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ENVIRONMENTAL CONDITIONS OF COMMON STURGEON (*Acipenser sturio* L.) SPAWNING IN RIVER RIONI (GEORGIA)*

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ABSTRACT

Environmental conditions in River Rioni (Georgia) were studied in two seasons, during purported spawning migrations of the common sturgeon. Water temperature and flow velocity were measured in the vicinity of Poti (downstream section of the river) and in the potential spawning areas. At comparable times, water temperature in the spawning grounds was by a few degrees lower than that downstream, the flow velocity being higher and ranging within 1.5 - 2.1 m s^{-1}. As shown by the observations, the area suitable for the sturgeon spawning had shrunk, possibly as a result of river damming. In the areas suitable for the common sturgeon spawning, the river bed was covered by coarse gravel and flattened stones, those measuring up to 30 mm in diameter being most abundant.

Due to deteriorating spawning conditions and intensive poaching, the Black Sea population of the common sturgeon is threatened by extinction.

Key words: endangered fish species, common sturgeon, *Acipenser sturio*, Black Sea, natural spawning, environmental conditions.

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INTRODUCTION

In the beginning of the 20th century, the common sturgeon (*Acipenser sturio* L.) was found occurring along the entire coastline of Europe, from the White Sea to the Norwegian, North, Baltic Seas, Atlantic, the Mediterranean Sea to the Black Sea [1, 3, 4, 8]. There was also a local freshwater common sturgeon population inhabiting the lakes Ladoga and Onega [7, 14]. In the Baltic Sea basin, the Odra and Vistula and their tributaries were the major rivers the sturgeon entered to spawn [8]. Intensive fisheries and deteriorating environmental conditions caused the common sturgeon population to dwindle to such an extent that, in the 1920s, the species was regarded as endangered within the Baltic basin [8]. In spite of legal protection the species received, its population was observed to decline further. In the second half of the 20th century, capture of single individuals only were reported [7, 12, 14, 16, 22].

At present, there are but two small common sturgeon populations that reproduce under natural conditions: the Atlantic population with a spawning ground in the Gironde and the Black Sea population ascending River Rioni (Georgia) to spawn [4, 5, 13, 15]. While the state and spawning conditions of the Atlantic population are well studied [2, 9, 18, 19], the situation of the Black Sea population is not clear because research on its size and spawning conditions in the Rioni ceased in the early 1990s.

The present paper is aimed at presenting an assessment of current conditions for the natural spawning of the common sturgeon, a particular attention being paid to the occurrence and state of the spawning grounds.

MATERIALS AND METHODS

Studies on and observations of spawning conditions were carried out during expeditions to River Rioni, undertaken by the present authors in late April-early May 2000 and in May 2002. During the first expedition, the area in the vicinity of Poti, i.e., the downstream section of the River, its delta, and the mouth area, was explored. During the second expedition, observations were begun near Poti and continued in the spawning grounds located mid-stream; the expedition was terminated by a river-borne trip to the Rioni confluence with the Black Sea.

Water temperature and flow velocity were measured during both expeditions. The temperature was measured (to 0.1°C) twice a day (at 7:00 and 19:00 hours) in the main part of the stream, at about 0.5 m depth, with a thermometer graduated over 0-30°C. The average of the two measurement was regarded as the diel temperature. Water flow was determined by measuring the time necessary for an object to float along a 10-m long reference section situated along a straight stretch of the river. Three measurements were usually taken and an arithmetic mean was calculated.

During the second expedition, sturgeon spawning grounds were surveyed; the surface area of a spawning ground was estimated and the bed morphology was examined. Sediment samples were collected with a corer. Bedload granulometry was analysed by splitting a sediment sample into pre-determined grain size fractions and calculating percentages the fractions contributed to the total sample weight. The grain size analyses were run on sediment collected from three randomly selected 1m^2 surface area sites located in the river bed sections lacking any obstacles. A mean of three measurements served as a basis for further calculations.

