The Macaroni Lab

A Directed Inquiry Project on Predator-Prey Relationships

Michelle Oyler John Rivera Melanie Roffol David J. Gibson
Beth A. Middleton Marilyn Mathis

If you were to take your students for a walk to record their observations of your school yard today, what would they write? Most students would record seeing trees, flowers, fungi, squirrels, birds and other obvious organisms. Some of your more insightful students would note the direction of the wind, humidity, amount of sunshine, the layout of the land, or a hawk catching a mouse. Ecologists sometimes study such *predator-prey relationships*. This directed inquiry activity will take your students one step further than observation, through the investigation of how living organisms capture prey. Your students actually will be doing science, not just hearing about it!

We use a directed inquiry field lab based upon predator-prey relationships to enliven our teaching of the food web concept to nonscience major freshman undergraduates. We think this lab can be applied to levels from high school biology students through college science majors. The students learn the scientific method by stating and testing their hypotheses, while at the same time posing in the role as "predator" catching their macaroni "prey."

Length of Time

2 to 3 class periods

Michelle Oyler and **John Rivera** are graduate students in the Department of Curriculum and Instruction, Southern Illinois University, Carbondale, IL 62901. **David J. Gibson** and **Beth A. Middleton** are Associate Professors, **Melanie Roffol** is an undergraduate student, and **Marilyn Mathis** is a graduate student in the Department of Plant Biology, Southern Illinois University, Carbondale, IL 62901. Reprint requests should be sent to David Gibson.

Materials Needed

- 2 variety boxes of plastic utensils
- forceps (about 5)
- timer (with a "bell" is helpful)
- colored pasta
- portable chalkboard (or large paper with stand)
- chalk
- eraser
- outdoor activity site

Teacher Preparations

1. Introduce the concepts of "food chain" and "food web," including a discussion of how a disturbance such as farming, logging or fire might change predator-prey relationships by altering habitat structure.
2. Introduce the concept of "biotic" and "abiotic" factors and how these interact. Include a brief discussion of which abiotic factors could affect predator-prey relationships.
3. Familiarize your students with the scientific method, particularly the development of a hypothesis.
4. Arrange for use of an outdoor site.
5. Warn your students to dress appropriately for working outdoors.
6. Spread "prey" (macaroni) out before class! We find that one 16 oz. bag is sufficient to adequately "seed" approximately 5 m^2.
7. Arrange for transportation to site if necessary.
8. For homework two days prior to the activity, have your students make their own food web using drawings and pictures from magazines. These student creations can be used for the food web discussion the day before. Students can volunteer to "show and tell" their food web. You can choose two or three posters to demonstrate the devastating effects of the removal, reduction or addition of one link in a food web.

Selection of Activity Site

The outdoor site that you choose for this activity should include differences in habitat structure, e.g. grass height, amount of woody material. At least two different structural types are necessary.

Procedure

Day One

After a short review of the material from the day before, bring the students and the necessary materials to the site chosen for the activity. Begin by asking, "What factors can limit the success of a predator?" A wide variety of answers is acceptable, such as: the weather, speed capabilities of the prey, the color of the prey, the technique or mechanism the predator uses to capture prey, and the location of the prey (e.g. in a tree, under leaves on the ground, in a hole). Write the responses of the students on a portable chalkboard. To assess whether your students fully grasp the great extent to which members of a food web are interconnected, ask them a question such as, "What effects would a fire have on the predator-prey relationship between a red-tailed hawk and a cotton-tail rabbit?" *(Possible answers include: fire would increase predation due to lack of cover for rabbits, increase mortality of rabbits, increase red-tailed hawk population due to immigration to the area, and a sharp decrease in rabbit population as more rabbits are captured in the open*

