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Seasonal Changes and Host Size-Dependent Variation in *Diplostomum* sp. Infection of Some Cyprinid Fish

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Abstract.- Some Cyprinid fish species including *Leuciscus cephalus, Chondrostoma regium, Capoeta tinca, Capoeta capoeta, Barbus plebejus* and *Cyprinis carpio* were monitored for *Diplostomum* sp. infection during one year period. In general, prevalence and mean abundance of *Diplostomum* sp. was higher in *L. cephalus, C. tinca*, *C. capoeta* and *B. plebejus* during autumn and *C. regium* and *C. carpio* during spring. Seasonal changes in the mean abundance of *Diplostomum* sp. was also significantly higher in autumn in *L. cephalus, C. tinca, B. plebejus* and in spring in *C. regium*. Parameters of infection of *Diplostomum* sp. in three size classes of fish were also studied. Mean abundance of *Diplostomum* sp. was significantly higher in *B. plebejus* and *C. tinca* in fish >20.1 and in *C. regium* in fish >30 cm. Furthermore, potential infection for fish farm located in Almus Dam Lake was also discussed.

Key words: *Diplostomum* sp., Cyprinid fish, seasonal changes, host-parasite interaction

INTRODUCTION

The life cycle of the eye fluke, *Diplostomum* sp. (Digenea: Diplostomatidae) requires three host to complete its cycle, which includes an avian definitive host, a snail first-intermediate host and a fish second-intermediate host. The cercariae of this parasite usually penetrate host fish through the gills and develops to metacercariae in the lenses of the fish eyes. Metacercariae in the eyes of fish can cause cataracts (Karvonen *et al*., 2004) which reduces fish vision and causes problems in the fish growth as a result of impaired food intake (Owen *et al.*, 1993; Buchmann and Uldal, 1994; Karvonen and Seppala, 2008), changes in behavior and appearance (Seppala *et al.*, 2008) and increases susceptibility of fish to predation (Seppala *et al*., 2004).

The seasonal occurrence of fish trematodes is primarily temperature dependent (Lyholt and Buchmann, 1996) and the presence of larger parasite infrapopulations in older, larger hosts is a common characteristic of fish host-parasite relationship (Dogiel, 1970). There have been few investigations into the seasonal occurrence of infection and host size dependent variation of *Diplostomum* sp. infection and the studies that have been conducted on different fish species (McKeown and Irwin, 1997; Dorucu and Ispir, 2001; Marcoglies *et al.*, 2001) or host size (Marcogliese *et al.*, 2001; McKeown and Irwin, 1997).

However, infection parameters of *Diplostomum* sp. and its relationship between the lengths of fish have not been previously studied from different fish. Therefore, in the present study, the diplostomid metacercarial infection in the eyes of several freshwater fish species in the Almus Dam Lake on Yeşilirmak river, Turkey was examined. Our objective was to determine the seasonal changes in prevalence and abundance of infection in several fish species and the relationship between the length of fish and diplostomid metacercarial infection.

MATERIALS AND METHODS

The study was conducted in Almus Dam Lake (40° 22' 348" N - 36° 55' 789"E), located on the main branch of the Yeşilırmak River, Turkey. It is an important reservoir for fishing, fish farming and irrigation. The lake exhibits oligotrophic characteristics during the winter and mesotrophic characteristics during the summer.

A total of 320 fish belonging to 6 fish species was studied every three months from April 2005 to January 2006. A total of 60 *Leuciscus cephalus* (19.5±5.3 cm), 76 *Chondrostoma regium* (20.2±4.4

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cm), 66 *Capotea tinca* (22.3±8.4 cm), 19 *Capoeta capoeta* (24.7±6.1 cm), 40 *Barbus plebejus* (20.6±10.4 cm) and 59 *Cyprinus carpio* (26.2±7.3 cm) were studied. No fish were sampled due to low water temperatures (4±0.9°C) during the winter months.

Fish were collected by using a seine net and live fish in lake water were directly brought to the lab, and then examined on the day of arrival. For parasitological dissection, the fish were killed and the total length of the fish was recorded, then the eyes of fish were examined for parasites using conventional methods.

The prevalence, mean abundance and intensity levels of the parasites species were determined according to Bush *et al.*, (1997). The length of the fish was classified into three classes; ≤ 20 cm, 20.1- 30 cm and > 30.1 cm. Kruskal-Wallis and Mann-Whitney analysis of variance was applied to the data to determine significant differences. Statistical analysis was performed using the statistical program SPSS 15.0.

