ISSUES : FIGURE SET

Do Antbirds Help or Hinder Army Ants?

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Army ant workers (*Eciton burchellii*) clustered around a captured insect.
Photo by Alex Wild, used with permission.

THE ISSUE:
The effects of species interactions are not always obvious. This issue examines the nature of the relationship between army ants and ant-following birds. Students will design a hypothetical experiment to measure the effect of birds on army ant foraging success, interpret the results of a real experiment, and consider the consequences of the interaction on the ant colony and the forest community.

SECTION 1:
Design an Experiment

PURPOSE:
To practice experimental design.

TEACHING APPROACH:
"informal group work"

COGNITIVE SKILLS:
knowledge, application, comprehension, evaluation

STUDENT ASSESSMENT:
design an experiment; critique an experimental design

CITATION:
Kuhlmann, Mark. April 2006, posting date. Do Antbirds Help or Hinder Army Ants? – Section 1. Teaching Issues and Experiments in Ecology, Vol. 4: Issues Figure Set #1 [online].
http://tiee.ecoed.net/vol/v4/issues/figure_sets/army_ants/background1.html

BACKGROUND

A massive swarm-raid by an army ant colony is one of the most impressive behaviors by social insects. Thousands of ants advance in a swarm, scouring the forest for food. Foraging workers carrying off small insects and gang up on and overwhelm larger animals by sheer numbers. Many insects and other animals flee ahead of the advancing swarm. Workers use their bodies to create living bridges to overcome obstacles, and at night, form a living shelter for the queen and brood.

As these huge colonies move through the forest, they are often accompanied by a community of other species, including birds, other insects, lizards, and even mammals (Schneirla 1971). But what exactly is the nature of the relationship between the ants and their followers? Do they help or hinder the ants?

"Army ant" is both a taxonomic designation and a description of a lifestyle. Most army ants are in one of two genera: *Dorylus* (paleotropics) and *Eciton* (neotropics). The army ant lifestyle includes nomadism (usually the whole colony moves), group predation (raids), and, often, above-ground nesting. Although ants in other genera have these behaviors, the extent to which they are developed and combined is unique to the "true" army ants (Gotwald 1995).

An army ant colony typically cycles between two behavioral phases: nomadic and statary (Schneirla 1971). During the nomadic phase, a colony moves daily, housing the queen and brood in a temporary bivouac, and conducts large foraging raids. During the statary phase, the colony stays in one place for several weeks and conducts small-scale raids during the day. The main prey of a raiding army ant colony are leaf-litter invertebrates and the brood of other social hymenoptera (ants, bees, and wasps). Workers usually aggregate on prey, collectively subduing and dismembering it (Gotwald 1995). As a result, army ants can capture prey many times larger than an individual worker. Because army ants will attack almost anything, many animals flee the oncoming swarm. After an army ant swarm raid has passed, arthropod densities in the leaf litter may be reduced by as much as 50% (Gotwald 1995). Because of their large colony sizes (up to 1.5×10^6 ants/colony) and mobility (raids cover >1000 m^2 of forest per day), army ants have a significant impact on tropical forest communities.

Army ants also have indirect effects by supporting a community of ant followers, especially birds. In the New World topics, over 50 bird species regularly follow army ant raids, many of them classed as "professionals" in that they get >50% of their food at army ant swarms. Common ant-following birds include members of the antbird family (Formicariidae) as well as woodcreepers, cuckoos, and tanagers. The number of birds following a particular ant swarm varies considerably from day to day, but large colonies of regularly-swarming army ants are frequently accompanied by flocks of over 20 individuals of several bird species (Willis and Oniki 1978).

Ant-following birds stay just ahead of the advancing army ant swarm or perch on branches just above it, capturing animals, mostly larger arthropods and small vertebrates, disturbed by and fleeing from the army ant raid. Although they may occasionally incidentally consume army ant workers that are attached to something else they are eating, studies reveal that the birds do not deliberately eat army ant workers (Willis and Oniki 1978). By getting food that they otherwise would not, the birds clearly benefit from the association. Early studies suggested that the birds might flush prey back to the ants, making the relationship mutualistic (Willis and Oniki 1978). However, later studies do not specifically describe the nature of the interaction, and it is possible that birds remove prey that the army ants would otherwise capture (Wrege et al. 2005). The balance between mutualism, commensalism, and parasitism is often a fine one, and determining the exact nature of this type of interspecific relationship often takes careful measurement of the costs and benefits to each species.

