



## BODY LENGTH—OPERCULUM RADIUS RELATIONSHIP IN THE PERCH *PERCA FLUVIATILIS* L.

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**Abstract.** Back-calculated body lengths of perch can be obtained from the relationship  $L_n = L \times (R_n/R)^{0.872}$ , where  $L_n$  is the back-calculated total body length ( $TL$ ),  $L$  is the final  $TL$ ,  $R$  is the operculum bone radius, and  $R_n$  is the corresponding intermediate operculum radius.

**Key words:** growth, *Perca fluviatilis*, back-calculation, operculum.

### INTRODUCTION

The perch *Perca fluviatilis* L. is an important commercial fish both in fresh waters and brackish coastal waters of the Baltic Sea and, as a relatively sedentary fish species, one of the most important fishes in coastal fish monitoring programmes (Thoresson, 1993). The age distribution and growth rate are important indices in monitoring perch populations. The age of perch is usually determined by reading the annual rings on the operculum bone, and the same structure is used in the back-calculation of the growth (Le Cren, 1947; Agnedal, 1968). As in several other fish species, the relationship between the sizes of these organs is best described by an exponential function:

$$L = a \times R^b,$$

where  $L$  is the fish length,  $R$  the radius of operculum,  $a$  the intercept of the line, and  $b$  the slope of the regression line log-fish length on the log-operculum radius. Back-calculated body lengths can be obtained from the relationship

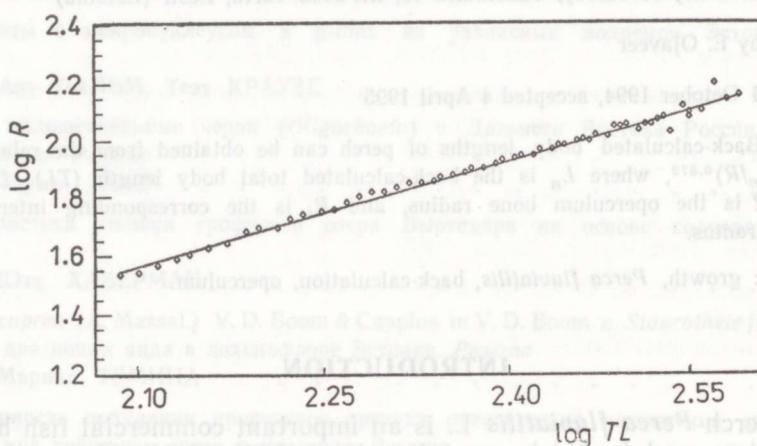
$$L_n = L \times (R_n/R)^b,$$

where  $L_n$  is the back-calculated body length and  $R_n$  is the corresponding intermediate operculum radius.

The values of  $b$  have been determined for freshwater perch from Lake Windermere (Le Cren, 1947) and Lake Erken in Sweden (Agnedal, 1968). However, the difference in back-calculated lengths obtained when using these  $b$  values (0.9202 and 0.861, respectively) may reach 10 mm in larger fish.

## MATERIAL AND METHODS

We determined the body length ( $TL$ , mm)—operculum radius ( $R$ ) relationship for perch from the coastal waters of the Baltic Sea (western coast of Estonia), captured during the coastal fish monitoring programme in July—August 1993, using gill nets (17—40 mm mesh size). This material covers 1628 specimens (958 females and 670 males) with  $TL$  from 116 to 420 mm and age from 1+ to 13+ years. The centre for operculum measurements was the same as in Le Cren (1947) and Agnedal (1968). The operculum radius was measured using a binocular microscope of the magnification of four times. Fish were divided into length groups of 5 mm, and mean log lengths ( $TL$ ) of the fish in these length groups and the corresponding mean log-operculum radius values were used in further calculations. The length groups 116—120 to 415—420 mm for females and 116—120 to 340—345 mm for males were covered.



The relationship between the perch total length ( $TL$ , mm) and the operculum radius ( $R$ , arbitrary units) in logarithmic coordinates.

