Ecological Niche Modelling for Assessing Habitat Suitability of *Aeridesodorata* in India

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Abstract

***Aerides odorata* (Orchidaceae), an economically important species, is distributed in Bhutan, Nepal, Bangladesh and India. The highly perfumed flowers from *Aerides odorata* form a dense hanging group variable in colour. Though an official IUCN assessment for *Aerides odorata* is unavailable, but the reports categorize the plant as threatened (Natta *et al*., 2021). The natural population of the species faces a significant threat due to human activities, thereby impacting its natural regeneration process. Therefore, the present study was carried out to predict the current suitable distribution of *Aerides odorata* in India using Maxent species distribution model. Output of maxent model reveal that the suitable habitat for distribution is Andhra Pradesh, Karnataka, West Bengal & Odisha. Annual Precipitation & Temperature Annual range were the strongest predictors for the distribution of *Aerides odorata*with 37.8% & 17.2% respectively.**

Key words: *Aerides odorata*, Maxent, Annual Precipitation

Introduction

Aerides odorata (Orchidaceae) is distributed in Bhutan, Nepal, Bangladesh and India (Manipur, Uttarakhand, West Bengal's Darjeeling Himalayas, and Arunachal Pradesh). The highly perfumed flowers from *Aerides odorata* form a dense hanging group variable in colour but mostly white with purple patch. The juice of leaves of *Aerides odorata* is used to heal boils in ears and nose and the grounded seeds speed up the healing of wounds (Friesen & Friesen, 2012). The flowers of *Aerides odorata* are aromatic and long-lasting, which makes them popular as cut flowers and pot plants. The fragrance of the flowers makes them valuable and a potential source for scent/perfume extraction. Though an official IUCN assessment for *Aerides odorata* remains unavailable, various reports categorize the plant as threatened (Natta *et al*., 2021). The natural population of the species faces a significant threat due to human activities, thereby impacting its natural regeneration process.

The application of suitable ecological methods, such as phytosociological analysis and environmental niche modelling, plays a crucial role in preserving and conserving the natural populations of endangered species. Despite being an important species, there is a lack of information on suitable habitat distribution range of *Aerides odorata*.Predicting its potential habitat distribution is primordial for its sustainable management, especially in the light of climatic variability. Without a clear understanding of habitat distribution and climatic preferences of *Aerides odorata*, it is challenging to formulate effective measures and management strategies for its conservation, cultivation or reintroduction. Therefore, this study was done to construct a habitat suitability map and predict suitable habitats for reintroduction and conservation under current climatic conditions

Methodology

Primary occurrence data for model building and evaluation were collected through field surveys in different parts of India. We also obtained occurrence records from the web resource of Global Biodiversity Information Facility (http://www.gbif.org) and published literature. The coordinates of all the occurrence points obtained through field surveys were recorded to an accuracy of ≤ 10 m using a GPS (Garmin). These coordinates were then converted to decimal degrees for use in modelling the distribution of habitats of the

species. To avoid spatial autocorrelations, only one location per grid (1 km × 1 km) was used in modelling. Finally, a total of 48 occurrence points of *Aerides odorata*were compiled and included in this study to model current and future potential distribution of the species.

Bioclimatic variables (Hijmans *et al.*, 2005, Booth *et al*, 2014) with 30 seconds spatial resolution, downloaded from World Clim dataset (www.worldclim.org) were used in the present study. The 19 bioclimatic variables from the WorldClim dataset were used to assess current climatic conditions. These variables are frequently used in modelling species distributions (e.g., Evangelista *et al*., 2008; Kumar *et al*., 2009; Sanchez *et al*., 2011), and capture annual ranges, seasonality, and limiting factors such as monthly and quarterly temperature and precipitation extremes (Hijmans*et al*., 2005).