RESULTS

Variation in Diplostomum *sp. infection*

Prevalence levels of *Diplostomum* sp. in the lenses of fish eyes were generally higher in the autumn and spring compared to the summer. Higher prevalence of this parasite was observed in *L. cephalus* (41.6%), *C. tinca* (64%), *C. capoeta* (60%) and *B. plebejus* (40%) during autumn and in *C. regium* (91%) and *C. carpio* (60%) during summer (Fig. 1, Table I).

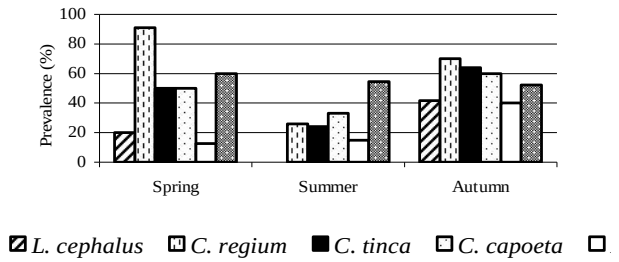

Fig. 1. Seasonal changes in prevalence of *Diplostomum* sp from fish species in Almus Dam Lake

Table I.- Seasonal changes in prevalence, mean abundance and mean intensity of *Diplostomum* sp. from different fish species in Almus Dam Lake

Fish species (n=320)	Spring			Summer			Autumn		
	Prevalence (%)	Mean abundance	Mean intensity	Prevalence (%)	Mean abundance	Mean intensity	Prevalence	Mean abundance	Mean intensity
Leuciscus cephalus(n=60)	20 (n= 25)	0.64 ^{b}	2.6	0 (n= 23)	0 ^{a}	0	41.6 (n=12)	1 ^{b}	2.4
Chondrostoma regium (n= 76)	91 (n=23)	14.9 ^{a}	16.38	26 (n=30)	1.03 ^{b}	3.88	70 (n=23)	3.35 ^{c}	4.8
Capoita tinca (n= 66)	50 (n=12)	2.4 ^{a}	4.8	24 (n=29)	0.65 ^{b}	2.71	64 (n=25)	4.76 ^{a}	7.43
Capoita capoeta (n= 19)	50 (n=4)	1.5 ^{a}	3	33 (n=6)	0.66 ^{a}	2	60 (n=9)	3.3 ^{a}	5.5
Barbus plebejus (n=40)	12.5 (n=8)	0.65 ^{a}	5	14.8 (n=27)	0.7 ^{a}	5.25	40 (n=5)	24.2 ^{a}	60.5
Cyprinus carpio (n=59)	60 (n=10)	1.1 ^{a}	1.8	54.5 (n=11)	2.3 ^{a}	4.3	52.3 (n=38)	1.36 ^{a}	2.6
Water temperature	10.6°C (10.5-10.8)			21.3°C (20.5-22.5)			17.1°C (11.5-22.8)		

Values with the same superscript letter are not significantly different (P< 0.05).

Mean abundance and mean intensity of *Diplostomum* sp. also showed similar result for all fish species examined (Figs. 2, 3, Table I).

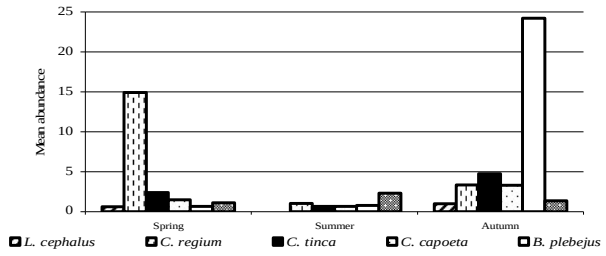

Fig. 2. Seasonal changes in mean abundance of *Diplostomum* sp from fish species in Almus Dam Lake

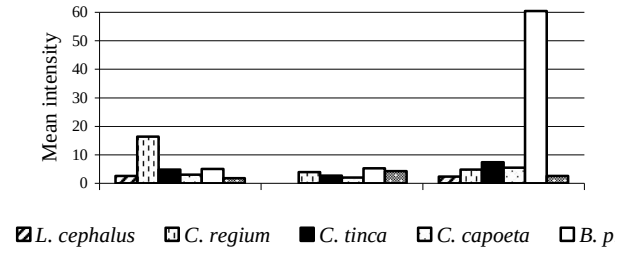

Fig. 3. Seasonal changes in mean intensity of *Diplostomum* sp from fish species in Almus Dam Lake

Seasonal changes in the mean abundance of *Diplostomum* sp. in *L. cephalus* and *C. tinca* showed significantly higher abundance in autumn and spring then in summer. In *C. regium*, the mean abundance of *Diplostomum* sp. was significantly higher in spring, then autumn and summer (Table I).

