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Salamander-Climate Paper – Ecological Niche Modeling

***What did I do, what did I ask, what does that mean?***

**Intro – very rough. How to ask the ‘good’ questions?**

*3 main questions – these should be very pointed questions and* ***not why*** *question because we can’t ask that*

1. Do arboreal species live in different climactic niches (characteristics) compared to terrestrial ones?

2. What climatic variables are important for explaining the arboreal microhabitat type?

3. In predicted highly suitable areas, ***why*** aren’t there arboreal species there? Who is there?

Definition for us to consider it a possibility and map it

4. What factors might drive the evolution of an arboreal microhabitat? Competition? Climate? Niche? EEEEEEEEK scary question that is unanswerable

Look at the reconstruction of the root. Anedies. Temperate vs tropical

**Material & Methods**

*These should be any limitations that happened or any decisions that were made. Justifications either from tests or previous literature. Methods necessary for certain tests.*

Phylogeny

Bonnet and Blair 2017

311 species with polygons/point data *only*

Presence points represented by polygons. We are using that as a proxy for “potential niche space” or the potential distribution and not realized niche. I don’t like that term, but I also don’t know what else to call it.

Microhabitat class

From Erica? And McEntire? New publication?

Preliminary differences between arboreal and terrestrial species?

IUCN polygons and LM polygons

\* Potential distribution and not realized niche \*

From IUCN and idk how to justify what I have done?

IUCN polygons from IUCN database that lacked specific point localities for every species. May be because of taxonomy changes. I found more species point data available through VertNet and took those. From there, I removed occurrence records that had coordinate errors and duplicates. I then created an extent of occurrence (EOO) polygon around them excluding oceans and unlivable area. I did not include fine scale industrial constraints to limit dispersal within a polygon. Some species have multiple polygons. This is what IUCN uses in most of their polygons which is why I felt comfortable including them with IUCN’s. Also, we have proven the signal does not go away due to my polygons – add to supplementary materials.

Climate data

WorldClim or Bioclim

For environmental layers, we used BioClim layers at a 2.5 arc second resolution (~4 ). We included x,y,z variables. Due to our investigation and previous literature that uses them in amphibian studies

We included an altitude layer at also a 2.5 arc second resolution.

Get altitude citation\* Nick sent me a 2.5 res raster

Continental data on 2.5 – *Jarnevich et al 2018*

Evapotranspiration and Water Vapor Pressure justifications

Additionally, we used monthly and water vapor pressure from the WorldClim database.

*Jarnevich et al 2018*

The potential evapotranspiration is from https://www.ntsg.umt.edu/project/modis/mod16.php and is deemed to be the most valid predictor of richness.

*Currie 1991*

Mainly for amphibians

*Martinez-Mendez et al 2019*

*Jarnevich et al 2018*

Also justify all vs modeler-choice

Modeler-choice justified by the anova regressions for significance in differences between Veg and Dirt

Niche Modeling

\* Potential distribution and not realized niche\*

\* Looking for continental global patterns that explain macroevolutionary trends\*

Simplified polygons per grid and centroid of that is the new point location – people usually simplify anyway because of spatial autocorrelation. Obtain localities in distance grids to match the spatial resolution of environmental layers (2.5 arc seconds).

Biologically meaningful variables to create maps of potentially suitable habitat for these species in North, Central, and South America.

Omit species in Korea and Italy due to lack of overlap with the majority of other species. Can add these in with the individual species-level overlap analysis.

Pretty sure I am just going to use MAXENT but doing an ensemble and comparing other popular modeling choice would be ok to justify they are saying the same thing – maybe add to the supplementary materials. Possibly include an ensemble map. *Mata et al 2017*

Run the training and test data differently for (5-10) times and compare the AUC values of these runs or consensus map of the same model multiple times. “k-fold #”

Run the training and test data differently for A1 and A2 or have one be training and one be testing to see if they have the same ‘niche’ space and the reciprocal. The cloud forest hypothesis - *Pompeu et al 2018*

Possibly competition hypothesis – species richness or using the Dirt species as a predictor for arboreal species. The hypothesis from this is unclear.

**Analysis**

Show the niche suitability raster and map out points and polygons

Maybe use the Revell pictures to connect polygons to phylogeny in some areas?

Schoener’s D for niche overlap. *Rodder et al 2011, Schoener 1968.* Do for the eco-groups (Veg, Dirt, Rock, Water) and individual species.

For this overlap in individual species we should see clustering either by region, phylogeny, or microhabitat. I am cautious of the individual species overlap analysis because of the low resolution, I don’t know how well this will go if some are only represented by one point in the spatial resolution grid.

Suitability scores for each individual point and we can see that distribution if the x-axis is richness and the y-axis is the suitable habitat scores or the % veg suitability within suitable habitat.

We can do a PCA of the individual points from the suitability scores as well and color them by V,D,R,W and then we can also look at disparity and clustering of these to maybe explain differences or similarities.

Results\*

Conclusions\*

**Necessary Citations**

WorldClim data

Fick, S.E. and R.J. Hijmans, 2017. Worldclim 2: New 1-km spatial resolution climate surfaces for global land areas. International Journal of Climatology.

IUCN Polygons

IUCN 2018. The IUCN Red List of Threatened Species. Version 2018-2. http://www.iucnredlist.org. Downloaded on 14 November 2018.

VertNet localities

Aggregated data from multiple datasets tbd (oh boy)

MAXENT

Steven J. Phillips, Miroslav Dudík, Robert E. Schapire. [Internet] Maxent software for modeling species niches and distributions (Version 3.4.1). Available from url: http://biodiversityinformatics.amnh.org/open\_source/maxent/. Accessed on 03/12/19.

R Statistical Software

R Core Team (2013). R: A language and environment for statistical

computing. R Foundation for Statistical Computing, Vienna, Austria.

URL http://www.R-project.org/.

Phylogeny

Bonett, R. M. and A. L. Blair. 2017. Evidence for complex life cycle constraints on

salamander body form diversification Proceedings of the National Academy of Science U.S.A. 114:9936-9941.

Using EOO

Gaston, K. J. and Fuller, R. A. (2009), The sizes of species’ geographic ranges. Journal of Applied Ecology, 46: 1-9. doi:10.1111/j.1365-2664.2008.01596.x

R packages - TBD