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First records of axanthism in African Reed Frogs (genus *Hyperolius*) and an updated checklist of axanthic amphibians

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Axanthism – the absence or strong reduction of yellow pigments from xanthophores – has been documented in a wide range of amphibian lineages (Dubois, 1979; Jablonski et al., 2014; Gould and McHenry, 2024). This pigment deficit can alter crypsis and intraspecific signalling, potentially affecting predation risk and mate choice (Hoffman and Blouin, 2000). African Reed Frogs (genus *Hyperolius*) comprise 145 species distributed across sub-Saharan Africa (Frost, 2025). Despite their diversity and bright colouration, we are unaware of any published records of axanthism for this genus.

A review by Jablonski et al. (2014) compiled records of axanthism in 23 species from nine amphibian families, highlighting its broad but sporadic distribution. A recent global synthesis by Womack et al. (2025) expanded the known distribution of axanthism to 36 species in 21 genera and 11 families, largely through systematic analysis of iNaturalist records (https://www.inaturalist.org/projects/aberrantly-blue-frogs). Their review, which cut off data collection in 2021, represents the largest published dataset of axanthism. Here, we build directly on that foundation by incorporating additional iNaturalist observations, literature records, and two original records for African Reed Frogs.

Materials and Methods

Field surveys were conducted in April–May 2017 in Kouilou Department, Republic of the Congo, and in December 2017 in Malanje Province, Angola (Fig. 1). Amphibians and reptiles were located using visual encounter surveys, using diurnal searches for reptiles and nocturnal searches for amphibians. Specimens were captured by hand or with capture tools, photographed, dispatched with MS-222 (Tricaine), and tissue samples (liver or tongue) preserved in RNAlater. Voucher specimens have been deposited in the collections of the Florida Museum of Natural History (FLMNH), the California Academy of Sciences (CAS), the Instituto Nacional da Biodiversidade e Áreas de Conservação (INBAC; authorisation N°08/INBAC.MINAMB/2017), Angola, and the Institut National de Recherche en Sciences Exactes et Naturelles (IRSEN; authorisation N°170 /MRSIT/IRSEN/DG/DS), Republic of the Congo.

Genomic DNA was extracted using Qiagen DNeasy kits. The mitochondrial *16S* rRNA gene was amplified with primers 16SA-L and 16SB-H (Palumbi et al., 1991) in 20 µl PCR reactions using AmpliTaq Gold master mix. Cycling conditions were 95°C for 10 min; 35 cycles of 96°C for 3 s, 54°C for 3 s, 68°C for 15 s; final extension at 72°C for 10 s. Products were sequenced by Genewiz

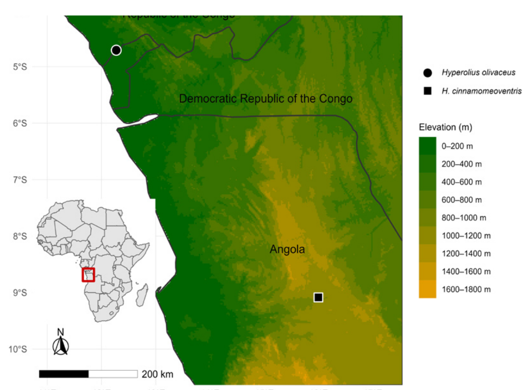

Figure 1. Map of Central Africa, showing axanthism localities for *H. cinnamomeoventris* in Angola (square) and *H. olivaceus* in the Republic of the Congo (circle).

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(Pennsylvania, USA). Sequences have been deposited in GenBank (accession numbers provided below).

Records from the "Aberrantly Blue Frogs" iNaturalist project were filtered by date (01 January 2022–20 August 2025). We did not include records with unresolved identifications ("Research Grade") or those where the image was of insufficient quality to determine the colour of the frog. We reviewed literature records using Google Scholar by searching the terms "axanthic", "axanthism", "frog", as well as a targeted review of any papers that cited Jablonski et al. (2014). We follow Amphibian Species of the World taxonomy (Frost, 2025; Table 1).

