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Predictive Distribution Modelling of *Calamus andamanicus* Kurz, an Endemic Rattan from Andaman and Nicobar Islands, India

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Abstract

Calamus andamanicus Kurz is one of the commercially important solitary rattans endemic to Andaman and Nicobar islands. The habitat suitability modeling program, MaxEnt, was used to predict the potential ecological niches of this species, based on bioclimatic variables. The study revealed high potential distribution of *C. andamanicus* across both Andaman and Nicobar islands. Of the 33 spatially unique points, 21 points were recorded from South and North Andamans and 12 from Great Nicobar Islands. The islands like Little Andaman, North Sentinel, Little Nicobar, Tllangchong, Teressa were also predicted positive even though this rattan is not recorded from these islands. Mean diurnal range, higher precipitation in the wettest month of the year, annual precipitation and precipitation in the driest month are the main predictors of this species distribution.

Key Words: *Calamus*, ecological niche modelling, GIS, MaxEnt, bioclimatic variables

Introduction

The systematic conservation planning and management of biodiversity requires the knowledge on the spatial distribution of resources (Margules and Pressey 2000). The information on the conservation aspects such as distribution, abundance and habitat quality are crucial (Baillie et al. 2004) to identify threats and derive suitable management strategy to prevent species extinctions. Methods involving ground surveys covering entire study region are either not possible or time consuming in most of the cases. Even the conventional approaches fail to synthesize the minuscule distribution details of a given species. New Geographical Information System (GIS) approach, has been explored under the rubric of "ecological niche modelling" [ENM; (SoberÓn and Peterson 2005)] which produces potential distribution maps by establishing a relation between the known presence localities and background information. ENM can provide diverse insights into the ecological and geographic extents of species distributions (SoberÓn and Peterson 2004), invasive species biology (Peterson 2003), conservation priority setting (Araújo and Williams 2000), and ecology and evolutionary biology (Kozak and Wiens 2006).

Calamus andamanicus Kurz is one of the important commercial rattans endemic to Andaman and Nicobar Islands (Fig. 1). This species was enlisted as Vulnerable (Walter and Gillet 1998) in 1997 IUCN Red List of Threatened plants. Its radical leaves are widely used as thatching material by the tribal communities and cane is used for the furni-

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Fig. 1. *Calamus andamanicus* in Andaman and Nicobar Islands.

ture industry. The Jarwa tribes of Andaman Islands used to cut the stem of this species as a source of soft drinking water during dry season (Sangal 1971). Its durable stem is also used for making huts, handles of house hold items, making bows and fences. This species represents Sixty-one percent of the total rattan trade in the islands and around 200 tonnes of this cane per year is exported to mainland as well as other European countries (Senthilkumar et al. 2014). Since *C. andamanicus* is a solitary rattan the over extraction may results in population trends and regeneration capabilities. ENM technique was used to construct the potential distribution of *C. andamanicus* in Andaman and Nicobar Islands and maxEnt has been known to produce accurate distribution predictions for numerous rare and threatened species in a restricted study region (Elith et al. 2006; Pearson et al. 2007). The attempt we make here is to produce accurate distribution map of this rattan using ecological niche modelling framework, for understanding local distribution pattern and habitat requirements which is a fundamental goal of modern biogeography.

