

Distribution and conservation of *Acipenser sturio* L., 1758 and related species in Greek waters

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ABSTRACT

Four sturgeon species have been reported to exist in Greek waters: the Atlantic sturgeon, the great sturgeon, the stellate sturgeon and the Adriatic sturgeon. The Atlantic sturgeon *Acipenser sturio* L., 1758 has an almost regular presence in the Evros River (Aegean Sea), and is rather rare in the Pinios and Acheloos Rivers. The great sturgeon or beluga *Huso huso* L., 1758 is suspected to be an occasional visitor in Greek waters, or it is a case of undocumented information. The presence of the stellate sturgeon *Acipenser stellatus* Pallas, 1771 has been recently verified by a specimen caught close to the Thracian shore. The Adriatic sturgeon *Acipenser naccarii* Bonaparte, 1836 is supposed to have its southern distribution limits in the waters around the island of Corfu, although this information has never been confirmed. The distribution of these species is obviously related to salinity, probably prohibiting the extension of other sturgeon species to the Mediterranean, except for *A. sturio*. The discontinuous distribution of *H. huso* and *A. stellatus* may be a result of sea-level changes, while salinity played some role in the last period of glaciation. In the marine area of the Evros River *A. sturio* has been economically significant until 1975, supporting a small black caviar industry. Since then, the species has become rare mainly because of overfishing, and the reduction and pollution of the Evros River, in the upstream of which some important sturgeon spawning sites have been located.

Key words: *Acipenser naccarii*, *Acipenser stellatus*, *Huso huso*, production, conservation status, Greece.

RESUMEN

Distribución y conservación de Acipenser sturio L., 1758 y especies próximas en aguas griegas

Cuatro especies de esturiones han sido citadas en las aguas griegas: el esturión atlántico *Acipenser sturio* L., 1758, el beluga *Huso huso* (L., 1758), el esturión estrellado *Acipenser stellatus* Pallas, 1771 y el esturión del Adriático *Acipenser naccarii* Bonaparte, 1836. El esturión atlántico *A. sturio* tiene una casi regular presencia en el río Evros (mar Egeo), y es bastante raro en los ríos Pinios y Acheloos. El beluga *H. huso* se sospecha que es un visitante ocasional de las aguas griegas, o es un caso de información indocumentada. La presencia de esturión estrellado *A. stellatus* ha sido recientemente verificada con un ejemplar capturado cerca de la costa tracia. El esturión del Adriático *A. naccarii* se supone que tiene sus límites meridionales de distribución en las aguas alrededor de la isla de Corfú, aunque esta información nunca ha sido confirmada. La distribución de estas especies está obviamente relacionada con la salinidad, impidiendo, probablemente, la extensión de otras especies de esturiones en el Mediterráneo, con excepción de *A. sturio*. La distribución discontinua de *H. huso* y *A. stellatus* puede ser el resultado de cambios en el nivel del mar, mientras que la salinidad desempeñó algún papel en el último periodo glacial. En el área marina del río Evros, *A. sturio* ha sido económicamente significativo hasta 1975, soportando una pequeña industria de

caviar. Desde entonces, la especie ha llegado a ser rara, principalmente a causa de la sobrepesca y la reducción y contaminación del río Evros, en cuya parte superior se localizaban importantes lugares de freza para el esturión.

Palabras clave: *Acipenser naccarii*, *Acipenser stellatus*, *Huso huso*, producción, estado de conservación, Grecia.

INTRODUCTION

It is generally accepted (Berg, 1948) that the watersheds of the Black and Caspian Seas comprise the most important areas in the world for the speciation of sturgeon. Few of these species, especially those unable to tolerate the higher salinities of seas such as the Mediterranean, have the ability to move far away from their dispersion centres. *Acipenser sturio* L., 1758 is obviously such a species, which apparently attracts the greatest attention in the many European countries where it is encountered. However, other sturgeon species are also found in some eastern European areas, and they are also in need of study and conservation measures. Additionally, because of the great confusion in the determination of many historical specimens and their citation, it is necessary to clarify this matter before any major study can proceed. Therefore, an overview for Greece is useful, because there is a contact with the main dispersal zone of the different sturgeon species, four of which have been reported in Grecian waters.