Results and Discussion

One adult male of Cinnamon-bellied Reed Frog, *Hyperolius cinnamomeoventris* Bocage, 1866, (UF-HERP-185676; Fig. 1) was collected at the species' type locality, Kalandula Falls (Duque de Bragança), Malanje Province, Angola (9.0854°S, 15.9968°E, elevation 960 m; Fig. 2A) on 5 December 2017. The individual exhibited partial axanthism with a blue-grey wash over the dorsum and head, contrasting with otherwise green limbs and body. Identification was confirmed with *16S* sequence data (GenBank accession: MK036466). This specimen is identical (0.0% uncorrected pairwise divergence) with other topotypic sequences for *H. cinnamomeoventris* (Bell et al., 2017; ZMB 83093; HM064461). This is the only individual that exhibited any colour aberration among the 28 individuals observed during the survey.

One adult female of Olive Reed Frog, *Hyperolius olivaceus* Buchholz & Peters, 1876, (UF-HERP-180586; Fig. 2B) was collected in the Kouilou Department, Republic of the Congo (4.7097°S, 12.2721°E, elevation 72 m; Fig. 1) on 25 April 2017. Females of this species are typically bright green on the dorsal surfaces of their back, head, and limbs, with orange to red digit tips and flash patterning on their thighs. The specimen exhibited atypical pigmentation, with a light blue back, greyish-blue head, and blue patches on the forearm. Identification was supported by *16S* sequence data (GenBank accession: PX399137). This specimen is identical (0.0% uncorrected pairwise divergence) to the southern population *H. olivaceus* described in Bell et al. (2017; orange hexagons; USNM 584161; MF376254), and 1.27% divergent from the topotypic population (orange stars in Bell et al. 2017; NCSM-81281; MF376207). This is the only individual that exhibited any colour aberration among the 81 individuals observed during the survey.

Many *Hyperolius* species, including *H. cinnamomeoventris* and *H. olivaceus*, exhibit sexual dichromatism, in which females undergo an ontogenetic colour change at sexual maturity, often developing more ornate or contrasting colouration than males (Portik et al., 2019). This female-biased dichromatism is thought to function in mate recognition or intersexual signalling in multi-species breeding assemblages where numerous *Hyperolius* species may call and display simultaneously (Portik et al., 2018). Given the role of colour signals in reproductive interactions, aberrant pigmentation such as axanthism could disrupt these cues, potentially reducing mate recognition efficiency or altering sexual selection

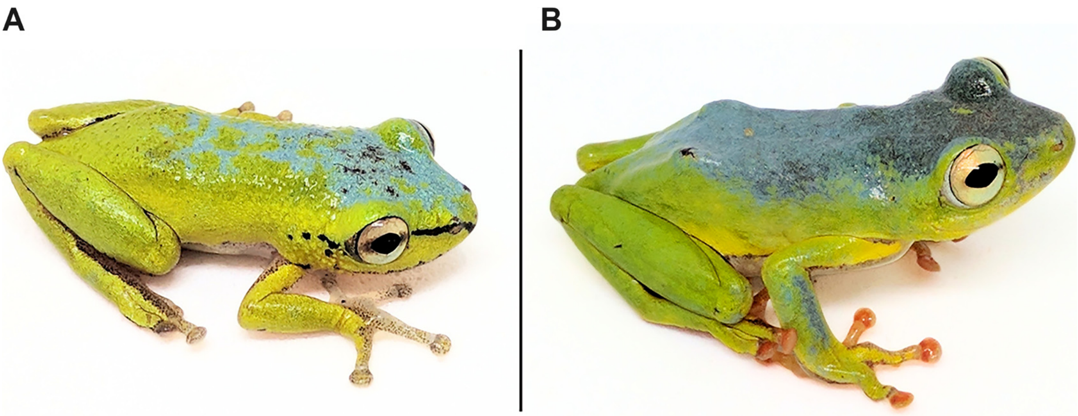

Figure 2. Partial axanthism in *Hyperolius cinnamomeoventris* (A; UF-HERP-185676, Angola) and *Hyperolius olivaceus* (B; UF-HERP-180586, Republic of the Congo). Photos by Gregory F.M. Jongsma.

Table 1. Axanthism in amphibians (75 species, 47 genera, 21 families). Records from Jablonski et al. (2014) and Womack et al. (2025), plus 26 new records from literature and iNaturalist through 2025. Columns show: Taxon (family and species with authority), Citation (earliest published reference or iNaturalist identifier), and Reviewed (J = Jablonski et al. 2014; W = Womack et al. 2025; New = This study).