The habitat model was constructed using the Maximum Entropy Distribution software, Maxent version 3.3.3 (Phillips *et al*., 2006; http://www.cs.princeton.edu/wschapire). This software generates a likelihood estimation for the presence of species, providing a range from 0 to 1, where 0 signifies the lowest probability and 1 indicates the highest probability. Of the 48 records, seventy-five percent were used for model training and twenty five percent for testing. To validate the model robustness, 10 replicated models runs for the species with a threshold rule of 10 percentile training presence was executed. In the replicated runs, cross validation technique was employed, where samples were divided into replicate folds and each fold was used for test data. Other parameters were set to default as the program is already calibrated on a wide range of species datasets (Phillips &Dudík 2008). From the replicated runs average, maximum, minimum, median and standard deviation were generated. Jackknife procedure and percent variable contributions were used to estimate the relative influence of different predictor variables.

Results

An AUC value of 0.50 indicates that model did not perform better than random whereas a value of 1.0 indicates perfect discrimination (Swets 1988). The maxent model for *Aerides odorata*performed well with an average AUC value of 0.960 (Figure 1). Relative importance of different environmental variables based on results of jackknife tests in Maxent are shown in Figure 2. In an effort to reduce potential inaccuracies in species occurrence data, any duplicated records were removed. The model suggests Andhra Pradesh, Karnataka, West Bengal & Odisha to be the most suitable habitat, with a significant area of 1,99,567 km^2 (Figure 3). The relative contributions of the predictor variables in Maxent for distribution of these species is given in Table 1. Annual Precipitation (bio 12) & Temperature Annual range (bio 7) were the strongest predictors for the distribution of *Aerides odorata*with 37.8%& 17.2% respectively.

Table 1: Selected environmental variables and their percent contribution in maxent model for *Aerides odorata*

Environment Variables	Percent Contribution
Annual Precipitation (bio 12)	37.8
Temperature Annual range (bio 7)	17.2
Precipitation of Driest Month (bio 14)	14.6
Mean Diurnal Range (bio_2)	7.9
Precipitation of Coldest Quarter (bio_19)	7.2
Mean Temperature of Coldest Quarter (bio_11)	6.7
Precipitation of Warmest Quarter (bio_18)	3.1
Annual Mean Temperature (bio_1)	2.2
Min Temperature of Coldest Month (bio_6)	1.5
Precipitation of Wettest Quarter (bio_16)	1

Temperature Seasonality (bio_4)	0.5
Mean Temperature of Warmest Quarter (bio_10)	0.3
Precipitation of Driest Quarter (bio_17)	0.2

