkan region, passes through this landscape. Until last decade, it was the only motorable and closest road connecting these two places. Development associated with this connectivity since historic times, influenced the surrounding landscape from time-to-time. Present study attempts to assess this sacred landscape with focus on the existence battle of Dhoop trees and eventually Dhoop-rahat in the backdrop of changes in the ecological, geographical, socio-cultural and economical dimensions associated with it, over time.

MATERIALS AND METHODS

The study area was surveyed for the following dimensions during years 2021 and 2022:

1. Ecological: Field visits were conducted for studying vegetation in the study area. GPS locations of the sacred groves and *C. strictum* trees were recorded using GPS, Garmin e-trex30. Observations on the regeneration of *C. strictum* were noted. Overall health and threatscape of the ecosystem were documented.

2. Geographical: Land ownership and landuse patterns in the sacred landscape and surrounding region were mapped using Google Earth images at different points of time. Geographical changes over the past 30 years were noted with the help of satellite images taken by Landsat

4, 5, 7, and 8. NDVI (Normalized Difference Vegetation Index) was calculated using QGIS software. It was used for calculation of vegetation health. Satellite images from month of March were used so as to avoid cloud cover.

3. Socio-cultural associations: Semi-structured interviews with the local community representatives including *Gurav* (local priest of the deities in the sacred grove) were conducted for understanding levels of awareness about *C. strictum*, occurrence of species in the nearby forests, traditional knowledge associated with the species, usage of the species in past and present and usage of extracted Dhoop in rituals of associated deities.

4. Economical: Survey was conducted in the nearby market places for commercial aspects of Dhoop and history of Dhoop trade in the region. Also, attempt was made to find out if there was any commercial reason for survival of these two individuals.

RESULTS

Geographical / Landscape Dimensions

The sacred landscape is located on the immediate eastern slopes of the Western Ghats, locally known as Rairi Hills. Sacred groves of Dhoop-rahat (18.092N & 73.635E), Janani (also known as Durgadevi) (18.093N & 73.628E) and Waghjai (18.105N & 73.655E) are situated near Bhor-Mahad road, which is part of an ancient trade route connecting historic coastal township of Choul with trade centre of Vijayapura (Karnataka) on Deccan. Sacred groves of Durgadevi and Dhoop-rahat are close to each other and are situated between villages Shirgaon and Abhepuri. As per revenue records of the lands these sacred groves are part of village Abhepuri. The eastern flowing River Nira originates from the first order streams in this landscape and makes its way ahead from Niramai Kund (sacred tank) (18.103N & 73.624E). The ownership and management pattern of this sacred landscape involves multiple stakeholders including a local temple trust, forest and irrigation departments of the government of Maharashtra, and local communities. The landscape is a mosaic of dense forest patches, waterbodies, grazing lands, agricultural fields, and occasional patches of shifting cultivation.

NDVI calculated over the past 30 years at the interval of 10 years from 1991 to 2021 indicates that the dense vegetation patches including reserve forests and sacred groves have remained intact. However, surrounding unprotected vegetation shows degradation as an effect of activities such as construction of dam and road widening during years 2001 and 2011. Slight increase in green cover as seen in NDVI of 2021 can be because of rise of water table due to dam backwaters. This does not represent any addition to the dense forest vegetation (Image 1).

Ecological Dimensions

Plant diversity observed in Dhoop-rahat and Durgadevi sacred groves comprises of 73 species of plants including 32 species of trees, 22 species of shrubs, and lianas and 19 species of herbs, climbers, and ferns. Durgabai sacred grove located at an aerial distance of 800 m and on foot distance of 1,200 m shows similar vegetation pattern except absence of *C. strictum* and presence of invasive plant species. From the vegetation survey at Dhoop-rahat, it was found that the forest is of moist deciduous and semi-evergreen type. The canopy species including old growth trees of *C. strictum*, *Terminalia bellirica, Schleichera oleosa*, and *Holigarna grahamii* form major canopy of the grove. Giant climbers such as *Gnetum ula, Dalbergia horrida, Entada rheedei*, and *Diploclisia glaucescens* were found in the grove. Epiphytic flora includes orchids such as *Eria dalzellii, Aerides maculosum*, and *Dendrobium barbatulum*. Seven endemic species including one IUCN Red List Vulnerable (VU) species (*Curcuma pseudomontana*) were documented from the study area. Invasive plant species were not observed. The forest is dense and forest floor shows deep leaf litter layer. Saplings of different plant species were seen. Seeds of *C. strictum* were found on the forest floor. However, its natural regeneration has not been observed so far. *Canarium strictum* is a canopy species and the two individuals are about 35 m in height and about 5 m in girth. The lowermost 3 m of the trunk shows uneven and globular structures called wood-knots.

