International Journal of Odonatology, 2016
Vol. 19, No. 4, 253–256, http://dx.doi.org/10.1080/13887890.2016.1258372

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Predation of *Telebasis vulnerata* (Odonata: Coenagrionidae) eggs by detritivorous caddisfly larva, *Phylloicus pulchrus* (Trichoptera: Calamoceratidae)

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(*Received 18 August 2016; accepted 3 November 2016*)

After observing the presence of *Phylloicus pulchrus* (Trichoptera: Calamoceratidae) and tadpoles of *Leptodactylus albilabris* (Anura: Leptodactylidae) on submerged leaves with recently laid eggs of *Telebasis vulnerata* (Odonata: Coenagrionidae), we set up an experiment to determine if they were consuming Odonata eggs. We collected leaves from the stream, where consumers were positioned over egg masses, and designed an experiment to expose *T. vulnerata* eggs for two days to consumers. Observations indicated that tadpoles did not harm *T. vulnerata* eggs. In contrast, *P. pulchrus* completely scraped eggs from leaves, with little damage to the leaf tissue itself. *P. pulchrus* is detritivorous insect that consume leaf tissue, but it is capable of consuming *T. vulnerata* eggs, potentially as a supplementary food resource.

Keywords: dragonfly; damselfly; egg mortality; consumption; tropical stream

Introduction

Egg predation in Odonata has received limited attention. Direct egg predation by aquatic consumers has rarely been reported (Corbet, 1999). Some species of mites and fish have been reported as egg predators, mostly consuming eggs from species of Odonata that lay them in open waters (i.e. exophytically) (Corbet, 1999). Endophytically laid eggs are expected to be better protected against predation, but little information is available (Corbet, 1999). Egg predation by parasitoids is another source of mortality reported in Odonata. However, their impacts on Odonata populations have not been documented. Parasitoids of the wasp species *Pseudoligosita longifrangiata* (Hymenoptera: Trichogrammatidae) have been reported in eggs of *Argia insipida* (Coenagrionidae) (Querino & Hamada, 2009).

Predation by non-predators is not an uncommon phenomenon. It is known that species that consume fine particle can also consume small prey while feeding. Shrimp, *Xiphocaris elongata*, are mostly detritivorous, but consume mayfly nymphs while foraging for particles (Macías, Colón-Gaud, Duggins, & Ramírez, 2014). Similarly, filter feeding caddisflies can often obtain a large proportion of their energy from small prey that drift into their nets (Benke & Wallace, 1980). We are not aware of reports of egg consumption by non-predators; however, it can be assumed that it also occurs, as consumers are sometimes not selective while foraging. Odonata

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eggs are small, but could provide important additional protein resources and improve consumer diets. Here we report, for the first time, a detritivorous caddisfly as a predator of the eggs of *Telebasis vulnerata* (Hagen).

Observations

While collecting recently laid eggs of *Telebasis vulnerata* in Buruquena stream, at El Verde Field Station, Rio Grande, Puerto Rico (18.321°N, 65.820°W), June–July 2016, we noticed the presence of *Phylloicus pulchrus* (Trichoptera: Calamoceratidae) larvae and tadpoles of *Leptodactylus albilabris* (Anura: Leptodactylidae) grazing on green leaves underwater. *Telebasis vulnerata* lays eggs endophytically, and there were as many as 10 *P. pulchrus* or *L. albilabris* apparently grazing on top of green leaves with recently laid egg masses. There were no other damselflies actively reproducing at the study stream. To determine whether they were actually consuming eggs, we collected leaves from the stream and observed whether eggs were damaged. We also designed a laboratory experiment to expose leaves with eggs to both consumers. We collected leaves with recently laid egg masses and placed them in numbered containers with an individual of *P. pulchrus* or *L. albilabris*. Leaves contained from 60 to 200 eggs each, all without evidence of any damage (Figure 1A and C). Egg consumption was assessed after 24 and 48 h. Caddisfly larvae ranged between 17 to 23 mm in length, while tadpoles ranged from 32 to 44 mm. Consumers were allowed one day under laboratory conditions for acclimation before the experiment. Five