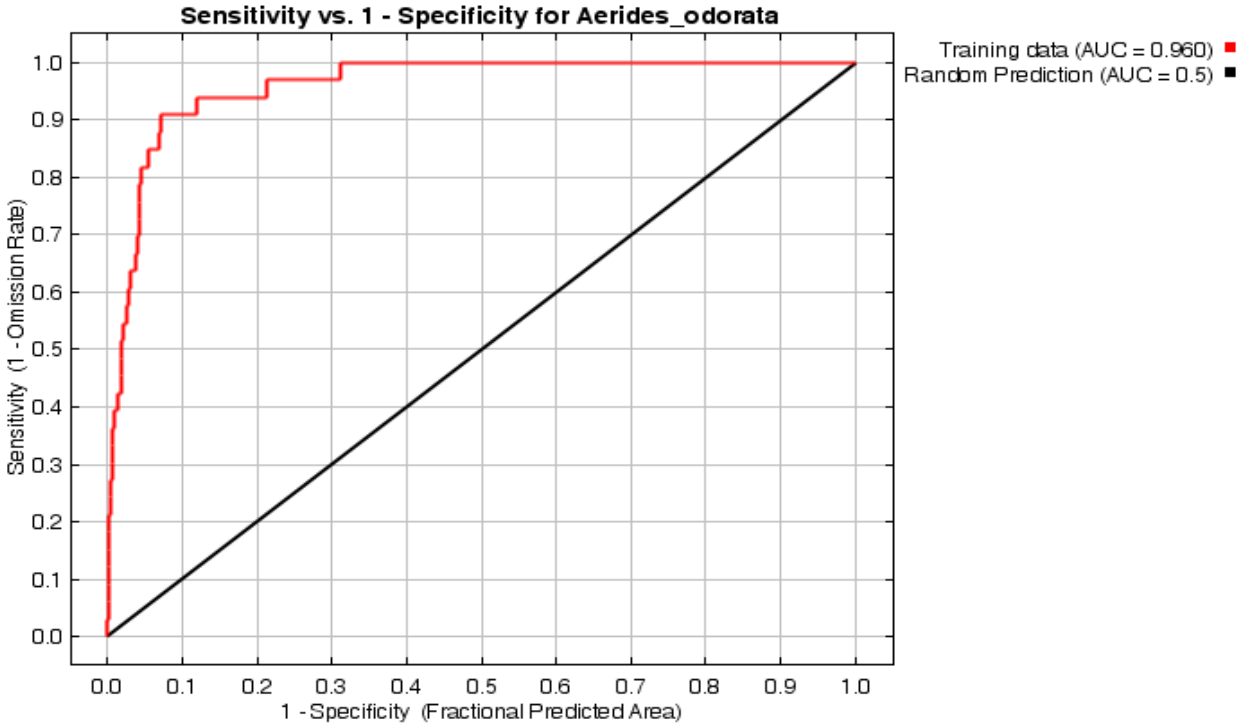

Figure 1: Result of AUC in developing habitat suitability model for *Aerides odorata*

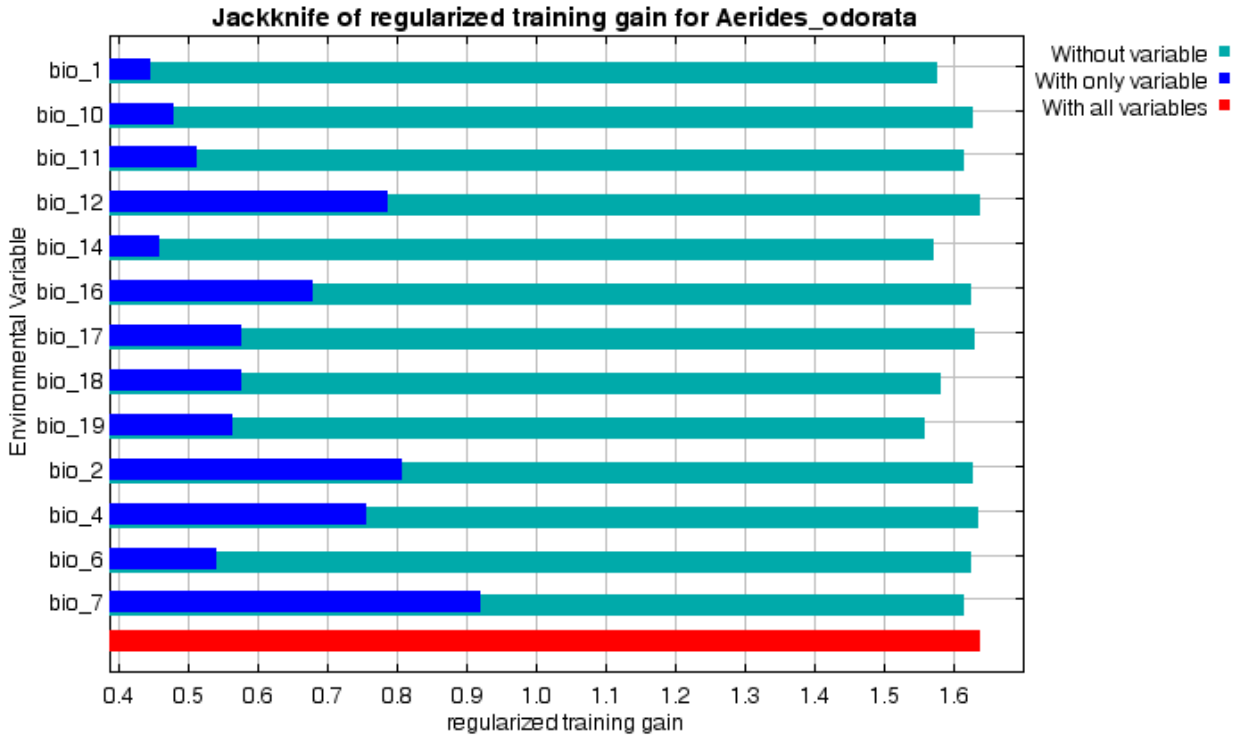

Figure 2: Relative predictive power of different bioclimatic variables based on the jackknife of regularized training gain in maxent model for *Aerides odorata*

