

Helminth Infections in Common Carp, *Cyprinus Carpio* L., 1758 (Cyprinidae) from Kovada Lake (Turkey)

İsmail KIR, Selda TEKİN ÖZAN

Süleyman Demirel Üniversitesi, Fen-Edebiyat Fakültesi, Biyoloji Bölümü, Isparta, Türkiye

SUMMARY: The aim of this study which was carried out from March 2003-February 2004 was to determine the parasites of carp (*Cyprinus carpio* L., 1758) inhabiting the Kovada Lake. During the study, a total of 63 common carps were caught in different regions of Kovada Lake each month and investigated parasitologically. In carps, the ectoparasite, *Dactylogyrus minutus* of Monogenea, was found and endoparasites; *Bothriocephalus acheilognathi* and *Caryophyllaeus laticeps* of Cestoda were found. The most common parasitic species was *Dactylogyrus minutus*.

Key Words: Kovada Lake, Common carp, endoparasite, ectoparasite, Turkey

Kovada Gölü (Isparta)'ndeki Sazan (*Cyprinus Carpio* L., 1758)'in Parazitleri Üzerine Bir Araştırma

ÖZET: Mart 2003 - Şubat 2004 tarihleri arasında yapılan bu çalışma ile Kovada Gölü'nde yaşayan sazan (*Cyprinus carpio* L., 1758)'in parazitlerini belirlemek amaçlanmıştır. Çalışma süresince toplam 63 adet sazan Kovada Gölü'nün değişik bölgelerinden aylık periyotlarla yakalanarak parazitolojik yönden incelenmiştir. Sazanlarda ektoparazit olarak Monogenea'dan *Dactylogyrus minutus*'a, endoparazit olarak Cestoda'dan *Bothriocephalus acheilognathi* ve *Caryophyllaeus laticeps*'e rastlanmıştır. En fazla rastlanan parazit türü *Dactylogyrus minutus*'tur.

Anahtar kelimeler: Kovada Gölü, Sazan, Endoparazit, Ektoparazit, Türkiye

INTRODUCTION

The common carp, *Cyprinus carpio* L., is apparently the most widely geographically distributed fish species. Owing to its adaptation to a wide range of climatic and geographical conditions, a substantial number of almost all major taxa of parasites have been found in wild and domestic carp. The most complete checklist of carp parasites records a total of 310 parasite species (6).

The helminth fauna of the common carp in Turkey was investigated by Oğuz et al., (22), Aydoğdu et al., (5, 4, 3), Kır et al., (15). Among the ectoparasites of the common carps, two species of monogenean parasites, *Dactylogyrus extensus* and *Dactylogyrus minutus* were collected from Uluabat Lake Oğuz et al., (22), Dalyan Lagoon Aydoğdu et al., (4), İznik Lake Aydoğdu et al., (3) and Karacaören Dam Lake Kır et al., (15). Two species of Crustacea, *Ergasilus sieboldi* and *Argulus*

foliaceus were collected from Dalyan Lagoon (4), İznik Lake (5) and Karacaören Dam Lake (15). The endoparasite fauna was found to be more diverse. Species of three genera of Cestoda *Bothriocephalus acheilognathi* from Uluabat Lake (22), İznik Lake (3) and Karacaören Dam Lake (15), *Caryophyllaeus laticeps* from Dalyan Lagoon (4), İznik Lake (3) and Karacaören Dam Lake (15), *Ligula intestinalis* from Karacaören Dam Lake (15) and one genus of Acanthocephala, *Neoechinohychus rutili*, from İznik Lake (5) were determined in Turkey.

This paper reports on seasonal changes in prevalence and abundance of three species of platyhelminth infecting a wild carp population and provides detailed information about their population dynamics in Kovada Lake, Turkey.

MATERIALS AND METHODS

Kovada Lake, the study area, is in southwestern Anatolia, geographically located at 37°38' N, 30°52' E, at an altitude of 821 m. The lake is shallow (mean depth ca. 5 m) and has a surface area of ca. 1100 ha.