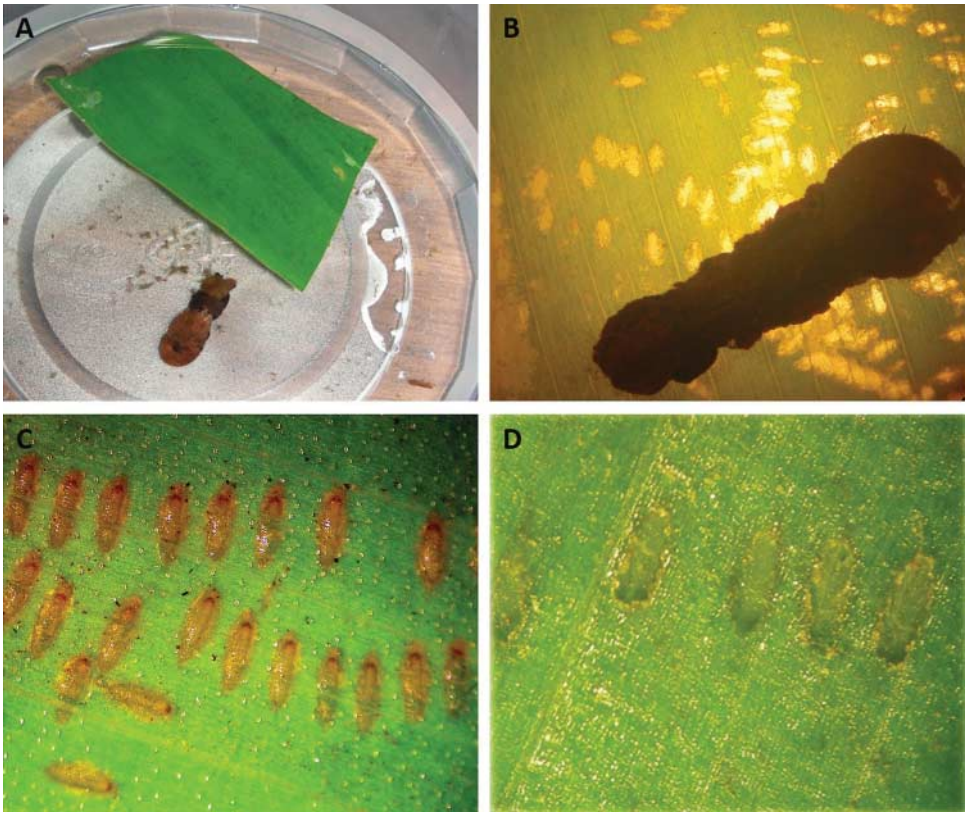

Figure 1. *Phylloicus* predation on *Telebasis* eggs. A) *Phylloicus* larvae and leaf with *Telebasis* eggs. B) *Phylloicus* consuming eggs. C) *Telebasis* eggs before exposure to *Phylloicus*. D) Egg scars after consumption.

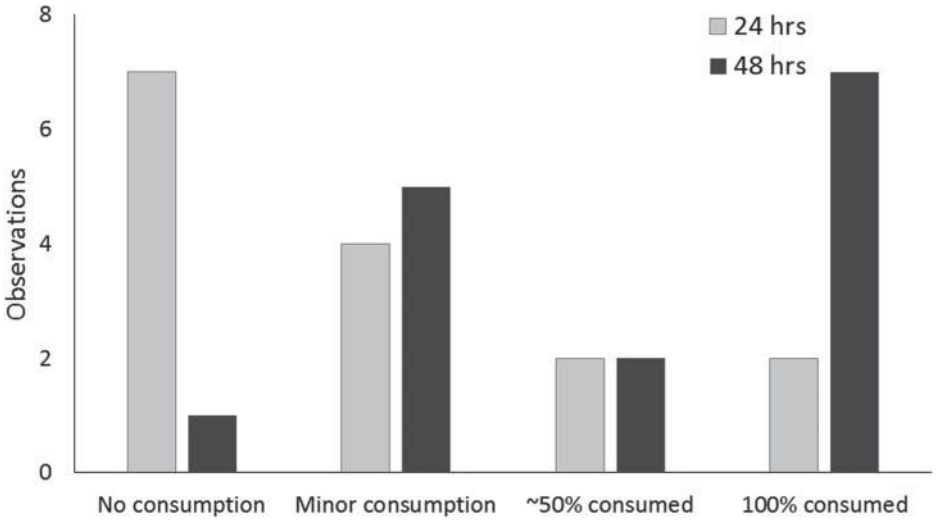

Figure 2. Levels of egg consumption after 24 and 48 h of exposure to *Phylloicus pulchrus* larvae. Columns represent the number of containers with a larva and a leaf with a group of *Telebasis vulnerata* eggs.

additional containers served as controls, with leaves that did not have eggs, to assess whether *P. pulchrus* or *L. albilabris* caused any leaf damage while foraging.

