

Evidence of malformation in the European cave salamander, *Hydromantes flavus*

ENRICO LUNGI^{1,2,3,*}, MARCO MULARGIA⁴, MANUELA MULARGIA⁴

¹Universität Trier Fachbereich VI Raum- und Umweltwissenschaften Biogeographie, Campus I, Gebäude N Universitätsring 15, 54286 Trier, Germany

²Natural Oasis, Via di Galceti 141, 59100 Prato, Italy

³Museo di Storia Naturale dell'Università di Firenze, Sezione di Zoologia "La Specola", Via Romana 17, 50125 Firenze, Italy

⁴Speleo Club Nuoro. Via Tunisi 3, 08100 Nuoro Italy

*Corresponding author email: enrico.arti@gmail.com

The Mont Albo cave salamander *Hydromantes flavus* (see Wake, 2013) is one of eight European cave salamander species, most of which are endemic to Italy (Lanza et al., 2006a). Three species are distributed in continental Italy and in south-eastern France, whilst five species, including *H. flavus*, are endemic to Sardinia (Lanza et al., 2006b). The distribution of *H. flavus* is restricted to the Mount Albo massif (Lanza et al., 2006b). Similar to other *Hydromantes* species, the Mount Albo cave salamander is usually found in habitats characterised by high moisture and cold temperatures (Lanza et al., 2006a); therefore, it is not difficult to find this species in hypogean habitats (Ficetola et al., 2012; Lunghi et al., 2015).

European *Hydromantes* are characterised by regeneration abilities that allow recovery of excised body parts (Salvidio, 1997; Scaravelli et al., 2002). The ability to regenerate enables reproduction of body parts including retaining the function (Straube & Tanaka, 2006). Regeneration represents a very complex developmental stage, during which salamanders have to deal with several factors (i.e. predators, genetics, pollution, parasites), which may induce malformations (Blaustein & Johnson, 2003; Bowerman et al., 2010). Some of the most common malformations affect limbs, toes and tail, which does not always compromise the survival of the individual (Williams et al., 2008). Irregular tail regeneration in European cave salamanders has already been observed by Salvidio (1997) but did not report the instance of a forked tail.

In September 2015, during a survey on Mount Albo nine individuals of *H. flavus* were found in a small cave located in Siniscola district. A female found in the middle of the cave, had almost half of the tail forked (Fig. 1a-b). The following morphometric features were taken: SVL = 7.5 cm; upper part of tail (length from cloaca to the fork) = 3.2 cm; dorsal length of the left part of the fork = 2.1 cm, dorsal length of the right part of the fork = 2.2 cm; forelimb length = 2.4 cm; hindlimb length = 2.1 cm; head length = 1.8 cm; head width = 1.4 cm. Except for the tail, all measures are within the range of those known for the species (Lanza et al., 1995).

The left part of the tail was the same colour as the rest of the body, while the background colour of the right was lighter (Fig. 1b); no differences were detectable on the



Figure 1. Female of *H. flavus* with forked tail (a). Details of the upper part of the fork (b) and of the lower part (c).

ventral side of the tail (Fig. 1c). The salamander was able to move both parts of the fork; the shape of the left was regular except for the last portion (about 5 mm) which appeared poorly developed (Fig. 1b), while the right was normal, but showing a peculiar posture terminally (Fig. 1a-c). Moreover, the tail showed several irregularities on its shape (Fig. 1a) possibly suggesting past stressful events. The female was found to be in good health and was gravid: six eggs were visible through her abdominal wall.

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