Table 1. Monthly changes and species composition (Dm: *Dactylogyrus minutus*, Ba: *Bothriocephalus acheilognathi*, Cl: *Caryophyllaeus laticeps*) of the parasites of common carp (*Cyprinus carpio* L.) in Kovada Lake. Months, number of examined fish (N), number of infected fish (In), percentage (%), minimum-maximum (M) and mean number of parasites (X±SD).

	N	In & (%)			M & (X±SD)			TOTAL		
		Dm	Ba	Cl	Dm	Ba	Cl	Dm	Ba	Cl
March-03	2	0	0	0	0	0	0	0	0	0
April-03	5	2 (40)	0	0	12-23 (17.5±7.77)	0	0	35	0	0
May-03	6	3 (50)	2 (33.3)	0	12-27 (20.6±7.76)	8-15 (11.5±4.04)	0	62	23	0
June-03	9	4 (44.4)	3 (33.3)	0	8-35 (19±11.97)	7-22 (13.6± 7.63)	0	76	41	0
July-03	6	2 (33.3)	2 (33.3)	0	8-12 (10±2.82)	20-30 (25.0±7.07)	0	20	44	0
August-03	9	7 (77.7)	1 (11.1)	0	7-23 (12.8±5.55)	3	0	90	3	0
September-03	7	3 (42.8)	3 (42.8)	3 (42.8)	18-28 (23.6±5.13)	12-22 (15.3±5.77)	8-24 (17.6±8.5)	71	46	53
October-03	6	3 (50)	1	4	8-32 (20.3±12.01)	5	2-18 (10.5±6.60)	61	5	42
November-03	6	3 (50)	0	0	8-21 (13.6±6.65)	0	0	41	0	0
December-03	3	1 (33.3)	0	0	4	0	0	4	0	0
January-04	2	0	1 (50)	0	0	5	0	0	5	0
February-04	2	0	0	0	0	0	0	0	0	0
Total	63	24 (38.89)	13 (20.63)	7 (11.11)	-	-	-	460	167	95

Samples of 2-9 carps were taken on a monthly basis from March 2003 to February 2004. The carp were caught using net, hook or bow-net by local commercial fisherman. The specimens were placed in plastic tanks with local lake water and immediately transferred to the research laboratory where they were kept in an aquarium and sacrificed within 24 hours. During the dissection, the gill filaments, the eyes, the fins and the skin were examined. The gill filaments were placed in separate petri dishes with 1:4000 formaldehyde. The intestine was dissected and placed in separate petri dishes with physiological saline solution. To determine the presence of parasites, intestines and gills were thoroughly examined under a binocular microscope; any parasites encountered were counted. The parasite specimens were fixed in formaldehyde, stained with aceto carmine, and were mounted in Canada Balsam.

The parasite specimens were identified using the reference keys of Bykhovskaya-Pavlovskaya (8), Reichenbach-Klinke (24), Cheng (9), Bauer (7), Chubb et al. (10) and Hoffman (13). Pearson's test was used to measure correlation among the density of each parasite species. Minimum and maximum values are given in tables, with the arithmetic mean and standard deviation in parentheses. All statistical analyses were performed using the statistical program SPSS 12.0.

RESULTS

Three platyhelminth species were recovered during the 12 month study on the wild carp population from Kovada Lake. These were the monogenean gill parasites *Dactylogyrus minutus* (overall prevalence 38.09 %) and two intestinal cestodes, *Bothriocephalus acheilognathi* and *Caryophyllaeus laticeps* (overall prevalence 20.63 and 11.11, respectively). Data on the prevalence, abundance, maximum and minimum intensity of the three helminth species in the monthly samples of *C. carpio* in Kovada Lake are given in Table 1.

The most common parasite species was *D. minutus* being the most frequent and numerous species. A total of 24 of 63 (38.09 %) fish were infected with *D. minutus*. This species was recorded on the common carp throughout the year except for March 2003, January 2004 and February 2004. A total of 460 parasites were found on 24 fish (Table 1). While the highest intensity were observed in August 2003, reaching a total number of 90 (77.7%; 12.8±5.55), the lowest level in intensity were recorded in December 2003, reaching a total number of 4 (33.3%; 0±0.00).

