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Infection Dynamics of Helminth Parasites in the Silver Carp, *Hypophthalmichthys molitrix* with Reference to Season

G. P. Thakur*, A. N. Jha and B. S. Jha

Department of Zoology, L.N. Mithila University, Darbhanga- 846008, India

**Corresponding author*

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A B S T R A C T

The present study, carried out from September 2018 to August 2019, reports the seasonal fluctuations in the intensity of infection level of helminth parasites in the silver carp, *Hypophthalmichthys molitrix*, reared along with native carps in ponds and other water bodies of Darbhanga , Bihar, India. The host fish were found to parasitize two monogenean ecto-parasites, *Dactylogyrus vastator* (in gill & skin) and *Gyrodactylus elegans* (in skin); one cestode (*Bothriocephalus acheilognathi* in intestine) and one nematode (*Camallanus ophiocephali* in stomach). These parasites revealed seasonal fluctuations in their prevalence percentage, mean intensity and abundance. The overall highest prevalence and abundance were of *Dactylogyrus* (54% and 0.064) followed by *Gyrodactylus* (5% and 0.06) *Bothriocephalus* (3.9% and 0.05) and *Camallanus* (3.3% and 0.05). However, the mean intensity was highest for *Camallanus* (1.5) and lowest (1.18) for *Dactylogyrus*. The highest prevalence and abundance of the parasites were recorded during summer (June-Aug) followed by spring (Mar-May) and autumn (Sept-Nov) and lowest in winter (Dec-Feb) seasons. The winter months did not show infection of any parasites except *Dactylogyrus* which was also minimal. The observed seasonal fluctuations have been attributed to physico-chemical parameters, especially temperature, feeding habits and lifecycle patterns of the parasites.

Introduction

Fishery sector has received due attention of the Govt. and scientific communities during the past few decades in our country. This sector besides providing cheap source of protein has become a source of livelihood for some 14 million people of socioeconomically backward sections and has substantial contribution to the national economy by earning revenue in foreign exchange through export. The efforts taken by the stakeholders of this sector have increased fish production manifold from just 0.75 million tonnes in 1950-51 to 9.04 million tonnes in 2012-13 (Baruah *et al.*, 2015) and 13.7 million tonnes in 2018-19 (The Economic Times, July, 04, 2019). Though a target of 20 million tonnes of fish production by the year 2022 has been set by the Govt. of India (Union Budget, 2020-21), yet this will leave a major gap when compared to growing fish demand.

Even this set target seems very difficult to achieve due to various natural and other constraints faced by this sector. One such important factor is the parasitic infections in fishes which deteriorates their food value and hampers growth leading to less productivity. Helminths are one of the major groups of parasites in fish causing severe loss in their productivity (Jha *et al.,* 1992, Sobecka and Slominska, 2007; Thakur *et al.*, 2019).

In consideration of the above facts, the present study was undertaken which reports the seasonal variation in the intensity of infestation of helminth parasites in the silver carp, *Hypophthalmichthys molitrix*, which is now well established in India and used in polyculture along with native major carps Catla, Rohu and Mrigal.

Materials and Methods

Specimens of the silver carp, *Hypophthalmichthys molitrix,* were collected fortnightly over a period of one year (September, 2018 to August, 2019) from the local fishermen to whom the regional ponds and other water bodies have been leased out by the Govt. of Bihar. Altogether 180 fishes (size ranging between 22 cm - 27 cm) were collected in one calendar year. Fish were brought to the laboratory in ice-box and then refrigerated.

These were examined for helminth parasites infection in skin, gill, stomach and intestine within 2-3 days following the procedure of Mofasshalin *et al.,* (2012). After identification (Yamaguti, 1958, 1963), the parasites were preserved in AFA (120 ml distilled water + 6 ml ethyl alcohol + 30 ml formalin + 10 ml glycerin + 0.5% neutral or methyl blue or acetocarmine) solution for detailed investigation.

