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Research Article

The Effect of Conspecific Density on Emergence of *Lestes bipupillatus* Calvert, 1909 (Odonata: Lestidae)

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Conspecific density may influence adult recruitment and consequently population dynamics. Several studies have shown the density dependence of larvae growth rates in Odonata. However, few studies studied how conspecific density influence final instar larvae emergence date decisions. Considering that larvae may choose the date of emergence, the present study investigated if density affects larvae choice. For this, we reared eight final instar larvae in individual aquaria and other 24 larvae in aquaria with three larvae each. This way, we simulated environments with low and high larval densities. We then noted the days that larvae took to emerge and compared it between low and high density groups. The results showed that larvae seem to emerge earlier when in high densities (Mann-Whitney, $U = 10.000$, $P = 0.03$). These results support the hypothesis that damselfly last instar larvae may postpone or hasten emergence in response to the social environment and related constraints.

1. Introduction

Natural environments may exhibit large temporal fluctuations, which entail a major challenge for animal species. Temporary pools comprise a harsh environment, inhabited by a unique fauna with physiological and behavioral adaptations that enable development and survival [1]. Reductions in water levels in temporary pools may affect species population dynamics, since density should increase.

Population dynamics are influenced by life history features such as individual development, survival, fecundity, and dispersal rates amidst environmental fluctuations. Variation in such features may be associated with density-dependent processes [2–6]. In insects, adult population dynamics are usually affected by larval density that may decrease or increase adult emergence rates [7, 8].

In Odonata, increasing density among conspecifics may shorten life cycle [9], influence larval growth rates, and affect species voltinism [1]. The density dependence of larvae growth rates in odonates is well studied [1], but there is no evidence of how conspecific density may determine the emergence rate of final instar larvae. The increased density during the reduction of water level could be an indicator cue of the drying out process. This mechanism could enable some species of Odonata to colonize and complete their life cycles in temporary pools.

Since final instar larvae of Odonata may postpone emergence, the date of emergence can determine individual body size, fecundity, and reproductive success [1] and may be critical to complete the cycle in temporary ponds. Thus, we tested if conspecific final instar larval density influences the date of emergence in the tropical species *Lestes bipupillatus*

Calvert, 1909 (Zygoptera: Lestidae). Lestids are good models for this kind of study since they inhabit temporary pools and must carry adaptations to such environment [1, 10–12].

2. Material and Methods

We collected last instar larvae in a temporary pond near the Ecological Reserve Horto Florestal in Assis, SP, Brazil (S 22°37′46.9″/W 50°24′11.7″) on 19 May 2007. This reserve is a conservation area with a mixture of native Atlantic Forest vegetation and Neotropical Savanna vegetation.

To test whether the density affects the time of emergence, we simulated two situations in laboratory: (i) low density, with one individual per aquarium; and (ii) high density, with three individuals per aquarium. We considered eight replicas for each situation. Each aquarium had 500 mL of capacity and was filled with 300 mL of filtered water collected in the habitat of larvae. The aquaria were wrapped with white paper to prevent visual contact between larvae and were provided with wood sticks for individuals to climb during the rearing process.

During the experiment, the aquaria were maintained in a cool room with 12 : 12 photoperiod. The aquaria were placed inside a vial filled with water to guarantee temperature constancy among replicas. The positioning of each aquarium in the vial was randomly sorted.

We checked for emergence each 12 hours and we finally compared the number of days that the two groups of larvae took to emerge since the collection date. For the high density group, we sorted eight individuals to represent the group. Differences between the median of emergence time of individuals at high and low densities were assessed using the Mann-Whitney U test.

3. Results and Discussion

The results show that high conspecific density decreased the number of days until emergence (Mann-Whitney, $U = 10.000$, $P = 0.03$, Figure 1). As the larvae at high densities emerged earlier, we can assume that, when there is low conspecific density, the larvae may delay emergence. These results show how density may influence adult recruitment and the number of flying reproductive individuals in a given time.

Based on this information, we can consider the fact that high density may force larvae to hasten emergence and impose a great impact on population dynamics, since larvae that emerge earlier are usually smaller and have a lower reproductive success [1, 12]. We can also consider extrinsic features related to species ecology and the peculiar habitat which they inhabit. Since this study collected *L. bipupillatus* larvae on a temporary pond, another possible selective force could be pond dryout [12], which may result in larvae aggregation with the decline of water level. In this case, the high density is an indicator that water level is dropping and the early emergence occurs to avoid death due to the low volume of water, high temperatures, and low dissolved oxygen.

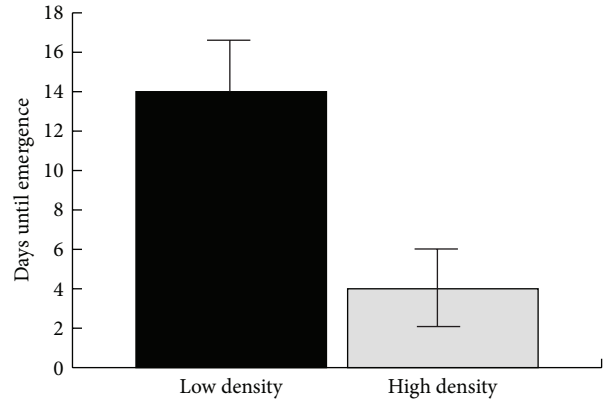

Figure 1: Days until emergence of last instar larvae reared with low and high conspecific densities.

The earlier emergence when in high densities may also be an evolutionary response to conspecific interactions as cannibalism, since odonate larvae usually feed on conspecifics [13–16] or competition, since they can be aggressive towards conspecifics and even harm or kill neighboring larvae [1, 16].

4. Conclusions

In conclusion, the experiment allows us to suggest that damselfly last instar larvae may postpone or hasten emergence in response to the constraints related to the social environment and water conditions. Although other studies show that many variables may affect development, and consequently emergence [1, 17], here we show that *L. bipupillatus* last instar larvae make decisions regarding emergence time, independently of previous development. This can give base for future perspectives, regarding other environmental variables and the intrinsic effects on adult survival and reproduction. We suggest that studies should now focus on the outcomes and handicaps of final instar larvae emergence syndromes in a set of species.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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