STUDY OF GONADOSOMATIC INDEX OF *SALMO OHRIDANUS* STEINDACHNER FROM OHRID LAKE

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Abstract
With the aim to investigate the gonadosomatic index of Ohrid belvica (*Salmo ohridanus,* Steindachner, 1892), investigations were conducted on individuals captured in vegetative and reproductive development period of belvica, on three localities of Ohrid Lake: Kalista, Kaneo and Elesec, on depth from 45 to 70 m. Samples for researching have average body mass from 90 to 100 g and average total body length from 217 to 225 mm. The gonadosomatic index is the ratio of fish gonads weight to the body weight. It was found that this ratio varies from 0.12 to 6.77 for the three localities during the two stages of development, or that is an average of 0.14 to 5.86. High gonadosomatic indexes were recorded in the reproductive development period, which suggested the spawning period.

Keywords: *Salmo ohridanus*; gonadosomatic index.

Introduction

Ohrid belvica (*Salmo ohridanus*, Steindachner, 1892) as one of the representatives of "living fossils" represents tertiary relict and endemic trout species belonging to macrostom salmonids and lives only in Ohrid Lake. It is a small endemic trout which represents expressively a lake and depth type of fish. Fish body weight and weight of gonad gives the gonadosomatic index (GSI). It is the ratio of fish gonad weight to body weight, and it is particularly helpful in identifying days and seasons of spawning, as the ovaries of gravid females swiftly increase in size just prior to spawning. The ratio determination between the gonad weight and the body weight of various fish species has been studied by many authors (Kompowski, 1982; Witkowski et al., 1989; Heese, 1990; Chelkowski et al., 1990; Chelkowski, 1992; Karabanowicz & Kompowski, 1994; Kompowski & Blaszczyk, 1997; Roesch, 2000; Neja & Kompowski, 2001; Dziewulska and Domagala, 2003; Czerniejewski et al., 2004; Ghanbahadur & Ghanbahadur, 2012; Sadekarpawar & Parikh, 2013; Ghanbahadur et al., 2013; Jan&Ahmet, 2016). Most of the authors concluded that the development and growth of gonad simultaneously take place in the fish and fish grows and the GSI is high. Gonadosomatic index of fish is related to spawning and reproduction of fish. At maturity stage fish has maximum GSI value and after spawning the GSI value declines. The GSI value, also, is related to the amount of food available to them in water and temperature of water also. So, generally, during the breeding season, *Salmo ohridanus* shows maximum GSI value and after spawaning it is reduced. This paper presents the data for the seasonal changes in gonadosomatic index (GSI) of vegetative and reproductive development period of Ohrid belvica from the lake of Ohrid.

Material and methods

Investigations were conducted on fish species from Ohrid belvica (*Salmo ohridanus,* Steindachner, 1892). The samples were captured in vegetative and reproductive development period of Ohrid belvica, on three localities of Ohrid Lake: Kalista, Kaneo and Elesec, on depth from 45 to 70 m. Tests were performed on 15 samples of each locality and each phase of development or a total of 90 fish. Samples for researching have average body mass from 90 to 100 g and average total body length

from 217 to 225 mm. The whole body weights, the eviscerated body weights of the examined fish and the weight of gonads were measured to 0,01 g. The gonad development was presented (after Nikolski, 1961 quoted by Pravdin, 1966) by means of the gonad maturity coefficient:

$$q = \frac{g_1}{g} \times 100$$

where: q = gonad maturity coefficient; g_1 = gonad weight; g = total fish weight.

Coefficient of relative gonads size was calculated using the following formula (Chełkowski, 1974):

$$I = \frac{i}{G} \times 100$$

where: I = coefficient of relative gonads size; i = gonad weight in g; G = eviscerated body weight (weight of the gutted fish in g).

The data obtained from measurements are processed by the method of the smallest squares, and the results consist of the arithmetic mean ($\overline{X}$), standard deviation (SD), coefficient of variation (Cv) and differences in $\overline{X}$.

Results and discussion

The gonadosomatic index (GSI) is expressed from the gonad maturity coefficient and the coefficient of relative gonads size. Gonad maturity coefficient is the ratio of fish gonad weight to the total body weight. Coefficient of relative gonads size is the ratio of fish gonad weight to the weight of the gutted fish. Gonad maturity coefficient and the coefficient of relative gonads size, separately for the vegetative and reproductive stage of development of the Ohrid belvica, are shown in Table 1 and Graph 1.

