USING ECOLOGICAL NICHE MODELS TO EXPLORE NICHE EVOLUTION ON WEST INDIAN BATS

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Background

Knowledge of species geographic distributions is important for many applications in evolutionary biology, ecology, and conservation. Evolutionary processes, such as speciation, can be greatly influenced by spatio-temporal environmental variation. New developments in Ecological Niche Modeling have provided insight into understanding evolutionary and historical processes that generate and/or affect biodiversity. Geographic data for a species of interest can be coupled with high resolution climate data to predict species distributions and determine niche use. The resulting niche models represent the environmental conditions in which populations of a species can be maintained.

Brachyphylla *Monophyllus*

The fragile nature of West Indian faunas today is exacerbated by the continuous disruption and loss of habitat.

This study focuses on four endemic and codistributed bat species on the West Indies (*B. cavernarum*, *B. nana*, *M. plethodon*, and *M. redmani*).

These species share similar habitats but show a distribution partitioned primarily as Greater (*B.n.* and *M.r.*) vs. Lesser (*B.c.* and *M.p.*) Antillean occupants.

Habitat requirements for these species are not well known.

Objectives

To use ecological niche models via MaxEnt to determine the predicted distribution of four bat species based on historical and current records.

To apply an ecological niche modeling approach to infer if niche specialization (i.e. niche evolution) may play a role on differentiation in sister bat species across the West Indies.

Methods

Data was obtained from MaNIS and complemented with records obtained from the literature and recent collections. Data was checked for georeferencing errors and dubious points were excluded.

Ecological niche models were run through MaxEnt using presence only data.

MaxEnt models were used to explore niche occupancy of four West Indian endemic bats (*B. cavernarum*, *B. nana*, *M. plethodon*, and *M. redmani*) and infer niche evolution.

Locality data was partitioned into 70% training and 30% testing.

Models were developed using 19 bioclimatic layers summarizing temperature and precipitation at a 1 km^2 scale.

MaxEnt distributions were obtained from log outputs of 50 cross-validated iterations.

Model performance was evaluated using AUC statistic.

Acknowledgments

D.L. Reed and J.L. Pino provided constructive dialogue pertaining to this project. R.G. Pearson and S.J. Phillips provided support with MaxEnt. Special thanks to R.D. Barrilito for moral support. Part of this research was funded by a University of Florida Biology Grinter Fellowship awarded to JASC.

