NATURAL HISTORY NOTE

A Sublethal Craniofacial Malformation in a California Red-legged Frog Larva, in the Western San Francisco Bay Area

Nathaniel Chamberlin, Midpeninsula Regional Open Space District, 5050 El Camino Real, Los Altos, CA; *nathanielchamberlin@gmail.com*

Matthew Sharp Chaney, Midpeninsula Regional Open Space District, 5050 El Camino Real, Los Altos, CA

Ariel Starr, Midpeninsula Regional Open Space District, 5050 El Camino Real, Los Altos, CA

Jeff A. Alvarez, The Wildlife Project, P.O. Box 188888, Sacramento, CA; *jeff@thewildlifeproject.com*

Worldwide, herpetofauna are experiencing steep population declines (Barinaga 1990, Alford and Richards 1999). Although a significant reason for those declines appears to be anthropogenic, there are other reasons that amphibian numbers appear to be in decline (Jennings and Hayes 1994, Pechmann and Wake 1997, Collins et al. 2009). A recently studied, yet still misunderstood, contributing factor appears to be malformations that deviate from the normal progression of development, which may then limit or decrease local population persistence (Johnson et al. 2002, Johnson et al. 2013, Vandenburg et al. 2013). Malformations are varied and complex in their origin and affect the ability of individuals to survive (Johnson et al. 2001, Henle and Dubois 2017). Physical malformations in herpetofauna can occur as a result of developmental complications during incubation (turtles), development of eggs (frogs), intersection with anthropogenic materials (turtles), presence of parasites, or may be idiopathic in nature (Johnson et al. 2002, Velo-Antón et al. 2011, Lunde and Johnson 2012, Vandenburg et al. 2013, Alvarez et al. 2023). Often, a malformation is observed opportunistically, without a context for its occurrence, and frequently without any understanding of the ultimate effect on the individual (pers. obs.).

In amphibians, frogs with limb malformations can frequently become easier prey for other species (i.e., birds, snakes, etc.), contributing to a successful lifecycle for a parasitic infestation (Johnson et al. 2013). Occasionally, a malformation has been reported that has no clear origin and no known effects since the observation may be over a single day at a single site (Alvarez et al. 2021, 2023, 2024). However, the increase in frequency may be of note if a particular habitat or aquatic system appears to support more individuals with similar malformations (Alvarez et al. 2021, 2024). In other cases, a malformation may be a rare observation in a single individual, at a particular site, which may not be observed again (Erickson and Chaney 2024).

When malformations are reported in species that are declining, this may become a confounding effect on local population persistence, with a higher likelihood of those individuals not surviving long enough to reproduce. We report here on an observation of a California Red-legged Frog (*Rana draytonii*), a species listed as threatened by the U.S. Fish and Wildlife Service (USFWS 1996), with a significant sublethal craniofacial malformation, which may or may not contribute to decreased survival.

We conducted dip netting surveys for California Red-legged Frog larvae within stock ponds at La Honda Creek Open Space Preserve in San Mateo County, CA. One pond, Schoolhouse Pond, was a maximum of 150 cm deep with 30% of the margins covered by Arroyo Willow (*Salix lasiolepis*) and cattails (*Typha* sp.), with the remaining 70% of the pond margin dominated by sedges (*Scirpus* sp.) and rushes (*Juncus* sp.). The interior of the pond was approximately 40% open water and 60% submergent vegetation. The pond was dip-netted for 20-person minutes and samples were taken from all accessible portions of the pond. All netted organisms were identified and then promptly released.

On 10 June 2025, a single malformed California Red-legged Frog larva at Gosner stage 25 (approximated) was found in Schoolhouse Pond (Figure 1 and 2). The larva had a facial abnormality resulting in the presence of only a single tooth row and asymmetrical facial appearance. The larva appeared to be otherwise healthy (typical size and movement capabilities when compared to conspecifics). In addition to the malformed larva, we found four more typical appearing larvae in the same pond. Other sympatric amphibian larvae found were California Newt (*Taricha torosa*), Rough-skinned Newt (*Taricha granulosa*), and Pacific Chorus Frog (*Pseudacris sierra*).

The larvae of frogs are known to have an ability to modulate morphogenic malformations, effectively compensating for deviations from the normal progression of development; reconstituting the desired anatomy (Vandenburg et al. 2013). However, this ability appears to be relegated to relatively minor anatomical malformations. Vandenburg et al. (2013) do suggest, however, that the ability of some species to correct malformations during metamorphosis can result in a typical appearance, although not always a morphology that meets expectations, yet still appearing substantially normal, and being functionally normal (foraging, moving, escaping, etc.; Vandenburg et

Worldwide, herpetofauna are experiencing steep population declines (Barinaga 1990, Alford and Richards 1999). Although a significant reason for those declines appears to be anthropogenic, there are other reasons that amphibian numbers appear to be in decline (Jennings and Hayes 1994, Pechmann and Wake 1997, Collins et al. 2009).

