

Conversations with Fireflies: A Case Study of Mimicry and Defense



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Moving In

Joe sighed as he sank into the overstuffed chair in what had once been the library of Dr. James E. Lloyd, a former entomology professor at Cornell University. Joe had graduated from college in May and was excited to begin his new life as a graduate student in entomology. His new apartment was in the old house that had belonged to Dr. Lloyd, and there had been plenty of cleaning to do.

It was raining outside and he didn't feel like moving, so Joe decided to relax and take a peek at the old, tattered field notebook he had found behind a pile of junk in the garage. He settled in and opened the notebook to reveal the long-hand scribbling from long ago.

"13 June 1963. Fife, Goochland County, Virginia," read the first entry. Walking through a grassy field at dusk with a flashlight in hand, Dr. Lloyd had been hunting fireflies that warm, humid June night.

Joe's interest was piqued. He thought fireflies sounded interesting and that it must have been fun to tromp around in the field studying them. He wouldn't mind doing some research on the natural history of such magical creatures. Intrigued, Joe continued reading:

13 June 1963. Fife, Goochland County, Virginia.

While searching in the site of Photinus ignites, I received a single-flash response to a quick flash of the flashlight after a delay of 5.5 seconds at 14°C. This is the delay time and flash of P. ignites females.

Joe sat up straighter in his chair. Had he read that right? Did that mean what he thought it meant? Had Dr. Lloyd "talked" to the firefly? Joe knew that males flash their lights in a species-specific pattern as they fly around to attract mates. He also knew that females of the same species respond with a flash pattern of their own from their perches in the grass, thus alerting males to their presence and willingness to mate.

Joe mused that if it were true that the delay time and flash pattern were species-specific, then Dr. Lloyd had not only "called" to the firefly, but he had called specifically to the female of that particular species! Dr. Lloyd was an entomological Dr. Doolittle!

Joe's mind was tired but alert, and he wondered if the males and females of the same species have the same flash pattern. He was intrigued, but awfully sleepy. He looked at his watch and, seeing it was after midnight, decided it was time to head to bed. He put the notebook on the table, still musing about talking to fireflies. He didn't notice the next sentence of Dr. Lloyd's faded entry:

When collected after several more similar flash responses, this female was found to be Photuris.

Question

1. What does this last sentence in the notebook tell you about the fireflies that Dr. Lloyd was observing?

Two Weeks Later

It had been a long but exciting two weeks as a new graduate student. Even though it was Friday night, Joe decided to spend a quiet night at home, with his mind back in 1963 with Dr. Lloyd and his fireflies. He settled into the overstuffed chair by the window and opened the tattered field notebook. As the light faded outside, his attention was caught by the following entry:

24 July 1963. Red Hills State Park. Lawrence County, Illinois.

*During the early period of activity of *Photinus pyralis* I located a *Photuris* female in a *P. pyralis* site by her flash, given 2.2 seconds after a flash from my flashlight at 21°C. This is the time delay my colleague Buck found for *P. pyralis*.*

Joe rubbed his eyes hard and looked at the entry again. Had he read it wrong? No, *P. pyralis* was a species in the genus *Photinus*, but the female Dr. Lloyd had found using the *Photinus pyralis* flash pattern was a female of the genus *Photuris*. That's what it said all right.

"That doesn't make sense," Joe said aloud. "I thought I read last time that the flash pattern was species specific. What's a *Photuris* female doing responding to a *Photinus* signal?" He turned the page and found the following entry:

24 May 1964. Gainesville, Alachua County, Florida.

*In the site of a large population of a species in the *Photinus collustrans* complex, two *Photuris* females repeatedly answered my single flash with a single long pulse, 1 second in duration, after a delay of about 1 second (the flash-and-delay-characteristics of this *Photinus* species). No *Photuris* males were seen.*

Joe thought things were getting stranger still. What were females doing responding as if they were a different species? Was Dr. Lloyd seeing things? Joe turned out the light and went to bed.

Three Months Later

It was raining again, and Joe felt depressed and discouraged. He had been working on his own research for three months, but so far none of his experiments had been successful. He decided to visit with Dr. Lloyd and his troublesome research. Maybe the fireflies would cheer him up on this dreary evening. He turned to the following entry:

6 April 1965. Gainesville, Florida.

*The flash pattern of males in one species of the *Photinus consanguineus* complex consists of two short pulses separated by about 2 seconds. This phrase is repeated every 4 to 7 seconds. While searching for females I received a response from the direction of a low weed along a stream. The flash appeared greener and brighter than usual, and upon investigation I found a large (14-mm) black *Photuris* female. One 11-mm black *Photuris* male was later caught which emitted single, ragged, flickering flashes at intervals from 3 to 5 seconds in duration.*

*I watched this female for the next half hour, and during that time she responded to 12 passing males of the *Photinus* species with a single-flash response similar to that of the females of this species—a single pulse about 1 second after the second male pulse. All of these males were at least partially attracted to her. One flew into the stream. Two flew into the grass below her and*

then she stopped answering them; presumably she couldn't see their flashes. Eight of the males were attracted to within 1 meter of her and then she stopped answering them.

While answering, she would occasionally flash after the first male pulse and then again after the second pulse. Usually she answered only after the second pulse. I also noted that, as the males neared her, she greatly reduced the intensity of her flashes. The last male attracted, after three or four flash exchanges, landed about 7 cm from her. After another flash sequence I turned on my light and found him 15 cm from her. Following the next flash exchange, after a pause of 10 to 15 seconds, I checked and found she was clasping him and chewing on him!

Joe's eyes lit up as bright as a firefly. He thought he saw what was going on, and if he were right, it would be the coolest thing he had learned about insects yet! And if those fireflies were doing what he thought they were doing, he had an awful lot to learn about how their behavior had evolved, and why they were doing it. He decided to see if there was more information on this in the library because surely there were unanswered questions. Maybe he could dump his research project and revive Dr. Lloyd's research.

More Questions

2. What further research questions regarding the behavior of the *Photuris* females are raised by these observations?
3. Propose two hypotheses explaining how this behavior might be advantageous to the *Photuris* females.
4. Design an experiment to test one of your hypotheses. Be sure to identify your dependent and independent variables and control treatment.

References

Lloyd, J.E. 1965. Aggressive mimicry in *Photuris*: Firefly Femmes Fatales. *Science* 149 (3684): 653–654.

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