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Results

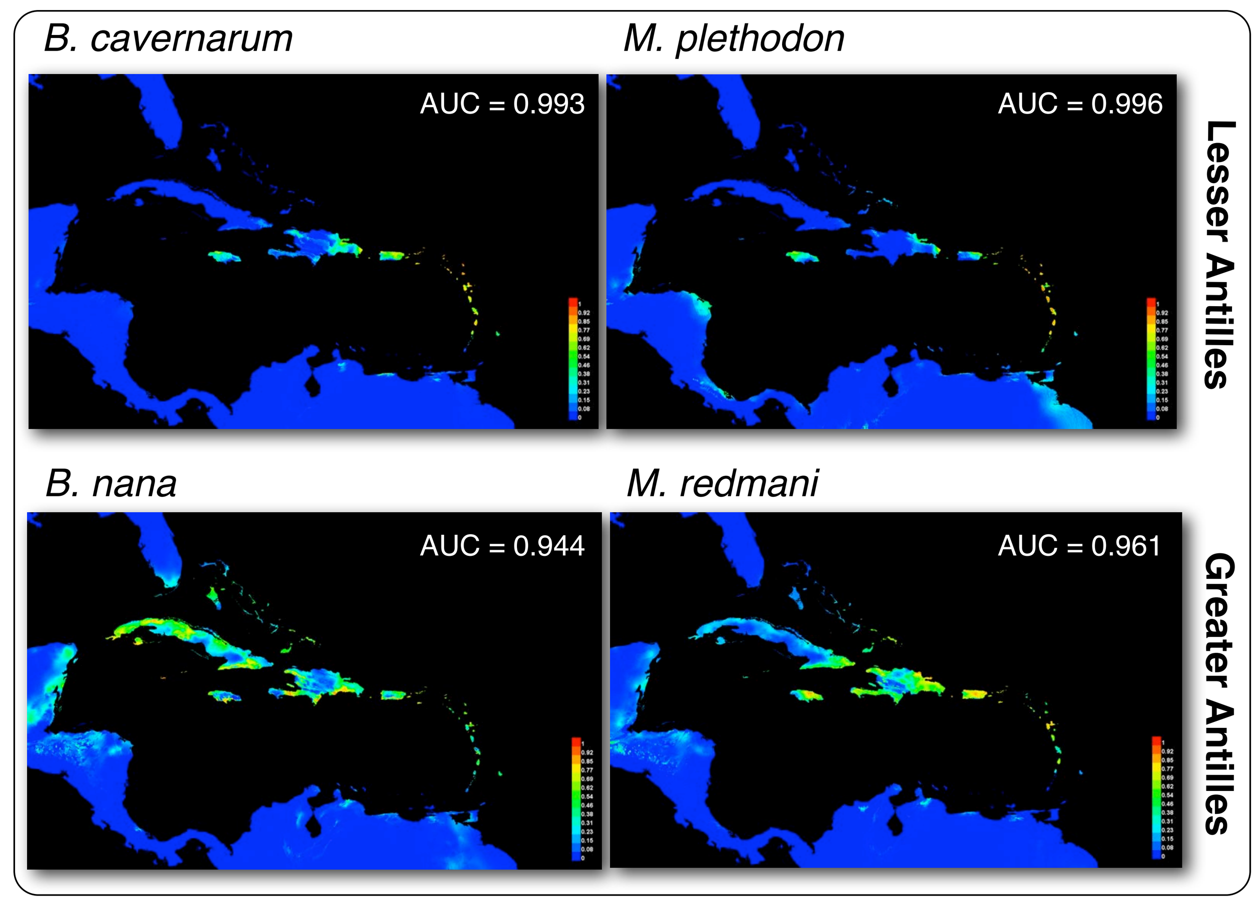

Fig. 1: MaxEnt distribution of four endemic West Indian bat species. Warmer colors represent areas of higher probability of occurrence. Distributions and AUC values represent mean outputs of 50 cross-validated iterations.

