The Ant GMap Project: Turning Outreach into Basic Research

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Introduction

GMap was initiated in 2010 as an outreach project to train Utah K-12 teachers in GIS technology that they could then use in their classrooms. In a series of annual workshops, Utah teachers used handheld GPS devices to record colony locations of two co-occurring species of seed-harvesting ants, *Pogonomyrmex occidentalis* and *Pogonomyrmex rugosus* at two localities in southeastern Utah, the Rio Mesa Center and the Canyonlands Research Center. Data and maps provided by teachers were used to analyze spatial point patterns for evidence of intraspecific and interspecific competition and microhabitat sorting among colonies of the two ant species. Maps were also used to selectively sample workers from geo-referenced colonies for dietary analysis using stable isotopes ^{13}C and ^{15}N. We were particularly interested in whether species identity or spatial location was the primary determinant of colony-level diets as reflected in isotope ratios. This study represents an unusual instance in which a project designed primarily as outreach has led to a new avenue of basic research in a university laboratory. We encourage other laboratories take advantage of such synergistic opportunities.

Field Sites and Methods

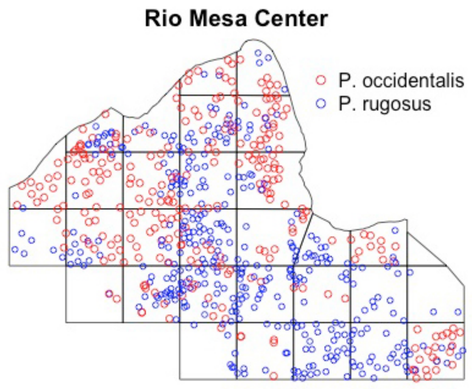
Ant colonies were mapped using handheld GPS devices in a 28.5 ha plot at the Rio Mesa Center (38°46.03' N 109°11.698' W 1280 m) and an 18 ha plot at the Canyonlands Research Center (38°8.102' N 109°37.032 W 1535 m) in southeastern Utah. Stable isotope analysis was conducted at the University of Utah Stable Isotope Ratio Facility for Environmental Research (SIRFER). All mapping and data analysis were conducted in R.

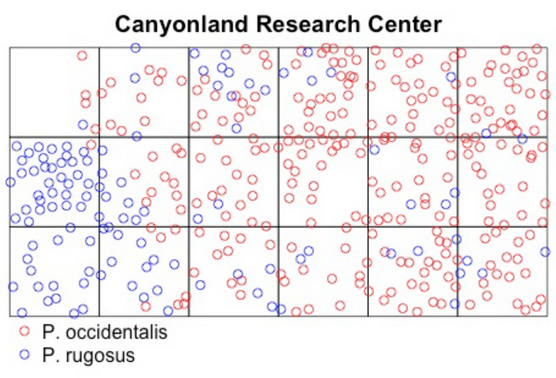
Spatial Analysis of Ant Colony Locations