Materials and Methods

A total of 33 spatially unique points of *C. andamanicus* were available from our field surveys from Andaman and Nicobar Islands (Sreekumar et al. 2002; Renuka and Sreekumar 2012). The points recorded during field surveys with Global Positioning System (GPS) were plotted in GIS. The points were further geo-rectified with the Survey of India topographic sheets and Google Earth (Google, Mountain View, CA, USA) to obtain accurate coordinates to be used in the modelling. The background environmental data is given in the form of 7 bioclimatic and five topographic variables. The bioclimatic variables are from the Worldclim dataset developed by Hijmans et al. (2005) available at a resolution of 1 km^2 (http://www.worldclim.org). These variables were derived annual and monthly values of mean temperature, precipitation and seasonality (Table 1). The topographic variables include elevation, aspect, slope, compound topographic index (CTI) and Terrain ruggedness index (TPI). The topographic variables were derived from Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (http://topex.ucsd.edu/WWWhtml/srtm30 plus.html) available at 30 meter resolution. All the geodata processing was done with the software ArcGIS. The maximum entropy modelling (MaxEnt) was chosen to predict the potential distribution of the species. MaxEnt is a presence only environmental niche modelling technique (Franklin 2009) which uses only species distribution presence records in space to generate potential prediction maps. It is a machine learning method which produces target distribution predictions from incomplete information i.e. with available few species distribution records, the algorithm generates full potential of its probable distribution in the environmental space where a species may survive (Phillips et al. 2006). MaxEnt has shown to produce competitive results when compared with other general purpose modelling methods in predicting the potential geographical distribution of a species (Elith et al. 2006; Wisz et al. 2008). MaxEnt version

Table 1. Bioclimatic and topographic variables used in the modelling

Sl. No	Environmental Variables	Type	Source
1.	Bio 01 Annual Mean Temperature	Bioclimatic- Temperature	Worldclim
2.	Bio 02 Mean Diurnal Range	Bioclimatic- Temperature	Worldclim
3.	Bio 05 Maximum Temperature of Warmest Month	Bioclimatic- Temperature	Worldclim
4.	Bio 06 Minimum Temperature of Coldest Month	Bioclimatic- Temperature	Worldclim
5.	Bio 12 Annual Precipitation	Bioclimatic- Rainfall	Worldclim
6.	Bio 13 Precipitation of Wettest Month	Bioclimatic- Rainfall	Worldclim
7.	Bio 14 Precipitation of Driest Month	Bioclimatic- Rainfall	Worldclim
8.	Elevation	Topographic	SRTM
9.	Slope	Topographic	SRTM
10.	Aspect	Topographic	SRTM
11.	CTI Compound Topographic Index	Topographic	SRTM
12.	TRI Terrain Ruggedness Index	Topographic	SRTM

Worldclim: http://www.worldclim.org; SRTM, Shuttle Radar Topographic Mission; http://topex.ucsd.edu/WWW_html/srtm30_plus.html

3.3.2e (http://www.cs.princeton.edu/~schapire/maxent/) was used to run the models. In the program, 500 iterations were ran with a convergence threshold of 0.00001 and a maximum of 10,000 background points and algorithm parameters were set to auto features (Phillips and Dudik 2008). Only the random test percentage in the settings was turned to 20% in order to test the model robustness through the Area under Curve (AUC). A simple jackknife test was done to test the accuracy. It was done by leaving randomly one presence point removed (n-1) and the model was ran. The predicted map is tested for the successful prediction of the left out point. The procedure is repeated for n times and the accuracy of prediction was done by a simple probability test. MaxEnt produces predictions in the form of real numbers between 0 and 100 representing the cumulative probability of occurrence. The cumulative output format is chosen and the values were imported into ArcGIS as integer grids for further analysis and comparison.

Results and Discussion

The simple probability test conducted from the jackknife test confirmed that the prediction is significantly better than at random ($p < 0.05$). The test and training Area under Curve (AUC) values were also higher (above 0.9) which implies the model accuracy and justifies the construction of final niche model with all the available points. The prediction was good because the final niche model includes all the 33 occurrence points from both Andaman and Nicobar Islands (Fig. 2). The predicted potential distribution is higher in the evergreen forests of both island groups and

