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GROWTH OF THE GOLDEN SPINED LOACH, *SABANEJEWIA AURATA* (FILIPPI, 1865) IN RIVER TISZA (EASTERN HUNGARY)

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Abstract.The paper presents data on the growth of golden spined loach, obtained on the basis of the study of 91 fish specimens. The study material was collected from an isolated lock chamber, at the same time and without any selection. Hence, its size and age distributions seem to represent those of the population well.

There were 78 first-year, 12 second-year and 1 third-year fish among the collected specimens. Their standard lengths ranged from 25 to 71 mm, their body weights, from 0.12 to 4.41. According to our results, the average standard length of the fish at age t (L_t in mm) can be expressed with the equation $L_t = 92[1-e^{-0.505(t+0.01)}]$.

There is no significant difference between the growths of males and females. Both body length and body weight increase intensely in the second year. Hence, the biomass of the second-year age group is well above that of the first-year fish, in spite of the high mortality.

The reach of the Tisza studied by us is dammed, and thus, environmental conditions are not optimal for golden spined loach. In addition, the population suffered damages also from the cyanide spill that polluted the river in February 2000. Though, the survival of the population is not in danger, as the species reaches maturity by the second-year age, and thus, there is an adequate proportion of mature specimens.

Keywords: Sabanejewia bulgarica, Bertalanffy's model, age structure, mortality, production

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Introduction

The species *Sabanejewia aurata* was first described from the territory of Hungary by Jászfalusi (1948) who classified the specimens found in the Tisza at Kőtelek into the subspecies *S. a. bulgarica*. Many authors accept the existence of the subspecies (Jászfalusi 1948, 1951, Bănărescu 1964, Bănărescu *et al.* 1977, Balon 1967, Terofal 1997) but consensus has not yet been developed in this respect. Numerous authors use only the species name *Sabanejewia aurata*, omitting the subspecific epithet (Müller 1983, Povž and Sket 1990, Györe 1995, Harka 1997, Spindler 1997), while Kottelat (1997) considers valid the species name *Sabanejewia bulgarica*.

Golden spined loach is legally protected in Hungary from 1974. At that time, its occurrence was proven only in the rivers Tisza (Jászfalusi 1948, Csizmazia *et al.* 1965) and Danube (Tóth 1971), but since, it has been detected from numerous rivers of Hungary (Harka 1986, 1997,; Sallai 1999a, 1999b). Due to the secretive habits and relative rarity of the species its biology is little known, no data on its growth rate have been available to us up to the present.

Material and methods

The study material consisted of 91 fish specimens collected between September 13 and 24, 2000, from the lock chamber of an irrigation canal branching off from the Tisza at Tiszafüred. Nets with mesh size of 3 mm were used for sampling in order to include even the smallest specimens.

Standard (L_c) and total length (L_t) measurements were done to the nearest millimetre, measurements of weight (W) to the nearest 0.01 g. The length-weight relationship was calculated by the formula $W = a \cdot L^b$, proposed by Tesch (1968). Age was estimated using the Petersen method, on the basis of the length frequency distribution, but older specimens were aged reading the annuli of the opercular bone. Sex of the adults was determined on the basis of the lateral distension of the body present in the males. The results were corroborated by dissecting the animals and examining their gonads.

The Walford (1946) method and the Bertalanffy (1957) model, suggested by Dickie (1968), were applied for mathematical description of the growth. Condition factors (CF) were calculated following Hile (1936), biomass (B) and production (P) according to Chapman (1968). The Microsoft Excel '97 programme was used for statistical evaluation of the data.

Result

Standard lengths of the fish ranged from 25 to 71 mm. Total lengths varied between 29 and 82 mm, body weights between 0.12 and 4.41 g. The equation describing the length-weight relationship in the golden spined loach population was $W = 3 \cdot 10^{-6} Lc^{3.2753}$ in case of standard length, $W = 10^{-6} Lt^{3.3779}$ for total length (Fig. 1).

