Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 26(6): 1187 – 1197(2022)
www.ejabf.journals.ekb.eg

Biological characteristics of the Pike perch (*Sander lucioperca*) from Aydar-Arnasay Lake system in the middle Stream of the Syrdarya River in Uzbekistan

Dilorakhon Dekhkonova[1]*, Jobir Sobirov[2], Mansur Yuldashov[1], Bakhtiyar Kamilov[1,2]
1. Tashkent State Agrarian University, Tashkent, Uzbekistan
2. Institute of zoology of Uzbekistan Academy of Sciences, Tashkent, Uzbekistan
*Corresponding Author: dilora.dehqonova@mail.ru

ARTICLE INFO
Article History:
Received: Oct. 15, 2022
Accepted: Nov. 29, 2022
Online: Dec. 28, 2022

Keywords:
Pike perch;
Sander lucioperca;
Fish morphology;
Growth;
Maturation;
Fecundity:
Uzbekistan

ABSTRACT

In 2021-2022, the biological characteristics of Pike perch (Sander lucioperca) were investigated in Aydar-Arnasay Lake System in the middle stream of the Syrdarya River in Uzbekistan. The ages, total lengths and weights of the samples ranged between 1 to 6 years, 23.9 to 71 cm, and 72 to 3030 g, respectively. The formula of dorsal fin rays was XIII-XV, II-III 19-22, of anal fin rays II–III, 11 – 12; 87 - 103 scales in lateral line were determined. The presence of 10 - 13 pyloric appendages was revealed at the Pike perch. Indexes of plastic characteristics are given. The mean back-calculated total length was 24.2 cm at an age I; 36.7 cm, II; 45.9 cm, III; 52.0 cm, IV; 57.2 cm, V; 63.1 cm, VI; 71.0 cm, VII. Males and females achieve first maturation in the 2nd year when the standard body length is reached 33 - 39 cm. Spawning lasts from the third decade of March until the middle of April at a water temperature of 12 - 16 °C. Individual absolute fecundity of 33 - 71 cm females was 51.1 – 1259.9 thousand eggs.

INTRODUCTION

The Pike perch, *Sander lucioperca* (Linnaeus, 1758), is one of the most important fish species as for commercial fisheries, so for recreational one in inland waters of Uzbekistan. The natural area of the species includes freshwater water bodies of the basins of the Baltic, Black, Azov, and Caspian Seas; in the Aral Sea basin, the Pike perch was noted in the sea itself and in the deltas of the Amudarya and Syrdarya rivers. Pike perch is acclimatized in many water bodies of Europe and Asia. The maximum known Pike perch sizes are 130 cm of length and 16 kg of weight **(Berg, 1949** and **Nauka, 2003)**.

The study of morphological features is important for general biological research, to determine intraspecific variability and micro-evolutionary processes as well as studying the structures of fish populations, solving issues of protecting species that are under the threat of extinction, as it gives a quantitative assessment of the variability of individuals **(Murta, 2000; Silva, 2003; Turan *et al*., 2006; He *et al*., 2013)**. A large amount of data in the development of research is provided by the morphological analysis of fish according to certain recognized schemes for different fish families **(Pravdin, 1966; Lagler *et al*., 1977; Moyle & Cech, 1981)**. Methods are evolving; the 'truss-protocol' is an example of this and provides new data in the study of fish morphology **(Strauss & Bookstein, 1982; Strauss & Bond, 1990)**. The studies of age, growth, maturation, fecundity are essential for fisheries and provides information on the productivity of a stock and at what rate it can be sustainably

harvested. The ageing of fish from calcified structures is in important tool in fisheries sciences. Age can be reliably estimated by examine of calcified structures such as fin rays, vertebrae, opercular bones and others; scale is one of such calcified structure **(Chugunova, 1963; Bagenal & Tesch, 1978; Klumb *et al.*, 1999; Campana, 2001; Cadima, 2003)**.

On the territory of Uzbekistan, Pike perch lived in the Aral Sea and in the deltas of the inflowing rivers (Syrdarya and Amudarya). This species was the last object of fish capturing in the Aral Sea as the water in it became hyper saline in 1980s. However, in other flat parts of the country it was not habitat. The pike perch was introduced into the flat part of the rivers of Uzbekistan from the Ural River in the 1950s. Under local conditions, pike perch found favorable environments, began to reproduce, and became one of the main commercial fish in the basins of the Syrdarya, Zarafshan, Kashkadarya, Amudarya Rivers **(Kamilov, 1973; Amanov *et al*., 1990; Yuldashov, Kamilov, 2018)**. At the same time, studies on the biology of pike perch, including morphology, are fragmentary and were carried out in the 20th century **(Mirzaev & Kamilov, 1993; Kamilov & Urchinov, 1995; Salikhov *et al*., 2001)**.

