

Albinistic tadpoles of the Apennine yellow-bellied toad *Bombina variegata pachypus*: observations on their development and metamorphosis

MATTEO RICCARDO DI NICOLA¹, SERGIO MEZZADRI², ANNA CERULLO^{1,3*}, IACOPO NEROZZI⁴,
ARIANNA MELETIADIS¹, PIER LUIGI ACUTIS¹ & GIACOMO BRUNI⁵

¹Istituto Zooprofilattico Sperimentale del Piemonte, Liguria e Valle d'Aosta, Via Bologna 148, 10154, Turin, Italy

²Via Palmerio, Piacenza, Italy

³Department of Veterinary Sciences, University of Turin, Grugliasco, Turin, Italy

⁴Alma Mater University of Bologna, Bologna, Italy

⁵Viale Palmiro Togliatti, Sesto Fiorentino, Florence, Italy

*Corresponding author e-mail: anna.cerullo@izsplv.it

Colour anomalies resulting from a lack of pigments are widely reported in European anurans (Henle et al., 2017; Lunghi et al., 2017; Bruni et al., 2020; Allain et al., 2023). The main chromatic aberrations that are consistent with white and whitish colouring are albinism, leucism and hypomelanism (Henle et al., 2017). Except for albinism, where the colour of the eyes is typically reddish, the distinction in external appearance between the others is not always clear. Therefore, in the literature there are often cases of misidentification (Henle et al., 2017). Colour anomalies are even more difficult to identify when they occur in the larval

stages (i.e. tadpoles) where the colour patterns are not as defined as in the adult individuals. Henle et al. (2017) classify light colouring or whitish tadpoles as 'albinistic pinto' using a picture of three *Bufo viridis* tadpoles (a whitish albinistic, a light albinistic with a more normal colouration and a normal one). The authors specify that these kinds of tadpoles are often described as albino or leucistic. In the present study we report albinistic tadpoles in two populations of the endangered *Bombina variegata pachypus* (Bonaparte 1838), giving some information on their developmental problems during metamorphosis.