Coefficients of the regression line  $\log TL = \log a + b \times \log R$  for perch

$TL$ , fish total body length;  $R$ , radius of operculum. The values of  $a$  are adjusted to the magnification  $\times 16$

Sex, length range	Intercept $\log a$	Slope $b$	$r$	$P$	Number of length groups, $n$	Reference
All fish (118—418)	1.3366	0.8724	0.996	<0.001	57	Our data
Females (118—418)	1.3282	0.8763	0.995	<0.001	57	Our data
Males (118—344)	1.3338	0.8741	0.994	<0.001	44	Our data
All fish (15—440)	1.357	0.9202			67	Le Cren, 1947
Females (80—440)	1.3761	0.8899	0.998	<0.001	52	Recalculated from Le Cren (1947, Table 4)
Males (80—395)	1.3688	0.8941	0.996	<0.001	31	
Juveniles (15—75)	1.3218	0.9877	0.996	<0.001	13	
All fish	1.289	0.8610				Agnedal, 1968

## RESULTS AND DISCUSSION

The relationship between logarithmic values of  $TL$  and  $R$  is linear (Figure). The coefficients of the regression line are presented in the Table. The slope ( $b$ ) of the regression line was similar in females and males, and close to that obtained by Agnedal (1968). The values of  $TL_n$  calculated using our and Agnedal's  $b$  values are rather similar even in larger fish (e.g. 218.5 and 220 mm, respectively, for  $TL=400$  mm and  $R_n/R=0.5$ ). We re-calculated the data presented in Table 4 of Le Cren (1947) for juveniles and adults of both sexes (Table). The values for adults appeared to be rather similar to our data, but  $b=0.988$  for juveniles appeared to be remarkably higher. However, when we excluded juveniles with  $TL<50$  mm (the length reached in the fast-growing populations during their first year of life), we got  $b=0.892$  instead of 0.9202, which is close to our and Agnedal's data.

The growth rate of perch in the study area was higher than that in fresh waters, and most fish reached 100 mm ( $TL$ ) at the age of 1 or 1+ years (Eschbaum, 1994). The length of one-year-old perch in all investigated Estonian lakes also exceeded 50 mm (Pahkla, 1962: standard length >40 mm in all lakes). Therefore, the  $b$  value obtained for the Baltic perch can probably also be used in most freshwater populations. Care must be taken in the case of perch populations showing extremely slow growth rates ( $TL_1<50$  mm).

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## KEHA PIKKUSE JA KAANELUU (*OPERCULUM*) RAADIUSE SUHE AHVENAL *PERCA FLUVIATILIS* L.

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Eesti rannikumere ahvena keha täispikkuse ( $L$ ) ja lõpusekaane kaaneluu raadiuse ( $R$ ) seost kirjeldab võrrand  $\log L=a+0,872\log R$ , kus  $a=1,3366$  suurendusel 16 korda. Täispikkuse vanuses  $n$  ( $L_n$ ) saab arvutada valemist  $L_n=L\times(R_n/R)^{0.872}$ , kus  $R_n$  on vastava aastaringi kaugus kaaneluu tsentrist.

# СООТНОШЕНИЕ МЕЖДУ ОБЩЕЙ ДЛИНОЙ ТЕЛА И РАДИУСОМ ОПЕРКУЛУМА У ОКУНЯ *PERCA FLUVIATILIS* L.

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Соотношение между общей длиной тела ( $L$ ) и радиусом оперкулума ( $R$ ) окуня прибрежных вод Балтийского моря (Западная Эстония) описывается уравнением  $\log L = a + 0,872 \log R$ , где  $a = 1,3366$  при увеличении в 16 раз. Общую длину окуня в возрасте  $n$  ( $L_n$ ) можно вычислить по формуле  $L_n = L \times (R_n/R)^{0,872}$ , где  $R_n$  — расстояние от центра оперкулума до соответствующего годичного кольца.

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The relationship between the perch total length (TL, mm) and the opercular radius ( $R$ , mm) is described by the equation  $TL = 1,3366 + 0,872 \log R$ . The coefficient of determination is 0.991. The regression equation is  $TL = 1,3366 + 0,872 \log R$ .

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