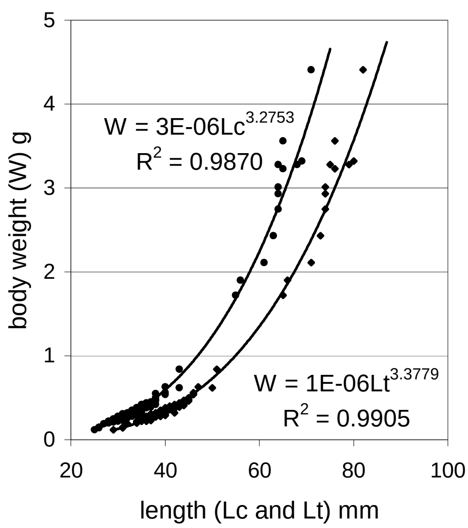

Fig. 1. The length-weight relationships

Considering that total length often figures in the results of growth studies, the relationship between the two lengths was determined in order to facilitate the conversion. The equation describing this relation is $Lt = 1.1403Lc + 1.3946$.

Length groups were formed from the standard length data of the collected specimens using 5-mm intervals. Presenting their frequency in a diagram, first-year (25 to 44 mm) and older age groups are clearly separated (Fig. 2).

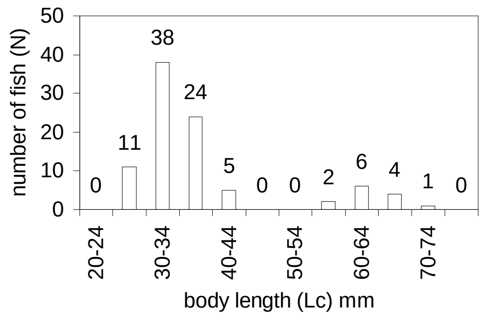

Fig. 2. Length-frequency of golden spined loach

Based on the study of the operculum, 12 of the 13 older specimens proved to be second-year (1+), and 1 to be third-year (2+). Five males were found among the second-year fish, with a mean standard length of 62.6 mm, and body weight of 2.82 g. In case of the seven females, the respective data were 63.6 mm and 2.78 g. The only third-year fish proved to be a male. The exponentially decreasing trend in the numbers of individuals in the age groups can be expressed by the equation $N = 762.99 \cdot e^{-2.1784}$ (Fig. 3).

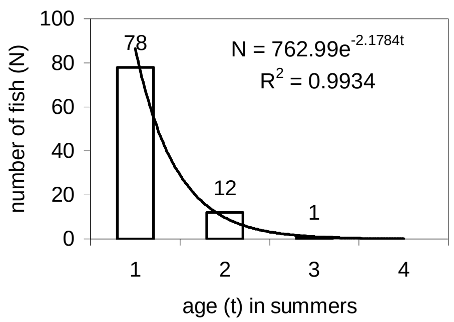

Fig. 3. Age distribution of the collected specimens

The following average values resulted from the actual measurements of standard and total lengths and body weights of the study material:

First year (0+) 33 and 40 mm, 0.34 g,

Second year (1+) 63 and 74 mm, 2.79 g,

Third year (2+) 71 and 82 mm, 4.41 g, respectively.

The Walford plot could be constructed using the average standard length data of the individual age groups, by plotting $y = Lc_{(t+1)}$ against $x = Lc_{(t)}$. The equation of the line, fitted to the data by linear regression analysis, is $Lc_{(t+1)} = 0.5958Lc_{(t)} + 37.092$, on the basis of which, the asymptotic length (L_{inf}), indicating the maximum possible size, is $91.75 \approx 92$ mm (Fig. 4).

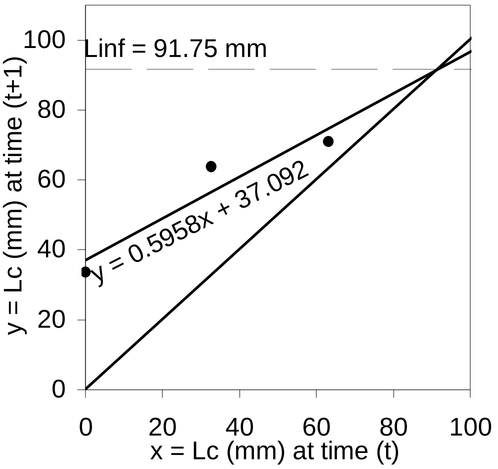

Fig. 4. Growth of golden spined loach, according to the Walford model

Standard and total lengths of the individual age groups, calculated according to the WALFORD growth model, were the following:

First year (0+) 37 mm and 44 mm,

Second year (1+) 59 mm and 69 mm,

Third year (2+) 72 mm and 83 mm, respectively.