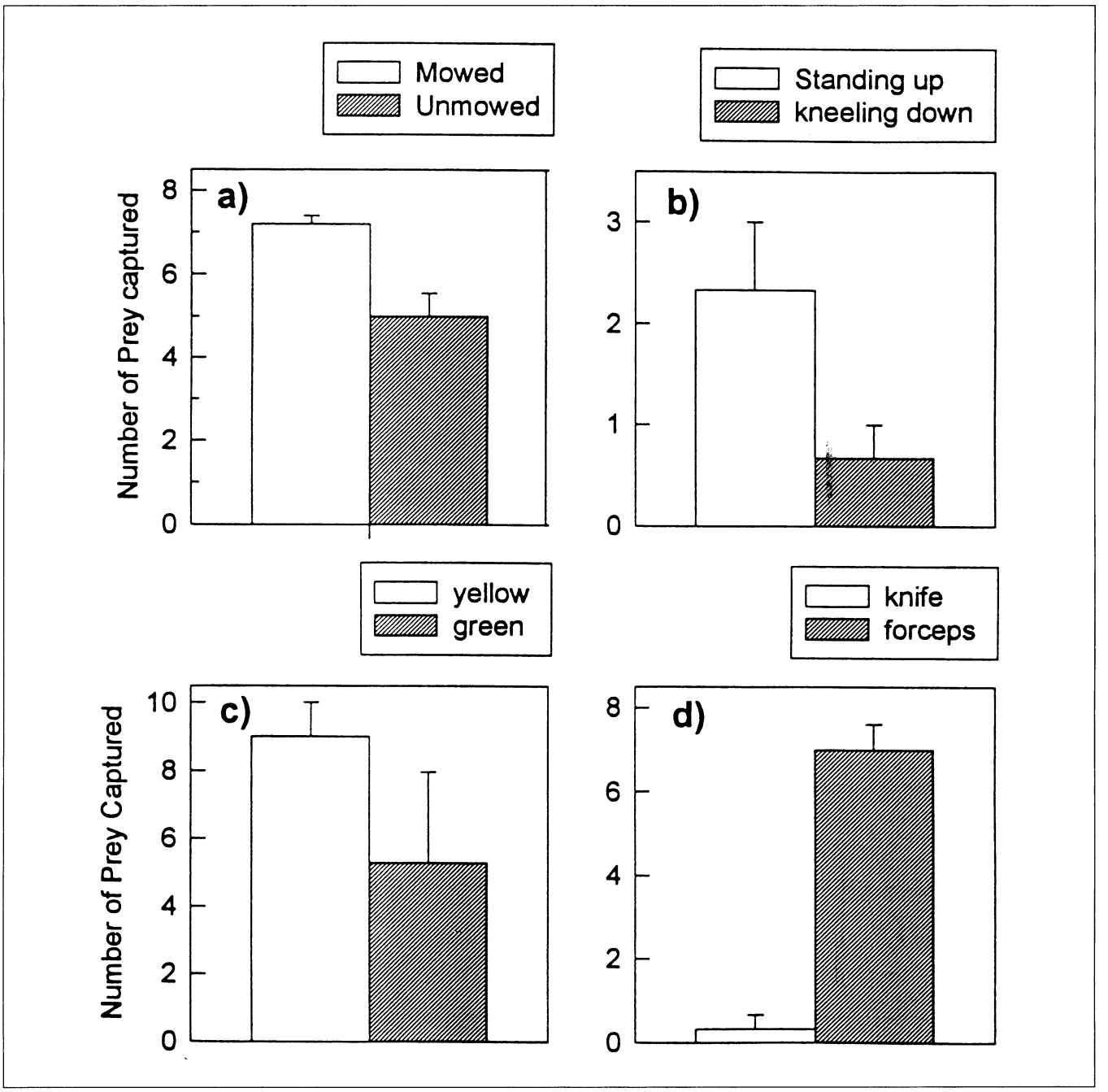

Figure 1. Representative data collected by students in an undergraduate nonscience majors biology class, Summer 1997. Student groups were comparing a) mowed and unmowed areas, b) high flying (student searches standing up) and low flying (student searches kneeling down), c) yellow versus green (camouflaged) prey, and d) knife versus forceps as a feeding appendage. Data are the mean number of prey items captured per minute + / − 1 SE.

habitat, followed by a decrease in red-tailed hawk population.)

Activity

Begin by explaining to your class that animals face multiple obstacles while trying to capture prey or to avoid becoming prey. The structure of the habitat of an animal affects the difficulty of finding food; for instance, it would be easier for a fox to spot a rabbit in an area with little vegetation than in an area with dense vegetation. Density of the vegetation in which the food is hidden, the space and density of the food item, the color of the food in relation to its background, and the type of appendage (e.g. claws, teeth, beak, tongue) predators use to obtain prey also affect prey capture rate. The purpose of the activity is for students to develop a hypothesis, test the hypothesis, analyze their data, and draw conclusions based on that data. In this way, the students will learn the scientific method, by doing what scientists do.

