

1-1-2005

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ERGÖNÜL, MEHMET BORGA and ALTINDAĞ, AHMET (2005) "The Effects of *Ligula intestinalis* Plerocercoids on the Growth Features of Tench, *Tinca tinca*," *Turkish Journal of Veterinary & Animal Sciences*: Vol. 29: No. 6, Article 19. Available at: <https://journals.tubitak.gov.tr/veterinary/vol29/iss6/19>

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The Effects of *Ligula intestinalis* Plerocercoids on the Growth Features of Tench, *Tinca tinca*

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Received: 15.04.2005

Abstract: A total of 272 specimens of tench (*Tinca tinca* L., 1758) caught in Lake Mogan (Ankara) were examined for the presence of the plerocercoids of *Ligula intestinalis*, and growth parameters such as age composition, age-length, age-weight and weight-length relationship and condition factor were calculated separately for both infected and non-infected fish. The only marked difference was observed in value b between infected (2.745) and non-infected (3.014) fish.

Key Words: *Ligula intestinalis*, *Tinca tinca*, Cestoda, plerocercoid, prevalence

Ligula intestinalis Plerocercoidlerinin Kadife Balığının (*Tinca tinca*) Büyüme Özelliklerine Etkisi

Özet: Bu çalışmada Mogan Gölü'nden (Ankara) yakalanan toplam 272 adet kadife balığı *Ligula intestinalis* plerocercoidleri yönünden incelenmiştir. Parazitli ve parazitsiz balıklar için yaş kompozisyonu, yaş-boy, yaş-ağırlık ilişkisi ve kondüsyon faktörü hesaplanmıştır. Parazitli ve parazitsiz balıklar arasındaki en belirgin farkın b değerinde olduğu bulunmuştur; b değeri parazitli balıklar için 2,745, parazitsiz balıklar için ise 3,014 olarak bulunmuştur.

Anahtar Sözcükler: *Ligula intestinalis*, *Tinca tinca*, Cestoda, plerocercoid, prevalans

Introduction

Ligula intestinalis (L., 1758) is a pseudophyllidean cestode that in its plerocercoid stage infests a range of freshwater fish species, particularly members of the Cyprinidae, as its second intermediate host (1). The plerocercoid stage is infective to a wide range of fish-eating birds, which serve as the final host.

Although *Ligula* has been the subject of a number of studies, mainly concerning the differences in pathogenicity and parasite-host relationships (2), there are limited data on the effects of this cestode on its fish hosts' growth features; including *Abramis brama* (3), *Notropis hudsonius* (4), *Scardinius erythrophthalmus* (5) and *Rutilus rutilus* (6). In addition, the effects of *L. intestinalis* plerocercoids on the growth features of its cyprinid fish host, tench, *Tinca tinca*, have not been reported previously.

Materials and Methods

The study was carried out in Lake Mogan (39.47°N 32.47°E), which is a shallow (mean depth 2.1 m), large (5.4–6 km²), non-stratifying lake with a total drainage area of 925 km². In 1990, the lake was declared a "specially protected area" by the Ministry of Environment, and due to its rich and diverse waterfowl the lake acquired the status of "important bird area" (IBA) (7).

A total of 272 fish samples were collected with gill nets and fyke nets, between 2002 July and 2003 June, from Lake Mogan, Ankara, Turkey. During the study, the lake froze between mid-January and February. The fork length (to the nearest 0.1 cm) and total weight (to the nearest 0.1 g) of the fish were noted and the sex was determined by macroscopic examination of the gonads. Age was determined from the scales (8) by a microfiche

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reader. The weight-length relationships were calculated according to Ricker (9) and condition factor according to Bagenal (10).

The body cavity was examined for the presence of plerocercoids, and, if present, the number of plerocercoids was counted and the total weight was recorded to the nearest 0.1 g. Parasitic index (IP %) was calculated according to Kennedy and Burrough (11). Prevalence and mean intensity were calculated according to Bush et al. (12). Student's t-test was performed to test the differences between the length and weight of infected and non-infected fish. A chi-square (χ^2) test was performed to test the dependence of being infected among genders. Results were considered significant when $P < 0.05$.

Results

The prevalence, IP %, mean intensity and mean parasite weight among age classes are given in Table 1. Infected specimens (N = 109) consist of 55 males and 54 females, and uninfected specimens (N = 163) consist of 80 males and 83 females. It was found that being infected is independent of gender in the population studied ($\chi^2_{0.05, 1; P = 0.921}$).

Non-infected fish were longer than their infected counterparts in all age classes, except for age class VII; however, these differences were significant only for age classes II, IV, V and VI (Table 2). In addition, the maximum difference between the length of infected and non-infected fish was 1.17 cm (in age class I). The fork lengths of the infected and non-infected fish in different age classes are shown in Figure 1.

The differences between the weight of infected and non-infected fish were clear. In all age classes, non-infected fish were heavier than their infected counterparts, except for age class II (Table 2). However, these differences were not statistically significant for age classes I, II and III. The weights of the infected and non-infected fish at different age classes are shown in Figure 2.