Plotting against time the natural logarithms of the differences between the asymptotic length (L_{inf}) and standard lengths reached at different ages (L_t), with all lengths expressed in millimetres, a linear plot resulted. The equation of this was $\ln(L_{inf}-L_t) = -0.505t + 4.5133$. From this, further parameters of the Bertalanffy equation could be determined: $t_0 = -0.01$ and $K = 0.505$.

The equation of the function describing the growth of the golden spined loach population, on the basis of which the average standard length (L_t) of the t year age group can be calculated, is as follows: $L_t = L_{inf}[1-e^{-K(t-t_0)}]$, or, substituting the calculated parameters: $L_t = 92[1-e^{-0.505(t+0.01)}]$.

Standard and total lengths for the individual age groups, calculated according to the Bertalanffy equation, were the following:

First year (0+) 37 mm and 44 mm,

Second year (1+) 59 mm and 69 mm,

Third year (2+) 72 mm and 83 mm, respectively.

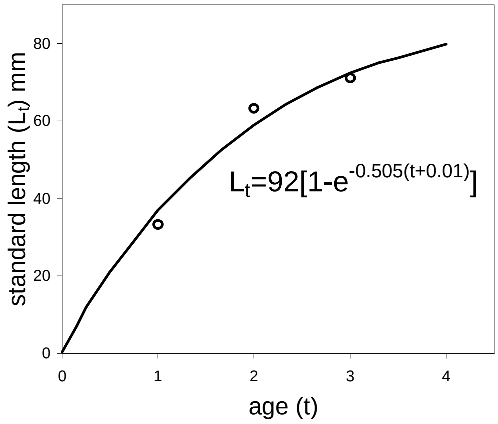

Fig. 5. Growth of golden spined loach according to the Bertalanffy model

The first two age groups were represented in the study material with a sufficient number of individuals to allow the estimation of the instantaneous mortality coefficient (Z), the survival rate (S) and the annual mortality (A). The calculated values were Z = 1.8718; S = 0.1539 and A = 0.8461.

In the studied material, biomass of the first-year fish (B_1) was 26.29 g, that of the second-year ones (B_2), 33,52 g. The instantaneous growth rate (G) of weight was 2.1148. Considering that biomass grew in the period in question, the value of G-Z, i. e. 0.2430, was used to calculate the mean biomass ($\bar{B}$) of the sample. Based on this, $\bar{B} = 29.75$ g.

Production (P) equals the multiplication product of the mean biomass and the instantaneous growth rate of weight: $P = \bar{B}G = 62.92$ g.

And finally, annual production (AP), expressed in percentile terms, was calculated by multiplying the $P/\bar{B}$ ratio by 100: $AP = P/\bar{B} \cdot 100 = 211.5$ %.

Discussion

Though the study material, consisting of hardly 100 specimens, cannot be regarded a big sample, it seems to represent the population adequately, considering that it was caught from one place, at the same time, and practically without any selection.

The value of the constant b of the equations describing the relation of length and weight – the so-called allometric exponent – was greater than 3, both in cases of standard and total lengths. This means that the growth rate of body weight in golden spined loach exceeds that of their length. As a consequence, condition of the fish improves with their age, as it can be seen from the increasing values of the condition factors, calculated from standard lengths according to Hile (1936). (Table 1).

Table 1. Length, weight and condition changes in golden spined loach

Age	Standard length Lc mm	Total length Lt mm	Body weight W g	Condition 10^5 CF
0+	33	40	0.34	0.9110
1+	63	74	2.79	1.1079
2+	71	82	4.41	1.2321

According to Bănărescu (1964), males of golden spined loach are hardly smaller than females. Our experiences are in accord with this. In our sample, the length of the second-year males was only 1 mm shorter than that of the females. At the same time, males are stouter because of the lateral distension of their bodies, and thus, their body weight exceeds that of the females in spite of their shorter size. It is possible, however, that this situation can periodically change. It cannot be excluded that in spring, when eggs are fully ripened, females can take the lead in this respect, too, although at the time of spawning the distension situated behind the gill openings and that in front of the dorsal fins of males also increase in size.