References

- Gotwald, W. H., Jr. 1995. *Army Ants: The Biology of Social Predation*. Cornell University Press, Ithaca, NY.
- Schneirla, T. C. 1971. *Army Ants: a Study of Social Organization*. W. H. Freeman and Company, San Francisco, CA.

- Willis, E. O., and Y. Oniki. 1978. Birds and army ants. *Annual Review of Ecology and Systematics* 9:243-263.
- Wrege, P. H., M. Wikelski, J. T. Mandel, T. Rassweiler, and I. D. Couzin. 2005. Antbirds parasitize foraging army ants. *Ecology* 86:555-559.

STUDENT INSTRUCTIONS

Peter Wrege, from Cornell University, and his colleagues wanted to find out if ant-following birds had a positive, neutral, or negative effect on the prey capture rate of a swarm-raiding army ant species. How would you go about testing the hypothesis that ants benefit from the presence of ant-following birds by capturing more prey?

With the other students in your group, design an experiment to test the hypothesis that ants benefit from the presence of ant-following birds by capturing more prey. A hint: the researchers figured out that aggregations (clusters) of army ant workers always indicated the capture of some sort of prey by the ants. Keep in mind the following key components of any good experiment: a control (something to which to compare the treatment), replication (do it more than once), and consideration of confounding factors (what might cause differences other than what you manipulate in your experiment?).

Follow your teacher's instructions for completion of the "Army Ant Experimental Design" handout and for reporting out.

NOTES TO FACULTY

This exercise is appropriate for upper-level biology students with some knowledge of experimental design and the ecology of the rainforest, but may be challenging for less-experienced students.

Before working on this exercise, students should get some introduction to the biology and ecology of army ants, either presented by the instructor or by reading the background material. In particular, students will be better able to design an appropriate experiment if they can visualize the habitat and phenomenon being studied. Some nice pictures that support the background material are available in Gotwald (1995), Willis and Oniki (1978), and the web references listed in the Resources section includes links to general information.

In addition, students need some knowledge of the elements of a well-designed experiment. The Resources include links to rubrics for judging the quality of students' experimental designs. Many teachers give students rubrics like this ahead of time to so that their students clearly understand evaluation criteria. For this activity, a rubric could be given to each group for students to discuss before they develop their experimental designs.

A class discussion of the experiments designed by the student groups (as described in the Student Instructions) with comments encouraged from other groups can be very useful. Careful management will be important here. Students will need clear instructions for reporting (e.g., select one person in the group to be the reporter, know there is limited time available for reporting per group, etc). Depending on students' level of experience, each group could preview another's design before the discussion and present their critique as a way to start the discussion. The instructor and students should help point out good points and flaws of different groups' experiments, helping to introduce or reinforce key elements of experimental design. Each group can turn in a written description of their experiment for assessment. The Army Ant Experimental Design [PDF] form will help students organize this assignment. Students can fill the form out together in class and hand it in as a group or do this individually as homework. Students can fill the form out together in class and hand it in as a group or do this individually as homework.

Wrege et al. (2005) includes the following description of their design:

> *The experiment consisted of paired, 10-min trials, during which we quantified the capture success of the army ant swarm in the presence, and then in the absence, of attendant birds. We could usually exclude birds from the experimental area simply by standing immediately adjacent to the area and gesticulating with our arms. The occasional persistent bird was discouraged with a shot of water from a squirt gun, or by throwing a fragment of bark into the leaf litter nearby when the bird began to approach too closely…We initiated trials when we expected the ant swarm to traverse relatively homogeneous habitat, and when the attending ant-followers were active and generally numerous (>3 birds).*
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> *E. burchellii aggregate on prey items just after capture when prey are larger than can be handled by a single worker. These groups of ants then subdue and dismember the prey (Rettenmeyer 1963, Schneirla 1971, Gotwald 1995). As prey size increases, the number of workers involved in subduing and processing increases, and "aggregations" on prey larger than ~0.8 cm persist sufficiently long to be counted as a measure of foraging success. In 2001, we presented crickets, or parts of crickets, to foraging E. burchellii and monitored the persistence of the aggregations for the purpose of estimating the size ranges of prey likely to be counted, beginning 20 min after the ants passed through an area.*

As an alternative, students could be given this experimental design to critique and to explain in a step-by-step fashion.