

## Artificial rearing of Sakhalin taimen (*Parahucho perryi*) on salmonid fish farms in the district of Sakhalin region (Russia)

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**Abstract.** This paper presents the history and the results of rearing *Parahucho perryi* (Brevoort) under commercial conditions at salmonid fish farms in the district of Sakhalin. Experimental work was conducted at five fish farms where fish originating from ten rivers were reared. The optimal temperature range during egg incubation and larval rearing was 8-10°C. Visible eye pigmentation was noted, on average, after 24 days of incubation, and the larvae hatched between days 34 and 54 of incubation. Egg fertilization rates were high at 89.2-98.2%. High losses during the egg incubation and larval hatching stages indicate that the methods applied must be optimized.

**Keywords:** conservation, endangered species, *Parahucho perryi*, rearing, Russia

Sakhalin is the most important region in the Russian Federation for rearing fish of the genus *Oncorhynchus* with 85% of the stocking material of these fish produced there. Currently, 38 salmonid farms that use a variety of fish rearing techniques are in operation in this region. The primary species

reared are *Oncorhynchus gorbuscha* (Walbaum) and *Oncorhynchus keta* (Walbaum) because of their commercial importance. In the early 1990s, rearing experiments were initiated with a few new species, including, among others, *Oncorhynchus kisutch* (Walbaum), *Oncorhynchus masou* (Brevoort), and *Oncorhynchus nerka* (Walbaum). Sakhalin taimen, *Parahucho perryi* (Brevoort), is a fish species from the family Salmonidae that is threatened with extinction (Rand 2006). This endangered species occupies a relatively small range, including the islands of Sakhalin, Hokkaido, Iturup, and Kunashir, and a section of the continental coast of the Tartar Bay (Fukushima et al. 2011, Zolotukhin et al. 2013). Sakhalin taimen is subject to stronger anthropogenic stress in the Russian part of its range, particularly from poaching, commercial fishing by-catch, and recreational fishing. The Sakhalin taimen population from Sakhalin Island was listed in the Red Book of the Russian Federation in 1997 under category 2 as endemic to the Far East and with decreasing population abundance (Anonymous 2001). Rearing stocking material of this species under controlled conditions is being conducted as part of projects to conserve this species. This short communication presents the history and results of the artificial rearing of *P. perryi* conducted at commercial fish farms.

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The decreased abundance of the Sakhalin population of *P. perryi*, which was noted especially distinctly in areas close to human populations and those that are readily accessible, required implementing conservation measures and artificially supplementing the stocks of this species (Khatkevitch 1973, Zelenkin and Fedorova 1997, Ivanova et al. 2001, Korablina and Ivanova 2001). Commercial biotechnologies were developed, and *P. perryi* broodstocks were built mainly at the fish rearing facilities of the company OOO Salmo. In 1996-1997, the Sakhalin Fish Farm, at the request of taimen fish farmers from Adzigasava (Japan, Aomori District, Honsiu Island), conducted the Taimen Program, which entailed transferring a small portion of fertilized eggs to Japan in order to counteract spawning stock inbreeding. Experimental laboratory work was also conducted in the aquariums of SakhNIRO.

Experimental rearing was conducted at five fish farms at which fish originating from ten rivers in the Sakhalin region were reared. At all farm, the broodstock numbered more than 50 fish of both sexes from which approximately 70,000 eggs were obtained and incubated. Egg incubation and larval rearing were performed based on guidelines for other salmonid species (Smirnov 1963) and Japanese experiments. The fish were mated according to the spawners caught, and often the sperm of two to four males was used for one female. Adult spawners were anesthetized with a solution of 2-phenoxyethanol for two to three minutes, during which the gametes were stripped, and then fertilization was performed using the semi-dry method within three minutes. The rinsed, fertilized eggs were left for 2.5 hours to swell in running water, then spread out on frames, and then fixed in 0.5% formalin solution. The frames containing the eggs were placed in Atkins apparatuses. After the

gamete stripping procedure, the spawners were released back into their natural habitats. Fertilization and placing the eggs in the incubation chambers took place from May 5 to 27. The temperature throughout the observation period ranged from 5.4 to 10.5°C, and the oxygen content in the water was 8.6-12.8 mg l<sup>-1</sup>. It was confirmed that rapid decreases in temperature and oxygen content lead to increased egg and larva losses (Korablina and Ivanova 2001).

During the series of experiments, the tolerance range and optimal rearing conditions of all egg stages of this species were determined. The optimal temperature range during incubation and larval rearing was 8-10°C. Eye pigmentation was noted, on average, after 24 days of incubation, and hatching occurred between days 34 and 54 of incubation (Table 1). Despite the large percentage of fertilized eggs (89.2-98.2%), losses during egg incubation and at the larval hatching stage were very large at 13.0-48.6% and 6.5-93.0%, respectively. Despite spawning at low temperatures, the developing embryos were sensitive to them. Excessively low water temperatures during incubation (5-7°C) had a negative impact on larval development and survival. Retarded embryonic development led to difficulties during the shift to exogenous feeding, and, consequently, juvenile fish were characterized by low quality parameters prior to the overwintering period and survival was less than 50%.

The current stage of the Sakhalin taimen culture program began in 2012 at the Okhotsk Fish Farm in the Lake Tunaicha basin. Two sexually mature female and four male spawners were caught with gillnets in the lake on April 25. The water temperature during the catch was approximately 6°C, and the oxygen content was approximately 10.5 mg O<sub>2</sub> dm<sup>-3</sup>. The spawners were first kept in a cage in a stream, and were then transported to the Okhotsk

**Table 1**

Mean (range) stages of embryonic-larval development of Sakhalin taimen (*Parahucho perryi*) at Lesnoy Fish Farm

Development sage	Dates	Time of development (days)	Age (degree-days)
Eye pigmentation	11.06 (7-15.06)	24 (18-28)	193.7 (167.0-220.5)
Hatching	23.06 (21-27.06)	41 (34-54)	345.7 (314.6-390.1)
Swimming	26.07 (24-31.07)	74 (68-83)	652.9 (625.5-706.7)

Fish Farm in a specially adapted car. On May 9, a total of 9,300 eggs were obtained from the females, but sperm quality was low since the males had matured earlier, and only about 4,000 eggs were fertilized. Incubation to the eyed-egg stage was done at a mean temperature of 7.7°C. After hatching the mean larval size was 23 mm at a mean weight of about 150 mg. The mass onset of swimming occurred on August 12 on day 95 of incubation at the age of approximately 720 degree-days. On January 31, 2013, the mean total length of the juveniles was 50 mm, and the mean weight was about 1 g.

Artificial breeding should occupy an important position among conservation strategies for Sakhalin taimen, and it should mimic natural conditions as fully as possible while taking into consideration the biological specificities of all taimen life cycle stages (Makeev 2012). Methods of reintroducing this species into river systems in which it has become extinct or is critically endangered should be given special attention, and techniques for monitoring the state of populations are also important.

**Author contributions.** S.M., V.S., P.S., I.B., and K.P. designed and performed the research, S.M. wrote the paper.

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