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THE EFFECT OF LIGULOSIS ON THE GROWTH OF BREAM (*ABRAMIS BRAMA* L.) IN LAKE BALATON

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In a previously published paper (BIRÓ and GARÁDI, 1974) the role of ligulosis as a basic effect essentially influencing the growth of this species has been discussed. As well known the 3–5 summer-old bream stock of Lake Balaton is strongly invaded by *Ligula* plerocercoids (MOLNÁR et al., 1968; PÉNZES, 1968). The parasitic effect may be determined directly from the growth as it was earlier published for ruff (*Acerina cernua* L.) of Lake Balaton (PONYI et al., 1972). Since the effect of *Ligula* invasion on the growth of bream has not been studied in details, therefore a scalimetric study of invaded specimens became necessary. The solution of this problem is still important the growth of bream population of Lake Balaton has been found to be fast even in European relation.

Material and methods

The material consisting of 100 *Ligula*-invaded specimens belonging to age-groups 1+ to 7+ was sampled from breams caught at the environs of Fonyód with 1000 m long nets in July, 1974. Their standard length and weight were measured, then 10–20 scales were detached from the area above the latera line of each fish. 4–8 well developed wet scales were placed between slides, and the year-ring distances and the caudal radii of scales were measured at a magnification 30 times with the use of a profile projector. Knowing the relationship between the average caudal radius and the standard length, the body dimensions attained during the previous years were back-calculated after FRASER (1916). The length-weight relationship was determined by HUXLEY (1924) (viz. LAGLER, 1956). The growth in standard length of *Ligula*-invaded breams was described by the methods of WALFORD (1946) and BERTALANFFY (1938; 1957). The findings were compared to the data on the growth of 145 breams of 2+ to 7+ age collected at the environs of Fonyód in 1972 (BIRÓ and GARÁDI, 1974).

Results

Age-distribution of fish in the samples was as follows: four specimens belonged to age-group 1+, 30 were 2+, 36 were 3+, 14 were 4+, 10 were 5+, four breams were 6+ and two were 7+. The length-weight relationship calcu-

lated for *Ligula*-invaded breams could be represented by a parabola fitted in lower position as compared to that of non-invaded ones *(Fig. 1)*. It means that a smaller specific weight belongs to the same standard length, or the relative weight deficiency arising in consequence of the parasitism is partly replaced by the biomass of *Ligula* plerocercoids in the abdominal cavity. The effect of parasitism on the length-weight relationship can be estimated from the value of its coefficient which proved to be 2.7469.

About 50 per cent of the examined scales of *Ligula*-invaded breams were found to be deformed and damaged. The formation of annuli on the proportionally developed scales differs in many respects from that on the sound fish scales. The annuli were generally confused depending on the extent of *Ligula*-invasion even on seemingly undeformed scales. It is especially valid during the first three years of their development. The regression between the caudal radii of scales and the standard lengths was calculated from significantly scattered means. The straight line cuts 1.2 cm from the abscissa *(Fig. 2)*. Average caudal radii of scales from age-group 1+ to 7+ were: 2.0, 2.63, 3.5, 4.26, 4.74, 5.16, 6.33 mm, respectively.

