CAGE CULTIVATION OF BESTER IN EAST KAZAKHSTAN

Damir ZHARKENOV[1] – József PEKLI[2] – Olga KIRICHENKO[3] – Katalin ZSUGA[4] – Toleuhkan SADYKULOV[5]

[1]Kazakh Fishery Research Institute, Almaty, Kazakhstan
[2] Szent István University, H–2100 Gödöllő, Páter Károly utca 1. E-mail: jozsef.pekli@gmail.com
[3]Altai branch, Kazakh Fishery Research Institute, Ust-Kamenogorsk, Kazakhstan
[4]AGRINT International Agriculture Trading and Consulting Ltd., H–2100 Gödöllő
[5]Kazakh National Agrarian University, Almaty, Kazakhstan

Abstract: The results of cage breeding of sturgeon hybrids in the third fish farming zone's climatic conditions are given. It is also shown the achieved fish breeding and biological features, the dynamics of the growth rate, the viability of the object and the possibility of breeding stocking material of hybrid sturgeon in providing certain technological conditions.

Keywords: sturgeon hybrids, cage breeding of juveniles, temperature regime, growth rate, stages of cultivation

Introduction

In the 21th century the water and food lack and safety are the main fundamental factors of life on Earth. The largest water consuming in the world is agriculture, food production. Nowadays one of the main economic and social problems is to lessen lack of protein of the population. The fishing, developing fish breeding can contribute to this considerably by setting up modern, water-saving recirculation systems (RAS, Recirculation Aquacultural Systems), and cage cultivation (Zsuga et al. 2015). Aquaculture development is an actual in ensuring food safeness of fish products supplying any state. For this aim the Republic of Kazakhstan has a huge fund of small fishery water bodies scattered practically throughout the country (Pekli et al. 2014).

Organization of fish breeding and fishing operations in small water bodies is associated with certain difficulties: the ambiguity of climatic and hydrological conditions. At the same time, climatic and hydrological differences allow to diversify the profile of fish farms significantly, taking into account the scientific advices. Fishery is an economic sector that fits the natural capabilities of the Republics of Central Asia. Development of the aquaculture of fresh water can provide significant measures to provide quality food for the peoples and opens up new possibilities on the area of exporting goods (Pekli – Zsuga 2015).

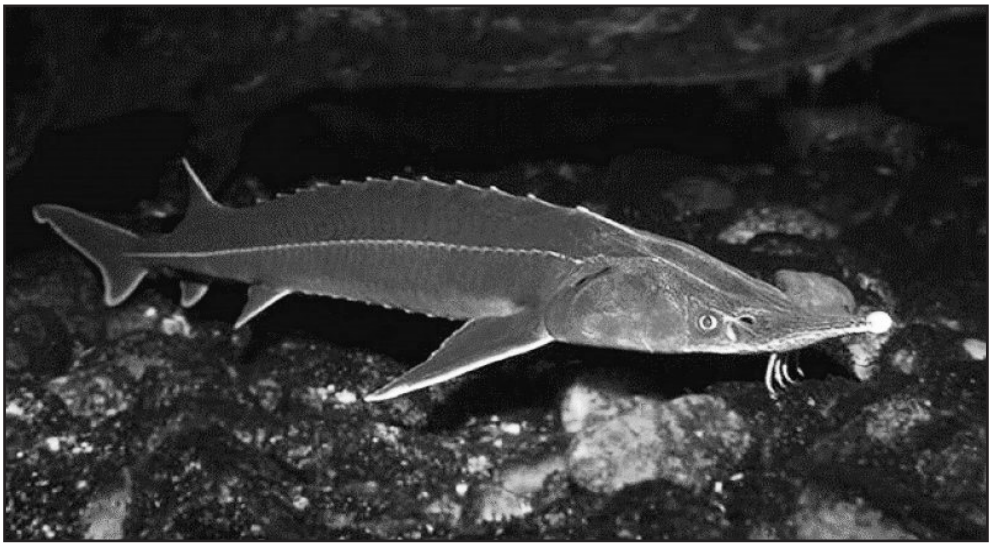

Photo 1. Bester hybrid (*Huso huso x Acipenser ruthenus*)

