
Record of abundance of *Salamandra salamandra* (Linnaeus, 1758) in its southernmost European populations: *S. s. longirostris*

R. Arroyo–Morales, A. Martín–Taboada, J. Juan–Rueda,
D. Romero

Arroyo–Morales, R., Martín–Taboada, A., Juan–Rueda, J., Romero, D., 2022. Record of abundance of *Salamandra salamandra* (Linnaeus, 1758) in its southernmost European populations: *S. s. longirostris*. *Arxius de Miscel·lània Zoològica*, 20: 27–31, Doi: <https://doi.org/10.32800/amz.2022.20.0027>

Abstract

Record of abundance of Salamandra salamandra (Linnaeus, 1758) *in its southernmost European populations: S. s. longirostris*. In Europe, the southernmost subspecies of *Salamandra Salamandra* is *Salamandra salamandra longirostris*, found in the south of the Iberian Peninsula. This subspecies, whose populations are currently in decline, has been proposed as a species due to its genetic differentiation and isolation by distance. In one survey at Fuente del Acebuche (Malaga, Spain), one of its most important breeding sites, we observed 67 adult individuals. These data represent a record density of this subspecies in the south of the Iberian Peninsula and are unique even for communities of *Salamandra salamandra* in the north.

Key words: Amphibian conservation, Endemic species, Habitat alteration, Malaga, Water point management

Resumen

Rècord de abundància de Salamandra salamandra (Linnaeus, 1758) *en las poblaciones europeas más meridionales: S. s. longirostris*. En el sur de la península Ibérica se encuentra la subespecie de salamandra más meridional de Europa, *Salamandra salamandra longirostris*. Se ha propuesto la clasificación de esta subespecie como especie debido a su diferenciación genética, su aislamiento y el actual declive de sus poblaciones. En un estudio realizado en Fuente del Acebuche (Málaga, España), uno de los lugares de cría más importantes para la subespecie, se observaron 67 individuos adultos de la misma. Este dato constituye una densidad récord de la especie en el sur de la península Ibérica y es singular incluso para comunidades de *Salamandra salamandra* en el norte peninsular.

Palabras clave: Conservación de anfibios, Especies endémicas, Alteración del hábitat, Málaga, Gestión de puntos de agua

Resum

Rècord d'abundància de Salamandra salamandra (Linnaeus, 1758) en les poblacions europees més meridionals: S. s. longirostris. Al sud de la península Ibèrica es troba la subespècie de salamandra més meridional d'Europa, *Salamandra salamandra longirostris*. S'ha proposat la classificació d'aquesta subespècie com a espècie atesa la diferenciació genètica que presenta, l'aïllament i l'actual declivi de les seves poblacions. En un estudi portat a terme a Fuente del Acebuche (Màlaga, Espanya), un dels llocs de cria més importants per a la subespècie, se'n van observar 67 individus adults. Aquesta dada constitueix un rècord de densitat de l'espècie al sud de la península Ibèrica i és singular fins i tot per a comunitats de *Salamandra salamandra* al nord peninsular.

Paraules clau: Conservació d'amfibis, Espècies endèmiques, Alteració de l'hàbitat, Màlaga, Gestió de punts d'aigua

Rebut: 26/04/2022; Acceptació condicional: 12/05/2022; Acceptació definitiva: 16/05/2022

R. Arroyo–Morales, A. Martín–Taboada, D. Romero: *Biogeography, Diversity and Conservation Research Team, Department of Animal Biology, Faculty of Sciences, Universidad de Málaga, E–29071 Málaga, Spain.*

Corresponding author: R. Arroyo–Morales. E–mail address: raularroyoamb@gmail.com

ORCID ID: R. Arroyo–Morales: 0000-0002-8089-2453; A. Martín–Taboada: 0000-0002-8269-5090; D. Romero: 0000-0003-4540-6349