Taxon	Citation (earliest) / iNaturalist identifier	Reviewed
FROGS		
Alsodidae		
Eupsophus calcaratus (Günther, 1881)	39635696	W
Alytidae		
Alytes obstetricans (Laurenti, 1768)	Galán et al., 1990	J
Bombinatoridae		
Bombina orientalis (Boulenger, 1890)	350092	W
Bufonidae		
Anaxyrus americanus (Holbrook, 1836)	81390542	W
Anaxyrus fowleri (Hinckley, 1882)	25203025	W
Anaxyrus woodhousii (Girard, 1854)	Bechtel, 1995	J
Bufo bufo (Linnaeus, 1758)	Dubois, 1969	J
Bufotes viridis (Laurenti, 1768)	Jablonski et al., 2014	J
Melanophryniscus estebani Céspedez, 2008	Chilote and Moreno, 2019	New
Rhinella arenarum (Hensel, 1867)	100055190	W
Rhinella diptycha (Cope, 1862)	facebook.com/photo?fbid=102261046335515 03&set=pcb.4749736815078229	W
Rhinella ornata (Spix, 1824)	Smith and Faust, 2020	New
Centrolenidae		
Espadarana durrellorum (Cisneros-Heredia, 2007)	99843614	W
Craugastoridae		
Craugastor phasma (Lips & Savage, 1996)	Lips and Savage, 1996	J
Dendrobatidae		
Dendrobates auratus (Girard, 1855)	99955455	W
Dicroglossidae		
Euphlyctis cyanophlyctis (Schneider, 1799)	Dubois, 1976	J
Fejervarya limnocharis (Gravenhorst, 1829)	107025826	New
Hoplobatrachus chinensis (Wiegmann, 1834)	9678656	W
Hylidae		
Acris crepitans Baird, 1854	Niccoli, 2013	W
Agalychnis callidryas (Cope, 1862)	100456051	W
Agalychnis dacnicolor (Cope, 1864)	75584907; Bagnara et al., 2007	W
Dendropsophus molitor (Schmidt, 1857)	Cortés-Suárez and Amaya-Villabona, 2023	New
Dendropsophus minutus (Peters, 1872)	Araújo et al., 2020	New
Drymomantis fallax (Peters, 1880)	102590402	W
Dryophytes cinerea (Schneider, 1799)	Cain and Utesch, 1976	J
Dryopsophus barringtonensis (Copland, 1957)	Twitter: jodirowley 05 Apr 2020	W

Table 1. Continued.

Taxon	Citation (earliest) / iNaturalist identifier	Reviewed
Dryophytes gratiosa (LeConte, 1856)	373812; Canterbury et al., 2023	W
Dryophytes japonica (Günther, 1859)	Nishioka and Ueda, 1985a	J
Dryophytes squirella (Daudin, 1800)	34850838	New
Dryophytes versicolor (LeConte, 1825)	100554292	W
Dryophytes versicolor - chrysoscelis	32299255	W
Hyla arborea (Linnaeus, 1758)	Hinz, 1976	J
Hyla meridionalis Boettger, 1874	15414229	W
Litoria latopalmata Günther, 1867	263227330	New
Osteopilus septentrionalis (Duméril & Bibron, 1841)	10786352	New
Pelodryas caerulea (White, 1790)	12740668	New
Pelodryas splendida (Tyler et al, 1977)	Mongabay News: Dasgupta, 2024,	New
Pithecopus gonzagai Andrade et al., 2020	Oliveira et al., 2021	New
Pseudacris regilla (Baird & Girard, 1852)	48795689	W
Ranoidea aurea (Lesson, 1830)	Gould and McHenry, 2024	New
Ranoidea moorei (Copland, 1957)	198711311	New
Smilisca baudinii (Duméril & Bibron, 1841)	Vázquez et al., 2023	New
Hyperoliidae		
Hyperolius cinnamomeoventris Barboza du Bocage, 1866	New	New
Hyperolius olivaceus Buchholz & Peters, 1876	New	New
Kassina senegalensis (Duméril & Bibron, 1841)	20803490	W
Leptodactylidae		
Leptodactylus fuscus (Schneider, 1799)	25495793	W
Mantellidae		
Boophis septentrionalis Glaw & Vences, 1994	36531	W
Mantella crocea Pintak & Böhme, 1990	33998	W
Microhylidae		
Gastrophryne carolinensis (Holbrook, 1835)	82728417	New
Pelodytidae		
Pelodytes punctatus (Daudin, 1802)	Doiteau, 2025	New
Pyxicephalidae		
Cacosternum boettgeri (Boulenger, 1882)	104020286	W
Pyxicephalus adspersus Tschudi, 1838	69823074	W
Ranidae		
Lithobates catesbeianus (Shaw, 1802)	Berns and Uhler, 1966	J
Lithobates clamitans (Latreille, 1801)	Berns and Uhler, 1966	J
Lithobates pipiens (Schreber, 1782)	Martof, 1964	J
Lithobates septentrionalis (Baird, 1854)	31397426	W
Lithobates sphenocephalus (Cope, 1886)	Hall et al., 2018	New
Lithobates sylvaticus (LeConte, 1825)	Reeves et al., 2008	J

