Ecological Niche Modeling of *Pogonomyrmex* Harvester Ant Lineages

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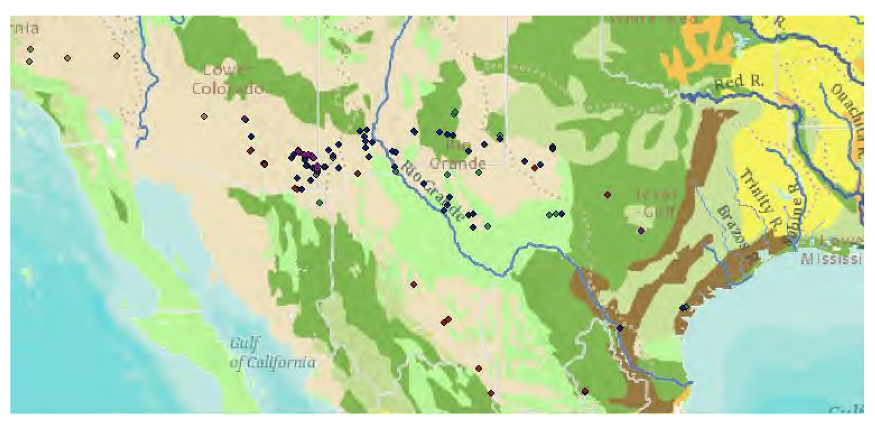
Why Harvester Ants?


-*Pogonomyrmex rugosus* and *Pogonomyrmex barbatus* occupy overlapping regions, with hybrid H and J lineages dispersed throughout overlap
-Hypothesizes that hybrids persist throughout parental species range based on ability to compete for specific habitats
-**Investigative Question:** What determines the distribution and dispersal of each harvester ant lineage?



USGS soil survey map with field and gathered points used in analysis. 230 GPS points analyzed from field collection, Helms Cahan lab, and literature.

What is an Ecological Niche?

→ the role an organism occupies in its environment

Organisms adapt to different habitats based on biotic/abiotic variables and niches occupied by other species.

Environmental factors tested include:
-Annual mean temperature
-Isothermality
-Max and min temp of warmest/coldest month
-Mean temp of warmest/coldest month
-Mean temp of wettest/driest month
-Temperature seasonality and range
-Annual Precipitation
-Precipitation of warmest/coldest quarter
-Precipitation of wettest/driest quarter

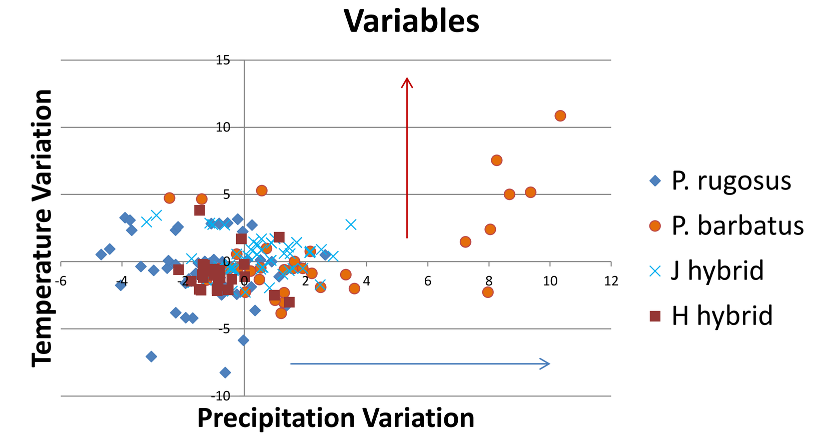
Abstract

Ecological niche modeling can be utilized to more fully understand the evolutionary influences of habitat variables on species composition and distribution. Harvester ants *Pogonomyrmex rugosus* and *Pogonomyrmex barbatus* have been confirmed to persist with multiple hybrid lineages throughout their ranges in California, Arizona, New Mexico, Texas, and Mexico due to genetic caste determination. Lineages were sampled throughout their range and identities of each specimen determined through DNA extraction and genetic sequencing. Large-scale Geographic Information Systems (GIS) data and modeling software were used to asses the influence of environmental factors on niche determination for each parental species and hybrid lineage. The model revealed highly specialized habitat of lineages compared to possible habitat of parental species.

