BIOLOGICAL ASPECTS OF MAIN MARINE MIGRATORY STURGEONS IN ROMANIAN DANUBE RIVER

MIGRATION OF FISHES IN ROMANIAN DANUBE RIVER, № 4

A. CIOLAC* – N. PATRICHE
*e-mail: andrei.ciolac@ugal.ro, npatriche@xnet.ro

"Dunarea de Jos" University of Galati, Fishing and Aquaculture Department,
Domneasca Street, 47, Galati 6200, Romania
Phone: +40-236-415641; fax: +40-236-401353
**Corresponding author*

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Abstract. Marine migratory sturgeons form one of the most valuable fish population of the Lower Danube River ecosystem and are also extremely important for the economy of Romania and some other riverside countries and freshwater fisheries. Decreasing sturgeon presence in the last several decades has been a true concern either for commercial fishermen and biologists. This paper is trying to analyze some biological aspects of three sturgeon species: beluga (*Huso huso* Linnaeus, 1758), Russian sturgeon (*Acipenser guelden-staedti* Brand, 1833) and stellate sturgeon (*Acipenser stellatus*, Brandt, 1833) and to compare them with formerly registered data and scientific information. This paper also tries to reveal some ecological particularities concerning their migration and natural reproduction process that could help scientists and other people to find the most probable causes of the tendency why stocks are decreasing and suggesting some pertinent actions to be done on the necessary mitigation and protection activities concerning actual and further presence of these very interesting sturgeon species in Danube River.
Keywords. *Danube River, migratory sturgeons, biology, migration, biometric data*

Introduction

Ones of the most interesting fish species in Europe from both scientific and commercial point of view are marine migratory sturgeons that swim up for reproduction to Danube River. Scientists are interested in them because sturgeons are considered among the most ancient fish species inhabiting the waters of the world. They appeared in the Upper Cretaceous, were very abundant in Devonian, but presently only two families exist: Acipenseridae and Polyodontidae, which altogether include 25 species. Because of the worldwide tendency of decreasing stocks some biologists believe that most of the sturgeon species are on their natural way to extinction [6] others consider the changes in their natural environment – especially in spawning places – and overfishing being the main causes of the evident decline of the populations of these fishes [5]. Fishing of sturgeons, from commercial aspects, is still a good business for interested investors, especially because of the high price of caviar and also a profitable activity for local communities of fishermen that depend mainly on fishing for their living. That could be one of the reasons of the actual tendency of accelerated decrease in the number of sturgeon populations which concerns both biologists, fishermen and other people involved in collateral activities in this matter. The present paper tries to bring up some bio-ecological aspects related to migration process of three marine sturgeon species in Lower Danube to compare them with formerly registered data and scientific information, to find the most probable causes of the decreasing of the stocks and suggesting some pertinent actions on the necessary mitigation activities and better management of this fishery.

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Materials and methods

In 2000 and 2001, several expeditionary fishings have been performed, in order to collect samples from different locations on the Romanian sector of Lower Danube River. Most of them took place in the middle of migration seasons in the fall and spring, some also in extra-season, focused mainly on places known as preferred sturgeon spawning sites as km 102–103, km 155, km 186, km 231, km 399 and accidentally between km 772–779.

In order to obtain specific data for different locations, the following sectors have been pointed out on Danube River in which we have collected several samples: sector 0: Danube Delta to km 73; sector I: km 73 to km 155; sector II: km 155 to km 231; sector III: km 231 to km 309; sector IV: Borcea Danube Branch and Bala Danube Branch.

For collecting the samples specialized fishing gears as drift bottom gillnets and appropriate boats operated by two or three fishermen have been used.

The sample has been sexed by morphological characteristics such as presence or absence of carved linear hollow on the stellate sturgeon male abdomen and the general characteristics and size of the abdomen. Several individuals were dissected later for having exact evidence of sex and also to determine the stage of the maturation of gonads, gonad mass ratio and the absolute or theoretical prolificacy.

A total number of 117 sturgeon individuals have been caught and investigated (23 of beluga, 57 of stellate sturgeon and 37 of Russian sturgeon).

Other biometrical characteristics which have been registered: total weight with 0.1 kg accuracy, total length with 0.1 cm, and gonad mass with 0.001 kg accuracy. The age of fish was determined from the degreased fine cross-section of the first pectoral ray in a laboratory in case of every caught individual.

