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Fishes in Mediterranean Environments

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The presence of *Acipenser* sturgeons in the Iberian Peninsula: a review of the existing literature

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SUMMARY

The conservation status of sturgeon species is highly alarming. Six of the European *Acipenser* species are critically endangered. Several studies developed in the last decades have analysed the distribution of sturgeons in the Iberian Peninsula, questioning the possibility of the native character of some *Acipenser* species there, with a special focus on the Adriatic sturgeon, *A. naccarii*. We review the available knowledge on the distribution on Iberian *Acipenser* sturgeons, in order to ascertain their nativeness status, as a necessary tool to implement measures for their management and conservation. One vagrant specimen of *A. oxyrinchus*, and several released or escaped specimens of *A. baerii* and *A. naccarii* have been recorded in the Iberian Peninsula. Our results show that the Atlantic sturgeon *A. sturio* is the only native sturgeon species that has had breeding populations in the past in the Iberian Peninsula. Regarding *A. naccarii*, further evidence is required to prove its dubious native character in the Iberian Peninsula. Although the reviewed studies have solidly shown that *A. naccarii* has been present outside the Adriatic basin, the presence of isolated individuals does not constitute sufficient evidence to sustain the existence of past breeding populations.

Keywords: *Acipenser naccarii*, *Acipenser sturio*, conservation plans, management, distribution

Citation: Miranda R, Oscoz J (2023) The presence of *Acipenser* sturgeons in the Iberian Peninsula: a review of the existing literature. Fishes in Mediterranean Environments 2023.002: 14p. https://doi.org/10.29094/FiSHMED.2023.002

DOI: 10.29094/FiSHMED.2023.002

INTRODUCTION

Sturgeons (Acipenseridae) are a family of actinopterygian fishes adapted to the cold and temperate climates of the Northern Hemisphere. Currently, they are grouped into four genera. *Scaphirhynchus* (three species, between the Mississippi basin and Northern Mexico) and *Pseudoscaphirhynchus* (three species, Aral Sea basins) include rheophilic species that inhabit large rivers. The genus *Huso* includes two species; the Kaluga sturgeon *Huso dauricus* (Georgi, 1775), distributed across the Amur Basin, the Okhotsk Sea, the islands of Sakhalin and Hokkaido, and North China (Shmigirilov *et al*., 2007), and the Beluga sturgeon *Huso huso* (Linnaeus 1758), native to the Black Sea and the Caspian Sea. Finally, according to Fricke *et al*. (2023), the *Acipenser* genus consists of 19 species across the Northern Hemisphere, nine of which occur in Europe.

The conservation status of all species of sturgeons is highly alarming, and according to the IUCN Red List (2020), six of the European *Acipenser* species are categorised as critically endangered. However, some species have also been successfully bred in captivity and are currently farmed for their roe, used to make caviar. The Beluga sturgeon, the Adriatic sturgeon *Acipenser naccarii* Bonaparte, 1836, and the Siberian sturgeon *Acipenser baerii* Brandt, 1869, are currently bred in the Iberian Peninsula for this purpose.

According to the reference biodiversity databases (IUCN, 2020; Froese & Pauly, 2019; Fricke *et al*., 2023) and monographies on the diversity of fishes in Europe (Kottelat & Freyhof, 2007), the Atlantic sturgeon *Acipenser sturio* Linnaeus, 1758 (Figure 1) is the only sturgeon species native to the Iberian Peninsula. Nonetheless, different studies published in the last decades have questioned this assumption, considering the presence of other native *Acipenser* species. Here, we examine the available information regarding the presence and distribution of *Acipenser* sturgeons in the Iberian Peninsula. Our aim is to gather the necessary evidence to determine their native status, which is crucial for implementing effective management and conservation measures.

