

## **LIMB MALFORMATION IN A FOOTHILL YELLOW-LEGGED FROG (RANA BOYLII) FROM SONOMA COUNTY, CALIFORNIA**

Authors: Alvarez, Jeff A, Garten, Kyla M, and Cook, David G

Source: Northwestern Naturalist, 102(3) : 258-260

Published By: Society for Northwestern Vertebrate Biology

URL: <https://doi.org/10.1898/1051-1733-102.3.258>

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

## LIMB MALFORMATION IN A FOOTHILL YELLOW-LEGGED FROG (*RANA BOYLI*) FROM SONOMA COUNTY, CALIFORNIA

JEFF A ALVAREZ, KYLA M GARTEN, AND DAVID G COOK

**ABSTRACT**—Reports of limb malformations in amphibians have increased in the last 20 y. In California, this includes anuran species in the families Hylidae and Ranidae. While working with Foothill Yellow-legged Frogs in Sonoma County, we observed a malformation of a hind limb in 1 individual, the source of which was undetermined. We believe this to be only the second such report of a malformation in this declining species.

**Key words:** California, declining, deformity, Foothill Yellow-legged Frog, malformation, parasite, pathogen, post-metamorphic, *Rana boylei*, Sonoma County

Malformations in amphibians are not uncommon (Sessions and Ruth 1990; Dournon and others 1998), and anurans specifically often show malformations that originate from parasites (Tidd 1962; Johnson and Sutherland 2003; Kupferberg and others 2009). In California, the trematode parasite *Ribeiroia* spp. is known to infect anuran larvae (for example, Pacific Treefrog [*Hyla* (*Pseudacris*) *regilla*], California Red-legged Frog [*Rana draytonii*], and American Bullfrog [*Lithobates catesbeianus*]; Johnson and others 2013, 2019), causing malformations during metamorphosis (Johnson and others 2002, 2013, 2019). These malformations typically occur in lentic eutrophic habitats, such as cattle stockpounds that support the primary intermediate host, the planorbid (family Planorbidae) snail (Johnson and Chase 2004; Budria and Candolin 2014; JAA and DGC pers. obs.). Anurans, the 2nd intermediate host, become infected, and the parasite drives developmental malformations, typically of the limbs (Johnson and others 2002, 2019).

Anurans from lotic habitats that show malformations are less common (Johnson and Chase 2004). Kupferberg and others (2009), however, found that the copepod *Lernaea cyprinacea* parasitized larval Foothill Yellow-legged Frogs (*R. boylei*) in the South Fork of the Eel River (Mendocino County, California), causing post-metamorphic malformations of the limbs, eyes, and snout. The Foothill Yellow-legged Frog is

typically a lotic species (Storer 1925) that rarely occurs in eutrophic systems (Wilcox and Alvarez 2019). Although the Foothill Yellow-legged Frog can be a host to a variety of parasites (Dodd 2013), there is a paucity of observations of malformations in this species. Herein we report a limb malformation in a Foothill Yellow-legged Frog from Sonoma County, California.

On 19 October 2019, we surveyed a small seasonal tributary to Sonoma Creek near the headwaters. This tributary was dry, except for a small perennial pool where we observed 1 adult and approximately 30 post-metamorphic Foothill Yellow-legged Frogs, and a few larval California Giant Salamanders (*Dicamptodon ensatus*). The pool covered 6 m<sup>2</sup>, had a depth of 0.3 m, a substrate of gravel and small cobble, and was shaded by riparian vegetation. The pool contained clear, cool water (approximately 11–13°C), filamentous algae (Charophyta), and no wetland vegetation. The site characteristics suggested that lotic conditions prevailed during winter and spring rainy seasons, transitioning to an oligotrophic isolated pool in summer and autumn. The surrounding uplands were undeveloped and not grazed by livestock.

We dip-netted 3 post-metamorphic Foothill Yellow-legged Frogs from the pool and placed them in water-filled plastic bins for observation. Two frogs appeared to be morphologically typical. The 3rd frog swam in small circles and was removed from the bin to allow for closer observation. Upon examination, the right rear leg of this individual appeared to be severely malformed. We noted that the lower leg, foot, and toes (tibia, fibula, astragalus, calcaneum, and phalanges) were all reduced by approximately 50% (visually estimated), and surrounding musculature was reduced or missing (Fig. 1). The distal portion of the leg was positioned atypically in that it was directed dorsally, as opposed to posteriorly. We also closely examined the frog for any atypical growths, parasites, and injuries; none were found. This malformation appeared morphometrically similar to the

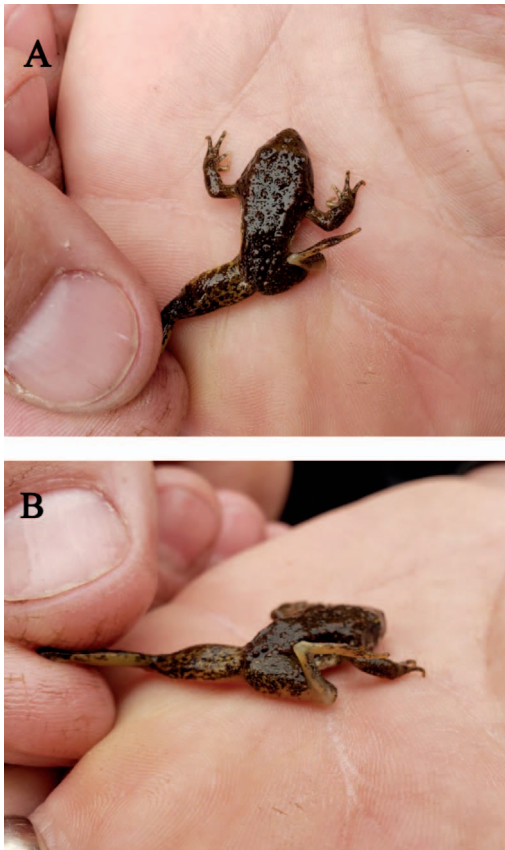


FIGURE 1. A post-metamorphic Foothill Yellow-legged Frog with limb deformity, Sonoma County, California: (A) dorsal view of frog; (B) lateral view showing right rear limb bent upward from its typical position. Photos by KM Garten.