DOI: 10.18380/SZIE.COLUM.2016.3.1.55

Sturgeon fish occupy a special place in the world of aquaculture. Bester is a hybrid species, the result of different variants of beluga (Huso huso) female and sterlet (Acipenser ruthenus) male crossing (Photo1). It is suitable for aquaculture because it shows better growth rates than its male and female parents (Burtsev, 1997). The results of genetic identification showed that bester hybrids are more similar to beluga – 0.68, in comparison with sterlet – 0.45 (Yarmohammadi et al. 2012).

Bester produces high quality caviar at a younger maturity age as compared to pure beluga. The bester has been cultured not only in Russia but also in other countries, such as Germany, Hungary, France and Japan (Omoto et al., 2005). It has excellent fish-breeding characteristics, and food value. High dietary qualities of bester production continuously provide a great demand on it. Bester has great potential for intensive aquaculture technology due to its quality caviar and meat production. Yet, in the field of bester sturgeon nutrition many authors consider that further investigation is desirable (Dediu et al. 2011).

The relevance of commercial breeding of sturgeons is due to their reduction in natural reservoirs. The implementation and working out of sturgeon's commercial breeding technologies in different types of fish farms are very important and actual task. The proven cultivation technology of individual sturgeon species will allow showing the ability of producing valuable commodity products in adapted small water bodies. This technology will be transferred for implementation to other fish farms of the eastern region of the republic in order to increase the efficiency of their production. The purpose of this research is to study the adaptation and implementation of innovative technologies of growing sturgeon hybrid (Bester) in cages in water bodies *("pond in pond")* with a small area in the third fish farming zone climatic conditions.

Material and Methods

The work includes research papers of 2013 under the program *019 „Hosting measures for the dissemination and implementation of innovative practices"*, aimed at studying the possibility of implementing innovative experience of cage fish breeding in farms of Eastern Kazakhstan.

All-breeding works carried out in stages at two experimental bases - in laboratory conditions in the aquarium fish tank („mini-RAS") and in fish farming capacity in conditions of the farm „Silver bream", located on the Tainty reservoir.

Tainty reservoir is located 85 km in the south-west of the city Ust–Kamenogorsk and formed by locking up the Tainty and Bestau rivers, the covered area 61 hectares. Minimum level falls to the winter months. The average depth is 5 m. The ground of the coastal bottom is rocky, the open part is gumbo. Overgrowing of the reservoir is low, 2 – 3 %. From rigid surface vegetation found cattails, sedges, from the underwater – pondweed.

Bester larva grown in the farm conditions has been under constant surveillance. Valuations have been carried out every 10 days. The hydrochemical and ichtyological monitoring of the habitat and gibrion (Bester larvae) in water in fish tanks has been systematically held in laboratory conditions. The amount of the collected material is shown in Table

Table 1. The amount of collected material

Name of works	The amount of material
Hydrochemical samples	92
Water temperature measurements	192
Measurement of the oxygen regime	192
Sanitary inspection of sturgeon's fry (specimens)	406
Grows and fatness of fishes (specimens)	406

DOI: 10.18380/SZIE.COLUM.2016.3.1.55

1.For analysis of water quality the following components were measured: dissolved oxygen, pH, calcium, magnesium, potassium, sodium, bicarbonate, chloride, sulphate, total hardness, ammonia, nitrite, nitrate, sulphate.

The matching of analyzes results with fishery MPC conducted by conventional „Generalized list of MAC ." (Izmaylov 1990).

In the process of ichthyology researches were assessed:

- the general health status of the fry;
- size and weights features of fry
- presence of morphopathological abnormalities.

While carrying out fishery works on the topic were used own innovative engineering on sturgeon breeding, prepared by experts of LLP "KazNIIRH."

Results and discussion

Phase I.

