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# Yellow is the new green: abnormal colouration of *Pelophylax* sp. in Latvia and Lithuania

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Amphibians exhibit a wide range of colour patterns that serve various crucial biological functions, including thermoregulation, camouflage, sexual signalling and predator deterrence (Rudh and Qvarnström, 2013; Rojas, 2017). Some species exhibit temporal colour changes, although the reasons for these rapid shifts are not always clear (Wente and Phillips, 2003; Rojas, 2017; Birbele et al., 2025). While most pigmentation follows species-specific patterns adapted to ecological pressures, abnormal colouration such as leucism, xanthism, and piebaldism represent deviations with diverse underlying causes (Allain et al., 2023). These abnormalities often stem from chromatophore deficits, impacting the specialised pigment and light-reflecting cells responsible for colouration (Gould and McHenry, 2024). Leucism is characterised by a partial or complete absence of all pigment cell types (melanophores, xanthophores, and iridophores) in certain skin areas, leading to white patches or an overall pale appearance, which typically does not affect eye colour, distinguishing it from albinism (Allain et al., 2016; Henle and Dubois, 2017; Gould and McHenry, 2024). This condition could result from developmental issues involving neural crest cells during embryogenesis (Parichy, 2006). Xanthism involves an excess of yellow pigments due to the increased density or overexpression of xanthophores, which may be genetically determined or influenced by environmental factors (Gould and McHenry, 2024). Piebaldism is characterised by unpatterned, unpigmented spots on an otherwise pigmented base colour. It does not affect eye colour (Allain et al., 2023). The inconsistent use of nomenclature and classification in scientific publications makes a direct comparison and summary of these cases particularly challenging (Henle and Dubois, 2017; Allain et al., 2023).

We document the first reports of xanthic and yellow-black aberrant colouration in *Pelophylax* sp. frogs from Latvia and Lithuania (Figs. 1, 2). In both countries, the genus *Pelophylax* is represented by the Pool Frog, *Pelophylax lessonae* (Camerano, 1882), the Marsh Frog, *Pelophylax ridibundus* (Pallas, 1771), and their hybrid, the Edible Frog, *Pelophylax kl. esculentus* (Linnaeus, 1758) (Frost et al., 2006; IUCN SSC Amphibian Specialist Group, 2022; Denoel et al., 2024). Two of the observations in Latvia were verified by researchers: a case from Liepari (56.8911ºN, 27.1061ºE) on 14 June 2025 (Fig. 1A) and from Gulbene (57.1727ºN, 26.7500ºE) on 15 August 2023 (Fig. 1 B). The third case, a frog observed during two years (2012–13) in Kārļi (57.2422ºN, 25.210556 E), was reported in a Latvian public nature observation database (LFN, LOS 2025a, b), (Fig. 1C). From Lithuania, two cases were reported in 2023: a yellow frog from Šakiai (54.9505ºN, 23.0497ºE) (Fig. 1D) and a yellow-and-black frog from Turlojiškė (54.3619ºN, 23.3025ºE) (Fig. 1E).

To have a better understanding of the worldwide reports about leucism, xanthism, and piebaldism, we reviewed available literature. We performed a literature search on Google Scholar focusing on three types of chromatic aberrations. The keywords 'leucism', 'xanthism', 'piebaldism', and 'amphibians' were searched either independently or combined, targeting all peer-reviewed literature related to these conditions in amphibian species. Given the observed variation of our records and across the identified literature records, we propose a more comprehensive classification for cases that do not align with the structured system proposed in recent publications (Henle and Dubois, 2017; Allain et al., 2023). The findings from the literature search, along with our new observations, are detailed in Table 1.