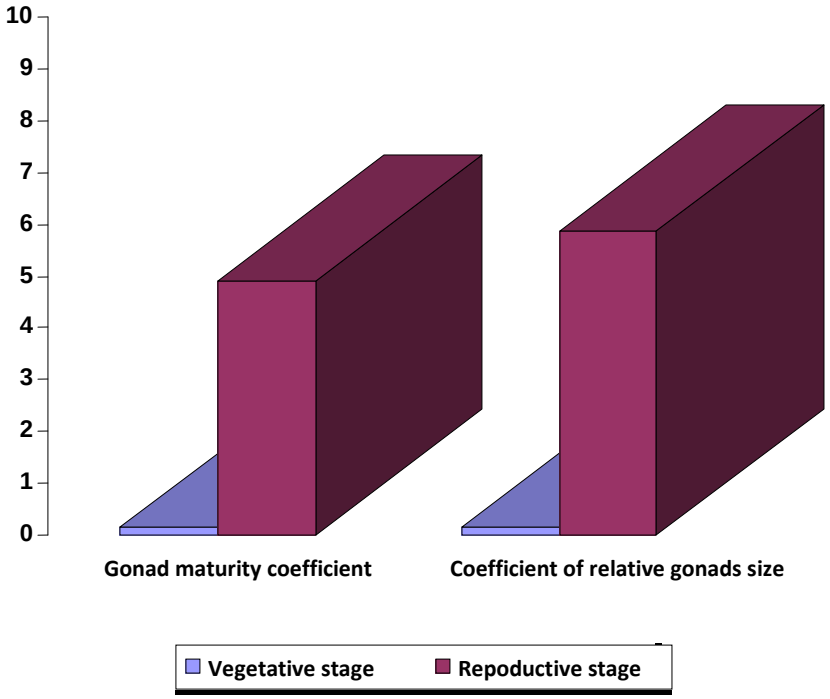
Table 1. Gonad maturity coefficient and coefficient of relative gonads size

Stage	Gonad maturity coefficient			Coefficient of relative gonads size		
	$\overline{X}$	SD	CV	$\overline{X}$	SD	CV
Vegetative stage	0,14	0,01	7,14	0,16	0,02	12,50
Reproductive stage	4,90	0,67	13,67	5,86	0,84	14,33

Gonad maturity coefficient for the investigated period of the individuals in the vegetative stage of belvica was 0.14 (0.12 – 5.60) and for the individuals in the reproductive stage – 4.90 (3.86 – 5,60). Coefficient of relative gonads size in the vegetative stage of belvica was 0.16 (0.13 – 0.18), and in reproductive stage – 5.86 (4.63 – 6.77).

The results from examination the gonadosomatic index, that is, the gonad maturity coefficient and coefficient of relative gonads size, show that the participation of gonads in the total mass of fish and in the eviscerated fish, in the reproductive stage are higher compared to the vegetative. The differences between the stages in the participation of gonads are significant ($P<0.05$). These differences are expected, because in the reproductive phase, gonads reach their maximum growth, i.e. they are sexually matured and their mass is greater. The gonadosomatic index expresses the relative change in gonad weight to the percentage of body weight. However, the unequal intensity of fish feeding during the year, is more accurate if the weight of the gonads is expressed as a percentage of the weight of the fish without the internal organs, thus avoiding the error that would arise as a consequence of the intensity of the diet at the moment of catching (Janković, 1958). The ratio of the gonad weight and the total weight of the fish Pravdin (1966) and Heese (1990) call the gonad maturity coefficient, and Witkowski et al. (1989) use the term gonadosomatic index. The relation of the gonad weight and the weight of the fish without internal organs (eviscerated fish)

Chełkowski (1974) is called as a coefficient of relative gonads size or relative gonad weight. Both relationships are parameters that have practical significance because according to them, they can judge the readiness of the population for spawning.



Graph 1. Gonad maturity coefficient and coefficient of relative gonads size

Much higher values for these coefficients (4.90 and 5.86, respectively) were found in the reproductive phase (winter period), when most of the examined individuals had maximally developed gonads (Table 1). This is, in fact, the time when most of the population of Ohrid belvica is found before the spawning or during the active spawning. In the vegetative stage of development of Ohrid belvica (autumn period), lower values of the coefficients (0.14, or 0.16) are determined, because then the weight of the gonads is small. According to Rakaj and Flloko (1995), the gonadosomatic index in the maximal development of ohrid belvica reaches 22 to 23% of the body's weight.

Conclusions

Based on the results of determination the gonadosomatic index of Ohrid belvica from three localities of Lake Ohrid, during the vegetative and reproductive stage, following could be concluded:

- The ratio of fish gonads weight to the body weight varies from 0.12 to 6.77 for the three localities during two stages of development, or that is an average of 0.14 to 5.86.
- High gonadosomatic indexes were recorded in the reproductive development period, which suggested the spawning period.

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