EUROPEAN *ACIPENSER* IN IBERIA

Acipenser baerii is distributed across Siberia, from the basin of the River Ob to the River Kolyma and Lake Baikal (Kottelat & Freyhof, 2007). Although aquaculture has led to the introduction of this species in several European river basins, they do not seem to have generated self-sustained wild populations. Kottelat & Freyhof (2007) consider that the native distribution of *A. naccarii* is restricted to the Adriatic Sea basin, encompassing the rivers between the Po (Italy) and the Bruna (Albania) basins, considering erroneous the references to the Tyrrhenian Sea, Spain and France (Kottelat & Freyhof, 2007). The American Atlantic sturgeon *Acipenser oxyrinchus* Mitchill, 1815 is distributed throughout the Northern Atlantic, occurring in Europe between the North and Baltic seas to the Northern Iberian Peninsula and between the Labrador Peninsula and the Mississippi Delta in America. Finally, *A. sturio* would originally have been distributed along Mediterranean and European Atlantic coasts, spawning in the main rivers draining to them. Currently, the distribution of this species appears to be restricted to the Garonne River basin in France. *Acipenser sturio* and *A. oxyrinchus* are sister species that diverged early from all other *Acipenser* species (Birstein & Desalle, 1998; Birstein *et al*., 1998; Birstein & Doukakis, 2000). In fact, some authors even consider that *A. sturio* and *A. oxyrinchus* should be considered a single species (Artykhin & Vecsei, 1999), and there is evidence of natural hybridization events (Tiedemann *et al*., 2007; Ludwig *et al*., 2008).

All the species mentioned above have been cited in the Iberian Peninsula. *Acipenser baerii* has been recorded from 1995 in the Ebro, the Duero and the Guadalquivir basins (Elvira, 1997, 1998, Elvira & Almodóvar, 1999, 2019). Elvira & Almodóvar (2001) include the Júcar basin. However, Ri-

beiro *et al*. (2008) consider that the different introduction events of *A. baerii* in the Iberian Peninsula have resulted in the establishment of self-sustained wild populations. Elvira & Almodóvar (2019) cite 1998 as the first introduction of *A. naccarii* in Spain. Elvira (2001) reported a detection by fishermen in 1997, but this record could not be validated. However, *A. baerii*, *A. naccarii* and their hybrids were farmed at a nearby fish farm.

