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Comparing the vegetation diversity in Sacred Groves and agroforestry plots around them, a case study in the Konkan Region of Maharashtra

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Abstract
The role of sacred groves in conserving biodiversity and providing other ecological services like water conservation and carbon sequestration is well known. Areas in the Konkan regions have rich sacred groves with conventional agroforestry plots in their vicinity, which together act as a crucial support for smaller mammals and birds. The conventional agroforestry plots with indigenous species can act as a buffer and connection of Sacred Groves. The current study compares tree diversity in two sacred groves from Ratnagiri District of Maharashtra and agroforestry plots around them.

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Introduction
India is one of the countries rich in biodiversity. Its biogeographic zones encompass a diverse range of habitats, which harbour a tremendous diversity of plants, animals, and microbes. Along with this, India also has a great diversity in cultures. A majority of India's population is engaged in nature-based livelihoods, with agriculture and animal husbandry being the primary occupations. Due to this dependence on nature, the cultures in various parts of India exhibit their profound connection with nature, both spiritually, emotionally, and economically. Sacred Groves that are spread all over the country are an excellent example of this connection. They are found in most of the Indian States. As per an estimation of Malhotra et al (2001) and IUCN, there may be around 1,00,000-1,50,000 sacred groves all over the country. Mundlye (2002) recorded around 3678 Sacred Groves from various parts of Maharashtra. According to Kosambi (1962), some sacred groves may date back to pre-agrarian times. These are the areas where human interference in the natural ecosystem is restricted. Except for the rituals or the extraction of Non-timber forest produce only up to some extent, the human interference in these forests is not allowed, a rule which is set not by any government law, but by the local communities for decades and centuries in some places. As the sacred groves have been protected by the communities for generations, they are known for the biodiversity they harbour.

As the transformation of hunter-gatherer communities into agrarian communities began around 10,000 years ago, biodiversity compositions began to change, and the forest maps started to alter. The landmass that was later to be known as India was also undergoing these changes. However, the stretches of forests protected by communities remained undisturbed and harboured the species that were disappearing from surrounding areas. Hence, the sacred groves show the relic flora of that area. A vegetation in the climax stage is typically observed in Sacred Groves (Gadgil and Vartak, 1976). These are rich habitats preserving medicinal, rare and endemic plants (Chandran et al, 1998).

Western Ghats, along with being one of the global biodiversity hotspots, show a great variety of cultures. A common component of all these cultures and communities is their nature-based lifestyle. Tribal and non-tribal communities both show their connections with nature in their day-to-day lives and also with their traditions and religious practices. Sacred grove is a very important component in these cultures.

Konkan region of Maharashtra consists of districts like Mumbai Suburban, Mumbai Metropolitan, Palghar, Raigad, Ratnagiri, Sindhudurg and Thane. Among these, Raigad, Ratnagiri and Sindhudurg have a large number of Sacred Groves. These districts are composed mainly of the agroforestry lands. Crops like rice, pulses, millets and vegetables are grown, but the fruit crops dominate the agriculture in these districts. High rainfall, lateritic soils support the fruit crops like mango, cashew, coconut, betel nut and jackfruits. While some private forests are also seen with good biodiversity, the transformation of these forests into commercial fruit cultivation is also happening rapidly. The sacred groves in these districts are also under pressure from development and encroachment.

With the changing socioeconomic conditions as well as land-use systems, many sacred groves are now threatened and altered in terms of size, vegetation structure and species composition. (Chandrashekara& Sankar, 1998). Cultural changes and the pressure for the extraction of natural resources are causing the disappearance of the sacred groves from various parts of India. The spiritual values and belief systems, which protected the sacred groves for generations, are now changing in the age of rapid urbanisation. As urbanisation

is reaching the villages faster, it is also altering the belief systems that were at the base of the tradition of Sacred Groves. It is hence necessary to see how the sacred groves are changing. Regular surveys to assess the biodiversity of flora and fauna are required. Along with this, recording the changes in the floristic composition of the areas around them is needed to analyse if the changes in the ecosystems around are affecting the plant assemblages in the sacred grove.

With this background, the current study was conducted to assess the plant diversity of the trees and the understorey vegetation in a sacred grove and agroforestry plots around it.

Materials and Methods

Study site: Two Sacred groves from the Guhagar Taluka of Ratnagiri District were selected for the current study.

1. **Varveli Sacred Grove:** The sacred grove is spread over an area of around 1 hectare. The village Varveli is at a distance of around 8 kms from the Block village of Guhagar. A considerable area inside the sacred grove has been cleared off for the temple. The Sacred Grove is surrounded by the fruit orchards.
2. **Chikhli Sacred Grove:** This forest is around 18 kms away from the block place of Guhagar. The forest over an area of 4.4 Ha is dedicated to the feminine deity Vyaghrambari and other village deities. Temple, cremation areas and tombs are present inside the forest. A narrow road passes through the forest, which connects the village with the main road connecting to the block place.

