



FIG. 1. *Anaxyrus americanus* resting in the v-shaped crotch of two *Liriodendron tulipifera* trunks, 1.67 m above the forest floor in Pennsylvania, USA.

forest in Delaware County, Pennsylvania, USA (39.9300°N, 75.3732°W; WGS 84; Fig. 1). We first observed the *A. americanus* at 1200 h on 16 July 2020, 0.68 m from the forest floor in the u-shaped crotch of a conjoined four-trunk Tulip Tree (*Liriodendron tulipifera*). Upon closer examination, the *A. americanus* retreated further into the crotch of the tree and burrowed into the leaf detritus. A few hours later, we observed the same *A. americanus* perched in a higher v-shaped crotch between two of the tree trunks 1.67 m from the forest floor. While we did not observe the *A. americanus* climb the interior of the tree, its markings matched the individual we photographed that same day. In regular visits to the tree over the course of the next 13 d, we repeatedly observed the *A. americanus* perched in the same v-shaped crotch feeding on insects that climbed up and down the trunk. Hourly visits over the course of 2 d revealed the *A. americanus* spent ca. 5–6 h each day in this v-shaped notch. The *A. americanus* was not seen in the tree after this two-week period.

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**ANAXYRUS BOREAS (Western Toad). DEATH FEIGNING.** Amphibians use a variety of behaviors and mechanisms in order to avoid potential predation, including encounter behavior, escape behavior, and toxicity and noxiousness (Duellman and Trueb 1994. *Biology of Amphibians*. McGraw-Hill, New York, New York. 670 pp.). Although most anurans typically utilize escape behavior, encounter behaviors include several specific mechanisms used by amphibians. Some frogs and toads will excessively inflate their lungs to appear larger, assume postures elevating noxious or toxic glands, use escape calls, bite the potential predator, or may feign death (Marchisin and Anderson 1978. *J. Herpetol.* 12:151–155; Stebbins and Cohen 1995. *A Natural History of Amphibians*. Princeton University Press, Princeton, New Jersey. 336 pp.; Ferreira et al. 2019. *Behav. Ecol. Sociobiol.* 73:1–21). Toledo et al. (2010. *J. Nat. Hist.* 44:1979–1988) considered death feigning as a form of tonic immobility, which they separated into two



FIG. 1. *Anaxyrus boreas* in thanatosis when in close proximity to an adult *Rana boylei* in Sonoma County, California, USA.

categories: death feigning (thanatosis) and shrinking or contracting the body. Death feigning, as described by Toledo et al. (2010, *op. cit.*) included complete immobility, extended limbs, and the eyes typically remaining open. Herein, we report an observation of thanatosis, or death feigning in *Anaxyrus boreas* when confronted by a *Rana boylei* (Foothill Yellow-legged Frog).

Concurrent with efforts to control *Lithobates catesbeianus* (American Bullfrog) at Stewart Pond, in Sonoma County, California, USA (38.64682°N, 122.66130°W; WGS 84), we regularly encountered *R. boylei* (Alvarez and Wilcox 2021. *West. N. Am. Nat.* 81:293–299), *Pseudacris regilla* (Pacific Treefrog), and *A. boreas*. During a night survey on 22 October 2020, we had completed control efforts of *L. catesbeianus* and were finalizing counts of *R. boylei*. Present at the time were numerous post-metamorphic *A. boreas*, and adult and post-metamorphic *R. boylei*, along the margin of the pond. While using eye shine to detect individuals, we noted a distant adult frog that required closer scrutiny to positively identify it to species. Upon our approach we noted a post-metamorphic *A. boreas* which lay ca. 1 cm immediately in front of a large female *R. boylei*. Under close inspection, we noted that the *A. boreas* was exhibiting a position that is similar to that described by Toledo et al. (2010, *op. cit.*) as thanatosis. The *A. boreas* was completely motionless, had all four limbs extended, and had its eyes open (Fig. 1); the body was rigid, straightened, and pressed toward the ground. We observed the event over several minutes. Neither the *R. boylei* nor the *A. boreas* moved for a period of 12 min, when the *R. boylei* suddenly rotated in place, quartering to the *A. boreas*, and leapt ca. 60 cm into the pond. The *A. boreas* remained prostrate for a few minutes, and then raised itself to its feet and, in short bursts of hops and walks, made its way to the pond.

Honma et al. (2006. *Proc. R. Soc. B* 273:1631–1636) conducted experiments to determine the effectiveness of thanatosis as a method to avoid predation. They determined that thanatosis is likely effective for prey that encounter predators that use a sit-and-wait method of foraging, which is the case for *R. boylei*. Endler (1991. *In* Krebs and Davies [eds.], *Behavioural Ecology: An Evolutionary Approach*, pp. 169–196. Blackwell Scientific Publications, Oxford, UK) added that the effectiveness of thanatosis is based on use of the behavior early in the encounter.

We speculate that the *A. boreas* detected the presence of *R. boylei* and engaged in thanatosis in order to remove the movement stimulus that is typically required for frogs to feed (Duellman and Trueb 1994, *op. cit.*; Stebbins and Cohen 1995, *op. cit.*).

