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Extant but rare: *Salamandra salamandra* and *Bufo spinosus* in Cortegada Island

Guillermo Velo-Antón[1,2,3]

[1] Departamento de Ecoloxía e Bioloxía Animal, Grupo de Ecoloxía Animal. Universidade de Vigo. Torre Cacti (Lab 97). 36310 Vigo. Spain.
[2] CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos. InBIO Laboratório Associado. Campus de Vairão. Universidade do Porto. 4485-661 Vairão. Portugal. C.e.: guillermo.velo@uvigo.es
[3] BIOPOLIS Program in Genomics, Biodiversity and Land Planning. CIBIO. Campus de Vairão. 4485-661 Vairão. Portugal.

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Resumen: La isla de Cortegada (54 hectáreas; Ría de Arousa; SO Galicia) se separa por tan solo 200 m del continente, estando prácticamente comunicada con la población de O Carril durante la bajamar. Está caracterizada por una amplia cobertura forestal dominada por una de las mayores extensiones de *Laurus nobilis* en Europa. Pese a su reciente aislamiento, cercanía al continente, disponibilidad de agua dulce y excelentes condiciones climáticas y forestales, la presencia de anfibios en esta isla es extremadamente rara. En esta nota presento el primer registro de *Bufo spinosus* en Cortegada, añadiendo una especie de anfibio a las ya conocidas en el Parque Nacional de las Islas Atlánticas de Galicia, al que esta isla pertenece. También aporto nuevos hallazgos de *Salamandra salamandra gallaica* que confirman la presencia de una población aparentemente muy escasa en esta isla, y resalto la necesidad de estudiar esta población para poder conocer su modo reproductivo (larvíparo o puerícparo), y evaluar si pudo evolucionar a un modo reproductivo terrestre como ocurrió en otras islas del parque (Ons y Cíes).

Cortegada is a flat (54 hectares) and an almost tidal island (i.e. low-depth seawater flows at low tide between the island and the mainland) at the end of a coastal inlet (Ría de Arousa) in

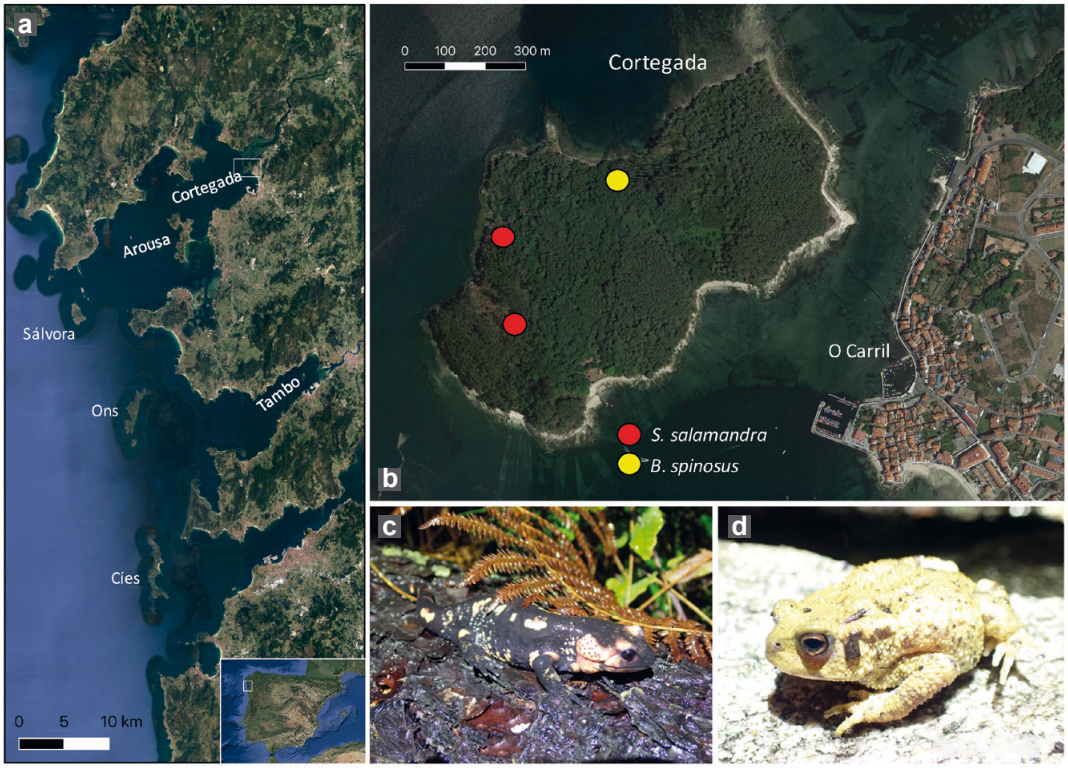

Figure 1: a) Map showing the distribution of archipelagos and main islands across the Rías Baixas with an insect depicting the location of this region in the Iberian Peninsula. b) Observations of *Salamandra salamandra* (red) and *Bufo spinosus* (yellow) individuals in Cortegada. c) One of the *S. salamandra* found. d) The only observed *Bufo spinosus* in this island.

