



Ocular Anomalies in Mountain Treefrogs, *Dryophytes eximius* (Baird 1854)

Liliana Gutiérrez-Tovar¹, Irving Yahan Rojas-Velasco², and Luis Fernando Hidalgo-Licona^{3*}

¹Universidad Autónoma Metropolitana, Av. De las Garzas No. 10, Col. El Panteón, Lerma, Estado de México 52005, México

²Facultad de Ciencias, Universidad Autónoma del Estado de México, Km. 15.5 Carretera Toluca-Ixtlahuaca, Toluca, Estado de México 50200, México

³Museo de Zoología “Alfonso L. Herrera,” Departamento de Biología Evolutiva, Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad de México 04510, México

*Corresponding author: fernandohlicona@outlook.com

Among the most frequent chromatic anomalies in amphibians is ocular heterochromia, a condition characterized by variations in the pigmentation of the iris, which can manifest unilaterally (i.e., affecting one eye) or bilaterally (i.e., affecting both eyes) (Gladstone 1969). When the color variation is restricted to a portion of the iris, it is classified as sectoral heterochromia, whereas the presence of a peripupillary pigmented ring with a different hue than the rest of the iris is termed central heterochromia (Tomar et al. 2018; Silva et al. 2021).

In amphibians, abnormal black pigmentation of the iris, often described as “black-eyed,” is considered a subcategory of heterochromia (Rivera et al., 2001; Henle et al. 2017). Following an exhaustive literature review, as of December 2025, only three cases of unilateral heterochromia had been documented in Mexican amphibians like *Agalychnis taylori* (Hernández Vázquez et al. 2023), *Lithobates forreri* (Monroy-Vilchis et al. 2015), and *Triprion spinosus* (de la Luz and Vásquez Cruz 2021).

At 1305 h on 22 October 2024, we observed two Mountain Treefrogs (*Dryophytes eximius*) in the Sierra Morelos Park Protected Natural Area, Municipality of Toluca, Estado de México, México (19.314167, -99.698889; elev. 2,734 m asl). The habitat consisted of subalpine grassland with small bodies of water and trees of the genera *Pinus*, *Quercus*, and *Eucalyptus*. Both frogs exhibited black pigmentation in the right eye, with variations in extent: one displayed complete coloration (Fig. 1A), whereas the other showed partial coloration (i.e., sectoral heterochromia; Fig. 1B). We encountered a third individual at 0800 h on 13 May 2025 in San Mateo Atarasquillo, Municipality of Lerma, Estado de México, México (19.320833, -99.479445; elev. 2,569 m asl). This individual, found resting on a concrete block in a shaded, humid area, exhibited bilateral black pigmentation in both eyes (Fig. 1C).

The black-eyed anomaly is generally attributed to the absence of a bright iris due to a lack of iridophores, reduced

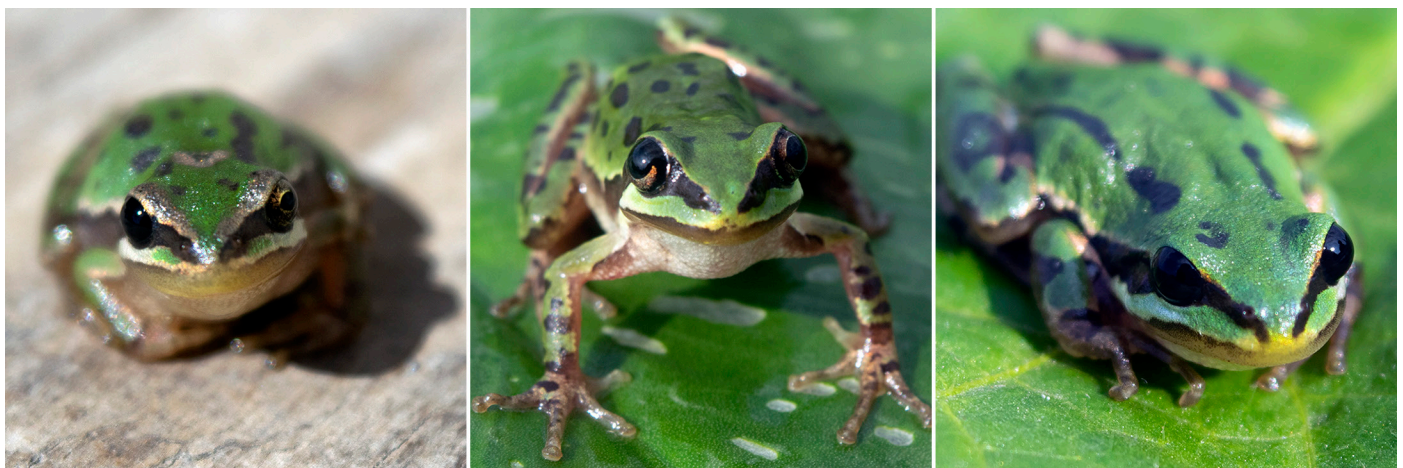


Figure 1. Mountain Treefrogs (*Dryophytes eximius*) from the Estado de México, México, exhibiting ocular pigmentation anomalies: Complete unilateral heterochromia (right eye, dorsal view) (left), partial unilateral heterochromia (right eye) (center), and bilateral black pigmentation (both eyes) (right). Photographs by Liliana Gutiérrez Tovar and Irving Yahan Rojas Velasco.

xanthophores, and a predominance of melanophores (Dubois 1976; Richards and Nace 1983). In amphibians, this condition, whether unilateral or bilateral, usually is associated with a recessive mutation (Vershinin 2004).

