



Morphological Anomalies in Frogs of the Genera *Pelophylax* and *Rana* (Anura: Ranidae) from Polluted Environments in Southern Italy

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Amphibians can exhibit a number of external anomalies including those relating to color and pattern, morphology, and those associated with edema or tumors and embryological causes (Henle et al. 2017). The presence of an additional limb (polymely) and the black-colored iris (black-eyed anomaly) are two of the most commonly known amphibian abnormalities and have been recorded in many amphibian species, more often in frogs and toads than newts (Sessions and Ruth 1990; Canestrelli et al. 2006; Henle et al. 2017).

On 14 April 2010, during field monitoring surveys on the biodiversity status of the Crati River (Calabria, southern Italy; Bonacci et al. 2011), one female Italian Edible Frog, *Pelophylax* kl. *hispanicus* (Bonaparte 1839), exhibited polymely (Fig. 1) and another female the black-eyed anomaly (Fig. 2). Both were collected along the banks of the Crati River in the Municipality of Tarsia, Province of Cosenza, Calabria, southern Italy (39.59169 N, 16.26342 E; elev. 58 m asl). A radiographic image of the individual with polymely revealed

duplication of the left forelimb. In the same area and on the same date, we found three Italian Pool Frogs, *Pelophylax bergeri* Günther 1986, and eight Italian Edible Frogs without any apparent morphological anomalies.

Pelophylax bergeri and *P. kl. hispanicus* are two closely related taxa, of which *P. bergeri* is the parental species and *P. kl. hispanicus* is a hybridogenetic or klepton hybrid (Dubois and Ohler 1994; Günther and Plötner 1994; Capula et al. 2007; Dubey and Dufresnes 2017; Di Nicola et al. 2019). *Pelophylax bergeri* and *P. kl. hispanicus* are morphologically and chromatically very similar (Capula et al. 2007; Di Nicola et al. 2019) and only a few small morphological differences distinguish adults of the two species (Capula et al. 2007; Lapini et al. 2007). In Calabria, as in the rest of central and southern Italy, the two species often coexist in the same habitat (Capula et al. 2007; Di Nicola et al. 2019), although at different frequencies, *P. kl. hispanicus* being generally more abundant than *P. bergeri* in bodies of water characterized by

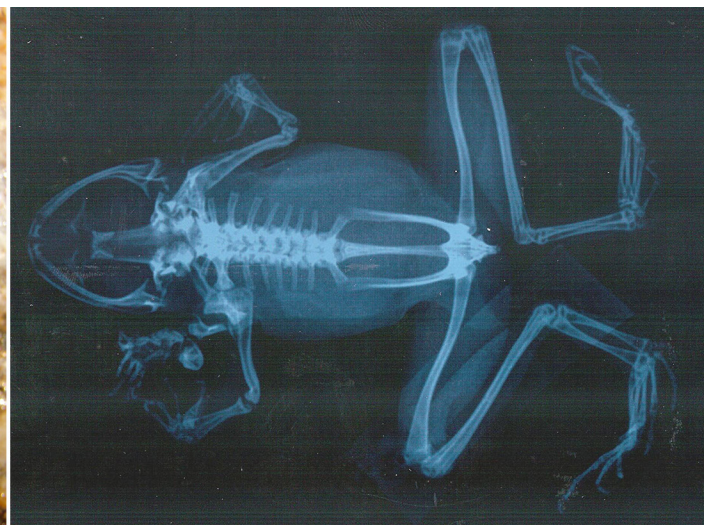


Figure 1. A female Italian Edible Frog (*Pelophylax* kl. *hispanicus*) from the Crati River in southern Italy with polymely and a radiograph of the same individual showing duplication of the left forelimb. Photographs by Gaetano Aloise.

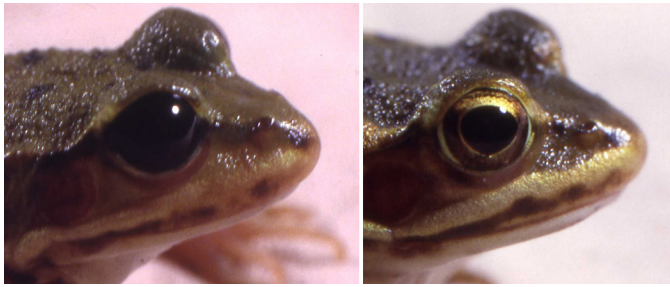


Figure 2. Female Italian Edible Frogs (*Pelophylax kl. hispanicus*) with the black-eyed anomaly from the Crati River (left) and a normally colored iris (right). Photographs by Massimo Capula.

organic pollution and/or in artificial ponds and agricultural drainage channels (Lapini et al. 2007).

On 2 May 2010, in a small tributary of the Crati River (39.60588 N, 16.26810 E; elev.75 m asl) very close to the previous locality, we found a single female Italian Stream Frog (*Rana italica* Dubois 1987) with a small fold or scar instead of a right eye (unilateral anophthalmia) (Fig. 3) and a normal left eye. The individual was active and appeared in good health. Some *R. italica* tadpoles were present but we encountered no other metamorphosed Italian Stream Frogs. Anophthalmia, the absence of one or both eyes, is a deformity that previously has been recorded in both anurans (Ramalho et al. 2017; Castro-Torreblanca and Blancas-Calva 2021) and urodeles (Ayres et al. 2022). Individuals exhibiting this condition have been known to survive to adulthood and appear in otherwise good health (Ramalho et al. 2017).

After examining and photographing the frogs, all were released at the sites of capture. Photographs were deposited in the Herpetological digital collection of Museo Civico di Zoologia di Roma.

Chemical agents, pollution, UV radiation, inbreeding, predation, and helminthic infection have been suggested by multiple authors to explain the origin of morphological deformities in frogs (Meteyer 2000; Cohen 2001; Blaustein and Johnson 2003; Ankley et al. 2004; Johnson and Chase 2004; Balmori 2006; Johnson et al. 2006, 2007; Goodman et al. 2022). In particular, a risk analysis carried out by Taylor et al. (2005) suggested a strong association between the incidence of deformities and proximity of a wetland to agriculture and/or other sources of water pollution. This is consistent with the

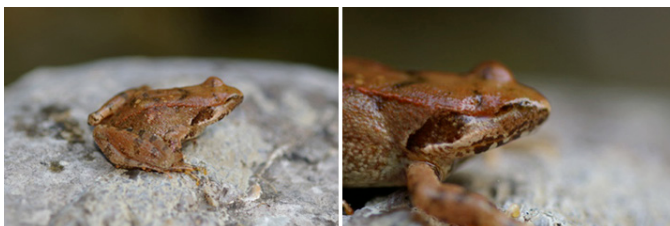


Figure 3. A female Italian Stream Frog (*Rana italica*) with unilateral anophthalmia (right eye). Photographs by Massimo Capula.

results of the investigations by Ouellet et al. (1997), Ouellet (2000), and Reeves et al. (2008). The area close to the Crati River is characterized by intense agricultural activity and massive use of pesticides (Ioel et al. 2020), and Batteggazzore et al. (2007) and Lucadamo et al. (2007) noted the poor environmental quality and compromised biodiversity of the area. According to Lucadamo et al. (2008) chemical-physical parameters measured in Crati water revealed intense alterations due to solid and soluble reactive phosphorous associated with the use of pesticides and herbicides in local agricultural activities, suggesting that water polluted with pesticides likely is the main cause of the deformities observed in local frogs.

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