The Field Experiment

1. Before the students arrive, spread the macaroni at the site.

2. After the students arrive, ask them to pair up.
3. Inform your class that they will simulate the predator/prey relationship. They can be a predator with any of the following appendages for prey capture: fork, spoon, knife, forceps, fingers. Colored macaroni will represent their prey. The students will choose habitat types within which to locate prey (e.g. mowed, unmowed, bushy).
4. Have each pair come up with a hypothesis concerning the success of prey capture using various types of prey capture devices (e.g. forks, spoons) within two habitat types.
   - Examples (only if needed!): "Fork" predators will capture more prey in the unmowed than the mowed area.

   If they come up with a hypothesis dealing with aspects other than area and appendage, that is good! Here is an example:
   - Spoons who search for prey close to the ground *(squatting)* will catch more prey than spoons who search for prey high off the ground *(standing)*.
5. After three minutes, have one or two of the groups read their hypotheses out loud to their classmates.
6. All groups will now test their hypotheses individually.

The groups need to spread out a little. One group member will act as a "predator" (e.g. spoon, fork) while the other records the data. The "predator" will have 45 seconds to capture at least seven "prey" with his/her appendage to avoid starvation. "Prey" should be picked up *one at a time* (in reality, most predators can only capture and eat one prey at a time!) without using fingers. Then, the prey is brought back to an area set aside as a "nest." At the end of 45 seconds, the recorder for the pair writes in the number of prey caught by his/her partner. This process will be repeated five times in each of the two habitat types *(Example: Five 45-second trials of forks in the mowed area and five 45-second trials of forks in the unmowed area).*

Day 2 (If designated lab time is too short to complete the exercise in a single one day lab)

Ask students to recap their findings in the last lab. The students will regroup into pairs. The students should graph the means of their data in a histogram *(bar graph [e.g. Figure 1])*. Leave it up to them how to organize the histogram; however, give a few guidelines (title, "x" and "y" axes labeled, neat and organized, overall good representation of their data set). This provides them a means to visually analyze the data they collected. Then, they can use this information to answer the following questions:

1. Summarize your results in complete sentences.
2. What conclusions can you deduce from these results?
3. Was your hypothesis supported? Explain thoroughly.
4. What are some abiotic factors that may affect the success or failure of predators?

Ask for pairs to volunteer to share their findings with the rest of the class. Data sheets, graph, and answers to questions can be turned in for assessment if the teacher so desires.

Additional Tips

1. Keep up the pace! Without rushing the students, keep a close watch on time. Make sure time inbetween 45-second trials is minimal to reduce down time and opportunity for students to stray off task.
2. Keep the discussions student centered! Let them come up with ideas in a discussion format. Provide as little guidance as needed throughout.
3. Keep students close enough together so they can hear you and stay on task, yet not so close as to cause confusion during the trials.
4. Designate some minimum number of macaroni capture per trial for the predator to keep its nestlings alive. This will add drama to the exercise.

Suggestions

This activity is a modification of a foraging/flocking behavior lab described by Smith (1993) that has been proven very successful for undergraduate nonscience majors at Southern Illinois University at Carbondale (Gibson et al., in press) and can be easily modified for use through the eighth grade. Not only does this activity engage students in actually "doing science," but it also builds their inquiry skills by allowing them to think for themselves (see Ebert-May et al. 1993).

Acknowledgments

We would like to thank Mike Oyler for assisting in the development of this activity. Financial support was provided by the National Science Foundation (DUE-9554807). Additional information is available on the World Wide Web at *⟨http://www.science.siu.long-term/⟩*

References

Ebert-May, D., Rowland, P. & Tashiro, J.S. (1993). Ecology as a way of knowing. *Bulletin of the Ecological Society of America, 74*(2), 125–130.

Gibson, D.J., Middleton, B.A., Saunders, G.W., Mathis, M., Weaver, W.T., Neely, J., Rivera, J. & Oyler, M. Learning ecology by doing ecology: Long-term field experiments in succession. *The American Biology Teacher*, in press.

Smith. C. (1993). Foraging and flocking behavior. In J.M. Beiswenger (Ed.), *Experiments To Teach Ecology* (pp. 111–135). Washington, DC: Ecological Society of America.