Copyright © Notice: Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

Figs. 1 and 2. Dorsal and ventral views of a single California Red-legged Frog (*Rana draytonii*) in Schoolhouse Pond, San Mateo County, California. Photos by Matthew Sharp Chaney.

al. 2013). In our observation, modulation of the malformation in the craniofacial appearance would be substantial, likely resulting in an atypical appearance in a metamorphosed frog.

Reports of malformations in amphibians, particularly those from the family Ranidae appear to be on the increase (Alvarez et al. 2021, 2023, 2024, Erickson and Chaney 2024). However, this may be a function of increased survey efforts due to the listing status (i.e., threatened) of a species. In the case of that reported here, it is clear that the malformation was sublethal at this life stage. Since we did not conduct follow-up surveys at this site, it is not clear if the individual survived metamorphosis. It is equally unclear what caused this malformation, or if it was a common condition among the population we sampled. We detected it in only a single individual, but this population should be monitored in subsequent years, to determine if the condition occurs in individuals over time.

Acknowledgments—We are grateful for access to the site from Midpeninsula Regional Open Space District. Permits to conduct the work were granted from the United States Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW) and include permit numbers: USFWS - ES225974 and CDFW Scientific Collecting Permit: S-190320005-19081-001-01. Assistance with field surveys was offered by Lauren Utne and Sherilyn Reinhart, for which we are grateful.

Literature Cited

Alford, R.A., and S.J. Richards.1999. Global amphibian declines: a problem in applied ecology. Annual review of Ecology and Systematics 30:133-165.

Alvarez, J.A., K.M. Garten, and D.G. Cook. 2021. Limb malformation in a foothill yellow-legged frog (*Rana boylii*) from Sonoma County, California. Northwestern Naturalist 102:258-260.

Alvarez, J.A., I. Jackson, M. Falicki, and J.T. Wilcox. 2023. *Rana draytonii*. (California red-legged frog). Larval malformation. Herpetological Review 54:276-277.

Alvarez, J.A., V. Lozano, and D.G. Cook. 2024. Hind limb malformation in a foothill yellow-legged frog, from Sonoma County, California. Sonoran Herpetologist 37:49-51.

Barinaga, M. 1990. Where have all the froggies gone? Science 247:1033-1034.

Collins, J.P., Crump, M.L., and T.E. Lovejoy, III. 2009. Extinction in our times: global amphibian decline. Oxford University Press. Oxford, England. 304 pp.

Erickson, L., and M. Sharp Chaney. 2024. An additional observation of malformation in the hind limb of the foothill yellow-legged frog (*Rana boylii*) in Santa Cruz County, California. Sonoran Herpetologist 37:124-125.

Gosner, K.L. 1960. A simplified table for staging anuran embryos and larvae with notes on identification. Herpetologica 16:183-190.

Henle, K., and A. Dubois. 2017. Studies on anomalies in natural populations of amphibians. Mertensiella 25:185-242.

Jennings, M.R., and M.P. Hayes. 1994. Decline of native ranid frogs in the desert southwest. Pages 183-211 *in*: Brown, P.R., and J.W. Wright (eds). 1994. Herpetology of the North American deserts, proceedings of a symposium. Special Publication No. 5. Southwestern Herpetologists Society, Van Nuys, CA.

Johnson, P.T.J., K.B. Lunde, E.G. Ritchie, J.K. Reaser, and A.E. Launer. 2001. Morphological abnormality patterns in a California amphibian community. Herpetologica 57:336-352.

Reports of malformations in amphibians, particularly those from the family Ranidae appear to be on the increase (Alvarez et al. 2021, 2023, 2024, Erickson and Chaney 2024). However, this may be a function of increased survey efforts due to the listing status (i.e., threatened) of a species.