Season-wise average prevalence, abundance and mean intensity was determined by following formulae (Margolis *et al.*, 1982).

$$\text{Prevalance} = \frac{\text{Total no. of host fish infected}}{\text{Total no. of host fish examined}} \times 100$$

$$\text{Mean Intensity} = \frac{\text{Total no. of Parasites collected}}{\text{Total no. of infected host examined}}$$

$$\text{Abundance or Relative density} = \frac{\text{Total no. of Parasites collected}}{\text{Total no. of infected host examined}}$$

Results and Discussion

The results of the present study have been elaborated in Table 1 and 2. Altogether four parasites were identified during this study, of which two (*Dactylogyrus vastator* and *Gyrodactylus elegans*) were monogeneans, one (*Bothriocephalus acheilognathi*) cestode and one (*Camallanus ophiocephali*) was a nematode. *Dactylogyrus*, collected from gill & skin and *Gyrodactylus*, collected from skin, are the two ecto-parasites whereas *Bothriocephalus* and *Camallanus* are the endoparasites isolated from intestine and stomach respectively. On annual basis, the overall prevalence (54.4%) and abundance (0.64) were recorded for *Dactylogyrus* followed by *Gyrodactylus* (5% and 0.06), *Bothriocephalus* (3.9% and 0.05) and *Camallanus* (3.3% and 0.05) respectively. As regards mean intensity, it was highest for *Camallanus* (1.5) and lowest for *Dactylogyrus* (1.18) with intermediate value of 1.42 and 1.33 for *Bothriocephalus* and *Gyrodactylus* (Table 1).

The seasonal fluctuations in intensity of infestation of these parasites in terms of prevalence (%), mean intensity and abundance have been shown in Table 2. The seasonal fluctuation in the infection level of all the four parasites revealed interesting results. The maximum prevalence and abundance of the parasites were recorded in summer followed by spring, autumn and winter months. The highest prevalence and abundance was recorded for *Dactylogyrus* (73.33% and 0.9) in summer months followed by spring (59% and 0.68), autumn (47.5% and 0.52) and winter (25.0% and 0.3) and lowest for *Camallanus.* Interestingly, during winter months (Dec-Feb) one ecto-parasite (*Gyrodactylus*) and both the endo-parasites (*Camallanus* and *Bothriocephalus*) were absent and as such could not be isolated / collected. Besides, heavily infected fish showed whitish to yellowish cysts in skin and gill as well as excessive secretion of mucus and slight haemorrhage at the base of fins.

Discussion

The findings of this study closely conform with those of some earlier reports (Pojmanska and Chabros, 1993, Ozan *et al.,* 2008, Shamsi *et al.,* 2009; Vijyaysundardeva *et al.,* 2018). Our results reveal that the major parasite of the host fish *H. molitrix* is *Dactylogyrus vastator* which was maximum in summer and spring with occurrence throughout the year in all seasons.

The prevalence of *Gyrodactylus* was second to *Dactylogyrus* followed by *Bothriocephalus* and *Camallanus,* however, the host fishes were observed to be free from these three parasites during winter a month (Dec – Feb) which suggests their consumption most preferably during this season. The observed seasonal fluctuations in the level of infection of these parasites may be attributed to abiotic factors as well as high contamination of the water bodies inhabiting the fish leading to impaired metabolic activity and suppression of immune system of the host fish.

Mofasshalin *et al.,* (2012) have also associated infection and infestation rate of parasites with stocking density, water depth, temperature and other physico-chemical parameters along with ill management of water bodies. Some earlier reports also correlate occurrence and intensity of infestation of helminth parasites with pH, temperature, oxygen content, salinity and eutrophication (Marcogliese, 2001; Modu *et al.,* 2011). The peak of infection of *Dactylogyrus* during summer months and decline to the minimum in winter season coincides with fall of water temperature and is in conformity with previous studies denoting seasonal fluctuation of *Dactylogyrus* to be influenced by temperature, that oxygen concentration and free CO_2 level of water (Pojmanskaya and Chabros, 1993).

