

First record of limb abnormalities in the Near Eastern fire salamander (*Salamandra infraimmaculata*)

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Polyphalangy (extra bones in a digit), together with ectrodactyly (missing toe) and brachydactyly (dwarfed toe) are among the more frequent skeletal malformations found in urodeles (Diego-Rasilla et al., 2007; Williams et al., 2008). On the contrary, syndactyly (fused digits), as well as polymelia (excessive number of limbs) and phocomelia (absence of the proximal portion of a limb) are rare (Escoriza & García-Cardenete, 2005; Diego-Rasilla et al., 2007; Villanueva, 2007; Williams et al., 2008). Skeletal malformations can be attributed to both anthropogenic and natural changes in the abiotic and biotic factors in the environment. Suggested causes for these abnormalities include parasites and pathogens, UV radiation, regeneration following trauma, high levels of anthropogenic pollution, or synergistic interactions of these factors (Blaustein et al., 1997; Reaser & Johnson, 1997; Gilliland & Muzzall, 2002; Johnson et al., 2002; Diego-Rasilla et al., 2007; Williams et al., 2008).

In the course of our fieldwork in the Tel Dan Nature Reserve (northern Israel, 33.248288°N 35.651375°E, 200 m alt.) we observed three cases of limb abnormality. All salamanders seemed to have a good body condition with around average weight for their size. An adult salamander with a partial polymelia next to its left hind limb was observed on 25 February 2014 (Fig. 1). There was an extra limb lacking any real digits. It had just two dwarf fingers. On 1 December 2014, another adult was found with a complete polymelia (Fig. 2), consisting in a complete fifth, non-functional leg that protruded from the upper right hind leg. A third adult salamander was observed on 20 November 2014 near the Tel Dan Nature Reserve with a case of ectrodactyly. The individual was lacking one finger of its right hind limb (Fig. 3).

Given the presence of many predators (fish, crabs, dragonfly nymphs, etc.) in the streams where the larvae develop, it is possible that these malformations are due to incorrect regeneration after bite injuries made by predators (Ballenge & Sessions, 2009) or conspecifics. Larvae of *S. infraimmaculata* are very likely to harm or cannibalise on conspecifics if raised in the same container, although such behaviour was not common in *S. salamandra* larvae when raised under similar conditions (personal observations). Thompson et al (2014) reported that only 43% of *Ambystoma mexicanum* larvae would present four anatomically normal looking adult limbs after incurring a bite injury, so salamanders from a high density predator environment like the Tel Dan Nature Reserve are expected to experience many limb malformations.



Figure 1. *S. infraimmaculata* with a partial polymelia.

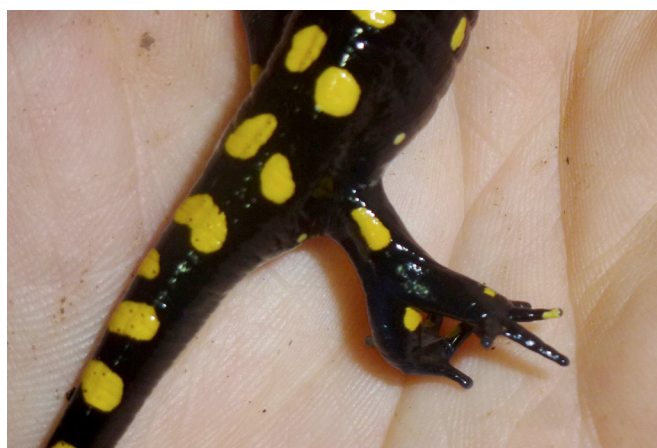


Figure 2. *S. infraimmaculata* with polymelia.



Figure 3. *S. infraimmaculata* with ectrodactyly.

REFERENCES

- Ballengee, B., & Sessions, S. K. (2009). Explanation for missing limbs in deformed amphibians. *Journal of Experimental Zoology. Part B, Molecular and Developmental Evolution* 312: 770.
- Blaustein, A. R., Kiesecker, J. M., Chivers, D. P. & Anthony, R. G. (1997). Ambient UV-B radiation causes deformities in amphibian embryos. *Proceedings of the National Academy of Sciences of the USA* 94: 13735–13737.
- Diego-Rasilla, F. J. (2000). Malformaciones en una población de *Triturus marmoratus*. *Boletín de la Asociación Herpetológica Española* 11: 88-89.
- Diego-Rasilla, F. J., Luengo, R. M. & Rodríguez-García, L. (2007). *Triturus marmoratus* (Marbled Newt). Limb abnormalities. *Herpetological Review* 38: 68.
- Escoriza, E. & García-Cardenete, L. (2005). Polimelia en *Alytes dickhilleni* y *Salamandra salamandra longirostris*. Dos casos de ejemplares con seis extremidades. *Boletín de la Asociación Herpetológica Española* 16: 39-41
- Gilliland, M. G., & Muzzall, P. M. (2002). Amphibians, trematodes and deformities: An overview from Southern Michigan. *Comparative Parasitology* 69: 81-85.
- Johnson, P. T., Lunde, K. B., Thurman, M., Ritchie, E. G., Wray, S. N., Sutherland, D. R., Kapfer, J. M., Frest, T. J., Bowerman, J. & Blaustein, A. R. (2002). Parasite (*Ribeiroia ondatrae*) infection linked to amphibian malformations in the Western United States. *Ecological Monographs* 72: 151–168.
- Reaser, J. K. & Johnson, P.T. (1997). Amphibians abnormalities: a review. *Froglog* 24: 2-3.
- Thompson, S., Muzinic, L., Muzinic, C., Niemiller, M. L., & Voss, S. R. (2014). Probability of regenerating a normal limb after bite injury in the Mexican axolotl (*Ambystoma mexicanum*). *Regeneration* 1: 27-32.
- Villanueva, A. (2007). Polimelia en un ejemplar de *Salamandra salamandra* en Asturias. *Boletín de la Asociación Herpetológica Española* 18: 90-91.
- Williams, R. N., Bos, D. H., Gopurenko, D. & DeWoody, J. A. (2008). Amphibian malformations and inbreeding. *Biology Letters* 4: 549-552

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