Data collection: The sacred groves were surveyed to collect the qualitative data of trees. Similarly, the agroforestry lands around these sacred groves were also surveyed to collect the quantitative data of trees.

Data analysis: The lists of trees from both the sacred groves and from the agroforestry plots were compared using Jaccard's similarity test.

Results and Discussion

54 species of trees were recorded in the study. 19 species of trees were recorded from the Sacred Grove of Varveli, 25 species from the Sacred Grove of Chikhli. In the agroforestry plots surrounding the Sacred Groves, 27 species of trees were recorded.

Table 1 gives lists of Trees recorded from both the Sacred Groves and Agroforestry plots around them.

Species	Varveli Sacred Grove	Chikhli Sacred Grove	Agroforestry Plots Varveli	AgroforestryPlots Chikhli
Acacia auriculiformis	-----	-----	✓	✓
Albizia procera	✓	✓	-----	-----
Alstonia scholaris	-----	✓	-----	-----
Anacardium occidentale	-----	✓	✓	✓
Aporosa lindleyana	✓	✓	-----	-----
Areca catechu	-----	-----	✓	✓
Artocarpus heterophyllus	-----	✓	✓	✓
Bombax ceiba	✓	-----	-----	-----
Bridelia retusa	-----	✓	✓	✓
Careya arborea	-----	✓	-----	-----
Caryota urens	✓	✓	✓	✓
Cassia fistula	-----	✓	-----	-----
Cassia siamea	✓	-----	-----	-----
Catuneragum spinosa	-----	✓	-----	-----
Celtis timorensis	-----	✓	-----	-----
Cocos nucifera	-----	-----	✓	✓
Ficus tinctoria	-----	✓	-----	-----
Flacourtia montana	✓	-----	-----	-----
Garcinia indica	-----	✓	✓	✓
Gardenia jasminoides	-----	-----	✓	✓
Gliricidia sepium	-----	-----	✓	-----
Gmelina arborea	-----	-----	✓	✓

Species	Varveli Sacred Grove	Chikhli Sacred Grove	Agroforestry Plots Varveli	AgroforestryPlots Chikhli
Grewia tiliifolia	✓	-----	✓	✓
Haldina cordifolia	-----	-----	-----	✓
Holarrhena antidysenterica	-----	✓	-----	-----
Holigarna grahmii	-----	✓	-----	-----
Holoptelea integrifolia	-----	-----	✓	-----
Ixora brachiate	✓	✓	-----	-----
Lagerstroemia macrocarpa	-----	✓	-----	-----
Lagerstroemia microcarpa	-----	-----	✓	✓
Lannea coromandelica	✓	-----	-----	-----
Mammea suriga	✓	✓	-----	-----
Mangifera indica	✓	-----	✓	✓
Manilkara zapota	-----	-----	✓	✓
Michelia champaka	-----	-----	✓	✓
Mitragyna parviflora	✓	✓	-----	-----
Olea dioica	✓	✓	-----	-----
Phyllanthus emblica	-----	-----	✓	✓
Pongamia pinnata	-----	-----	✓	✓
Psidium guajava	-----	-----	✓	✓
Spondias pinnata	-----	✓	-----	-----
Sterculia guttata	✓	✓	-----	-----
Sterculia villosa	✓	-----	-----	-----
Syzygium cumini	✓	-----	✓	✓
Syzygium jambos	-----	-----	✓	✓
Tabernaemontala alternifolia	-----	✓	-----	-----
Tamarindus indica	-----	-----	-----	✓
Tectona grandis	-----	-----	✓	✓
Terminalia bellirica	✓	✓	-----	-----
Terminalia chebula	✓	-----	-----	-----
Terminalia tomentosa	-----	-----	✓	✓
Thespesia populnea	-----	-----	✓	✓
Xantolis tomentosa	✓	✓	-----	-----
Zanthoxylum rhetsa	-----	✓	-----	-----

Table 1: Trees Present in Sacred Groves and Agroforestry Plots Around Them

Trees that were present in agroforestry plots and absent in Sacred Groves: Acacia auriculiformis, Areca catechu, Cocos nucifera, Gardenia jasminoides, Gliricidia sepium, Gmelina arborea, Haldina cordifolia, Holoptelea integrifolia, Lagerstroemia macrocarpa, Manilkara zapota, Michelia champaca, Phyllanthus emblica, Pongamia pinnata, Psidium guajava, Syzygium jambos, Tectona grandis, Terminalia tomentosa, Thespesia populnea (18)

