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Sevilla. Thursday, 10th October 2023

American crayfish occupy 95% of the Italian crayfish's niche in the Iberian Peninsula

- **Researchers from the Doñana Biological Station – CSIC have studied the changes in the distribution of the three species of crayfish introduced in Spain throughout history.**

- **The study was based on historical sources to describe the evolution of the species distributions and the factors that may have influenced the process.**

Specimen of the red swamp crayfish in Caño de la Algaida de la Caquera, in Doñana. / EBD-CSIC

A scientific team led by the Doñana Biological Station (EBD) of the Spanish National Research Council (CSIC) has studied the changes in the distributions and ecological niches of the three species of crayfish that have been introduced in Spain throughout history. The work focuses on the Italian crayfish, introduced in the 16th century, and on

two North American species, the red swamp crayfish and the signal crayfish, introduced in the 1970s. The results, published in the *Journal of Animal Ecology*, show that these two American species occupy more than 95% of the Italian crayfish's niche space, with the sole exception of colder headwater environments that have served as a refuge for this species.

To carry out this work, the researchers have compiled systematic data on the presence of crayfish over the last 200 years. The scientific team used the geographical dictionaries published by Sebastián Miñano and Pascual Madoz in the first half of the 19th century, to describe the distribution of the Italian crayfish around 1850. The distribution in the 1960s was obtained from a monograph on the Italian crayfish published in 1964 by the River Fishing and Hunting Service of the Spanish regime. Data provided by the Spanish Ministry of Ecological Transition and Demographic Challenge were used to analyse the most recent scenario.

"Although we often hear about the native crayfish, in reality there are no native crayfish species in the Iberian Peninsula," says researcher **Miguel Clavero**, from the EBD-CSIC. "According to the latest research, the species we consider native is actually the Italian crayfish, with the scientific name *Austropotamobius fulcisanius*," he points out. This species was introduced into Spain at the end of the 16th century by order of King Phillip II, who wished to fill the ponds of his new palaces with these striking animals that he had met at the courts of the Netherlands and Italy. The exclusivity held by the king gradually disappeared through new introductions, not yet well documented, until the species became a common food resource of Spanish people.

Although the distribution of the Italian crayfish increased considerably between 1850 and 1960, its ecological niche in 1850 was already fairly representative of what it would be in the 1960s. Introductions of Italian crayfish were numerous throughout the 20th century and the Franco's regime heavily promoted the crayfish fishery.

"Probably due to overexploitation, many Italian crab populations began to decline and even disappear in the early 1970s," says researcher **Duarte Viana**, first author of the study. "This raises alarm in a society with a rampant love of crayfish, which favoured the introduction of two North American species, the red swam crayfish and the signal crayfish. After the arrival of these new species, the distribution of the Italian crayfish was drastically reduced and its niche shifted to abrupt and colder headwater environments.

Current refuges, uncertain future

The ecological niches of the two American crayfish species are remarkably complementary: the signal crayfish (*Pacisfastacus leniusculus*) is found in colder environments in the north of the peninsula, while the red swamp crayfish (*Procambarus clarkii*) lives in warmer, low-lying areas. The wide and complementary niche of the North American species has eventually occupied virtually the whole environmental space use of Italian crayfish in any historical period, leaving only upstream reaches, when still free of the North American species, as refuge habitats. Moreover, like all American species,

these crayfish are carriers of crayfish plague, a lethal disease for all European crayfish species, including the Italian crayfish.

"the ecological conditions under which species live permanently change, and more so under ongoing, fast global environmental change," explains Viana. "Species are able to thrive in ranges with certain minimum or maximum temperatures, a specific extent of forest and the presence of other species in particular, configuring what we call an ecological niche. Although it is often assumed that species' niches are stable, they can actually shift in response to environmental changes, and understanding all these interlinked changes is relevant to promote biodiversity conservation".

The study of changes in species' ecological niches has been poor by the limited availability of long-term data. As biodiversity information has been collected in a standardised way only in the last few decades, many changes in earlier periods tend to go unnoticed. This study on crayfish is an example of the potential of information from historical sources to describe distributions of organisms and ecological processes over periods that the natural sciences have barely explored. This long-term view is, according to the researchers, key to assessing human impacts on natural systems and providing baseline conditions for biodiversity conservation.

Duarte S. Viana, Francisco J. Oficialdegui, María del Carmen Soriano, Vigilio Hermoso, Miguel Clavero. **Niche dynamics along two centuries of multiple crayfish invasions**. *Journal of Animal Ecology*. DOI: **/10.1111/1365-2656.14007**

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