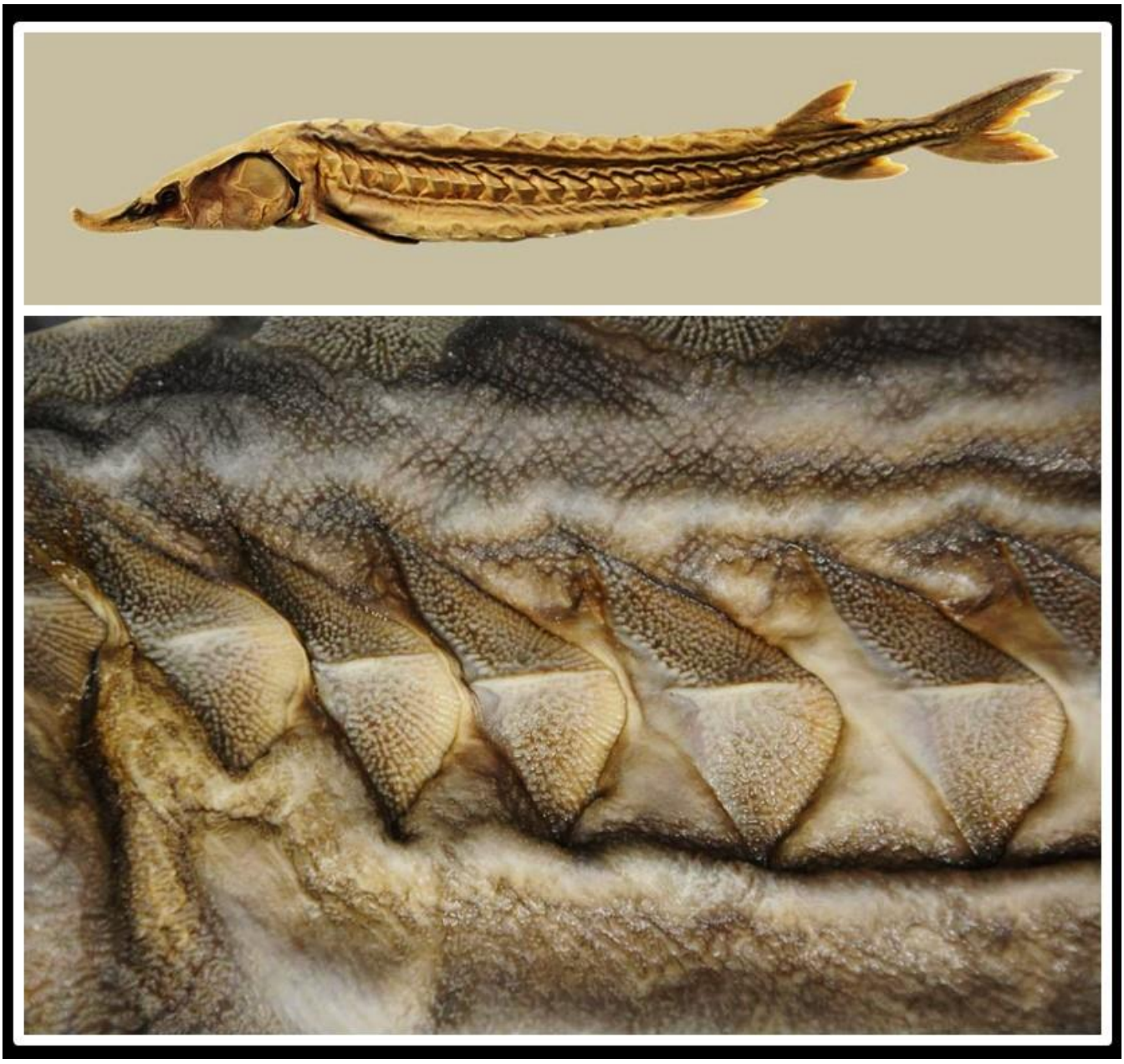

Figure 1. Naturalised specimen of Atlantic sturgeon *Acipenser sturio* (upper photo, approx. 97 cm FL) collected in the Cantabrian sea on 21st May 1975. Lower photo, detail of lateral scutes (Museum of Zoology of the University of Navarra, MZNA 137264). Specimen collected with trammel net at 6-7 miles from San Sebastián (Basque Country, Spain).

Acipenser sturio has been traditionally considered the only sturgeon native to the Peninsula (Elvira *et al*., 1991; Almaça, 1995; Doadrio, 2001). The species occurred in both the sea and along the main rivers, including the Ebro, the Duero, the Guadiana, the Guadalquivir, and the Fluvià (Clavero 2007). Remains of this species have also been found in ancient human settlements (Morales-Muñiz & Roselló, 1998; Morales-Muñiz *et al*., 2012). The last specimen of *A. sturio* known to have been captured in Spain was caught in 1992 by a local fisherman near the mouth of the Guadalquivir River (Elvira & Almodóvar 1993). Fernández Pasquier (1990, 2000) highlights water flow regulation and overfishing as causes for the decline of this species in the River Guadalquivir, which eliminated the specimens with the greatest potential before they could spawn.

However, the idea that *A. sturio* is the only Iberian native sturgeon has been challenged by some authors. Garrido-Ramos *et al*. (1997) made a morphometric and genetic analysis of different specimens of sturgeon. Some specimens were subjected solely to morphological analysis, some others solely to a genetic study, and others to both. They measured 25 Iberian specimens from a fishery and several Spanish and Portuguese museums. The morphometry of the snout and relative position of the barbels led the authors to conclude that the two museum specimens prior to the 1900s from the rivers Mondego and Tagus were *A. naccarii*, similar to various specimens from the Guadalquivir (two museum specimens and five of which only data collected on the date of capture was available). Other specimens from the Guadalquivir, as well as those from the Ebro and the Miño would be *A. sturio*. The genetic analysis first determined that the HindIII DNA satellite was specific to *A. naccarii* and it was absent in *A. sturio*. By studying some specimens (not all from the morphometric analysis, only four were a match, one of them from a fish farm), Garrido-Ramos *et al*. (1997) concluded that the Guadalquivir specimens preserved at the collection of the Doñana Biological Station - CSIC, dating 1974 and 1975 (specimens EBD 8173 and EBD 8174) were *A. naccarii*. Hernando *et al*. (1999a,c) made a morphological and cytometric study of some of these and other specimens. They proposed that *A. naccarii* and *Huso huso* were native to the Iberian Peninsula. Based on the work by Garrido-Ramos *et al*. (1997) and some classical studies that mentioned the presence of *A. naccarii* in the Iberian Peninsula (1818-1956), Domezain *et al*. (1999) proposed a plan for the recovery of the *A. naccarii* in the Guadalquivir River.

Contrastingly, by reviewing the historical bibliography on the presence of sturgeons in the Iberian Peninsula, Almaça & Elvira (2000) concluded that *A. sturio* was the only native species, considering the mentions of *A. naccarii* in Portuguese rivers to be erroneous. Additionally, Elvira & Almodóvar (1999) made a morphometric analysis of around 20 specimens of sturgeon preserved in different museums in Iberia and compared them with a specimen of *A. sturio* from Central Europe, four of farmed *A. naccarii* and 24 specimens of *A. baerii*. They concluded that all the museum specimens were *A. sturio*, which would be the only native sturgeon in the Iberian Peninsula.

