



Correspondence

Ocular anomaly in a Blue-sided Treefrog, *Agalychnis annae* (Amphibia: Anura: Phyllomedusidae), in Costa Rica

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Agalychnis annae (DUELLMAN, 1963) is a nocturnal arboreal treefrog in the family Phyllomedusidae (DUELLMAN et al. 2016) that is currently listed with an IUCN Red List status of Vulnerable due to a combination of habitat loss, disease (chytridiomycosis), and the small, fragmented nature of remaining populations in Costa Rica and possibly in western Panama (IUCN SSC Amphibian Specialist Group & NatureServe 2020). It occurs mainly in premontane forests of Costa Rica at mid-level elevations (600–1650 m a.s.l.), with recent records extending into some of the highly anthropogenic landscapes of the Central Valley (HIDALGO-MORA et al. 2021). In such reduced and disturbed populations, the documentation of congenital or developmental anomalies as well as injuries may provide useful, albeit indirect, information on underlying environmental and/or genetic stressors.

During nocturnal surveys on 25 May 2024 at an extralimital locality for the species in Puntarenas Province, Costa Rica (Fila Paraguas, 1500 m a.s.l.; specific locality withheld because of conservation concerns), we encountered an adult *A. annae* with an unusual ocular anomaly in one eye. The right eye had two distinct, pupil-like apertures within a single iris (Fig. 1). The larger structure was a normal-looking vertical pupil while the second opening had a more irregular, vertical shape. Both ocular apertures were sharply demarcated against the pigmented iris and appeared approximately oval in outline. The contralateral eye was externally normal. No other morphological deformities or signs of disease were evident, and the frog behaved normally, showing appropriate righting response, climbing ability, and avoidance behaviour. The individual was not collected.

In human and veterinary ophthalmology, the presence of more than one pupil in the same iris may be diagnosed as polycoria. In strict or “true” polycoria, each extra opening is a functioning supernumerary pupil bordered by its own sphincter pupillae muscle capable of active constriction to regulate light entry to the retina. Alternatively, pseudopolycoria refers to iris openings or defects that superficially resemble additional pupils but lack an independent muscular sphincter and are usually non-reactive (GUYER & GREEN 1962, ISLAM et al. 2007, KANSKI & BOWLING 2011). While rudimentary field testing using a flashlight appeared to show a reaction in both pupils, it is difficult to diagnose this condition ad hoc. Differentiating true polycoria from pseudopolycoria requires slit-lamp biomicroscopy and/or histopathology, which were not feasible in a free-ranging wild frog from a vulnerable population. The presence of a sharp border around the anomalous opening, resembling the one around the normal pupil, allows us to confidently rule out that we merely observed a colour anomaly. However, absent specialized testing we were unable to determine unequivocally whether the extra opening was a tear with a healing edge or a fully functioning supernumerary pupil. Frogs have the ability to regenerate at early life stages and of regenerative wound healing at older stages, even of retinal injuries (SHARMA & RAMACHANDRAN 2022), and these processes can obscure traces of early trauma (GODWIN & ROSENTHAL 2014). Thus, we cannot rule out pseudopolycoria, even though there was no indication of any trauma to the adult frog’s eye that could have caused an internal rupture.

The most troublesome diagnosis would be polycoria. This condition is considered an extremely rare congenital iris

anomaly in humans, where it may occur as an isolated defect or as part of broader anterior segment dysgenesis, such as Axenfeld-Rieger Spectrum (KANSKI & BOWLING 2011). It has also been reported sporadically in domestic animals in the veterinary literature (e.g., dogs and cats; SANKEERTHANA et al. 2023), again as an uncommon malformation of the iris and pupillary apparatus (BEDFORD 1982). There are photographs online of a treefrog with bilateral polycoria (https://www.reddit.com/r/frogs/comments/1foivei/more_pics_of_ciartha_my_frog_with_polycoria) and also

of a seagull with this condition in the left eye (https://www.reddit.com/r/mildlyinteresting/comments/q4yli7/found_this_seagull_that_has_2_pupils/?rdt=50753). In mammals with a foetal stage, this anomaly is generally thought to result from abnormal reabsorption or remodelling of the foetal pupillary membrane and/or defective development of the iris stroma and sphincter muscle. In these frogs, the eggs are laid on leaves exposed to the environment, and the tadpoles hatch and drop into water during rain, remaining free-swimming tadpoles for an extended period of up to