Communities in this landscape are dependent on agriculture (mainly rice) for their livelihood and pastoralism for milk and meat requirements. Slash-and-burn shifting cultivation is practiced for cultivating millets like Nachani (Ragi) and Varai (Barnyard millet). As a traditional cultivation practice, the forest patch adjoining the Dhoop-rahat and a part of it were slashed and burned during the years 1985, 1995 and then in the year 2005 for cultivation of Ragi millet, whereas the Dhoop-rahat forest patch having *C. strictum* trees was kept untouched (Image 2). The patch used in the year 1995 was not repeated in the year 2005. In fact, the earlier used patch showed regeneration of forest in the fallow period. Major developments that impacted the landscape include construction of Nira-Deoghar dam and associated infrastructure during the years 1994–2000, widening of roads in the area during the years 2010–

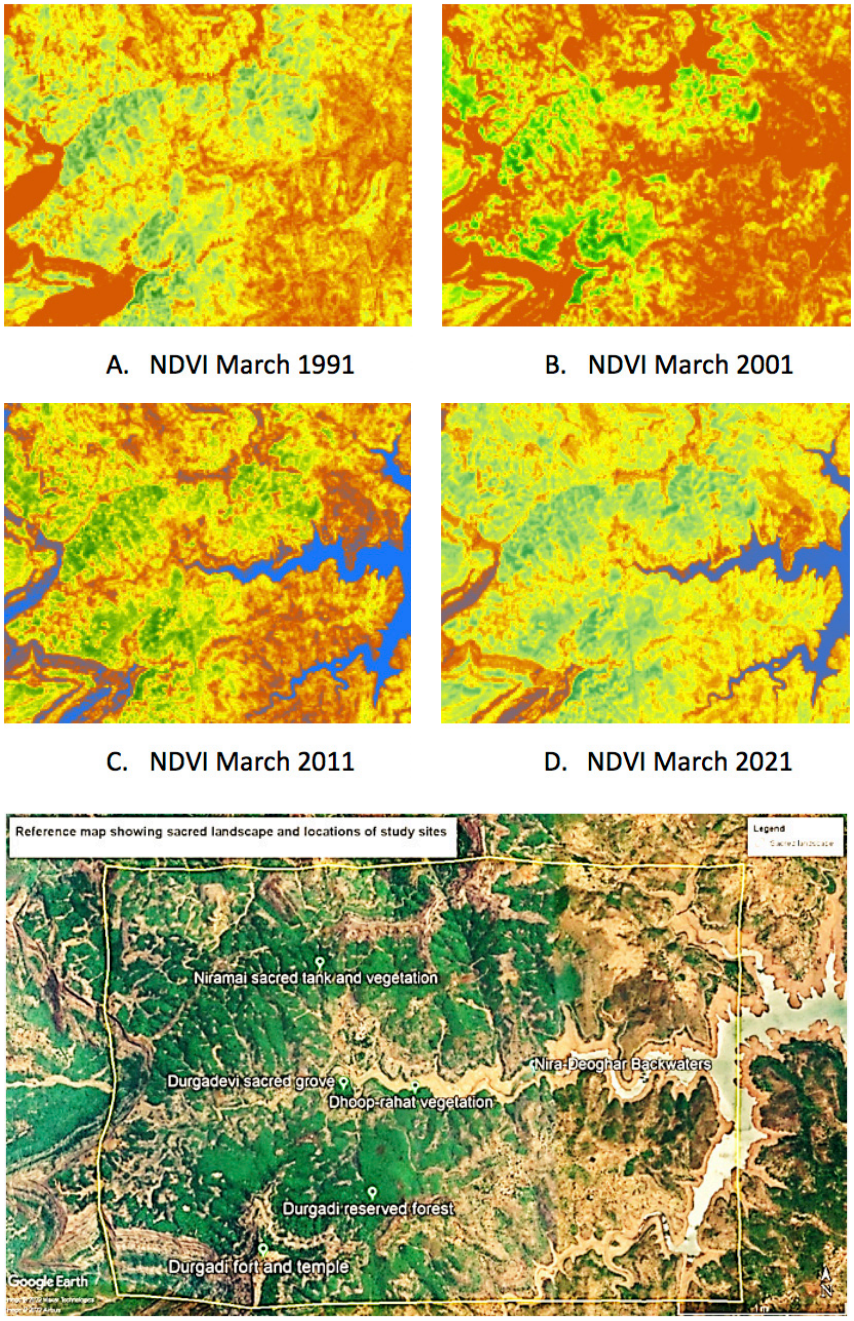

