PRELIMINARY RESULTS REGARDING STURGEON BREEDING ON THE ROMANIAN LITTORAL

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ABSTRACT

The action plans for the rehabilitation of the sturgeons populations include the legal protection of species and habitats, trade marks (CITES) and management measures, efforts for the key-habitats recovery (migration routes, reproduction sites), programs for the artificial propagation and repopulation and research activities also.
The sturgeons have many positive characteristics for culture, including the rapid breeding, good conversion of food and the ability to accept high densities. On a worldwide scale, many breeding technologies were developed. The limits of sturgeon culture are due to the long duration of maturation (5-10 years, depending on the species) and the limited disponibility of spawners and juveniles. The promoting of the aquaculture techniques for caviar production and meat represent a way to reduce the pressure by catch for sturgeon natural populations.
The paper presents the preliminary results regarding the experimental breeding for the Beluga *Huso huso* and Russian sturgeon *Acipenser gueldenstaedti* in Black Sea water. The breeding was realized in the experimental base of NIMRD in the period 2005-2007.

KEY WORDS : sturgeons, habitats, repopulation, culture, breding

INTRODUCTION

The sturgeons represent one of the oldest vertebrates on Earth, the discovered fossils having the age of about 250 million years. The sturgeons in Acipenseridae family count 26 species, belonging to 4 genus, from which in the Romanian marine waters were signaled in the last years three species (Beluga *Huso huso,* Russian sturgeon *Acipenser guldenstaedtii,* Stellate sturgeon *Acipenser stellatus*). Most of the species are anadromous or semianadromous: they carry on a big part of their life cycle in marine waters and migrate in fresh waters for reproduction, so they can be encountered in theDanube, up to Bratislava, Vienna and even Regensburg (BILLARD, LECOINTRE, 2001).

Starting with 1970, the migration of the sturgeon species from the Black Sea was interrupted through the building of the Portile de Fier I dam (on Danube, at 942 km). Later, in 1984, by the building of the second dam at Portile de Fier II (at 863 km), a new obstacle in the migration route of these fishes was realized.

Despite the reduction of the historical migration with almost 1000 km and an intense fishing in Serbia, Bulgaria, Romania and Ukraine, the sturgeon populations adapted to the new conditions. The main threats on this group are overfishing and the lack of an adequate protection of the essential habitats for wintering and reproducing (REINARTZ *et al*., 2003).

Even if sturgeon identification is not systematically clear, it is generally accepted that six Acipenseridae species have their origin in Danube's Basin: *Acipenser gueldenstaedti* (Russian sturgeon), *A. nudiventris* (Ship sturgeon), *A. ruthenus* (sterlet), *A. stellatus* (Stellate sturgeon), *A. sturio* (common sturgeon) and *Huso huso* (beluga). Exotic acipenseriform species and hybrids were introduced in ponds and aquaculture systems in Danube's Basin in order to produce caviar and meat. Juveniles of different sturgeon species can also be found in aquariums or pet shops, being sold to persons that have this hobby.

According to the FAO 2002 statistics, in the Romanian waters of the Black Sea, the dynamics of the sturgeons fishing dropped dramatically after 1970. We have to remark that the reported data on these species fishing are most of them wrong, lacking important quantities of sturgeons, illegally commercialized.

In order to conserve and restore the sturgeons stock in Danube, one of the important actions for reducing the fishing pressure on sturgeon populations (REINARTZ *et al*., 2003) is to promote aquaculture techniques for producing caviar and flesh (including possibilities for disseminating the resulted profits through the apparition of new jobs for the local fishermen).

Sturgeon aquaculture for caviar and meat consume was first developed in the ex-USSR. The hybrid named bester (*H. huso* ♀ x *A. ruthenus* ♂) was at the base of this development. Today, the development is based mainly on *A. baerii* and *A. gueldenstadtii*. Starting with 1990, the sturgeons breeding slowly developed in Europe and USA. In the Western Europe, interesting species for aquaculture are *A. transmontanus*, *A. baerii* and *A. nacarii*. Recently, after 1989, in Romania the following species aquaculture started to develop: *A.*

stellatus, A. gueldenstadtii, A. ruthenus, Huso huso, in specialized farms at Galaţi, Isaccea, Tamadau etc.

