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RARE ACIPENSERIDS IN RUSSIAN AQUACULTURE

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РЕДКИЕ ВИДЫ ОСЕТРОВЫХ РЫБ В РОССИЙСКОЙ АКВАКУЛЬТУРЕ

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Abstract. A review of experience the using the Russian rare species sturgeon in aquaculture taking into account the information of the former USSR compiled on the basis of publications exclusively Russian scientists. In Russia are cultivated and studied the 7 rare sturgeon species belonging to 2 families of Acipenseriformes: *Acipenser nudiventris, A. naccarii, A. sturio, A. oxyrhynchus, A. mikadoi, Pseudoscaphirhynchus kaufmanni* and *Polyodon spatula.* All of these species are endangered and listed in the International Red List and regional Red Data Books. Above named rare sturgeon species are preserved in various Russian aquaculture hatcheries and fish farms. The fish farms titles where they are exposed to breeding or commercial cultivation are given. Biotechnologies of their cultivation were done a long time, with the exception of Sakhalin sturgeon as inhabiting inaccessible areas and Amu Darya big shovelnose sturgeon, because the last is currently not in the Russian rivers in present state borders. New data about their biology, including reproduction are given.

Key words: rare sturgeon, Russia, endangered species, aquaculture, reproductive biology, basis of artificial reproduction.

Реферат. Обзор опыта использования редких видов российских осетровых рыб в аквакультуре с учетом информации, полученной в бывшем СССР, сформированной на базе публикаций исключительно российских ученых. В России выращивают и изучают 7 редких видов осетровых рыб, принадлежащих к 2-м семьям Acipenseriforms: Acipenser nudiventris, A.naccarii, A. sturio, A. oxyrhynchus, A. mikadoi, Pseudoscaphirhynchus kaufmanni и Polyodon spatula. Все эти виды находятся под угрозой уничтожения и занесены в национальную и региональные Красные Книги. Вышеуказанные редкие виды осетровых сохраняют в различных российских аквакультурных рыбоводных питомниках и рыбхозах. Представлены наименования рыбхозов с указанием,

занимаются они разведением либо коммерческим выращиванием рыбы. Биотехнологии их выращивание были разработаны уже давно, за исключением сахалинского осетра, обитающего в труднодоступных регионах и амударьинского большого лопатоноса по той причине, что последний отсутствует в реках в пределах современных границ Российской Федерации. Приведены новые данные об их биологии, включая, воспроизводство.

Ключевые слова: редкие виды осетровых рыб, Россия, виды под угрозой исчезновения, аквакультура, репродуктивная биология, основа искусственного воспроизводства.

Introduction

The gigantic state territory of the Russian Federation (as well as the former Russian Empire and the Soviet Union) overspreads from Atlantic to Pacific Oceans. Its European part geographically corresponds to area of the sturgeon species formation. It was here, in the river system of western part of the former pracontinent Laurasia were inhabited their ancient ancestors who have mastered Tethys Ocean and it's following geographical derivatives (Sarmatian, Meotic, Mediterranean, Black, Azov and Caspian Seas) (*Mikulin, 2003*). Civilization has developed rapidly in Western Europe than in Eastern one, because of it Russian sturgeon were have survived more long time than in another localities and have the greater species diversity. It was promoted by ethnic composition of the population (not only Russian), religion (muslim), lifestyle (nomads) and food (meat, milk) preferences of different ethnic groups living on the coast of sturgeon water bodies (*Mikodina, 2014*).

In this regard, Russian scientists have been studying sturgeon living not only in the present boundaries of the Russian Federation. Russia in various state forms has always Russian official language as now English ones is in the world, but sturgeon aquaculture has long time been out of sight of other countries. Because of it the majority of sturgeon publications were issued in Russian language. Therefore, this review is based only the Russian national publications that little-known for some foreign scientists.

Materials and methods

It were used the publications about the reproductive biology, artificial

reproduction and marketable rearing of rare Russian sturgeon, which were published in Russian or Russian and/or English in 1979–2014 by Russian scientists. Sakhalin sturgeon was fished in Viakhtu River (western Sakhalin Isl.); its photography was made by A. Novosadov. Ship was cultivated at Shatura fish farm cages (Moscow region) and was photographed by A. Novosadova. Shovelnose was caught in the Amu-Darya River near Urgench city. Its photo was made by A. Barmintseva and N. Mugue under artificial conditions at experimental scientific station of Uzbekistan Khorezm Ma'mun Academy near Khiva city. We thank all of them for their assistance very much.

