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Limb and digit malformations in the Alpine Newt, *Mesotriton alpestris* (Laurenti, 1768), in the United Kingdom

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In amphibians, the presence of limb and digit abnormalities has long been of interest to researchers. Urodeles (newts and salamanders) appear to be quite prone to such malformations, which likely stems from their ability to regenerate their limbs and digits (Riquelme-Guzmán and Sandoval-Guzmán, 2024; Thompson et al., 2014). While some defects are frequently reported, such as missing toes (ectrodactyly) and extra digital bones (polyphalangy) (Diego-Rasilla et al., 2007; Williams et al., 2008), the fusing of digits, known as syndactyly, and the presence of extra limbs, known as polymelia, appear to be relatively rare in urodeles.

Polymelia has been detected in fossils of the Jurassic Salamander *Chunerpeton tianyiensis* (Wang et al., 2016), as well as extant *Ambystoma ordinarium* populations (Soto-Rojas et al., 2017) and Smooth Newt (*Lissotriton vulgaris*) and Palmate Newts (*L. helveticus*) in the United Kingdom (Allain, 2021). The presence of fused digits has been observed in wild salamander populations in Mexico (Sánchez Manjarrez et al., 2022), as well as in Northern Crested Newts in the Czech Republic (Mačát et al., 2015) and *L. helveticus* in Spain (Diego-Rasilla, 2009). Syndactyly has also been identified in the regenerated forelimbs of axolotls following amputation under laboratory conditions, emphasising the potential role of tissue healing in producing webbed digits (Bothe et al., 2021). However, there do not appear to be any reports of polymelia or syndactyly in the Alpine Newt (*Mesotriton alpestris*).

The Alpine Newt is a medium-sized urodele that is widespread across continental Europe, with introduced populations present in the United Kingdom (Allain and Lynn, 2021; Ball et al., 2023). Both male and female *M. alpestris* have a distinct orange abdomen and characteristic blue to dark grey dorsum, although prominent differences in colouration and appearance are observed when these amphibians display sexual chromatism during the breeding season (Griffiths, 1996). The dorsal surface of breeding male *M. alpestris* is typically bright to dark blue in colour, while females tend to display a brown and green marbled pattern during the mating period (Griffiths, 1996; Lüdtke and Foerster, 2019). The species typically reaches around 8–12 cm in length and exhibits sexual body size dimorphism, with females generally growing larger and weighing heavier than their male counterparts (Marzona et al., 2004). Like many other amphibians, *M. alpestris* alternates between aquatic sites, which they visit during the breeding season, and terrestrial habitats, which they occupy during the remainder of the year. On land, *M. alpestris* typically resides in forests and semi-natural pastures and grasslands, using plant litter, rocks and artificial debris as places to hide (De Troyer et al., 2020; Joly et al., 2001). The species is capable of tolerating a wide range of aquatic habitats, and are known to occupy polluted, stagnant and even frozen water bodies (Staniszewski, 1995). Typically, *M. alpestris* breeding sites range from small ponds and streams to fens and large reservoirs (De Troyer et al., 2020), although they will avoid aquatic habitats that have been previously utilised by disease-carrying newts (Daversa et al., 2021).

During fieldwork in July 2024 at Chorleywood Common, Hertfordshire (51.6550°N, 0.5158°W) two Alpine Newts with limb abnormalities were detected. Funnel traps were set at 20:00 h on 6 July 2024 and collected at 8am the following morning. The first individual was a male Alpine Newt, with webbed digits (syndactyly) on both of its hind feet (Figs. 1A–B). The newt weighed 3.1 g and had a snout-vent length (SVL) of 44.3 mm. The second individual was a female *M. alpestris*, with an extra, smaller limb flanking the right limb (Figs. 2A–B). This newt weighed 5.7 g and

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Figure 1. Polymelia observed in a female *Mesotriton alpestris* in dorsal view (A), and as found in the field (B). Photos by Rachel Hester.

had a SVL of 55.4 mm. The locomotion of these newts did not appear to be significantly impacted by the malformations. However, the newt with polymelia did appear to slightly drag the right forelimb when moving, with the resting position of this limb differing slightly to that of the left forelimb (Fig. 2C). The site has been sampled three times (September 2022, June 2024 and July 2024), with 25 Alpine Newts and 50 Ssmooth Newts caught during this period. During my visits to this site, no previous limb abnormalities, in either newt species, had been observed before these observations. All *M. alpestris* collected were euthanised in accordance with Section 14 of the Wildlife and Countryside Act 1981, which states that it is illegal to release non-native species into the wild in Great Britain.