Image 1. Changes in vegetation pattern over time using satellite image processing.

2015 and changes in land ownership from local people to the non-native farmhouse owners.

Vegetation patches of both Dhoop-rahat and Durgadevi sacred groves have been partly lost due to submergence in the dam backwater. Durgadevi grove has been divided because of road passing through it. There is forest clearing at different locations for developmental reasons around this grove. During years 2020 to 2022, maximum number of landslides were observed in the landscape and surroundings (Image 3). Another road construction work on the other side of this grove has further fragmented the grove from surrounding vegetation. Invasive plant species such as *Lantana camara*, *Chromolaena odorata*, and *Cosmos sulphureus*, which were not present earlier, have started appearing along the road side at Durgadevi sacred grove.

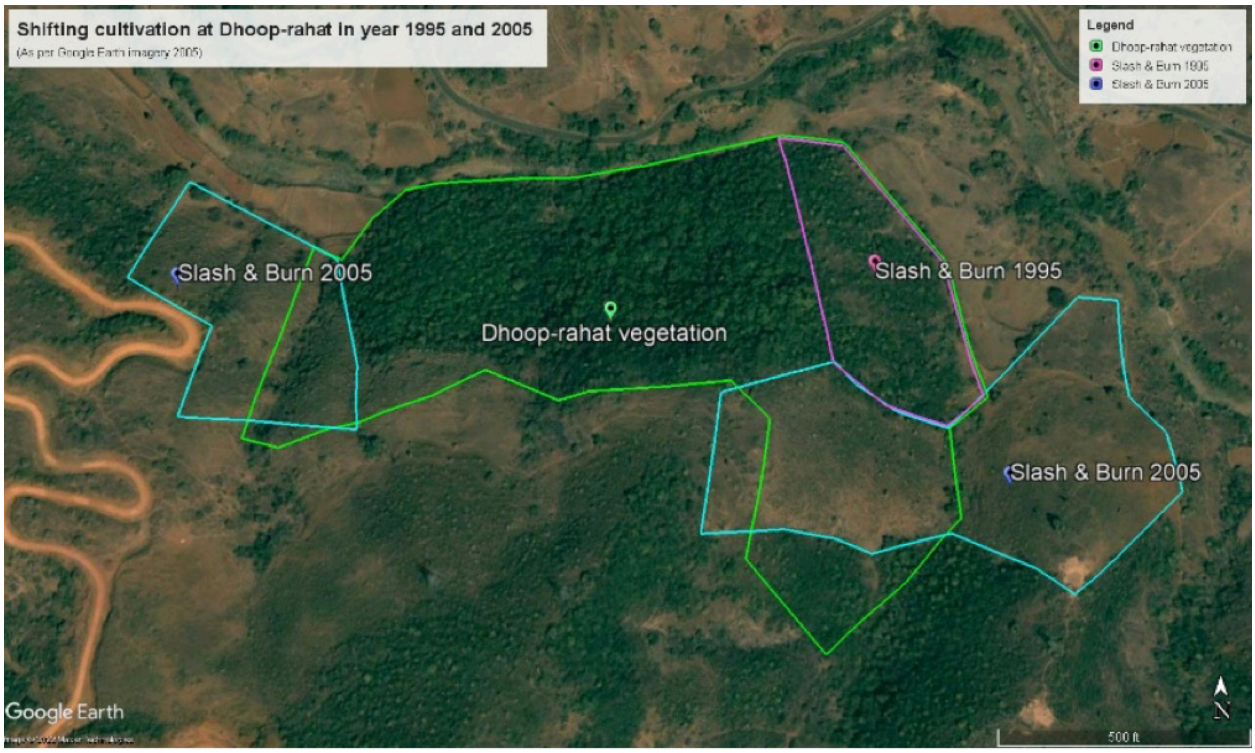

Image 2. Shifting cultivation patches around Dhoop-rahat during years 1995 and 2005.