AREA OF STUDY

As already mentioned, the study was carried out in the 327-km long River Rioni (Georgia) which has its sources at the feet of glaciers descending along the southern slopes of the Caucasus (Fig. 1). The Rioni flow rate varies throughout the year, the long-term mean flow rate, as measured downstream, increasing from 244 $m^3 s^{-1}$ in September to 581 $m^3 s^{-1}$ in June. In individual years, the flow rate variability is even more extensive, the extreme values being as low as 100 and as high as 3000 $m^3 s^{-1}$ [11]. Flow velocity changes proportionally to the flow rate and, in the downstream part of the river, may vary from less than 1.0 to 2.5 m s^{-1}.

Fig.1. River Rioni drainage

The Rioni empties into the south-eastern part of the Black Sea, near the harbour city of Poti. The river discharges via two channels, the norther channel running north of Poti and the southern one cutting through the city, for which reason the channel water quality is poor. The flow rate in the channels is controlled by a system of sluices (Plate 1) which present no obstacle to fish migrating to spawn. The northern channel discharges much more water than the southern one does. Moreover, the northern channel is deeper than the southern one, so it is more suitable for the sturgeon to ascend. Before it reaches the sea, the northern channel splits into two branches (Plate 2), each dividing into smaller ones. Consequently, the Rioni delta contains a number of islands most of which are ephemeral structures.

Plate 1. Sluices controlling water flow in the northern and southern channels of River Rioni delta

Plate 2. Northern part of the rion delta

According to the existing knowledge, sturgeon spawning grounds were located near Samtredia, i.e., about 120-130 km upstream from the Rioni mouth (Fig. 1) [10, 11, 21]. The upstream boundary of the spawning area was formed by a cascade of four dams serving the power stations situated near Vartsikhe (Fig. 1), the downstream boundary being the confluence of River Tshanis-Tshkali. In spring, the Tshanis-Tshkali carries a considerable load of loess, for which reason the Rioni bottom dowstream of the Tshanis-Tshkali confluence is covered by a layer of silt [13].

RESULTS AND DISCUSSION

During the first season of observations, the Rioni water temperature showed an increasing trend in April so that late in that month the water was warmer than 16°C (Fig. 2). This turned out to trigger the spawning migrations of warm-water sturgeon species (the Persian sturgeon, *A. persicus colchicus* Marti and the stellate sturgeon, *A. stellatus* Pallas), fairly frequently caught by local fishermen [6]. The water temperature at that time was too high for the common sturgeon to spawn, the species' spawning migration upstream beginning at a temperature of 12–14°C. In early May, the water temperature dropped rapidly as a result of intensified meltdown of snow higher up in the mountains. In consequence, the sturgeon spawning migration was slowed down. The fast increase in the amount of water in the river resulted in flow acceleration to 1.7 m s^{-1} (Fig. 2) and in a further drop in water temperature. As shown by Fig. 3, an inverse relationship between water temperature and flow veclocity is observed at velocities exceeding 1.0 m s^{-1}. At higher flow velocities in the spring, the downstream water temperature is controlled rather by the influx of cold water produced by the snow melting higher up in the Caucasus than by air temperature which may at that time be by 5 – 7°C higher than the water temperature. In spring, particularly during the rapid increase in flow rate, the water takes up a dark-beige hue (Plate 2), the transparency decreasing virtually to null. On such occasions, the Rioni water may contain up to 4.1 mg SiO_2 dm^{-3} and up to 1.2 mg Mn^{+2} dm^{-3}, the salt content being even as high as 300 mg dcm^{-3} [11, 21].