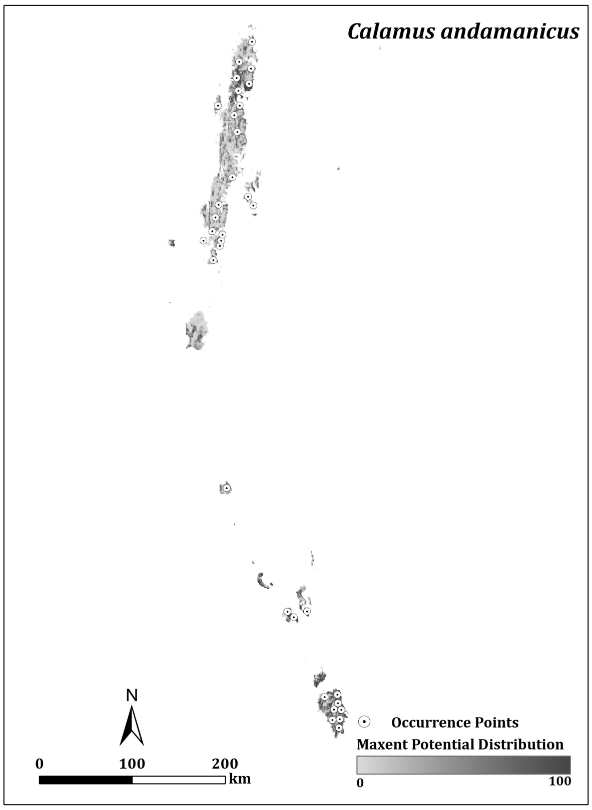

Fig. 2. Potential distribution of *Calamus andamanicus* in Andaman and Nicobar Islands.

Table 2. *C. andamanicus*: Variable contribution of bioclimatic and topographic data used in modelling

Variable Contribution %											
Bio 01	Bio 02	Bio 05	Bio 06	Bio 12	Bio 13	Bio 14	Elevation	Slope	Aspect	CTI	TRI
1.6	46.8	9	2.2	12	17.4	6.2	-	3.7	0.1	-	1.1

more in the northern half of the Andaman Islands. Mean diurnal range, higher precipitation in the wettest month of the year, annual precipitation and precipitation in the driest month are the main predictors of this species distribution. The contribution of environmental variables that influences the potential distribution of *C. andamanicus* in Andaman and Nicobar Islands is provided in Table 2. Of the 33 reported localities of *C. andamanicus*, 21 were from Andaman group of Islands and 12 were from Nicobar group. Though there were no reported records from islands like North Sentinel and Little Andaman in Andaman group and Teressa and Little Nicobar in the Nicobar group, the species was predicted to be present in these islands also. This indicates the possibility of wider scattered distribution of *C. andamanicus* in all these islands. The islands have humid, tropical, and coastal climate and receives heavy rainfall from both South-west and north-east monsoons, with the average annual rainfall ranging from 3000 to 3500 mm. The maximum precipitation is between May and December. The mean relative humidity is 80%. Thus, the climate of Andaman and Nicobar Islands is highly favorable for the evergreen forest. However, habitat fragmentation, over exploitation of resources and rapidly warming climate appears to be threatening plant biodiversity in these islands. According to the Action plan on climate change prepared by UNDP (2013), there will be a gradual shift in changes of forest types especially shrinking of evergreen forests giving way to moist deciduous forests and increasing the proportion of open forests in the islands. Moreover the erratic and more intense rainfall during a short period of time will lead to increased soil erosion and reduced water availability during drought. The International Plant Genetic Resources Institute (IPGRI) has identified *C. andamanicus* as one of the priority species for research and development programme (Rao et al. 1998). There are two distinct phenotypes observed with respect to stem diameter, leaf sheath characteristics and the length of infructuscence (Renuka et al. 1998). Some of the specimens especially from Nicobar and North Andaman Islands have long flagellate infructescence, while others have short non-flagellate infructescence. Since, this is a solitary species the extraction of cane before flowering ages drastically affects the natural regeneration and hence for the *in-situ* conservation measures priority sites should be identified. The potential predicted distribution information of *C. andamanicus* species will be helpful in planning, conservation areas encompassing its existing populations. Even though the available information on biology of this species is scarce, our approach provides an opportunity to identify top-priority survey sites, and to set priorities to restore its natural habitat for more effective conservation. A detailed study on population structure, spatial ecology, reproductive phenology and seed dispersal and predation are recommended further to develop species specific conservation programmes.

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References

Araújo MB, Williams PH. 2000. Selecting areas for species persistence using occurrence data. Biol Conserv 96: 331-345.

Baillie JEM, Hilton-Taylor C, Stuart SN. 2004. IUCN Red List of Threatened Species: a global species assessment. IUCN, Gland, Switzerland and Cambridge, UK.