There are a number of potential causes of limb and digit abnormalities in amphibians. Environmental factors which may contribute to polymelia and syndactyly include high levels of UV radiation (Ankley et al., 2002), chemical pollutants (Taylor et al., 2005) and parasitic infections (Johnson et al., 2024). In particular, there is mounting evidence that trematode infection contributes to limb deformities in many amphibian species, by disrupting the cell signalling pathways involved in development (Stopper et al., 2002). Cases of the trematode *Ribeiroia ondatrae* causing limb abnormalities in wild amphibian populations have primarily been detected in the United States, with minimal evidence that this trematode is present in the U.K. (Johnson et al., 2002) However, another trematode species, *Strigea robusta*, also causes anomalies in the developing limbs of amphibians, with experimental evidence confirming this association (Svinin et al., 2023). Limb malformations in wild frog populations in Russia have been attributed to infection by *S. robusta* (Svinin et al., 2023), with this trematode frequently found in bird hosts across Europe (Svinin et al., 2022). Although no cases of *S. robusta* induced morphological abnormalities in the UK have been reported, there is a possibility that infection by this trematode, or another parasite, could have caused the syndactyly and polymelia observed in M. *alpestris* at Chorleywood Common.

Chorleywood Common is a local nature reserve, utilised by the community for recreational activities. The site comprises a mix of grassland, heathland and woodland, and various initiatives are in place to improve habitat quality and manage the reserve. The sampled pond was likely initially created for use by grasing animals, and has since been stocked with non-native fish for recreational activities. The pond is surrounded by tall vegetation, which acts as a buffer zone to prevent run-off from entering the water body (Countryside Management Service, 2018). Bearing these details in mind, it is unlikely that the observed limb abnormalities

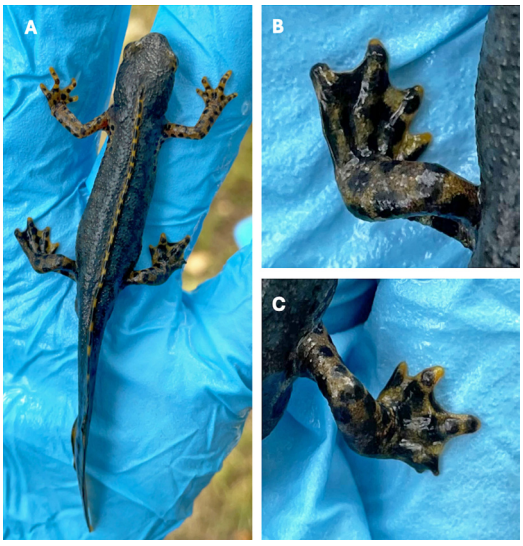

Figure 2. Syndactyly observed in a male *M. alpestris* in dorsal view as encountered in the field (A), with a close-up of syndactyly in left hind limb digits (B), and right hind limb digits (C). Photos by Rachel Hester.

were caused by pollution or contaminants, given the active management of the site and the lack of mass deformity events. The presence of introduced fish in the pond means that the abnormalities may have developed following predation-induced injury, which has been observed in wild amphibian populations (Eaton et al., 2004) and can even act synergistically with parasitism to produce limb malformations (Johnson et al., 2006).

The site at Chorleywood Common should continue to be monitored for amphibian limb and digit abnormalities, by conducting population studies and sampling additional ponds at the site. Future monitoring efforts should continue to document any morphological malformations, particularly also to assess its presence in other species in the region, such as the protected Great Crested Newt *Triturus cristatus*. Further research would furthermore be needed to confirm whether trematode species are present at the site, and if they are, whether they are indeed infecting amphibian hosts.

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