malformations observed in other California amphibian species with *Ribeiroia* infection (Johnson and others 2002; Johnson and Chase 2004; JAA, pers. obs.); however, in this case the cause of the malformation was not determined. We returned the 3 frogs to the habitat in which they were captured.

To our knowledge, malformations in Foothill Yellow-legged Frogs have been documented in only 1 watershed throughout the range of the species (Kupferberg and others 2009), suggesting that the incidence of malformations is either extremely rare, underreported, a new phenomenon, or a combination thereof. Although we did not evaluate or determine the cause of the malformation we observed, parasites such as *Ribeiroia* or the copepod reported by Kupferberg

and others (2009) could be responsible; however, other plausible causes remain possibilities such as physical injury, an unknown parasite, or other pathogen. Owing to the recent declines of some populations of the Foothill Yellow-legged Frog in California (Patterson 2019), we recommend further investigations into the possible causes and effects of malformations in this species, and amphibians in general, at the local and regional level.

*Acknowledgments.*—We thank C Shaffer for supporting this study. Constructive comments on earlier versions of the manuscript were provided by Z Cava and JT Wilcox. Field surveys were conducted under the auspices of California Department of Fish and Wildlife.

#### LITERATURE CITED

- BUDRIA A, CANDOLIN U. 2014. How does human-induced environmental change influence host-parasite interactions. *Parasitology* 141:462–474.
- DODD K JR. 2013. *Frogs of the United States and Canada*, Vol. 2. Baltimore, MD: Johns Hopkins University Press. 982 p.
- DOURNON C, BAUTZ A, MEMBRE H, LAUTHIER M, COLLENOT A. 1998. Expression of hindlimb abnormalities under rearing temperature effects during the larval development of the salamander *Pleurodeles waltl* (urodele amphibian). *Development Growth and Differentiation* 40:555–565.
- JOHNSON PT, CHASE JM. 2004. Parasites in the food web: Linking amphibian malformations and aquatic eutrophication. *Ecology Letters* 7:521–526.
- JOHNSON PT, SUTHERLAND DR. 2003. Amphibian deformities and *Ribeiroia* infection: An emerging helminthiasis. *Trends in Parasitology* 19:332–335.
- JOHNSON PT, LUNDE KB, THURMAN EM, RITCHIE EG, WRAY SN, SUTHERLAND DR, BLAUSTEIN AR. 2002. Parasite (*Ribeiroia ondatrae*) infection linked to amphibian malformations in the western United States. *Ecological Monographs* 72:151–168.
- JOHNSON PTJ, PRESTON DL, HOVERMAN JT, RICHGELS KLD. 2013. Biodiversity decreases disease through predictable changes in host community competence. *Nature* 494:230–234.
- JOHNSON PTJ, CALHOUN DM, RIEPE T, McDEVITT-GALLES T, KOPRIVNIKAR J. 2019. Community disassembly and disease: Realistic—but not randomized—biodiversity losses enhance parasite transmission. *Proceedings of the Royal Society B* 286: 20190260. <http://dx.doi.org/10.1098/rspb.2019.0260>.
- KUPFERBERG SJ, CATENAZZI A, LUNDE K, LIND AJ, PALEN WJ. 2009. Parasitic copepod (*Lernaea cyprinacea*) outbreaks in Foothill Yellow-legged Frogs (*Rana boylei*) linked to unusually warm summers and

- amphibian malformations in Northern California. *Copeia* 2009:529–537.
- PATTERSON L. 2019. A status review of the Foothill Yellow-legged Frog (*Rana boylei*) in California. Sacramento, CA: California Department of Fish and Wildlife.
- SESSIONS SK, RUTH SB. 1990. Explanation for naturally occurring supernumerary limbs in amphibians. *Journal of Experimental Zoology* 254:38–47.
- STEBBINS RC 1956. Amphibians and reptiles of western North America. New York, NY: McGraw-Hill Book Company. 536 p.
- STORER TI. 1925. Synopsis of the Amphibia of California. Berkeley, CA: University of California Press. 343 p.
- TIDD WM. 1962. Experimental infestations of frog tadpoles by *Lernaea cyprinacea*. *Journal of Parasitology* 48:870.
- WILCOX JT, ALVAREZ JA. 2019. Wrestling for real estate: Male-male interactions in breeding Foothill Yellow-legged Frogs (*Rana boylei*). *Western Wildlife* 6:14–17.
- The Wildlife Project, PO Box 188888, Sacramento, CA 95818 USA (JAA); jeff@thewildlifeproject.com; 16973 El Jardin Road, Perris, CA 92570 USA (KMG); 3003 Magowan Drive, Santa Rosa, CA 95405 USA (DGC). Submitted 7 January 2021, accepted 5 March 2021. Corresponding Editor: Robert Hoffman.*