Ludwig & Kirschbaum (1998) consider that the morphological and genetic analysis performed by Garrido-Ramos *et al*. (1997) had important limitations. The morphological analysis could also be affected by morphological differences that may exist between farmed, wild and museum specimens. Other researchers have also pointed out that certain morphological features of sturgeons may undergo changes after death depending on the preservation method employed (Artyukhin & Vecsei, 1999). In addition, some morphological characteristics may have a small reliability due to variations along sturgeon growth (Loy *et al*., 1999; Doukakis *et al*., 2000; Elvira & Almodóvar, 2000a). Furthermore, using measurements associated with snout length is discouraged (Debus, 1999), although Hernando *et al*. (1999b) considered them as valid parameters in a study involving *A. naccarii* from two fish farms. Ludwig & Kirschbaum (1998) proposed that mitochondrial 12S ribosomal

DNA sequences could be a useful marker to discriminate between the two species.

Subsequently, a study by Doukakis *et al*. (2000), which involved three independent laboratories (New York, Berlin and Madrid), was unable to amplifying DNA from three museum specimens of the Guadalquivir River (including the two identified as *A. naccarii* by Garrido-Ramos *et al*., 1997). In fact, results were occasionally contradictory results, classifying the same specimen as belonging to more than one species. Doukakis *et al*. (2000) thus stated that they could not replicate the study by Garrido-Ramos *et al*. (1997) since these authors did not describe the methods used. Using different methodologies and different genes, they were unable to replicate reliable DNA material. One risk of using museum specimens for DNA analysis is the existence of artefacts and contaminants in them, owing to the display or storage methods that may have been used. They consider that the samples might be contaminated. In a new study, Ruiz-Rejón *et al*. (2000) confirmed that HindIII mitochondri-al DNA is unique to *A. naccarii* and *A. baerii*, and does not appear in *A. sturio*. They consider that *A. sturio* has followed an independent evolution to the previous species (in addition to *H. huso*, which is closely related to the genus *Acipenser*). With the confirmation of the difference in HindIII mitochondrial DNA, although they did not re-examine the Guadalquivir specimens, they sticked to the conclusions of their earlier study (Garrido-Ramos *et al*. 1997), presenting *A. naccarii* as a native species to the River Guadalquivir. Ruiz-Rejón *et al*. (2000) considered that Doukakis *et al*. (2000) were unable to obtain DNA due to the fact that they used the PCR technique instead of cloning DNA extracts, as they did in their 1997 research, indicating that the laboratories would have amplified contaminants. In this regard, a co-editor of the volume of the Bulletin of the Spanish Oceanographic Institute, where the essay by Ruiz-Rejón *et al*. (2000) was published, added a note stating that the authors have still not provided reliable proof that the DNA extracted from specimen EBD 8173 was not a contamination, and they have neither considered nor refuted the new morphological data of other authors that classify the specimens as *A. sturio*. Ruiz-Rejón *et al*. (2000) also cite the works of Hernando *et al*. (1999a, 1999c) to support their conclusions that the Guadalquivir specimen EBD 8173 was *A. naccarii*. A second note by the co-editor of the volume of the Bulletin of the Spanish Oceanographic Institute points out that both of the mentioned papers do not provide details or information on measurements of erythrocytes and that the authors cannot state for certain that the process of preservation has remained the same over the years and has not affected the measurements taken. The co-editor also highlighted that no measurements or statistical data had been provided in the aforementioned works, therefore, their conclusions are not reliable.

In a work on the genetics of *A. sturio* and *A. oxyrinchus*, Birstein & Doukakis (2000) provided an overview of the controversy surrounding the presence of *A. naccarii* as a native species of the Iberian Peninsula, and criticise that previous approaches were not replicable because the methodology was not described. Additionally, Garrido-Ramos *et al*. (1997) were counting on the fact the HindIII DNA satellite was unique to *A. naccarii*, but its presence has been subsequently detected in other sturgeon species (Ruiz-Rejón *et al*., 2000; De la Herrán *et al*., 2001; Fontana *et al*., 2001; Robles *et al*., 2004), although not in *A. sturio* or in *A. oxyrinchus*. Birstein & Doukakis (2000) consider that further proof would be required before the claim of the nativeness of *A. naccarii* in Iberia could be accepted, and they did not discard the possibility of a contamination in the study under discussion. This, along with the existence of other morphological and molecular studies that did not support the conclusions of Garrido-Ramos *et al*. (1997), led Birstein & Doukakis (2000) to consider that *A. sturio* is the only sturgeon native to the Iberian Peninsula.

