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TAM MAKALE

THE OCCURRENCE OF *Ligula intestinalis* IN ITS FISH HOST *Rutilus rutilus* (L.) AND THE EFFECTS OF PARASITE ON THE FISH GROWTH (BÜYÜKÇEKMECE RESERVOIR, TURKEY)

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Abstract:

Roach *Rutilus rutilus* (Linnaeus, 1758) is a very common fish species for Turkish inland waters, especially in Büyükçekmece Reservoir (İstanbul). The species is one of the most caught fish species and holds economic consumption value even though it is mostly infected by *Ligula intestinalis* (Linnaeus, 1758), a pseudophyllidean cestode causing severe pathological effects on fishes. The aim of the study was to determine the presence of *L. intestinalis* plerocercoids in its fish host *R. rutilus* and investigate the effects of the parasite on the condition of the fish. With this purpose, the fish specimens have captured from Büyükçekmece Reservoir with using gillnets having different mesh sizes (10×10 mm, 20×20 mm, 30×30 mm, 40×40 mm and 50×50 mm) from March 2009 to February 2010. The fork length and body weight of fish specimens (n=1857) were varied between 6.0–29.2 cm and 2.53–561.00 g, respectively. In total, 4.52% of specimens were infected by the plerocercoids. Infection by *L. intestinalis* was observed during summer, autumn and winter months but not spring. Parasite-host index (PSI %), prevalence (%) and mean intensity of plerocercoids for infected fishes were calculated, monthly. PSI (%) was estimated maximum in January as 18.49%

while prevalence (%) was 32.31% in July and mean intensity of plerocercoids is 6.0 in October. Statistically significant differences between K values of non-infected and infected specimens among length groups and months were recorded (Mann-Whitney U Test, $p<0.05$). Results showed that, *L. intestinalis* plerocercoids seem to be affected significantly on the condition and body health of its host *R. rutilus*.

Keywords: Plerocercoid, Condition, Intensity, Parasite-host index, Prevalence

Introduction

Fish is very important protein sources as food besides their importance for the economies of countries and being an object of sportive and ornamental fishing. Besides direct losses caused by mortality, parasites may have considerable impact on growth and fish behavior, their resistance to other stressing factors, susceptibility to predation, etc.; their presence may also reduce marketability of fish (Scholz, 1999). In Turkish inland waters, especially in Marmara Region, roach *Rutilus rutilus* (L.) is very common and has an economical value (Geldiay and Balık, 2007). Its first record for Büyükçekmece Reservoir is given in 1986 (Meriç, 1986) and now it's one of the most dominant fish species of the reservoir.

Ligula intestinalis (L., 1758) is a pseudophyllidean cestode which is known to induce severe pathological effects on fish (Ergönül and Altındağ, 2005; Loot et al., 2001) and the most common infection parasite reported in Turkish inland waters (İnnal et al., 2007). Ligulids have a complex life cycle involving copepods, fishes and birds. Firstly, the coracidium larva surviving 1-2 days in the water penetrates the gut wall of a copepod and develops into a proceroid. The infected copepod is ingested by a planktivorous cyprinid fish (e.g. *R. rutilus*), and the parasite larvae develop into the plerocercoid stage in the body cavity. The definitive host is an ichthyophagous predatory bird in which *L. intestinalis* reaches sexual maturity. Parasite eggs are then released into the water with bird faeces (Loot et al., 2001; İnnal et al., 2007).

Infection with *L. intestinalis* effects cultured or free-living fish of freshwater in all over the world (Shargh et al., 2008). It has been reported from a broad range of fish families, such as Cyprinidae, Cobitidae, Salmonidae, Esocidae, Pleuronectidae or Siluridae (İnnal et al., 2007; Bouzid et al., 2008). It is known to effect especially *Alburnus escherichii*, *Leuciscus cephalus*, *Tinca tinca*, *Cyprinus carpio*, *R. rutilus* which are members of the Cyprinidae (Loot et al., 2001; Ergönül and Altındağ, 2005; İnnal et al., 2007). According to Williams and Hoole (1992), numerous ecological and pathological studies have revealed that the parasite can seriously affect the population dynamics of both wild fish and those involved in aquaculture. There is limited data on relation of the parasite and its fish host *R. rutilus* (Kennedy and Burrough, 1981; Loot et al., 2001; Oğuz et al., 2004; Carter et al., 2005). The aim of

the present study is to determine the occurrence of the parasites on host and investigate the effects of parasite for condition and length-weight relationship of host fishes living in Büyükçekmece Reservoir.