Since early historical times, a plethora of information on sturgeon has appeared in the books of many classical Greek authors (Thompson, 1947). This became even more frequent when ancient Greek colonies became involved in a number of important economic activities around the Black Sea shore, which continued up to the late Byzantine period, even during the Ottoman Empire. Information about species of these fishes in the Greek seas, such as the Aegean and Ionian, has been rather poor. Avoiding any literate approach, the information given by Atheneus (2nd-3rd century A.D.) concerning a much valued fish, for which Rhodes was celebrated, seems to be interesting. This was "a kind of short sized and large snout *akkipisios* (sturgeon) with a rather triangular shape". This description led Cuvier to think of the little sterlet *Acipenser ruthenus* L., 1758 which has not, however, entered the Mediterranean

(Thompson, 1947). Furthermore, as was pointed out by Georgacas (1978), many products, especially around the Black Sea, derived from the treatment of fish ovaries have kept names of Greek origin (e.g. caviar and botargo) to the present.

For the present study we have used previous original but contemporary references, usually poorly documented, as well as some new material.

MATERIALS AND METHODS

Some morphometric characteristics of three *A. sturio* specimens, collected by Economidis (1974) from the Evros River (Aegean Sea) and stored in the fish collection of the School of Biology of the Aristotle University, have been used. The morphology and measurements of *Acipenser stellatus* Pallas, 1771 presented below are based on a rather immature male specimen caught recently close to the Thracian shores and deposited in the fish collection of the Fisheries Research Institute of Nea Peramos (Kavala). All measurements and counts are made according to those proposed by Holčík, Banarescu and Evans (1989) for sturgeon taxonomy. Standard length (SL), fork length (FL), predorsal distance (pD), head length (lc) and body depth (H) are calculated as % of the total length (TL, mm), while head depth at nape (hc), head depth at center of eye (hco), distance between tip of snout and mouth (s-m), distance between tip of snout and cartilaginous arch of mouth (s-mc), distance between base of barbels and cartilaginous arch of mouth (b-mc), length of barbel (lb) and width of mouth (lam), as well as width of snout at base of barbels (lab) are calculated as % of the head length (lc). Dorsal (SD), lateral (Sl) and ventral (SV) scutes, dorsal (D) and anal (A) fins and branchial spines (Sp.br) are counted separately. The rest of the material included in this paper comes from literature collected for historical overview purposes.

RESULTS

Species records

The sturgeon species have been known in the Greek language from ancient times under several names: *akkipisios* (ακκιπίσιος, ancient name), *xyryhi* (ξύρυχι, ancient name: οξύρυγχος), *mourouna* (μουρούνα), *stourioni* (στουριόνι). According to Economidis *et al.* (2000), three sturgeon species, *Acipenser baerii* Brandt, 1869, *Acipenser gueldenstaedtii* Brandt & Ratzeberg, 1833 and *Acipenser ruthenus*, have been introduced in Greek waters (mainly Lake Pamvotis), while the four species discussed below are reported as native.

Acipenser sturio L., 1758

As is well known, the species has the largest distribution among all the other species of Acipenseridae in the European watersheds (Holčík *et al.*, 1989). In the Greek seas and freshwater catchment, the species was reported off Corfu (Apostolidis, 1883, 1907); in the rivers flowing into the Thracian Sea, such as Evros (table I), both on the Greek and the Bulgarian sides (Kovatchev, 1921; Konsuloff and Drensky, 1943; Drensky, 1948, 1951; Berg, 1948; Belloc, 1948; Stancovic, 1960; Economidis, 1973, 1974); Strymon (Drensky, 1948, 1951; Belloc, 1948; Stancovic, 1960); and in the estuaries of the Pinios River, in Thessaly (Panagiotopoulos, 1916; Athanassopoulos, 1917). Belloc (1948), in his monograph on fishery research in Greek waters, also mentions the presence of the species in the Gulf of Euboikos, in Peloponnesia, on the western coasts of Greece and off Corfu. Furthermore, the presence of the species in the estuaries of the Acheloos River has been confirmed by material deposited in the zoological collections of the University of Patras. It also has a rather regular occurrence along the Turkish coasts of the Aegean Sea (Geldiay and Balik, 1988) and in the Adriatic and Albanian watersheds, mainly in Lake Skadar (Poljakov, Filipi and Basho, 1958;

Vuković and Ivanović, 1971; Ivanović, 1973; Rakaj, 1995).