Waghjai sacred grove in the interiors shows hardly any disturbance due to its inaccessible location.

Socio-cultural Dimension

Dhoop-rahat plays a complimentary role to the Durgadevi sacred grove. These groves in this landscape are not visited often by the local villagers and the forests are left undisturbed except for ritualistic purposes. In earlier times, feelings of fear and respect dominated the association of people with grove and deity. Over time and generations, dilution of such strong feelings has been observed. However, even in present times, during important lifecycle rituals, the deities in the grove are worshipped via simple rituals and are invited for placating and/or seeking blessings. Important decisions related to livelihood practices are taken by the local communities via a practice of 'koul' (Marathi: special permission of the deity) conducted by the Gurav in the grove.

The Dhoop is traditionally extracted from the Dhoop trees from this grove for an annual ritual during the Navaratri festival. The Dhoop-rahat is not dedicated to a particular anthropomorphic deity. The two *C. strictum* individuals in this grove are considered sacred (Image 4). The villagers believe that it is a formless deity and is referred to as 'Dhoopdev' / 'Guptdev' (invisible deity). Access to the Dhoop-rahat and rights of extraction of Dhoop are restricted and Gurav plays a role in decision making regarding the same. The resin is extracted either from natural oozing from fissures of the tree trunk or by making an incision to the tree trunk.

Economical Dimension

Indian black dammar is preferred among incense sticks manufacturers as it is of very good quality. The present market price of Dhoop is Rs. 300 to Rs. 600 per kilogram based on the source and purity. Dhoop from this area used to be extracted in earlier times for commercial purposes. The local markets sold the locally harvested Dhoop in the past. Since the early 1980s extraction of Dhoop from the Dhoop-rahat was stopped for commercial purposes. Restricted extraction is allowed for ritualistic purposes of Durgadevi sacred grove.

DISCUSSION

Certain forest-dwelling communities, often made up of tribal people, offer myriad insights into ways to make sustainable use of forest plants and animals for food and other purposes (Myers 1990). Association of sacredness and sustainable harvesting of Dhoop has resulted in community protection to the rare *C. strictum* individuals and the surrounding vegetation. Earlier records indicate that this species was probably distributed once

Image 3. Landslide observed in the vicinity of Durgadevi sacred grove during 2021.

throughout Western Ghats, but due to developmental activities it now survives only in this particular grove in Pune District. The geographical location of the present study area in the global biodiversity hotspot of Western Ghats makes it a critically important landscape in terms of conservation of biodiversity. Proximity to the ancient trade route also makes it a historically important site. These sacred groves harbour climax vegetation and are home to important endemic and globally and locally rare and vulnerable species of plants and animals. This highlights the significance of groves being vital for conservation and sustenance of biodiversity (Kulkarni et al 2018). Sacred groves are also important for their ecological functions and values. Around the origin of each river in the Indian subcontinent, there is a sacred grove of a small or large dimension (Paranjpye & Paranjpye 1998). Sacred groves in the region protect the headwaters thus safeguarding the origin of river Nira. Many sacred groves are located along the ancient trade routes (active from BCE to 16th CE) through deep forests (Burman 1997). These groves provided shelter and protection to the traders. The offerings they made to the reigning deities of the groves were shared by the villagers (Burman 1997) ensuring safe travel and transport of goods. Proximity to the trade route (possibly overlapping with the ancient incense trade route) of the present landscape had enabled sale of Dhoop extracted from the region. As per interviews with the local knowledgeable individuals and sellers of Dhoop in local markets, locally extracted Dhoop was available for sale in nearby market areas, probably till the time when *C. strictum* trees were abundant in the surrounding landscape. The vegetation community could have been different during that time. An unprecedented pace of development on the northern Western Ghats occurred during the British period due to major interventions like construction of railways, roads,