The present study aimed to investigate the biological characteristics of Pike perch (*Sander lucioperca*) from Aydar-Arnasay Lake system in middle stream of Syrdarya River in Uzbekstan.

MATERIALS AND METHODS

Pike perch samples were collected in February – April at 2021 and 2022 from lakes Aydar and Tuzkan belonged to Aydar-Arnasay Lake System in the middle stream of Syrdarya river, Uzbekistan. Recently this system is the biggest waterbody in the Aral Sea basin and lasts from 41^{o}01’42’’N 67^{o}99’74’’ on the East to 41^{o}00’18’’ N 65^{o}95’12’’ on the West. That is an arid zone with an extremely continental temporary climate. Summer is hot (average monthly air temperature is about 29 °C in July, it often reaches 35-42 °C in daytime and can be even higher). Winter is rather cold (average monthly temperature is -2 °C in January, water bodies with stagnant water are often covered with ice for up to 1.5 months). The total area of lake system reservoir is more than 400 000 ha **(Fig. 1)**.

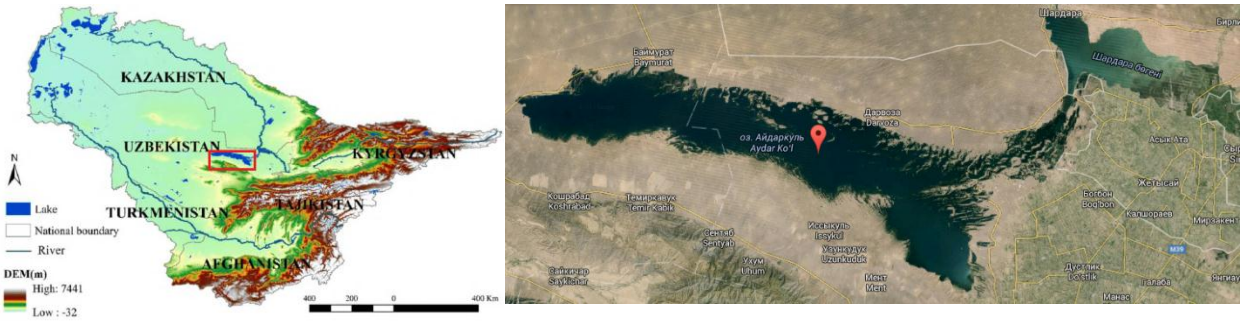

Fig. (1). Map of the Aral Sea basin and region of Aydar-Arnasay Lake System (circled in a square)

Morphological identification and systematic status of the pike perch was made, using characters given by **Mitrofanov *et al*. (1989)** and **Salikhov *et al*. (2001)**.

The total length (L), standard length (without caudal fin, to the end of scale coverlet) (SL) in the nearest 1 mm and body weight (W) in the nearest 1 g were recorded for each fish. Scales were taken from above lateral line under 1st ray of dorsal fin. Scales were cleaned in water and examined under binocular microscope for the age determination. Annuli measurements on the scales were measured for growth back-calculation. Growth rate was measured using Lea equation **(Pravdin, 1966)**.

The fish were fixed in a 4% formalin solution. In laboratory conditions meristic characteristics were counted in each fish. Plastic characteristics were measured according to the measurement scheme for percids **(Pravdin, 1966)**. Ten landmarks along the fish body perimeter were identified **(Fig. 2)**. Each fish was photographed at a strict right angle using a fixed tripod. The photographs were used to measure the distances in a straight line between landmarks, i.e. made up according to "truss" protocol **(Strauss & Bookstein, 1982; Strauss & Bond, 1990)**. The sounding lines are specified in the following format: for example, "2–4" indicates a straight-line measurement between landmarks 2 and 4. The absolute plastic feature characters were converted into indexes in %% of the standard body length.

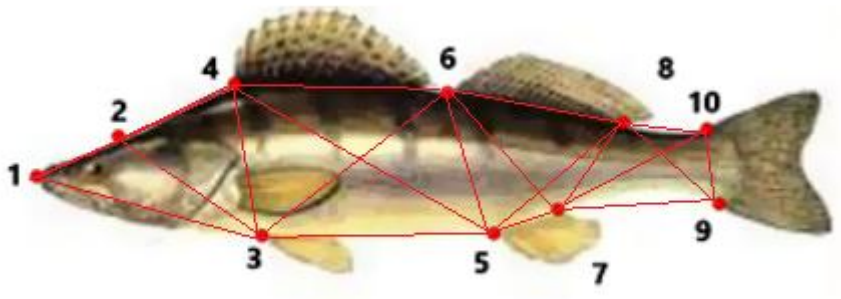

Fig. (2). Established landmarks on the body surface of pike perch

Gonad weight was determined for females at stage IV in the nearest 0.1 g. The number of ripe eggs was counted in 1 g; the result was multiplied by the total ovary weight in order to determine individual absolute fecundity. Female ripe egg size was calculated as average of 100 egg diameter measurement using a projector for microfiche reading “Mikrofot 5 PO – 1”; two mutually perpendicular diameters were measured for each egg and the average was calculated.

