University of Florida Book of Insect Records
Chapter 29 *Greatest Bioluminescence*

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There are a few studies that report the brightness of bioluminescent insects. Pyrophorus noctilucus *(Coleoptera: Elateridae) is not only one of the largest bioluminescent insects, but it has also been reported as having the greatest surface brightness, 45 millilamberts. The research on insect luminescence has placed a greater emphasis on flash patterns and wavelengths of emission, than on quantifying insect brightness.*

Introduction

Many organisms have been described as bioluminescent. Some animal luminescence can be attributed to infection by luminous bacteria, while other animals have evolved luminous organs (Harvey 1952). Insects with luminous organs occur in Collembola, Hemiptera, Coleoptera and Diptera. Insect bioluminescence has evolved to allow insects to signal mates of the same species at night (Coblentz 1912).

Flash patterns and wavelengths of maximum light emitted have been studied. This research has shown that these characteristics of insect light are diagnostically important because they are unique to each species studied (Lloyd 1978). These characteristics of insect luminescence can be used to distinguish bioluminous insect species from each other in the field more effectively than comparisons of surface brightness.

The insect with the brightest bioluminescence is discussed in this report. Surface brightness, or flux emitted per unit area of light organ, is measured in *lamberts* (Seliger & McElroy 1965). One *lambert* is equal to one lumen per square centimeter of a perfectly diffusing surface. A *lumen* is the flux emitted per unit solid angle by a point source of one *candela*. Many studies have measured the intensity of emitted insect light in *candelas*, rather than the surface brightness of insect light organs. Luminous intensity is found by determining how many insects it takes to give the same light density as the flame of a standard sperm candle (Coblentz 1912). These measurements cannot be accurately converted to units of surface brightness because measurements of luminous areas are not reported.

Methods

Dr. J. E. Lloyd and Dr. S. Wing were useful resources. I consulted them to determine how to approach my literature search. LUIS and CAB abstract searches revealed references on Coleoptera taxonomy, and on bioluminescence emission studies. Physical chemistry and physics text books were used to interpret the numerical data and the units of measure.

Results

Dr. Lloyd and Dr. Wing both suggested that the brightest insect was a Coleoptera. My review of the literature found that the brightest insect is the very large *Pyrophorus noctilucus* (Coleoptera: Elateridae), with a brightness of 45 millilamberts (Harvey & Stevens 1928). This measurement was made by comparing the light of the insect with that made by a calibrated Macbeth illuminator, and by measuring the area of the insect light organ. This insect is also known as the Jamaican Click Beetle and the "Cucujo" beetle of the West Indies.

Supporting evidence reported by Nicol (1978), names *Pyrophorus* as having the greatest number of photons emitted per unit area per unit of time, $7x10^{-4}$ photons cm^{-2} s^{-1}. These measurements were taken with a calibrated photometer. This record of photon emission does not name a species.

Discussion

The literature search revealed that more attention has been given to determining the wavelength of an insect's maximum emission, and to recording the flash pattern, than to quantifying surface brightness. Flash patterns and emission spectra can be used to distinguish species from each other. These bioluminescent signals attract animals of the same species to each other for mating (Lloyd 1978). Brightness not only varies between members of the same species, but can also vary for an individual insect with environment and therefore, is not a good diagnostic marker (Harvey & Stevens, 1928).

Coblentz (1912) named *Photinus pyralis* as having the greatest recorded light density, 1/50 that of a sperm candle. He used a photograph taken with a spectrograph and a phototgraphic plate that was most sensitive at 590 nm and did not report any measurements of the area of the light organs. Experiments on flash intensity reported by Harvey (1952) name *Pyractomena borealis* (Coleoptera: Lampyridae) as having the greatest recorded light density, 9/50 the light of a standard sperm candle, but he did not give the area of the light organ. These two reports give no data that can be converted into units of brightness.

The human eye is most sensitive to light at a wavelength of 540 nm (Coblentz 1912). Light emitted at other wavelengths requires more quanta for the human eye to record the same brightness. For example, *Pyrophorus noctilucus* gives a maximum light emission at 538-540nm and *Photinus pyralis* at 567 nm. Most of the experiments found in the literature use the human eye and a candle to estimate relative intensities. Instruments that can measure photon emissions at different wavelengths would give less biased results.

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