Elvira & Almodóvar (2000a) conducted a new morphometric analysis on 31 specimens of *A. sturio* from various museums. This expanded the previous study by the same authors (Elvira & Almodóvar 1999), which included specimens from the

River Guadalquivir classified as *A. naccarii* by Garrido-Ramos *et al*. (1997). The analysis confirmed that all the specimens examined were *A. sturio*. The study criticized Garrido-Ramos *et al*. (1997) for not including two distinct characteristics in their diagnosis that would differentiate between the two species, i.e. i) the presence of rhombic plates in cross-lines between the dorsal scutes in *A. sturio* (Figure 1), as opposed to small grainy or plain or star-shaped plates in *A. naccarii*, and ii) the number of gill rakers, which have non-overlapping ranges. By studying these characteristics in the controversial specimens (EBD 8173 and EBD 8174), it was determined that they were indeed *A. sturio*, refuting the conclusion of Garrido-Ramos *et al*. (1997). Elvira & Almodóvar (2000b) further expanded their morphological study to include 42 specimens from 21 Portuguese and Spanish collections, as well as collections from Germany and Italy. They compared them to 21 specimens from other *A. sturio* populations (11 from the North Sea and 10 from the Adriatic Sea) and 16 *A. naccarii* specimens. The analysis of these specimens, including two from the Guadalquivir and two from Portugal previously classified as *A. naccarii*, confirmed that all of them were *A. sturio* species based on the scute patterns. According to Elvira & Almodóvar (2000b), this confirms once again that the only species of Iberian sturgeon present in zoological collections is *A. sturio*.

A study by Almodóvar *et al*. (2000) sought to establish a valid method to extract DNA from museum samples. In addition to characterising and identifying with molecular methods Iberian *A. sturio* specimens, including one of the debated Guadalquivir specimens (EBD 8174) and specimens from other areas in Europe (stuffed, preserved in ethanol, freshly caught), and other sturgeon species (*A. naccarii* from fish farms and *A. baerii* caught in some rivers in the Iberian Peninsula, and from which fresh DNA material was taken). They were able to create a protocol for the extraction and amplification of cytochrome b DNA sequences, achieving a long sequence of 402 base pairs (obtained in all the fresh specimens) and a short segment of 155 base pairs, which is the final part of the long sequence (obtained from the 3 museum specimens stuffed or preserved in ethanol). This study found 26 zones of polymorphism (due to change in base pairs) in the long sequence between the three species of sturgeon under study, whereas the short sequence had 16 polymorphic sites. Four genotypes were identified for Cyt-b, one for *A. sturio*, one for *A. naccari* and two for *A. baerii*. This analysis identified EBD 8174 as *A. sturio*, as its sequence was identical to the specimens from the Gironde River (the lower section of the Garonne), the North Sea, and the Adriatic Sea. This result reinforced the idea that *A. sturio* would be the only species of sturgeon native to the Peninsula, in agreement with the conclusions of morphometric and meristic studies on museum specimens.

Rincón (2000a, 2000b) re-examined the morphological data of Garrido- Ramos *et al*. (1997) and data from eight more specimens of *A. naccarii* from fish farms, and found some methodological problems related to the effect of the preservation techniques used in the museum specimens, typographical errors in the data, and not accounting for the effect of allometric growth. He considered that there was no morphological evidence to prove that *A. naccarii* is native to the Iberian Peninsula.

In an additional effort to shed light on the controversy, the Laboratory of Molecular Ecology of the Biological Station of Doñana (EBD-CSIC) performed a study on the identification of sturgeons from the River Guadalquivir from museum samples (Gasent-Ramírez *et al*. 2001). This study highlighted the difficulties of extracting DNA from museum samples due to preservation techniques, in addition to the possible problems arising from contamination. The team once again analysed the controversial specimens EBD-8173 and EBD-8174. Strict safety measures were implemented to avoid contaminations, and the work was performed in two separate laboratories, with the pre- and post-PCR procedures separated in space and time. They amplified three mitochondrial DNA fragments that could be used for phylogenetic comparisons with the previously published sequences of *A. sturio* and *A.*

naccarii, using independent replicates to validate the results. EBD-8174 was univocally identified as *A. sturio*, but all attempts to amplify DNA from EBD-8173 failed, arguably to the degradation of genetic material.