Colonies of two species of seed-harvesting ants were mapped at two localities

Pogonomyrmex occidentalis nest

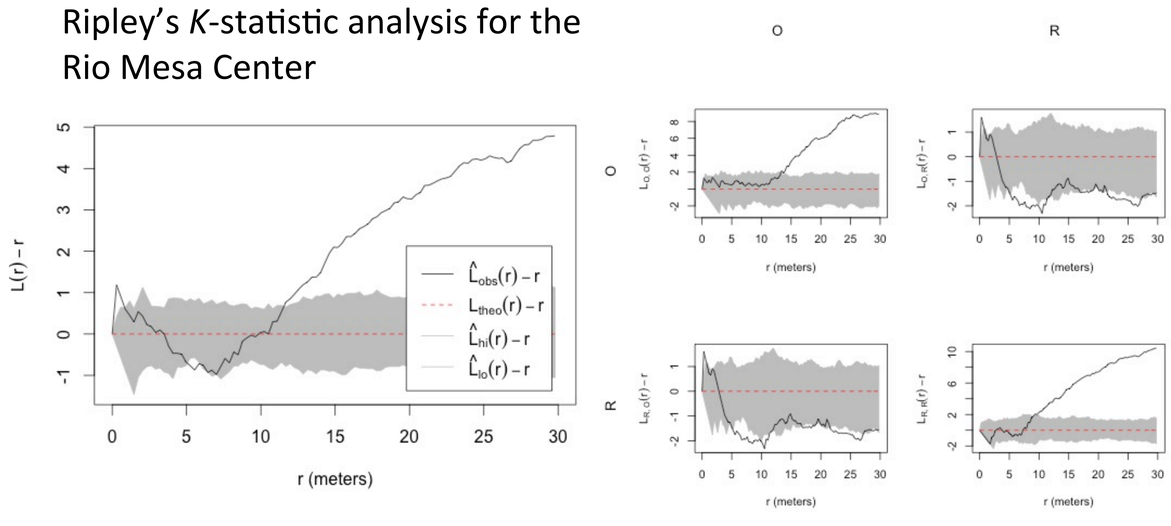
Pogonomyrmex rugosus nest





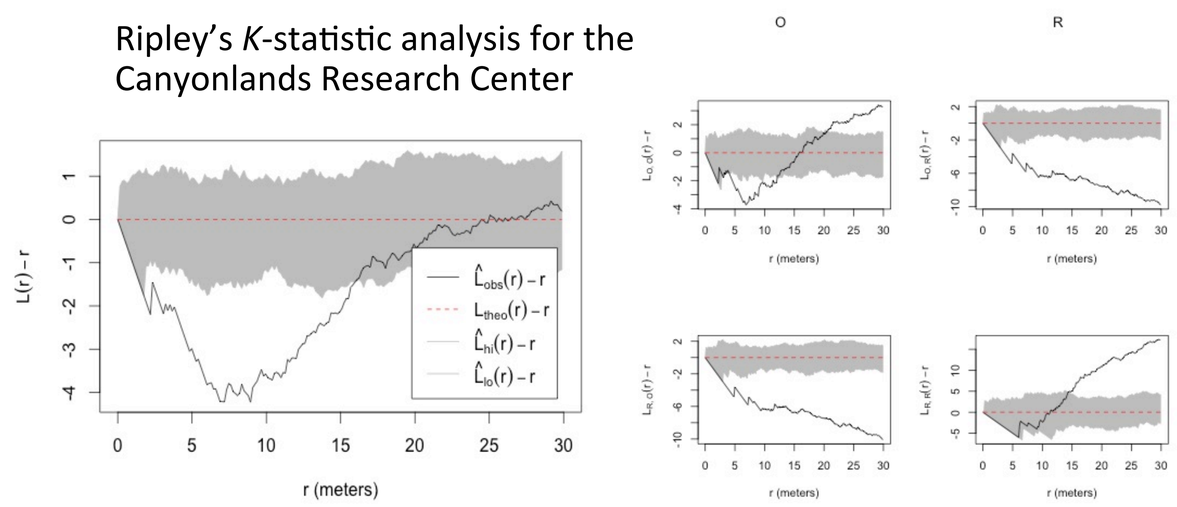
At the Rio Mesa we have mapped the location of 279 *P. occidentalis* colonies and 384 *P. rugosus* colonies. At the Canyonland Research Center we have mapped the location of 278 *P. occidentalis* colonies and 123 *P. rugosus* colonies. Although the two species broadly overlap throughout the plots, neither species is uniformly distributed, with some areas of the plots favored by *P. occidentalis* and other areas favored by *P. rugosus*.

Ripley's *K*-statistic analysis for the Rio Mesa Center



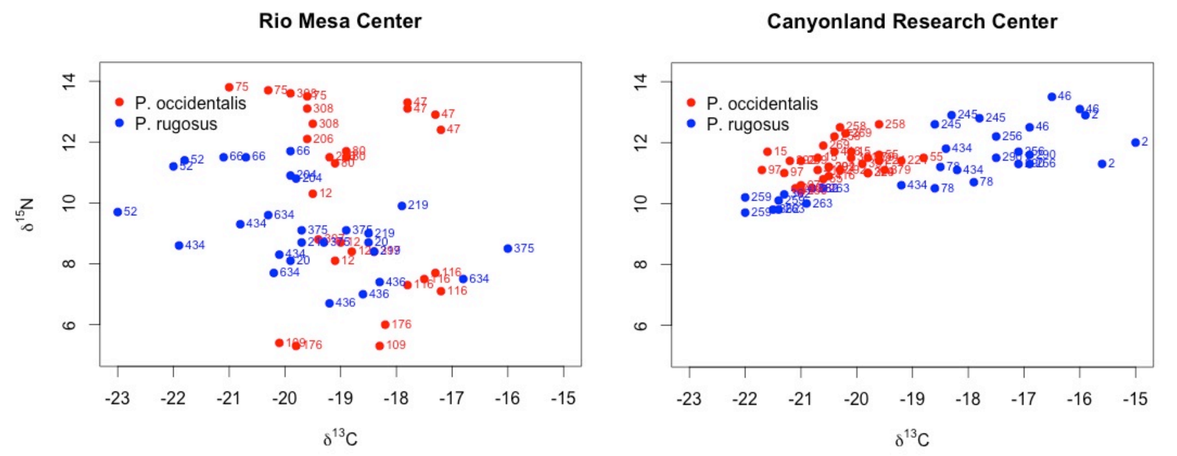
Ripley's K-statistic indicates that *Pogonomyrmex* ant colonies at Rio Mesa are randomly distributed with respect to one another at distances between 0-12 m and clumped at distances > 12 m. However, examination of interspecific spacing patterns suggest that colonies of these two species repel one another at distances between 5-10 m, the range over which direct behavioral interactions are most likely. Evidence for interspecific overdispersion at distances >10 m may be related to differences in microhabitat preferences.