Salamandra salamandra (Linnaeus, 1758) is a species of urodele of the Salamandridae family whose presence in the Iberian Peninsula is undergoing a significant regression (Pleguezuelos et al., 2002; Jiménez et al., 2016). According to the IUCN criteria for Spain, the subspecies *Salamandra salamandra bejeræ* (Wolterstorff, 1934) and *Salamandra salamandra almanzoris* (Müller and Hellmich, 1935) in northern Spain and *Salamandra salamandra longirostris* (Joger and Steinfartz, 1994) in southern Spain are currently considered Vulnerable to Extinction (VU) (Pleguezuelos et al., 2002). The main threats include loss of habitat due to changes in land use, pollution (especially of water points), and the current trend towards desertification due to climate change and human activity. Climate change foresees higher temperatures and lower humidity by 2050, and it has been predicted that the south of the Iberian Peninsula will be severely affected (Romero et al., 2019). Concomitantly, climate change promotes the expansion of exotic species (Romero et al., 2019) and emerging diseases (Bosch et al., 2007). Amphibians are one of the most vulnerable groups of fauna, and populations worldwide are affected by chytridiomycosis, an infectious disease caused by the fungus *Batrachochytrium dendrobatidis* (Olson et al., 2013).

In the Iberian Peninsula, up to nine subspecies of *S. salamandra* are recognized (Velo–Antón and Buckley, 2015). The southernmost subspecies in Europe is *S. s. longirostris*, endemic to the south of the Guadalquivir valley. Its presence is currently restricted to the provinces of Màlaga and Cadiz. Due to the morphological and genetic differences (García–París et al., 1998) and the accumulated isolation of this subspecies, several authors have proposed it as a species (Dubois and Raffaelli, 2009). In view of the genetic isolation and decline of its populations, it is currently considered Vulnerable to Extinction (Pleguezuelos et al., 2002). Part of this regression is the most recent population declared extinct in the province of Granada (Pleguezuelos and Feriche, 2003) (grids 30S UG90 and UG91) in March 1989 (Juan Pablo González de la Vega, pers. comm.). The loss and fragmentation of *Quercus* forests are among the main threats for *S. s. longirostris* (Romero et al., 2013).

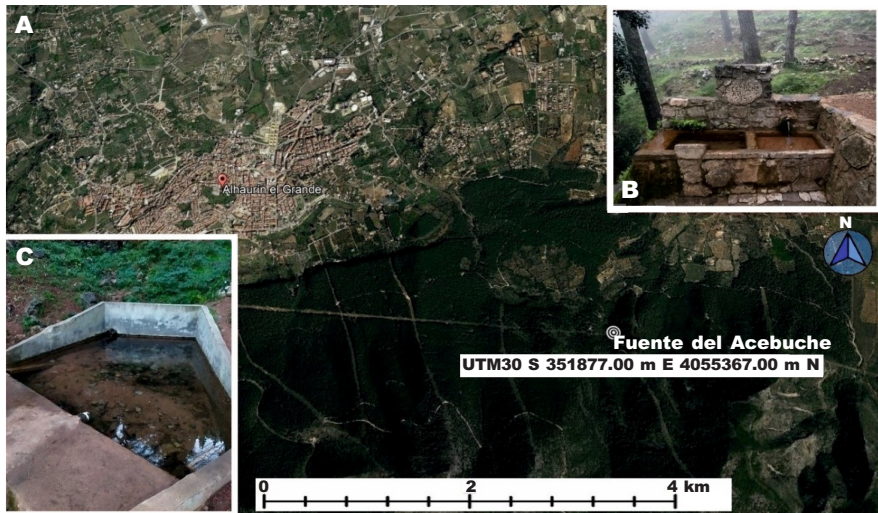


Fig. 1. A, location of Fuente del Acebuche, northern slope of the Sierra de Mijas (Málaga); B, Fuente del Acebuche; C, the main action measure in the area. (A, Google Earth Pro map; B and C, photographs by Raúl Arroyo–Morales).