In Europe, the main producing countries are Italy, Germany and Spain. The European production was in 1999 between 1000 and 1600 tons/year. For the same year, the European caviar production was of 5 - 6 tons, obtained from sturgeons cultivated in the countries mentioned above.

In this context are written our researches on establishing the cultivation possibilities of two important sturgeon species, beluga and Russian sturgeon, at the Romanian littoral, using the marine water.

MATERIALS AND METHODS

Biologic material came from artificial reproductions, developed at Isaccea (property of SC Kaviar House SRL), and constituted of Beluga and Russian sturgeon juveniles, of about 6 months of age. The taking over from Isaccea was made in fresh water, and the transition to marine water was made gradually, through continuous alimentation, at low marine water output.

The breeding basins were represented by:

- 2 interior basins, circular (special tank for sturgeons - 1500 l, with inclined bottom and legs), permanently alimented with marine water and pressured air;
- 1 interior concrete basin (5 x 10 x 1.30 m) intermittently alimented with marine water and permanently with pressured air.

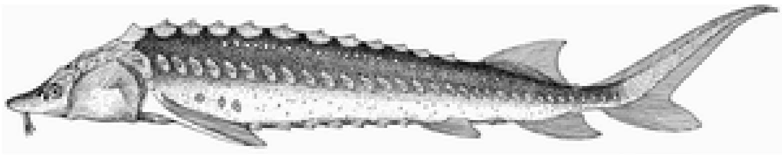
The food was represented exclusively by imported (Danish) granulated nourishment, with supplement in young stages, of larval stages of *Artemia*, breed in marine water, in special devices.

The physical and chemical analyses of the culture water, made during the whole breeding period, were made in the institute's analyses laboratory (accredited by RENAR), by using the standard analyze methods.

RESULTS AND DISCUSSIONS

A short description of the both experimental species is presented below (http://www.fao.org/fishery/species/):

Acipenser gueldenstaedtii (Brandt & Ratzeberg, 1833)



Diagnostic Features

Spiracle present. Snout short and blunt. Gill membranes joined to isthmus. Mouth transverse and lower lip with a split in the middle. The barbells are attached closer to the tip of snout than to the mouth and they are unfimbriated. 15-51 gill rakers, which are not fan-shaped, terminated by a single tip. D: 27-51; A: 18-33 rays. 8-18 dorsal scutes; 24-50 lateral scutes and 6-13 ventral scutes. Between the rows of scutes there are numerous bony plates. The colorations is grayish black, dirty green, or dark green dorsally. Laterally, it is usually grayish brown, and ventrally, grey or lemon. The juveniles are blue dorsally and white ventrally.

Habitat and Biology

In the sea, the Russian sturgeon inhabits shallow waters of the continental shelf; in the rivers it remains at depths from 2 to 30 m. The larvae are found at considerable depths and in rapid currents. Besides the main diadromus form, a freshwater form that does not migrate downstream to the sea has been reported from various rivers. The Russian sturgeon is a bottom-dwelling mollusk-feeder (*Corbulomya*, *Abra*, *Cardium*, *Nassa*). They also readily consume crustaceans (shrimps and crabs) fishes (*Engraulis encrasicolus*, *Sprattus sprattus* and gobies) and polychaetes. The main food items of juveniles are crustaceans, including mysids and corophiids, and polychaetes.

The great majority of the males begin to reproduce at an age of 11 to 13 years, while the equivalent age for the females is 12 to 16 years. In the Volga River, the males requires two to three years to reproduce again after spawning, while the females take four to five years. Usually, the spawning run of this species into the rivers begin in early spring, reaches its peak in mid o later summer and ceases in late autumn. In the Volga River the spawning period extends from mid-May through early June. The spawning sites are gravel or stony beds at depths from 4 to 25 m. Spawning at water temperatures between 8.9º C and 12º C. May reach 3 m, usually 110-140 cm. Reports of 4 m and about 600 kg may refer to *Acipenser sturio*.