Image 4. *Canarium strictum* from the sacred grove.

and dams (Gadgil 2011). During the 1940s to 1960s, many forest patches in this region were chopped down for the purpose of coal and timber, resulting in changes in vegetation type and size of the sacred groves. Sacred association of *C. strictum* individuals in Dhoop-rahat could be the reason for their survival, thus making *C. strictum* a relict species in northern Western Ghats region. Ecological surveys conducted in southern India have revealed decreased sizes of *C. strictum* populations, which could lead to still smaller populations over the long term (Meena et al. 2012). Also, seedling fitness decreases as the grove area reduces due to inbreeding among the fewer individuals and accumulation of lethal characters in the smaller groves (Tambat et al. 2005). Occurrence of *C. strictum* seedlings is of prime importance because this tree is very rare in Western Ghats of Maharashtra (Kulkarni & Nipunage 2009). In the present case study seeds of *C. strictum* were observed on forest floor,

however successful regeneration was not observed. Fruits and seeds of *C. strictum* are edible; so monkeys, civets, rodents, and birds like hornbills relish the same. Studies on traditional ecological knowledge of resin harvesters from southern India indicate that regeneration occurs when fruits are eaten and dispersed by giant squirrel, flying squirrel, and civets (Varghese 2014). Population loss of agents of seed dispersal like giant squirrel and flying squirrel due to loss of large canopies, habitat fragmentation, loss of corridors and feeding by langurs could be one of the reasons for unsuccessful regeneration of *C. strictum* in this region. Habitat fragmentation due to increased forest fires, clear-felling for shifting cultivation, construction of private resorts has totally degraded the habitat of seed dispersers like giant squirrels in this region and their populations have drastically reduced (Mehta 2012). The landuse changes in the study area includes increased area under agriculture, shifting cultivation, and watershed. Thus, seed predating rodents like field rats are also negatively impacting regeneration. Further studies in this area can throw light on the ways to encourage natural regeneration of *C. strictum* in northern Western Ghats. Attempts have been made for germination of *C. strictum* using nursery techniques and its reintroduction in wild in other areas of northern Western Ghats. Similar efforts in the study area with the help of local community may help in conservation of the species (Patwardhan & Vasudeva 2010). For successful regeneration of certain species, whether natural or artificial, it requires a number of key parameters to function in synergy so as to form a conducive environment.

The shifting cultivation patches during the fallow period showed regeneration of species like *Strobilanthes callosa*, *Syzygium cumini*, *Memecylon umbellatum*, *Leea indica*, *Carissa carandas*, and *Terminalia* spp. Presence of sun-loving species in the upper, middle, and lower storey of sacred groves in this region indicate large scale felling in the past, recent past, and present period, respectively (Ghate 1994). Clear-felling of part of Dhoop-rahat and surrounding area, in the past, has brought about changes in the vegetation community from evergreen to moist deciduous. The two individuals of *C. strictum* have endured the drastic changes in the surrounding vegetation. In the business-as-usual scenario, there is a high risk of losing the last two individuals of *C. strictum* in the region and eventually the grove itself. The way in which traditional societies perceive and modify the landscape and biodiversity around them, both in space and time to ensure ecosystem stability and resilience, is significant for landuse management (Ramakrishnan 2009). Shifting cultivation using slash-and-burn is one such traditional practice in the study area, which alters the ecosystems at landscape level. Earlier, these alterations were part of a resilient ecosystem. However, on the background of increased developmental pressures and with increased demand of agricultural resources from the growing human population such practice may contribute to threats. Ecological studies indicate forest degradation of overall landscape with original dense climax vegetation surviving in pockets of sacred groves. Association and inter-dependence of the two groves of Durgadevi and Dhoop-rahat by *C. strictum* use for ritualistic purposes indicates the role of culture in connecting and protecting these forest patches. Dhoop harvesting technique, via incisions, used presently is a sustainable method compared to scorching in the past. Ownership and management of Durgadevi sacred grove and Dhoop-rahat involve multiple stakeholders. Diverse landuse types coupled with multiple owners / managers make it a complex system, when it comes to decision making. Biodiversity as well as cultural values of a site and the communities which hold them are dynamic and evolving over generations (Watve & Chavan 2020). The community has taken cognizance of the threat to the *C. strictum* individuals by putting a stop to commercial harvesting of Dhoop. This indicates application of traditional knowledge system along with possible role of environmental awareness in recent times.

