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## Correspondence

# Polydactyly and polymely in two populations of *Rana temporaria* and *Pelophylax esculentus* (Anura, Ranidae) in southern Germany

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In the last decades, amphibian population declines and extinctions have been recorded in different regions around the world (Houlahan et al. 2000, Alford et al. 2001, Young et al. 2001, Stuart et al. 2008). This amphibian diversity loss is stimulated by many factors, and high percentages of body anomalies or malformations of larvae and adults are considered auxiliary agents for such declines (e.g., Pounds et al. 1997). Some recent studies reported on great numbers of abnormal specimens in natural amphibian populations (Helgen et al. 2000, Johnson et al. 2002, Gardiner et al. 2003, Johnson & Sutherland 2003, Vandenlangenberg et al. 2003, Gridi-Papp & Gridi-Papp 2005, Piha et al. 2006). The apparent increase of such anomalies has raised interest of ecologists and public health professionals, and several authors evaluated possible causes (Blaustein et al. 1997, Ankley et al. 2002, Kiesecker 2002, Degitz et al. 2003, Johnson & Chase 2004, Piha et al. 2006, Rajakaruna et al. 2008, Ballengée & Sessions 2009). Most studies made evident the influence of environmental change and pointed out the importance of studies to verify the occurrence of abnormalities in nature (Gridi-papp & Gridi-Papp 2005). However, in many cases the causes of deformities and their role in local amphibian declines remain unclear (Johnson et al. 1999).

Among anomalies in natural amphibian populations, polydactyly (or polydactylism) and polymely (or polymelism) are frequently documented (e.g., Mahendra 1936, Dubois 1974, Dubois 1979, Borkin & Pikulik 1986, Lada 1999, Vorobyeva 1999, Faizulin et al. 2003, Eaton et al. 2004, Lannoo 2008). Here we report on several cases of such anomalies documented from two anuran populations of *Rana temporaria* Linnaeus, 1758 and *Pelophylax esculentus* (Linnaeus, 1758) in southern Germany. The malformed individuals were detected in an amphibian collection of around 1,000 specimens, which recently has been transferred from the University of Tübingen, Germany, to the herpetological collection of the Staatliches Museum für Naturkunde Stuttgart (SMNS), Germany. These specimens had been accidentally captured in pitfalls with formaline, presumably installed for collecting small arthropods. There are no exact data available on capture period or locality, except that the material was collected in 1981 at the "Seelenhofer Ried" (handwritten notice on a cardboard box). This moorland, partially overgrown with reeds, and wet grassland area, which in 1999 has become the nature reserve "NSG Westliches Federseeried/Seelenhofer Ried", is located in Upper Swabia in the South of Germany, on the western margin of Lake Federsee. The lake, with a maximal depth of 2 m and a size of around 33 km², is located northeast of Bad Buchau, in the district of Biberach, at an elevation of 592 m a.s.l. The coordinates are 48°05' N and 9°38' E.

The amphibian collection from the "Seelenhofer Ried" was examined in February 2010. Besides ca. 400 adult and juvenile newts [(*Ichthyosaura alpestris* (Laurenti, 1768), *Lissotriton vulgaris* (Linnaeus, 1758)] and few specimens of *Bufo bufo* (Linnaeus, 1758) and *Hyla arborea* (Linnaeus, 1758), the collection contained a total of 456 juveniles of *Rana temporaria* and 192 juveniles and adults of *Pelophylax esculentus*.

The examination of *P. esculentus* revealed that 13 individuals (SMNS 13937–13940 , and 13994-14002) (6,8% of the specimens collected) presented anomalies, i.e., malformations of the hand (Fig. 1a) or polydactyly (Figs. 1b–d). Polydactyle specimens showed variation in the number of fingers with one to four additional toes or one additional finger on the forelimbs. Such developmental abnormalities are rare, and in amphibian populations, they are commonly found at low frequencies of 0–3% of the individuals (Meyer-Rochow & Asashima 1998, Gillilland et al. 2001). Their occurrence is considered unusually high when the frequency exceeds 5% (e.g., Ouellet 2000 in Piha et al. 2006). As the circumstances of capture are not known, the significance of our data cannot be tested.

Among the samples of *R. temporaria*, we found neither polydactyly nor malformations of extremities, but one case of polymely (Figs. 2, 3) (SMNS 13936).

An X-ray carried out to locate the articulation of this additional arm revealed that the specimen, a juvenile (snout–vent length = 17.9 mm), did not possess well-cal-


Figure 1. Close-up of the extremities of *Pelophylax esculentus*: (a) malformation of the forelimb of a young specimen, SMNS 13937; (b) additional finger of the young specimen SMNS 13938; (c) forelimb of the adult female SMNS 13939, with one additional finger; (d) hindlimb of the young specimen SMNS 13940, with four additional toes. Photos: C. Machado.

Figure 2. Close-up of the scapular region of a young specimen of *Rana temporaria* (SMNS 13936) with an additional forelimb. Photo: C. Machado.

Figure 3. Radiograph of the young specimen of *Rana temporaria* (SMNS 13936), illustrating the articulation of the additional forelimb. Photo: Nuclear Medicine Radiology Center, Hospital Robert Bosch, Stuttgart

cified bones. Therefore, the X-ray photograph was difficult to analyze, but apparently this additional arm is inserted in the articulation of the right shoulder and incompletely developed (Fig. 3).

Polymely in amphibians has been known from literature for more than 250 years. Mahendra (1936), who described a case of polymely in *Hoplobatrachus tigerinus* (Daudin, 1802), noted that the first case of polymely in amphibians was probably documented by Superville (1740). Specimens with supernumerary hindlimbs or forelimbs have been aroused particular attention by embryologists and anatomists (Woitkewitsch 1959, Meyer-Rochow & Koebke 1986). Recently, some authors cited cases of polymely in different species and localities, e.g., *Triturus marmoratus* (Latreille, 1800) from Spain (Recuero-Gil & Campos-Asenjo 2002), *Ichthyosaura alpestris* (Lau-

RENTI, 1768) from Italy (CANESTRELLI et al. 2006), or *Rana temporaria* from Finland (PIHA et al. 2006).

As possible relevant agents for the incomplete development or absence of limbs and for the presence of polydactyly or polymely in amphibians, four main factors have been suggested: (i) deficient regeneration of injured extremities by accidents or predators (BALLENGÉE & SESSIONS 2009); (ii) exposition to high UV-B radiation (BLAUSTEIN et al. 1997, ANKLEY et al. 2002, BAUD 2005); (iii) chemical agents and degradation of the environment (KIESECKER 2002, LANNOO 2008); (iv) infections caused by trematodes such as *Ribeiroia* sp. (JOHNSON & SUTHERLAND 2003, JOHNSON & CHASE 2004, JOHNSON et al. 1999, 2002, 2006). The accumulation of anecdotic information about the occurrence of such anomalies in natural amphibian populations, as the case presented here from Lake Federsee, might inspire hypotheses and is essential as stimulus for future studies. On the other hand, an increasing incidence of deformities in some populations of amphibians is troubling, because the environmental status and possible impact of causal agents has not yet been identified for both wildlife and human health (BURKHART et al. 2000). The Seelenhofer Ried belongs to a nature reserve with little anthropogenic influence, including chemical agents, but the high frequency of predators observed in this area, such as alpine newts (*Ichthyosaura alpestris*), aquatic insects and their larvae, leeches (*Haemopis sanguisuga*), and turbellarians (*Polycelis nigra*) (KWET 1996), may contribute to the relatively high percentage of deformities.

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