Three-day Bester larvae were delivered on 25th of May for growing process. At this time the water temperature in the reservoir was only 7.4 ^{0}C in the daytime. For this reason the larvae were placed at first in the laboratory for rearing in an aquarium mini-installation, until the temperature was at least 12 ^{0}C in the reservoir.There is very important to insure both the suitable water quality and solving of the accidental problems for the satisfactory development of larvae. In the process of sturgeon larvae growing in laboratory were made daily observations of the gas mode, physicochemical properties and content of biogenic ions.

For sturgeon cultivation in a closed cycle is necessary to ensure the normal oxygen conditions. In the hatchery tank for water saturation with oxygen was used two submersible compressors. In addition, the water passing through one of the compressors and the external filter, passed through additional flutes, saturating the water with oxygen and creating the necessary water flow. Due to this the content of dissolved oxygen in the hatchery tank were stable and were at a high level during the whole period of rearing. The value of dissolved oxygen was in the range 7.8 – 8.6 mg/dm^3 (85 – 95.2% saturation).

Sturgeon tolerates fairly wide variations of pH, but most optimal values lead at a pH range of 6.5 - 8.5. The pH value was in the lab hatchery aquarium averaged 7.8. In some instances 8.17 maximum values were observed in the morning that seems to have been due to the accumulation of waste products in the fish aquarium. In this case the changing of the water in an amount of 30 % of the total reduced the pH to 7.5 – 7.6.

Photo 2. General view of the cage line in Tainty reservoir

DOI: 10.18380/SZIE.COLUM.2016.3.1.55

Table 2. The composition of water and water quality standards for sturgeon growing

Indicators	**Measurement unit**	**Tainty reservoir**	**$MPC_{aquaculture}$**
pH	-	7.5	7.2 - 9.0
Oxygen	mg/dm^3	9.0	6 - 8
Permanganate oxidation	mgO_2/dm^3	2.6	до 10
Ammonium nitrogen	mg/dm^3	0.0	0.5
Nitrite	mg/dm^3	0.0	0.08
Nitrate	mg/dm^3	0.48	40.0
Phosphate	mg/dm^3	0.11	-
Chloride	mg/dm^3	1.74	50
Sulphate	mg/dm^3	13.9	50
Total hardness	$Mg\text{-}EQ/dm^3$	1.3	60 - 80
Total mineralization	mg/dm^3	143.5	400 - 900

The concentration of ammonium ions in the tank during the larvae hatching period varied in a fairly wide range - from 0.0 to 1.95 mg/dm^3. To improve the hydrochemical regime was made water changing (about 30 % of the total). Increasing water temperature to 19.5 ^{0}C made a possible to reduce the concentration of ammonium ions to zero values. Along with this, in one of plates of the outer filter was loaded zeolite as an adsorbent that allowed partially lowering the concentration of ammonium ions and significantly reducing the turbidity of water.

High-protein feed residues deposited on the soil surface of the aquarium were a source of nitrite in the water. On some days, the contents of nitrite in the water in the fish tank aquarium reached a value of 0.63 mg/dm^3. Partial water changing reduced the content of nitrite to the optimal values. The concentration of nitrate in the process of growing in the fish tank does not exceed the normative values and changed in the range of 0.0 – 11.4 mg/dm3.

Feeding of larvae began on the third day with yolk after placing them in the conditions of the aquarium. After some days they were fed with starter feed imported with grit sizes up to 1 mm, with addition of live food (Oligochaetes). At the rate of 10 % by weight of the larvae feeding was at intervals 5 times a day, the last was at 6.00 p.m. Later the ration was changed towards increasing the share of dry starter feed, gradually bringing its value in the daily