Fig. 2. Changes in River Rioni water temperature and flow velocity during the first study season

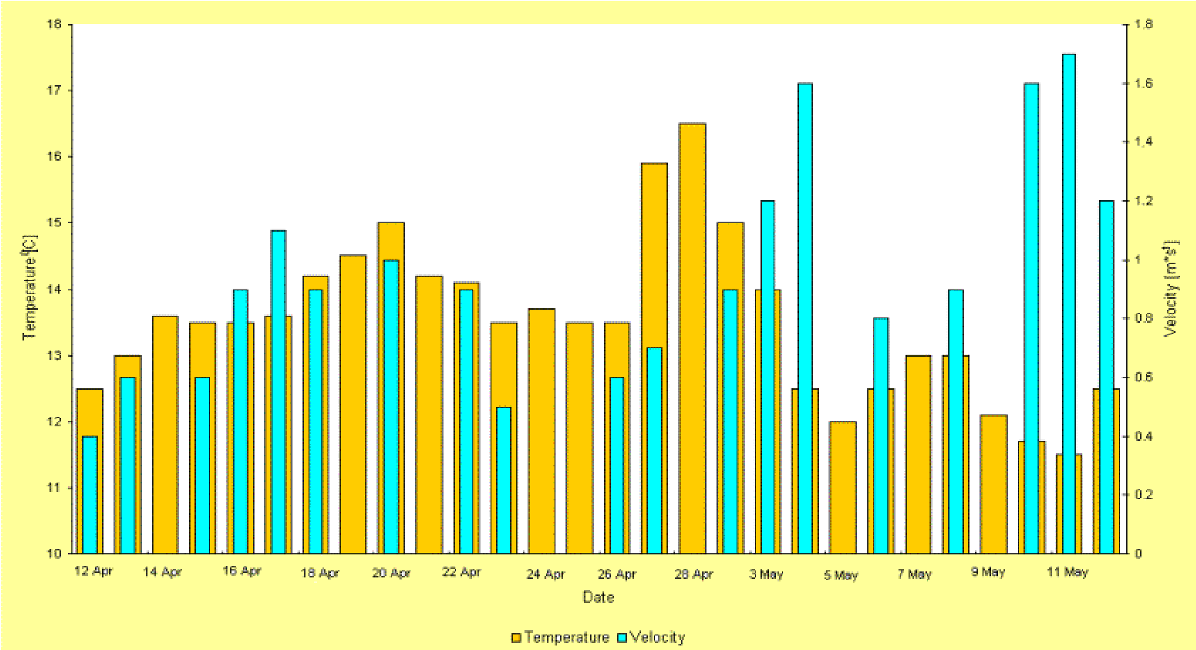
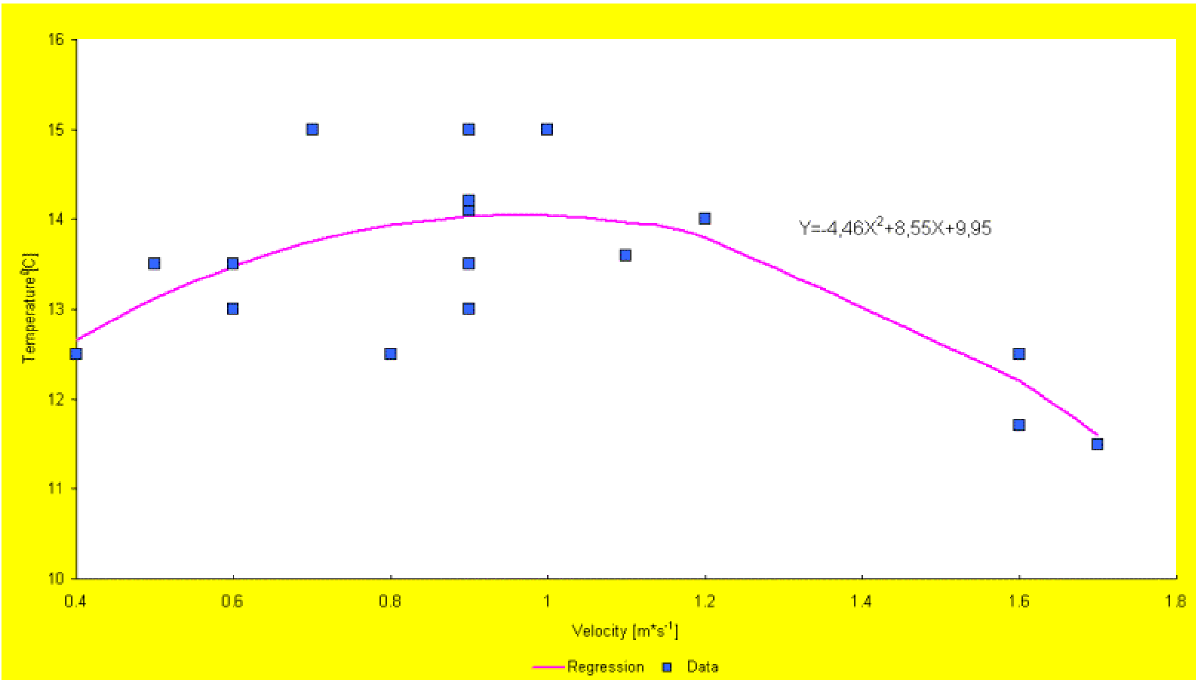