The yellow frogs (Figs. 1C, D) observed in Latvia and Lithuania can be classified as xanthic, based on the

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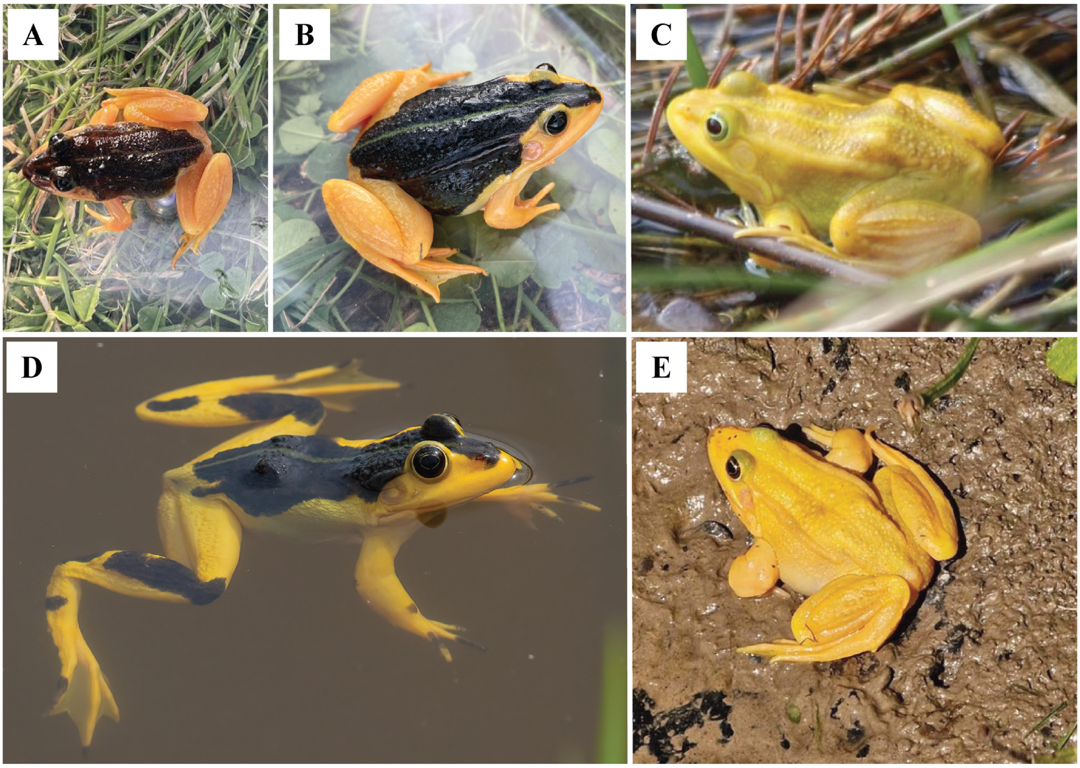


**Figure 1.** Aberrant green frog records: (A) Liepari, Latvia 2025; (B) Gulbene, Latvia 2023; (C) Kārļi, Latvia 2012-13; (D) Šakiai, Lithuania 2023; and (E) Turlojiškė, Lithuania 2023. Photos by E. Birbele (A, B), A. Valdovskis (C), and M. Čepulis (D, E).

description provided by Henle and Dubois et al. (2017). The three yellow-black frogs (Fig. 1A, B, E) are more difficult to classify due to their unique colouration patterns. The yellow-black colouration appears different among the three individuals. The two frogs from Latvia (Fig. 1A, B) share a primary pattern of a black body with yellow legs, with the second specimen (Fig. 1B) retaining a reduced green line on its back. However, the individual from Turlojiškė (Fig. 1E) is distinguished by a more extensive black pattern that extends onto its legs. Allain et al. (2023) defined piebaldism as the presence of unpatterned, depigmented (white or pale) areas, such as those described for the Common Frog, *Rana temporaria* Linnaeus, 1758, by Baker and Biddle (2020). While our specimens (Fig. 1A, B, E) also exhibit unpatterned areas, the yellow background colouration of these sections leads us to exclude piebaldism.