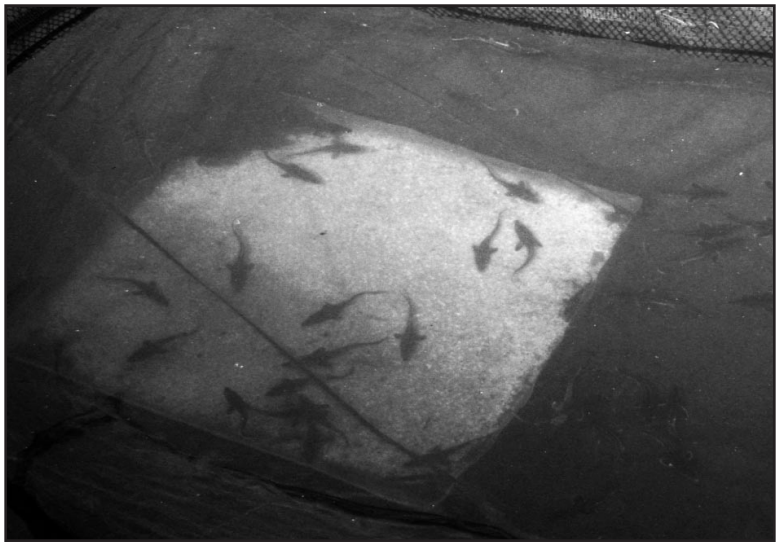

Photo 3. The cage with bester larvae

DOI: 10.18380/SZIE.COLUM.2016.3.1.55

diet to 25-30 % or more.

Thus, one of the required conditions of feeding in the initial stage is a strict management of standards in the calculation of daily rations, which depends on the temperature, the growth indicators and the mandatory inclusion in the diet of live food.

Bester larvae grown in laboratory conditions in general showed a high survival on a first phase, composed exactly 30 days from the date of putting them into the system, as indicated by the value of their survival 48 %. The maximum deviation of the larvae was observed on 9th-10th day after hatching 40 %, which is coincided with the transition to active feeding larvae. At this time due to technical problems, larva was in critical water exchange and water purification more than a day that affected its survival. Later departure stabilized (12 – 16 hours cultivation) at a very low level 2-3 % per day.

An analysis of fish breeding and biological features of the growing fry according to the first month cultivation results showed the following results: the average growth of the bester larvae from the starting was 97.7 % by weight and 71% by length of the fish, reaching an average of 7.25 cm in length and 2.64 g weight of their body. These results are higher than the corresponding features from the experience of Korean (average weight was 1.0 grams on 43rd day of cultivation) and Russian (the average weight was 0.9 – 1.0 g on day 30th growing day) fish farms (Burtsev et al. 2007, Filippov et al. 2004).

After 30 days in late June bester larvae were transferred from the "mini-RAS" and placed in a cage line of Tainty reservoir (Photo 2.). There were also the larvae grown in suited base condition. Since young bester, grown under different conditions, and vary greatly in their size and weight characteristics, was performed calibration in order to align its growth. All the plant material was sorted and put on into 3 cages:

- cage number 1– "large" fry, weight 3 grams or more
- cage number 2 – "medium" fry, weight at least 2 grams
- cage number 3 – "small" fry, weight under 2 grams.

Phase II.

The hydrochemical compositions were measured before the transplant of young bester in cages of water of Tainty reservoir. The composition of the water and the value of the water quality standards for sturgeon growing are given in Table 2.

