



Niche model based conservation and ecorestoration area prediction of threatened *Prioria pinnata* (Fabaceae) and conservation implication on IUCN status

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Abstract

Prioria pinnata (Roxb. ex DC.) Breteler, a threatened endemic canopy tree in the Western Ghats-Sri Lanka biodiversity hotspot, which is threatened by habitat loss and low density. Bioclimatic modelling predicts 2999km² of potential habitat across nine ecoregions, but 2452km² is converted for agriculture, making it unsuitable for niche-specific species restoration. Combining Grinnellian and Eltonian niche factors enhances model accuracy and predictions using a modified Niche modelling coupled with community composition. The study adds more information to the IUCN Red List assessment, expanding the Extent of Occurrence and Area of Occupancy. The species' status has been upgraded from Endangered to Vulnerable due to recovery and increased awareness. A niche profile-based management plan and seedling reintroduction are recommended for this threatened endemic canopy tree.

Introduction

Prioria pinnata (Roxb. ex DC.) Breteler is a large evergreen tree of the low-elevation tropical evergreen forest endemic to the Western Ghats region of southern India. It is a Leguminous tree that grows up to 30m high, with characteristic imparipinnate leaves with abruptly acute to acuminate leaflets, panicle racemose inflorescence, oil exudation from the stem, and rigid, obtusely beaked dark brown pendulous pods (Fig. 1). The species was first reported by Roxburgh [1] as *Hardwickia pinnata* Roxb. ex DC and the taxon has been treated with another name, *Kingiodendron pinnatum* (Roxb. ex DC.) Harms, until recently, even though Breteler had renamed it *Prioria pinnata* (Roxb. ex DC.) Breteler in 1999. The nomenclature uncertainty is scrutinised here with a critical review of all the taxonomic records and preserved specimens.

The species is locally known as Kulavu, and the indigenous Kadar community mentions the tree as Ennappayin," indicating the traditional oil extraction practise from the tree [2]. The IUCN assessed the species as Endangered (EN) based on criteria A1c and A1d [3], indicating degradation in habitat quality and overexploitation for the traditional oil extraction practise. A detailed population study was conducted on the species from the 2019–2021 period [2], which is updated and used here for a detailed understanding of the population structure, associations, and population dynamics. The Area of Occupancy (AOO) and Extent of Occurrence (EOO) based on the distribution records were not used in the previous red list assessment [3]. An attempt for multiple criteria-based assessment using IUCN guidelines (Version 3.1) was conducted [2] and is being published on the IUCN red list.

The important inferences from the IUCN reassessment and the population data used in this paper provide a detailed understanding of population dynamics and the conservation implications of this threatened tree. The potential habitats of *Prioria pinnata* in its whole distribution range are predicted; the ecoregion-level priority site and its extant habitats are enumerated here for site-specific conservation and ecorestoration planning. Based on IUCN criteria and standards, this study critically analyses endangerment grounds using updated, extensively examined distribution records, estimated AOO and EOO, and population statistics. Ex situ and in situ conservation efforts on the species [4], local community awareness and withdrawal from traditional oil extraction practices, and better seed germination and seedling production [2] are critically examined as the taxon's conservation implications.

In the current era of climate change and ecosystem-based approaches (EbA) requiring niche uniqueness and ecosystem resilience, such conservation practices without ecological integrity are questionable. Traditional bulk multiplication or monoculture plantation disturbs or invades other species' niches, causing ecosystem imbalance. Black wattles (*Acacia mearnsii*) in the Western Ghats and *Senna spectabilis* in Wayanad, part of the Nilgiri Biosphere Reserve, are examples of such interventions. The SER and IUCN produced various studies to standardise ecological restoration ideas and methods [5]. Also consider how mass proliferation and widespread planting of any species affects niches and ecosystems.

Among the various species distribution modelling techniques, MaxEnt based modelling is considered a better platform than traditional regression models [6,7,8,9,10]. Therefore, MaxEnt based modelling is now broadly used to forecast possible habitats for the species [11]. This approach significantly contributes to several studies, especially those on species invasion [12,13,14,15,16,17]. There are some studies based on habitat prediction using niche modelling in the Indian context [18,19,20,21,22] but those focused on endemic and threatened tree species are limited [[23], [24], [25],26,27,28,29,30].