Figura 1: a) Mapa que muestra la distribución de archipiélagos e islas principales a lo largo de las Rías Baixas con un inserto que representa la ubicación de esta región en la península ibérica. b) Observaciones de individuos de *Salamandra salamandra* (rojo) y *Bufo spinosus* (amarillo) en Cortegada. c) Una de las *S. salamandra* encontradas. d) El único *B. spinosus* observado en esta isla.

SW Galicia, Spain (Figure 1a). This island, and surrounding islets, form part of the Galician Atlantic Islands National Park that also includes the archipelagos of Sálvora, Ons and Cíes. The four archipelagos, together with other islands and islets located across the inlets of Rías Baixas, were gradually formed with the sea level rise after the last glacial maximum (starting ~8000 years ago). Both the low bathymetric level between mass lands and the short distance to the mainland (200 meters from the village O Carril; Figure 1b) evidence the recent formation of Cortegada as an island (last few hundred years).

Nowadays Cortegada is largely covered with a dense woodland, and its renowned for having one of the largest, if not the largest, laurel (*Laurus nobilis*) forest in Europe. Pine (*Pinus pinea* and *P. pinaster*) and oak (*Quercus robur*, *Q. suber* and *Q. pyrenaica*) trees are also abundant across the island, forming a continuous mixed forest that once dominated much of the coastal areas of the surrounding mainland, but which was heavily transformed with the extension of logging, grazing and agricultural practices. The oceanic climate provides mild temperatures and a favorable wet climate

environment for amphibian species. The high levels of moisture in this island is exemplified with the presence and abundance of numerous species of ferns, bryophytes, mosses and lichens (including some endemic species). However, and despite i) its close proximity to the mainland; ii) the continuous and large native forest; iii) its mild and wet climate; and iv) the presence of seasonal water ponds and temporary puddles across the island, the presence of amphibians was unnoticed during multiple herpetological surveys in Cortegada (e.g. Galán, 2003; Velo-Antón *et al.*, 2008; personal observations), and only recently discovered.

Salamandra salamandra was first reported in Cortegada (Hernández-Sastre, 2018). On August 17th, 2017, a herpetological activity organized by the Asociación Herpetológica Española and Organismo Autónomo de Parques Nacionales mobilized 15 volunteers to survey the island, where one female was found under a stone near the ruins of an old village. This activity was repeated on October 20th of the same year, focusing the sampling efforts on the area where the first salamander was detected, and resulting in the second observation of the species. However, and given the nocturnal activity inherent to this species (but see Velo-Antón & Cordero-Rivera, 2017) and most amphibian species in this region, nocturnal surveys should be conducted to increase the chances of amphibian detection and obtain better estimations of population abundance. In this note I summarize the findings, and the environmental conditions, of the two successful nocturnal herpetological surveys I conducted in Cortegada, which resulted in observations of a few *S. salamandra* and the first record of the Iberian toad, *Bufo spinosus*, for this island.

On November 28th, 2018, I conducted a nocturnal survey (20:30-23:30h) in Cortegada with the help of three colleagues. We covered all the available paths, and other areas, while actively searching for the presence of *S. salamandra*. The climatic conditions for that day were the following: rain: 2.6 l/m^2; mean humidity: 70 %; mean temperature: 14.1º C; wind speed: 19.7 km/h (data collected from a nearby weather station at in Corón, at 4 km SW from the island, www.meteogalicia.gal). We found one single adult (male) on top of a fallen tree but no other amphibian species was detected. On October 4th, 2021, I conducted a nocturnal survey (one observer) from 21:00 to 23:30h, covering the central and south parts of the island. The climatic conditions were: rain: 16.8 l/m^2; mean humidity: 88 %; mean temperature: 15.5º C; wind speed: 16.0 km/h (data collected from the same weather station). I found a small adult of *Bufo spinosus* walking along the north-central coastal path and three fire salamanders (two females and one male), laying on fallen trees, on the southwestern part and near to previous observations (Figure 1b).