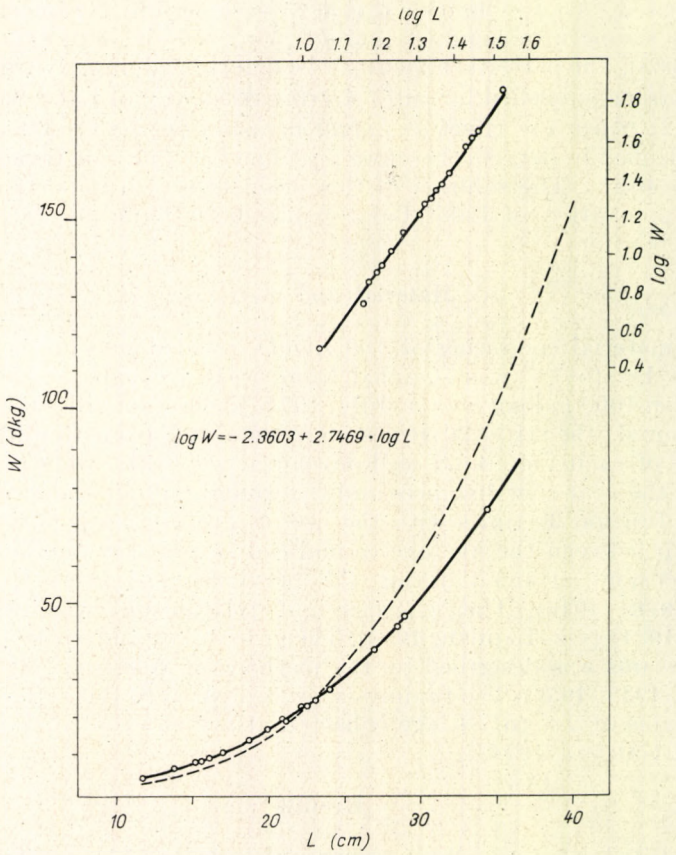

Fig. 1. Length-weight relationship of breams infected with plerocercoids of *Ligula intestinalis* (The dotted line concerns the sound specimens).

Estimating the yearly increments in length with use of standard lengths back-calculated, the growth of specimens invaded by *Ligula* seems to be slower than that of the sound ones. A stepped increase in standard length both in measured and back-calculated values could be observed *(Figs 3—4)*. In

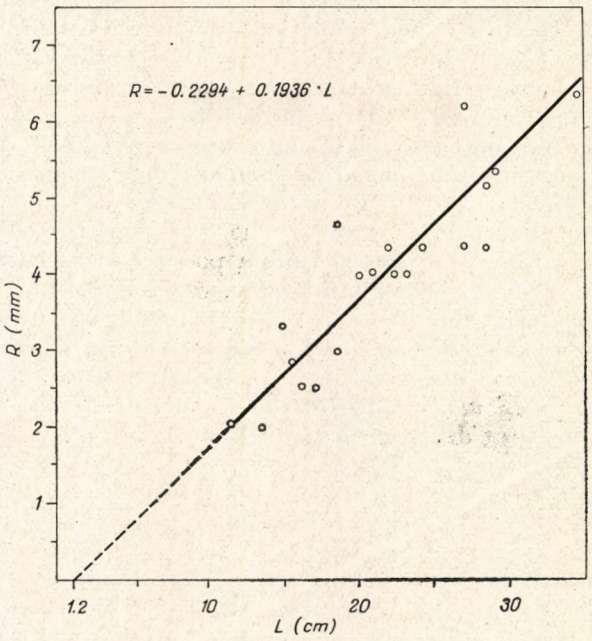

Fig. 2. Linear regression expressing the relationship between the total caudal radii of scales (R) and the standard lengths (L) of the invaded breams

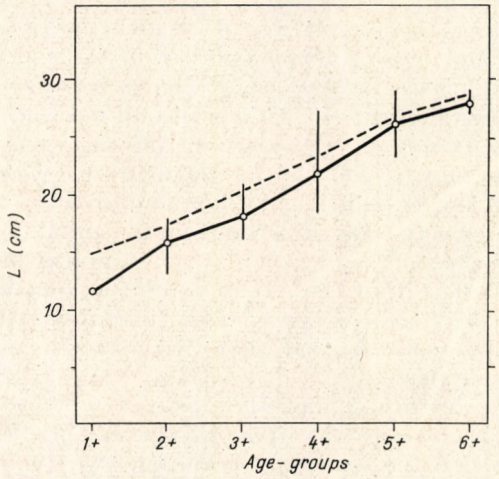

Fig. 3. The measured averages as well as the minimum and maximum values of standard lengths in *Ligula*-infected breams (the dotted line shows the averages for sound individuals)

age-groups 1+ to 6+ the deviations from the mean values were significant, up to $\pm 6-8$ cm.

Average standard lengths of age-groups 1+ to 6+ back-calculated from the scales, were as follows: 7.7, 12.1, 16.3, 19,8, 25.0 and 26.8 cm. Analysing the growth by year-class strengths the growth in age-groups 1+ to 5+ seems to be relatively linear, and contrary to this it is stepwise in age-groups 6+ to 7+ *(Fig. 5)*. Because of small number of latter ones their growth deviating from the younger age-groups could not be analysed properly.

