SIMULATING DARKNESS USING DIM RED LIGHT: A CAUTIONARY NOTE BASED ON EXPERIENCE WITH LARVAL *AESHNA JUNCEA* (L.) (ANISOPTERA: AESHNIDAE)

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Abstract – Reactive distance and capture success by *A. juncea* larvae were studied under 3 light regimes: natural light (400 ± 50 lux), dim red light (2-4 lux), and total darkness (IR-light). Reactive distance did not differ significantly between natural and dim red light conditions, while it was significantly shorter in total darkness compared to natural and dim red light. Capture success was significantly higher under natural light conditions compared with dim red light and dark conditions; there was no significant difference in capture success under conditions of dim red light and total darkness. Results showed that simulation of darkness using dim red light may be inappropriate when studying the behaviour of aquatic insects with well developed eyes.

Introduction

Many aquatic insects are nocturnal. To better understand their behaviours it is therefore necessary to make observations at night time conditions. Often, dim red light is used to simulate darkness. This method has been used in experiments with dragonfly larvae during long (CROWLEY, 1979; PIERCE, 1988) or short (NILSSON, 1981; BLOIS-HEULIN & CLOAREC, 1988) time periods. Aquatic insects such as dragonfly larvae that have well developed eyes (MILLER, 1987; ROWE, 1987) may not perceive dim red light as darkness. Below, I present data on the predacious behaviour of *Aeshna juncea* larvae under three different light regimes: natural light, dim red light and total darkness (IR-light). Larvae belonging to this genus have well developed eyes, (RICHARD, 1960; PRITCHARD, 1965), live amongst vegetation (PRITCHARD, 1965), and are active predators compared to most other dragonfly larvae (PRITCHARD, 1965).

Material and methods

To quantify the reactive distance and capture success of *A. juncea* larvae a series of experiments were performed in small plastic aquaria (18 x 12, hight 12 cm) during the autumn. The bottom surfaces of the aquaria were roughened to allow grip for the predators and filled to a depth of 5 cm with tap water (18 ± 1°C). This low water level facilitated observations and measurements of reactive distance. The dragonfly larvae were in their ultimate or penultimate instar. *Chaoborus flavicans* (Meig.) (Diptera) larvae (about 1 cm long) were used as prey. Predation was observed under three light regimes: (1) natural light (400 ± 50 lux), by placing the aquaria close to a window; (2) a dim red light (2-4 lux), by arranging a red incandescent lamp (Osram, Belcolor, 25 W) above the aquaria; (3) total darkness. In the total darkness observations an IR-lamp (Videmech 830, 500 W, wavelength 715-850 nm), was arranged above the aquaria; and dragonfly larvae are unable to see in this light spectrum (SHERK, 1977). Initial predator hunger level was standardized by starving larvae for 24 hours before the start of the observation period. A single larva was allowed to acclimatize under natural light conditions in each aquarium from late evening to forenoon next day (14 ± 2 h) after which the observation period started. At the start of an observation period 15 *Chaoborus* larvae were introduced into each aquarium. All experiments were run between 08 30 and 11 00 hours. Each *A. juncea* larva was allowed to capture a maximum of six prey during a 30 min period. The numbers of dragonfly larvae used under each light regime were six, four and five in natural light, dim red light and total darkness, respectively. The predation act was recorded with a video camera equipped with IR-sensitive elements. The tape was later analysed with respect to reactive distance and capture success. Reactive distance (mm) was measured as the shortest distance between the predator and its prey. When no orientation towards prey was observed, the reactive distance was defined as the distance between the dragonfly and its prey when the predator attacked the prey. Capture success was calculated for each individual predator as the number of captures divided by the number of attacks.

Results

The reactive distance was about the same during light and dim red light conditions, whereas it was considerably lower in darkness (Tab. I). The mean ractive distances under natural and dim red light conditions differed significantly from dark conditions (Tukey's test, $p<0.001$ for both comparisons), while there was no significant difference in mean reactive distance between natural and dim red light conditions (Tukey's test, $p>0.05$). Maximum reactive distance was long under natural light conditions, intermediate under dim red light conditions and short in darkness (Tab. I).

Capture success was higher under natural light conditions than under dim red light and dark conditions (Tab. I). Capture success was significantly higher under the natural light condition than in dim red light and dark conditions (χ^2-test, $p<0.05$ in both comparisons). There was no significant difference in capture success between dim red light and dark conditions (χ^2-test, $p>0.05$). The χ^2-tests were compensated with the Bonfferoni procedure as I performed three pairs of comparisons.

Discussion

In total darkness the mean reactive distance and maximum reactive distance was low compared to that in dim red light and natural light. This suggests that only mechanical cues were used for prey capture in darkness. Under dim red light conditions the mean reactive distance was about the same as under light conditions and maximum reactive distance was longer than under dark conditions. This indicates that *A. juncea* larvae are able to use visual cues for capturing prey even

Table I — (a) Mean, maximum and minimum reactive distance (mm) for larvae under three light conditions: natural light, dim red light, and darkness (prey; larvae). Total number of attacks (n) and S.D. are also shown. The number of individuals used were six, four and five for natural light, dim red light and darkness, respectively. — (b) Capture success for *A. juncea* larvae under the same light conditions as above. — [Number of individuals used (n) and S.D. are also denoted].

Experimental parameters	Natural light *350-450 lux*	Dim red light *2-4 lux*	Darkness *0 lux*
(a) Reactive distance			
$\bar{x}$	2.2	2.0	1.1
max.	6.0	4.3	2.5
min	0.5	0.5	0.3
S.D.	1.3	1.0	0.6
n	46	40	26
(b) Capture success	0.69	0.30	0.27
S.D.	0.17	0.07	0.14
n	6	4	5

at this low light intensity. In contrast to reactive distance, capture success seemed to be dependent on a high light intensity, indicating that the eyes are important for the success of an attack. In summary, my results show that when studying foraging behaviour of aquatic insects with well developed vision (e.g. late instar larvae of Lestidae, Coenagrionidae and Aeshnidae), it may be inappropriate to use dim red light when simulating darkness.

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