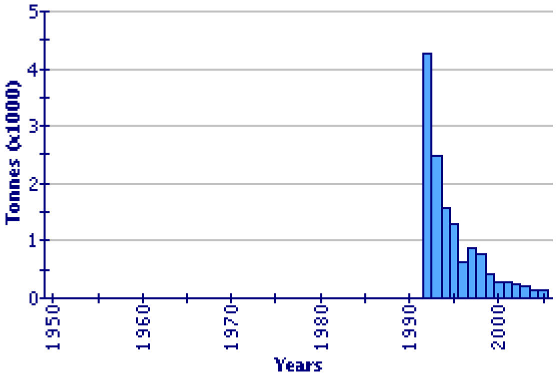
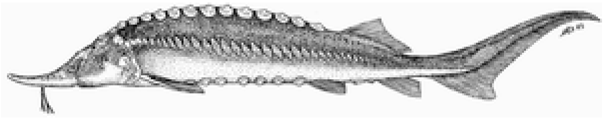


Fig. 1 – Global capture production for *Acipenser gueldenstaedtii*
(FAO Fishery Statistic)

Huso huso (Linnaeus, 1758)



Diagnostic Features

Spiracle present. Snout moderate and pointed, turning slightly upward. Gill membranes joined to one another to form a fold free from the isthmus. Mouth crescent. Lower lip not continuous, interrupted at centre. Barbels oval or flat, leaf-like posterior reaching almost the mouth. 17-36 rod-shaped gill rakers. D:48-81; A:22-41 rays. 9-17 dorsal scutes; 37-53 lateral scutes and 7-14 ventral scutes. Dorsal scutes oval, with a longitudinal denticulate comb. First dorsal scute is the smallest. Lateral scutes smooth. Ventral scutes hidden beneath the skin. There are numerous small bony plates between the scute rows. Back ashen gray or black, gradually transitioning to white toward the underside. Belly white, and the snout is yellowish.

Habitat and Biology

During the period of marine life, the adults mainly inhabits the pelagic zone descending at depths of 160-180 m. During both the seaward and the spawning migration, the beluga usually travels in the deepest parts of the riverbed. Juveniles during the first year of life remain in warmer, shallow habitats. The main food of juveniles appears to be insect larvae, especially of Ephemeroptera, crustaceans (gammarids, mysids, copepods, and cladocers). Beluga begins preying on fishes , at a very early age (with a length of 24 cm in the lower Danube). Preferred prey items are *Alosa* spp., *Engraulis encrasicolus*, cyprinids (*Cyprinus*, *Leuciscus*, *Scardinius*, and *Aspius*). Marine fishes, such as *Scomber scombrus*, *Trachurus mediterraneus ponticus* and *Sprattus sprattus* are important in it diet between May and September, when the beluga are congregating near the coast prior to entering rivers; during the autumn and winter they descent into deep regions of the sea and feeds mainly on *Mullus barbatus ponticus*, *Merlangius merlangus euxinus*, *Platichthys flesus flesus* and *Engraulis encrasicolus*.

First sexual maturity is reached by the great sturgeon very late. Most males of the Volga population mature at 14-16 years; most females reach this stage at 19-22 years. Subsequent spawning apparently begins at least 5 years later. The great sturgeon spawns far upstream in all rivers. Spawning period usually coincides with a high-water period in spring and begins at a water temperature of 6° to 7° C, and it ceased when the temperature reaches 21° C. The spawning sites are usually in the river bed, at a depth of 4 to 15 m, with a hard, stony or gravelly bottom; the hatchlings at an early age travel to the sea.

Maximum size: about 6 m and a weigh exceeding 1000 Kg. Lengths of 8 m and weights of 3200 kg have been reported, but they raise doubts. Usually 120-260 cm and to 363 kg.