No significant differences were observed in the mean abundance of *Diplostomum* sp. between spring, summer and autumn in *C. capoeta*, *B. plebejus* and *C. carpio* (Table I).

Size dependent variation in Diplostomum sp.

Infection parameters of *Diplostomum* sp. in three size classes of fish were studied (Table II). Increase in the prevalence of *Diplostomum* sp. occurred with increasing of size of fish. Fish >30 cm showed increasing in the prevalence of

Table II.- Infection parameters of *Diplostomum* sp. in the three size classes of fish studied.

Fish species (n=320)	≤ 20 cm			> 20.1 - <30			>30.1		
	Prevalence (%)	Mean abundance	Mean intensity	Prevalence (%)	Mean abundance	Mean intensity	Prevalence	Mean abundance	Mean intensity
Leuciscus cephalus(n=60)	23.5 (n=34)	0.6 ^{a}	2.5	8.3 (n=24)	0.2 ^{a}	2.5	50 (n=2)	1.5 ^{a}	3
Chondrostoma regium (n= 76)	43.7 (n=32)	1.9 ^{b}	4.4	70.5 (n=44)	8.8 ^{a}	12.6	-	-	-
Capoita tinca (n= 66)	31.25(n=32)	2.5 ^{a}	10	45.8 (n=24)	2 $^{a b}$	4.4	80 (n=10)	3.9 ^{b}	4.9
Capoita capoeta (n= 19)	33.3 (n=3)	0.7 ^{a}	2	61.54(n=13)	3 ^{a}	4.9	33.3 (n=3)	0.7 ^{a}	2
Barbus plebejus (n=40)	9.1 (n=23)	0.09 ^{a}	3.5	28.6 (n=8)	0.86 $^{a b}$	3	57.1 (n=9)	19.4 ^{b}	34
Cyprinus carpio (n=59)	38.46(n=13)	1 ^{a}	2.6	65.6 (n=32)	1.7 ^{a}	2.6	35.7 (n=14)	1.5 ^{a}	4.2
Overall fish species (320)	30.1(n=137)	1.3 ^{a}	4.5	52.1(n=145)	3.8 ^{b}	7.3	52.8 (n=38)	5.6 ^{b}	10.6

Values with the same superscript letter are not significantly different (P<0.05)

Diplostomum sp. in *L. cephalus, C. tinca* and *B. blebejus* and the high prevalence also occurred in fish between 20.1-30 cm in *C. regium, C. capoeta* and *C. carpio* (Fig. 4).

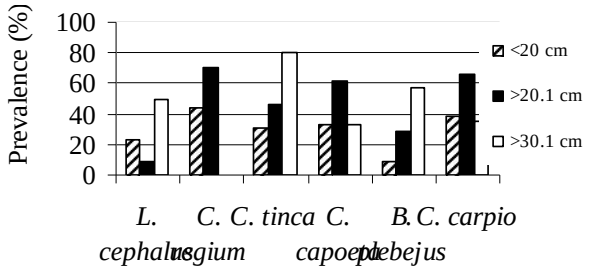

Fig 4. Prevalence of *Diplostomum* sp. in relation to length of several fish species from Almus Lake.

Significant differences determined between fish size classes were shown in Table II. The mean abundance of *Diplostomum* sp. infection was significantly higher in the >30 cm size classes of *C. tinca* and *B. plebejus*, and >20.1 in *C. regium* compared to smaller fish size. However, no significant relationship was observed between size classes in *L. cephalus*, *C. capoeta* and *C. carpio.*

When all fish species were pooled and size classes were compared, there was a significant relationship between three size classes. Significantly higher mean abundance was observed in fish between >20 and ≥30 cm comparing to fish ≤20 cm.

DISCUSSION

Diplostomum species are found in the eyes of a wide variety of fish species from freshwater and brackish water environments, and parasitize at least 105 fish species (Schwab, 2004). Diplostomids are also reported to be highly seasonal in relation to their transmission patterns between the snail host and fish intermediate host (Lyholt and Buchmann, 1996; Marcoglies *et al.,* 2001; Dorucu *et al*., 2002). The present study also showed a clear seasonal variation with the prevalence, abundance and intensity of *Diplostomum* sp. from several fish species, having increase in autumn and spring and decrease in summer.