From the marked figures it is clear, however, that there is a different growth rate in age-groups 1+ to 4+ and 5+ to 7+, which reflects the hindering effect of ligulosis on the growth that mainly succeeds during the first five years of their life. Since *Ligula* hardly damages older fish, therefore it cannot have peculiar effect on their growth. With use of standard length back calculated from the scales a growth line was constructed by WALFORD's (1946) transformation, and the maximum possible size (L_∞) was estimated. It was 51.58 cm *(Fig. 6)*. The parameters necessary to BERTALANFFY's model were also determined ($K = 0.1077$, $t_0 = -0.4076$), and using them, the exponential curve of growth in standard length was drawn *(Fig. 7)*. From the parameters obtained and from the slope of the curve it can be established that the growth rate of *Ligula*-invaded breams remains below those of sound fish previously observed at different areas of Lake Balaton.

Discussion

Bream has the greatest population in Lake Balaton, and the fishermen catch 900—1100 tonnes of them every year (BIRÓ and ELEK, 1970). Because of a dense population its ecological role (niche) is especially important from the point of energy turnover of the lake. Strong infection of breams — as the second intermediate host — with *Ligula* plerocercoids in Lake Balaton is well known (MOLNÁR et al., 1968; PÉNZES, 1968). In Hungary a significant *Ligula* infection occurs in natural waters, lakes, and closed arms of the rivers, where the ligulosis decimates the population of bream (*Abramis brama* L.), roach (*Rutilus rutilus* L.) and bleak (*Alburnus alburnus* L.) every year. In the fish ponds significant ligulosis rarely occurs (KOCZYLOWSKI and MIACZYNSKI, 1963; MOLNÁR and SZAKOLCZAI, 1973). The second intermediate host of *Ligula* emerges from the Cyprinids. In the case of a strong invasion, the weight of *Ligula* plerocercoids may reach the one-third of the weight of fish. Consequently, the physiological condition, feeding and growth of the host changes. Their external features may be established from the annuli formed on the scales, or from several deformations and irregular development of them. During the studies it became obvious that the annuli exhibit a compact stock depending on the intensity of the *Ligula* invasion. Their distances have decreased significantly which unanimously showed that the growth rate became slower in relation to the sound fish.

Studying the growth and mortality rate of breams invaded by *Ligula* in the WDZYDZE lake-complex (Poland), BRYLIŃSKI (1969, 1970) found that the annuli developed on the scales of bream one-two years before they have been caught are extremely close to each other. Their distances have been greatly varied related to the number of parasitic *Ligula* plerocercoids being

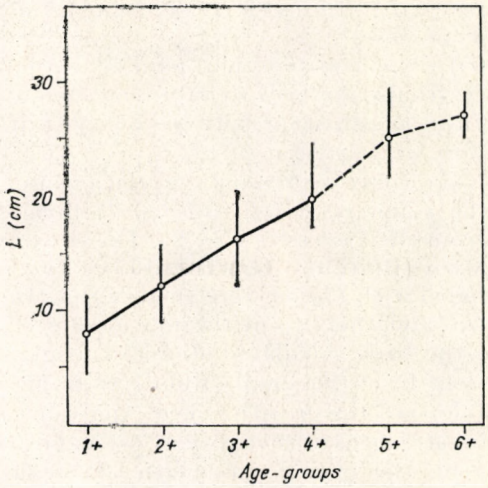

Fig. 4. Average, minimum and maximum standard lengths back-calculated from the scales in different age-groups of the infected breams. Data on the age-groups 4+ to 6+ are represented by the dotted line because of their small individual number.