All the works that support the hypothesis that *A. naccarii* is native to the Iberian Peninsula were summarised in a PhD thesis (Domezain 2003), which reiterated the results obtained, and the conclusions reached, and concluded that *A. naccarii* had a distribution ranging from the Adriatic to the French Atlantic (at the mouth of the Gironde). The thesis defended that *A. naccarii* populations should be recovered, and proposed a recovery plan for the Guadalquivir River (Domezain 2009).

In a new study of museum specimens of sturgeon from the Guadalquivir and from Italy, De la Herrán *et al.* (2004) and Garrido-Ramos *et al.* (2009) concluded that the distribution of *A. naccarii* expanded beyond the Adriatic. They found HindIII sequences, which they deemed exclusive to *A. naccarii* (a fact denied by Birstein & Doukakis, 2000), in specimens from the Guadalquivir and in an Italian specimen (classified in collections as *A. sturio*). In specimen EBD-8174 they found that mitochondrial DNA classified it as *A. sturio*, as pointed out in earlier studies (Almodóvar *et al.*, 2000, Gasent-Ramírez *et al.*, 2001), but that nuclear DNA classified it as *A. naccarii*. The authors thus concluded that the specimen is a *A. sturio* × *A. naccarii* hybrid, and claimed that the second species is also native to the Iberian Peninsula. Consequently, the historical distribution of *A. naccarii* would extend from the Adriatic to the Iberian Peninsula, and the authors defended that this species should be included in sturgeon conservation programmes in Western Europe. Additionally, Garrido-Ramos *et al.* (2009) found that a sturgeon specimen captured in the River Ebro in the 18th century was classified as *A. oxyrinchus*. Therefore, they proposed that this species, also found in the Baltic Sea and Northern Europe, would also be native to the Iberian Peninsula.

Desse-Berset *et al.* (2008), Pages *et al.* (2009), and Brosse *et al.* (2009) analysed archaeological remains from the Rhône (France) using both morphological methods and genetic analysis of cytochrome-b in mitochondrial DNA. They only found remains belonging to *A. sturio*, concluding that this was the only species present in this river. These authors also performed an analysis of museum specimens of sturgeon captured in the Rhône or along the French coast, locating 12 specimens that were formerly classified by morphometric methods. One specimen caught in 1876 in Nice was classified in 1997 by Vasil'eva as *A. naccarii*. This does not allow concluding that there might have been sympatry between the two species of sturgeon in the Rhône, as only one *A. naccarii* specimen was caught, it was caught at sea (not in the river), and it may have been a young wanderer (something that has been observed in sturgeons). The authors also point out that the specimens being more than a century old are often deteriorated, without barbels and with many deformations (of the snout, among others), which makes it difficult to carry out a correct taxonomic determination based on morphological criteria.

Ludwig *et al.* (2009a) studied all available remains of sturgeon from 12 archaeological sites in the Iberian Peninsula. They indicate that there are few sturgeon remains in Iberian digs, possibly due to the lack of rivers with flows suitable for this species. Their morphological and molecular study of the remains covers a period of 11000 years, until the 15th century. Both methods classified all samples as *A. sturio*. Given these results, they were unable to find proof of the presence of other sturgeon species in the Iberian Peninsula, although the low number of samples was an acknowledged limiting factor.

Robles *et al.* (2010) analysed (previous and some new) results of a study of eight molecular markers in historical samples of sturgeon, including a 19th-century specimen from the University of Granada, three specimens from the River Guadalquivir between the 70's and 80's from the EBD-CSIC and prehistoric samples (remains of scutes in

archaeological digs dating 12000 years ago in the Caves of Nerja and of 1500 BCE in Ronda Vieja). The eight markers identified the specimen from the University of Granada as *A. sturio*. According to five markers, two of the EBD-CSIC specimens were *A. naccarii*, while the third specimen (EBD-8174) was a mixture and was defined as *A. naccarii* by three nuclear markers, and as *A. sturio* by four mitochondrial markers. This suggested, as mentioned previously, that it is a hybrid specimen. Hybridisation among sturgeons is not infrequent and different examples of hybridisation between various species in different places have been mentioned (Ludwig *et al*. 2009b). Among prehistoric samples, authors could only analyse DNA from the mitochondrial 12S gene marker from the scute from Ronda Vieja, identified as *A. naccarii*. However, this marker is not exclusive to this species but is shared with other species of sturgeon (*A. gueldenstaedtii*, *A. baerii*, *A. persicus* and *A. nudiventris*). The authors deemed necessary to perform further research in order to have a more complete vision of the distribution of different species of sturgeon in Western Europe.