For nutritional analysis, the entire intestinal tract was cut out and placed with a label in a three-layer piece of gauze, the piece was tied with a bag and placed in a common jar with a 4% formalin solution. Under laboratory conditions, the samples were washed with water and disassembled by conventional methods, determining the content.

Statistic characters including coefficient of variation (Cv, %) were calculated. Correlation and regression analyses were done to describe fecundity equations; for all statistical tests, P values ≤ 0.05 were considered significant.

RESULTS

The pike perch has a torpedo-shaped body, elongated, laterally compressed. The belly is white, the back and top of the head are dark (gray, greenish), there are dark transverse stripes on the sides. The mouth is large. There are teeth on the vomer, jaws, palatine bones, including strong fangs. There are two dorsal fins, they are well separated. Pike perch has lateral line.

A total of 162 specimens of different sizes of pike perch ranging from 23.9 to 71 cm in standard length and 72 to 3030 g in total body weight at the age of 1-6 years were collected. There were no sexual differences in terms of morphological features and growth; as a result, fish of both sexes were combined into one group.

The formula of the rays in two dorsal fins is D_1 XIII-XV, D_2 II-III 19-22, in the anal fin - A II-III, 11-12. The presence of 87-103 scales was determined in the lateral line. The presence of 11-13 pyloric appendages was determined in Pike perch in the studied system of lakes.

Plastic characteristics of pike perch according to traditional scheme are shown in **Tables (1 & 2)** for "truss-protocol" in **Table (3)** (indexes in relation to the standard body length).

Table (1): Indexes of plastic morphological characteristics of the pike perch of the Aydar-Arnasay Lake System (%% of standard length), 2021-2022 (n = 40 pieces)

Morphological characteristics %	Range	Average ± SD	Cv%
First dorsal- fin base length	22.4 – 28.6	26.5 ± 0.18	4.4
First dorsal- fin the greatest height	10.5 – 15.1	12.0 ± 0.13	6.8
Second dorsal- fin base length	22.2 – 27.2	24.7 ± 0.18	4.6
Second dorsal- fin the greatest height	9.0 – 13.4	10.9 ± 0.15	8.5
Anal- fin base length	12.1 – 14.2	13.0 ± 0.08	4.0
Anal- fin the greatest height	9.8 – 15.4	11.9 ± 0.20	10.8
Head length	22.6 – 29.3	27.9 ± 0.19	4.4
Snout length	6.1 – 8.2	7.0 ± 0.08	7.3
Eye diameter	2.6 – 4.9	3.5 ± 0.09	15.9
Postorbital length of the head	15.7 – 19.6	17.6 ± 0.12	4.4
Head height at the back	11.9 – 16.5	13.4 ± 0.16	7.5
Forehead width	3.7 – 4.9	4.3 ± 0.04	5.9
Lower jaaw length	11.6 – 13.0	12.4 ± 0.05	2.8
Upper jaw length	22.9 – 32.5	30.8 ± 0.23	4.8
Maxillary length	40.2 – 45.1	42.2 ± 0.15	2.3
Antedorsal distance	27.1 – 33.8	31.8 ± 0.20	4.1
Postdorsal distance	60.0 – 63.1	62.2 ± 0.12	1.2
Anteventral distance	18.5 – 24.1	20.8 ± 0.25	7.5
Anteanal distance	6.8 – 8.7	7.8 ± 0.06	4.8
Maximum body height	22.0 – 26.6	24.8 ± 0.17	4.3
The smallest body height	13.6 – 19.8	16.2 ± 0.21	8.4
Caudal peduncle length	12.6 – 17.7	14.8 ± 0.19	8.1
Caudal fin upper lobe length	14.4 – 17.6	15.8 ± 0.09	3.7
Caudal fin lower lobe length	15.1 – 17.4	16.1 ± 0.08	3.2
Pectoral- fin length	6.3 – 7.6	7.2 ± 0.06	5.2
Ventral- fin length	30.4 – 32.8	32.3 ± 0.12	2.3
pectoral – ventral fins distance	2.5 – 3.5	3.0 ± 0.04	8.2
Ventral – anal fins distance	0.9 – 1.9	1.4 ± 0.03	15.0