In the literature, we found two cases of frogs with a yellow and dark body pattern. The case described by Hughes et al. (2019) differs from our observations, as they report a completely yellow tadpole that developed

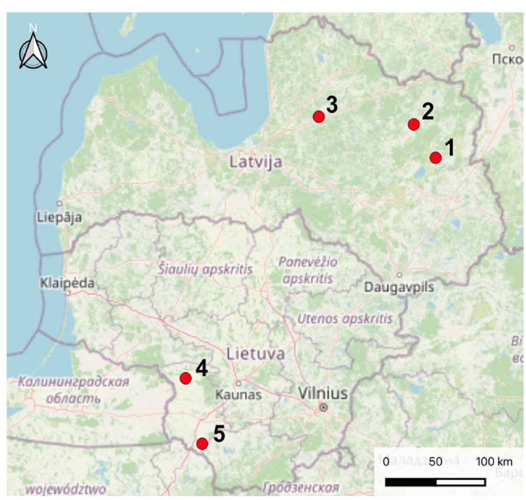


**Figure 2.** Map with the observation: 1: Liepari; 2: Gulbene; 3 Kārļi; 4 Šakiai; and 5 Turlojiškė.

**Table 1.** Reported cases of leucistic, piebald and xantic colour abnormalities in anurans. Bolded records concern the contributions of this manuscript.

| Family | Species | *n* | Place | Colour | Colouration name | Reference |
|---|---|---|---|---|---|---|
| Aromobatidae | *Allobates femoralis* | 1 | Brazil | White with black dots | Partial leucism (probably piebald) | Tavares-Pinheiro et al., 2020 |
| | *Anomaloglossus stepheni* | 1 | Brazil | Red-white | Leucism (possibly erythristic) | de Lima Moraes and Kaefer, 2015 |
| Batrachylidae | *Atelognathus patagonicus* | 1 | Argentina | Spotted depigmentation | Piebald | Rolón et al, 2023 |
| Bufonidae | *Bufo bufo* | 1 | France | White-yellow | Leucism | Muratet et al., 2010 |
| | *Bufo bufo* | 1 | England | White-yellow | Leucism | Allain et al., 2023 |
| | *Bufo bufo* | 1 | England | Red-black | Piebald | Allain et al., 2023 |
| | *Epidalea calamita* | N.D. | N.D. | N.D. | N.D. | Beebee and Griffiths, 2000 (in Allain et al., 2023) |
| | *Rhinella marina* | 1 | Brazil | Depigmented | Leucism (tadpole, unclear) | Hemnani et al., 2021 |
| Dendrobatidae | *Epipedobates anthonyi* | 1 | Ecuador | Yellow with dark spots | Partial leucism (possibly piebald) | Brito-Zapata, 2021 |
| Hylidae | *Agalychnis callidryas* | 2 | Panama | Yellow | Leucism | Güell et al., 2021 |
| | *Agalychnis spurrelli* | 5 | Costa Rica | Yellow | Leucism (see article about the subadult) | Güell et al., 2021 |
| | *Phyllomedusa vaillantii* | 1 | Brazil | Yellow with red dots | Xanthism | Pedroso-Santos et al., 2022 |
| | *Leptodactylus melanonotus* | 1 | Honduras | Golden | Leucism | Brown et al., 2020 |
| Ranidae | *Lithobates clamitans* | 1 | USA | Yellow with brown legs | partial leucism (possibly piebald) | Hughes et al., 2019 |
| | *Lithobates sylvaticus* | 1 | USA | Yellow | Leucism | Smith, 2014 |
| | ***Pelophylax kl. esculenta*** | **2** | **Latvia** | **Yellow-black** | **Leucism-piebald** | **this study** |
| | ***Pelophylax kl. esculenta*** | **1** | **Latvia** | **Yellow** | **Leucism** | **this study (A. Valdovskis pers. obs.)** |
| | ***Pelophylax* sp.** | **1** | **Lithuania** | **Yellow-black** | **Leucism-piebald** | **this study (M. Čepulis pers. obs.)** |
| | ***Pelophylax* sp.** | **1** | **Lithuania** | **Yellow** | **Leucism** | **this study (M. Čepulis pers. obs.)** |
| | *Pelophylax lessonae* | 1 | Ukraine | Yellow-orange | Flavism | Marushchak et al., 2021 |
| | *Rana draytonii* | 1 | Mexico | Yellow | Leucism | Solis Sotelo et al., 2022 |
| | *Rana temporaria* | 4 | England | White with black patch | Piebald | Baker and Biddle, 2020 |
| | *Rana temporaria* | 1 | England | White with black patch | Piebald | Baker and Biddle, 2020 |
| | *Rana temporaria* | 2 | England | White with black patch | Piebald | Baker and Biddle, 2020 |
| | *Rana temporaria* | 1 | England | Yellow (red eyes) | Xanthochromism | Allain and Goodman, 2017 |
| | *Rana temporaria* | N.D. | N.D. | N.D. | N.D. | Nicholson, 1997 (in Allain et al., 2023) |