Materials and Methods

The present study was carried out in Büyükçekmece Reservoir between March 2009 and February 2010. During the monthly sampling surveys, gillnets (50 m length and 2.5 m depth) having different mesh size (10×10 mm, 20×20 mm, 30×30 mm, 40×40 mm and 50×50 mm) were used for fishing. Fish specimens were measured to the nearest 0.1 cm (fork length, FL) and 0.01 g (body weight, W), and then dissected to determine the number and weight of plerocercoid larval forms of parasites occurring in the abdominal cavity. Prevalence (%) and mean intensity were calculated according to Bush et al. (1997). Parasite-host index (PSI %) was calculated according to Kesler et al. (2009). Variations of prevalence (%), mean intensity and PSI (%) among months and length groups were examined.

The length-weight relationship was calculated using the equation " $W = a \cdot L^b$ ", where W is the total weight (g), L is the fork length (cm), and a and b are the equation parameters (Le Cren, 1951; Froese, 2006). Fish condition was assessed by Fulton's Condition Factor " $K = (W/L^3) \cdot 100$ " (Ricker, 1975) for infected (without plerocercoids) and non-infected specimens. All statistical analyses were performed with SPSS software 16.0. Prior to statistical analysis, all data were tested for normality of distribution using the Kolmogorov-Smirnov test. Mann Whitney U test was performed to test the differences between the length, weight and condition values of infected and non-infected fish among months and length groups (Zar, 1999).

Results and Discussion

In present study, a total of 1857 *R. rutilus* specimens, captured from the Büyükçekmece Reservoir, were investigated and the results showed that 84 of the 1857 fishes (4.52%) were infected by plerocercoids. The fork length ranged from 6.5 to 25.0 cm for infected specimens while it was between 6.0 and 29.2 cm for non-infected specimens. Total weight ranged between 3.66 and 327.30 g for infected fish and 2.53 and

561.00 g for non-infected fish, respectively (Table 1).

Infection by *L. intestinalis* was observed during summer, autumn and winter months but not spring. The maximum infection rate was determined in July while it was lower during the autumn and winter (Figure 1). Parasite-host index (PSI %), prevalence (%) and mean intensity of plerocercoids for infected fishes were calculated among months (Table 2) and length groups (Table 3). PSI (%) was estimated maximum in January as 18.49% while prevalence (%) was 32.31% in July and mean intensity of plerocercoids was 6.0 in October.

The condition factors of non-infected and infected specimens (without plerocercoids) specimens are given at Table 1. Statistically significant differences between K values of non-infected and infected specimens among length groups and months were recorded (Mann-Whitney U Test, $p < 0.05$). Differences between K values for non-infected and infected specimens among length groups and months are shown in Table 3 and Table 4.

The length–weight relationships were estimated and *b* values were determined as 3.383 ± 0.001 and 3.222 ± 0.011 for the non-infected fishes and infected fishes (without plerocercoids), respectively (Figure 2).

It was reported that the values of intensity and prevalence have changed according to seasonal conditions and fish species, increasing of the parasites especially in summer (Akmirza, 2007). Since the immune response of poikilothermic vertebrates is temperature dependent, lower water temperatures would result in a lower antibody response (Williams and Hole, 1992). Oğuz et al. (2004) were observed that the rate of infection

increased steadily from winter to summer and autumn except spring. In Yenice Irrigation Pond (Turkey), the maximum density of this parasite has occurred in July. Similarly, in present study, infection wasn't observed in spring and the maximum infection rate was determined in July while it was lower during the autumn and winter.

The condition factor of infected fishes is significantly lower than that of healthy ones (Mahon, 1976). In present study, a similar result was monitored as condition factor of infected fishes is significantly lower from the non-infected specimens (Table 3 and Table 4). The parasite may have changed the food intake of the host and so, the condition as an indicator of feeding intensity of fish was effected negatively. Also, many researchers have studied some effects of this parasite for fish host such as growth, endocrine system, gonadal development and had determined that *L. intestinalis* was caused many pathogenic effect on host fish. The parasite can cause damage to the host fish specimens especially by compression and atrophy of vital organs including the gonads, liver in the coelomic cavity of the infected fish (Öztürk and Altınel, 2001; Jopling and Taylor, 2003; Oğuz et al., 2004; Carter et al., 2005; Hecker and Karbe, 2005; Dejen et al., 2006). Similarly, in present study, macroscopic investigations showed that stomachs of fish specimens were swollen and gonads were deformed. Conversely, Ergönül and Altındağ (2005) reported that the condition factors calculated for infected and non-infected tench did not exhibit a marked difference for Mogan Lake population and, Weekes and Penlington (1986) were found no significant difference in condition factors between infected and uninfected trout *Salmo gairdneri* in New Zealand.

