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Fireflies As a Catalyst For Science Education¹

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SYNOPSIS. The study of fireflies makes an ideal subject for introducing students of all ages to the world of science, conservation biology, field studies and the importance of observation and understanding connections in the natural world.

The synchronous fireflies, *Photinus carolinus* of the Great Smoky Mountains National Park's Elkmont Historic District can be used as a basis for classroom and field activities in subjects as diverse as conservation biology, economics, geography, ecology, governmental policy, zoology, history, taxonomy and animal behavior.

Having been fascinated with the synchronous fireflies for over two decades, I will use the life cycle of the Elkmont *Photinus carolinus* found in the Great Smoky Mountains National Park as an example.

INTRODUCTION

In June, hours to a few days after mating, the female firefly lays a clutch of ~50 eggs in the soil. After three weeks, sometime, in July, these eggs hatch into voracious larvae that go through a series of molts, a stage commonly known as glow worms. Slugs and earthworms are their major prey. Next spring, the larvae pupate and emerge in late May or early June as beetles that live 2 to 4 weeks. The majority of their energy is spent in finding a mate: mating displays for the males, copulation and, ultimately, egg laying for the females. The cycle then repeats.

In our experience with the use of fireflies, the teacher should have students in the field for a large part of the learning experience. In preparation for observation of synchronous flashing, students should already have participated in an exercise of clapping their hand in synchrony. This activity clarifies both the word "synchrony" and the relatively simple observation that living things thus possess the ability to achieve mass synchrony.

The synchronous fireflies of the Elkmont Historic District make for an especially dramatic introduction to field study. Every June thousands of these insects emerge and loosely congregate on the wing for several weeks in a synchronous nocturnal display traditionally called "The Light Show." On nights surrounding the "peak Night," this rhythmic spectacle of masses of flying male fireflies blinking six rapid blinks in unison and then going into their dark phase together, must be witnessed to be fully appreciated. The peak of this behavior can be determined only in hindsight, since it can vary by several weeks depending on the weather. The viewer comes away from "The Light Show" not only in awe of the firefly, but also wanting to know more.

The fact that this display is a sexual strategy is made even more interesting if learners are lucky enough to

witness the highly competitive mating clusters, similar to but larger than *Photinus pyralis* "love knots," that form around the ground dwelling females where up to 10 males struggle in the stack of grappling suitors to reach the receptive female.

The student may have started the class in a classroom that morning, then moved to the nighttime fields and woods as the sun set. They may find themselves in the dark hours near midnight, crouched on hands and knees, squinting at the fierce competition in the leaf litter, which will result in the next generation of fireflies.

Fireflies and their behavior are certainly not the only catalysts for teaching natural history and science to students, but they are quite impressive and leave a lasting impression.

USING FIREFLIES AS A TEACHING CATALYST FOR EMERGING SCIENTISTS

As a teaching tool, fireflies make ideal subjects. As long as one lives east of the Rocky Mountains and has access to a dark, relatively unpolluted area of vegetation on warm spring and summer evenings, lightning bugs are easy to observe. Fireflies are likable, magical and along with lady bird beetles, they are considered "charismatic insects" by National Geographic.

As a naturalist who gives talks on a variety of topics to groups as diverse as college level field schools, students aged five to eighty plus years, to government, civic and to environmental organizations, my job is to convey a sense of wonder and understanding for the natural world, while stressing the importance of observation and conservation of our environment and how life is interconnected.

Fireflies have the ability to almost effortlessly encourage interested learners to integrate Biology, Ecology, Animal Behavior, Chemistry, Zoology, Geography, Taxonomy, Politics, Conservation, Economics and History into the total picture of lampyrid life and the living world beyond. For instance, a very simple example of geography is that the reader has probably already noticed these beetles have been called both fireflies and lightning bugs in the first two paragraphs.

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In general (but not always!), those of us who grew up south of the Mason Dixon Line call these insects “lightning bugs.” Everyone else seems to use the term “fireflies.” They are one and the same. For the rest of this article I will use the term “firefly.” We will return to each of the aforementioned fields of study and how they support one another at different points in this paper.

FIREFLY ECOLOGY

The beetle family Lampyridae has about 123 known species in the United States, 1,200 in the Western hemisphere and 2,000 worldwide, and many more are yet to be discovered. The life cycle of the Elkmont *Photinus carolinus* found in the Great Smoky Mountains National Park is typical.

There may be as many as nine different firefly species displaying in the same area on a given night. How does one tell them all apart? The following characteristics determine distribution:

- The time of year they emerge and fly, between April and October
- The time of day or night they display—some blink at dusk, others at true dark, others post midnight, some non-blinkers are active during the day
- Length of time of display—some blink for 30 minutes, others for several hours
- The phase of the moon
- Air temperature and humidity
- Height above ground. Some fly at 1 meter, others at 2 meters, and others at treetop levels
- Elevation—*Photinus carolinus* the synchronous species in the Great Smoky Mountains National Park has not been found below 700 meters.
- Structure—open field, deep woods, thickets
- There are the blinks. Is the beetle flying or stationary? What pattern are the blinks? What color? Intensity? Crescendo? Periodicity? Is it a male or female blink? What type of blink—sexual, distress, predatory, or communication.
- In a classroom setting, hands-on chemistry activities strive to make understandable the many chemical reactions going on inside the fireflies

By making the learner aware of the all the different variables affecting firefly biology, the teacher is encouraging the importance of accuracy in observation, timing, field notes and awareness of the details of the habitat. Just simply looking does not teach very much, but looking with the knowledge of what to look for opens up a previously unrecognized world.