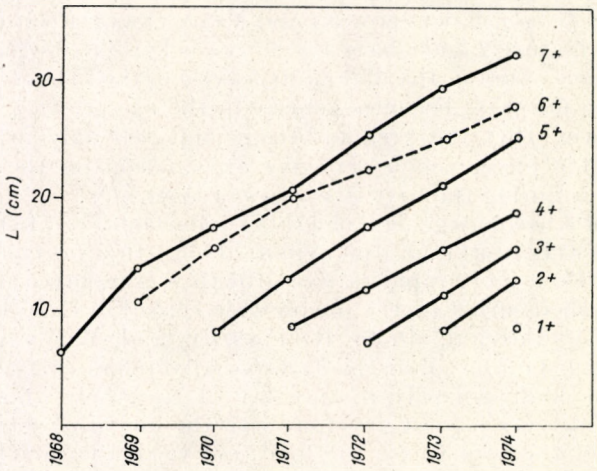

Fig. 5. The growth in length by year-class strengths

present in the abdominal cavity of the fish. Their total amount has reached 15—26 per cent of the body weight of the fish. From the small distances of annuli the parasitic effect clearly follows and manifests itself in the length-weight relationship, too. The growth in length of breams in the age-groups 1+ to 7+ studied by him was slower by 1.5—40.5 per cent as compared to the healthy individuals. The same in weight varied between 20—52 per cent.

The parasitic effect on the growth in length and weight of breams in Lake Balaton may be obviously followed from the length-weight relationship *(Fig. 1)*. At 30 cm standard length the difference in body weights of sound

and invaded fish has reached 10 grams i.e. 17 per cent. From this size the difference in weight rapidly increases.

BRYLIŃSKI (1969) demonstrated that parallel with the increase of invasion in different age-groups the growth rate decreases annually to such an extent that the growth in length stops between 36—38 cm. In the same time there is a significant loss in weight.

The linear regression curve expressing the relationship between the caudal radii of scales and the standard lengths of *Ligula* invaded breams in Lake Balaton cuts 1.2 cm from the abscissa *(Fig. 2)*. The same value for the sound fish proved to be 0.8 cm (BIRÓ and GARÁDI, 1974). The measured standard lengths of breams invaded with *Ligula* were smaller than those of non-invaded ones *(Fig. 3)*, and the deviations from the mean were 6—8 cm in different age-groups. Based on the back-calculated standard lengths *(Fig. 4)* the fact of slow growth is evident from the small differences in mean sizes of the age-groups, and from the slope of the growth curve. Analysing the length increase according to year-class strengths, the relatively slow growth is more striking *(Fig. 5)*. Consequently, the growth in length of bream in Lake Balaton is differently influenced by the invasion of *Ligula* plerocercoids in the first five years (age-groups 1+ to 4+), and further on (age-groups 5+ to 7+). In older individuals, although their small number is forewarning, nevertheless it can be seen that the extent of *Ligula* invasion is smaller, or the breams are less sensible than during the first five years of their life. Concerning the development cycle of *Ligula*, KOCZYLOWSKI and MIACZYNSKI (1963) have described that the life of mature *Ligula* lasts for 2—3 weeks, but its plerocercoid can stay even for three years in the abdominal cavity of the fish. According to our observations the infection becomes general in the age-group 1+. It is highly probable, however, that the breams become infected only in their third or fourth years. This phenomenon can give explanation on the differences in growth of breams during the first five years of their life.

The ligulosis becomes general chiefly in undernourished fish having dense population (KOCZYLOWSKI and MIACZYNSKI, 1963). In a previous paper (BIRÓ and GARÁDI, 1974) a more rapid rate of growth was reported as compared to other data published earlier on the bream wide-spread in Lake Balaton (WUNDER, 1930; WOYNÁROVICH, 1958; RIBIÁNSZKY and WOYNÁROVICH, 1962; PÉNZES, 1966; 1968). This observation especially refers to the SW-ern part of Lake Balaton and primarily to the Bay of Keszthely and waters in its surroundings. This may have connection with the increased eutrophication of different areas of the lake where the food-reserve of the mud has increased. The intensive fishing also contributes to the changes of the population dynamics of the fish. The average mortality of age-groups 3+ to 7+ of bream stock in Lake Balaton has been previously observed as 62 per cent. The estimation of influencing effect of ligulosis on the mortality of bream at different areas of Lake Balaton both from theoretical and practical points of view is wanted.

