



# Synchronic Firefly Research at Congaree National Park

## Research Summary

by Dr. Frank Henning, Dr. David C. Shelley and Dr. Jonathan Copeland



**Above:** humpback posture and hourglass headshield that are characteristic of *Photuris frontalis*. © LYNN FAUST

## Synchronic Fireflies and their Sophisticated Form of Animal Communication

The first historic accounts of synchronous flashing are from records that date back to the late 1500s of fireflies that grouped in trees along waterways in Southeast Asia. More recently, synchronous flashing was discovered in certain species of North American fireflies that do not congregate. Synchronous flashing fireflies that can be found in North America include: *Photinus carolinus*, *Photuris frontalis* and *Photinus knulli*.

The synchronous quick single flashes of male *P. frontalis* fireflies are typically observed at Congaree National Park for approximately two weeks between mid-May and early June. Synchronous flashing is defined as concurrent rhythmic group flashing. Although the males appear to be continuously synchronic, they are actually intermittently synchronic. Flashing of the group is continuous, but individual fireflies flash synchronously for several cycles and then pause for several cycles.

Research is being conducted on *P. frontalis* at Congaree National Park to improve understanding of this species' unique characteristics including rapid synchronous flashing and intermittently synchronous flashing. Scientists are interested in collecting more data on female *P. frontalis* in order to better understand the

courtship and mating behavior of this species.

## Background

Naturalists often appreciate insects for their fascinating visual displays. Unlike butterflies and moths, fireflies are often identified at a distance by their bioluminescent displays rather than their physical appearances.

When viewing free flying insects at night, factors such as photic depth of field, distinctiveness of flash patterns and the number of different species simultaneously active may confuse field recognition. Basic knowledge of seasonal variation, geographic range and flash patterns are helpful for identifying fireflies.

Firefly flashing is a sophisticated form of animal communication that is species-specific. The male firefly's flash duration as well as the duration of the pause between successive flashes (interflash interval) are components of this species-specific flash pattern. These specific flash patterns communicate information such as sex and species to other fireflies.

While patrolling, male fireflies of most species flash their species-specific pattern independently of other nearby males so that there is no discernible group-wide pattern among flashing males. In contrast, some firefly species flash in pairs or in coordination with a larger group (synchronous flashing).

Continued from previous

The range of *P. frontalis* covers much of the southeast, including Alabama, Florida, Mississippi, North Carolina, South Carolina and Tennessee. Mature forests and wet bottomlands such as those found at Congaree National Park are the preferred habitat of this firefly. *P. frontalis* males are approximately 1/2 inch (13mm) in length, and females are thought to be similar in stature (information on females is limited because they are difficult to find).

One possible explanation for the shortage of data on *P. frontalis* females is female firefly scarcity. The sex ratio of most fireflies is strongly male, especially early in the season. Females are susceptible to predation, so they are often hard to locate because they survive by being cryptic.

Synchronous flashing displays are rare among North American fireflies. The speed and rhythm of *P. frontalis* flash pattern is unique and can be used to separate this species from other synchronous fireflies. Male fireflies produce synchronous quick single flashes twice per second. Flashing of the group may appear continuous, but individual fireflies join in and out of the synchronized display.

Another identifying characteristic of *P. frontalis* males is the height at which they fly. These fireflies usually patrol an area at a height of approximately 2 to 4 ft. (0.6 to 1.2 m) off the ground.

Flashing typically begins shortly after sunset and lasts for approximately one hour before the display dissipates. Smaller displays can also be viewed shortly before dawn.

Female fireflies typically view male displays from a stationary location and respond with their own species-specific flash pattern. The exchange of light displays between male and female fireflies is called a photic dialog. Photic dialog usually occurs between two fireflies but sometimes more than one male can court the same female. This photic dialog continues until male and female meet and ultimately mate.

## Research Overview

Research is being conducted on *Photuris frontalis* at Congaree National Park to improve understanding of this species' unique characteristics including intermittently synchronous flashing.

Beginning in 2009, Congaree National Park partnered with Georgia Southern University to study flash communication and physiology of the synchronic firefly *P. frontalis*. Male behavior is well documented, but mating flash communication has never been described.

The male *P. frontalis* flash code involves a single flash repeated rhythmically every 0.6 to 1.0 sec., depending on temperature. Flying males fly into proximity (1 ft. , or 30cm) and flash together repeatedly and rhythmically at the species-specific interval for several flash cycles. Then, one firefly will stop flashing while the others (if there are more than two fireflies) continue flashing. Shortly thereafter, the non-flashing firefly will resume synchronous flashing.

## Results:

Research suggests that the male-male activity of synchrony in this species serves to spatially separate the flying flashing males. Previous studies found that males neither congregated in the field nor the lab. The flashing is likely a form of competition for females.

The precision and rapid start of synchrony may attract females. Likewise, males that are able to remain flashing may be preferred because they are more visible to females. The separation of males may allow females to choose a single partner for mating.

The lantern morphology of *P. frontalis* females is well known, but their behavior is not well studied. Neither courtship nor mating behavior have been observed or recorded.

Although mass synchrony of firefly flashing appears continuous, researchers found that individual flying males flash intermittently - they enter the flashing pattern synchronously on beat. The intermittent synchrony of *P. frontalis* reinforces evidence that there is a diversity of synchronies in fireflies.

## Research and Management in Action

Researchers continue to study mechanisms associated with synchronous flashing. In addition, they continue to search for female *P. frontalis* in order to better understand the courtship and flash communication.

## For More Information

1. Copeland, J. and A. Moiseff. 2004. Flash precision at the start of synchrony in *Photuris frontalis*. *Integr. Comp. Biol.* 44: 259-263.
2. Faust, L. 2015. *Fireflies, Lightning Bugs and Glow-worms! Field Guide to the Fireflies of the Eastern US and Canada*. The University of Georgia Press. Athens, GA.
3. Moiseff, A., J. Metcalfe, J. Copeland, and F. Palmieri. 1999. Synchrony in fireflies: Diversity, mechanisms, and model. In A. Roda and P. Snelling (ed.) *Bioluminescence: Perspectives for the 21st century*, pp 573-576. John Wiley and Sons, Chichester.