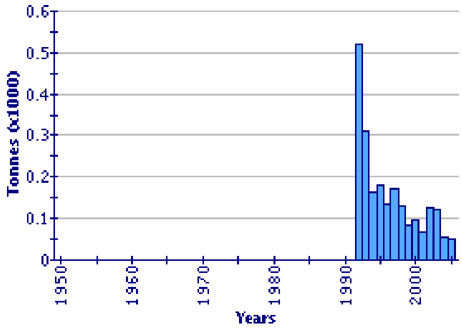


Fig. 2 – Global capture production
for *Huso huso*
(FAO Fishery Statistic)

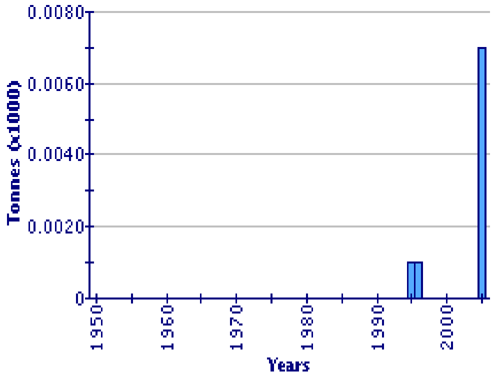
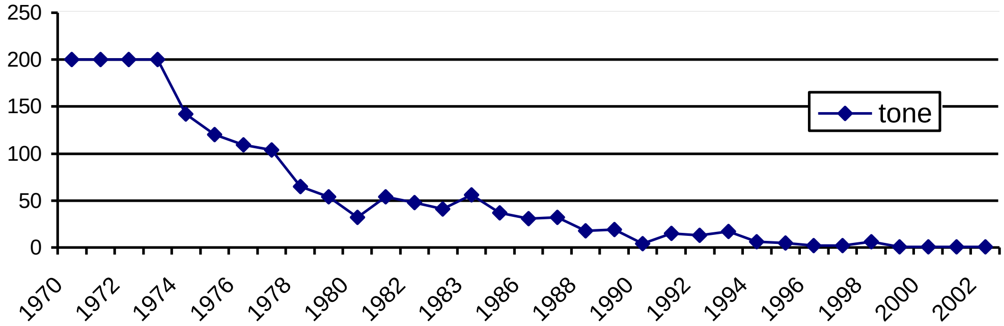


Fig. 3 – Global aquaculture production
for *Huso huso*
(FAO Fishery Statistic)

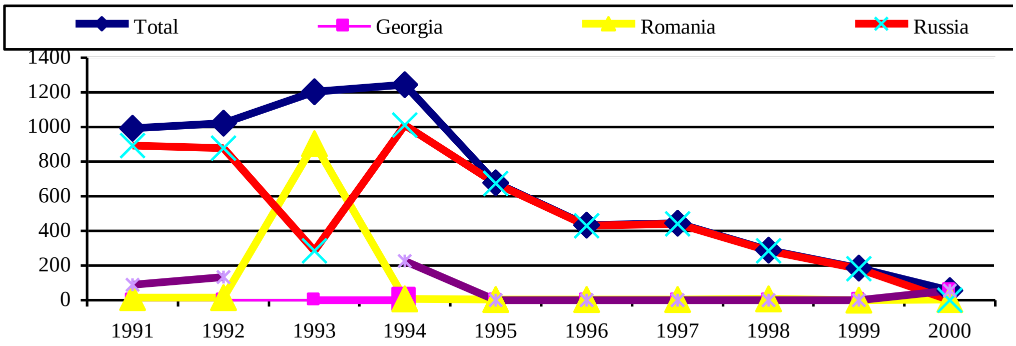
According to the FAO statistics, 2002, in the Romanian Black Sea waters the dynamics of sturgeon fishing, between 1970 and 2002, experienced a dramatic drop, following the 1970's (Fig. 4). We must underline the fact that the data regarding the fishing of these species are, in most of the cases, wrong, as large quantities of illegally commercialized sturgeons are being omitted.

Figure 4 - Dynamics of Sturgeon Fishing in the Romanian Black sea Sector, between 1970 and 2002 (FAO, 2002)



All the riverain countries take part in the exploitation of these crucial fishing resources of the Black Sea, of which the Russian fleet is the most important (Fig. 5).

Figure 5 - Dynamics of Sturgeon Fishimg in the Romanian Black sea Sector, between 1991 and 2000 (FAO, 2002)



There is a high demand for caviar. This, along with concern that sturgeon habitat is being altered, caused to be added in 1998 to the Appendix II list of the United nation's Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). This CITES listing restricts the import export of sturgeon products of the Romania unless a CITES permit is obtained through the Ministry of Environment and Sustainable Development.