Further, the life cycle of both *Dactylogyrus* and *Gyrodactylus* is direct with no intermediate host and both being thermophilic parasites with a shorter life cycle may also be a possible explanation for the dominance of both the genera of parasites during summer months (Pojmanskaya, 1995).

The observed higher population of Dactylogyrus may be a matter of concern for fish production since these cause high mortality of fry and fingerlings leading to low productivity of fish (Shamsi *et al.,* 2009).

The observed absences of Gyrodactylus, Camallanus and Bothriocephalus during winter and higher occurrence during summer seasons have direct correlation with temperature.

The eggs of these parasite is sensitive to low temperature and even die within 2-3 hours of exposure to very low temperature and when the temperature rises above 25-26^{o}C, its coracidium larvae develop from eggs which are ingested by their intermediate hosts (several species of copepods) where the procercoid stage of parasite develops and the fish gets infected by consuming the intermediate host (Kir and Tekin-Ozan, 2007).

These may be cited as one of the major reasons behind higher occurrence of both these parasites in summer and lowest to nil during autumn/winter months.

Table.1 Overall prevalence of helminth parasites in the silver carp, *Hypophthalmichthys molitrix*

No of Host Fish Examined	No. of Host infected with type of parasite	Site of Infection	No. of parasites collected	Prevalence %	Mean Intensity	Abundance
180	*Dactylogyrus vastator*-98 (Monogenea)	Gill, Skin	116	54.4	1.18	0.64
180	*Gyrodactylus elegans*-09 (Monogenea)	Skin	12	5.0	1.33	0.06
180	*Camallanus ophiocephali*-06 (Nematode)	Stomach	09	3.3	1.5	0.05
180	*Bothriocephalus acheilognathi*-07 (Cestode)	Intestine	10	3.9	1.42	0.05

Table.2 Infection dynamics of helminth parasites in the silver carp with reference to season

Season	No.of Host fish examined	No. of Infected fish	Parasites (Site of infection and No. collected)	Prevalence %	Mean Intensity	Abundance
Autumn (Sept- Nov)	40	19	*Dactylogyrus vastator*(Gill,Skin)-21	47.5	1.10	0.52
		02	*Gyrodactylus elegans*(Skin)-02	5.0	1.0	0.05
		01	*Camallanus ophiocephali* (Stomach)-01	2.5	1.0	0.025
		01	*Bothriocephalus acheilognathi* (Intestine)-01	2.5	1.0	0.025
Winter (Dec-Feb)	36	09	*Dactylogyrus vastator* (Gill, Skin)-11	25.0	1.22	0.30
		Nil	*Gyrodactylus elegans* (Skin)-Nil	-	-	-
		Nil	*Camallanus ophiocephali* (Stomach)-Nil	-	-	-
		Nil	*Bothriocephalus acheilognathi* (Intestine)-Nil	-	-	-
Spring (Mar- May)	44	26	*Dactylogyrus vastator* (Gill, Skin)-30	59.09	1.15	0.68
		02	*Gyrodactylus elegans* (Skin)-02	4.54	1.0	0.04
		02	*Camallanus ophiocephali* (Stomach)-02	4.54	1.0	0.04
		02	*Bothriocephalus acheilognati* (Intestine)-03	4.54	1.5	0.06
Summer (June-Aug)	60	44	*Dactylogyrus vastator* (Gill, Skin)-54	73.33	1.22	0.9
		05	*Gyrodactylus elegans* (Skin)-08	8.33	1.6	0.13
		03	*Camallanus ophiocephali* (Stomach)-05	5.0	1.66	0.08
		04	*Bothriocephalus acheilognathi* (Intestine)-06	6.66	1.5	0.1

This study concludes that water bodies of Darbhanga region (present area of study) need proper management particularly during summer which are peak months of helminth parasites infection causing heavy mortality to fish fry and fingerlings leading to their less production and that most favoured periods for consumption of the fish *H. molitrix* by human beings are the winter months (Dec to Feb.) when, save and except very low degree of infection by *Dactylogyrus*, the fish were free from all other parasites.

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