Aguayo *et al*. (2012), in a study on the consumption of sturgeon in prehistoric and protohistoric communities, re-analysed the morphological features of the scute from the Ronda Vieja, concluding that it belonged to *A. naccarii*. However, Desse-Berset (2011a) pointed out that dermal scutes are less reliable for morphological discrimination than cranial bones. On the other hand, it must also be highlighted that in their comments, the authors point out that the Ronda site is located far away from the zones where the fishes (sturgeon and other fish such as dogfish and snapper) would have been obtained, which would mean that their presence is due to trade and barter, which would involve the existence of problems in its conservation and transportation. It would mean that these big fishes would have been cut into smaller pieces and subjected to some sort of processing, in order to explain their presence on this site. Amphoras were found in similar strata at the site of Ronda Vieja that appeared to have held remains of fish (in salt perhaps), and proofs has also been found in different sites (Phoenician, Sardinian, etc.) which demonstrate the existence of salt-cured fish and other preserved fish in Mediterranean containers and amphoras. The authors considered that the samples from the site of Ronda Vieja may have come from Atlantic areas such as Cádiz, not mentioning the possibility that the preserved fish may have come from greater distances.

The aforementioned study by Desse-Berset (2011a) found morphological characteristics in the bones and scutes that helped to discriminate three species of sturgeon (*A. sturio*, *A. oxyrinchus* and *A. naccarii*). Upon analysing the archaeological remains, she found that the first two species appeared to be present in the remains from Atlantic rivers, but the remains from the Mediterranean basin were only those of *A. sturio*. The existence of the *A. naccarii* in the western Mediterranean basins could not be proved in that work.

A study by Chassaing *et al*. (2011) found five possible nuclear markers to differentiate *A. sturio*, *A. oxyrinchus* and *A. naccarii*, although the fact that only one relict population existed for *A. sturio* and *A. naccarii* posed a difficulty in studying intraspecific variation. Notably, the study questioned the use of some of the markers (e.g. HindIII, PstI, 5S rRNA or 18S rRNA) employed in the studies by Garrido *et al*. (1997), Robles *et al*. (1997, 2004, 2005) and some other studies of the same group, indicating that they are not reliable for distinguishing between the aforementioned species.

Desse-Berset (2011b) re-analysed the remains of sturgeon found in different sites in France, after having detected the presence of *A. oxyrinchus* in some sites. This new study confirmed that the only remains found in Mediterranean basins belonged to *A. sturio*, and there was no evidence of the presence of the *A. naccarii*. Remains of *A. sturio* and *A. oxyrinchus* have been found in the Atlantic coasts, the North Sea, and the Channel over a long period of time, cohabiting in certain zones and time periods, therefore both must be considered native, sympatric species, a view supported by

DOI: 10.29094/FiSHMED.2023.002

Thieren *et al*. (2016). Desse-Berset (2011b) also pointed out the specimens of *A. oxyrinchus* of the Baltic basin appeared to have come from Western Europe and not directly from America. Having unearthed the presence of *A. oxyrinchus* in the Atlantic coasts of France and the Baltic Sea, Chassaing *et al*. (2013) performed a study of five archaeological samples (between 1800 and 5000 years ago) and 21 museum specimens (from the 19th and 20th centuries) of the French Atlantic and Channel coasts. They detected the presence of both *A. sturio* and *A. oxyrinchus*, and even found hybrid specimens (in both possible crossings). They also found that some morphological classifications did not match DNA results, which is deemed the result of poor conservation of the discriminant diagnostic characters used.

Elvira *et al*. (2015) reported the capture of an adult female *A. oxyrinchus* in Gijón, northern Iberian Peninsula. The specimen was considered a stray or vagrant, while its eventual birthplace (the Baltic Sea or the northernmost populations of North America) could not be determined.

Ludwig *et al*. (2011) also analysed the presence of sturgeon in the Iberian Peninsula. They considered that *A. sturio* was the only species that could be considered undoubtedly native to the Peninsula. In their view, records of other Acipenseridae species could not be unreservedly confirmed, further arguing that the mere presence of an individual would not constitute conclusive evidence of the existence of a native population, as sturgeons are migratory species that can travel over great distances. With regard to the debate on the presence of *A. naccarii* and its nativeness status, they pointed out that earlier studies had shown that this species is a new post-glacial species from the Caspian Sea, being related to other sturgeon species from that area. They considered that the presence of *A. naccarii* populations in Iberia was highly doubtful.