Copyright © Notice: Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

Johnson, P.T.J., K.B. Lunde, E.M. Thurman, E.G. Ritchie, S.N. Wray, D.R. Sutherland, J.M. Kapfer, T.J. Frest, J. Bowerman, and A.R. Blaustein. 2002. Parasite (*Ribeiroia ondatrae*) infection linked to amphibian malformations in the western United States. Ecological Monographs 72:151-168.
Johnson, P.T., D.L. Preston, J.T. Hoverman, and K.L.D. Richgels. 2013. Biodiversity decreases disease through predictable changes in host community competence. Nature 494:230-234.
Lunde, K.B., and P.T. Johnson. 2012. A practical guide for the study of malformed amphibians and their causes. Journal of Herpetology 46:429-441.
Pechmann, J.H.K., and D.B. Wake. 1997. Declines and disappearances of amphibian populations. Pages 135-137 *in*: Meffe, G.K., and C.R. Carroll (eds). 1997. Principles of Conservation Biology. 2nd ed. Sinauer Associates, Sunderland, MA.
U.S. Fish and Wildlife Service (USFWS). 1996. Endangered and threatened wildlife and plants: Determination of threatened status for the California red-legged frog, *Rana draytonii*. Federal Register 61:25813-25833.
Vandenberg L.N., D.S. Adams, and M. Levin. 2013. Normalized shape and location of perturbed craniofacial structures in the *Xenopus* tadpole reveal an innate ability to achieve correct morphology. Developmental Dynamics 241:863-878.
Velo-Antón, G., C. Guilherme Becker, and A. Cordero-Rivera. 2011. Turtle carapace anomalies: the roles of genetic diversity and environment. PLoSONE 6:e18714.

NATURAL HISTORY NOTE

Total Meromely in a Limb of the Mountain Horned Lizard (*Phrynosoma orbiculare*) in Central Mexico

Edgar Oviedo-Hernández, Karla Noemi Colin-Medina, and Oswaldo Hernández-Gallegos, Laboratorio de Herpetología, Facultad de Ciencias, Universidad Autónoma del Estado de México, Instituto Literario No. 100, Colonia Centro, Toluca, Estado de México, México, C.P. 50000; *eoviedo.biocienciasb@gmail.com*

Gabriel Suárez-Varón and Orlando Suárez-Rodríguez, Facultad de Ciencias, Universidad Autónoma del Estado México, Instituto Literario No. 100, Colonia Centro, Toluca, Estado de México, México, C.P. 50000

Limb aberrations have been associated with altered developmental processes as well as with selective pressures faced by organisms (Gvoždík 2000, Sánchez-Manjarrez et al. 2022, Díaz-Marín et al. 2023a). Among the most cited causes are alterations that occur during embryonic development, frequently derived from mutations; however, greater empirical support contemplates hypotheses related to frustrated predation events, infections or injuries caused by agonistic interactions with conspecifics (Vervust et al. 2009, Decemson et al. 2021, Suárez-Varón et al. 2025).

Particularly in lizards, documented anomalies range from incomplete loss of the tail and subsequent regeneration of the caudal appendages (Kolenda et al. 2017), to various alterations in the locomotor limbs (Decemson et al. 2021, De La Rosa-Silva et al. 2023, Suárez-Varón et al. 2025). The latter are of particular interest, as they are less frequently reported and their causes remain largely speculative (Mora et al. 2020, Díaz-Marín et al. 2023b).

Kolenda et al. (2017) and De La Rosa-Silva et al. (2023), taking up the criteria proposed by Rothschild et al. (2012), describe the anomalies in lizard locomotor limbs under the general term of ectomely, understood as the partial absence of distal structures of the limbs. Within this category, the following are recognized: amely (total absence of a limb), hemimely (deficiencies in the distal portion of the limb), and meromely, referring to the absence of fingers or adactyly. Cases of amely have been recorded for the Mountain Horned Lizard (*Phrynosoma orbiculare*; Suárez-Varón et al. 2025) and for the Green Basilisk (*Basiliscus plumifrons*; Mora et al. 2020), hemimely in the Sand Lizard (*Lacerta agilis*) and in the Viviparous Lizard (*Zootoca vivipara*; Kolenda et al. 2017), to mention a few. The case of meromely is controversial, since, according to the definition of Rothschild et al. (2012) and De La Rosa-Silva et al. (2023), this condition manifests specifically when there is a complete loss of phalanges in one or more fingers. However, it has been reported in lizards in which the damage involves more than the loss of fingers (see Kolenda et al. 2017).

The Mountain Horned Lizard (*Phrynosoma orbiculare*) is a species endemic to Mexico with a wide distribution in the country (Bryson et al. 2012). It belongs to the Phrynosomatidae family and is characterized by the presence of spines and horns (Sherbrooke 2003). It is mainly found in pine-oak forests and xerophilous scrublands, in an elevation gradient ranging from 1,300 to 3,400 m. elev (Suárez-Rodríguez et al. 2018). In accordance with standards stipulated by the Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT) it is classified as an endangered species (Oviedo-Hernández et al. 2024).

The Mountain Horned Lizard (*Phrynosoma orbiculare*) is a species endemic to Mexico with a wide distribution in the country (Bryson et al. 2012). It belongs to the Phrynosomatidae family and is characterized by the presence of spines and horns (Sherbrooke 2003).

Copyright © Notice: Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)