The condition factors of infected and non-infected fish in the same age classes are shown in Table 2. There were no significant differences between the infected and non-infected fish, except for age class VI. Although not significant, the condition factor calculated for infected fish in age class I was higher than that for non-infected fish.

Table 1. Prevalence, IP %, mean intensity and mean parasite weight among age classes. N' indicates the number of non-infected fish. (CI: confidence interval; IP: parasitic index).

Age classes	N	N'	Prevalence (95% CI)	I.P (%) (min-max)	Mean intensity (95% CI)	Parasite Weight (g) (min-max)
I	3	4	42.85 (9.00-81.0)	2.10 (1.10-3.80)	1.00	0.16 (0.1-0.3)
II	2	19	9.52 (1.10-30.0)	0.95 (0.30-1.60)	1.00	0.30 (0.1-0.5)
III	4	11	26.66 (7.00-55.0)	1.97 (0.50-3.20)	1.75 (1-3)	1.57 (0.3-2.6)
IV	24	38	38.71 (26.0-51.0)	1.27 (0.10-3.40)	1.83 (1-7)	2.00 (0.1-5.6)
V	57	61	48.30 (39.0-57.0)	2.04 (0.10-7.60)	2.82 (1-9)	3.94 (0.1-15.6)
VI	12	21	36.36 (20.0-54.0)	1.62 (0.20-2.90)	3.08 (1-7)	4.08 (0.6-7.2)
VII	7	9	43.75 (19.0-.70.0)	1.02 (0.10-2.70)	2.29 (1-7)	3.36 (0.5-8.4)
Total	109	163	40.01 (34.2-46.1)	1.74 (0.1-7.60)	2.48 (1-9)	3.23 (0.1-15.6)

Table 2. The comparison of fork length (FL), weight (W) and condition factor (CF) between infected and non-infected fish. N' indicates the number of non-infected fish.

Age	N	N'	FL (cm)		t test P < 0.05	W (g)		t test P < 0.05	CF		t test P < 0.05
			Infected	Non-infected		Infected	Non-infected		Infected	Non-infected	
I	3	4	7.13	8.30	0.45	8.20	9.95	0.33	2.25	1.75	0.59
II	2	19	12.80	12.87	0.04*	32.30	31.93	0.09	1.54	1.48	0.55
III	4	11	17.72	18.28	0.48	75.40	91.95	0.33	1.34	1.49	0.71
IV	24	38	20.81	21.20	0.0001*	150.29	154.95	0.001*	1.67	1.62	0.68
V	57	61	23.12	23.37	0.004*	195.43	203.48	0.0001*	1.58	1.58	0.17
VI	12	21	25.37	25.63	0.005*	254.59	272.46	0.005*	1.55	1.60	0.019*
VII	7	9	28.23	27.73	0.059	338.74	346.44	0.004*	1.51	1.60	0.87

*refers to significant differences.

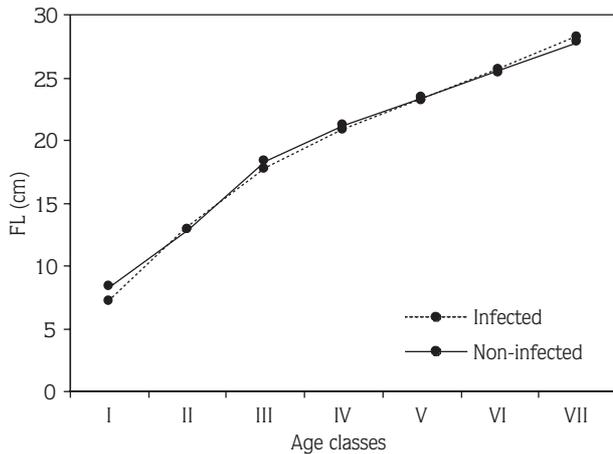


Figure 1. The fork length of infected and non-infected fish in different age classes.

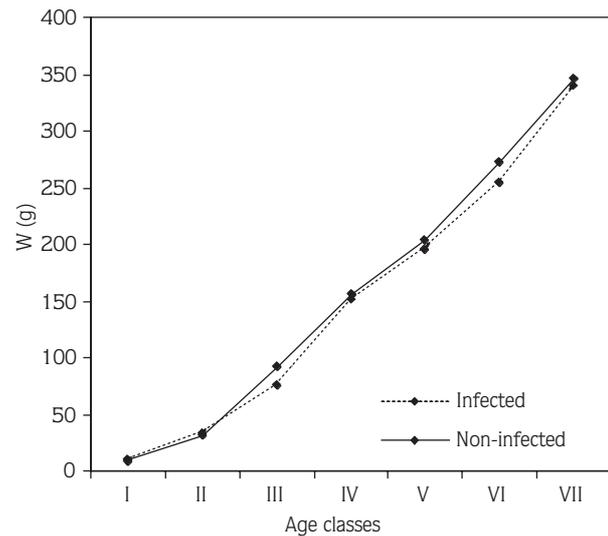


Figure 2. The weight (somatic weight, not including the weight of plerocercoids) of infected and non-infected fish in different age classes.