Results and discussion

Among the 10 Acipenserids fish species inhabiting in Russia water bodies the best known are Russian sturgeon *Acipenser gueldenstaeadtii*, Beluga sturgeon *Huso huso* (*Acipenser huso* sensu *Vasil'eva et al., 2009*) and Siberian sturgeon *A. baerii* which have spread around the world in aquaculture (*Mikodina, 2014*). But now in Russia all of them are too rare in wild and because of it their low strength whereupon their commercials catch is stopped. The exceptions are a few populations Sterlet sturgeon: *A. ruthenus*. Now the Sturgeon fishing in Russian water bodies is allowed only for artificial reproduction and scientific research. Total allowable catch (TAC) for all native Sturgeon populations ranges from 1 to several hundred kg (*Mikodina, 2014*). Sturgeon TAC in Azov Sea determines Russian-Ukrainian Commission. Thanks to the new state innovation strategy sturgeon reproduction biotechnology, i.e. formation of brood stocks, their artificial reproduction continues successfully. For example, International Center of Reproduction the Caspian Sturgeon (Astrakhan city, KaspNIIRKH) involves 6 sturgeon hatcheries, 3 spawning-rearing farms, several marketable sturgeon farms, centralized brood stock and Molecular Genetics Center where developed genetic passports for each female and male of brood stock (*Vasil'eva, Naumov, 2014*).

So in Russia inhabit, cultivated and studied the 7 rare sturgeon species belonging to 2 families of order Acipenseriformes: and Acipenseridae, the last with

2 subfamilies. There are: Paddlefish *Polyodon spatula* (Polyodontidae), Ship Sturgeon (or Spike) *A. nudiventris*, Sakhalin sturgeon *A. mikadoi*, Adriatic sturgeon *A. naccarii*, Baltic (Atlantic) sturgeon *A. sturio*, Atlantic sturgeon *A. oxyrhynchus oxyrhynchus*: (Acipenserinae) and Amu Darya big shovelnose sturgeon *Pseudoscaphirhynchus kaufmanni* (Scaphirhynchinae).

All of them since 1996 are protected by International Union for Conservation of Nature (IUCN) Red Lists and regional Red Data Books of Russian Federation (since 1984 in former USSR), as well as of Tadzhikistan, Turkmenistan (since 1985) and Uzbekistan (since 1983) as critically endangered fishes and they are the objects of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Many years ago it has been declared the necessity of Russian Acipenseridae conservation. Since that time, this concept is carried out. The main focus is the optimization of sturgeon biotechnology in view of adaptability to the environment and the tolerance ranges. For rare sturgeon species is important the knowledge of their biology, which has been studied for a long time and foreign is known in fragments. However, the main publications about rare sturgeon species were published in Russian, which seems to be inaccessible to the often readers. Most clearly this thesis is illustrated by the Sakhalin sturgeon. Recent scientific literature (*Atlas of Russian Freshwater Fishes, 2002; Commercial Fishes of Russia, 2006; Fish in the reserves of Russia, 2010*) provides information on its biology and distribution of 50–60-year-old without new published data. Not updated information on the biology of this species in Fishbase.org. These information need to be updated at this time. Below, we have tried to fill this gap in relation to rare sturgeon species – the Russian aquaculture objects, with special consideration of the updated data.

Rare species in Russia is the Sakhalin sturgeon *A. mikadoi* (*Figure*). The study of the reproductive biology of Sakhalin sturgeon was began in Russia in the late 1980s (*Artyukhin, Andronov, 1990; Artyukhin, 2008*). It is complicated very much because of the difficulties in sparsely populated areas catches. However, there were not only studied many aspects of the biology of this species, but were formed 2 its

brood stocks with the aim of artificial reproduction (Okhotsky and Anyuisky hatcheries). Besides it allowed in the second half of the 2000s to release several parts of artificially produced of Sakhalin sturgeon juveniles in the in natural environment – Tumnin River (Khabarosky region), for this species maintenance in Russian part of its areal (*Khrisanfov et al., 2009*). Sakhalin sturgeon is cultivated in Russia it 5 hatcheries, two of which are placed at Russian Far East and have brood stocks with two generations: Okhotsky (Sakhalin Isl.) (*Mikodina et al., 2004; Khrisanfov et al., 2005; Mikodina, Khrisanfov, 2008*) and Anyuisky (Khabarovsky region) federal hatcheries (*Khrisanfov et al., 2009*), as well as Alexinsky Chemical Complex fish hatchery.

