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First evidence of scavenging behaviour in *Ichthyosaura alpestris* (Laurenti, 1768)

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Abstract

The alpine newt is an opportunistic predator whose diet consists predominantly of aquatic and terrestrial invertebrates with Crustacea, Plecoptera, Collembola, Diptera, Isopoda and Gastropoda being the predominant prey groups. Consumption of amphibian eggs and larvae are another common food source. Here, we report the first documented case of adult *Ichthyosaura alpestris* feeding on a rodent carcass, thus adding to its menu a prey item that belongs to the Class Mammalia, while showcasing the previously unknown scavenging behaviour. This finding suggests that rodent carcasses can serve as an important resource for nutrients in remote, high-altitude populations of the alpine newt.

Key Words

alpine newt, Pindus, predator-prey relationship, Urodela

Scavenging behaviour is typically used to overcome food resource scarcity (Cramer 2008; Amor et al. 2010) and is showcased by almost all carnivorous vertebrates (DeVault et al. 2003; Selva and Fortuna 2007). However, only the vultures are obligate scavengers (Ruxton and Houston 2004; Walker et al. 2021), whereas most others (e.g. coyotes, freshwater turtles etc.) are facultative scavengers (DeVault and Krochmal 2002; DeVault et al. 2003; Selva and Fortuna 2007; Pereira et al. 2014; Santori et al. 2020), thus capitalising on opportunity. In amphibians, there are no known obligate scavengers; nevertheless, facultative scavenging has been recorded in some frog species (Nishikawa and Ochi 2016; Bassett et al. 2023) and in one salamander species (Unger 2018). In newts specifically, one such record exists where several individuals of the species *Triturus cristatus* were observed consuming a fish carcass (Iftime and Iftime 2011). Although scavenging is considered random and opportunistic behaviour, it plays a crucial role in the food web as it enhances nutrient recycling and community stability (Wilson and Wolkovich 2011). In harsh environments, such as high-altitude alpine ecosystems or arid environments where food and prey availability are scarce and unpredictable, such adaptive flexibility in foraging behaviour could be an important feature for the animals' survival (Castilla et al. 2011).

The alpine newt *Ichthyosaura alpestris* (Laurenti 1768) is a small-sized newt species, native to Europe known to occupy permanent or ephemeral waterbodies, such as lakes, troughs or puddles and, within Greece, it can be found in elevations between 659 m and 2,350 m (Tzoras 2023). The species is a polyphagous opportunistic predator exhibiting significant daily (Salvidio 2019), seasonal and spatial plasticity (Heiss et al. 2013) in the predator-prey interaction. Its multiphasic lifestyle, with adults shifting from a terrestrial to an aquatic lifestyle and vice versa (Heiss et al. 2013), its presence in high altitude lakes (Schabetsberger and Jersabek 1995) and its temporal diel activity shifts (Fasola and Canova 1992) have forced it to expand its diet as an adaptive response to the variation of food availability.

In alpine karst lakes, the alpine newt can be placed at the higher level of the trophic pyramid as a top predator (Schabetsberger and Jersabek 1995). The alpine newt's diet, feeding habits and predatory behaviour have been studied thoroughly in many European countries including, but not limited to, Romania (Covaciu-Marcov et al. 2010; Kovács et al. 2010; Bogdan et al. 2011), Italy (Fasola and Canova 1992; Joly and Giacoma 1992; Salvidio et al. 2019), Czechia (Kopecký et al. 2011, 2016), Austria (Schabetsberger and Jersabek 1995; Heiss et al. 2013) and Greece (Mettouris and Giokas 2017). Most studies were carried out predominantly through the method of flushing the stomach contents (Solé et al. 2005) of a high number of alpine newt individuals, thus allowing satisfactory results on the diet composition. The alpine newt's diet largely consists of invertebrates, such as Crustacea, Plecoptera, Collembola, Isopoda, Coleoptera, Diptera and Homoptera. Other prey categories include tadpoles (Dimancea et al. 2011) and *Salamandra salamandra* larvae (Bogdan et al. 2011). Non-discriminatory oophagy has also been documented against their own or other amphibian eggs (Kopecký et al. 2011; Mettouris and Giokas 2017). Own and conspecific sloughs were also found to be regularly consumed as classic non-prey items (Griffiths 1986; Schabetsberger and Jersabek 1995; Kopecký et al. 2011). Vegetal items have also been known to be accidentally ingested during the feeding process (Covaciu-Marcov et al. 2010; Kovács et al. 2010; Bogdan et al. 2011; Kopecký et al. 2011), something that has been documented in other amphibian species as well (Dolmen and Koksvik 1983; Sas et al. 2005). Inorganic elements from the substrate sediment have been found in the alpine newt's stomach contents and are also attributed to accidental ingestion (Bogdan et al. 2011; Kopecký et al. 2011). Within the current literature, the opportunistic behaviour of the newts is highlighted (Joly and Giacoma 1992; Denoël and Andreone 2003; Kovács et al. 2010). However, there is no reference to an alpine newt or to any other newt species feeding on an animal prey item that does not belong to any of the previously mentioned categories, but to the Class Mammalia.

Herein, we provide the first record of alpine newts feeding on a rodent carcass (Order Rodentia). The observation was made mid-day in October 2023 during a field survey to assess the presence of newt species in the sub-alpine lake, "Kosmeou" also known as "Tsouka Rossa" (39°51.825'N, 21°2.322'E, 1690 m a.s.l.) in the Province of Metsovo, Ioannina, Greece. Kosmeou Lake spans just over 100 m in length and over 60 m in width with varying depth between half and 2 metres and it is constantly supplied with water from low output springs (Fig. 1).

Towards the end of the survey, a rodent carcass at the shallow end of the lake bank was observed. Upon closer inspection, two male and one female alpine newts were seen nibbling on the carcass, managing to remove and swallow small pieces of it (Fig. 2). To eliminate potential confounding factors affecting the newts' feeding behaviour, like the presence of invertebrates on the carcass, a kick-net with a 0.5 mm - opening mesh was used to bring out the dead rodent. The carcass was thoroughly inspected to identify any hidden aquatic invertebrates or worms that could explain this uncommon newt behaviour. The examination revealed no evidence of invertebrates, forcing us to hypothesise that the newts were indeed lured to the carcass itself. The carcass was then placed back to the water in a different site and closer to the lake's overflowing point. Within minutes three female alpine newts approached it and started eating its decomposing flesh

Figure 1. Lake Kosmeou in Ioannina, Greece.

Figure 2. A female alpine newt feeding on a decomposing rodent carcass.

again. Notably, the sympatric newt *Triturus macedonicus* had no interest in the carcass.

These scavengers revealed the hitherto unknown foraging behaviour in *I. alpestris*, expanding upon previous research on its diet and further indicating that newts are generalists and opportunists, capable of adopting an energy-efficient behaviour to acquire food in demanding conditions. Given the current loss of suitable aquatic habitats and breeding sites due to agriculture and agrochemical pollution (in Greece, the populations of the Peloponnese are classified as Endangered according to Valakos et al. (2008)), dietary research can complement management actions via the identification of suitable habitats. Such research also possesses intrinsic value towards fully comprehending the alpine newt's biology and natural history.

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