Elith J, Graham CH, Anderson RP, Dudík M, Ferrier S, Guisan A, Hijmans RJ, Huettmann F, Leathwick JR, Lehmann A, Li J, Lohmann LG, Loiselle BA, Manion G, Moritz C, Nakamura M, Nakazawa Y, Jacob McC M Overton, Townsend Peterson A, Phillips SJ, Richardson K, Scachetti-Pereira R, Schapire RE, Soberón J, Williams S, Wisz MS, Zimmermann NE. 2006. Novel methods improve prediction of species dis-

tributions from occurrence data. Ecography 29: 129-151.
Franklin J. 2009. Mapping Species Distributions: Spatial Inference and Prediction. Cambridge University Press, Cambridge.
Hijmans RJ, Cameron SE, Parra JL, Jones PG, Jarvis A. 2005. Very high resolution interpolated climate surfaces for global land areas. Int J Climatol 25: 1965-1978.
Kozak KH, Wiens JJ. 2006. Does niche conservatism promote speciation? A case study in North American salamanders. Evolution 60: 2604-2621.
Margules CR, Pressey RL. 2000. Systematic conservation planning. Nature 405: 243-253.
Pearson RG, Raxworthy CJ, Nakamura M, Peterson AT. 2007. Predicting species distributions from small numbers of occurrence records: a test case using cryptic geckos in Madagascar. J Biogeogr 34: 102-117.
Peterson AT. 2003. Predicting the geography of species' invasions via ecological niche modeling. Q Rev Biol 78: 419-433.
Phillips SJ, Anderson RP, Schaipire RE. 2006. Maximum entropy modelling of species geographic distributions. Ecological Modelling 190: 231-259.
Phillips SJ, Dudik M. 2008. Modelling of species distributions with MaxEnt: new extensions and a comprehensive evaluation. Ecography 31: 161-175.
Rao AN, Rao VR, William JT. 1998. Priority species of bamboo and rattan. IPGRI and INBAR.
Renuka C, Indira EP, Muralidharan EM. 1998. Genetic diversity and conservation of certain species of rattan in Andaman and Nicobar islands and southern India. KFRI Research Report 157. Kerala Forest Research Institute, Peechi.
Renuka C, Sreekumar VB. 2012. A field guide to the palms of India. Kerala Forest Research Institute, Peechi, Kerala, India.
Sangal PM. 1971. Forest Food for the Tribal Population of Andaman and Nicobar Islands. Indian For 97: 646-650.
Senthilkumar U, Ritesh KC, Sanjappa M, Narasimhan D, Uma Shaanker R, Ravikanth G. 2014. Livelihood and Revenue: Role of rattans among Mongoloid tribes and settlers of Andaman and Nicobar islands, India. Ethnobot Res Appl 12: 141-154.
Soberón, J, Peterson AT. 2004. Biodiversity informatics: managing and applying primary biodiversity data. Philos Trans R Soc Lond B Biol Sci 359: 689-698.
Soberón J, Peterson AT. 2005. Interpretation of models of fundamental ecological niches and species distributional areas. Biodivers Inform 2: 1-10.
Sreekumar VB, Renuka C, Induchoodan NC. 2002. Distribution of rattans in Andaman and Nicobar islands and their conservation. (Das MR, ed) Proceedings of the 14th Science Congress, Cochin, pp 142-146.
UNDP. 2013. State Action Plan on Climate Change. Draft Report. Andaman and Nicobar Islands. www.moef.nic.in/sites/default/files/sapcc/Andaman-and-Nicobar.pdf
Walter KS, Gillett HJ. 1998. 1997 IUCN Red List of Threatened Plants. World Conservation Monitoring Centre. IUCN - The World Conservation Union, Gland, Switzerland and Cambridge, UK.
Wisz MS, Hijmans RJ, Li J, Peterson AT, Graham CH, Guisan A, NCEAS Predicting Species Distributions Working Group. 2008. Effects of sample size on the performance of species distribution models. Divers Distrib 14: 763-773.