Table (2): Indexes of head measurements from the head length (%%) of the pike perch of the Aydar-Arnasay Lake System, 2021 – 2022 (n = 40 pieces)

Head measurements	Range	Average ± SD	Cv %
Snout length	21.6 - 33.0	25.2± 0.35	8.9
Eye diameter	9.0 - 17.5	12.5 ± 0.33	16.9
Postorbital length of the head	58.5 - 143.4	65.3 ± 2.06	20.0
Head height at the back	42.5 - 72.8	48.4 ± 0.78	10.2
Forehead width	13.4 - 20.4	15.5 ± 0.22	8.8

Table (3): Indexes of 'truss-protocol' measurements of the pike perch of the Aydar-Arnasay Lake System (% of standard length), 2021-2022 (n = 40 pieces)

Characters	Tuzkan Lake			Aydar Lake		
	Range	Average + SD	Cv%	Range	Average ± SD	Cv%
2-4	14.0 - 38.4	19.8 ± 1.41	27.6	16.5 - 24.1	19.2 ± 0.46	9.6
4-6	25.1 - 32.4	27.9 ± 0.47	6.6	25.0 - 32.1	27.8 ± 7.4	7.4
6-8	19.1 - 24.0	21.8 ± 0.37	6.7	15.9 - 26.7	21.1 ± 12.7	12.7
8-10	10.6 - 21.8	16.1 ± 0.89	21.5	10.5 - 25.3	17.4 ± 25.1	25.1
9-10	8.6 - 13.3	10.2 ± 0.28	10.6	7.9 - 11.9	10.5 ± 11.1	11.1
7-9	13.2 - 25.6	19.1 ± 1.01	20.4	17.6 - 26.7	22.6 ± 12.5	12.5
5-7	9.6 - 13.5	12.3 ± 0.32	10.1	11.1 - 16.9	14.2 ± 12.7	12.7
3-5	28.2 - 42.1	33.7 ± 0.91	10.5	30.7 - 36.8	33.8 ± 5.6	5.6
2-3	20.0 - 24.5	22.4 ± 0.36	6.2	20.9 - 28.8	23.3 ± 8.7	8.7
1-2	14.4 - 19.1	16.4 ± 0.36	8.4	14.0 - 17.8	16.0 ± 7.3	7.3
1-4	30.5 - 38.7	34.9 ± 0.62	6.9	21.9 - 38.7	34.1 ± 11.1	11.1
1-3	28.5 - 36.2	33.0 ± 0.47	5.6	29.2 - 40.0	33.3 ± 7.9	7.9
3-4	16.9 - 22.4	19.6 ± 0.42	8.3	17.9 - 24.1	20.2 ± 8.6	8.6
5-6	17.4 - 21.6	19.1 ± 0.33	6.6	15.3 - 23.1	18.3 ± 9.0	9.0
7-8	10.0 - 14.6	11.5 ± 0.29	9.7	9.3 - 13.0	11.4 ± 8.2	8.2
4-5	33.9 - 44.2	38.5 ± 0.71	7.1	34.8 - 42.0	37.3 ± 5.6	5.6
3-6	31.6 - 37.8	34.0 ± 0.48	5.5	31.2 - 36.9	34.6 ± 4.3	4.3
6-7	21.2 - 25.8	23.1 ± 0.36	6.0	21.0 - 27.7	22.8 ± 7.0	7.0
5-8	16.2 - 23.2	20.9 ± 0.46	8.6	17.6 - 26.7	22.0 ± 11.1	11.1
7-10	18.3 - 27.2	22.7 ± 0.74	12.6	20.5 - 27.8	24.5 ± 9.0	9.0
8-9	13.7 - 23.8	18.8 ± 0.79	16.2	14.6 - 27.6	21.1 ± 18.0	18.0

Growth:

The observed standard lengths and body weights of the pike perch at different ages are given in **Table (4)**. Back-calculated growth of the pike perch is given in **Table (5)**. The pike perch in Aydar-Arnasay Lake System can be characterized as fish with fast growth rate.