So far, community managed sacred groves have been conserved through their vigilance and efforts. However, community aspirations, changing belief systems and developmental pressures are challenging the very existence of these groves. Sacred groves, thus need multidimensional and integrated conservation and management strategies that will be able to appreciate and consider their complexity through systems approach (Mahabaleshwarkar & Ghayal 2020).

RECOMMENDATIONS

Detailed documentation of existing conservation initiatives via traditional practices and monitoring impact of development can be the first step towards conservation of this important landscape. GIS and remote sensing tools can prove useful for documenting and monitoring long term changes in the vegetation health and landuse patterns in the landscape. Further research on harvesting of Dhoop and regeneration of *C. strictum* are needed to ensure sustainability of harvesting practices. For conservation of the rare species *C. strictum*, efforts towards seedling collection from wild, germination and

nurturing saplings can be carried out with community for creating village-level nurseries. Reintroduction of these saplings in the forest and monitoring their growth can help in revival of this species. Conservation of *C. strictum* species and associated cultural aspects are linked to the conservation of the surrounding landscape elements. Formation of a village-level Biodiversity Monitoring Committee can support long term monitoring of vegetation health of the forest. It will also help create and implement local level guidelines for conservation of these sacred groves. A deeper understanding of this link between the conservation of the species and associated historical, geographical, ecological, economic and cultural fabric of the area can open up newer possibilities of conservation by combining traditional ecological knowledge with modern day scientific methods.

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Author details: Mukul Mahabaleshwarkar (M.Sc., MBA): executive committee member, INTACH Pune Chapter and doctoral fellow at MES Abasaheb Garware College, Pune. Working in the field of environmental research, natural heritage, conservation strategy and policy, farming and sustainability with an interdisciplinary approach. He has authored and contributed to a number of scientific and popular articles in reputed media.

Prof. Dr. Nivedita Ghayal: professor, Department of Botany, MES Abasaheb Garware College Pune. She has academic experience of 32 years and research experience of 20 years. She has published 35 research papers and two book chapters. With her research area as plant physiology, biochemistry, allelopathy and ecology, she is guiding PhD fellows (Environmental Science) of Savitribai Phule Pune University.

Supriya Mahabaleshwarkar: With a master's degree in biodiversity; she is working with INTACH for the last 17 years and is presently Co-convenor, INTACH Pune Chapter. She is working on documentation and conservation of sacred groves, associated natural and cultural heritage. She designs, curates and conducts heritage and environment awareness programs.

Dr. Vinaya Ghate: retired as scientist E and in-charge, Botany Group of Plant Science Division, Agharkar Research Institute, Pune. Floristics, taxonomy, ethnobotany, especially medicinal plants and biodiversity conservation are the areas of her lifelong research interest and passion. She has successfully completed more than 20 in-house research projects in concerned areas and published over 90 research papers.

Author contributions: MM—Conceptualization, research design, background research, field data collection, GIS mapping and analysis, manuscript design and writing. NG—Review and research insights, manuscript checking. SM—Background research, interviews, field data collection, writing and analysis. VG—Past field observation and notes, manuscript checking.

Journal of Threatened Taxa is indexed/abstracted in Bibliography of Systematic Mycology, Biological Abstracts, BIOSIS Previews, CAB Abstracts, EBSCO, Google Scholar, Index Copernicus, Index Fungorum, JournalSeek, National Academy of Agricultural Sciences, NewJour, OCLC WorldCat, SCOPUS, Stanford University Libraries, Virtual Library of Biology, Zoological Records.

NAAS rating (India) 5.64

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Journal of Threatened Taxa

www.threatenedtaxa.org

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

February 2023 | Vol. 15 | No. 2 | Pages: 22559–22770
Date of Publication: 26 February 2023 (Online & Print)
DOI: 10.11609/jott.2023.15.2.22559-22770

Publisher & Host

WILD ZOOREACH
Threatened Taxa