BEHAVIORAL RESPONSES OF *BUFO ARENARUM* TADPOLES TO ODONATE PREDATION

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Abstract.—In the presence of predators, anuran tadpoles often exhibit behavioral plasticity, which in turn reduces predation risk. We evaluated indirect effects of odonate larva predation on activity of *Bufo arenarum* tadpoles. We reared intact and tail-damaged larvae in three different predator treatments: (1) caged predators fed tadpoles; (2) caged predators that were starved; and (3) no predators. Both intact and damaged tadpoles were significantly less active when exposed to predator cues. There were no differences in activity between tadpoles with damaged and intact tails, however significant differences were observed between fed and starved predator treatments. Our results are consistent with other studies that have shown bufonid tadpoles reduce activity when exposed to predator cues and address a novel contribution of southern-hemisphere bufonid, expanding the knowledge of that family in ecological experiments.

Key Words.—behavior; *Bufo arenarum*; insect predator; predation; *Sapo común*; tadpoles

INTRODUCTION

It is well known that many species of anurans alter their behavior and morphology in the presence of predators (McCollum and Van Buskirk 1996; Relyea 2001a; Van Buskirk 2001; Moore et al. 2004) and that these responses increase the probability of survival (Van Buskirk and McCollum 2000a, 2000b). Common responses of tadpoles when exposed to predators are reduced activity, increased tail depths, and a shorter head to body ratio (e.g., Relyea 2004 and references therein; Miner et al. 2005). These responses can be induced both by predator presence or chemical cues (Stauffer and Semlitsch 1993; Adams and Claeson 1998).

Anuran tadpoles of the genus *Bufo* make good candidates for predator-response studies for several reasons: (1) They are more vulnerable to predators during intermediate stages of development (i.e., Gosner stages 30-33; Gosner 1960) (Brodie and Formanowicz 1987), (2) different degrees of tail damage result from direct encounters with predators (McCollum and Leinberger 1997; Hoff and Wassersug 2000; Van Buskirk and McCollum 2000a), and (3) *Bufo* tadpoles can perceive presence of predators by detecting chemical cues released from conspecifics that were killed by predators (Hews 1988). The alarm substance was described by Pfeiffer (1982) as a pheromone that is secreted by one individual and received by a second individual of the same species, eliciting specific behavior. This type of alarm response is innate in *Bufo* tadpoles (Semlitsch and Gavasso 1992), and indirect in the sense that tadpoles can respond to chemical cues without directly experiencing contact with a predator. Then tadpole responses can be induced by chemical cues from predators (kairomones) and injured prey (alarm cues) (Relyea 2001b; Schoepfinger and Relyea 2005).

Here we provide evidence for behavioral plasticity in *Bufo arenarum* (Sapo Común) when exposed to the predatory dragonfly *Pantala* sp. *B. arenarum* is a common toad in Argentina that breeds in ephemeral and permanent ponds. There are no data on predator abundance in *B. arenarum* habitats, but it is well known that tadpole predator abundance varies with hydroperiod and size of pools (Skelly 1995; Wellborn et al. 1996). We have observed *B. arenarum* living in ephemeral pools without predators and in permanent pools that harbor invertebrate predators. *Pantala* sp. are voracious tadpole predators that commonly occur with *B. arenarum*. On several occasions we have observed *B. arenarum* tadpoles with varying degrees of tail damage resulting from encounters with predators, presumably *Pantala* sp. Because *B. arenarum* frequently inhabit sites with high numbers of *Pantala*, we hypothesized that tadpoles should elicit changes in behavior when reared with predators. Furthermore, we wanted to examine whether behavioral responses varied when tadpoles were exposed to different levels of predator cues and tail damage.

We designed an experiment to manipulate the tadpole experience in two treatments: "intact tadpoles" were tadpoles with no direct predation experience, and "damaged tadpoles" were tadpoles that experienced simulated encounters with predators by having a portion of the tail excised. We hypothesized that damaged and intact tadpoles may respond differently to the predatory environment particularly, damaged tadpoles may have a strong response in reducing activity to predator presence than intact tadpoles do. Therefore we examined variation in activity between intact and damaged tadpoles in the absence of predators (“no predator”), in the presence of predators that had not eaten tadpoles (“starved”), and in the presence of predators that were fed tadpoles (“fed predator”) to determine what cues trigger changes in behavior and whether or not these changes varied between treatments.
RESULTS

Our results suggest that the presence of dragonfly larvae induces changes in the behavior of *Bufo arenarum* tadpoles and non-contact cues associated with predation are sufficient to induce these changes. Antipredator responses among amphibians may be influenced by the predator’s recent diet (Wilson and Letcott 1993) particularly when predators have recently fed on prey conspecifics (e.g., Kats et al. 1988; Semlitsch and Gavasso 1992; Schoepnner and Relyea 2005). Several studies have shown that *Bufo* species reduce activity when they are exposed to predators fed with conspecifics (Skelly and Werner 1990; Semlitsch and Gavasso 1992; Anholt et al. 1996; Kiesecker et al. 1996; Summey and Mathis 1998). Our results show that *Bufo arenarum* tadpoles respond not only to the simple presence-absence of predator cues, but also to additional cues provided by predators when feeding with conspecifics.

Thus, our observations confirm the hypothesis that responses in amphibian larvae are mediated by water-borne cues and particularly *Bufo arenarum* tadpoles could also respond to the presence of excretions related to consumption of conspecifics in addition to the presence of the predator. In addition, this study expand the coverage of the Bufonidae family in ecological experiments, particularly improving the knowledge for southern-hemisphere species and providing further evidence that behavioral plasticity of tadpoles in the genus *Bufo* is widespread and may be deeply rooted within the family.

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LITERATURE CITED


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