Optimization of the temperature regime, providing favourable conditions for

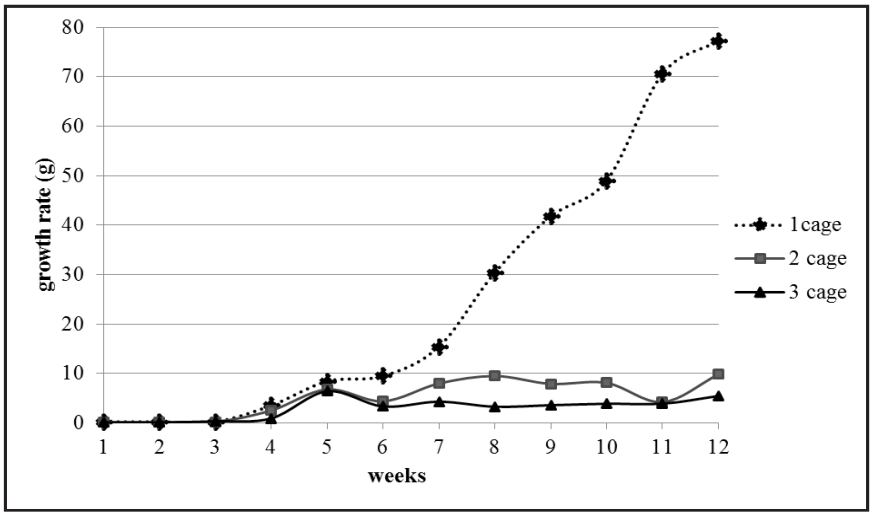

Figure 1. The dynamic of growth of juvenile Bester in a cage line (July – October).

growing of sturgeon, is the basis of growing technology in the closed cycle of water supply. Changes in temperature influence to an oxygen consumption, a rate of development and growth, as well as on an intensity of consumption and digestion. During the fish works implementation in the reservoir operational control over the temperature regime was carried out daily.

Since early July, the second phase of growing fry bester started in a cage line of Tainty reservoir (Photo 3.).

For the favourable development of sturgeon temperature plays an important role. During the growing period water temperature (July-August) was significantly below the optimal temperatures for juveniles rearing. So, the average temperature in the month of July totalled 17.4 ^{0}C, while the standard is in accordance with the aquaculture norms is 23 – 26 ^{0}C, in August average temperature was even lower and amounted 16.2 ^{0}C.

In the process of young Bester rearing the oxygen regime monitoring was daily carried out, water sampling to determine an active reaction of environment and concentrations of ions were carried out every 10 days. Oxygen regime of the reservoir was optimal for rearing juveniles throughout the fish works carrying out – the concentration of dissolved oxygen was in the range of 7.9 to 9.2 mg /dm3, the average saturation of water with oxygen was 87.8 %.

By the results of the cage fish culture experiments in Hungary, the best weight gain of Bester was at 18 – 23°C temperatures and an oxygen content of water higher than 6 mg/dm3. There was a dramatic decrease in the appetite of fish, however, if DO content decreased below this value (Müller – Váradi).

Characteristic pH value of Tainty reservoir water is 8.2 to 8.3. In the period from July to August, the pH of water in the test cage line was in the range of 7.9 – 8.65 and the minimum values were recorded during the period of rainfall. In this period were took place an increasing of the hydrological level of the reservoir and the degree of water flowage, and as a consequence, the decrease of pH value.

Ammonium nitrogen excreted by fishes in water as the end product of metabolism. Ammonium ions (NH4+) in large quantities are toxic. The concentration of ammonium ions in the period of fry rearing in cages averaged 0.23 mg/dm^3. The growth of the ammonium ions content in water was recorded on 19 July and was caused by the processes of decay of uneaten feed and waste products of juveniles actively flew in the case of water heating. To reduce the content of ammonium ions were conducted an additional cleaning of the cages, a removal of algae in the area of the cage lines, after which there was a decrease of ammonium ions concentration.

Nitrite is toxic for fish, since it breaks the binding of oxygen by haemoglobin. During the work, the content of nitrite was at an optimal level (0 – 0.02 mg/dm3) and also does not exceed the recommended aquaculture norms.

The nitrate formed from nitrite in a process of nitrification, and it is much less toxic than nitrite. The content of nitrate in the process of cage line cultivation did not exceed normative values and varied from 0 – to 2.99 mg/dm3.

The phosphate content during the growing period in cages amounted 0.0 – 0.34 mg/dm^3 (there is no limit value by normative).

Comparing recorded values of the main hydrochemical indices of water with the regulatory requirements of the allowable values for aquaculture water gives grounds to verify that fluctuations in the values of above mentioned indicators in most cases did not exceed the permissible norms and ensured a normal growth of sturgeon.