Results

Marine migratory sturgeons have been caught in Danube River all around the year but the most abundant captures were registered during the periods of migration: fall and spring. It is supposed therefore, that water level and seasonality also have an important impact on the number of sturgeon spawners coming into Danube River from Black Sea.

Mainly, spring migration starts when water temperature is constantly higher than 4 °C and fall migration regularly begins when the temperature is less than 23 °C. Optimal intervals of temperature for spawning are a bit different according to each species' biology: beluga (10–17 °C), Russian sturgeon (15–21 °C) and stellate sturgeon (17–23 °C).

Beluga

Huso huso Linnaeus, 1758 (beluga) is the migratory sturgeon that swims up into the Danube River just for reproduction. Older individuals prefer an earlier migration in spring season which actually starts in the winter months. Medium sized (middle-age) individuals migrate mainly in fall, while younger spawners at the end of spring.

Biometric data in *Table 1*. represent the measured characteristics of every single caught and investigated individual. Data show that beluga individuals weighted from 40–140 kg, with lengths of 178–286 cm and ages from 11–21 years old.

Females average gonad mass ratio has been generally no more than 9.5% by increasing to 11.5–13.0% for the individuals caught in the eve of the reproduction time and more than 15% to a maximum of 17.93% for the individuals investigated in the spawning season (regularly from mid-April to May).

The male : female ratio (M : F) was favorable for the males (average M : F = 0.44). In fact, for all species of sturgeons studied M : F has been significantly above this value.

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Absolute prolificacy has been extremely variable depending on the age and size of the females, from 0.24 to 3.2 million roes (frequently 0.3–0.9 million roes), the calculated average of absolute prolificacy for all caught female being 0.506 million roes. The evaluated theoretical prolificacy at the last stage of the maturation of gonads was between 29 and 32 roes per gram meanwhile the diameter of the roes were of 3.6–3.7 mm.

Theoretically the best reproduction sites should be in the deep area of Danube River (8–20 m deep) and hard bottom formed by gravel or sand such those of higher sector of Romanian Danube River. A few similar places could be found also upstream at Calarasi Town. Even when optimal conditions are missing, belugas are very likely reproducing also on different spots on the whole lower zone of Danube River, between 0 and 400 km.

Russian sturgeon

Acipenser gueldenstaedti Brand, 1833 (Russian sturgeon) migrates upstream Danube River in the fall and spring but the most important season takes place during the spring months (March–May) rather than fall (September–October). The spring migration may last till late June and because this species is well adapted to fresh water, few biologists consider that some biological forms of Russian sturgeon remain all year long in Danube River [3]. Russian sturgeon adult individuals use almost the same sites for spawning places as beluga.

Absolute fecundity has been between 0.04–0.4 million roes with the average of 0.14 million per female. Theoretical prolificacy for the last stage of the maturation was 40.5 roes per gram, the roe diameter being of 3.2–3.3 mm. Females gonad mass ratio differed by season: being 12–14% in October and more than 16% in April with a maximum value of 18.35%.

Table 1. *Biometric data of all beluga individual caught in Romanian Danube River during the 2001 expeditionary fishing campaign*

fish	fishing	sex	age	total length	total weight	gonad weight	gonad mass
1		F	23	286	145	21	14.48
2	sector 0	M	11	175	40	0.5	1.25
3		M	11	180	45	0.6	1.33
4		F	16	214	80	12	15
5	sector I	M	15	220	75	2.5	3.34
6		M	12	178	50	1.0	2
7	sector II	M	19	237	90	3.1	3.45
8		F	21	250	120	19	15.83
9		F	21	256	125	12.5	10
9		M	15	220	75	1.7	2.26
10	sector III	M	19	240	80	3	3.75
11		M	15	212	65	1.5	2.3
12		M	18	235	82	3.2	3.9
13		M	12	175	50	1.0	2
14		F	21	250	117	19	16.2
15		F	23	260	140	20	14.28
16		F	17	202	115	18	15.65
17		M	18	220	85	2.5	2.94
18	sector IV	M	11	175	45	0.6	1.33
19		M	20	240	90	3.5	3.89
20		M	13	215	68	2	2.94
21		M	14	217	70	2	2.85
22		M	19	245	98	3.5	3.57
23		M	12	195	60	1.5	2.5