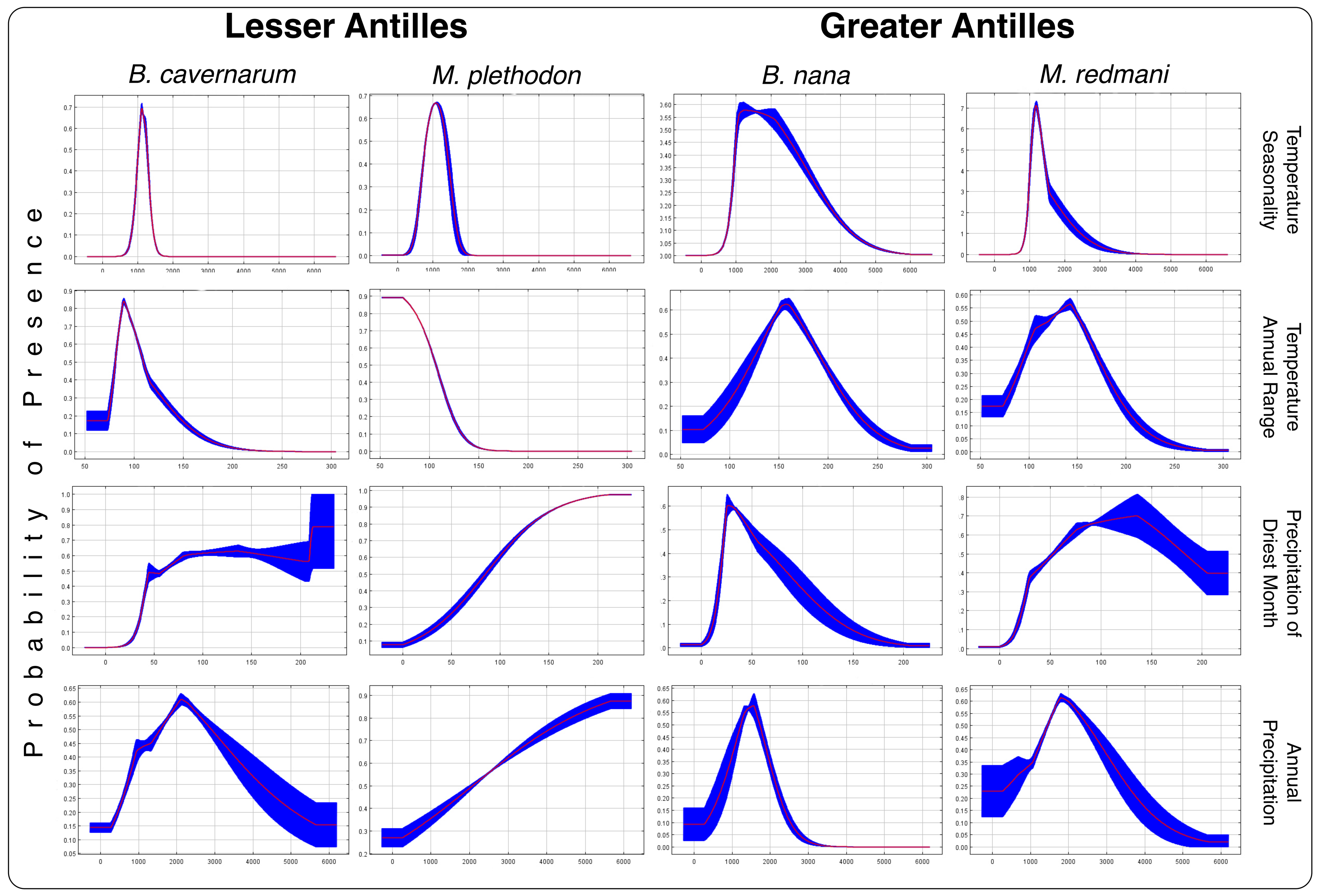

Fig. 2: Response curves for some climatic variables each representing a different MaxEnt model created using only the corresponding variable. X-axis represent relative temperature and precipitation.

Discussion

All AUC statistic values are above 0.94, which compares well with values reported in the literature corresponding to strong model predictions (Fig. 1).

The fitted distributions of the Lesser Antillean species are consistent with island geographic position, size, and topography. Greater Antillean species show a wider range in their distribution, which can be attributed to the wider variety of climatic conditions they experience on larger islands (Fig. 1).

Climatic models for temperature showed similar patterns between Greater and Lesser Antillean species (Fig. 2). However, the highest probability of presence in Lesser Antillean species is higher for the annual temperature range suggesting differential climatic temperature niche use.

For annual precipitation, *Brachyphylla* shows similar patterns (Fig. 2). However, different precipitation niches are used in the driest month. *M. plethodon* shows a greater probability of occurrence as precipitation increases, whereas *M. redmani* has higher probability of occurrence in the low-to-mid precipitation levels (Fig. 2).

Many factors can contribute to climatic niche evolution. This models show that it can be inferred by comparing peak probabilities of occurrence between species. Differential climatic tolerances for annual temperature range can be observed in both Greater and Lesser Antillean species. Species of *Monophyllus*, for example, show considerable variation in climatic niche of precipitation (Fig. 2). These patterns appear to support the hypothesis that island geography, size, and topography provided suitable climatic habitats for bat species differentiation on the West Indies.