Trees that were present in Sacred Groves and absent in agroforestry plots:
Albizia procera, Alstonia scholaris, Aporosa lindleyana, Careya arborea, Cassia fistula, Catunaregam spinosa, Celtis timorensis, Ficus tinctoria, Holarrhena antidysenterica, Holigarna grahamii, Ixora brachiata, Lagerstroemia macrocarpa, Mammea suriga, Mitragyna parviflora, Olea dioica, Spondias pinnata, Sterculia guttata, Tabernaemontana alternifolia, Terminalia bellirica, Xantolis tomentosa,

Zanthoxylum rhetsa (27)

Trees that were common in Sacred Groves and agroforestry plots:
Caryota urens, Grewia tiliifolia, Mangifera indica, Syzygium cumini, Anacardium occidentale, Artocarpus heterophyllus, Bridelia retusa, Garcinia indica.

Jaccard's similarity index for the similarity between the sacred groves and agroforestry plots.

Table 2 shows the similarity percentage between the tree diversity of sacred groves and the agroforestry plots.

Varveli and Chikhli Sacred Grove	29%
Varveli Sacred Grove and Agroforestry Plot	10%
Chikhli Sacred Grove and Agroforestry Plot	11%
Varveli and Chikhli Agroforestry Plots	85%

Table 2: Similarity percentage between the tree diversity of Sacred Groves and Agroforestry plots

The Similarity percentage was high between the agroforestry plots around the two sacred groves. The agroforestry plots were mainly composed of commercial plantations of fruit trees and some wild plants. Plantation was dominant.

Both the Sacred Groves showed a low similarity percentage with the agroforestry plots around them. The Common trees in sacred groves and agroforestry plots were indigenous species and not the exotic species like Acacia auriculiformis and Gliricidia sepium, which were recorded in the agroforestry plots.

Species endemic to the Western Ghats:
The trees that were recorded only in the sacred groves and not in the agroforestry plots included some trees endemic to the Western Ghats.

Holigarna grahamii, Olea dioica (regional endemism), Ixora brachiata, and Flacourtia montana were the endemic plants found in the Sacred Groves. *Mammea suriga* was found to be abundant in Chikhli Sacred Grove. The occurrence of this tree in private lands has become very rare in the villages where the sacred groves in the current study are situated. Consistent deforestation to grow orchards, to sell the wood, causes the relic flora of the habitats to be replaced by the secondary species. The diversity then thrives in small patches of sacred forests protected by the community in the name of deities. The presence of species like *Mammea suriga*, *Ixora brachiata* in the region of sacred forests is a very good example of it.

In the studies done by Patil et al (2018), in Dapoli Tahsil of Ratnagiri, Sathish et al (2020) in Sacred forests of Karnataka, it was observed that the species was mainly located in the area of sacred groves and was not recorded from the areas around it. Similar observations have been recorded about *Ixora brachiata.*

The agroforestry plots showed how the natural vegetation was transformed when the relic flora was replaced by commercial plantations. The agroforestry plots did not show only the cash crops like Mango, Cashew, Betel nut and Coconut, but they also showed species that are not commercially important. It should be noted that the traditional home gardens, or as they are called 'Bagayati' or 'Wadi' in Marathi, consist of a great variety of plants that provide timber, medicines, flowers, fruits and cash crops. This provided the faunal elements like birds, smaller mammals the shelter, food, and they sustained in their niche. Even in the modern era, this same composition is observed. When such plots with indigenous trees are present near the Sacred Groves, they provide a natural buffer, which does not allow the entry of exotic and invasive species. Sacred Groves are best protected when they are outside the village and away from human activities. But when compared with developmental activities like roads, the buffer provided by the traditional agroforestry plots is better. These plots, when they are close to the sacred groves, also provide safe passages to smaller mammals like Civets, Mongoose, Pangolins, Porcupines, and many birds. However, any kind of encroachment on the sacred grove lands should not be permitted. This affects the relic flora of the sacred groves and it may result in changes in species composition.

The current study should be repeated at regular intervals of one year or six months to monitor any changes in the diversity. The agroforestry plots showed the presence of exotic trees like Gliricidia sepium and Acacia auriculiformis, which have been known to become invasive.

Conclusion

The study revealed the presence of endemic trees in the sacred groves and the presence of trees specific to both the sacred groves and the agroforestry plots. The presence of exotic and invasive species is alarming and needs attention. This study is replicable in all areas with small and large sacred groves, and also for their understorey vegetation. This will help create a picture of the floristic composition

and in recording the alterations in the species composition, which will be useful in determining the actions for the management of the sacred groves.

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