Dörücü *et al*. (2002) examined the seasonal variation of *Diplostomum* sp. from *Acanthobrama marmid* in Keban Dam Lake, Turkey and reported the highest infection during spring and autumn and the infection decreased in the summer months. Marcoglies *et al.* (2001) reported that *Diplostomum* sp. in *Notropis hudsonius* showed to increase in abundance in the early summer and then to decrease during fall and followed spring. Present work and other studies shows that there are two periods of annual accumulation of these parasites. McKeown and Irwin (1997) suggested that the first period of accumulation was occurred by a cercariae which had been released by snails survived through the winter, whereas the second period of accumulation resulted from cercariae shed by snails which had hatched in the spring and had been infected by diplostome miracidia in the summer. Further, Lyholt and Buchmann (1996) found that the cercariae of *Diplostomum* were able to penetrate the fish and subsequently infected its eyes at 7°C. In the present study, water temperature was above 10ºC in spring and 12.1ºC in autumn. This might explain the high presence of *Diplostomum* sp. in spring and autumn. Unfortunately sampling was problematic in winter because the water temperature drop, fish became difficult to be collected, presumably because they were in deeper water.

Patterns of infection appeared to vary among fish species collected from the lake. *C. regium, C. tinca, C. capoita and C. carpio* had a highest prevalance with over 50% and *L. cephalus, B. plebejus* with prevalance lower than 50%. This might be related to the number of reason such as it took a number of years for *Diplostomum* sp to accumulate and survive in fish and habitat of different fish (Marcoglies *et al.*, 2001). The fish which were studied in this work are all benthopleagic fish.

Karvonen *et al.* (2006) suggested population dynamics of *Diplostomum* sp. may also be influenced by the size of the bird population at fish farms. The bird population on Almus Dam Lake is usually the highest in spring and late autumn, and decreases during summer (personal observations). This might also explain the increasing of this parasite in the autumn and spring period and the

decreasing in summer months.

In general, there is a positive relationship between the level of parasitic infection and the size of the host fish (McKeown and Irwin, 1997; Zelmer and Arai, 1998; Marcogliese *et al*., 2001; Barber and Crompton, 1997). In the present study, the infection prevalence, mean abundance and mean intensity values increased as the size of the fish increased. Similar results were obtained with *Diplostomum* sp from different fish and localities (Barber and Crompton, 1997; McKeown and Irwin, 1997; Zelmer and Arai, 1998; Valtonen and Gibson, 1997, Marcogliese *et al.,* 2001). The infection level of *Diplostomum* sp might increase as the result accumulation with increasing host age and size.

Because of the common occurrence of the parasites in natural waters, fish reared at farms using water from infected sources may become to expose to infection. Diplostomid infection is also frequently reported from farmed fish using re-circulated water (Karvonen and Seppala, 2008; Schwab, 2004; Voutilainen *et al.,* 2009).

Infection of *Diplostomum* sp. was also surveyed in 6 rainbow trout fish farms located in Almus Dam Lake and the infection was found in one of the farms which was located close to the shore. Prevalence of infection was 70% (n= 15) during autumn and 20% (n= 15) during spring (unpublished data). Further, mean abundance and mean intensity of infection were measured (2 parasites/ fish). Although, Diplostomid infection did not cause any abnormalities in the eyes of fish from fish farms, they must be considered important factors in terms of aquaculture and fisheries management as rainbow trout are especially vulnerable to cataract formation from eye fluke infections. This is problematic for fish farming because salmonids are one of the most prevalent cultured fish.

The results of this study have shown that *Diplostomum* metacercariae can often occur with high prevalence in the eyes of a variety of fish species. Both season and host sizes were affected to the population dynamics of *Diplostomum* sp. More studies are needed to examine *Diplostomum* infection in fish farms, wild fish populations, their life cycle and infection in intermediate host over longer time periods and on different geographical scales as it may have considerable to be problems on fish farms with increasing fish farming facilities and changes in water quality.

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REFERENCES

BARBER, I. AND CROMPTON, D.W.T., 1997. The ecology of *Diplostomum phoxini* infections in two minnow (*Phoxinus phoxinus*) populations in Scotland. *Helminthologia*, **71**:189-196.

BUCHMANN, K. AND ULDAL, A., 1994. Effects of eye fluke infections on growth of rainbow trout (*Oncorhynchus mykiss*) in a mariculture system. *Bull. Eur. Assoc. Fish Pathol.*, **14:** 104-107.