In Romania, beginning with 2006, was banned the sturgeon fishing throughout the Common Order of Minister of Environment and Water Management and Minister of Agriculture, Forests and Rural Development, throughout the commercial fishing of sturgeon is banned for 10 years and were sustained the programs for the reproduction and repopulation of the Danube with the sturgeon juveniles (Order nr. nr.262/330/2006).

In these conditions, sturgeons aquaculture represents the only viable way in Romania, both for obtaining caviar and flesh for consume and juveniles.

The term aquaculture represents the producing (or breeding) with the aim of obtaining a production and the products destination.

In this sense, worldwide, the aquaculture of the sturgeons comprehends four categories:

- producing alevins and juveniles for sustaining the natural (wild) stocks;
- producing alevins and juveniles for producing adult individuals, for direct human consumption;
- ex-situ conservation, a particular form of conservation (conservation of the patrimony and diversity);
- breeding a species as biologic model which will allow the development of a methodology designated to be applied on one or many species when experimentation is not possible.

In sturgeons aquaculture some important limitations exist. The delivering of the reproducers and juveniles is limited. The growing up period is long, at least of 8 years, until the female produces caviar. The sturgeons require medium temperatures (20 - 26 ºC for an ideal growing) and an intense supply with good quality water. Generally, the facilities for sturgeons breeding are intensive, with expensive tanks, which demand an important capital investment. The existing information is quite limited, each producer protecting his business carefully, so the data on the culture requirements are little.

This is the reason why every breeder must establish his own necessities concerning sturgeons' aquaculture, in tight correlation with the place possibilities, water supply, juvenile supply and granulated food, etc.

In our experiments, we started with the possibilities offered by the Romanian shore: huge resource of marine water, unused until present for aquaculture, the existence of some land surfaces where the needed facilities can be located, the existence of working force with the corresponding degree of qualification (mainly from the former fish farms), the existence of some nurseries that produce sturgeon juveniles (fated mainly or the national repopulating program), the existence on the market of the specific granulated food, etc.

The transport of the juveniles, having an initial average weight of 225 g/individual for Russian sturgeon (38.2 cm/individual), and 342 g/individual for beluga (45.87 cm/individual) was made using a car, in polyethylene bags, with oxygen supplement. The equalization of the water temperature was needed, and an initial prophylactic bathing was made (Photo 1).

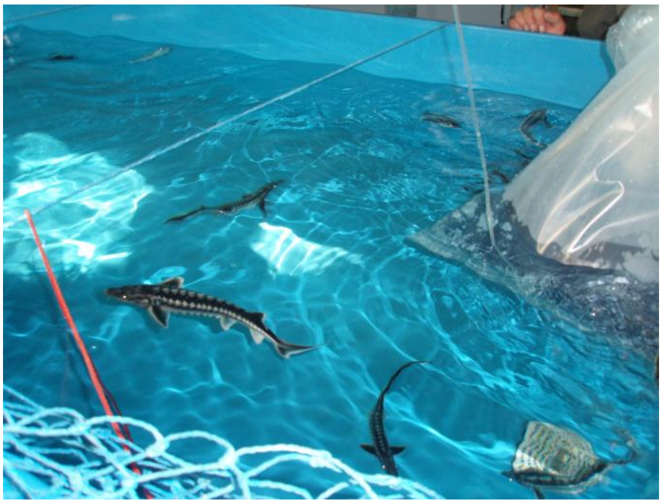


Photo 1 - Temperature equalization after transport (photo NIMRD)

After launching in the interior basins, the progressive supply with marine water was begun, at low flow (1 l/min), so the total renewal of the water was made in 48 hours (Photo 2).

Photo 2 - Interior tank for sturgeon breeding (photo NIMRD)

Two days after transportation, the distribution of the granulated food was recommenced, twice a day, with a ratio of about 1.5 – 3% of the body weight, according to water temperature and fish size. Supplementary, in the first three months of breeding in marine water, *Artemia* sp. nauplia and metanauplia (Salt Lake, USA - origin) were distributed, from a culture of 1.5 – 2 eggs/1 water litre (Photo 3). They were given micro – algae, also obtained from cultures (*Tetraselmis suecica* species– Photo 4).