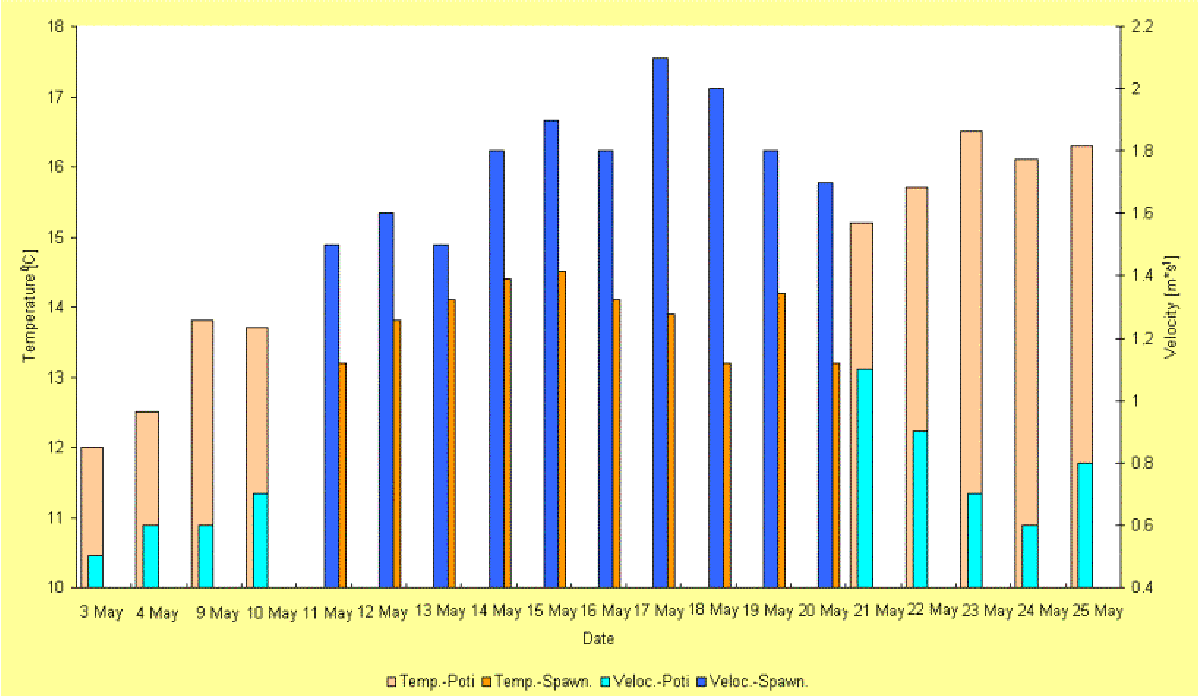
Fig. 3. A relationship between water temperature and flow velocity in River Rioni



Measurements taken at the spawning grounds showed that the water temperature there could be by 1-3°C lower than that recorded near Poti (Fig. 4). This finding supports earlier observations of Zarkua [21] who noted still higher differences, up to 7.5°C in April.