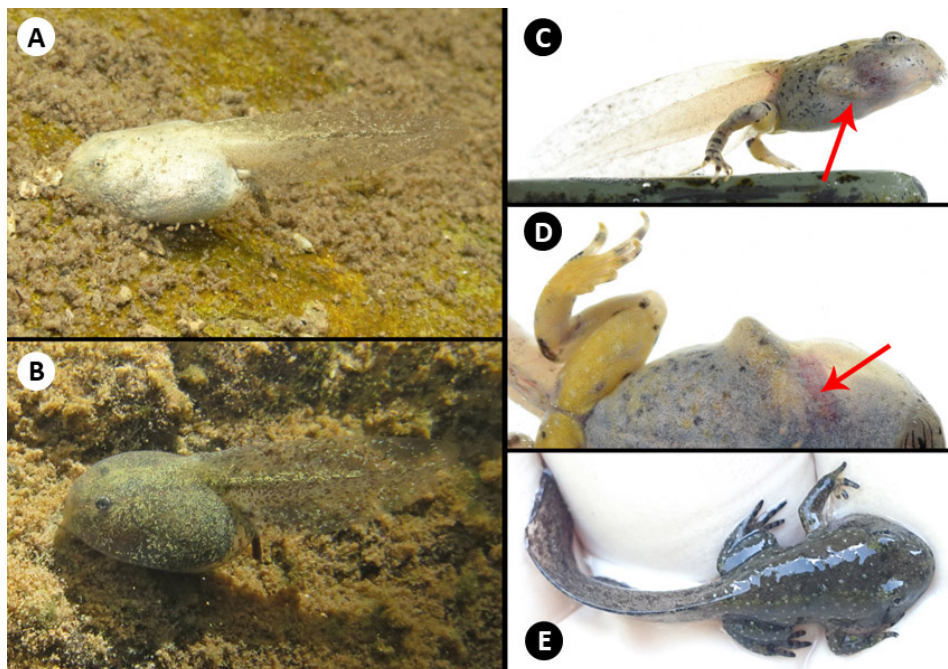


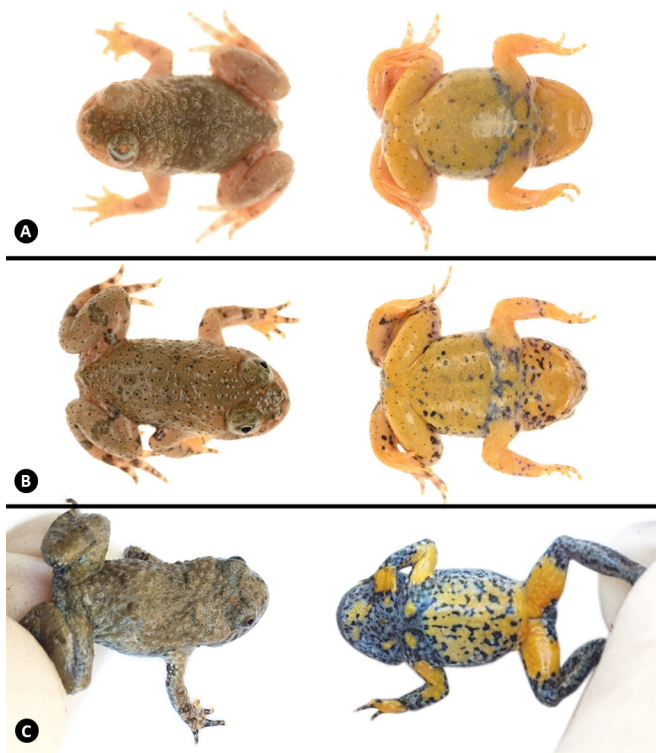
Figure 1. Comparison between normal and albinistic tadpoles of *Bombina variegata pachypus* - **A.** Albinistic tadpole, Gosner stage 32, **B.** Normally coloured tadpole, Gosner stage 31, **C.** & **D.** Albinistic tadpoles, Gosner stage 41, with internal fully developed hindlimbs, **E.** Normally coloured tadpole, Gosner stage 42, with emerged and fully developed hindlimbs. Red arrows indicate the position of internal fully developed forelimbs.

Table 1. Number of albinistic *Bombina variegata pachypus* at each site by date

Site	Date	Albinistic individuals	Notes
Lorsica	14 July 2017	3 tadpoles	
	9 August 2017	2 tadpoles	Both tadpoles had internal developed forelimbs
	17 August 2021	4 tadpoles	
	20 September 2021	1 tadpole	The tadpole had internal fully developed forelimbs
	10 August 2023	4 tadpoles	
	26 September 2023	2 froglets	One had a malformed eye
Sambuca Pistoiese	9 August 2020	1 tadpole	
	22 July 2021	2 tadpoles	
	12 August 2023	2 tadpoles	One of them had fully developed hindlimbs
	27 May 2024	1 tadpole	
	5 August 2024	3 tadpoles	Two of them had fully developed hindlimbs
	29 September 2024	1 tadpole	The tadpole had internal fully developed forelimbs

The Italian endemic Apennine yellow-bellied toad is nowadays considered as a subspecies of *Bombina variegata* (Sindaco & Razzetti, 2021), a species in which albino tadpoles and froglets have been already reported (Neudorfer, 1989; Charbonnier et al., 2017). However, the only colour anomalies that have been recorded to date for *B. v. pachypus* are some albino tadpoles born and raised in captivity at a breeding centre (U. Fusini, pers. comm.). Normal metamorphosed individuals of this anuran present a brownish-greyish dorsal colouration and an aposematic ventral colouration with yellow or orange spots on a bluish and black background (Guarino et al., 2007). We found albinistic *B. v. pachypus* tadpoles (Fig. 1A) in different years in two populations in the northern part of the subspecies range in the municipalities of Lorsica (Genova, Liguria; approximate co-ordinates: 44° 26' N, 9° 16' E) and Sambuca Pistoiese (Pistoia, Tuscany; approximate co-ordinates: 44° 5' N, 11° 1' E). Both sites were visited on several occasions since 2010 and albinistic tadpoles were often observed; Lorsica site was visited since 2013 at least once a year and at least one albinistic tadpole was always present. Given our opportunistic and unstandardised visual sampling, we report only a series of annotated observations for both sites in Table 1; the actual number of observations of albinistic tadpoles is therefore greater and covers a greater number of years than shown.