Computational techniques and modelling are important to address the enormous variety and complexity of nature, which define the habitat of a species, the ecosystems it represents, and its dynamics over time. The Ecological niche modelling technique was criticised for its limitation to bioclimatic variables, which define more of the factors of the Grinnellian niche [31,32,33]. Consideration of factors like species associates, altitude, terrain features, and land use can help increase the prediction accuracy while contributing Eltonian niche factors [26]. This is also suggested for the regional niche model [34]. Standardisation of data sets for regional areas, especially landscape units and biodiversity hotspots, can have greater importance in the conservation of threatened tree species.

Here, the distribution records were used to predict potential habitats using Maximum Entropy based model such as MaxEnt, utilising the bioclimatic variables provided in the World Clim database [35]. A modified niche modelling standardised for the Western Ghats region [36,26] incorporating other variables for fine-tuning the prediction is employed here to address certain limitations of ecological niche modelling.

No site-specific species conservation and restoration plan exists. Traditional mass propagation and wide planting strategies are used for restoration without addressing species niche specialisation. Here we predicted regions with maximum niche appropriateness in their distribution range using modified niche modelling. Which is again divided into potential habitats that need protection, ecological restoration zones, and places permanently lost to large-scale alteration. This is tailored as a model to each landscape and ecoregion to create niche-specific and location-specific threatened tree conservation plans.

Section snippets

Taxonomic scrutiny and distribution

Detailed taxonomic scrutiny was done to understand the nomenclature issues and actual distribution pattern of the species based on preserved herbarium specimens. The type specimen was obtained from the Kew virtual herbarium [1]. The important collections based on various records were verified, and the voucher specimens were examined at the herbariums of CALI, JNTBGRI, KFRI, BSI, and virtual herbariums. The taxonomic records were reviewed from the Biodiversity Heritage Library (BHL) and the...

Nomenclature history and identity

Prioria pinnata (Roxb. ex DC.) Breteler was first described as *Hardwickia pinnata* Roxb. ex DC. in the Prodrromus Systematis Naturalis Regni Vegetabilis (DC.) based on a Roxburgh specimen (5807). Robert Wight and Arnott [46] reported the taxon in the Prodrromus Florae Peninsulae Indiae Orientalis and also Beddome [47] in 'The Flora Sylvatica for Southern India'. The Flora of British India [48] mentions this species. Harms, in 1897 renamed the taxon *Kingiodendron pinnatum* (Roxb. ex DC.) Harms in...

Discussion

The bioclimatic modelling of *Prioria pinnata* shows a maximum prediction of 2999km² across nine ecoregions in the Western Ghats. Incorporating terrain features and vegetation layers resulted in a modified niche model with 546km² of potential habitat. The Coorg (301 km²), Anamalai (106 km²), Chikmagalur (71 km²), and Nilgiris South-Palghat Hills (24.2 km²) are the major ecoregions with potential habitats for *Prioria pinnata* (Table 2). The entire predicted area in the Periyar ecoregion (47 km²)...

Conclusion

Prioria pinnata (Roxb. ex DC.) Breteler is a threatened endemic canopy tree in the tropical low-elevation evergreen forest of the Western Ghats-Sri Lanka biodiversity hotspot. It is characterized by low density and abundance due to habitat loss, with a low frequency of 7.6%. The species' habitats are limited to areas between 130 and 950m elevation. The bioclimatic modelling of *Prioria pinnata* predicts 2999km² of potential habitat across nine Western Ghats ecoregions. Modified niche models...

Funding

The work regarding this species was supported by Prakriti Research Fellowship provided by CARPE. Support from Rufford Foundation was also useful during the research....

Credit authorship contribution statement

M.A. Devika: Conceptualization, Methodology, Writing.

K.H. Amitha Bachan: Conceptualization, Writing, Review & Editing....

Declaration of Competing Interest

We declare, there is no competing interests for this study or data....

Acknowledgements

The authors are grateful to Western Ghats Hornbill Foundation and MES Asmabi College, P. Vemballur for the support. We owe our sincere thanks to IUCN Red List team. Authors also shares a gratitude towards Rufford Small Grants, Prakriti Research Fellowship and CARPE for the supporting the field work. Special thanks to Kerala Forest Department for the permission to do the field work....

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