Table 1. Descriptive statistics and estimated parameters of length-weight relationships and condition factors of infected and non-infected *R. rutilus*, Büyükçekmece Reservoir, İstanbul, Turkey (n, number of individuals; FL, fork length; W, body weight; K, condition factor; b, slope; CL, confidence limits; r^2 , coefficient correlation).

	n	FL (cm)	W(g)	K	b ($\pm 95\%$ CL)	♀	♂
Infected specimens	84	6.5 – 25.0	3.66 – 327.3	1.56	3.222 ± 0.011	24	36
Non – infected specimens	1773	6.0 – 29.2	2.53 – 561.0	1.52	3.383 ± 0.001	468	501

Table 2. Prevalence (%), mean intensity and PSI (%) among months (n*: number of infected specimens; n: number of non-infected specimens; pn: plerocercoid numbers)

Months	n*	n	Prevalence (%)	Mean Intensity	PSI (%) (min. - max.)	pn (min. - max.)
June	11	154	6.77	2.6	13.12 (4.04 - 20.91)	29 (1 - 6)
July	21	44	32.31	3.6	14.03 (3.49 - 33.98)	75 (1 - 13)
August	11	30	26.83	4.5	12.14 (4.88 - 42.21)	49 (1 - 8)
September	17	56	23.29	3.9	13.87 (4.89 - 24.39)	66 (1 - 9)
October	1	58	1.69	6.0	9.35	6
November	4	44	8.33	4.5	11.41 (4.77 - 20.17)	18 (1 - 13)
December	13	93	12.26	2.9	12.63 (5.01 - 25.32)	38 (1 - 11)
January	5	97	4.90	2.8	18.49 (12.04 - 21.07)	14 (2 - 4)
February	1	123	0.81	2.0	11.13	2

Table 3. Comparison of condition factor (K) with prevalence (%), mean intensity and PSI (%) among length groups for non-infected and infected fishes without plerocercoids (n*: number of infected specimens; n: number of non-infected specimens; pn: plerocercoid numbers; *p*: values of Mann-Whitney U Test)

Length Groups (cm)	n*	n	K		<i>p</i> (0.05)	Prevalence (%)	Mean Intensity	PSI (%) (min. - max.)	pn (min. - max.)
			Infected	Non-infected					
6.0-8.9	1	893	1.27	1.27±0.18 (0.94-2.02)	—	0.11	1	5.01	1
9.0-11.9	9	38	1.55±0.18 (1.26-1.81)	1.82±0.14 (1.51-2.24)	0.000*	19.15	3.4	14.04 (4.99 – 25.3)	31 (1 – 7)
12.0-14.9	61	408	1.53±0.11 (1.33-1.88)	1.69±0.13 (1.22-2.24)	0.000*	13.01	3.1	13.98 (3.49 – 42.21)	189 (1 – 9)
15.0-17.9	6	125	1.77±0.07 (1.65-1.86)	1.87±0.14 (1.57-2.21)	0.035*	4.58	5.7	14.17 (4.04 – 28.56)	34 (2 – 13)
18.0-20.9	6	249	1.64±1.80 (1.36-1.84)	1.84±0.12 (1.58-2.24)	0.003*	2.35	4.8	9.49 (7.85 – 12.18)	39 (2 – 11)
21.0-23.9	0	47	—	1.88±0.10 (1.72-2.18)	—	—	—	—	—
24.0-26.9	1	8	1.91	1.97±0.20 (1.72-2.27)	—	11.11	13.0	4.77	13
27.0-29.9	0	4	—	2.17±0.08 (2.12-2.30)	—	—	—	—	—

* means significant differences between groups

Table 4. The comparison of fork length (FL), weight (W) and condition factor (K) between infected and non-infected fish among months (n* the number of infected fish; n: the number of non-infected fish; *p*: values of Mann-Whitney U Test)