Photo 3 - Installation for obtaining *Artemia* sp. nauplii (photo NIMRD)

Photo 4 - Microalgae cultures (photo NIMRD)

The granulated food was of Danish origin, with the following biochemical composition: proteins 15%, carbohydrates 21%, and cellulose 2.5%. The vitamins composition was vitamin A - 2500 IU/kg, vitamin E - 1400 mg/kg. The nourishment had as base: fish flour - 42%, soy flour - 5%, fish oil - 7.2%, soy oil - 2.3%. For the entire growing period, a food conversion coefficient of 0.98 was obtained, for the both species.

Photo 5 - Exterior basin for sturgeon breeding (photo NIMRD)

The maintaining in the interior basins was carried up until the beginning of June 2006 (19 months of growing, fish age of 25 months); at this date, the fishes were transferred in the exterior basins, where they have been maintained until July 2007 (another 13 months of growing, final fish age of 38 months - Photo 6). During the experiment period the survival was of 100% for both species.

The quality of the culture water was permanently monitored, through physical and chemical analyses, made in NIMRD laboratory, RENAR accredited. During the experiment, the water parameters varied in large limits, some overtaking were recorded, especially for the organic substance and ammonic - nitrogen, in correlation with the damages at the marine water pumping station.

Photo 6 - Harvest fishing (July 2007 - NIMRD)

Table 1

The values of the physical and chemical parameters of the culture water in the breeding basins of Russian sturgeon and Beluga (Nov. 2004 – July 2007)

T **^{0}C**	**Salinity PSU**	**PH**	**O_2 Cm^3**	**O_2 %**	**Subst.org. mgO_2/l**
2 - 28	15.34 - 18.09	7.6 - 8.2	2.75 - 9.44	112.6 - 123.1	2.08 - 12.16
P-PO_4	**P total**	**Si-SiO_4**	**N-NO_3**	**N-NO_2**	**N-NH_4**
0.01 – 1.06	0.05 – 0.09	0.20 – 2.69	0.05 – 1.57	0 – 1.57	0.03 – 2.46

The survival rate was of 100% for both species, during the whole experiment. The biomass and length growing of the two studied species, for the whole experimenting period (November 2004 - July 2007 - 32 months) was relatively uniform, but with better results for Russian sturgeon, even if the initial length was bigger for beluga (Fig. 6 and 7).

The relative robustness or degree of well-being, of a fish is expressed by “coefficient of condition” (also known as condition factor, or length-weight factor). Variations in a fish coefficient of condition primarily reflect state of sexual maturity and degree of nourishment. Condition values may also vary with fish age, and in some species, with sex.