The upstream Rioni flow velocity is high, compared to that recorded downstream (near Poti). In the spawning grounds, the flow velocity changed from 1.5 to 2.1 m s^{-1} (Fig. 4), the minimum and maximum velocities downstream being, in the first season of the study, 0.5 and 1.1 m s^{-1}, respectively (Fig. 2); the corresponding velocities in the second season were 0.4 and 1.7 m s^{-1} (Fig. 4). Due to the high flow velocity, the sturgeon have to allocate a considerable amount of energy to migration because, considering the flow, the fish have to cover a distance 10 times longer than that measured directly along the shore [11].

Fig. 4. Changes in River Rioni water temperature and flow velocity during the second study season



Apart from weather changes, river damming for the purpose of power station operation was another cause of the high variability of flow velocity in the spawning grounds. Dam maintenance was carried out with no regard whatsoever to the needs of the fish ascending to spawning grounds and to those already there. Consequently, the water level was observed to vary greatly over the diurnal cycle, the variations being as wide as 0.4 m in amplitude. At low water levels, extensive swaths of the river bed were exposed (Plate 3). The rapidly changing flow velocity and the concomitant water level variability must have affected the sturgeon spawning migration, the spawning itself, and its success.

Plate 3. River Rioni water colour during the spring spat

The river bed fragments exposed during the lowest water levels allowed the bed cover material and structure to be directly examined (Plate 4). The spawning area bed was covered by coarse gravel and flattened, well-polished stones; most numerous were those measuring up to 30 mm in diameter (Table 1). Observations showed this type of river bed to be prevalent along an about 17-km long stretch, i.e., from the confluence of the Sulori to about 5 km before the bridge near Samtredia (Fig. 1). Upstream of the Sulori confluence, the high flow velocity resulted in preponderance of larger stones, the gravel and stones just before the bridge being covered by a layer of silt. It can be therefore concluded that the river stretch in question offers conditions conducive to the common sturgeon spawning. However, due to the small depth and a considerable water velocity (in excess of 2.5 m s^{-1}) in the Rioni between confluence of the Sulori and Akhali Sopeli, conditions optimal for the common sturgeon spawning prevail downstream of the latter place. The river in that part is about 200-250 m wide and 2 - 4 m deep. In the spawning area zone, the river bed splits to form islands, thus producing more hydrological variability and offering the fish a chance to select optimal spawning sites.

Plate 4. Exposed surfaces of the Rioni bed near sturgeon spawning grounds

Table 1. Per cent contributions of selected grain size fractions of gravel covering the River Rioni bed in sturgeon spawning areas

Grain size range (mm)	Percent contribution
<10	27.5
10 – 20	41.7
20 – 30	19.2
30 – 40	8.7
40 –50	2.9

The study has demonstrated that, compared to earlier observations, the area suitable for the common sturgeon spawning in the Rioni had shrunk substantially. Tikhiy [17] and Marti [10] found the sturgeon spawning grounds to extend from the railway bridge downstream of Samtredia to the area upstream of the Sulori confluence. In the early 1990s, Zarkua (unpublished data) found the river stretch meeting the sturgeon spawning needs to have shrunk by about 5 km, mostly due to the construction and operation of the already mentioned dams near Vartsikhe. According to local fishermen, particularly detrimental for the quality of spawning grounds were discharges from the retention reservoir upstream of the dam, whereby the reservoir was being prepared for intercepting the spring meltwater. During the final phase of preparations, the reservoir discharges large amounts of fine sand and silt it has accumulated, the fine-grained material being deposited in the river bed where flow velocity is lower. This in turn leads to shrinking of the extent of areas suitable for sturgeon spawning.

SUMMING UP

It has to be emphasised that the small population of the Black Sea common sturgeon is still highly endangered. One of the factors increasing the threat of extinction is the deterioration of conditions for reproduction, i.e., reduced spawning ground areas and unstable hydrological conditions. Another important factor is the poaching that, in spite of legal measures and actions of the so-called ecological police, goes on particularly intensively during the sturgeon spawning migrations. It seems then that the active protection of the Black Sea population of the common sturgeon is its only chance for persistence. The active protection measures should involve artificial spawning of the fish captured in the Rioni, egg incubation, and rearing of the hatch and larvae under controlled conditions; a small fractions of the juvenile fish could be used to build up a broodstock.

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