

A case of polymelia in the Balkan Spadefoot, *Pelobates balcanicus* Karaman, 1928, from Euboea island, Greece

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Amphibians are vulnerable to a wide range of environmental stressors, including chemical contaminants, pathogenic infections and ultraviolet radiation, among others (Henle et al., 2017). Exposure to these elements during early developmental stages is often linked to increased mortality and morphological malformations concerning limb structure, naturally affecting fewer than 5% of individuals in a population (Johnson et al., 2010). However, higher prevalence levels during recent years might signal emerging issues; amphibian populations worldwide are declining at alarming rates (Hof et al., 2011), and monitoring cases of morphological malformations could play a key role in their conservation. Such limb malformations include extra, missing or reduced limbs (Johnson et al., 2010). Polymelia is the presence of supernumerary limbs, which can be fully or partially developed and are usually non-functional (Henle et al., 2017). It can also occur congenitally during embryogenesis or due to subsequent developmental anomalies (Degitz et al., 2000; Blaustein and Johnson, 2003).

The Balkan Spadefoot, *Pelobates balcanicus* Karaman, 1928, is one of two spadefoot species in Greece, the other being *P. syriacus* Boettger 1889, which is distributed on some of the eastern Aegean islands. The former is restricted to the Balkan peninsula, from northwest Romania and northern Serbia to the Peloponnese peninsula, ranging from sea-level to elevations of 920 m (Dufresnes et al., 2019, Katsiyiannis and Tzoras, 2025). It is a semi-fossorial, nocturnal amphibian that inhabits open habitat like floodplains and

agricultural land with loose or sandy soil, spawning in freshwater ponds and other seasonal or perennial bodies of freshwater (Sofianidou, 2012; Natchev et al., 2022). Spadefoot toads occupy a narrow ecological niche, while their larval development stage lasts significantly longer than most syntopic amphibians (Džukić et al., 2005). This makes them particularly vulnerable to loss of habitat, and thus they have drastically declined in large parts of their range (Nyström et al., 2002). In southern Greece, the distribution of *P. balcanicus* consists of only a few, isolated, relict sites, with a single insular population surviving to this day on the island of Euboea (Dufresnes et al., 2019). Changes in land use, pollution, habitat destruction, introduced species, road casualties and aridity are major challenges for the species, and numerous populations have vanished over the last decades (Sofianidou, 2012; Katsiyiannis and Tzoras, 2025).

On 25 October 2025, we conducted a faunistic survey of Dystos lake, on the island of Euboea in southern Greece (38.3541°N, 24.1307°E). Between 22:00–23:00 h, with an air temperature of approximately 16 °C, we encountered six adult individuals of *P. balcanicus* moving on an agricultural dirt road. Upon close inspection of one of the individuals, we noticed an extra appendage emerging from the base of the right forelimb (Fig. 1A). The supernumerary limb was ossified, noticeably smaller and less robust than the typical limbs, pointing upwards and apparently non-functional. Furthermore, the focal limb presented four fully-formed digits and seemed to substantially hinder the mobility of the original right forelimb (Fig. 1B, C). While morphological abnormalities are usually associated with lower survival rates (Michel and Burke, 2011), the individual appeared to be in good overall health and had survived into sexual maturity. No further malformations were noted.

Limb deformities in amphibians have been extensively covered in the scientific literature. Cases of polymelia have been published for numerous Western Palearctic species, including examples from the

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Figure 1. (A) The encountered adult *Pelobates balcanicus*. (B) Lateral view of the same individual showing the position of the extra and the original limb. (C) Close-up of the supernumerary limb. Photos by Platon Stefanopoulos.

families Bufonidae Gray, 1825, Hylidae Rafinesque, 1815, Ranidae Batch, 1796, Alytidae Fitzinger, 1843 and Salamandridae Goldfuss, 1820 (García-Muñoz et al., 2010; Hinckley et al., 2015; Serrano and Segurado, 2017; Jordan and Shadbolt, 2021; Couto and Rebelo, 2022; Martínez-Gil and Martínez-Solano, 2024; Cuéllar et al., 2025). To our knowledge, this is the first record of a supernumerary limb in the genus *Pelobates* Wagler, 1830. Other deformities, such as brachydactyly, ectromelia and some eye malformations have been reported for *Pelobates fuscus* (Laurenti, 1768) and *Pelobates cultripipes* (Cuvier, 1829) (Maruschak and Muravynets, 2018; Arribas and Lapeña, 2024). Our literature search revealed only two cases of amphibian malformation reported from Greece; a *Hyla arborea* (Linnaeus, 1758) tadpole exhibiting a bifurcated tail and an adult *Salamandra salamandra* (Linnaeus, 1758)

with microphthalmia (Henle et al., 2012; Balogová et al., 2022). We recorded a total of ~70 *P. balcanicus* individuals in Dystos lake during four different surveys carried out in 2024 and 2025, but noticed no other cases of polymelia in the population. Isolated cases of malformations are certainly expected in nature and can be attributed to inbreeding, developmental errors and hyper-regeneration subsequent to physical damage, usually caused by predation attempts or trematode parasites (Reeves et al., 2010; Henle et al., 2017). Indeed, infections by trematodes like *Riberoia ondatrae* Looss, 1907 and *Strigea robusta* (Szidat, 1928) have been shown to cause various morphological anomalies in wild anurans (Svinin et al., 2020; Johnson et al., 2024). However, mass occurrences of such deformities grossly exceeding the typical < 5% baseline frequency have also been linked to mutagens like chemical pollutants

and radiation (Blaustein and Johnson, 2003; Henle et al., 2017; Salla et al., 2023). Prolonged exposure to glyphosate-based herbicide (Roundup®) and high levels of ultraviolet-B (UV-B) radiation, for example, can cause mortality and malformations (Croteau et al., 2008; Herek et al., 2020). The aforementioned factors may also act synergistically, with pesticide exposure possibly leading to increased trematode infection (Kiesecker, 2002). Although an isolated case is not alarming, it is worth noting that the areas surrounding Dystos lake are active agricultural grounds, where use of fertilisers and pesticides could spike an event of malformations. This highlights the importance of amphibians as bio-indicators; systematic monitoring is required, as future findings of deformities in the area could raise population-level concerns.

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