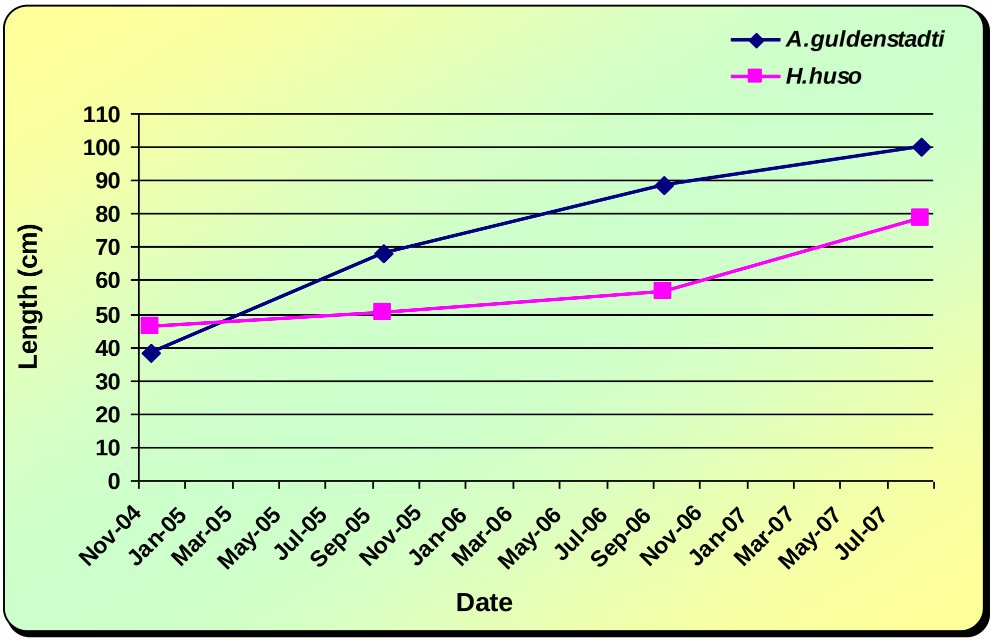


Fig. 6 - Length growth for Russian sturgeon and Beluga bred in Black Sea marine water

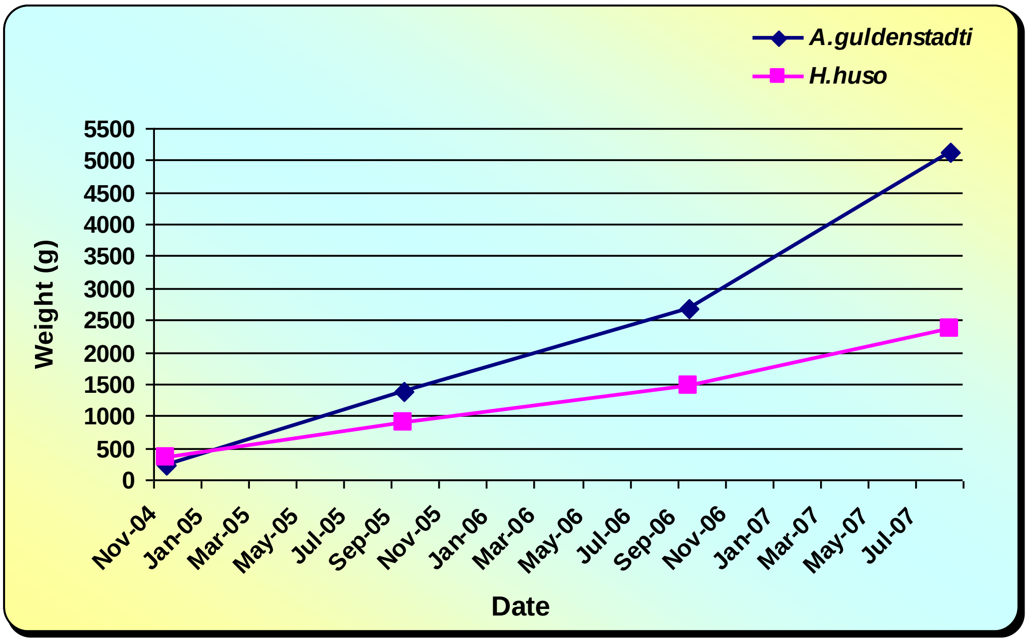


Fig. 7 - Biomass growth for Russian sturgeon and beluga breed in pontic marine water

The coefficient of condition has usually been represented by the letter *K* when the fish is measured and weighed in the metric system (WILLIAMS, 2000). The formula most often used is:

$$K = \frac{100{,}000\ W}{L^3}$$

Where: *W* = the weight of the fish in grams;

L = the standard length of the fish in millimeters

At the beginning of the experiment, the correlation between biomass and length indicated similar condition factors for both species:

- Russian sturgeon: $Ki = \frac{100{,}000 \text{ x } 225}{3850^3} = \frac{22500000}{57066625000} = 3{,}94 \text{ e}^{-4}$
- beluga: $Ki = \frac{100{,}000 \text{ x } 342}{4587^3} = \frac{34200000}{96513090003} = 3{,}54 \text{ e}^{-4}$

At the end of the experiment, the condition factor is still better for Russian sturgeon:

- Russian sturgeon: $Kf = \frac{100{,}000 \text{ x } 5120}{9985^3} = \frac{512000000}{995506746625} = 5{,}14 \text{ e}^{-4}$

- beluga: $Kf = \frac{100{,}000 \text{ x } 2370}{7883^3} = \frac{237000000}{489862934387} = 4{,}83 \text{ e}^{-4}$

The correlation between the biometric characters (length and mass) for the two species indicates a liniar growth for the Beluga during the entire period of the experiment, while the Russian sturgeon, even if initially it has a higher mass, this advantage was lost as a consequence of a lower growth rate. (Fig. 8 and 9).