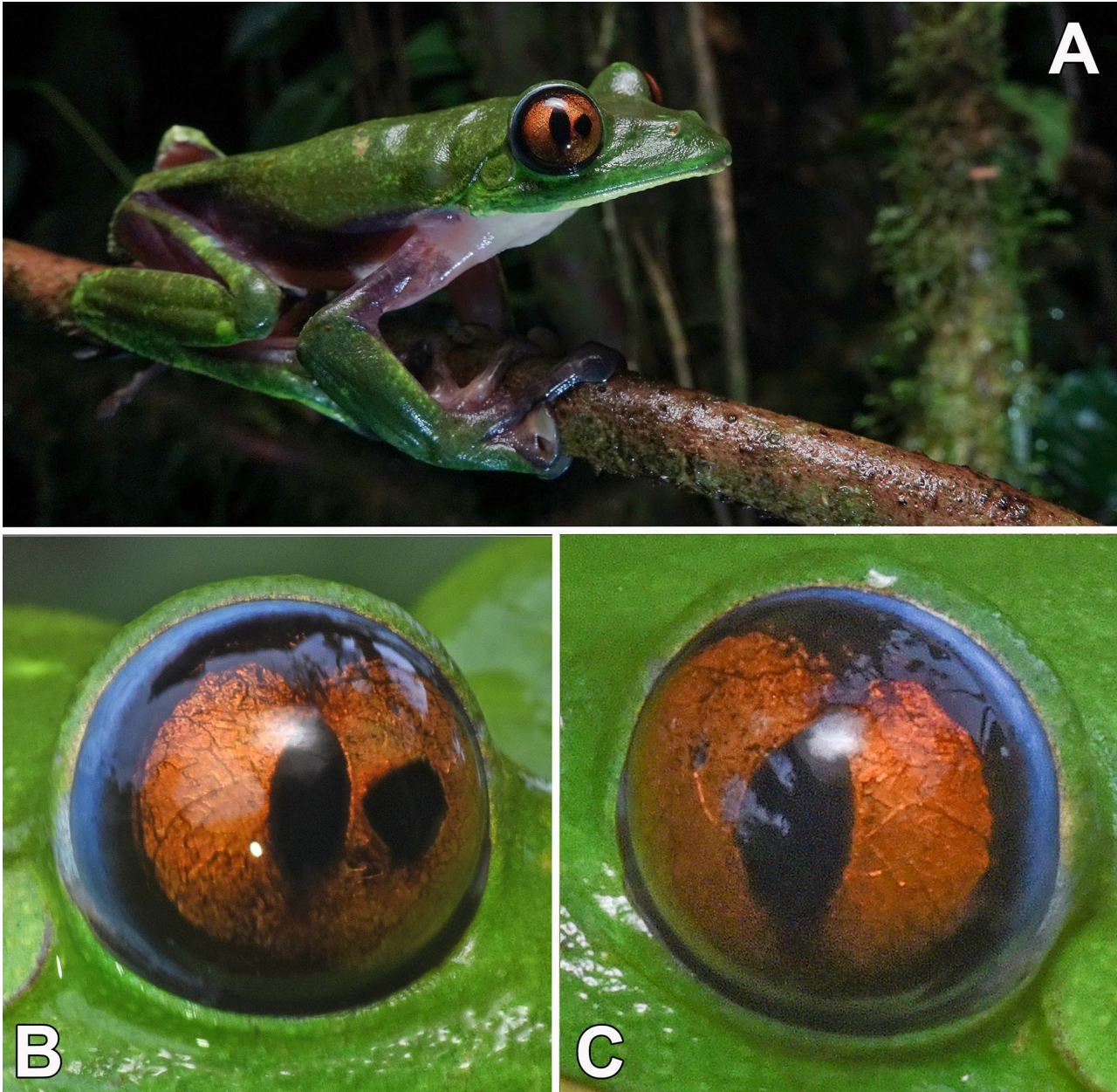


Figure 1. An adult *Agalychnis annae* from Costa Rica in life with an extra pupil-like opening in the right eye: (A) lateral whole-body view of the animal in its environment; (B) close-up view of the right eye, showing two vertically aligned, pupil-like apertures within the single iris. Both openings appear to have similar margins, which may indicate the presence of musculature; (C) close-up view of the left eye, which appears externally normal. Photos by C. L. BARRIO-AMORÓS.

eight months before they metamorphose. Thus, there is extensive opportunity for mechanical injury before the mature eye develops, either from accidental trauma or from attempted predation or even parasitism.