We believe this is the first record of *A. boreas* engaged in thanatosis, and we were unaware of *R. boylei* apparently targeting *A. boreas* as a food item prior to this observation. Thanatosis is an intriguing behavioral display for the juvenile *A. boreas* to employ since adult *A. boreas* possess toxins in their dorsal skin rendering them either unprofitable prey, or possibly lethal, to some predators (Stebbins and Cohen 1995, *op. cit.*). If the toxicity is developed in the juvenile life stage of *A. boreas*, we would have anticipated that it would instead assume postures elevating noxious or toxic glands. This observation provides insight into previously unobserved interactions between two sympatric anurans within the habitat of a pond margin.

We are grateful to the Peter Michael Winery and Tom Eakin for access to the Stewart Pond site, and for support of the bullfrog control project.

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**ANAXYRUS BOREAS (Boreal Toad). EGG PREDATION.** Chemical defenses are a mechanism used by amphibians to prevent predation (Daly 1995. *In* Eisner and Meinwald [eds.], *Chemical Ecology: The Chemistry of Biotic Interaction*, pp. 17–28. National Academy Press, Washington, D.C.). Adult bufonids are known to contain bufotoxins that make them unpalatable to predators (Úveges et al. 2019. *Ecol. Evol.* 9:6287–6299). In extreme cases, fish starved for 13 days would still not consume a single egg, tadpole, or adult of one bufonid species (*Anaxyrus canorus*) due to unpalatability (Grasso et al. 2010. *Copeia* 2010:457–462). Although all life stages contain the bufotoxin, eggs have the highest concentrations and most diverse library of bufadienolide toxins compared to all other life stage (Hayes et al. 2010. *J. Chem. Ecol.* 35:391–399), a logical evolutionary tactic given the immobile vulnerability of the egg strings. Eggs and hatchlings are more distasteful than motile life stages, particularly in wetlands with permanent water capable of sustaining fish and alternative prey (Gunzberger and Travis 2005. *J. Herpetol.* 39:547–571).

During night surveys on 27 May 2021 at a constructed ephemeral wetland near Grand Teton National Park, USA (43.83289°N, 110.35463°W; WGS 84; 2089 m elev.), we observed multiple *Anaxyrus boreas* in amplexus and depositing egg strings among the vegetation. The following night (2230 h on 28 May 2021) a convergence of over a dozen *Ambystoma mavortium* (Western Tiger Salamander) individuals was observed consuming *A. boreas* eggs that had been deposited 24–48 h earlier (Fig. 1). We observed the salamanders barrel rolling among the egg strands and tugging side-to-side to rip apart the egg strands for consumption. Upon capture we noticed that the midsection of multiple salamanders was considerably turgid, suggesting significant egg consumption.

Consumption of *A. boreas* eggs by *A. mavortium* may be feasible because salamanders engulf rather than masticate their food. This may reduce the distastefulness of the eggs. Furthermore, the gel-like matrix that holds the eggs (in the strings) together may add an additional protective and more palatable barrier around the *A. boreas* eggs. An alternative hypothesis is that the



FIG. 1. *Anaxyrus boreas* egg strings being consumed by two different *Ambystoma mavortium* at Grand Teton National Park, USA.

bufadienolide concentration and subsequent toxicity decreases as a function of increasing elevation, as has been shown for tetrodotoxin of *Taricha granulosa* (Stokes et al. 2015. *Northwest. Nat.* 96:13–21). Given the relatively high elevation of the observation (2089 m elev.), the distasteful toxins may be at lower concentrations than expected. Although previous accounts have reported larval and adult tiger salamanders (*Ambystoma* spp.) preying on *A. boreas* tadpoles (Dodd 2013. *Frogs of the United States and Canada*. The Johns Hopkins University Press, Baltimore, Maryland. 460 pp.; Swartz et al. 2014. *Herpetol. Rev.* 45:303), we provide an observation from the field demonstrating *A. mavortium* predation on *A. boreas* eggs.

We thank A. Ray for edits and comments that improved the manuscript. This manuscript is contribution #826 of the USGS Amphibian Research and Monitoring Initiative. Any use of trade, firm, and product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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**ANSONIA LEPTOPUS (Matang Stream Toad). PARASITES.** There is little published information regarding the endoparasites of the genus *Ansonia* which contains 37 species, mainly in southeast Asia with two restricted to the Philippines (Frost 2022. *Amphibian Species of the World: an Online Reference*. Version 6.1; <https://amphibiansoftheworld.amnh.org/>; 3 Jan 2021). In this paper we establish the initial helminth list for *A. leptopus*. *Ansonia leptopus* is widely distributed in Borneo where it inhabits hilly primary forest or old secondary growth below 600 m; adults move to clear, medium sized streams for breeding, males usually call in groups (Inger et al. 2017. *A Field Guide to the Frogs of Borneo*. Third Edition. Natural History Publications, Borneo, Kota Kinabalu, Malaysia. 228 pp.). Seventeen *A. leptopus* (mean SVL: 33.4 mm ± 2.9 SD; range: 28–39 mm) were loaned from the Field Museum of Natural History (FMNH). The sample consisted of: FMNH 138822, 138826, 138827, 138834, 138838 (collected 1962), FMNH 138841 (collected 1963) from Malaysia,