Two different types of Cestoda were found in the present study and were identified as *C. laticeps* and *B. acheilognathi*.

The second most common parasite species was *B. acheilognathi*. 13 of 63 fish were infected by *B. acheilognathi*. A total of 167 parasites were found (Table 1). Parasite specimens were found on the common carp from May 2003 to October 2003 and in January 2004. The infection was the highest in September 2003, reaching a total number of 46 (42.8%; 15.3 ± 5.77). The infection was the lowest in August 2003, reaching a total number of 3 (11.1%; 0 ± 0.00).

C. laticeps only occurred in carp in September 2003 and October 2003, with a total of 7 of 63 (11.11%) fish infected, most commonly in October 2003 (66.6%). A total of 95 parasites were found on 7 fish.

The correlation coefficient and its significance for each parasite species is given in Table 2. As can be seen from the table, *D. minutus* and *C. laticeps* showed significant variations in density between months (<0.05).

Table 2. Pearson correlation between parasite species (Dm: *Dactylogyrus minutus*, Ba: *Bothriocephalus acheilognathi*, Cl: *Caryophyllaeus laticeps*). r: Correlation coefficient, p: significance (2-tailed).

		Dm	Ba	Cl
Dm	r	1	.079	.583*
	p	.000	.808	.047
Ba	r	.079	1	.359
	p	.808	.000	.252
Cl	r	.583*	.359	1
	p	.047	.252	.000

* Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

Two helminth parasites were found in the intestine of the host fish: 2 Cestoda and one on the gills: 1 Monogenea.

The study results (Table 1) show that the major parasite is *Dactylogyrus minutus*. The present data show that *D. minutus* infection is optimal during summer and autumn, however infestation by this parasite occurred throughout year except March 2003, January 2004 and February 2004. *Dactylogyrus* by eggs on fish gills or in water, where they fall to the bottom of the reservoir. Egg development depend on external conditions, primarily on temperature, eg., in summer at 22-24 °C. *D. vastator* larvae develop and hatch in 2-3 days at 18 °C larval development takes approximately a month in water when water temperature fall below 4 °C no changes can be observed in eggs with development only commencing when the temperature rises (21). The data from the Kovada Lake seem to support the link with water temperature: In Kovada Lake, the peak of infection of *D. minutus* from April to June corresponds with increasing water temperature, and the decline in infection by *D. minutus* decreased, during winter, coinciding

with the decline of water temperature. This may be explained by the report that *D. minutus* is a thermophilic parasite with a shorter life cycle at higher temperatures (17,18,26,23) which could explain the dominance of this species in summer months. The present study supports the data in the literature concerning the dynamics of the occurrence of this monogenean species.

Bothriocephalus acheilognathi is a very common parasite species of many freshwater fish species (eg. *Cyprinus carpio*, *Tinca tinca*, *Alburnus alburnus*, *Silurus glanis*) (11,16). The eggs of this parasite species sensitive to desiccation and low temperature and die when frozen for 2 hours or within 20 hours when exposed to 20 °C. In temperature regions therefore worms are thought to over winter in the intestine of their definitive host and in young fish two populations of parasite may occur: smaller worms obtained from recent infection and larger individuals acquired the previous spring/summer. Development of larva, the coracidium, enclosed in the egg is dependent on water temperature and can take as little as 2 days at 25 °C to 4 days at 16 °C. The intermediate, host several species of copepod, e.g. *Cyclops abyssorum*, *Mesocyclops leuckarti*, *Ectocyclops phaleratus*, *Thermocyclops taihokuensis*, ingests the liberated larval stage in which the proceroid stage of the parasite develops. The fish becomes infected by eating the infected intermediate host (14). Water temperature in Kovada Lake is suitable for *B. acheilognathi*, exceeding 25 °C from May through November. The data from Kovada Lake seem to support the significance of water temperature, with the peak of infection of *B. acheilognathi* in summer and autumn corresponding with the increase water temperature. Also there was a seasonal change in *B. acheilognathi* infection. This species appeared in January. Likewise, Granath and Esch (12) and Riggs and Esch (25) found a negative correlation between the abundance of *B. acheilognathi* and water temperature.