Table (4): Standard length and weight of the pike perch, Aydar-Arnasay Lake System (Min – Max)

Age group	Standard length, cm	Total body weight, g	N, pieces
1+	23.9 – 35.9	198 – 695	41
2+	36.6 – 47.8	642 – 1459	30
3+	41.5 – 55.1	1100 – 1980	32
4+	50.0 – 61.8	1704 – 3180	25
5+	60.9 – 69.5	1750 – 3980	19
6+	70.0 – 75.1	4502 - 5890	14
7+	74.2 – 79.1	6080 - 6900	3

Table (5): The mean stanard length determined by back-calculation method according to age groups of the pike perch (males and females combined)

Age group	Fish No.	Back-calculated standard length according age group, cm						
		SL_1	SL_2	SL_3	SL_4	SL_5	SL_6	SL_7
1	**41**	25.4						
2	**50**	25.4	38.4					
3	**32**	24.3	38	46.5				
4	**25**	24	36.5	46.7	53.8			
5	**19**	21.4	34.1	45.2	51.1	58.5		
6	**14**	21.1	32.4	44.8	50.5	56.1	63.5	
7	**3**	21	31	41.2	50	54.2	61.1	71
Mean SL_i (cm)		**24,2**	**36.7**	**45.9**	**52.0**	**57.2**	**63.1**	**71.0**
Annual increment (cm/year)		**24,2**	**12.5**	**9.2**	**6.2**	**5.2**	**5.9**	**7.9**

Food and diet analysis.

Analysis of the pike perch diet showed the presence of food diversity, up to 10 components were found in the intestines. Currently, the diet of the pike perch included such fish species as goby, *Rhinogobius similis* (53 %); roach, *Rutilus rutilus* (24 %); goby *Micropercops swinhonis* (5 %); stony moroco, *Pseudorasbora parva* (5 %); river freshwater shrimp, *Macrobranchium nipponense* (4 %). In some years, the proportion of different species may increase, for example, roach, stony moroco, ziege, *Pelecus cultratus*, could be main components. In the summer there were many pike perches, in the stomach of which exclusively freshwater shrimp were found (up to 30 pieces/fish).

Sex ratio:

The ratio of males to females among matured fish was nearly 1 : 1.

Maturation:

Males and females reach sexual maturity at the 2nd year of life when reaching a standard body length of 33 - 39 cm.

Spawning:

It was noted that the pike perch spawning occurred from the third decade of March until the middle of April at a water temperature of 12 - 16 °C.

Fecundity:

The individual absolute fecundity of the pike perch in Aydar-Arnasay Lake System in females of standard length 33 - 71 cm was determined by the range of 51.1 – 1259.9 thousand eggs.

Oocytes diameter:

In February matured females had gonads at stage 4; the diameter of ripe oocytes in gonads was ranged from 0.69 – 1.19 mm (at average of 0.91 mm).

DISCUSSION

With large-scale irrigation construction in arid Uzbekistan, a number of reservoirs and lakes for residual waters storage were created, including Aydar-Arnasay Lake System in the middle stream of Syrdarya river. There was no commercial species of predators in the local ichthyofauna. With this in mind, in the 1950-60s the pike perch was introduced from the Ural River **(Kamilov, 1973; Salikhov *et al.*, 2001)**., In these new lentic water bodies, stocks of

roach, *Rutilus rutilus*, and following this, stocks of the pike perch became massive. Features of the biology of the pike perch in these largest lakes system was studied in the 1960-80s **(Amanov *et al*., 1990)**. More than 15-20 generational changes took place in the conditions of the lake system.

Studies of the plastic features of freshwater fish were carried out according to certain classical measurement schemes; one of those is described by **Pravdin (1966)** for *Percidae*. Those investigations provided a lot of valuable material for assessing the intraspecific variability and plasticity of species. However, over time, they have revealed some limitations of methods. To overcome these limitations, methods of a new direction were developed, one of those is 'truss-protocol' as method of the geometric morphology of fish. These methods make it possible to characterize the body shape of fish of different species and their populations **(Strauss & Bookstein, 1982; Strauss & Bond, 1990)**. There were no such data for fishes in Uzbekistan, as a result of which we began to conduct research in this direction. The present data gave an estimate of the pike perch in the currently largest lakes of the republic.

The pike perch has a very wide range of natural distribution, and is also was introduced into many regions of Eurasia. In the literature, the pike perch have formulas for unpaired fins D_1 XIII-XVII, D_2 I-IV 17-25, A II-IV 10-15. There were noted 8–18 gill rakers on the first arch, 80–111 scales in the lateral line and 4-9 pyloric appendages. Sexual dimorphism in meristic and plastic characters has not been revealed (**Mitrofanov *et al*., 1989**; **Nauka, 2003; Kottelat & Freyhof, 2007)**. The pike perch from the Ural River were introduced into the flat regions of Uzbekistan river basins. For Pike perch in Ural River D_1 XIII – XV, D_2 I–III 19 – 23, A II – III, 11 – 13 ray formula, 85 – 103 scales in the lateral line, 11 – 15 rakers on the first gill arch were noted. Comparison of the morphological data of the pike perch in the Aydar-Arnasay system of lakes with the fish in the Ural River shows that no changes in meristic characters (which have important systematic significance) have occurred. At the same time, there are some differences in plastic features.

