

A Theory to Explain the Fitness Benefit of Ultraviolet (UV) Induced Fluorescence in Lepidopteran Immature Stages

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The immature stages of many Lepidoptera are known to fluoresce when showered with UV radiation. For the caterpillar hunter, this has little practical benefit during the day when the extra visible light that is produced is lost in the sea of daylight that already floods the area. At night, however, the use of UV torches becomes an extremely effective way of inducing fluorescence and thereby locating cryptically coloured larvae or pupae that would be very hard to find during the day.

In recent years, hunting for caterpillars in this way has become a favourite nocturnal pastime of many butterfly enthusiasts, and several papers have been written to highlight particular butterfly species, or butterfly families that may be suited to surveys of this kind (e.g., Moskowitz, 2021; Tilley et al., 2023; Tilley & Stewart, 2025). This is a new field of study that is very much still in its infancy and, thus far, the published work tends to be limited to listing species that fluoresce and investigating at which stage of their development the fluorescence is strongest.

Although this new and powerful survey tool will no doubt soon be widely adopted as an effective way of establishing presence for certain species, I am personally most excited by the potential for it to be used to facilitate landscape-wide studies that can address wider questions around butterfly ecology that have traditionally been beyond the scope of the available methodology.

The fitness advantage to the fluorescing species is not currently well understood and it is my intention here to put forward the following theory:

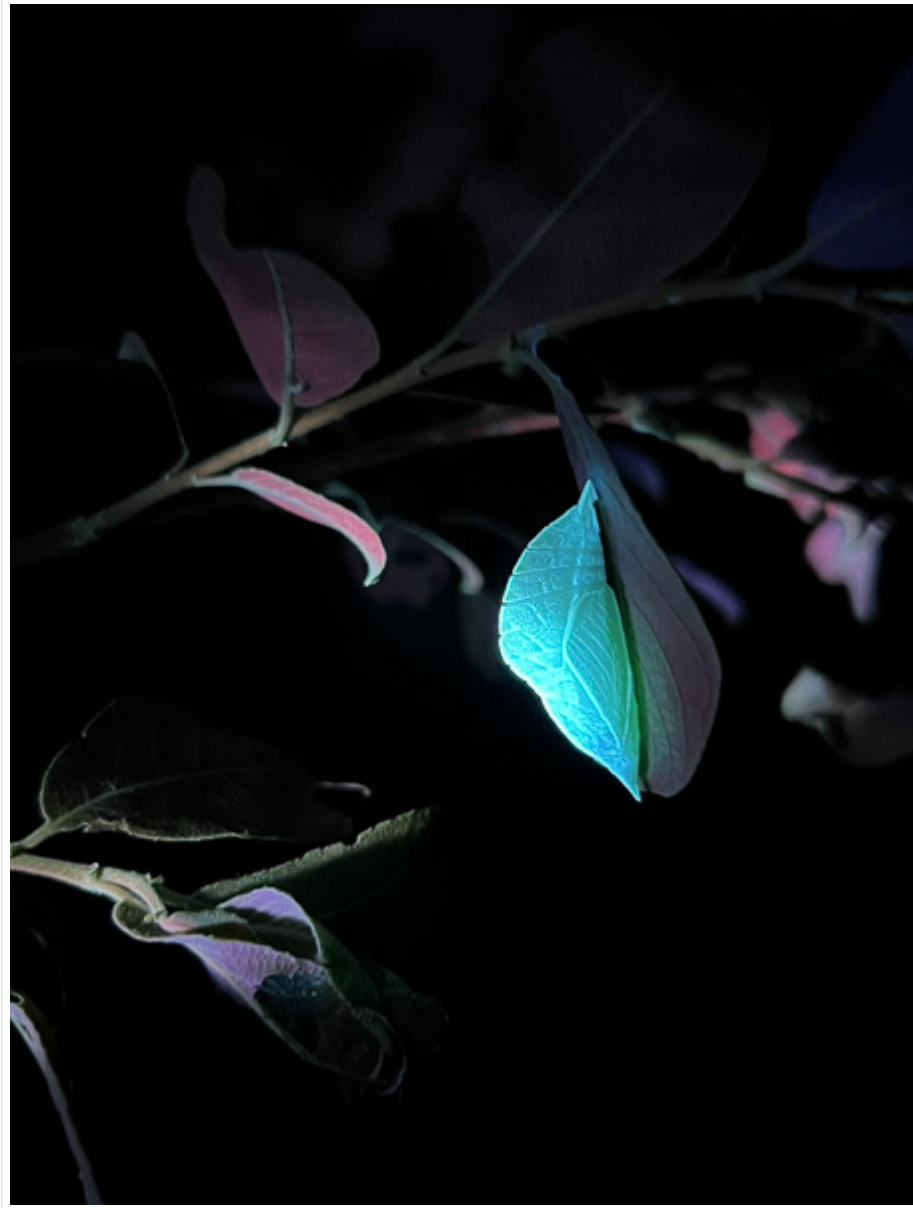
UV radiation is potentially harmful to all organisms, but many plants have evolved the ability to absorb large amounts of it without harm (Solovchenko & Merzlyak, 2008). In the vast majority of cases, the invertebrates that feed on these plants do not share this ability and the simplest way for them to avoid damage is to reflect the UV radiation at their surface. The cost of this to the invertebrate is a higher chance of predation, as birds and other predators can see in this part of the spectrum and have evolved to forage by seeking out these striking UV signals scattered throughout the UV-absorbing foliage (Church et al. 1998; Siitari et al. 1999; Lyytinen et al. 2004).

What the invertebrates that fluoresce appear to be doing, when showered with UV radiation, is eliminating this tell-tale UV signal by not reflecting the UV radiation, and instead temporarily absorbing it, converting it to visible light and reradiating it at the new wavelength. If absorbing this high energy radiation in a more permanent way is too damaging for these invertebrates, and simply reflecting it increases the chance of predation, then the evolution of UV induced fluorescence would appear to make sense as a solution to this absorb/reflect conundrum.



Purple Emperor *Apatura iris* pre-pupation larva
Image © Ben Greenaway

Although this adaptation is dramatically exposed by nocturnal UV torch surveys, we must remember that this is an entirely artificial situation and, by showering these invertebrates with UV radiation at night, we are simply exposing an adaptation that has evolved to benefit them during the day, by processing the UV radiation that they receive from the sun in a novel way.



Purple Emperor *Apatura iris* pupa

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