Caryophyllaeus laticeps is a characteristic common parasite of cyprinid fishes in Europa. Seven of 63 fish were infected by this parasite and found in September and October. It has been speculated that a cycle may be affected by fish hormone levels, a temperature dependent immune response and the presence of other parasitic species, e.g. *Ligula intestinalis*. Mathematical models based on the association between *Caryophyllaeus laticeps* and bream have shown that the seasonal variations in the parasite numbers related to a temperature dependent mortality rate, feeding activity of the host and recruitment rate of larvae. The increase in intensity and prevalence of infection in fish in spring and early summer has been noted in other countries, e.g. Poland, and has been associated with fish mortality (14). The studies of Andersen (1,2) on the population dynamics of *Caryophyllaeus laticeps* in final and intermediate hosts based on field data and a theoretical population model showed three factors responsible for the cyclic changes in the parasite population size; a: final host's feeding behaviour, b: egg production by adult worms, causing periodic

availability of infective larvae and c: temperature-dependent mortality of the parasites within final host. The data from Kovada Lake seem to validate at least the two first factors. In Kovada Lake, the peak of infection of *C. laticeps* in autumn occurs in the Kovada Lake, a new generation of *Tubifex tubifex* can already harbour the infective procercooids of *C. laticeps* which require 3.5-4 months for development from egg to infective stage (19,20). Some of the factors such as availability (seasonal occurrence) of intermediate hosts, tubificids, are currently being investigated in the Kovada Lake. In addition, further investigations are obviously necessary in the Kovada Lake before causes of this seasonal occurrence of *C. laticeps* can be ascertained.

There can be no doubt that the parasite fauna is relation with the host's diet. The common carp fed mainly detritus, plankton, algae, higher plants (including seeds), aquatic vertebrates (e.g. insect larvae, worms, crustaceans and snails) (14). The choice and composition of carp's food is very important for the formation of the helminth fauna in this fish and this is considerably influenced by local conditions.

ACKNOWLEDGEMENTS

This work supported by Süleyman Demirel University, SDÜBAP-03-M-724 project. I would like to thank Süleyman Demirel University-Scientific Research Project Management (SDÜ-SDÜBAP) for their financial support.