Summary

On the basis of their scales, the growth of 100 two-to eight-summer-old breams has been studied. This specimens invaded with *Ligula* plerocercoids have been caught by fishermen at the environs of Fonyód in July 1974. It was concluded that

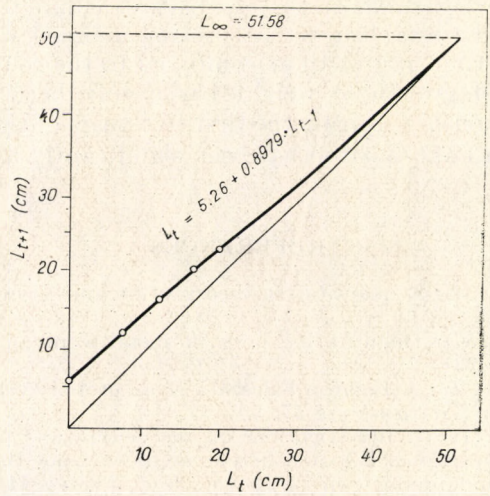

Fig. 6. FORD-WALFORD's plot in *Ligula*-invaded breams. L_t = standard length (cm) in every t-period of time if $t = 1$ year, L_{t+1} = the same one year later, L_∞ = maximum standard length in cm

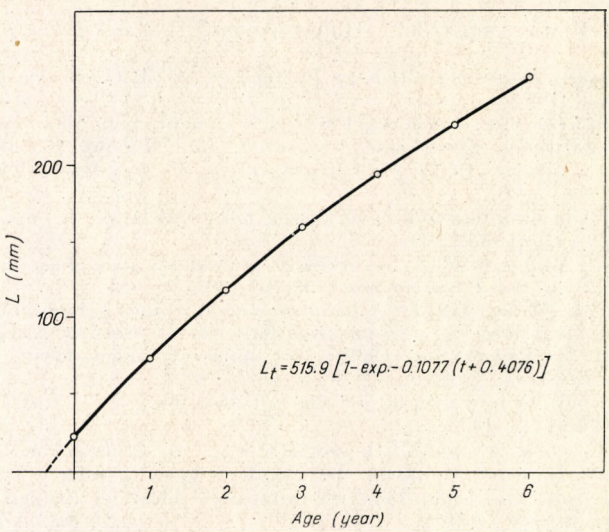

Fig. 7. Exponential growth in standard length of *Ligula*-invaded breams in Lake Balaton represented by BERTALANFFY's model. L_t = standard length in every t-period of time where $t = 1$ year

1. The relationship between the total caudal radii of scales and the standard lengths may be described by a linear regression. It cuts 1.2 cm from the abscissa. The annuli on the scales developed irregularly in connection with the extent of *Ligula* invasion. About a half of the scales studied were deformed and regenerated.

2. Based on the standard lengths back-calculated from the annuli of the scales it could be established that breams invaded with plerocercoids of *Ligula intestinalis* stunt in growth as compared to the sound specimens. Their different pattern of growth in weight has evenly been observed from the length-weight relationship. During the first five years of their development the growth of bream in Lake Balaton has been significantly hindered by ligulosis.

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LIGULÓZIS HATÁSA A BALATONI DÉVÉRKESZEG (*ABRAMIS BRAMA* L.) NÖVEKEDÉSÉRE

Összefoglalás

1974 júliusában Fonyód környékén a halászok által fogott dévérkeszegek közül 100 db, *Ligula intestinalis* plerocerkoidokkal fertőzött másod-nyolcadnyaras példányt választottunk ki és vizsgáltuk pikkelyeik alapján növekedésüket.
Megállapítottuk, hogy:

1. A pikkelyek teljes kaudális rádiusza és a törzshossz összefüggése lineáris regresszióval leírható, a test pikkelyzetének kialakulása 1,2 cm-es törzshosszra tehető. A *Ligula*-invázió mértékétől függően, a pikkelyeken a téli évgyűrűk zavartan s egymásba olvadóan képződtek. A tanulmányozott pikkelyeknek kb. fele deformálódott, vagy regenerálódott volt.

2. Az évgyűrűkből visszaszámított törzshosszak alapján nyilvánvaló, hogy a *Ligula intestinalis* plerocerkoidokkal fertőzött dévérkeszegek évenkénti növekedése elmarad az egészséges példányokétól. A testhossz-testsúly viszonyából a súlynövekedés eltérő volta a fertőzésmentes példányokhoz képest szintén megállapítható volt. A ligulózis a dévérkeszeg növekedését az első öt életévig jelentősen gátolja, majd ettől kezdve a hatás kevésbé érződik.