Acipenser naccarii Bonaparte, 1836

The presence of this species in Greek waters, along its northwestern shoreline (mainly the island of Corfu), still remains undocumented. The first record for Corfu is from Heldreich (1878), who was not an ichthyologist, but a botanist. Some years later Apostolidis (1883) claimed that *A. sturio* lived off Corfu, a piece of information he repeated later (Apostolidis, 1907). None of these two authors' reports were based on actual fish material. Carus (1893), perhaps following Heldreich, listed the species as present off Corfu. The same is also true for Berg (1933), and more recently for Tortonese (1989). Despite the fact that the species could appear around the waters of Corfu, mainly close to the nearby estuaries of the Thyamis River, it seems that all of the above references are undocumented, because they are not based on actual material, and the confusion with *A. sturio* is very probable. Nevertheless, although rarely (Svedovidov, 1984; Tortonese, 1989), the species is present in the Adriatic Sea (Berg, 1933; Vukovic and Ivanovic, 1971), mainly on the eastern shore (Tortonese, 1989), and especially in Albanian waters, around Lake Skadar (Poljakov, Filipi and Blasho, 1958; Rakaj, 1995). Rakaj (1995) reports two specimens from Buna-Skadar.

Acipenser stellatus Pallas, 1771

The most recent approach (Shubina, Popova and Vasiliev, 1989) considers the species as having a regular distribution in the Black and the Caspian Seas, and on the Adriatic coast at Zadar, while its presence in the watershed of the Aegean Sea is disputable. This is based on older references, mainly from Berg (1933, 1948). Concerning the Aegean Sea area, Berg (1948) claims that "individual specimens some-

Table I. Measurements (in mm) of the three Atlantic sturgeon specimens *Acipenser sturio* (after Economidis, 1974). Fish collection of the School of Biology of Aristotle University (Thessaloniki)

Total length Tl	Dorsal Du	Anal Au	Branchial spines Sp.br.	Dorsal scutes SD	Lateral scutes SL	Ventral scutes SV
410-485	36-43	23-26	18-20	13-14	34-38	11-12

times penetrate the Maritza (Evros)". Drensky (1948, 1951) notes that the species is present in the Maritza River, where it does not enter so far (up to Svilengrad?). The species has been reported by Stanković (1960) as also living in the Evros and Strymon Rivers, while Geldiay and Balik (1988) have traced it on almost all the Turkish coasts of the Aegean Sea. On the other hand, the species seems to have a certified presence in the Albanian watershed of the Adriatic, since Rakaj (1995) mentions three specimens from the Matit River.

All of this confusion has been definitely clarified by the confirmation of the presence of the species in the Thracian Sea (North Aegean Sea) after the catch on 20 March 1999 of one specimen at a depth of about 1-2 m, near the village of Fanari (figure 1). This specimen was a rather immature male of 476 mm TL, with a snout 60 % larger than its head length (figure 2). It is deposited in the fish collection of the Fisheries Research Institute of Kavala. Measurements are given in table II.