In order to ensure greater survival of planting stock and the efficiency of the growth process, the gotten larvae before putting in the cage lines of fish farm were grown in adapted

DOI: 10.18380/SZIE.COLUM.2016.3.1.55

Table 3. Fish breeding and biological indicators in a cage Bester line

Indicators	Phase I.	Phase II.	Phase III.
Growing period (days)	30	60	47
Planted on the cultivation (pcs)	500	226	197
The initial mass (gram)	0.09	2.30	20.31
The final mass (gram)	2.64	20.31	30.83
Average daily gain (milligram)	88	300	263
Fulton condition factor	0.70	0.42	0.46
Survival rate (%)	48	92	87 (28)

„mini-RAS" aquarium with the required water exchange and water purification. All received Bester larvae was divided in two control groups: one was put in a laboratory's aquarium, the second was delivered to Tainty reservoir. Rearing was carried out in the reserve tank, installed in a trailer. Medium size of Bester larvae figures on the total body length, measured up to the end of the caudal fin rays averaged 1.5 cm while the size features of the planting stocks varied from 1.3 to 1.7 cm.

Analysis of the size and weight indicators juveniles in the second growing period shows the highest growth in both length and weight, the "large" fry from cage number 1, where the average weight gain for the reporting period reached 700 mg, the "medium" group 90 mg, and the" small "fry 50 mg.

Some variation of the average values of weight in the group of "medium" and "small" fry is due to the heterogeneity of its size and composition of the different growth rates of individuals. Aligning growth is achieved by periodic calibration. The gradual decline in nutritional status of young bester in the process of growing is quite natural and is due to the acceleration of the growth of individual species and the intensification of metabolism in the body, most of all when entering the body of nutrients begins spent on protein growth.

In addition, a prolonged period of adaptation to the changed conditions of juvenile protection had a role in the decline in nutritional status of fish, in this case, after the transportation it from the laboratory to the cage line reservoir.

Thus, it should be stated that as a result of transplantation, and the second calibration stage of cultivation, the growth rate increased significantly only in the young group of "large" fish. In the "medium" and "small" group heterogeneity growth trend persists that apparently depends on genetic potential of an individual which was obtained from the original parental forms (Figure 1). The grown in a natural pond fry bester showed good viability in the second phase, as indicated by the value of survival rate of the planted (92%) – in Table 3).

Phase III.

The third phase of growing fry bester lasted 47 days; from early September to mid–October. The hatchery process associated with a significant backlog growth in size and weight of fish from the category "medium" and "small" specimens. Attempt to stimulate it through the use of immune modulator and probiotics.

Analysis of fish breeding (Photo 4.) and biological indicators on the results of fry rearing in the third phase showed the following results: the mean growth of fry bester, by all size groups, from the initial value was about 52 % by weight and about 4 % by the length of the fish. It is noted the apparent excess of weight gain over the linear growth of fish, which in principle is a natural process. The general fall in the rate of growth due to the decline in water temperature, which slows down the metabolic processes in the body, including the digestive system and, ultimately, affects the largest growth rates.

Photo 4. Valuation of young bester in cage cultivation

Using krezatcin and probiotics had some effect – the growth processes of young "medium" and "small" groups increased: for example, if the weight gain in the category of "large" fish in the same period amounted to slightly more than 10 %, then the "small 40 %, and the "average" 135 %. The survival rate of young fish at the end of the third stage was 87 %. In late October, the fry Bester was placed for the winter lowered in special cages to a depth of 3 – 5 meters.

Conclusions

Adapted and improved technology will allow sturgeon breeding farms on the example of the possibility of obtaining valuable commodity products adapted to small ponds. Here are some recommendations developed during the mining process.

Artificial breeding of valuable fish becomes more effective when the larvae, before boarding a cage fish farm line were grown to full-system RAS providing optimal exchange of water and water treatment.

It is necessary to undertake a systematic monitoring of hydrochemical water for the most important indicators – water temperature, oxygen content, an active reaction (pH) and ions, nutrients (ammonium, nitrite, nitrate).

The system RAS provide a full cycle of water treatment; to reduce the toxic effects of metabolic products is expedient as filter substances in the biofilter used natural adsorbents – zeolites, expanded clay. Water in pools for rearing trays or fed directly from the reservoir, which will be installed cages, preferably adjusted to the optimum temperature 18 – 23 ^{o}C with oxygenation of 6 – 8 mg /L, pH: 6.5 – 7.5 with average rigidity.