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Table 2. *Average values of main biometric data calculated on beluga age classes*

age (years)	total length (cm)		total weight (kg)		gonad weight (kg)		gonad mass ratio (%)	
	males	females	males	females	males	females	males	females
11	176.6	NA	43.3	NA	0.66	NA	1.30	NA
12	125.7	NA	53.3	NA	1.17	NA	2.17	NA
15	217.7	NA	71.2	NA	1.93	NA	2.69	NA
17	NA	214.0	NA	97.5	NA	15.00	NA	15.32
19	237.0	NA	90.4	NA	3.30	NA	3.63	NA
20	240.0	NA	90.5	NA	3.5	NA	3.89	NA
21	NA	250.5	NA	125.5	NA	17.87	NA	14.25
23	NA	260.0	NA	145.1	NA	25.8	NA	17.93

NA = not available

Table 3. *Average values of some biometric data on stellate and Russian sturgeon (age in years, M = males, F = females)*

age	*stellate sturgeon*								*Russian sturgeon*							
	total		total		gonad		gonad		total		total		gonad		gonad	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
4	70.0	NA	3.0	NA	0.08	NA	2.4	NA	—	—	—	—	—	—	—	—
5	78.0	NA	3.5	NA	0.15	NA	4.3	NA	—	—	—	—	—	—	—	—
6	85.5	NA	4.2	NA	0.12	NA	3.2	NA	—	—	—	—	—	—	—	—
7	90.2	NA	4.5	NA	0.15	NA	3.5	NA	67.5	NA	5.1	NA	0.15	NA	1.2	NA
8	92.7	97.3	5.2	6.2	0.18	0.98	3.0	16.5	107.2	NA	7.0	NA	0.15	NA	2.2	NA
9	113.0	125.8	5.4	7.1	0.12	1.16	2.4	16.4	109.1	NA	6.6	NA	0.15	NA	2.3	NA
10	118.7	127.0	6.1	7.0	0.27	1.23	3.7	16.0	113.3	NA	7.9	NA	0.27	NA	3.5	NA
11	119.0	138.2	6.7	9.5	0.33	1.55	5.2	15.4	117.5	NA	8.3	NA	0.31	NA	3.8	NA
12	126.7	NA	7.4	NA	0.36	NA	4.9	NA	119.0	123.0	7.9	12.4	0.44	2.1	4.3	16.7
13	145.0	148.0	8.0	11.2	0.41	1.81	5.14	16.0	126.5	133.0	10.7	13.8	0.46	2.2	4.6	15.6
14	—	—	—	—	—	—	—	—	135.7	NA	11.7	NA	0.35	NA	3.1	NA
15	—	—	—	—	—	—	—	—	136.0	132.5	12.9	14.8	0.95	2.3	4.2	15.5
16	—	—	—	—	—	—	—	—	NA	141.4	NA	16.5	NA	2.6	NA	15.7
17	—	—	—	—	—	—	—	—	138.0	NA	14.6	NA	0.72	NA	4.9	NA
18	—	—	—	—	—	—	—	—	140.0	NA	15	NA	0.76	NA	5.1	NA
19	—	—	—	—	—	—	—	—	138.0	NA	18.5	NA	0.98	NA	5.3	NA

NA = not available

The M : F ratio has been a little different in the case of Russian sturgeon than by beluga, females being more present in captures (M : F = 0.54) but yet less than males in number. Number of total male individuals was 25, with a relatively uniform distribution in all investigated sectors.

Stellate sturgeon

Acipenser stellatus, Brandt, 1833 (stellate sturgeon) comes upstream for reproducing either in fall or in early spring. It is supposed that individuals that migrate in fall will spawn also in spring because their degree of gonad maturation is inferior to the one of the adults migrating in spring (usually at the beginning of March). The spawning usually takes place at the end of May in deep locations with fast current.

Study of the captured individuals shows that main capture have been represented mainly by small individuals that weighted no more than 6 kg as well as the number of bigger spawners were very reduced: just 9 from 57 (15.8%) individuals weighted more

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than 7 kg, with a maximum weight of 11.2 kg – a single individual caught on main branch of Danube River in Galati City neighborhood.

The estimated female gonad mass ratio was 6.5 to 7.0% for the younger individuals caught in fall and 14.15 to 16.48 for the biggest spawners caught in late May.

Absolute fecundity had a very large range (30 to 180 thousand roes) and theoretical prolificacy at the last stage of the maturation of the gonads was an average of 57.5 roes per gram, the diameter of the roes being no more than 2,4 mm (average: 2.2 mm). M : F ratio calculated for a number of 57 caught individuals was 0.50.