Methods

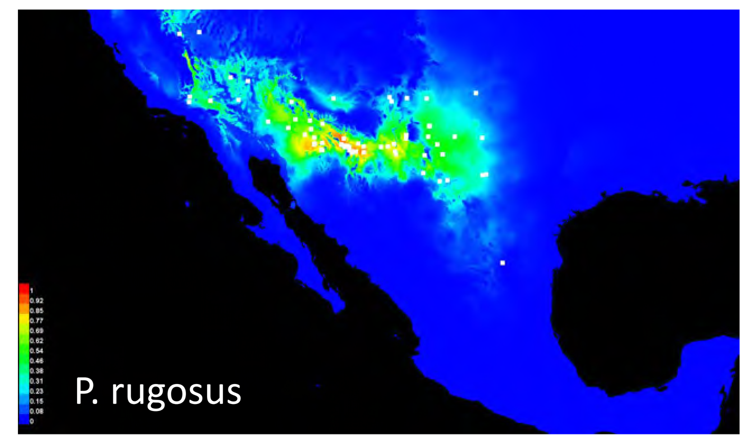
-Sampled 3 colonies each at 12 locations, recorded GPS points, and added to existing range data
-DNA Extraction and genetic sequencing to determine lineage and relatedness of samples
-Garmin GIS data mapped using ArcGIS- ArcMap 10
-BioClim set of 19 environmental factor maps used with Maximum Entropy (MaxEnt) software for suitable habitat projection and importance of habitat variables
-Linear discriminate analysis for evaluation of variable contribution to model