Months	n*	n	FL (cm)		<i>P</i> (0.05)	W (g)		<i>P</i> (0.05)	K		<i>P</i> (0.05)
			Infected	Non-infected		Infected	Non-infected		Infected	Non-infected	
June	11	154	13.7 ±2.1 (11.8 - 18.3)	14.2 ±2.5 (11.0 - 20.2)	0.909	51.59 ±27.73 (31.4 - 116.82)	59.09 ±35.01 (23.38 - 180.02)	0.927	1.66 ±0.14 (1.43 - 1.88)	1.87 ±0.13 (1.52 - 2.24)	0.000*
July	21	44	13.2 ±1.7 (11.6 - 18.0)	14.4 ±2.6 (11.6 - 19.5)	0.087	44.10 ±21.73 (28.76 - 106.80)	59.31 ±34.88 (26.94 - 152.16)	0.126	1.82 ±0.12 (1.65 - 2.13)	1.80 ±0.15 (1.44 - 2.24)	0.715
August	11	30	12.6 ±0.8 (11.3 - 13.6)	13.7 ±2.3 (10.8 - 19.3)	0.375	36.83 ±6.62 (27.12 - 49.30)	50.15 ±32.18 (22.06 - 132.03)	0.591	1.54 ±0.14 (1.26 - 1.81)	1.78 ±0.12 (1.54 - 2.06)	0.000*
September	17	56	13.7 ±1.8 (12.0 - 18.8)	16.1 ±3.6 (11.2 - 22.9)	0.033*	46.56 ±26.28 (26.28 - 128.14)	85.21 ±57.46 (25.94 - 216.6)	0.070	1.54 ±0.12 (1.35 - 1.84)	1.74 ±0.13 (1.48 - 2.00)	0.000*
October	1	58	19.5	18.3 ±3.6 (12.3 - 27.3)	—	134.53	126.20 ±72.36 (30.56 - 430.8)	—	1.66	1.82 ±0.12 (1.56 - 2.12)	—
November	4	44	15.5 ±6.3 (12.2 - 25.0)	18.3 ±4.3 (12.6 - 29.0)	0.090	105.59 ±147.81 (30.66 - 327.3)	133.99 ±111.06 (32.13 - 561.0)	0.106	1.57 ±0.25 (1.33 - 1.91)	1.80 ±0.16 (1.50 - 2.30)	0.090
December	13	93	13.5 ±3.4 (6.5 - 20.9)	15.3 ±4.7 (6.0 - 23.4)	0.114	48.41 ±38.02 (3.66 - 145.44)	80.85 ±58.28 (2.99 - 24.31)	0.124	1.47 ±0.11 (1.27 - 1.65)	1.70 ±0.18 (1.29 - 2.15)	0.000*
January	5	97	12.9 ±0.8 (12.0 - 14.1)	16.6 ±3.4 (6.7 - 22.3)	0.006*	35.72 ±4.39 (33.03 - 43.34)	93.38 ±52.68 (3.97 - 212.2)	0.014*	1.44 ±0.08 (1.38 - 1.58)	1.75 ±0.17 (1.22 - 2.06)	0.001*
February	1	123	11.9	16.3 ±3.8 (9.7 - 25.5)	—	26.42	91.84 ±69.84 (14.89 - 377.2)	—	1.43	1.75 ±0.17 (1.22 - 2.27)	—

* means significant differences between groups

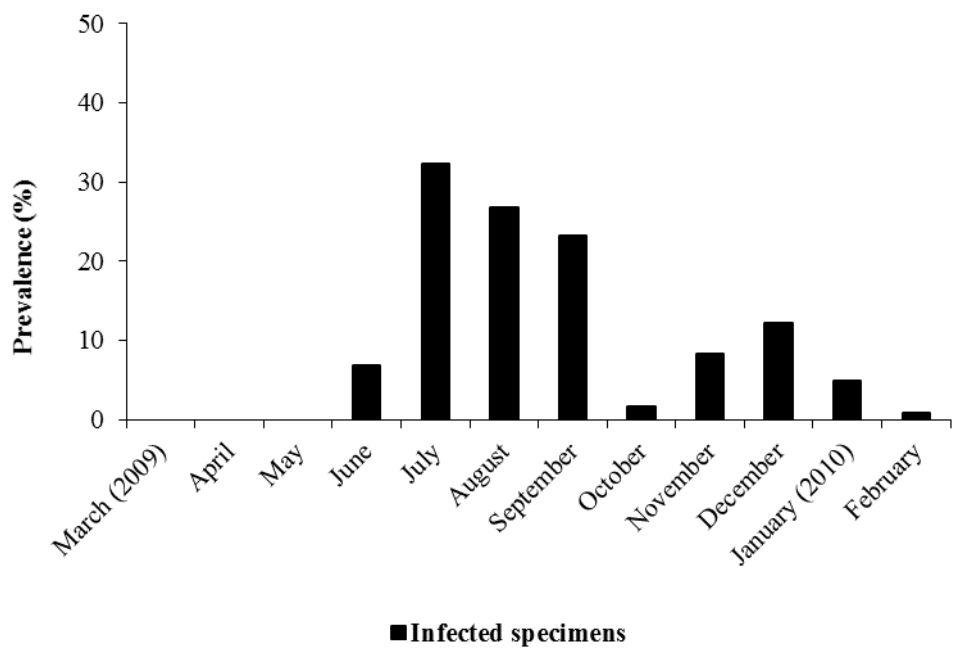


Figure 1. Monthly variations of prevalence values (%) for infected *R. rutilus* specimens, Büyükçekmece Reservoir, İstanbul, Turkey.