Standard lengths calculated for the first- to third-year golden spined loach on the basis of the Walford and Bertalanffy models used for describing and modelling the growth, are presented in Table 2. Lengths calculated using the two methods differ only in tenths of millimetres, and thus, data rounded to millimetres are absolutely identical. However, there is a marked difference between lengths measured and calculated for the first two age groups, which requires explanation.

Table 2. Body lengths calculated on the basis of the measurements with the Walford method and the Bertalanffy equation

Age	Standard length (Lc) mm		
	According to measurements	According to Walford	According to Bertalanffy
0+	33	37	37
1+	63	59	59
2+	71	72	72

It is clearly visible in Fig. 5. that the point defined by the data pair of the second-year age group is well above the y value determined by the function $Lc_{(t)} = 0.5958Lc_{(t-1)}+37.092$, which follows from the excellent physical development of the specimens belonging to this age group. These specimens hatched in spring of 2000, when the early and long-lasting flood was accompanied by a similarly early and long-lasting warm weather. This created favourable conditions for an early spawning, while the longer growth season resulted in a more intensive development of the fry. It had been found in the fry of pike-perch in River Tisza, too, that they grew bigger than the average in the year in question (Harka, 2000).

Therefore, we assume that the outstanding size of the second-year specimens did not result from the conditions of the year of the sampling, but of the previous one. It can also be seen that the circumstances did not favour the growth of the first-year age group as much as in the previous year, and thus, their size reflects rather the conditions of worse years.

Mathematical models allow to reduce the amplitude of incidental deviations and hence, to show a better picture of the growth process. Therefore, while our measured data are valid only for the conditions of 2-3 particular years, the values calculated according to Walford or Bertalanffy show the average size conditions on a longer time span, and thus, are more suitable for making predictions.

Though the annual mortality rate, which resulted in 84.61% in our case, seems quite high, Bíró (1975) found an even higher value (89.35 %) in first-year bleak (*Alburnus alburnus*) of Lake Balaton. Taking into consideration that the youngest generation is the most vulnerable, these values can be considered realistic. Mortality probably decreases in the following year, although it can be deduced from the trend curve of Fig. 4 that the proportion of specimens surviving the fourth-year age must be negligibly small in the population. Therefore, the life span of golden spined loach in the studied reach of the Tisza can be put at 4-5 years.

In our case, estimation of biomass and production was possible only for first- and second-year fish. Lacking other data that would allow comparison, we can record only that weight gain was very rapid in the period in question (the weight gain rate was considerably higher than the values common in older generations). Hence, biomass grew in spite of the high mortality, and the annual production was above 200 %.

In conclusion, it seems – partly from our previous observations, partly on the basis of our experiences on other waters – that the environmental conditions in the dammed reach of River Tisza studied by us are not really favourable for the golden spined loach. Hence, the number of older (third- to fourth-year) specimens is little, and, according to our subjective evaluation, they do not attain the size of fish inhabiting waters that provide more favourable conditions. However, the proportion of mature specimens still reaches the level necessary for the stability of the population, and thus, this population of golden spined loach is not immediately endangered.

References

Bănărescu, P. M. (1964): Fauna Republicii Populare Romîne. XIII. Pisces – Osteichthyes. — Editura Academici Republicii Populare Romîne, Bucuresti, pp. 959.

Bănărescu, P., Nalbant, T., Chelmu, S. (1972): Revision and geografical variation of *Sabanejewia aurata* in Romania and the origin of *S. bulgarica* and *S. romanica* (Pisces, Cobitidae). — Ann. Zool. et Bot. (Bratislava) 75, 1-49.

Balon, E. K. (1967): Ryby Slovenska. Bratislava, 413 p.

Bertalanffy, L. (1957): Quantitative laws in metabolism and growth. — Q. Rev. Biol. 32, 217-231.

