Self-organized bioluminescence synchronization as a group-foraging strategy in cave glowworms

David Merritt*[1]

[1]University of Queensland (UQ) – Brisbane, Australia

Abstract

Larval gnats of the genus *Arachnocampa* are sit-and-lure predators that use bioluminescence to attract flying prey to their silk webs. Some species are most common in rainforest habitat and others, inhabit both caves and rainforest. The structure of the light organ, the role of the visual system in bioluminescence regulation and the neural regulation of light output are similar in all species investigated. However, circadian regulation of bioluminescence differs between two of the species; one found in subtropical rainforest with no known cave populations, the other found in temperate rainforest with large populations in caves. The rainforest species is typical of most nocturnal animals in that individuals are entrained by the light:dark cycle so that their propensity to bioluminesce is greatest at night. The dual-habitat species' bioluminescence propensity rhythm is entrained by L:D exposure to peak during the day. Nevertheless, in L:D environments, individuals don't bioluminesce during the day because ambient light inhibits their bioluminescence (negative masking), pushing bioluminescence into the dark period. This bioluminescence entrainment is responsible for colonies of larvae in the cave dark zone synchronizing to each other, creating a daily sinusoidal rhythm of bioluminescence intensity in the many thousands of individuals making up a colony. Agent-based modelling of the synchronization process is presented, confirming that the two species' phase-response curves either facilitate self-organized synchronization in one species or synchronization to the L:D cycle in the other species. Synchronization in the cave species could provide a group-foraging advantage, allowing the colony to glow most brightly when the prey are most likely to be active.

Keywords: insect, glowworm, cave, synchronization

*Speaker