Although the exact causes of these anomalies remain unclear, and their population-level effects cannot yet be determined (Souza et al. 2021), previous studies have documented that pesticides and agrochemicals can induce chromatic alterations in various organisms, including amphibians (Noriega and Hayes 2000; Kumari and Sinha 2009; Lifshitz and St. Clair 2016). Since we were unable to identify the specific origin of the observed ocular anomalies, future research should address causal mechanisms (i.e., genetic, environmental, or both), the potential impact on individual fitness and population dynamics, and mitigation strategies, should the anomalies prove to be anthropogenic in origin.

Acknowledgements

We thank Georgina Tovar García for her invaluable fieldwork support. LFHL thanks SECIHTI for scholarship support (CVU: 85019), and we gratefully acknowledge DGAPA-PAPIIT (grants IN227720 and IN200624).

Literature Cited

- de la Luz, N.M. and V. Vasquez Cruz. 2021. *Triprrion spinosus* (Coronated Treefrog). Heterochromia. *Herpetological Review* 52: 840.
- Dubois, A. 1976. Deux *Rana cyanophlyctis* du Népal aux yeux noirs (Amphibiens, Anoures). *Bulletin Mensuel de la Société Linnéenne de Lyon* 45: 303–307. <https://doi.org/10.3406/linly.1976.10279>.
- Gladstone, R.M. 1969. Development and significance of heterochromia of the iris. *Archives of Neurology* 21: 184–192. <https://doi.org/10.1001/archneur.1969.00480140084008>.
- Henle, K., A. Dubois, and V. Vershinin. 2017. Commented glossary, terminology and synonymies of anomalies in natural populations of amphibians. *Mertensiella* 25: 9–48.
- Hernández Vázquez, M.E., M.A. García Jiménez, and R. Montejó Hernández. 2023. Anomalies in three species of anurans in the state of Chiapas, Mexico. *Reptiles & Amphibians* 30: e20113. <https://doi.org/10.17161/randa.v30i1.20113>.
- Kumari, K. and R.C. Sinha. 2009. Acetylcholinesterase activity in the plasma and brain of the frog *Rana tigrina* and the toad *Bufo melanostictus* following the treatment with carbaryl & methyl parathion. *Journal of V. N. Karazin Kharkiv National University* 9: 117–120.
- Lifshitz, N. and C.C. St. Clair. 2016. Coloured ornamental traits could be effective and non-invasive indicators of pollution exposure for wildlife. *Conservation Physiology* 4: cow028. <https://doi.org/10.1093/conphys/cow028>.
- Monroy-Vilchis, O., L.L. Parra López, T. Beltrán-León, J. Lugo, A. Balderas, and M. Zarco-González. 2015. Morphological abnormalities in anurans from central Mexico: A case study. *Herpetozoa* 27: 115–121.
- Noriega, N.C. and T.B. Hayes. 2000. DDT congener effects on secondary sex coloration in the reed frog *Hyperolius argus*: A partial evaluation of the *Hyperolius argus* endocrine screen. *Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology* 126: 231–237. [https://doi.org/10.1016/S0305-0491\(00\)00184-1](https://doi.org/10.1016/S0305-0491(00)00184-1).
- Richards, C.M. and G.W. Nace. 1983. Dark pigment variants in anurans: Classification, new descriptions, color changes and inheritance. *Copeia* 1983: 979–990. <https://doi.org/10.2307/1445100>.
- Rivera, X., O. Arribas, and F. Martí. 2001. Revisión de anomalías pigmentarias en los anfibios de la Península Ibérica y de Europa. *Butlletí de la Societat Catalana d'Herpetologia* 15: 59–75.
- Silva, L.F., A.S.B. Lima, C.F. Dall'Oglio, and R.J. Hallal Júnior. 2021. Heterocromia de íris: Uma revisão das condições que podem afetar a pigmentação iridiana. *Revista Brasileira de Oftalmologia* 80: e0050. <https://doi.org/10.37039/1982.8551.20210050>.
- Souza, F.C., A.L.F. da Silva, C.S. dos Anjos, T.F. Estevinho, M. de Oliveira Lisboa, and M. Menin. 2021. New anomaly records in anurans, with a review for Brazil. *Herpetology Notes* 14: 31–41.
- Tomar, M., R. Dhiman, G. Sharma, and N. Yadav. 2018. Artistic iris: A case of congenital sectoral heterochromia iridis. *Journal of Ophthalmic and Vision Research* 13: 359–360. https://doi.org/10.4103/jovr_91_17.
- Vershinin, V.L. 2004. Frequency of iris depigmentation in urban populations of *Rana arvalis* frogs. *Russian Journal of Ecology* 35: 58–62. <https://doi.org/10.1023/B:RUSE.0000011112.17428.f5>.