The use of soils in the basins is impractical because it is difficult to clean from the products of metabolism, feed residues.

For sturgeon typical uneven growth, manifested in the end result in a large spread by weight of fish, so the fish sorting should be performed periodically during the growing process, separating them by size groups: small, medium and large.

During breeding larvae and young fish, it is necessary to enter a live feedstuffs in the diet, depending on the water temperature, growth parameters (average linkage) fish and their quantity; daily diets calculated taking into account the use of live food. If you are unable to sort and place separately juveniles, it is imperative to organize a few tables of food in different places, in order to reduce competition during feeding. In case of a different quality of growth processes of the young, in order to stimulate growth in the contingent of "small"

DOI: 10.18380/SZIE.COLUM.2016.3.1.55

fish enter into the diet dressing vitamins, probiotics and produce handling juvenile immune modulator. To minimize the stress load on the weighing of fish, produce electronic scales in the tank with water, adding ascorbic acid feed rate of 10 grams per 1 kg of feed. Thus, experience shows that the availability of the sufficient necessary equipment and suitably trained fish farmers, allows rearing sturgeon larvae from stage a three-day weather conditions in Eastern Kazakhstan (third aquaculture zone) and economically feasible.

References

Burtsev, I. A. (1997): Bester in aquaculture, In: Sturgeon stocks and caviar trade workshop. (eds): Birstein, Aauer and A. Kaiser – Pohlman, IUCN, Gland, Switzerland. 35-432.

Burtsev, I. A. – Kuznetsova, E. N. – Zuevsky, S. E. (2007): Cooperation with VNIRO hatcheries the Republic of Korea in the field of sturgeon fish. Ed. VNIRO, Moscow. 22 p.

Dediu, L. – Cristea, V. – Docan, A. – Vasilean I. (2011): Evaluation of condition and technological performance of hybrid Bester reared in standard and aquaponic system.

AACL Bioflux, 2011, Volume 4, Issue 4.

Filippov, O. P. – Bychkova L. I. – Trifonova, E. S. (2004): Soft F.F experience of using probiotic preparation - bifilaktrina in the early stages of cultivation Bester. Proc. Scientific-practical, Conf. "Issues of immunology, pathology, health fish". Moscow. 534-538.

Müller, F. – Váradi, L.: http://www.fao.org/docrep/x5744e/x5744e0f.htm

Omoto, N. – Maebayashi, M. – Adachi, Sh. – Arai, K. – Yamauchi, K. (2005): Sex ratio of triploids induced in the hybrid sturgeon, the Bester (*Huso huso* female × *Acipencer ruthenus* male). *Aquaculture*, 245, 39-47.

Pekli, J. – Mahatov, B. M. – Rysuly, M. – Kulataev, B. T. (2014): Industrialization of Technology in Fishery, Ed. common KazNAU – AGRINT, SZIE University Press, Gödöllő, Hungary. 171-252, 483-520.

Pekli, J. – Zsuga, K. (2015): The possibilites of environmental and fisheries development of Central Asian regions countries. In Conference: "The new strategy of research and educational priorities in the context of the agricultural-industrial complex". November 27-29, 2015. KazNAU, Almaty, Kazakhstan.

Zsuga, K. – Mamadiyarov, B. – Kozhamkulov, D. – Pekli, J. (2015): Actual changes in water strategy and water usage in the world. In Conference: "The new strategy of research and educational priorities in the context of the agricultural-industrial complex". November 27-29, 2015. KazNAU, Almaty, Kazakhstan.

Yarmohammadi, M. – Shabani, A. – Pourkazemi, M. – Baradaran, N. S. (2011): Identification of Bester hybrids (female *Huso huso* Linnaeus, 1758 and male sterlet *Acipenser ruthenus* Linnaeus, 1758) using AFLP molecular technique. Iranian Journal of Fisheries Sciences 11(2) 415-423.