CONCLUSIONS

The scientific evidence obtained by researchers and compiled in the literature reviewed here allow us to state that *A. sturio* is the only sturgeon species native to the Iberian Peninsula (Figure 2), with confirmed breeding populations until the second half of the 20th century. The presence of *A. oxyrinchus* in the river Ebro is not confirmed, and there is only known a stray or vagrant adult female on the coast of the northern Iberian Peninsula.

Further evidence is required to prove the native character of *A. naccarii* in the Iberian Peninsula. Although some studies have shown that the species could have been recorded in rivers outside the Adriatic basin, the presence of isolated individuals does not constitute enough proof to consider that there have been viable populations. In light of the many performed studies, *A. naccarii* cannot be considered native to the Iberian Peninsula. The fact that *A. naccarii* is a critically endangered species should not justify the implementation of conservation programmes for this sturgeon in the Iberian Peninsula.

AUTHOR CONTRIBUTIONS

Both authors performed the review and co-wrote the text.

AKNOWLEDGEMENTS

This study has been carried out within the framework of the agreement between the Government of Navarre and the Iberian Society of Ichthyology, as part of the actions of the project of the convention the Information and Governance European project LIFE17 GIE/ES/000515 entitled 'Aquatic Invasive Alien Species of Freshwater and Estuarine Systems: Awareness and Prevention in the Iberian Peninsula (INVASAQUA)'.

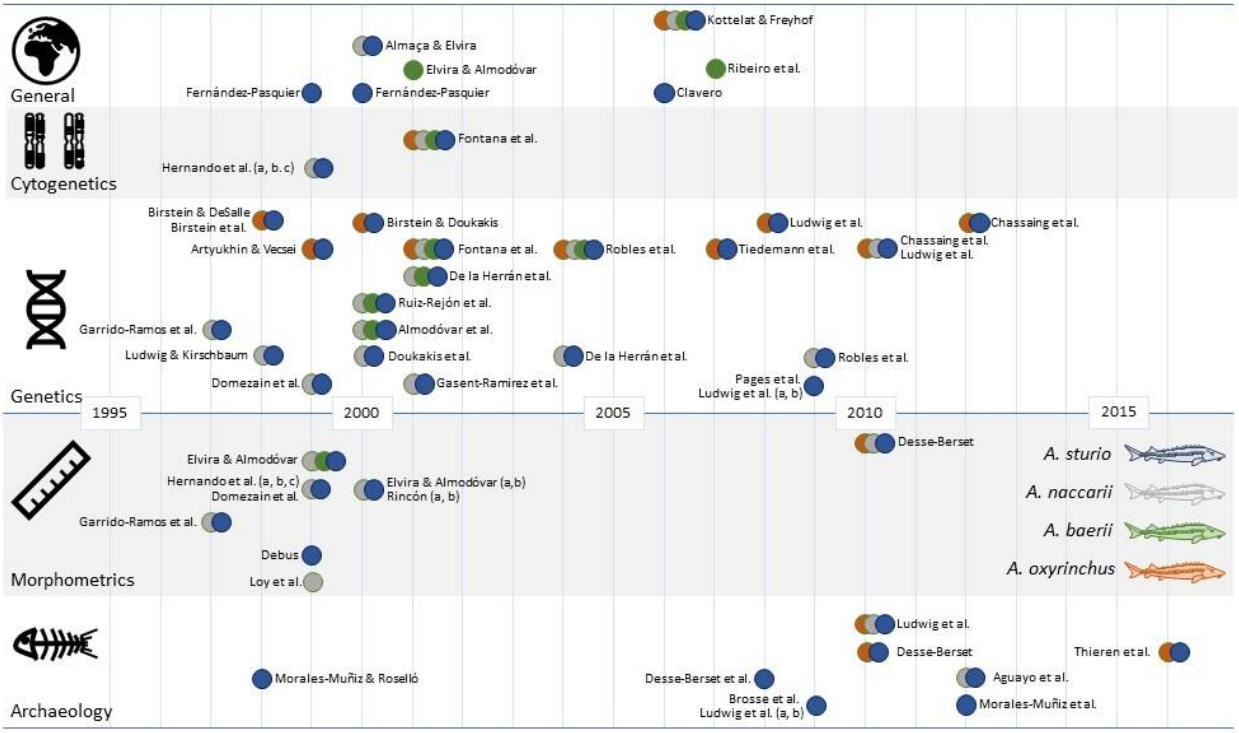

Figure 2. A timeline of publications on *Acipenser* sturgeons in the Iberian Peninsula, noting the approach (general, cytogenetics, genetics, morphometrics, archaeological) and the species addressed (see colour code)

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