Table 1. Continued.

Taxon	Citation (earliest) / iNaturalist identifier	Reviewed
Lithobates yavapaiensis (Platz & Frost, 1984)	170893350	New
Odorrana ishikawae (Stejneger, 1901)	74365411	New
Odorrana swinhoana (Boulenger, 1903)	306957658	New
Pelophylax lessonae (Camerano, 1882)	Dubois and Vachard, 1971	J
Pelophylax nigromaculatus (Hallowell, 1861)	Liu, 1931	J
Pelophylax perezi (López-Seoane, 1885)	Gonzalez de la Vega, 1994	New
Pelophylax plancyi (Lataste, 1880)	Liu, 1931; Jablonski et al., 2014	J
Pelophylax porosus (Cope, 1868)	Nishioka and Ueda, 1985c	J
Pelophylax ridibundus (Pallas, 1771)	88965034; Allain et al., 2023	W
Pelophylax sp.	32604220	W
Rhacophoridae		
Zhangixalus schlegelii (Günther, 1858)	Nishioka and Ueda, 1985b	J
SALAMANDERS		
Ambystomidae		
Ambystoma mexicanum (Shaw & Nodder, 1798)	Frost et al., 1984	J
Salamandridae		
Lissotriton helveticus (Razoumovsky, 1789)	Dubois et al., 1973	J
Salamandra salamandra (Linnaeus, 1758)	Lucchini, and Pizzigalli, 2020	New
Taricha granulosa (Skilton, 1849)	Livezey, 1960	J
CAECILIANS		
Grandisoniidae		
Gegeneophis ramaswamii Taylor, 1964	Venu et al., 2022	New
Ichthyophiidae		
Uraeotyphlus narayani Seshachar, 1939	Venu et al., 2022	New

dynamics. Such effects could have consequences for reproductive success, especially in species where visual cues complement acoustic signalling during courtship. Given the apparent low prevalence of axanthism in *Hyperolius*, this will be challenging to study in natural populations; however, community science platforms offer a promising avenue for researching rare phenotypic phenomena in nature, as demonstrated by Womack et al. (2025).

Including our vouchered records of two *Hyperolius* species, axanthism has now been documented in 75 amphibian species across 47 genera and 21 families (Table 1). Our updated compilation adds 26 new species not present in Womack et al. (2025) or Jablonski et al. (2014), increasing the total axanthic records of amphibians by nearly 50%. Of these records, 14 were sourced from scientific literature, ten from recent iNaturalist records, and two from personal field observations. This demonstrates a recent and rapid uptick in published axanthic records in the literature and those facilitated by community science platforms such as iNaturalist.

Jablonski et al. (2014) noted that ranids dominate the published records, likely reflecting research bias toward common, well-studied species as well as taxa common in the Global North. This pattern is further supported by Womack et al. (2025) who report the highest incidences of axanthism in Ranidae and Hylidae in North America. In Africa, colour anomalies in anurans remain rarely reported: aside from an albino *Tomopterna* sp. from Kenya and a recently reported leucistic *Hemisus guineensis* from Namibia, axanthism has only been documented on the continent from community-science records (Wojnowski et al., 2010; Womack et al., 2025; Channing and Paxton, 2025). Our vouchered specimens represent the first confirmed axanthic records for the genus *Hyperolius*. Given the rarity of colour aberrations and their dispersed taxonomic and geographic distribution, community science platforms, like iNaturalist, are playing a key role in detecting new cases; however, geographic participation bias on such platforms will likely continue to bias our understanding of colour aberrations globally.

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