Ripley's *K*-statistic analysis for the Canyonlands Research Center



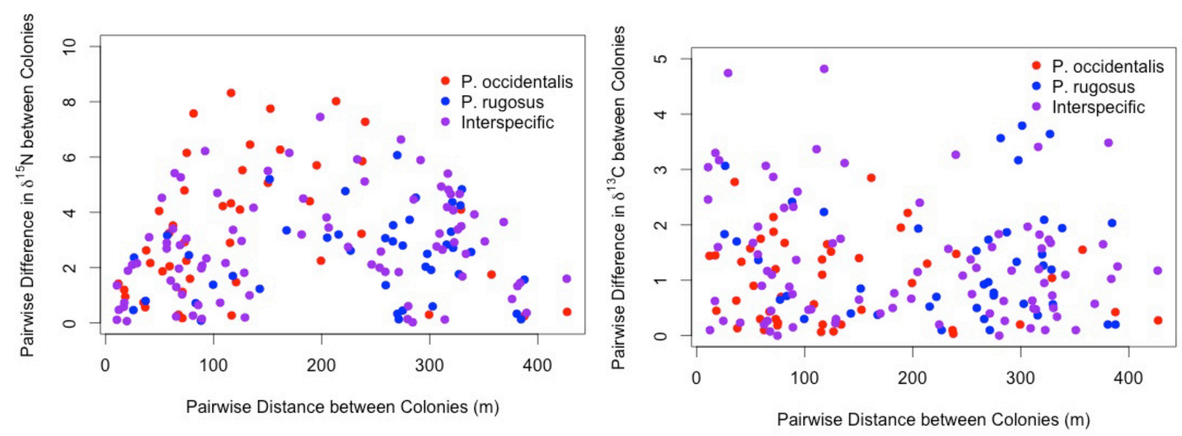
Ripley's K-statistic indicates that *Pogonomyrmex* ant colonies at Canyonlands are overdispersed with respect to one another at distances between 0-16 m and and randomly distributed at distances > 16 m. Intraspecific spacing patterns suggest colony repulsion a small spatial scales and microhabitat clumping at distances > 15-20 m. Interspecific spacing patterns suggest that colonies of these two species are overdispersed at all spatial scales, which probably results from a combination of direct behavioral interactions at small spatial scales and differences in microhabitat preferences at large spatial scales.

Stable Isotope Analysis of Diet



Analysis of ^{13}C and ^{15}N isotope ratios obtained from the heads of individuals workers indicate that workers from the same colony have similar isotopic signatures (numbers in graphs refer colony ID). Based on ^{13}C ratios, both species feed on broad mixture of C3 and C4 plants. However, *P. occidentalis* colonies at Canyonlands appears to be more restricted to C3 plants. Based on ^{15}N ratios, colonies also consume a significant amount of animal protein. Colonies at Rio Mesa feed across at least 3 trophic levels, whereas colonies at Canyonlands feed across 2 trophic levels. Absence of ^{15}N ratios less than 10 at Canyonlands suggest there is less plant-based food available at this locality.

Rio Mesa Center



We found no consistent relationship between the pairwise distance between colonies and the difference in their stable isotope signatures at Rio Mesa. Adjacent colonies did not have more similar isotope signatures than widely separated colonies. Moreover, it did not make a difference whether the comparison was between colonies of the same species or from difference species. The wide scatter in the relationship between geographic distance and difference in stable isotope signatures suggest that the diet of colonies is idiosyncratic and not strongly influenced by geographic location or by species identity. Data for Canyonlands showed similar patterns.

Conclusions

This study demonstrates that outreach projects can make a significant contribution to basic science. Results of our study to date have shown that the spatial distributions of the seed-harvester ant species *Pogonomyrmex occidentalis* and *Pogonomyrmex rugosus* are the result of behavioral interactions between species at small spatial scale and probable habitat sorting or recruitment limitation at large spatial scale. The diet of these species is broadly overlapping as indicated by stable isotope ratios, but may be different at the two localities. In future studies we will examine the demography and genetic structure of these populations.

Acknowledgments

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