Fig. 1. A, localización de Fuente del Acebuche, vertiente norte de la Sierra de Mijas (Málaga); B, Fuente del Acebuche; C, principal actuación en la zona. (A, mapa Google Earth Pro; B y C, fotografías de Raúl Arroyo–Morales).

Currently, populations of *S. s. longirostris* are divided into two main centres, separated by the Guadalhorce River (Málaga) (Jiménez et al., 2016). Populations of *S. s. longirostris* from the province of Malaga require special attention due to the continued loss of breeding sites (Fernández–Cardenete et al., 2000), specifically, in Fuente del Acebuche, on the northern slope of the Sierra de Mijas (Málaga, Spain) (coordinates UTM30 S 351877.00 E 4055367.00 N) (fig. 1). Located in a *Pinus halepensis* forest, this is one of the best known breeding sites for *S. s. longirostris* in the province of Malaga. The area is classified as having moderate, favourable conditions (or to be of intermediate favorability according to spatial distribution models) for the subspecies (Romero et al., 2019). In order to conserve the reproduction points for amphibians, in 2009 a project named 'Restoration of water points for the reproduction of amphibians in Malaga' was carried out. The main action was the installation of a cement pool to enable the reproduction of amphibian species that inhabit the area: *S. s. longirostris*, *Pleurodeles walt* (Michahelles, 1830), *Hyla meridionalis* (Boettger, 1874), *Bufo spinosus* (Daudin, 1803), *Epidalea calamita* (Laurenti, 1768) and *Discoglossus jeanneae* (Busack, 1986).

During a spot survey of the environmental status characterization of Fuente del Acebuche and the study species, on 19 XII 19, between 7:50 p.m. and 8:30 p.m., on a day of high cloud cover, light rainfall, winds of 9 km/h and a temperature of 13.7 degrees, 67 adult specimens of *S. s. longirostris* (fig. 2) were found over a distance of 308 meters (0.2 indiv./m), subsequently differentiated by visual identification supported by photo–identification through the open source program WILD–ID (version 1.0, 2011).



Fig. 2. Specimens of *S. s. longirostris* adults found during sampling. Photograph by Adrián Martín–Taboada.

Fig. 2. Especímenes adultos de *S. s. longirostris* encontrados durante el muestreo. Fotografía de Adrián Martín–Taboada.

These data suppose a singular observation density, especially for the south of the Iberian Peninsula, where, due to hotter and drier climatic conditions, the presence of the species is scarcer (García–París et al., 2004). This singularity became evident in subsequent samplings carried out in the same area, during which at least fifteen adult individuals (0.048 indiv./m) were observed at any one time along the same route and in the same environmental conditions. These samplings were carried out throughout 2021 and 2022 and consisted of occasional surveys during the period of activity of the species (from October to December in 2021 and January to May in 2022). Specifically, sampling consisted of observing reproduction (of salamander larvae) at the two breeding sites of the species in the study area (at water sources for hikers and restored amphibian breeding sites), and an adult salamander observation transect of 300 metres around these sites (of one–hour duration). These point densities contrasted with the measured densities described for the north of the peninsula of 0.1 indiv./m (Hernández–Sastre, 2018), only exceeded with densities of 0.3 indiv./m recorded in a sampling (Cordero–Rivera et al., 2007) in the Atlantic islands of Galicia (Spain). These unique data detected in one of the southernmost points for salamanders could suggest the enormous importance of this breeding point for *S. s. longirostris*.

In our most recent surveys (from January to March 2022), we counted similar numbers of *B. spinosis* and *S. s. longirostris*, with up to fifteen adults for both species. These numbers suggest that the restoration actions in Fuente del Acebuche are benefiting *B. spinosis* (a generalist), to the detriment of *S. s. longirostris* (a specialist). Future surveys are needed to assess the effectiveness of the conservation measures adopted in areas around Fuente del Acebuche, to evaluate the state of this community of salamanders in the medium and long–term, and to analyse and understand the environmental conditions that modulate these densities.

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