REFERENCES

1. Andersen RM, 1974. Population dynamics of the cestoda *Caryophyllaeus laticeps* (Pallas, 1781) in the bream (*Abramis brama* L.). *J Animal Ecol*, 43: 305-321.
2. Andersen RM, 1976. Seasonal variations the population dynamics of *Caryophyllaeus laticeps*. *Parasitology*, 72: 281-305.
3. Aydoğdu A, Kostadinova A, Fernandez M, 2003. Variations in the distribution of parasites in the common carp, *Cyprinus carpio*, from Lake İznik, Turkey: population dynamics related to season and host size. *Helminthologia*, 40(1): 33-40.
4. Aydoğdu A, Öztürk MO, Oğuz CM, Altunel FN, 2001. Investigations on metazoan parasites of the common carp (*Cyprinus carpio* L. 1758) in Dalyan Lagoon, Karacabey, Turkey. *Acta Veterinaria-Beograd*, 51(5-6): 351-358.
5. Aydoğdu A, Yıldırımhan HS, Altunel FN, 1997. An investigation on some metazoan parasites of common carp (*Cyprinus carpio* L.) in İznik Lake. *Turkiye Parazitol Derg*, 21(4): 442-445.
6. Baruš V, Peňáz M, Kohlmann K, 2002. *Cyprinus carpio* (Linnaeus, 1758), In: Banaresku PM, Paepke HJ, editors, *The freshwater fishes of Europa*. Cyprinidae 2 Vol. 5/III. Part III: *Carassius* to *Cyprinus*. Gasterosteidae, AULA-Verlag: Wiebelsheim, 85-179.
7. Bauer ON, 1987. *Key to the Parasites of Freshwater Fishes in the Fauna of the U.S.S.R.* Leningrad, 583 pp.
8. Bykhovskaya – Pavlovskaya AV, 1964. *Key to Parasites of Freshwater Fishes of the U.S.S.R.* II,III., Transl. by Birrow, A., Cale, Z.S., Israel Program for Scientific Translations, Jerusalem, 890 pp.
9. Cheng CT, 1973. *General Parasitology*. Academic Press Inc, London, 726 pp.
10. Chubb JC, Pool DW, Veltkamp CJ, 1987. A Key to the Species of Cestodes (Tapeworms) Parasitic in British and Irish Freshwater Fishes. *J Fish Biol*, 31: 517-543.
11. Erkul S, 1997. Infection of helminths in freshwater fish seen in the region of Ankara. Ankara University, Medical Institution, Master Thesis. Ankara.
12. Granath WO, Esch GW, 1983. The temperature and other factors in regulating the intrapopulation densities and composition of *Bothriocephalus acheilognathi* in *Gambusia affinis*. *J Parasitol*, 69(1): 116-124.
13. Hoffman GL, 1999. *Parasites of North American Freshwater Fishes*. Cornell Univ. Press, Portland, 539 pp.
14. Hoole D, Bucke D, Burgess P, Wellby I, 2001. *Diseases of carp and other cyprinid fishes*. MPG Books Ltd, Bodmin, Cornwall, 264 pp.
15. Kır İ, Ayyaz Y, Barlas M, Tekin-Özan S, 2004. Seasonal distribution and effect of parasites on carp (*Cyprinus carpio* L., 1758) inhabiting the Karacaören Dam Lake. *Turkiye Parazitol Derg*, 28(1): 45-49.
16. Koyun M, 2001. The helminthofauna of some fishes in Enne Dam Lake. Uludağ University, Medical Institution, Doctora Thesis. Bursa.
17. Kritscher VE, 1982. Die fische des neusiedlersees und ihre parasiten VII. Trematoda Monogenea Und Zusammen Tassung. *Ann. Naturlist. Mus. Wien*. 90B: 407-421.
18. Kritscher VE, 1988. Die Fische Des neusiedlersees und ihre parasiten VI. (Cestoidea). *Ann. Naturlist. Mus. Wien*. 90B: 183-192.
19. Kulakovskaya OP, 1962. Development of Caryophyllaeidae (Cestoda) in an invertebrate host. *Zoolgichoskii Zhurnal*. 41: 986-992.
20. Kulakovskaya OP, 1964. Life cycles Caryophyllaeidae (Cestoda) in the conditions of western Ukraine. *Ceskoslovaska Parasitologie*, 11: 117-185.
21. Markewich AP, 1951. Parasitic fauna of freshwater of the fish of the Ukrainian SSR. *Trans by Rofael, N. Kudus*. 157: 213-224.
22. Oğuz MC, Öztürk MO, Altunel FN, Ay YD, 1996. A parasitological investigation on common carp (*Cyprinus carpio* L., 1758) caught in Uluabat Lake. *Turkiye Parazitol Derg*, 20(1): 97-103.
23. Pojmanskaya T, 1995. Seasonal dynamics of occurrence and some parasites in four Cyprinid fish cultured in ponds, II. Monogenea. *Acta Parasitologica*, 40(2): 79-84.

24. **Reichenbach-Klinke HH**, 1966. *Krankheiten und Schädigungen der Fischer*, Gustav Fischer Verlag, Stuttgart, 389 pp.
25. **Riggs MR, Esch GW**, 1987. The suprapopulation dynamics of *Bothriocephalus acheilognathi* in a North Carolina Reservoir: Abundance, dispersion and prevalence. *J Parasitol*, 73: 877-892.
26. **Silvia LG, Sepulveda R, Mercado-Hernandez R, Martinez JJ, Salinas F**, 1991. New localities for monogenetic trematodes and other ectoparasites of carp (*Cyprinus carpio*) and catfish (*Ictalurus punctatus*) in northeastern Mexico and their relation with some biotic and abiotic factors. *The Journal of the Elisa Mitchall Scientific*, 106(3): 64-77.