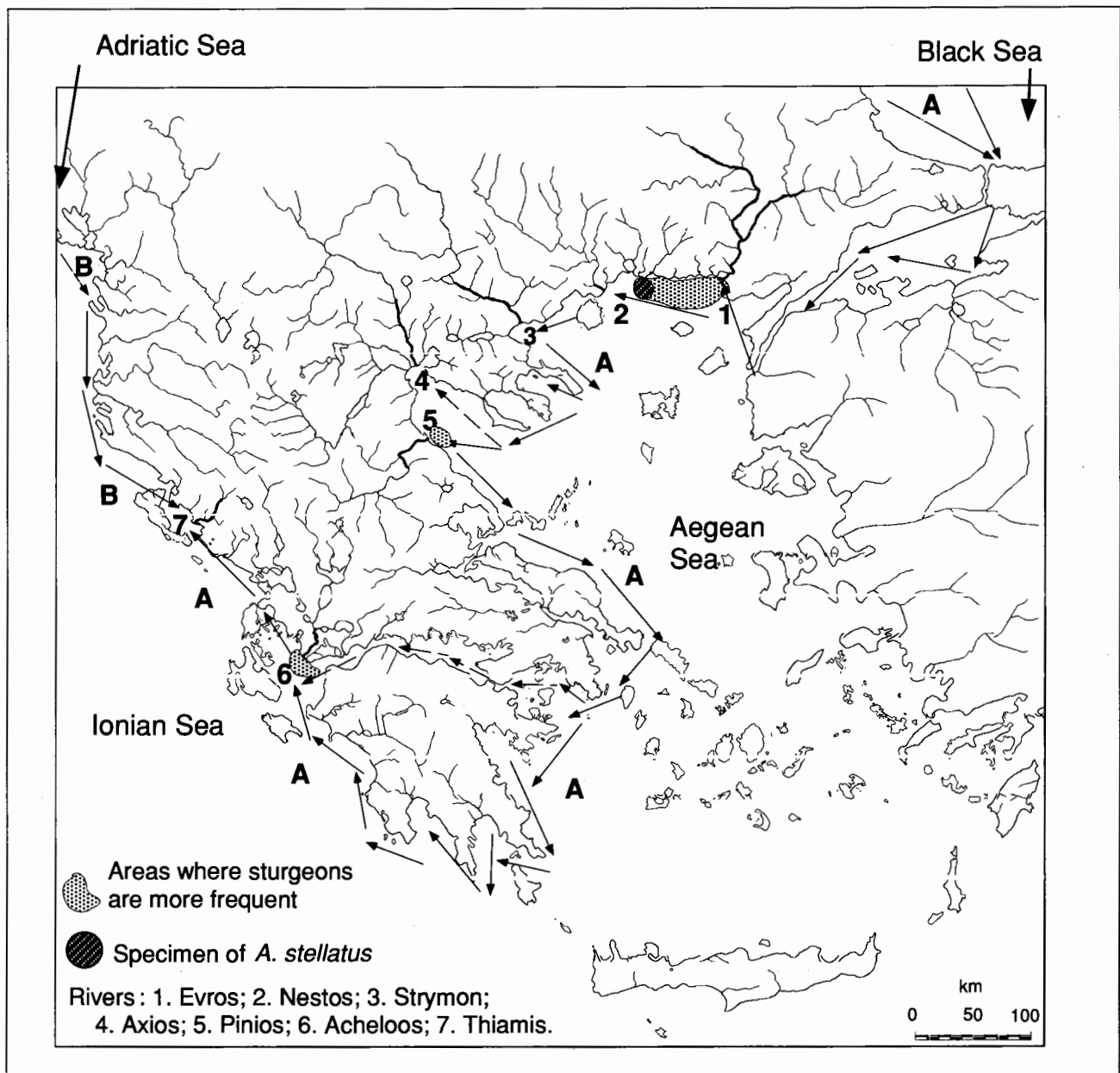


Figure 1. Dotted areas indicate where sturgeon are more frequent, black hatched circles mark sites where *Acipenser stellatus* was caught. Arrows mark putative migration route: (A): of *Acipenser sturio* and eventually *A. stellatus* and *Huso huso*; and (B): of *Acipenser naccarii*

Table II. Measurements (in mm) of a stellate sturgeon *Acipenser stellatus* specimen caught in the North Aegean Sea (after Holčík, Banarescu and Evans, 1989). (*): Fish collection of Fisheries Research Institute of Nea Peramos (Kavala)