The pike perch habitats in fresh and brackish waters have potamodromous forms (it moves up to rivers for spawning). It is pelagic predator of open areas with a wide range of food. It keeps to surface waters, occurs at depths from 2 m to 3 m, but cases are noted - up to 30 m **(Berg, 1949; Gerstmeier & Romig, 1998; Riede, 2004)**.

Growth rates of the pike perch vary greatly between regions depending on water temperature and water body nutritional base. In the northern water bodies of Russia and Kazakhstan, yearlings reach a body length of 11 cm, in the south - up to 17 cm (**Mitrofanov *et al*., 1989** and **Nauka, 2003**).

Geographical variability in the rate of maturation was determined also: in the north of the range (in Russia) the pike perch reaches maturation at 5-7 years with a body length of 50 cm, in the south of Russia - at 3-4 years with a length of 35-40 cm **(Nauka, 2003)**. In the northern regions of Europe, populations have been noted where it reaches sexual maturity at the age of 10 years **(Kottelat & Freyhof, 2007)**. In the environments of Kazakhstan, it matures faster - in 2-4 years when the body length reaches 20 - 45 cm, males - a year earlier than females. In the Ural River, the pike perch reaches sexual maturity with a body length of 38 - 40 cm at 3 years **(Mitrofanov *et al*., 1989)**

Absolute fecundity depends on the age and size of females and varies in Russian water bodies from 70 to 1180 thousand eggs. Diameter of ripe eggs was noted as 1.0 – 1.1 mm **(Nauka, 2003)**. In the environments of Kazakhstan, a very wide variability of absolute fecundity was noted within the range of 11 - 2200 thousand eggs **(Mitrofanov *et al*., 1989)**. In our samples diameter of ripe oocytes were very similar (0.7 – 1.19 mm).

The pike perch spawning is one-time. In different regions, the time of spawning varies greatly. Spawning in Lake Onega (Russia) occurs in mid-June at a water temperature of 15 - 16 °C, in the Sea of Azov - from mid-April to early June at a water temperature of 17 - 18 °C. In Kazakhstan, spawning begins when the water warms up to 6-8°C, and occurs mainly from the end of March to the beginning of April at a water temperature of 12-15°C, in more northern regions - until the beginning of May.

Comparison of the pike perch growth rates in different parts of species area provides with useful information. In many-years studies, length without tail was used to estimate growth parameters of inland fishes including silver carp in the former-USSR, and the total length in many other countries **(Table 3)**. In Aydar-Arnasay Lake system, the pike perch growth for ages 1 through 6 years is fast in comparison with other areas of the temporary climate zone, including inland freshwater water bodies and lagoons of Turkey, Hungary, France, Estonia, Finland and Sweden **(Svardson & Molin, 1973; Goubier, 1975; Harka, 1977; Lehtonen, 1983; Gerdeaux, 1986; Mitrofanov *et al*., 1989; Kamilov & Urchinov, 1995; Kangur & Kangur, 1996; Balik *et al*, 2004** and **Kamilov *et al*., 2017)**.

Table (3): Growth of silver carp in different regions

Water body, country	Length *	Mean length in each age (cm)								Authors
		I	II	III	IV	V	VI	VII	VIII	
Gravel pit Créteil, France	**TL**	9.1	20.1	31.6	41.7	49.1	54.6	59.5		**Gerdeaux, 1986**
Lake Peipsi, Estonia	**TL**	12.7	20.7	28.8	36.7	43.0	49.1	54.3	58.5	**Kangur &Kangur, 1996**
Lake Ivösjön, Sweden	**TL**	13.8	24.8	35.2	44.2	51.1	57.0	63.5	67.7	**Svardson &Molin, 1973**
Gulf of Finland, Finland	**TL**	-	18.8	25.8	31.9	38.2	40	41.6	44.2	**Lehtonen, 1983**
Vaccares lagoon, France	**TL**	23.0	42.5	51.5	59.0	66.0	71.0			**Goubier, 1975**
Lake Eğirdir, Turkey	**TL**	18.5	24.7	30.4						**Balik *et al*., 2004**
Lake Stzetch, Hungary	**SL**	17.1	26.7	34.0	40.6	46.9	53.0	55.9		**Harka, 1977**
Ural river, delta, Kazakhstan	**SL**	15.8	23.7	30.5	35.6	41.9				**Mitrofanov *et al*., 1989**
Syrdarya river, delta, Kazakhstan	**SL**	12.1	21.9	30.3	38.3	44.4	51.0	56.9		**Mitrofanov *et al*., 1989**
Chardara reservoir, Kazakhstan	**SL**	15.9	25.3	33.7	41.9	48.8				**Mitrofanov *et al*., 1989**
Talimardjan reservoir, Uzbekistan	**SL**	17.3	28.8	38.3	44.1	48.6	51.6			**Kamilov&Urchinov, 1995**
Tudakul reservoir, Uzbekistan	**SL**	22.3	38.8	47.0	59.9	62.7	68			**Kamilov *et al*., 2017**
Aydar-Arnasay Lake System, Uzbekistan	**SL**	24.2	36.7	45.9	52.0	57.2	63.1	71.0		**Present study**