CONCLUSIONS

The experiments that took place between Nov. 2004 and July 2007 followed the breeding of two valuable sturgeon species (Beluga and Russian sturgeon) in Black Sea water;

The experiments developed in the experimental base of NIMRD, the breeding being made both in interior and exterior basins;

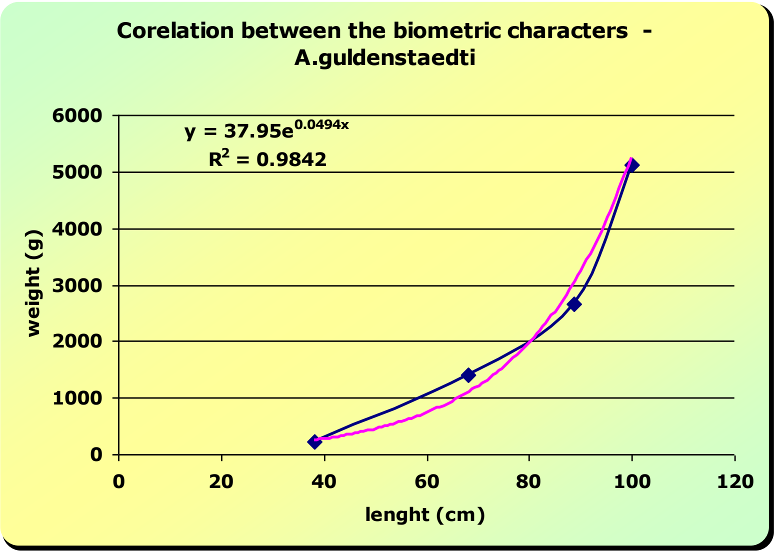


Fig. 8 – Correlation between biometric characters for *A. guldenstaedti*

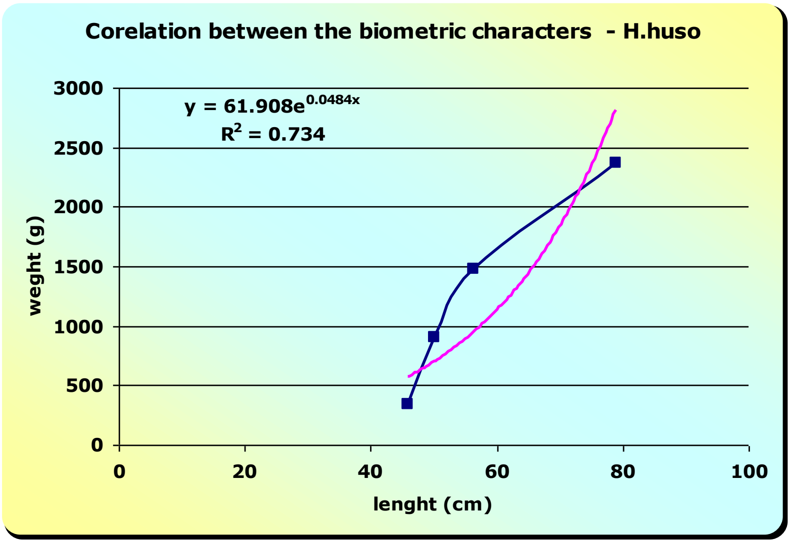


Fig. 9 – Correlation between biometric characters for *H. huso*

The juveniles came from the fresh water nursery (Isaccea, Tulcea), the passing to the marine water was made gradually;

The biomass and length growing of the two studied species, for the whole experimenting period (November 2004 – July 2007 – 32 months) was relatively uniform, but with better results for Russian sturgeon, even if the initial length was bigger for beluga. The survival rate was of 100% for both species, during the whole experiment. For the entire growing period, a food conversion coefficient of 0.98 was obtained, for the both species. Our experiments prove the capacity of beluga and Russian sturgeon to adapt to breeding in marine water, even from the age of six months;

Today, other experiments regarding the comparative breeding of Russian sturgeon in marine and fresh water are being carried out.

Acknowledgements

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