Comparison of flash characteristics and morphology between *Photinus pyralis* and *Photinus greeni* fireflies

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Introduction

Fireflies use flash communication in courtship displays. Females select males based on flash characteristics that vary among species (Lloyd 1966). In at least two species with single-pulse male flashes, *P. ignitus* and *P. pyralis,* females prefer longer duration pulses (Cratsley 2000, Cratsley & Lewis 2003). Females of species with multi or dual-pulse flashes (e.g. *P. consimilis, P. greeni*) appear to discriminate on the basis of pulse rate (reviewed by Lewis et al. 2004). Additionally, larger species of fireflies appear to produce longer duration flashes (Figure 1).

These observations suggest variation in flash characteristics (e.g. duration) among conspecifics may be correlated with morphology. Due to differences in flash behavior of *P. greeni* and *P. pyralis*, we predicted dissimilar relationships between body size and flash duration.

Flashing behavior is thought to have energetic costs, however this has not been documented. If flashing is energetically taxing, male flash characteristics should vary over time.

Objectives were to explore relationships between flash duration, time, and morphology of P. greeni and P. pyralis males.

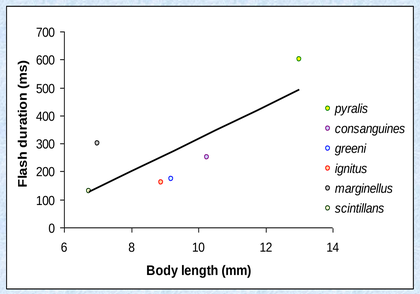

Figure 1. Flash duration versus body length in *Photinus* fireflies

Methods

- Flying, flashing *P. greeni* and *P. pyralis* fireflies were collected in Lincoln, Massachusetts and Plainsboro, New Jersey respectively.
- Each firefly was weighed and then digitally imaged using a Zeiss dissecting microscope with video attachment.
- Elytron length, lantern length, and lantern area were measured from digital images with Scion Image software.
- Male courtship flashes were elicited from male fireflies using a microcontroller based virtual firefly that produced species-specific female flashes from a LED.
- Male flashes were recorded using a photomultiplier and included adjusted half maximal, rise, and decay duration (Figure 2).
- Relationships between flash duration, morphology, and species were analyzed using stepwise multiple regressions and two-tailed t-tests.
- Variation in flash duration between successive flashes of P. pyralis and successive pulses of P. greeni were analyzed using paired t-tests.
- Analyses were conducted at alpha = 0.05.

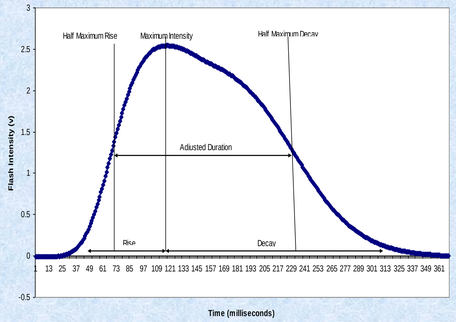

Figure 2. Wave form of a firefly flash and characteristics measured

Results

- Species and elytral length was a better predictor of body mass than elytral length alone ($r2$= 0.85, F=51.46, df=2,18, $p \leq 0.001$; Figure 3).
- *P. pyralis* males were significantly heavier than *P. greeni* males (two tailed t-test, t = -8.34, df=19, $p \leq 0.001$).

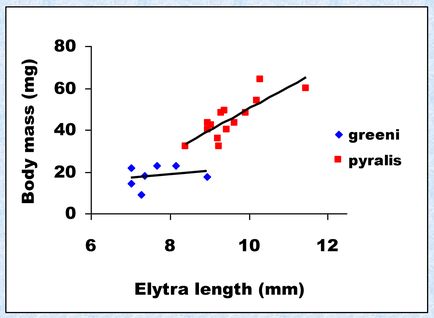

Figure 3. Relationship between elytra length, species, and body mass

- Species was the only significant predictor of flash duration; morphology within species was not associated with flash duration (r^2= 0.43, F=14.22, df=1,19, $p \leq 0.001$; Figure 4).
- *P. pyralis* males produced a significantly longer flash than *P. greeni* males (two tailed t-test, t= -3.69, df=11,p=0.0036).
- There was a non-significant trend towards longer flash duration in the last flash recorded from *P. pyralis* males compared with the first flash recorded on a given night (Paired t-test, t =1.70, df=7, p=0.067; Figure 5a).
- Individual *P. greeni* males produced significantly longer duration second pulses compared to first pulses (Paired t-test, t=-4.12, df=6, p=0.006; Figure 5b).

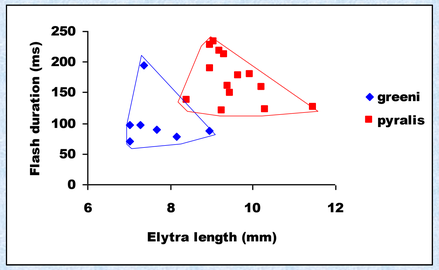

Figure 4. Relationship between elytra length, species, and flash duration.

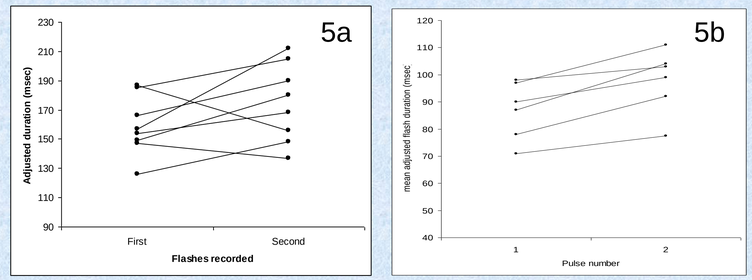

Figure 5. Variation in flash duration between first and second flashes of *P. pyralis* (5a) and first and second pulses of *P. greeni* (5b).

Conclusions

- *P. pyralis* males are both significantly heavier and larger and produce longer duration flashes than *P. greeni males.*
- In contrast to patterns observed among species, there were no significant relationships between flash duration and morphology within species.
- Other factors including age, prior flash behavior, or mating may influence flash characteristics.
- Data suggest that initial flashes and pulses of male fireflies are shorter in duration relative to successive flashes and pulses.
- Future research will explore potential relationships between flash duration and other factors, including prior courtship efforts and mating experiences.

Literature Cited

Cratsley, C. K. 2000. Sexual selection in *Photinus* fireflies: the roles of male courtship signals and nuptial gifts. Ph.D. thesis, Tufts University, Medford, MA.

Cratsley, C. K., and S. M. Lewis. 2003. Female preference for male courtship flashes in *Photinus ignitus* fireflies. Behavioral Ecology 14:135-140.

Lewis, S. M., C. K. Cratsley, and K Demary. 2004. Mate recognition and choice in *Photinus* fireflies. *Ann. Zool. Fennici* 41:809-821.

Lloyd J. E. 1966. Studies on the flash communication system in Photinus fireflies. Ann Arbor: Museum of Zoology, University of Michigan.

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