Long time observations demonstrate that stellate sturgeon prefers for spawning almost the same places as the other sturgeons: km 102–103, km 186, km 234–404 and km 772–779 of Danube River.

Collateral study done on 57 individuals in order to establish the nutritional spectrum of all these species of sturgeons has revealed an almost empty stomach to every single fish. This indicates that spawners do not feed themselves in Danube River before their reproduction time or they eat only accidentally. However, nutritional spectrum observations on the juvenile sturgeons (of 10 to 14 cm length) have indicated that they prefer worms and insect's larva (75%) and small crustaceans (25%).

Discussion

The literature relating to sturgeons migration informs that all three studied species of sturgeons migrate for reproduction in the same seasons, but first the Russian sturgeon and stellate sturgeon enter Danube River in March, and beluga starts the migration in April. Also there is information that the minimum value of water temperature that triggers the beginning of the migration should be not less 6 °C [6]. In fact, we have found that the first species that entered Danube River was beluga, in January, when water temperature was 2.5 °C, followed in February, almost in same time by Russian sturgeon and stellate sturgeon. At higher water temperatures – such as registered in May and June – the increased intensity of migration is a common fact for all three species. However, the intensity and length of migration should also closely correlate with the change of water level during spring, summer and the beginning of fall. Higher water levels could be correlated with increased intensity of migration and also to a more successful reproduction and offspring development. It is quite difficult to build a credible estimation of migration intensity only on capture studies because some particularities of fishing sturgeons in Danube River [2]. High and long lasting water level induces an increased migration but also catching difficulties resulting a lower amount of captured individuals. Lower water levels usually mean lower intensity of migration but a relative increased capture due to the easiness of sturgeons fishing in Danube River in the low-water period. Even there is some information about a different biological type [4] that could lay spawn in fall (September–October). Beluga is reproducing certainly in the spring (April–May). Sexual maturity is accomplished at the age of 11–14 years old for the males and 16–18 years old for the females but sometimes it is supposed to be earlier, at about 14–16 years of age. During our expeditionary fishing campaigns we did not find any female younger than 17. Stellate surgeon reaches sexual maturity at different ages: 4–7 years for the males and 8–10 years for the females. There are also some other opinions about the age of reaching full sexual maturity such as 7–10 years for males and 10–14 years females [3] but we have found many females younger than 10 years that accomplished their final stage of gonad maturation and also a lot of male individuals younger than 7 years old. Russian sturgeons sexual maturity age is usually between 8–

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12 years for the males and of 13–15 years for the females. A single male individual that has been caught in Danube Delta zone was sexually mature at the age of 7 as well as two females at the age of 12.

Actual biometric measurements show that there is a very important difference between these data and the registered data of the early 20th century when most of the caught beluga weighted 200 kg to 600 kg with sizes of 3–5 m. That time it was not unusual to find in captures tremendous individuals like the huge beluga of 888 kg caught in 1980 near Sfântu Gheorghe Village [1]. Presently the medium weight of caught belugas were below 150 kg. The largest individual caught in our study was a female of 23 years old weighting just 145 kg. We do not have much very credible earlier data on Russian and stellate sturgeons to compare their average size with the present data, but it is important to show that for all sturgeon species the number of younger mature individuals were higher than older ones. The biological meaning of this interesting distribution on age classes is quite difficult to interprete. It could be a result of some successful reproductions in the last years and also a sign of an incipient but timid tendency of sturgeons stock increasing. Last data on dynamism of sturgeon captures seems to confirm that idea even there is not sure that the fishing effort has remained constant.

Conclusions

The biology of beluga, stellate surgeon and Russian sturgeon that migrate for reproduction in Danube River, is not very well known. There are lacks of information on their behavior in the Black Sea where they grow up and became sexually mature and also not enough or enough credible data about some aspects related to the time spent for spawning in Danube River. There is indirect information about their preferred spots for laying their spawn that it is supposed to be the same area in which they used to crowd, and also about offspring biology either in Danube River or Black Sea. There are not too much biometric data and studies regarding their development and growing up process in their natural environment. We hope that our study could bring out some more aspects on this topic and will be a useful tool for further comparative studies. However, more specialized research including targeting and surveying of evolution of stocks, mortality evaluation and the effect of water pollution on roes and offspring need to be done. Further monitoring activities focused on biological, ecological and fishing aspects should be the key to find the appropriate solution to stop the general decreasing tendency of the stocks of these species.

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