For both sites, our observations mostly refer to tadpoles without limbs or with hindlimbs partially or fully developed. In some cases, the absence of tadpoles without forelimbs can be explained by individuals with internal fully developed forelimbs (Fig. 1C & D). Failure of forelimb emergence may reduce successful metamorphosis by albinistic tadpoles. At the Lorsica site, albinistic froglets were not observed until 26 September 2023 at 11:00 h (T max 26 °C, T min 19 °C), when two very light froglets were observed (Fig. 2A & B) among more than twenty normally coloured ones. The first froglet (Fig. 2A) was 1.7 cm SVL and weighed 0.7 g. It presented malformed eyes, the right one being covered with cutaneous tissue. The second froglet (Fig. 2B) was darker in colour, had normal eyes and was 1.8 cm SVL and weighed 0.7 g. When compared to normal *B. v. pachypus* froglets from the same site (Fig. 2C), the two albinistic froglets are lighter in colour and present scarce blue and black ventral pigmentation. Given the rarity of albinistic froglets and the absence of albinistic adults at both sites, we suggest that the mortality rate of these individuals is likely high. A similar phenomenon is reported in albinistic tadpoles of common frog *Rana temporaria* in the Piedmont region of Italy (Seglie & Martelli, undated). The authors observed several albinistic tadpoles over different years and reported that about 40% of them lacked one or both eyes and faced difficulties in metamorphosis, typically dying before completing the process. The presence of albinistic tadpoles might be a sign of genetic depletion in the population. Indeed, our observation sites are located at the northern range limits of a subspecies known for its 'southern genetic richness' (Canestrelli et al., 2006; Talarico et al., 2019; Bernabò et al., 2022).

**Figure 2.** Comparison between normal and albinistic *Bombina variegata pachypus* froglets - **A.** Albinistic froglet with very light colouration and malformed eyes, **B.** Albinistic froglet with light colouration, **C.** Normally coloured froglet

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REFERENCES

- Allain, S., Clemens, D. & Thomas, O. (2023). Taste the rainbow: a review of color abnormalities affecting the herpetofauna of the British Isles. *Reptiles & Amphibians* 30(1): e18470–e18470.
- Bernabò, I., Biondi, M., Cittadino, V., Sperone, E. & Iannella, M. (2022). Addressing conservation measures through fine-tuned species distribution models for an Italian endangered endemic anuran. *Global Ecology and Conservation* 39: e02302.
- Bruni, G., Di Mitri, A., Grecchi, L. & Di Nicola, M.R. (2020). “Translucent” colour aberrations in *Bufo balearicus* (Anura: Bufonidae) and *Hyla perrini* (Anura: Hylidae) from Italy. *Herpetology Notes* 13: 57–60.
- Canestrelli, D., Cimmaruta, R., Costantini, V. & Nascetti, G. (2006). Genetic diversity and phylogeography of the Apennine yellow-bellied toad *Bombina pachypus*, with implications for conservation. *Molecular Ecology* 15(12): 3741–3754.
- Charbonnier, Y., Theillout, A., Ancrenaz, K. & Bernard, Y. (2017). Cas d'albinisme chez le sonneur à ventre jaune (*Bombina variegata* Linné, 1758) en marge de sa répartition méridionale. *Bulletin de la Société Herpétologique de France* 162: 109–111.
- Guarino, F.M., Picariello, O. & Venchi, A. (2007). *Bombina pachypus*. In: *Fauna d'Italia. Vol XLII. Amphibia*. 277–280 pp. Lanza, B., Andreone, F., Bologna, M.A., Corti, C. & Razzetti, E. (Eds.). Edizioni Calderini, Il Sole 24 ORE, Editoria specializzata S.r.l., Bologna.
- Henle, K. & Dubois, A. (2017). Studies on anomalies in natural populations of amphibians. *Mertensiella* 25: 185–242.
- Lunghi, E., Monti, A., Binda, A., Piazzini, I., Salvadori, M., Cogoni, R., Riefolo, L.A., Biancardi, C., Mezzadri, S., Avitabile, D. & Ficetola, G.F. (2017). Cases of albinism and leucism in amphibians in Italy: new reports. *Natural History Sciences* 4(1): 73–80.
- Neudorfer, R. (1989). Albinotische gelbbauchunken, *Bombina variegata* Varie-Gata (Linnaeus, 1758) (Anura: Discoglossidae). *Berichte Der Österreichischen Gesellschaft Für Herpetologie*.
- Seglie, D. & Martelli, M. (undated) *Rana temporaria* - white tadpoles. https://www.pralymania.com/RanaTemporariaBianca_UK.html.
- Sindaco, R. & Razzetti, E. (2021). An updated check-list of Italian amphibians and reptiles. *Natural History Sciences* 8(2): 35–46.
- Talarico, L., Babik, W., Marta, S. & Mattocchia, M. (2019). Genetic drift shaped MHC IIB diversity of an endangered anuran species within the Italian glacial refugium. *Journal of Zoology* 307(1): 61–70.

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