BUSH, A.O., LAFFERTY, K.D., LOTZ, J.M. AND SHOSTAK, A.W., 1997. Parasitology meets ecology on its own terms: Margolis *et al*. revisited. *J. Parasitol.*, **83**: 575–583.

DOGIEL, V., 1970. Ecology of the parasites of freshwater fishes. In: *Parasitology of fishes.* (eds. V.A. Dogiel, G.K. Petrushevski and Y.I. Polyanski). T.F.H. Publications, Inc. Ltd, Hong Kong, pp. 1-47.

DORUCU, M. AND ISPIR, U., 2001. Seasonal variation of *Diplostomum* sp. infection in eyes of *Acanthobrama marmid* Heckel, 1843 in Keban Dam Lake, Elazig, Turkey. *Ege Univ. J. Fish. aquat. Sci.,* **18:** 301-305

DORUCU, M., DILSIZ, N. AND GRABBE, M.C.J., 2002. Occurrence and effects of *Diplostomum* sp. infection in eyes of *Acanthobrama marmid* in Keban Dam Lake, Elazig, Turkey. *Turk. J. Vet Sci.,* 2**6:** 239-243

KARVONEN, A., KIRSI, S., HUDSON, P.J. AND VALTONEN, E.T., 2004. Patterns of cercarial production from *Diplostomum spathaceum*: terminal investment or bet hedging? *Parasitology,* **129**: 87-92

KARVONEN, A., SAVOLAINEN, M., SEPPALA, O. AND VALTONEN, E.T., 2006. Dynamics of *Diplostomum spathaceum* infection in snail hosts at a fish farm. *Parasitol. Res.*, **99**: 341- 345

KARVONEN, A. AND SEPPALA, O., 2008. Effect of eye fluke infection on the growth of whitefish (*Coregonus lavaretus*)-an experimental approach. *Aquaculture,* 279: 6-10

LYHOLT, H.C.K. AND BUCHMANN, K., 1996. *Diplostomum spathaceum*: effects of temperature and light on cercarial shedding and infection of rainbow trout. *Dis. Aquat. Org.*, **25**: 169-173.

MARCOGLIESE, D.J., DUMONT, P., GENDRON, A.D., MAILHOT, Y., BERGERON, E. AND

MCLAUGHLIN, J.D., 2001. Spatial and temporal variation in the abundance of *Diplostomum* spp. in walleye (*Stizostedion vitreum*) and white sucker (*Catostomus commersoni*) from the St. Lawrence River. *Can. J. Zool*., **9**: 355-36

MCKEOWN, C.A. AND IRWIN, S.W.B., 1997. Accumulation of *Diplostomum* spp. (Digenea: Diplostomatidae) metacercariae in the eyes of 0+ and 1+ Roach (*Rutilus rutilus*). *Int. J. Parasitol*., **27**: 377-380.

OWEN, S.F., BARBER, I. AND HART, P.J.B., 1993. Low level infection by eye fluke, *Diplostomum* spp., affects the vision of three-spined sticklebacks, *Fasterosteus aculeatus*. *J. Fish Biol*., **42**: 803-806

SCHWAB, 2004. Everyone wants a window seat. *Br. J. Ophthalmol*., **88**: 455

SEPPALLA, O., KARVONEN, A. AND VALTONEN, T., 2004. Parasite induced change to host behavior and susceptibility to predation in an eye fluke fish interaction. *Anim. Behav.*, **68:** 257-263.

SEPPALLA, O., KARVONEN, A. AND VALTONEN, T., 2008. Shoaling behavior of fish under parasitism and predation risk. *Anim. Behav*., **75**: 145-150

VALTONEN, E. T. AND GIBSON, D.I., 1997. Aspects of the biology of diplostomid metacercarial (Digenea) populations occurring in fishes in different locations of northern Finland. *Ann. Zool. Fenn*., **34**:47-59

VOUTILAINEN, A., VALDEZ, H., KARVONEN, A., KORTET, R., KUUKKA, H., PEUHKURI, N., PIIRONEN, J. AND TASKINEN, J., 2009. Infectivity of trematode eye flukes in farmed salmonid fish-effect of parasite and host origins. *Aquaculture*, **293**: 108-112.

ZELMER, D.A. AND ARAI, H.P., 1998. The contributions of host age and size to the aggregated distribution of parasites in yellow perch, *Perca flavescens*, in Garner Lake, Alberta. *J. Parasitol*., **84**: 24-28

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