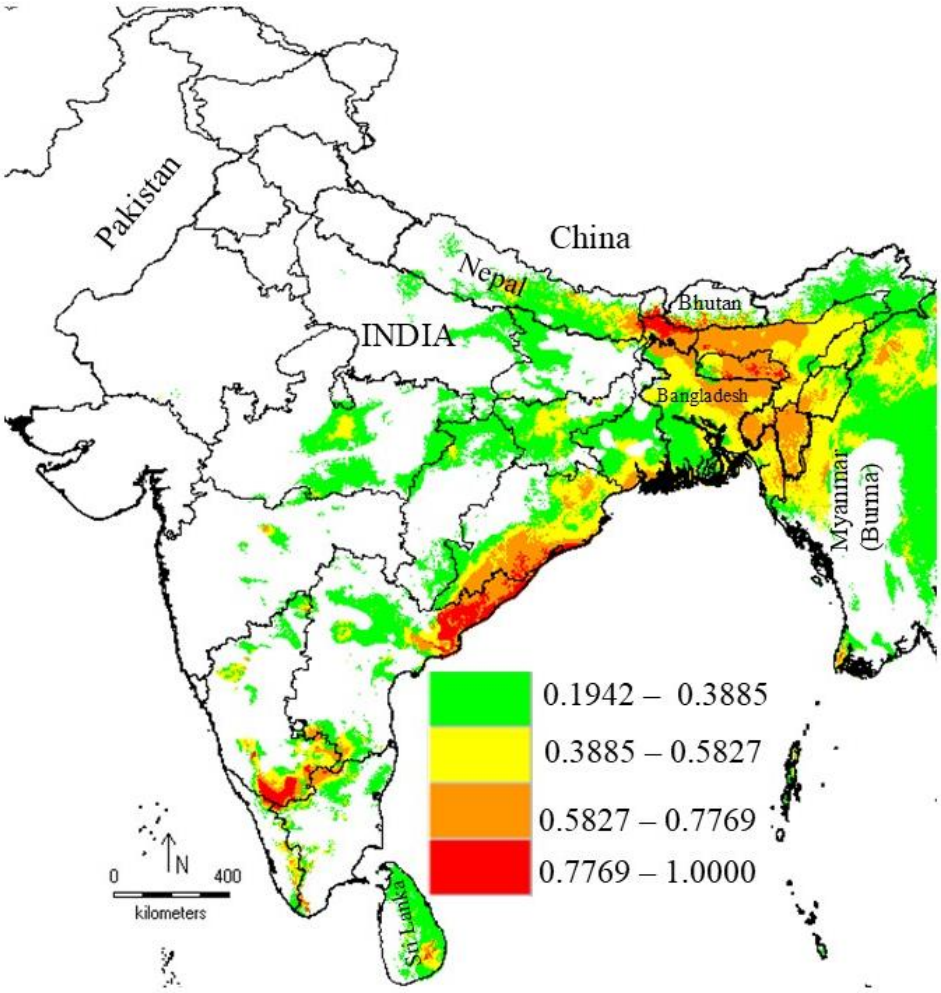

Figure 3: Predicted current potential suitable habitat of *Aerides odorata* (Shapefile republished from DIVA-GIS database (https:// www.diva-gis.org/) under a CC BY license, with permission from Global Administrative Areas (GADM), original copyright 2018.)

Discussion

Species like *Aerides odorata*, which possess recognized economic value face pressures from habitat loss resulting from rapid climate change, land use and land cover alterations and overexploitation due to their known usefulness (Khanum et al., 2013). Land transformations for agricultural and urban purposes, along with climate changes, will lead to an expansion of unsuitable habitats in the species' range. Therefore, proper planning is essential to preserve the species through successful execution of in-situ conservation within protected areas offering suitable habitats, as well as ex-situ conservation (Urbina & Flores, 2010). Both macro- and micropropagation techniques should be employed to cultivate plantlets, which can then be introduced to appropriate protected sites identified via ecological niche modelling.

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