



Optical characterization and redescription of the South Pacific firefly *Bourgeoisia hypocrita* Olivier (Coleoptera: Lampyridae: Luciolinae)

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Abstract

Bourgeoisia hypocrita Olivier is an atypical species of firefly where males lack light organs in ventrite 7 and have reduced light organs in ventrite 6 and may not produce light at all, while females are flightless and produce a long-lasting glow (up to tens of seconds). Here, photobiology of females is described for the first time. Colour of produced bioluminescence ranges in the green to yellow/green. Spectrum is unimodal peaking at 575–595 nm but more complex than other fireflies in having two shoulders at 545–550 nm and 600–610 nm. A taxonomic re-examination of the species based on recent collections and type material shows that larvae and adults exhibit a peculiar dark pigmentation. Fluorescence and absorbance of adult extracts indicate this pigmentation could be involved in UV protection, in addition to possibly serving as cryptic camouflage. Fluorescence and absorbance of eggs, which have a light gold colour, indicate the luminous compound could be used as an antioxidant during this early life stage. Overall, the signal of bioluminescence shows characteristics of a basal system of flash communication in *B. hypocrita*, which associates light production not only to visual communication but also possibly to UV and/or free radicals protective mechanisms.

Key words: Firefly; South Pacific; Bioluminescence; Photobiology; UV protection, *Bourgeoisia*

Introduction

Bioluminescence, the production of visible light by living organisms, has been long reported from fireflies that then rapidly became popular models for assessing insect evolution and behaviour associated with light production (Buck & Case 2002; Dubuisson *et al.* 2004; Harvey 1956; Stanger-Hall *et al.* 2007). More recently, the chemistry of light production in fireflies has been used for multiple biotechnological applications in molecular biology, biomedicine and genetic engineering (*e.g.*, Alvarado *et al.* 2004; Malley & Henry 1981). Bioluminescence is characterized by a high quantum efficiency, a monophasic species-specific spectrum, and pH sensitive colour that is variable upon specific changes of few specific amino acids (Ugarova & Brovko 2002; Viviani 2002).

Fireflies, during their luminous displays, have always fascinated people and scientists from around the World. Numerous reports and studies are now available from firefly populations of South East Asia, Europe, North and South America, and the Caribbean (Lewis & Cratsley 2008; Stanger-Hall *et al.* 2007). The literature on flash production, however, is mainly focused on male fireflies, which fly and use elaborate luminous signals for the localisation of conspecific females. The literature is much less extensive for firefly species of the South Pacific, although fireflies there are also commonly observed (Lloyd 1972; 1973a; 1973b).

Bourgeoisia was erected by Olivier (1908) for two species of Luciolinae from the South Pacific – *Luciola hypocrita* Olivier from Fiji, and *L. antipodum* Bourgeois from New Caledonia. *Bourgeoisia hypocrita* has females that are bioluminescent, and flying males that may not produce light as they have reduced light