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SCIENTIFIC NOTE

A Field Experiment on the Effect of Introduced Light Pollution on Fireflies (Coleoptera: Lampyridae) in the Piedmont Region of Maryland

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During the past several years, scientists and citizen scientists have both noted declines in firefly (Lampyridae) populations, which have been attributed to a number of factors, such as habitat destruction and pesticide use (Picchi *et al*. 2013). However, increasing amounts of light pollution may also be a causal factor in this beetle family's decline (Picchi *et al*. 2013), especially for the species who rely on bioluminescence for mating and communication. Artificial light at night has increased globally and been associated with changes in land-use, transportation networks, and industry (Gaston *et al*. 2014). Increases in artificial light have been shown to impact a variety of species-level and community-wide characteristics from changes in gene expression and individual behavior to effects on species abundance, distribution, and composition (Lloyd 2006; Gaston *et al*. 2014). Although some studies have observed a negative, correlational relationship between light pollution and firefly populations (*e.g*., Lloyd 2007; Thancharoen *et al*. 2008), no studies to date have examined this association experimentally in the field.

Lampyridae are found on every continent, except Antarctica (McDermott 1966), and they occur in a wide variety of habitats from woodlands to urban areas (Picchi *et al*. 2013). Worldwide, there are approximately 2,000 species of Lampyridae in more than 90 genera (McDermott 1966). Approximately 32 species of Lampyridae are known from the combined Maryland, Virginia, and District of Columbia (Barrows *et al*. 2008). In that same region, lampyrids emerge during late April and are active through early October (Barrows *et al*. 2008). The particular time of day at which flashing occurs varies among species. In Maryland, flashing activity generally takes place between 30 minutes before and an hour past sunset, but most species begin flashing 12–16 minutes after sunset (Lloyd 1969). Males generally fly one meter above the ground early in the evening, but tend to fly higher as light level declines, which suggests that males can respond to very slight changes in ambient light (Lloyd 1979, 2000).

Although there is scant research published on the ecological importance of Lampyridae in their larger communities, some research suggests that they can perform valuable ecological functions (Symondson 2004; Wang *et al.* 2007). Larvae are predatory and consume a variety of arthropods and terrestrial mollusks (Barrows *et al*. 2008). Some lampyridae (both adults and larvae) scavenge dead insects (Barrows *et al*. 2008), and a few species eat pollen and/or nectar as adults (Faust and Faust 2014). Some Lampyridae species have also shown promise as biological control agents of both native and non-native pest species (Symondson 2004).

In this study, six sites were used to investigate the effect of artificial night light on Lampyridae. All study sites were natural grassland habitats in the Piedmont region of Maryland and adjacent to a forest edge with both a nearby water source and no artificial lighting. The study started on 18 June 2014, one week after the first lampyrid flashes were detected in the field, and data collection ended on 2 August 2014. During the study period, the moon was waxing or waning gibbous (www.calendar-12.com/moon_phases/2014), which reduced the interference of lunar light during our experimental light introductions. Each study site was monitored for two nights for a total of 12 monitoring events across all sites. The first night at each site was used as the control condition in this study. During that first night, no experimental light source was introduced, and the number of baseline lampyrid flashes per minute was recorded under natural, moonlit conditions. All temperature and humidity measurements were taken from local WeatherBug® stations on each sampling night. All weather stations were located within 1 km of each site.