Chapter 10

Resource Partitioning in Potentially Competing Insect Taxa

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RESOURCE PARTITIONING IN POTENTIALLY COMPETING INSECT TAXA

The idea that many biotic communities are competitively structured has both supporters and critics (Salt, 1983). Competitive structuring implies that interspecific competition is or has been an important force in determining which species are present in an area as well as their relative abundances and resource use patterns. If such communities exist it seems reasonable that there should be a limit to the similarity of coexisting species (Hutchinson, 1959). Studies on patterns of resource partitioning in coexisting, potentially competing, taxa provide real world information on how similar coexisting species are.

However, it is important to bear in mind that interspecific competition may be relatively unimportant in many communities. There are a variety of factors that may play a role in determining which species are present in a community, how abundant each is, and the niche each occupies. Such factors include geographic barriers and the opportunity for colonization, abiotic factors such as soil and climate and physical disturbance, and other biotic factors including resource supply, predators, pathogens, and parasites.

Thus it becomes important to select communities that are likely candidates for competitive structuring. Members of parasitoid and folivorous insect communities may find themselves on a coevolutionary mobius strip of defense and counter-attack where interspecific competition is relatively unimportant (Price, 1980; Lawton and Strong, 1981). In other communities competition may have been important historically but is no longer demonstrable because of past divergence (Connell, 1980). Ideally, one should select a set of similar species sharing a resource that is apparently limited in supply. Their populations should show a relatively rapid response to any change in resource supply or manipulation of suspected competitor population sizes.

OLD FIELD ANT COMMUNITIES

Ants are a diverse group with roughly 660 North American species and are excellent candidates for studies of resource partitioning (Schoener, 1983). Some tropical species are leaf-cutters and many western species forage for seeds (Hansen, 1978), but most temperate species are generalist scavengers foraging for other arthropods or feeding at plant nectaries and tending honeydew secreting insects (Carroll and Janzen, 1973). Any habitat is likely to have upwards of six coexisting species (Post and Jeanne, 1982) and it becomes a challenge for the investigator to unravel their niche relationships (Lynch, et.al., 1980).

A long term investigation would include species' distributions across habitats (i.e., which species are habitat generalists or specialists) and a comparison of their seasonal abundance patterns. In this exercise we will concentrate on analyzing the niche relationships of an old field ant community at a single point in time. Niche dimensions to be examined include space (distribution within a field), time (diurnal activity periods), and food (resource preference).

PROCEDURES AND ANALYSIS

The instructor should locate a potential study site and set out baited petri plates prior to the field exercise. Plates with ants should be collected and frozen so that students have time to acquaint themselves with the species to be encountered and acquire some practice at doing counts. When large numbers are attracted to the baits, it is sometimes necessary to count by tens or twenties. Students must learn not to dote over a plate and to be satisfied with a good approximation of the numbers present.

Establish a grid of petri plates (e.g., one hectare grid at 10 meter spacing = 100 petri plates). Early in the morning, bait each plate with a ca.. 10 gram mixture of honey and tuna (pancake syrup and catfood if under a tight budget). Groups of students then visit the grid periodically throughout the day and record weather conditions, surface temperature, and the species and numbers of each visiting each plate. In 20 of the spaces betwen grid points, place divided petri plates containing different types of baits in each quadrant (e.g., pure tuna, Grape Nuts cereal soaked in cooking oil, grapes, centimeter cubes of sponge soaked in honey). Students observing these plates will count the number of individuals of each species attracted to each bait type and also make note of any aggressive encounters or displacements that occur. Additional information that could be recorded are discovery time, recruitment rates, and differences in food handling. For example, are large items dismembered by many individuals of a small species or are they ignored and subsequently carried off by a larger species.

1) Prepare a map of the study area locating grid points and conspicuous patches of vegetation. Superimpose upon this map the ant species collected at each grid point. Are certain species associated with particular patches of vegetation? Do aggressively dominant species appear to be segregated spatially?

2) Calculate the extent of spatial overlap between each species using the formula: 2c/a+b where a = no. baits containing species a, b = no. baits containing sp. b, and c = number baits containing both spp. a and b.

3) Are the same species present at the baits throughout the day or is there a diurnal succession of species? If species change throughout the day what do you think might be responsible (e.g., innate activity patterns, physiological responses to ambient temperature, aggressive displacements)? How might you test these ideas?

4) Calculate the extent of temporal overlap between each species using the formula $TO = 1 - .5\,\Sigma\,|p_{it} - p_{jt}|$ where pit and pjt are the proportions of the ith and jth species active during a particular time interval (t).