Figure – View of the three species of rare Russian Acipenserids supported of national artificial reproduction: up – head of *Acipenser mikadoi, A. nudiventris,* below – *Pseudoscaphirhynchus kaufmanni*

The most important results the fundamental biology study of the of Sakhalin sturgeon is the establishing of its chromosome set. By two different methods were shown it affiliation to 250-chromosome sturgeon types, and as its karyotype ranges from 247±33 (*Vishnyakova et al., 2008;Vishnyakova et al., 2009*) up to 262±4 (*Vasil'ev et al., 2008; Vasil'eva et al., 2009*). Visual characteristics and

morphometric parameters of Sakhalin sturgeon oocytes, ultrastructural features of their envelopes surface and micropyle were studied. Its micropyle number ranges 4 to 17 (*Mikodina, Novosadova, 2011*). It was shown that Sakhalin sturgeon lives not only in Tumnin River and Datta Bay of Khabarovsk region but also in Bay Viakhtu and Viakhtu River of Western Sakhalin (*Koshelev et al., 2012*). In our opinion, this is due to geomorphological changes in the tertiary period of the Earth.

In Russian water bodies rare autochthonous Acipenserid species – a Ship Sturgeon *A. nudiventris*, is still inhabits (*see Fig.*). Its biology studied for a long time. This species has a high absolute and relative fecundity (*Avetisov, 2006*), so this attractive species for aquaculture. Its biotechnology is well developed. Russian fish farms are reproduced and reared the *A. nudiventris* of both Aral and Caspian populations. Five Russian Ship facilities are: Alexinsky Chemical Plant fish hatchery (Tula region), BIOS, SB FBGC, Donskoy hatchery (Rostov-on-Don region), Karmanovsky fish farm in Republic of Bashkortostan, Diana fish farm at Kaduy settl., Vologogradsky region) (*Shebanin et al, 2001*; *Erbulekov, Kokoza, 2004*; *Avetisov, 2006; Boubounets, Labenets, 2009*; *Ponomaryova et al., 2010*). During 2007-2010 were additionally studied the growth and reproductive system development of the Ship under artificial conditions. The obtained at aquacomplexes "Kagalnik" of Southern Scientific Center RAS data are necessary for the formation of its local brood stock (*Ponomaryova et al., 2010*). It was described the ultrastructure of the Ship egg envelope surface. Was established the micropyle number varied from 2 up to 19 (average 7), entrance diameter of the micropyle is 50-60 microns *(Vorobyeva, Markov, 1999).* Recently were investigated the *A. nudiventris* progeny anomalies in its early ontogenesis, obtained from brood stock under aquaculture conditions (*Mikodina, Novosadova, 2010; Novosadova, 2013*). The proportion of the larvae anomalies was at 8.5%, which in 1.4-2-fold higher than in wild progeny caught at p. Ural, where this indicator ranged between 4-6% (*Erbulekov, 2004*). These data suggest that the biological quality of the cultivated *A. nudiventris* progeny is worse than the wild. Among 7 previously known types of pre-larvae abnormalities in cultured Ship sturgeon revealed only 4 ones, as well as combined ones. In this

species, the percentage of body shape abnormalities account for 61%, of external organs – 12%, functional abnormalities – 6%, mechanical ones – 11%, combined anomalies – 11%. The most common abnormalities in Ship during hatching stage are deformation of the body, lack of eyes rudiments, microcephaly and defects of the yolk sac form (9-38%). The share of other anomalies does not go beyond permissible (6%) (*Novosadova, 2013*).

