Apodemus sylvaticus, an unexpected consumer of aposematic salamanders in a remarkable high-density insular population of *Salamandra salamandra*

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Resumen: En esta nota describimos el primer caso de consumo de salamandra común (*Salamandra salamandra*) por ratón de campo (*Apodemus sylvaticus*). En noviembre de 2024 encontramos varios cadáveres de salamandra en un muestreo diurno en la isla de Tambo (ría de Pontevedra, SO Galicia, España), con heridas en la parte ventral compatibles con mordiscos. El consumo de un cadáver de salamandra por el ratón de campo, así como su previa manipulación para comenzar mordiendo la zona ventral, fue grabado con una cámara de fototrampeo.

The combination of toxicity, through a mix of alkaloids secreted by epidermal glands that cover the dorsal body (Mebs & Pogoda, 2005; Knepper *et al.*, 2019) of the common salamander, *Salamandra salamandra* (Linnaeus, 1758), together with its conspicuous yellow and black coloration patterns (Alarcón-Ríos & Velo-Antón, 2024), confers it an aposematic antipredator strategy (Rojas *et al.*, 2017). However, some vertebrates have been identified as possible predators of this amphibian, although the opportunistic or specialist behaviour of these vertebrates when facing salamanders has not been rigorously evaluated. Among the few recorded predators are several mammals, such as the black rat, *Rattus rattus* (Velo-Antón, 2024), the wild boar, *Sus scrofa* (Carretero & Rosell, 1999; Velo-Antón *et al.*, 2025), and the otter, *Lutra lutra* (Morales *et al.*, 2004), but also birds such as the buzzard, *Buteo buteo*, (Bustamante Díaz, 1985), and snakes (water snakes, *Natrix* spp. and vipers, *Vipera seoanei*, Bas *et al.*, 1979). The detection of predation events on *S. salamandra* usually comes from the observation of partially consumed remains of salamanders, which gives clues about possible predators. For instance, some predatory birds would discard the salamander´s head to possibly avoid the parotid glands that contain a high concentration of alkaloids (Łaciak, 2022), although this behavior has not yet been demonstrated. The use of plasticine models, or carcasses combined with camera traps, helps to identify not only the possible predators responsible for the carcasses found, but also the type of predatory behavior towards prey that have anti-predator strategies. For instance, it was possible to identify, in insular populations of *S. salamandra*, that the black rat consumes different parts of the body but mainly the head and anterior part of the body (Velo-Antón & Cordero-Rivera, 2011; Velo-Antón, 2024).

In a recent work, we have reported the highest density for *S. salamandra* (2120 salamanders/hectare) in an insular population of NW Spain (Velo-Antón & Alarcón-Ríos, 2024), corres-

ponding to the subspecies *S. s. gallaica* (Velo-Antón & Buckley, 2015). This population is found on Tambo Island (42º24'41"N / 8º42'31"W), a small island of only 28 hectares located at the bottom of the Pontevedra estuary (Figure 1a). This island is characterized by a drastic habitat alteration since the island is now totally dominated by two species of allochthonous trees from Australia, *Eucalyptus globulus* and *Acacia melanoxylon*, which were planted along the western and northern Iberian Peninsula to produce paper pulp. The apparent scarcity of trophic resources due to the alteration and degradation of the soil (e.g. Aslam *et al.*, 2015) and the reduction or disappearance of surface water bodies (Le Maitre *et al.*, 2002) typical of altered areas dominated by eucalypt plantations, suggested a reduction of possible *S. salamandra* predators. This apparent scarcity of potential predators would help to explain the extraordinary population density of *S. salamandra* on this small island. Using five camera traps and salamander carcasses, an attempt has been made to evaluate the presence of possible vertebrates on this island during March 2024, and their predatory character on *S. salamandra*. These data (still unpublished) only showed the presence of the American mink, *Neogale vison*, although without any type of interaction (i.e. consumption and/or manipulation) with the deployed carcasses, as was already verified in a previous work carried out on other nearby islands (Velo-Antón, 2024). To a lesser extent, the presence of the field mouse, *Apodemus sylvaticus*, was also detected, but no other mammal species was recorded on the cameras.