Bíró, P. (1975): The growth of bleak (*Alburnus alburnus* L.) (Pisces, Cyprinidae) in Lake Balaton and the assesment of mortality and production rate. — Annal. Biol. Tihany, 42, 139-156.

Chapman, D. W. (1968): Production. In Ricker (ed.): Method for Assesment of Fish Production in Fresh Waters. Blackwell Sci. Publ. Oxford and Edinburgh, pp.182-196.

Csizmazia, Gy., Homonnay Sz., Kolosváry, G., Nógrádi, S. (1965): Neuere Daten zur Fauna des Tisza-tales. — Tiscia (Szeged) 1, 84-88.

Dickie, L. M. (1968): Addendum: Mathematical models of growth. In Ricker (ed.): Method for Assesment of Fish Production in Fresh Waters. Blackwell Sci. Publ. Oxford and Edinburgh, pp. 120-123.

Györe, K. (1995): Magyarország természetesvízi halai [Natural water fishes of Hungary]. Környezetgazdálkodási Intézet, Budapest, 339 p.

Gulland, J. A. (1965): Manual of methods for fish stock assesment, part I. Fish population analysis. — FAO Fisheries Technical Paper 40, Revision 1. Rome

Harka Á. (1986): A törpe csík (*Cobitis aurata*; Filippi, 1865) [The golden spined loach (*Cobitis aurata*; Filippi, 1865)]. — Halászat 32(79), 1, 24.

Harka Á. (1997): Halaink [Fishes of Hungary]. — Természet- és Környezetvédő Tanárok Egyesülete, Budapest, 175 p.

Harka Á. (2001): A süllő (*Stizostedion lucioperca* L.) szaporodása és növekedése a Tiszában a 2000 februárjában történt cianidos szennyezés után [Reproduction and growth of pike-perch (*Stizostedion lucioperca* L.) in R. Tisza after the cyanide-containing pollution of February 2000]. — Halászat 94. 2. 74-76.

Hile, R. (1936): Age and growth of the cisco, *Leuciscus artedi* (Le Sueue) in the lakes of the Northeastern Highlands, Wisconsin. — Bull. Bur. Fish. U. S. 48, 19, 211-317.

Jászfalusi L. (1948): *Cobitis aurata bulgarica* Drensky, eine neue Fischart für die Fauna Ungarns, nebst allgemeinen Bemerkungen über die *Cobitis*-Arten — Fragmenta Faunistica Hungarica 11, 1, 15-20.

Jászfalusi L. (1951): Die endemische *Cobitis*- und *Gobio*-Arten der Tisza, sowie ihrer Nebenflüsse. — Országos Természet-tudományi Múzeum Évkönyve 1949-1950, 113-125.

Müller, H. (1983): Fische Europas. — Neumann Verlag, Leipzig – Radebeul 320 p.

Povž, M., Sket, B. (1990): Naše slatkovodne ribe. Mladinska knjiga, Ljubljana

Sallai, Z. (1999a): Adatok a Mura és vízrendszere halfaunájához [Contributions to the fish fauna of R. Mura and its catchment]. — Halászat 92, 2, 69-87.

Sallai, Z. (1999b): Néhány adat a Maros hazai szakaszának halfaunájáról [Some data on the fish fauna of the Hungarian reach of R. Maros]. — Crisicum (Szarvas) 2, 158-198.

Spindler, T. (1997): Fishfauna in Österreich. Bundesministerium für Umwelt, Jugend und Familie, Wien

Terofal, F. (1997): Édesvízi halak [Freshwater fishes]. Magyar Könyvklub, Budapest, 288 p.

Tesch, E. W. (1968): Age and growth. In Ricker (ed.): Method for Assesment of Fish Production in Fresh Waters. Blackwell Sci. Publ. Oxford and Edinburgh, 93-120.

Tóth, J. (1970): Fish fauna list from the Hungarian section of the River Tisza. — Ann. Univ. Sci. Budapest de R. Eötvös Nom. Sect. Biol. 12, 277-280.

Walford, L. A. (1946): A new graphic method of describing the growth of animals. — Bull. Biol. Mar. Lab. Woods Hole, 90, 141-147.