Besides it there are three sturgeons species are undergoing of artificial reproduction for restoration of former abundant autochthonous species but now disappeared ones in Russia: *A. naccarii, A. sturio, A. oxyrhynchus oxyrhynchus*. Artificial reproduction the lost earlier in Russia two Atlantic sturgeon species: *A. sturio* and *A. oxyrhynchus oxyrhynchus*, on purpose of their re-acclimatization or restoration is carried out at AtlantNIRO and Kalinigrad State Technical University by experimental way. Adriatic sturgeon *A. naccarii* is cultivated at Alexinsky Chemical Complex fish hatchery (*Mikodina, 2013, 2014*) for collection of rare Acipenserids species.

Quite rare in Russian commercial aquaculture is American acclimatized paddlefish *Polyodon spatula*. Paddlefish is not an aboriginal Russia species, but an alien one (*Mikodina, 2013*). It allochthonous species was entered to our country from North America and acclimatized many years ago to diversify the number of aquaculture fish objects for increasing biological production. This zooplanktophage permits maximize to utilize of fish food base and therefore is used in polyculture. Its biotechnology under Russian aquaculture conditions have established long ago. Now in Russia are three paddlefish aquacultural stocks: in the Kaspnirkh scientific-experimental Center "BIOS" (Ikryanoye village near Astrachan city), South Branch of Federal Breeding and Genetics Center (SB FBGC) in Krasnodar city, Yl'yich Fish Farm in Rostov-on-Don region.

Biology of reproduction of paddlefish studied well enough not only in North America (*Proceedings, 1998*) but also in Russia (*Melchenkov, 2001; Vinogradov, 2003*). These studies are ongoing. Recently was known the number of micropyle in its eggs: 6 (2-33) (*Podushka, 2001*).

Recently renewed interest to artificial reproduction of the Amu Darya big shovelnose sturgeon *Pseudoscaphirhynchus kaufmanni* (*see Fig.*). Reproductive biology, artificial reproduction and early ontogeny of this species have been studied still in the former Soviet Union (*Sagitov, 1968; Goncharov et al., 1991; Schmalgausen, 1991*). Already in the 1980s, the need of this sturgeon species artificial reproduction was an expressed with the possibility of commercial breeding (*Makeeva, Sagitov, 1979*). First in 1983, the few specimens of big shovelnose sturgeon were brought from the Amu Darya River in to Moscow Zoo, where was received the first experience of its cultuvature and reproduction under artificial conditions (*Shubravy et al., 1989*). It was shown that this fish is capable of living for a long time in the facilities for reophilic hydrobionts. Normal development of the sex products in captivity was recorded and it occurred during a shorter period than in nature. For the first time mature gametes and larvae were obtained after hormonal stimulation (*Goncharov et al., 1991*). On this material has been studied the early development of large the big shovelnose sturgeon. The structure of the prelarvae of *P. kaufmanni* at consequent stages of development was described. Relative size of organs and parts of the body were determinated at the same embryonic stages (*Schmalgausen, 1991*).

Recently (since 2010) Russian naturalists of the Moscow Zoo, scientists of VNIIPRKh, Zoological Museum of M.V. Lomonosov Moscow State University and A.N. Severtsov Institute of Ecology and Evolution were again cooperated with Uzbekistan and Tadzhikistan in renew studies of Amu Darya big shovelnose biology in Vakhsh River and its artificial reproduction (*Cherniak, 2012*; *Kovalev et al., 2014*). Was shown that karyotype of *P. kaufmanni* consist of 118-120 chromosomes and including a about 18-20 large bi-armed chromosomes, about 32-34 small bi-armed chromosomes, from one to two pairs of large acrocentric, and about 64 small acrocentrics or microchromosomes (*Kovalev et al, 2014*).

In 2012 new attempts to output of *Pseudoscaphirhynchus kaufmanni* progeny were made again for the first time after the end of XX century in the water area of the

Vakhsh River (Tadzhikistan). Similar studies are conducted in Turkmenistan (*Salnikov, 2003*).

Due to our opinion only one way of rare Russian Sturgeon conservation and its restitution in water bodies and commercial aquaculture of our county is their artificial reproduction. Now ichthyologists hope that its Acipenserids can be saved in fish farms that have sturgeon genetic collections and at list in Zoos.

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