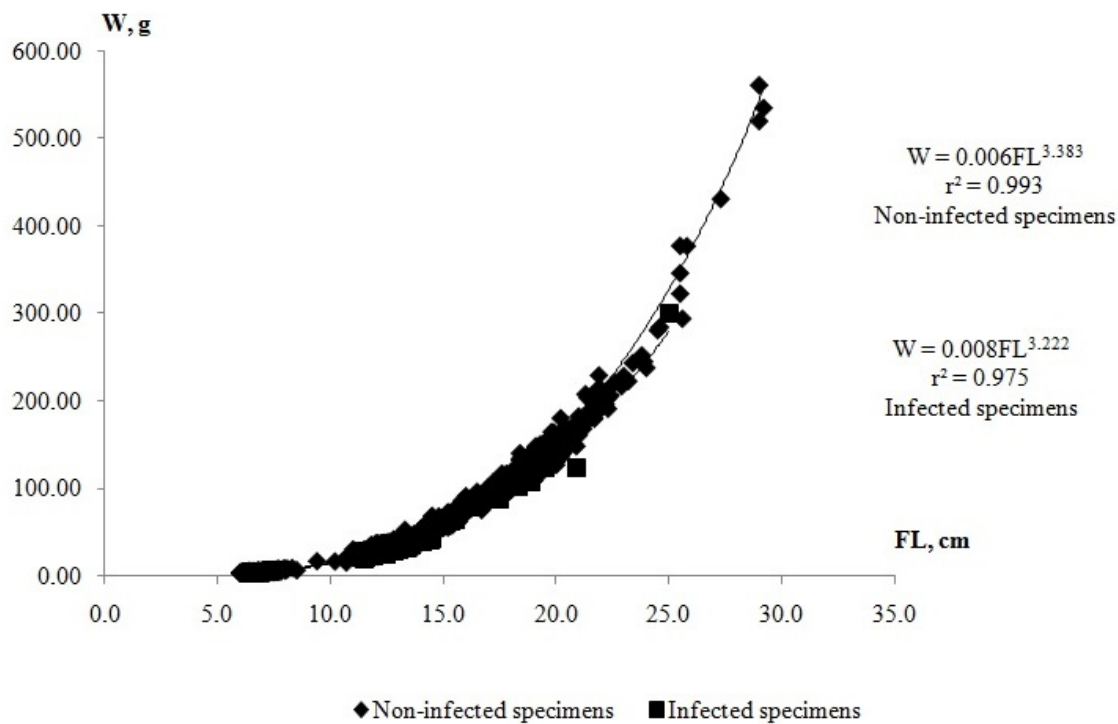


Figure 2. The length-weight relationships for non-infected and infected specimens of *R. rutilus*, Büyükçekmece Reservoir, İstanbul, Turkey.

Kelle (1978), were compared length–weight relationship between infected and non-infected specimens and were determined a reducing about 19 % for infected *Acanthobrama marmid* specimens in Devegeçidi Dam Lake. Ergönül and Altındağ (2005) were found a marked difference between the *b* value among infected and non-infected tench and were estimated value of *b* as 2.745 for infected and 3.014 for non-infected tench in Mogan Lake. But in present study, the growth was determined as positive allometrical and the *b* values were estimated with 3.222 ± 0.011 and 3.383 ± 0.001 for of infected and non-infected specimens, respectively.

The prevalence (%) among the length groups showed that, infection rates were high in 9.0-11.9 and 12.0-14.9 cm length groups. According to Tarkan (2006), sizes at maturation for *R. rutilus* living in Sapanca Lake (Marmara Region, Turkey) is 12.26 cm in males and 14.98 cm in females (total length). In present study, our macroscopic investigations also showed that the gonads of the roach matured after 11.0 cm (fork length) and gonadal damages were observed in infected fish specimens. It was thought that besides the negative effects on fish growth, it may have effected on fish reproductive activity.

Conclusion

In conclusion, *L. intestinalis* plerocercoids appear to have significant effect on fish condition within certain length groups. Due to the high infection rates specifically during summer months, it is led to believe that this parasite may seriously effect fish health. After reproduction, efficient fish feeding is essential to regain general fish condition, decreased by spawning activity. According to the findings of this study, the status of *L. intestinalis* may be a threat to the host's, *R. rutilus*, presence in the lake.

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