A targeted literature search using combinations of the terms “polycoria”, “pseudopolycoria”, “multiple pupils”, “double pupil” with “reptile”, “amphibian”, “frog”, “toad”, “lizard”, “snake”, and “turtle” in major bibliographic databases (Web of Science, Scopus, Google Scholar) failed to uncover any previous published reports of polycoria or pseudopolycoria in non-mammalian vertebrates. Ocular anomalies described in herpetofauna largely involve anophthalmia (missing eye), microphthalmia (smaller than normal eye), coloboma (irregularly shaped iris), lens opacity, lens displacement, and traumatic lesions, but not duplication or subdivision of the pupil. On this basis, the present observation appears to constitute the first documented case of a polycoria-like condition in an amphibian.

Functionally, the presence of more than one pupil in a single eye can potentially disturb normal pupillary dynamics and optical performance. In humans with polycoria, the secondary pupils may constrict asynchronously or incompletely, causing irregular openings to the pupils, reduced effective aperture and increased higher-order aberrations, leading to monocular diplopia (double vision), glare and decreased visual acuity (GUYER & GREEN 1962, KANSKI & BOWLING 2011). In pseudopolycoria, additional openings may allow stray light to bypass the main pupil and the iris margin, likewise generating light scatter and degraded image quality. In a nocturnal frog such as *A. annae*, the impact of such a defect is difficult to assess: the species normally operates with a relatively large pupil under low light conditions, and visual tasks often occur at short focal distances, where large depth of field and high acuity may be less critical than motion detection and contrast. The frog we encountered showed no evident impairment in its overall behaviour, although subtle deficits in spatial resolution or contrast sensitivity on the affected side cannot be excluded, even in the absence of direct evidence.

The cause of this anomaly in this individual of *A. annae* remains unknown. As with other ocular anomalies, possible causes include spontaneous developmental errors, mutations in genes involved in eye morphogenesis, nutritional imbalances during larval development, exposure to teratogenic agents (including contaminants or excessive ultraviolet radiation), or some kind of traumatic injury (e.g. from predation or parasitism) during some stage of development. The occurrence of the condition in a single adult, in the absence of other structural abnormalities, is certainly not a signal for alarm and there is no evidence of a widespread problem. Nevertheless, as in all such cases of abnormalities in wild-caught animals, especially species that are vulnerable, it would be good to informally “keep an eye out” for any similar cases.

From a conservation and population health perspective, the lack of baseline data means that even rare anomalies merit documentation in small, threatened amphibian populations. The report of unilateral anophthalmia in a re-

cently metamorphosed *A. annae* from Costa Rica (BLAND & McLAREN 2023) highlights that ocular anomalies, although individually rare, do occur in this species. Additional ophthalmological problems in Central America and Mexico alone have included unilateral black eye malformations in *Triprion spinosus* (CORTES-SUAREZ et al. 2021) and *Anaxyrus compactilis* (GUZMÁN-RAMÍREZ et al. 2025), microphthalmia in *Lithobates forreri* (CASTRO-BASTIDAS et al. 2022), anophthalmia in *Rhinella horribilis* (CASTRO-BASTIDAS et al. 2025) and *Lithobates maculatus* (SALGUEIRO-SÁNCHEZ et al. 2024), a corneal dermoid in *Agalychnis callidryas* (ABARCA et al. 2024), and dyscoria (non-round pupils) in *Lithobates magnaocularis* (CASTRO-BASTIDAS et al. 2025). Even though we were not able to distinguish between polycoria, pseudopolycoria, or other causal factors, our observation adds an additional, previously unreported type of eye anomaly to the spectrum observed in *A. annae* and in Central American amphibians more broadly. Although we do not advise that systematic searches be initiated to determine the frequency of such abnormalities in wild populations of frogs, we do encourage field herpetologists and conservation practitioners to document any ocular anomalies of encountered individuals photographically whenever possible, particularly in species of conservation concern. Such incidental records may provide valuable baseline data as well as early signals of environmental stressors or emerging developmental issues.

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