The exponential growth curves and log transformed weight-length relationship for infected and non-infected fish are shown in Figure 3. The value b for infected fish was 2.745 while it was 3.014 for non-infected fish.

Discussion

L. intestinalis is known to infest many freshwater fish species, especially members of the Cyprinidae, and it has a wide distribution throughout the northern hemisphere (1). It is also a common parasite of tench (*Tinca tinca*) in Turkey (13). Several authors reported the detrimental

effects of this cestode on the biology of its fish host (2). However, there are limited data on the effects of this cestode on its fish hosts' growth features (3-6). In addition, the effects of this cestode on the growth features of tench have not been reported previously.

The prevalence, mean intensity and parasitic index (IP %) values were similar to those reported by Yavuzcan et al. (14) from Lake Beyşehir in Turkey. It is clear from the results we obtained that *Ligula* has no preference for male or female tench in Lake Mogan.

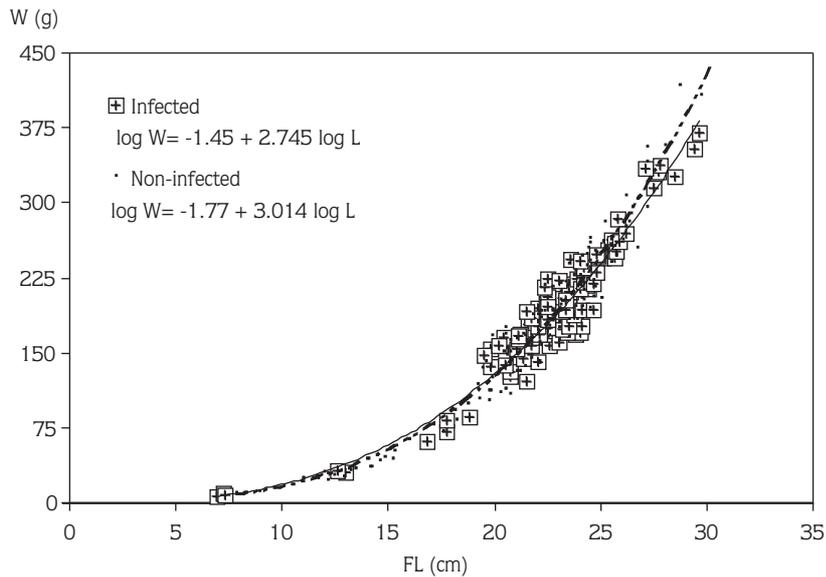


Figure 3. The exponential growth curves and log transformed weight-length relationships of infected and non-infected fish.

The maximum difference between the fork length of infected and non-infected fish was 1.17 cm. As shown in Figure 1, there was no obvious discrepancy between the length of infected and non-infected fish. Similar findings have been reported for *Ligula*-infested rudd (5).

For all age classes, except age class II, non-infected fish were heavier than infected fish. In age class II, the scarcity of infected fish might have concealed the underlying situation. However, statistically significant differences were only observed in fish older than 3 years old. Kwiatkowski and Pokora (5) stated that there were significant differences between the weight of infected and non-infected rudd. While tench grows, it continues to pick up infections, and in older fish, as a result of accumulation of plerocercoids in the body cavity of fish, the detrimental effects of this cestode will be clearer, especially in fish older than 3 years old. Garadi and Biro (3) observed a similar situation; *Ligula*-invaded breams were stunted in growth, especially in the first 5 years of their life.

Mahon (4) reported that the condition factor of infected fish was significantly lower than that of healthy ones. However, in this study the condition factors calculated for infected and non-infected fish did not exhibit a marked difference. In age class I, although it was

not significant, the condition factor was higher than that of non-infected fish. Parasite-associated growth enhancement in the first 2 years of life in roach infected with *L. intestinalis* (6) has been reported earlier. The most reasonable explanation for this seems to be related to the reduced activity (15) and/or increased foraging activity (6) in the younger fish, caused by the parasite. However, to confirm this enhancement in the condition factor of young tench, large quantities of younger samples are needed.

In contrast to the findings reported by Kwiatkowski and Pokora (5), we found a marked difference between the value of *b* among infected and non-infected fish. The values of *b* were 2.745 for infected and 3.014 for non-infected fish. This clearly indicates that the growth of non-infected fish is isometric, as reported for tench (16). However, the growth of infected fish is allometric, which may result from the lower weight values of infected fish.

In conclusion, based on age-weight, age-length and exponential growth curves, it seems that *L. intestinalis* plerocercoids, have little effect on the growth features of its fish host, tench, in Lake Mogan. This may simply result from the lower parasitic load of *Ligula* in tench, compared to that in other fish species.

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