legs with a normal brown striped pattern after metamorphosis. The most similar case is the Anthony's Poison Arrow Frog, *Epipedobates anthonyi* Noble, 1921, reported by Brito-Zapata (2021). Although the author classified the animal as having partial leucism, its yellow background and blackish colouration resemble those as we report on here. The abundance of similar cases in a restricted geographic area is rare in the existing literature on these chromatic alterations. Güell et al. (2021) reports on a comparable cluster of five Gliding Treefrogs, *Agalychnis spurrelli* Boulenger, 1913, from Costa Rica that exhibited yellow colouration within the same geographical region. Baker and Biddle (2020) documented multiple cases of piebald frogs observed over several years in a single private garden pond. Different hypotheses have been proposed to explain the occurrence of colour aberrations in amphibian populations. Namely, Güell et al. (2020) considered two potential explanations: a "normal rate" of spontaneous mutation or, alternatively, a more abundant mutation rate linked to an isolated population. In a similar vein, Brito-Zapata (2021) suggested that the observed case in *E. anthonyi* could be a form of natural variation. In contrast, Baker and Biddle (2020) proposed that the high frequency of piebald frogs they observed was due to fragmented populations influenced by human-altered habitats. Although not in anurans, the case of the Eastern Red-backed Salamanders, *Plethodon cinereus* (Green, 1818), is also interesting. This species is a well-studied example of an amphibian with multiple documented observations of erythrism, particularly in its terrestrial eft stage (Moore et al., 2014; Fisher-Reid et al., 2024; LeClair et al., 2024).

Colour aberrations are usually results from developmental abnormalities in pigment cell differentiation that are not necessarily associated with genetic mutations (Acevedo et al., 2009), and there is also evidence to suggest that it is genetically inherited (Baker and Biddle, 2020). Beyond genetic predispositions, environmental factors can also influence or directly induce these colour alterations (Rudh and Qvarnström, 2013; Radovanović et al., 2023). Exposure to environmental pollutants (e.g., heavy metals, pesticides) and radiation is linked to colour anomalies in amphibians, as these factors disrupt the physiological processes essential for chromatophore development and pigment synthesis (Henle and Dubois, 2017; Burraco and Orizaola, 2022). The increasing number of these reported aberrations suggests a connection to environmental degradation and highlights their potential as indicators of ecosystem health (Marushchak et al., 2021). Interestingly, we received a report in June 2025 of an axanthic *Pelophylax* sp. (Fig. 3) from the same garden pond in Gulbene where one of the yellow-and-black frogs (Fig. 1 B) was found in 2023. No other colour aberrations were observed in this location.

More research is needed to better understand the origin of these colourations and their potential implications for conservation. The use of a unified classification for these alterations will also be essential for analysing the results of new studies.

**Figure 3.** An axanthic *Pelophylax* sp. frog found in 2025 at Gulbene, Latvia, in the same pond of the yellow and black frog (Fig. 1B). Photo by K. Matisons.

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