These observations confirm the presence of another insular population of *S. salamandra* in Rías Baixas and suggest the presence of a unique insular population of *B. spinosus* in this region. Insular populations of *S. salamandra* in this region have been previously reported in Cíes and Ons (Galán, 2003), Tambo (Velo-Antón, 2008), and one individual was observed in A Illa de Arousa (Moisés Cabirta, personal communication). Indeed, populations occurring in Ons and San Martiño (the only surviving population in the Cíes archipelago) have been thoroughly studied (e.g. Velo-Antón *et al.*, 2007; 2012; 2015; Lourenço *et al.*, 2018; Alarcón *et al.*, 2020a, 2020b) due to the reproductive mode shift from larviparity (i.e. delivery of aquatic free larvae) to pueriparity (i.e. delivery

of fully terrestrial juveniles), constituting an excellent natural laboratory to study an evolutionary novelty. Thus, the identification of other insular populations and the characterization of their reproductive mode is crucial to fully understand the origin and evolution of this reproductive shift, and to protect and preserve these evolutionary units. The case of the Iberian toad is quite remarkable because it constitutes the only present insular record for the species (Ortiz Santaliestra, 2014). Although there are not current insular populations for the species, the presence of *B. spinosus* in other inlands were attributed to unsuccessful introductions from the mainland, such as the possible recent introduction in Ons (Galán, 1999; 2003), and the more evident cases of species introductions in Fuerteventura (specimens in the Natural History British Museum) and Balearic Islands (Lizana, 2002).

Despite these nocturnal surveys were conducted during favorable climatic conditions (mild temperatures and high humidity levels -see Velo-Antón & Buckely, 2015 and Ortiz Santaliestra, 2014- for *S. salamandra* and *B. spinosus*, respectively), these two species seem to have extremely small population sizes. This is supported by: i) the low number of observations in these "successful" surveys; ii) the lack of observations in many other nocturnal surveys, and iii) the fact that both species have been unnoticed by the staff of the national park that regularly patrol the island. Indeed, these are the two most common species that I frequently observe during my nocturnal surveys in nearby areas across this region, where fire salamanders are commonly found in dozens (or hundreds) under similar climatic conditions.

The causes of such rare observations of both species and their apparently small population sizes are yet unclear. *Salamandra salamandra* in Cortegada likely constitutes another insular and natural population in this region, and the low abundance and the spatial restriction of the species within this island could be the result of the intensive land use of the colonists and settlers that worked and lived in the island until the 20th century. During the human settlements, present over a few centuries, the island was largely covered with crop fields. However, with the abandonment of the island (due to the sale of the island to the crown) a natural rewilding process was followed, and the mixed forest was able to grow and take over the entire island. Yet, this might have caused the population decline of the *S. salamandra*, which seems to occur in a specific area of this continuous woodland. The recent arrival of a potential predator, the wild boar (*Sus scrofa*) might also contribute to the decline of this species. Wild boars come and go because the sea water channel do not constitute a barrier for their wide daily movements, although they are now established in the island where they find more protection from hunter activities in the mainland. It is unclear if their presence might be or not disastrous for the small *S. salamandra* population (and other taxa) in this island, but it is definitely one of the few potential predators (Irizar *et al.*, 2004; Velo-Antón & Buckley, 2015). Wild boars were always observed in my nocturnal surveys, but usually on the intertidal where they easily feed on the clams and cockles cultivated in this area, and on other marine invertebrates. Surprisingly, and contrarily to the expected behavior of this species, none of the salamanders were found on the ground when active but laying on fallen large trees and a few dozen centimeters above the ground. A remarkable behavioral shift (i.e. diurnal activity) observed in the insular population San Martiño pinpoints to the ability of *S. salamandra* to overcome the predation pressure exerted by the invasive rat species, *Rattus rattus*

(Velo-Antón & Cordero-Rivera, 2017), and thus it will be interesting to explore possible behavioral changes of salamanders in Cortegada in response to potential predation pressures. The presence of *B. spinosus* in the island is perhaps harder to explain, as no insular populations exist for this species. Despite the relatively narrow and shallow sea water barrier separating the island, a recent and natural colonization from the mainland seems implausible, however, I cannot rule out human-mediated introductions as it occurred in other islands. Further field work on this island is needed to gather more data on the specific range and population size both *S. salamandra* and *B. spinosus*, but also on the behavior and reproductive mode of the former. I will be also important to identify the potential current threats for the amphibians occurring in this apparently well suitable island.

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