Telebasis vulnerata females inserted the eggs into the leaf tissue forming rows of individual eggs. Leaves from the stream had a variety of scars, some suggesting egg consumption by insects. Leaves used in the experiment were examined on day zero and all eggs were found to be intact (Figure 1C). After 24 h, in the *Phylloicus* treatment, half of the egg groups remained intact and half had some sign of consumption that ranged from minor to complete consumption (Figure 2). After 48 h, most egg groups in the *P. pulchrus* treatment were consumed (Figure 2). *Phylloicus pulchrus* completely consumed individual eggs, apparently avoiding consuming the leaf tissue. Scars showed that only the egg tissue was removed (Figure 1D), often leaving a translucent scar on the leaf (Figure 1B). Egg masses exposed to tadpoles showed no signs of consumption after 24 or 48 h (data not shown). In addition, leaves without eggs that were exposed to consumers did not have any kind of markings indicating consumption.

Discussion

Trichoptera is a diverse order of insects with species occupying a variety of trophic levels, from detritivores to predators. Some predatory species are known to consume eggs as part of their diets. Some Limnephilidae caddisflies, *Hesperophylax occidentali*, consume newt eggs and some Phryganeidae larvae, *Phrygania varia*, prey upon fish eggs (Fox, 1978; Gall, Stokes, French, Brodie III, & Brodie Jr, 2012). Other caddisfly groups tend to be omnivorous, like filter-feeding species that feed upon drifting particles, including live larvae (e.g. chironomids) (Benke & Wallace, 1980). However, groups that are considered detritus specialists are not often reported as consumers of other resources. To our knowledge this is the first time that a detritivorous species of Calamoceratidae caddisflies are reported as predators of Odonata eggs.

Calamoceratidae larvae play an important role fragmenting leaf litter entering streams and generating small particles that are then available to other consumers. *Phylloicus* spp. are key consumers in Neotropical headwater streams, where they consume leaf material, accelerating detritus breakdown (Encalada, Calles, Ferreira, Canhoto, & Graca, 2010). It was surprising to

observe larvae of this species on top of green leaves, which are normally not used by them. Egg consumption was rather clear; *P. pulchrus* consumed the eggs only, leaving the green leaf mostly intact, except for the area where eggs were inserted. In addition, leaves without eggs were completely ignored by the larvae.

During the period of observation, *T. vulnerata* reproductive activity was conspicuous. Most leaves near the water surface were already marked with numerous eggs. Even so, the impact of caddisfly consumption on egg survival could be significant. In the laboratory experiment, a single *P. pulchrus* larva was able to consume up to 200 eggs in 48 h and we observed up to 10 larvae feeding on leaves used by female *T. vulnerata* to lay eggs in the field. Although *T. vulnerata* lays a large number of eggs, development time ranges from 14 to 24 days (unpublished data), enough time for caddisflies to consume a large proportion of the eggs.

Egg consumption could represent a supplementary food resource for *Phylloicus*, due to the low energetic value of leaf detritus. *Phylloicus* spp. are known to be able to select among resources for case construction versus food ingestion (Rincón & Martínez, 2006). In addition, studies that reduced food availability documented an increase in intraspecific interaction and even cannibalism in *P. pulchrus* when no other food was available (Lund, Wissinger, & Peckarsky, 2016). Thus, Odonata eggs represent additional protein-rich food resources. For *T. vulnerata*, egg mortality to this non-traditional consumer could be significant and the effects on population dynamics merit further investigation.

Acknowledgments

We thank students and researchers at El Verde Field Station during the summer REU program of 2016 for their support. Funding was obtained through the REU Site program at El Verde Field Station, University of Puerto Rico, NSF-grant number DBI-1559679.

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