On November 30th, 2024, with the aim of continuing the study of the phenotypic differentiation of this insular population (salamanders show the lowest body size and condition compared to other insular and continental populations, Velo-Antón & Alarcón-Ríos, 2024), a diurnal survey was carried out along the island's perimeter path. During this survey, we detected a total of nine fresh carcasses of *S. salamandra*, with no signs of bites or apparent degradation on the dorsal side, but all of them showed one or two wounds on the ventral side in the anterior and posterior area (Figure 1b). Taking advantage of four of these fresh carcasses, they were placed in front of a camera trap for 24 hours to record the consumption of these specimens by the species that possibly caused their death in the

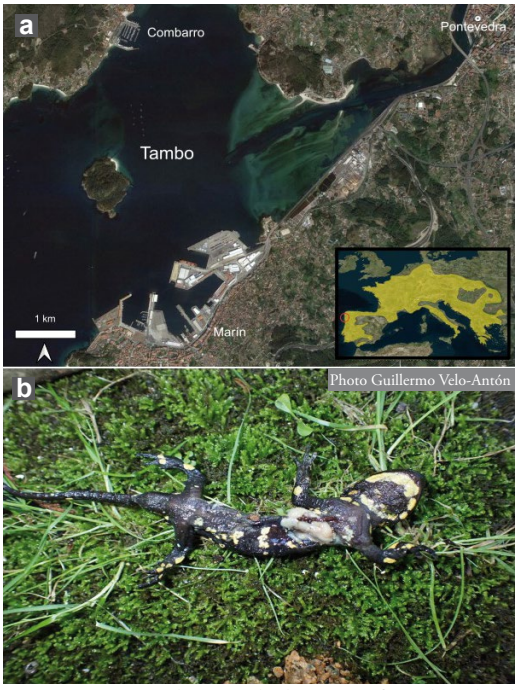

Figure 1: a) Map showing the location of Tambo Island on the NW Spain. The inset represents the distribution of *Salamandra salamandra* across Europe. b) Example of the ventral wounds observed on *S. salamandra* carcasses found during the survey on Tambo Island.
Figura 1: Mapa mostrando la localización de la isla de Tambo en el noroeste de España. El recuadro representa la distribución de *Salamandra salamandra* en Europa. b) Ejemplo de las heridas ventrales observadas en los cadáveres de *S. salamandra* encontrados durante el estudio en la isla de Tambo.

previous days. We obtained only one video, but in which the presence of *A. sylvaticus* is confirmed and its behavior when facing the possible prey is recorded (https://youtu.be/HozKqjLRjDE). It first manipulated a carcass on several occasions until it was left upside down, at which point the mouse began to bite and chew pieces of the salamander body removed from the anterior ventral side. Later, the mouse heads towards another salamander carcass, but without biting it, before it moves away.

With the data obtained, which include: i) confirmation of salamander predation by observing fresh carcasses on the island; ii) detection of only two mammals on the island; iii) lack of interaction of minks with salamander carcasses; and iv) recording of an *A. sylvaticus* handling and consuming a salamander carcass, which left it with wounds similar to those observed on the ventral part of other carcasses found on the island, we can suggest that *A. sylvaticus* could be the only predatory mammal that salamanders have on Tambo. This would be the first report of the wood mouse consuming *S. salamandra* (Sánchez-González *et al.* 2016). Indeed, the wood mouse is considered omnivorous, with a diet mainly composed of seeds (70-80%) and small invertebrates (20%) (Hansson, 1985). It is also worth noting that the behavior of *Apodemus sylvaticus* towards *S. salamandra* carcasses was previously recorded in a recent study conducted on Cortegada Island, a nearby island located at the bottom of the Arousa estuary. However, in none of the 54 events recorded on this island did the mouse bite or chew any salamander carcass (Velo-Antón *et al.*, 2025). This would suggest a potential expansion of the diet of *A. sylvaticus* due to the reduced availability of seeds and native plants on Tambo Island, or that this mammal is more generalist than previously thought and can also include amphibians as prey.

Future surveys on this island will gather more information about the possible impact of this mammal on the salamander population. The extraordinary density and large population size of this salamander population contrast with the apparent scarcity of the wood mouse, thus potentially buffering a possible negative impact caused by mouse predation events. Contrary to the nearby San Martiño island, where *S. salamandra* shows an exceptional behavioral shift to diurnal activity (Velo-Antón & Cordero-Rivera, 2017), likely as a response to the high predation pressure exerted by rats (Velo-Antón, 2024), the salamanders in Tambo show a typical nocturnal activity, and thus share the temporal, spatial, and habitat niche with *A. sylvaticus*.

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