* TL – total length, SL – standard length

CONTRIBUTION OF AUTHORS IN THE ARTICLE

Materials collection and fixation works were done by D. Dekhkonova and J. Sobirov. Cameral processing, calculation, article formation by D. Dekhkonova and M. Yuldashov. Editing was carried out by B. Kamilov.

ORCID:
Dekhqonova Dilorakhon https://orcid.org/0000-0002-8361-124X
Sobirov Jobir https://orcid.org/0000-0002-4904-750X
Kamilov Bakhtiyar https://orcid.org/0000-0002-9274-8635
Yuldashov Mansur https://orcid.org/0000-0002-1597-6132

REFERENCES

Amanov, A.A.; Kholmatov, N.M. and **Sibirceva, L.K.** (**1990).** Akklimatizirovannie ribi vodoemov Uzbekistana (Acclimatized fish of water bodies of Uzbekistan). Tashkent, Fan., 116 pp. (in Russian)

Bagenal, T.B. and **Tesch, F.W.** (**1978).** Age and growth- In.: Methods For Assessment of Fish Production in Fresh Water, 3rd edition (Bagenal T.B. ed.), Oxford, Blackwell Scientific Publications, pp. 101-136.

Balik, I.; Cubuk, H.; Őzlők, R. and **Uysal, R.** (**2004).** Size composition, growth characteristics and stock analysis of the pikeperch, *Sander lucioperca* (L. 1758), population in Lake Eğirdir. Turk. J. Vet. Anim. Sci., **28**: 715-722.

Berg, L.S. (1949). Ribi presnikh vod SSSR i sopredelnikh stran (Fresh Water Fishes of The USSR and Neighboring Countries). 4th edition. Moscow – Leningrad, Izdatelstvo AN SSSR, Part 2, 458 pp (in Russian)

Campana, S.E. (**2001).** Accuracy, precision and quality control in age determination, including review of the use and abuse of age validation methods. J. Fish Biol., **59**: 197-242.

Cadima, E.L. (**2003).** Fish stock assessment manual. – FAO Fisheries Technical Paper. No 393, Rome: FAO, 161 pp.

Chugunova, NI. (**1963).** Age and Growth Studies in Fish. National Science Foundation, Washington D.C., 132 pp.

Gerdeaux, D. (**1986).** Ecologie du gardon (Rutilus rutilus L.) et du sandre (*Lucioperca lucioperca* L.) dans le lac de Créteil de 1977-1982. Etude de la ligulose du gardon, Université Pierre et Marie Curie, VI, Paris. – 161pp. (In French).

Gerstmeier, R. and **Romig, T.** (**1998).** Die Süßwasserfische Europas: für Naturfreunde und Angler. Franckh-Kosmos Verlag, Stuttgart, Germany, 368 p.

Goubier, J. (**1975).** Biogéographie, biométrie et biologie du Sandre, *Stizostedion lucioperca* (L.), Osteichthyen, Percidé, Université Claude-Bernard-Lyon I, 259 pp. (in French).

Harka, Á. (1977). Growth of pike perch (*Lucioperca lucioperca* L.) in Lake Tisza Stretch at iscafüred. – Tiscia (Szeged), **12**: 109-115.

He, Y.; Wang, R.L.J.; Blanchet, S.; Lek, S. (2013). Morphological variation among wild populations of Chinese rare minnow (*Gobiocypris rarus*): Deciphering the role of evolutionary processes. Zoological Science, **30**(6): 475-483.

Kamilov, B.; Mirzayev, U. and **Mustafayeva, Z. (2017).** Age and growth of Pike perch (*Sander lucioperca* (L.)) in Tudakul reservoir, Uzbekistan. International Journal of Fisheries and Aquatic Studies; **5**(3): 361-364

Kamilov, G.K. (1973). Ribi vodohranilisch Uzbekistana (Fishes of reservoirs of Uzbekistan). Tashkent, FAN, 234 pp. (In Russian).

