

ABSTRACT

THESIS: Embryonic antipredator defenses and behavioral carryover effects in the fathead minnow (*Pimephales promelas*)

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PAGES: 37

Most research on embryonic learning and behavior in aquatic vertebrates has focused on fitness benefits after hatching, but the ability of embryos to perceive and respond to environmental stimuli may also have immediate adaptive value. Here, we examined whether fathead minnow embryos, *Pimephales promelas*, detect and respond to cues indicative of predation risk, and whether the embryonic environment influences behavior after hatching. We compared the behavior of 5-dpf embryos reared in the presence or absence of olfactory alarm cue, alone or in combination with cues of a piscivorous predator (Bluegill sunfish, *Lepomis macrochirus*). Next, we reared larvae from the embryonic treatments to 21 dpf, and tested them in two antipredator behavioral assays varying in the degree of immediate risk (predator avoidance vs attack evasion). Embryos that developed in perceived high-risk conditions exhibited reduced activity compared to those from low-risk environments. Larvae from high-risk environments also showed enhanced antipredator behavior, and evidence for embryonic predator learning. These data provide new insight into the learning capabilities and antipredator behaviors of aquatic vertebrate embryos.