NATURAL HISTORY NOTE

Presumed Ocular Trauma in a Foothill Yellow-legged Frog

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Anurans are voracious feeders, eating most anything that fits in their mouth (Duellman and Trueb 1986, Chai 2011). Cryptic coloration affords a sit-and-wait strategy, where visual cues manifest feeding responses to size, velocity, and orientation of prey (Roth 1978). The eyeball itself, or globe, is large, bulging, and nearly spherical; conferring a wide field of vision with very little blind area (Williams and Whitaker 1994). This nearly complete field of vision is critical for feeding and predator avoidance in an animal that essentially cannot move its head. The visual acuity of some anurans is such that they were demonstrated to distinguish bumblebees, and their robberfly mimics, as unprofitable prey (Brower et al. 1960), yet they require movement by prey in order to detect it (Freed 1980).

Within the eye, focusing of the lens is achieved by lenticular movement rather than changing its shape (Keller and Shilton 2002). Four of the six muscles that turn the eye in most amphibians have become rudimentary or disappeared in anuran evolution; ocular movements, other than retraction into and out of the orbits, are negligible (Williams and Whitaker 1994). The two functioning ocular muscles are responsible for the only movement of the eyes: the retractor bulbi muscle pulls the globe into the orbit, protruding into the buccopharyngeal cavity, separated by only a thin membrane; the levitator bulbi returns the eye from the eye socket (Williams and Whitaker 1994, Wright 2003). Pulling the eye into the orbit protects the eye but also aids the frog in moving captured prey back to the pharynx for swallowing (i.e., frogs blink when they eat; Chai 2011).

Adult anurans have short lids and an elastic translucent conjunctival fold—the false nictitating membrane—whose role is protecting the exposed eye (Williams and Whitaker 1994). The cornea is typical to that of other vertebrates. The thin iris is vascularized and colored with melanophores, carotenoid pigments, and crystals of guanine that provide an apparent metallic sheen (Williams and Whitaker 1994, Keller and Shilton 2002). The iris contains myoepithelial sphincter and dilator muscles (Williams and Whitaker 1994). In some anuran species the iris may have autonomous acivity, constricting directly with light, while other iridial activities may be initiated voluntarily, though sluggishly; thus, pupillary light reflexes are not a good measure of light response as they are in mammals (Williams and Whitaker 1994). Given the importance of eye function in prey recognition, feeding, and predator avoidance, any malformation, morbidity, or permanent damage to the eye could directly affect survival by compromising foraging capability and increased vulnerability to predation.

While conducting visual encounter surveys along the North Fork of the American River, near Colfax, California, a female Foothill Yellow-legged Frog (*Rana boylii*) was observed underneath a rock and then captured by hand. The frog's left eye appeared reduced in size (Fig. 1), the pupil malformed due to near complete posterior synechia (i.e., pupillary margin of the iris stuck to the lens) and iris bombe (bulging forward of ciliary and peripheral iris due to near complete posterior synechia), and a pigmented pupillary was evident (Fig. 2). The false nictitating membrane moved normally over the eye when engaged. The frog was photographed and returned to its place under the rock where it was found, but hopped out and ultimately remained in a shallow pool on the bank of the river. We did not possess the necessary agency permits to collect the frog, nor to temporarily remove it from the field for an eye examination. Although we could not determine the cause of the condition of the left eye by direct examination, there are pathologies we can rule out, and causes that we can postulate, using the photos from the field.

The first consideration to what may have caused the frog's ocular abnormality should be on the small size of the eye relative to normal. A small eye could be phthisis bulbi, which is a shrunken eye due to ocular damage (e.g., trauma, chronic uveitis or other severe

Fig. 1. Foothill Yellow-legged Frog (*Rana boylii*) hand captured along the North Fork of the American River, Colfax, California, showing ocular abnormality in the left eye. Photo by Jeffery T. Wilcox.

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Fig. 2. Comparison of left and right sides of the Foothill Yellow-legged Frog (*Rana boylii*) showing ocular abnormality in the left eye. Photos by Jeff A. Alvarez.

intraocular disease), or microphthalmia, which is a developmentally smaller eye. Given the combined signs of extensive posterior synechia, iris bombe, and a pupillary membrane, phthisis bulbi is most likely. Thus, we speculate that the eye was injured, possibly during feeding or during an attempt to escape predation. Phthisis bulbi is a chronic, end-stage clinical sign that usually indicates blindness, and thus we observed the frog post-healing. The frog was in relatively good physical shape, suggesting that the abnormality in the eye may not be completely impeding the current ability to feed. Abnormalities in frogs are not commonly reported, but in some cases may reduce fitness or survival. In the case of this particular Foothill Yellow-legged Frog, the abnormality does not appear to be decreasing the overall physical condition of the frog, which may survive while at a likely increased risk of predation.

Recently, a term "hyperxanthism of the eyes" has been used to in the literature to describe apparent ocular abnormalities in wild caught anurans. Svinin et al. (2108) first used it in specimens of Moor Frog (*R. arvalis*) caught at a nature reserve in the Southern Russian Federation. He attributed the condition to excess pollution but provided no pathology for it. Bosch and Marrero (2020) described hyperxanthism as an "excess of yellow pigments" in the eye of a Cuban Spotted Toad (*Peltophrhyne taladai*) but again provided little more than photos and a characterization without a pathology. Clinically, "hyperxanthism of the eyes" is a corneal disease termed lipid keratopathy, corneal lipodosis, or xanthomatosis, and is a very common ophthalmic disease in captive amphibians (Wright 2003). The cause is undetermined but conflicting support for high dietary lipid and cholesterol, sedentary lives, age, and sex hormones, have been discussed (Moore and Gjeltema 2019). We saw no evidence of lipid keratopathy in either eye of the present frog.

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