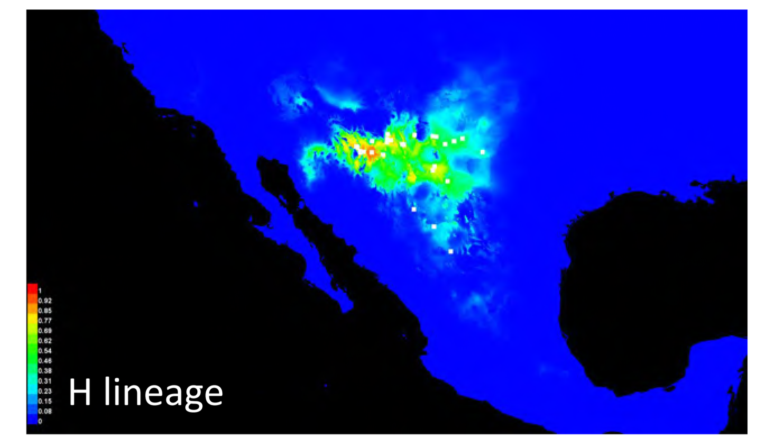
Results

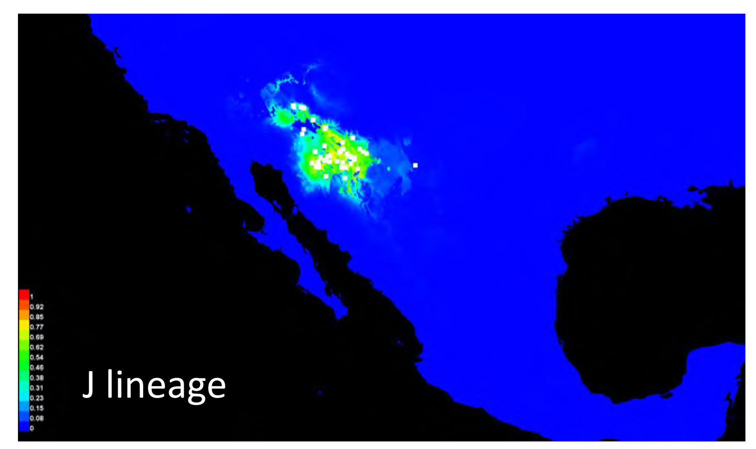


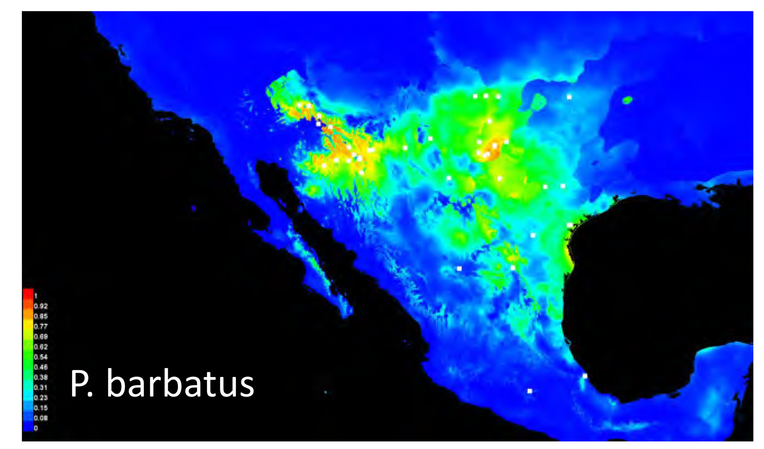
Comparison of precipitation and temperature variation (two principal components explaining most variation). J and H hybrids show overlapping values with parental species but not between each other. Barbatus has the most spread but each lineage remains fairly clumped.

H and J hybrids were restricted in size to areas of specific habitat requirements within the ranges of *P. barbatus* and *P. rugosus*, with parental lineages extending in predicted directions based on known ranges.









MaxEnt predicted ranges for parent species and hybrid lineages.
Red color indicates high habitat suitability, green showing moderate suitability, and blue indicating unsuitable areas. White dots indicate points utilized by the model for comparison of climate variable maps.

Percent Important of Climatic Variables	P. rugosus	P. barbatus	H	J
Annual Mean Temperature	0	0.8	0	3.9
Mean Diurnal Range (Mean monthly (maxtemp-mintemp))	15.8	0.2	**19.2**	8.8
Isothermality (MeanDiurnalRange/TempAnnualRange)	11.1	0.4	3.1	14.8
Temperature Seasonality	**21.1**	**22.8**	**21.5**	**16.7**
Max Temperature of Warmest Month	0.8	1	0.6	0
Min Temperature of Coldest Month	0.1	0	6.7	0.6
Temperature Annual Range	0.4	0	0	0
Mean Temperature of Wettest Quarter	0	8.6	0.8	7.2
Mean Temperature of Driest Quarter	2.4	4	2.6	**19.8**
Mean Temperature of Warmest Quarter	0	4.9	0	0
Mean Temperature of Coldest Quarter	13.9	13.3	4.7	1
Annual Precipitation	12.1	0	5.2	0
Precipitation of Wettest Month	0.4	2.2	0.5	0
Precipitation of Driest Month	5.4	7	2.9	9.1
Precipitation Seasonality (coefficient of variation)	12.1	**21.9**	**22.8**	4.4
Precipitation of Wettest Quarter	0	0.3	0.7	0
Precipitation of Driest Quarter	2.1	0	0.7	1
Precipitation of Warmest Quarter	0.4	7.5	5.9	3.1
Precipitation of Coldest Quarter	1.7	5.1	2	9.4

Conclusions

Based on the MaxEnt ecological niche model, temperature seasonality contributed most to the range of *P. barbatus* and *P. rugosus*, precipitation seasonality to H lineage, and mean temperature of driest quarter to J lineage. Discriminate analysis revealed tight clumping and restricted ranges of H and J lineages compared to larger, more general ranges of the parents.

Future Work

Analysis will be continued to quantify physical distances between lineages and test physiological differences in parent and hybrid ability to resist temperature changes.

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