5) Do the ant species found in your field differ in resource preference? Which prefer sugar baits, protein baits, or show no preference? Do they differ in the size of bait they can handle?

6) Calculate the extent of food overlap between each species using the formula $FO = 1 - .5\,\Sigma\,|p_{if} - p_{jf}|$ where pif and pjf and the proportions of the ith and jth species attracted to a particular type of food (f).

7) Calculate total overlap along the dimensions of space, time, and food by multiplying the **3** overlaps calculated above. Which species are most sim^_ilar (dissimilar) in their niches? Which species do you suspect are the most serious competitors? Does the extent of niche overlap necessarily reflect the intensity of interspecific competition? See Colwell and Futuyma, 1971.

8) Which are the dominant and which the passive species in your ant community? Does displacement occur via aggressive fighting (e.g. leg or antennal pulling) or does some chemical appear important? For example, do any species gaster-flag or show evidence of anal secretions? See Adams and Traniello, 1981.

ADDITIONAL QUESTIONS AND SUGGESTIONS

The work and analysis done previously has helped to define the realized niches of the ants in a particular old field community. Use of space, daily activity pattern, and food preference in the absence of all other species would be a species' fundamental niche. Many of the following questions are designed to look for 'niche shifts' when some of the community elements have been altered.

1) Place baited petri plates along transects passing through various habitats and collect the ants visiting them. Are some of the ants observed in old fields also found in wooded areas? What new species are encountered? Which species have the broadest (narrowest) niches? How might you quantify 'niche breadth'?

2) Establish a grid of baited petri plates in another abandoned field. Are the same species present in similar abundances or is this ant community different? What might account for any differences in species composition? For example, is the field more xeric? If the two fields differ somewhat in the complement of ant species, is there any evidence of a temporal niche shift in a species found in both fields? For example, does it forage earlier (or later) in the day when another species is present?

3) Test whether any diurnal changes in species abundances are due to innate activity patterns or physiological responses to ambient temperature by shading a colony and bait with a plywood board.

4) Locate a bait site that is dominated by a particular species having a nearby colony, and isolate that colony from the bait by encircling it with aluminum flashing rimmed with Tanglefoot Do other species of ants now use the bait?

5) Compare food preference of an ant species at a site where it is the only one to utilize the baits and at sites where other species are present. Is there any evidence of it being displaced from more desirable resources by another species?

6) Crush several ants suspected of chemically repulsing other species in petri plates containing honey/tuna baits. After removing the dead ants place these and uncontaminated baits near the colony of another species of ant Are both types of baits utilized with equal rapidity?

REFERENCES

Adams, E.S. and J.F.A. Traniello (1981). Chemical interference competition by Monomorium minimum. Oecologia 51: 265-270.

Carroll, C.R. and D.H. Janzen (1973). Ecology of foraging by ants. Ann. Rev. Ecology and Systematics 4: 231-257.

Colwell, R.K. and D.J. Futuyma (1971). On the measurement of niche breadth and overlap. Ecology 52: 567-576.

Connell, J.H. (1980). Diversity and the coevolution of competitors, or the ghost of competition past. Oikos 35: 131-138.

Creighton, W.S. (1950). The ants of North America. Bull. Mus. Comp. Zool. Harvard 104: 1-585.

Hansen, S.R. (1978). Resource utilization and coexistence of three species of Pogonomyrmex ants in an Upper Sonoran grassland community. Oecologia 35: 109-117.

Hutchinson, G.E. (1959). Homage to Santa Rosalia, or why are there so many kinds of animals? Amer. Naturalist 93: 145-159.

Lawton, J.H. and D.R. Strong (1981). Community patterns and competition in folivorous insects. Amer. Naturalist 118: 317-338.

Lynch, J.F., E.C. Balinsky, and S.G. Vail (1980). Foraging patterns in three sympamc species, Prenolepis imparis, Paratrechina melanderi and Aphaenogaster rudis. Ecol. Entomology 5: 353-371.

Post, D.C. and R.L. Jeanne (1982) Rate of exploitation of arboreal baits by ants in an old-field habitat in Wisconsin. Amer. Midland Nat. 108:88-95.

Price, P.W. (1980). Evolutionary biology of parasites. Princeton Univ. Press, Princeton, N.J. 237 pp.

Salt, G.W. (editor) (1983). A round table on research in ecology and evolutionary biology. Amer. Naruralist 122: 583-705.

Schoener, T.W. 0983). Field experiments on interspecific competition. Amer. Naturalist 122: 240-285.