Kamilov, G. and **Urchinov, Z.U. (1995).** Fish and fisheries in Uzbekistan under the impact of irrigated agriculture. In: Inland Fisheries Under the Impact of Irrigated Agriculture: Central Asia, FAO Fisheries Circular, No 894, Rome, FAO. pp. 10-41.

Kangur, A. and **Kangur, P. (1996).** The condition, length and age distribution of pikeperch, *Stizostedion lucioperca* (L.) in Lake Peipsi. Hydrobiologia, **338**: 179-183.

Klumb, R.A.; Bozek, A. and **Frie, R.V.** (**1999).** Validation of Dahl-Lea and Fraser-Lee backcalculated models by using oxytetracycline-marked blue gills and blue gill x green sunfish hybrids. NAJFM., **19:** 504-514.

Kottelat, M. and **Freyhof, J. (2007).** Handbook of European Freshwater Fishes. Publications Kottelat, Cornol and Freyhof, Berlin, 646 pp.

Lagler, K. F., Bardach, J.E., Miller, R.R., Passino, D.R.M. (1977). Ichthyology. Wiley, New York, 528 pp.

Lehtonen, H. (1983). Stocks of Pike perch (*Stizostedion lucioperca* L.) and their management in the Archipelago Sea and the Gulf of Finland. Fin. Fish. Res., **5**: 1-16.

Mirzayev, U.T. and **Kamikov, B. (1993).** Kharakteristika vosproizvoditelnoy sposobnosti samok sudaka Yujnosurkhanskogo vodokhranilischa (Characteristics of the reproductive ability of female Pike perch of the Yuzhnosurkhansky reservoir). Uzbeksky biologichesky Jurnal, **1**: 59 – 61.

Mitrofanov, V.P.; Dukravec, G.M. ***et al*****, (1989).** Ribi Kazakhstana. In 5 volumes.Volume 4. (Fishes of Kazakhstan) Alma-Ata, Nauka, 312 p. (in Russian)

Moyle, P.B. and **Cech, J.J.Jr. (1981).** Fishes: An Introduction to Ichthyology. Prentice Hall, Englewood Cliffs, New Jersey, 744 pp.

Murta, A.G. (2000). Morphological variation of horse mackerel (*Trachurus trachurus*) in the Iberian and North Africa Atlantic: implications for stock identification. ICES J. Mar. Sci., **57**: 1240– 1248

Nauka, (2003). Atlas presnovodnikh rib Rossii (Atlas of freshwater fishes of Russia). In 2 volumes. Volume 2. Moscow, 253 p. (in Russian)

Pravdin, I.F. (1966). Rukovodstvo po izucheniyu rib (preimuschetvenno presnovodnikh) (Guide to The Study of Fish (mainly Freshwater)). Moscow, Pischevaya promishlennost', 376 p. (in Russian).

Riede, K. (2004). Global register of migratory species - from global to regional scales. Final Report of the R&D-Projekt 808 05 081. Federal Agency for Nature Conservation, Bonn, Germany, 329 pp.

Salikhov, T.V.; Kamilov, B.G. and **Atadjanov, A.K. (2001).** Ribi Uzbekistana (Fishes of Uzbekistan). Chinor ENK, Tashkent, 152 pp. (In Russian).

Silva, A. (2003). Morphometric variation among sardine (*Sardina pilchardus*) populations from the northeastern Atlantic and the western Mediterranean. ICES J. Mar. Sci., **60**: 1352–1360

Strauss, R.E. and **Bond, C.E. (1990).** Taxonomic Methods: Morphology. Chapter 4 In: Methods for Fish Biology, Carl B Schreck; Peter B Moyle editors, Bethesda, Md., USA: American Fisheries Society, pp. 109 – 140.

Strauss, R.E. and **Bookstein, F.L. (1982).** The truss: body form reconstruction in morphometrics. Syst. Zool., **31**(2): 113 – 135.

Svardson, G. and **Molin, G. (1973).** The impact of climate on Scandinavian populations of the zander (*Stizostedion lucioperca* L.) Inst. Freshwater Res. Drottningholm Rep., **53**: 112-139.

Turan, C.; Oral, M.; Öztürk, B. and **Düzgünes, E. (2006).** Morphometric and meristic variation between stocks of Bluefish (*Pomatomus saltatrix*) in the Black, Marmara, Aegean and northeastern Mediterranean Seas. Fish Res., **79**: 139–147

Yuldashov, M., Kamilov, B. (2018). Rezultati introdukcii chujerodnikh vidov rib v vodoemi Uzbekistana (Results of introductions of alien fish species into water bodies of Uzbekistan). – Nauchnii trudi Dal'ribvtuza, **44**(1): 40 – 48 (in Russian)