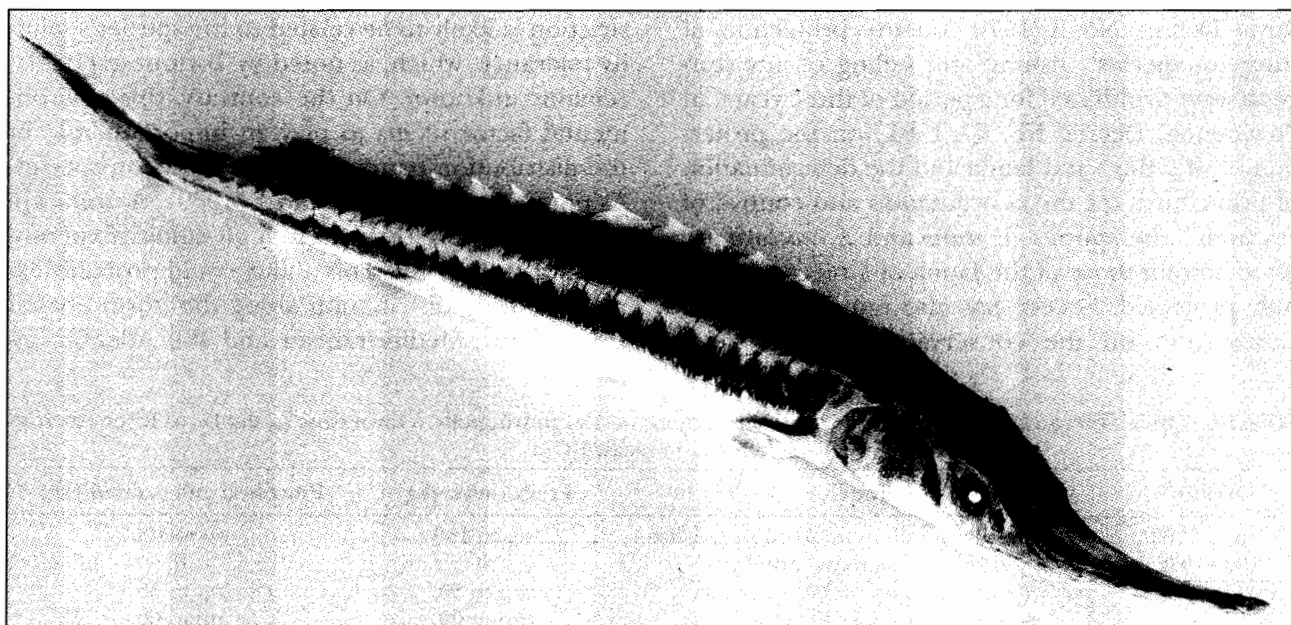
	Total length TI	Standard length SI	Fork distance FI	Dorsal scutes SD	Lateral scutes SL	Ventral scutes SV	Predorsal length pD	Head length lc	Body depth HI	Head depth hc	Head depth hco	Premouth length s-m	Premandible length s-m	Prebarbel length s-b	Postbarbel length b-mc	Barbel length lb	Mandible length lam	Barbel zone width lab
Immature rater male specimen*	476	404	415	13	33-34	11	319	115	45	29	24	81	77	53	24	14	18	24

Huso huso (L., 1758)

According to Pirogovskii, Sokolov and Vasiliev (1989), the species is distributed in the drainage of the Caspian and Black seas and in the Adriatic, as well. This discontinuous distribution is quite peculiar, mainly because the Aegean and Ionian are inserted between the Black and the Adriatic Seas, making the communication between them completely free. It could thus be supposed that the species is an occasional visitor, passing through Greek waters; it cannot stay permanently, because of the higher water temperatures and salinities, as well as the lack of large estuaries. If this were true, it is obvious that such a large fish should be observed rather frequently in the area, and even fished. However, Banarescu (1964) is the only author who regards the presence of the species in the Aegean Sea as probable. Additionally, on the Ladiges and Vogt (1965, 1979) distribution map the species is traced (in black) with no documentation along the shoreline of Greece. Concerning the

distribution of the species in the Adriatic, there are many records of its presence along the coast (Berg, 1933, 1948; Vuković and Ivanović, 1971; Svedovidov, 1984; Pirogovskii, Sokolov and Vasiliev, 1989; Rakaj, 1995). Rakaj (1995) reports two specimens from Albanian waters (Drin River at Lezhâ), while Geldiay and Balik (1988) do not trace the distribution of the species along the Aegean shoreline of Turkey. All of this information strongly suggests that the species probably has a discontinuous distribution between the Black and the Adriatic Seas, as is also the case of some other euryhaline fish.

Several records of sturgeon catches in Greek waters have appeared in newspapers or market reports. Apparently, they cannot be validated because they confuse the species. Two such cases are, for instance, the catch of a specimen weighing about 40 kg near the Acheloos River estuary (6 February 1984), and another very recent catch, inside the Evros River delta, of a non-preserved or examined specimen, weighing about 3 kg (29 June 1999).

Figure 2. Specimen of *Acipenser stellatus* caught on the Thracian shore (north Aegean Sea)

Production

Sturgeon have high market demand for consumption as fresh meat and for the production of black caviar. Regarding the latter, it is noteworthy that in the past a number of artisanal enterprises producing small quantities of black caviar operated in several areas of the Aegean Sea. According to Potamianos (1965) and Marsellos (1973) the main centres of such production were the estuaries of the Evros River in Thrace (Alexandroupolis) and the estuaries of the Pinios River in Thessaly (Tsagezi). Belloc (1948) reports that before World War II the annual production of sturgeon in Greece was about 10 t, and the production of black caviar about 2-2.5 t. After the war, production declined dramatically due to irrigation works in the rivers (e.g. dams and channels), overfishing, and pollution of the water, mainly in the Evros River, which is the most important area for sturgeon in the Aegean Sea. The watershed of this river is shared by three countries (Greece, Bulgaria, Turkey); consequently, any activity in it is practically out of control. According to Georgacas (1978), the last registered catches of sturgeon and black caviar production were as shown in table III.

Conservation status

Sturgeon are protected by the Greek State by a set of restrictions and conservation measures. With Royal Decree No. 1/1970 "on the protection of sturgeon species", fishing and selling of any sturgeon were prohibited for a period of three years. In Presidential Decree No. 67/1981 "on the protection of wild flora and fauna and the determination of procedures for the coordination and control of research", the species *A. sturio* and *A. naccarii* are listed among those of the fauna of Greece that are fully protected. Greece has also ratified the Bern Convention on the conservation of European

wildlife and natural habitats, where *A. sturio* and *A. naccarii* are also included. Due to the continuous decline in the *A. sturio* population, the IUCN Red List of Threatened Animals considers it as "critically endangered". It has also been placed in the lists of the CITES (1973), the European Red List of Globally Threatened Animals and Plants, and Annex II of the 92/43/EEC Habitats Directive, which was also ratified by Greece (December 1998).

It seems that this set of measures was quite effective, because sturgeon began to appear more frequently in the Greek seas, especially in their main distribution area, the Evros River and its estuary. Consequently, it is necessary for these appearances to be registered, and for any caught specimens to be kept alive for further study.

DISCUSSION

The species *A. sturio* and *A. stellatus* are frequent in Greek waters, the former historically mostly around the estuaries of the country's larger rivers, the latter at the moment only in the Thracian Sea (North Aegean), close to the estuary of the Evros River. The distribution of *H. huso* and *A. naccarii* in Greek territorial waters still remains doubtful. In the case of the latter species, it should be noted that no serious reasons exist preventing its presence south of the Greek coasts along the Ionian Sea. This, however, could only be proved by catching some live specimens. The only probable restriction is likely to be related to the species's salinity tolerance, which, as noted by Tortonese (1989), remains unknown. On the contrary, this environmental factor seems to play an important role in the distribution pattern of other sturgeon species. As pointed out by Holčík *et al.* (1989), *A. sturio* appears to be more resistant to high salinity than other sturgeon species. This ability could probably explain its wide distribution along the north coastal zone of the Mediterranean and the Atlantic, in

Table III. Annual fish catch and caviar production of sturgeons in Alexandroupolis, a town close to the Evros River estuaries (after Georgacas, 1978)

Years	Individuals	Fresh caviar (kg)	Processed and canned (kg)
Up to 1969	12 individuals, weight up to 40 kg per fish	up to 150	up to 100
1970-1972	Sturgeon fishing was prohibited	0	0
1973	5 individuals up to 35 kg per fish	up to 50	up to 35
1974	8 individuals up to 40 kg per fish	up to 90	up to 60
1975	9 individuals up to 45 kg per fish	up to 120	up to 90

cluding the Black and Baltic Seas. Regarding the other species considered here, Pirogovskii, Sokolov and Vasiliev (1989) note that *H. huso* survives at salinities as high as 22 ‰, and Shubina, Popova and Vasiliev (1989), based on studies done in the Black and Caspian Seas, underline that *A. stellatus* is not dependent on any particular salinity, and both adults and juveniles are encountered in a wide range of salinities from 0.1-13.5 ‰. It can thus be explained that, apart from *A. sturio*, which can survive and migrate easily to high- or low-salinity areas, the other species obviously have difficulties in controlling their osmoregulation when confronting the Mediterranean waters. Apart from such factors as the very dense traffic in large ships to and from the Black Sea across the straits of the Dardanelles and Bosphorus, the pollution in many watersheds of the Black and North Aegean Seas, and overfishing, the only other species which can migrate from one sea to the other is perhaps *A. stellatus*. If such movements are presently possible, they should follow the Greek shoreline, mainly near estuaries (figure 1). Nevertheless, it would be more convenient to accept the view that the Adriatic stocks of *H. huso* and *A. stellatus* have been separated from those of the same species of the closely-related Black Sea stocks since the end of the last glaciation. During this time, the two stocks were isolated because of the progressive salinity increase in the southern parts of the Mediterranean, combined with the lack of major estuaries and the elevation of the sea level. If this is true, then any genetic approach to these stocks could essentially contribute to our knowledge. The population of *A. stellatus* in the north Aegean Sea may be an interesting intermediate one.

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