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Investigations on Parasitic Diseases in Fish of River Yamuna during the Summer Season

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Abstract:

The four types of fishes (Common carp, Tilapia, cat fish, eel fish) have been examined in the Yamuna river at Gau Ghat, Allahabad during the summer season to fulfil the proposed dissertation. The Common Carp and Tilapia (omnivorous) was investigated with the infection of ecto parasites (protozoa- Ichthiophtheris spp., Sarcodina spp. , Tricodina spp. and arthropods-Ersilus sp.) on their body surface and gills whereas eel and cat fishes (carnivorous fishes) were recorded with the infections of Cestodes-Polyonchobothrium sp. and Nematode – Dacnitoides sp. in their intestine respectively as endoparasites. The observed infection pattern was explained on the basis of habitat selection and dietary behavior. The occurrence of parasites was discussed with their diseases in fishes, weight wise infection prevalence, mean intensity and ecology during the course of study.

Key words: Fish, ecto parasites, endoparasites, Protozoans, Yamuna River.

Introduction

The Fish and fisheries provide important contributions to poverty and food security through three main interlinked pathways Nutritional benefits from the consumption of fish, Income to those employed in the sector and multiplier and spillover effects in fishery-dependent regions and Through generation of revenues from exports, taxation, license fees and from payment for access to resources by foreign fleets or foreign investment in aquaculture.Therefore, the world policy maker are attempting to make the fish and fisheries as supplement of food source in view of increased food demand, food security and earning of income for poor people **World Fish Centre, 2011.**

The parasites are organism depended organisms usually found on the body surface or G.I. tracts or viscera of an organism (host). Ecologically, parasites are organism that found symbiotically associated with its hosts for organic nutrients and always makes harms to its hosts **(Bush *et al*., 2001)**. These parasites are intimated to the organisms (hosts) by evolutionary forces for maintaining ecological equilibrium. Similarly, natural or cultured fishes are also hosts to several parasites and it is well documented **(Klinger and Floyd, 2013)**. Fishes are susceptible to all the phyla of parasites including to annelids and arthropods and can affect the fish biology which tends into diseases, mortality, disordered growth pattern and ultimately make loss to fish values **(Lafferty, 2008)**. The fish parasites have also been signified as zoonotic and biological hazard in prospective of human health **(Chaia, 2005)**. Hence ichthioparasites are seems to deduct the fish production in culture or in natural habitat.

The investigating site has more fish diversity being near to the confluent of two rivers Ganga and Yamuna hence different varieties of fishes are easily available in the markets over all the year. Although these two rivers also have exotic fishes like Common Carp (*Cyprinus carpio*,) and Tilapia

(*Oreochromis niloticus*, Linnaeus) which are easily available in the market at less value because of their comparatively more growth and itioparity reproduction. *Rita rita* (Hamilton), a Cat fish and *Mastacembellus armatus*, (Lacepède) Eel fish are the market values fishes in this region which are also used to export to adjacent states. Hence, the above fishes have selected for parasitic examination during the summer season due to their food values and availability in the market.

The fishes were collected randomly from the market as well as live directly from fisher man. The Tilapia and common carp have been examined for ecto and endo parasites and infection were observed only in the gill of both the fishes. The gills of Common Carps harboured more infections of necrosis and rotten under severe conditions than Tilapia .Their tail and body surface also showed the infection of protozoan The infections of protozoan (*Ichthiophtheris sp*., *Sarcodina spp*., and *Tricodina sp*.,) were observed more severe in tail portion of both the fishes but moderately more protozoan in Common Carp (Infection prevalence- 49.8%) than Tilapia (Infection prevalence- 44.7%). The further investigations of infected gill revealed that protozoan were responsible for the investigated rotten gills of fishes. Whereas *Rita rita* and *Mastacembellus armatus* were infected with nematode (*Dacnitoides sp*.) and cestode (*Polyonchobothrium sp*.) respectively from their intestines significantly. Similar infections of *M. armatus* were also reported by **Kumar *et al*., 2007), Kumar (2012)**. and **Chaurasia and Ansari, (2008)** in *Rita rita*. Nematodes and cestodes are the macroparasites which make weight loss in fishes spite of food intake. Interestingly helminthes infections (cestode and nematode) were only observed in examined carnivorour fishes, *Mastacembellus armatus* and *Rita rita* whereas not in herbivorous fishes, carp and Tilapia. The cat and eel fishes are bottom dweller (benthic zone) carnivorous fishes (eat- crustaceas, arthropods larvae and small fishes) that prefer to live between middle (Metalimnion) to bottom water

(hypolimnion, temperature 4.0-20°C). On the other hand the common carp and Tilapia are surface living (limnetic zone) and omnivorous fishes (feed on phytoplankton, periphyton, aquatic plants, invertebrates, benthic fauna, detritus, films, prefer to live between middle to surface (**FAO, 2012**). **(Teichert-Coddington *et al.*, 1997)**. Immunologically, cat fish and eel fish has moderately thick skin and without scale than carp and Tilapia. That is, cat and eel are immunologically stronger than carp and eel. It can be argued that observed pattern of protozoan, infections in Common Carp and Tilapia would be the result of habitat selection, immunity and water thermal gradation that did not make susceptible to cat and eel fishes **(Belland and Burt, 1991; Robert *et al.*, 2008; Khan, 2012).**

Objectives

1. To investigate the occurrence of protozoan parasites in gills and at body surfaces of the fishes in the aquatic system of Yamuna River at Gau Ghat, Allahabad.
2. To investigate the cestodes, nematodes and trematodes intestine and visceral organs.
3. To compare the body weight of healthy and infected fishes in correlation of other physical and physiological parameters with infection.

Review of Literature

Allahabad had been the centre of parasitological investigations at the time of Prof. Woodland (1912-1922), department of Zoology, University of Allahabad. Till that time it has been progressively propagated by eminent parasitologists. Consequently many species of parasites including nematodes, cestodes and trematodes in fishes have been reported from this aquatic fauna **(Kumar *et al.*, 2007 and 2012)**. Fish parasites have been documented nationally and internationally **(Singh, 1998 and Klinger and Floyd, 2013).** It has been concerned seriously to our food stuff fishes and aquaculture industries for freshwater as well as marine **(Belland and Burt, 1991; Adams, Murrell and Landsberg, 1997; FDA, 2002; EFSA, 2010; Ogbulie, Nwigwe ; Anyadoh, 2011).** The Aggression or bioload of parasites in host (fish) body can influence the population dynamic and depletion of hosts resulted mortality. **Anderson and May, (1991) and Hudson and Dodson, (1995)** suggested that parasitic transmission and host mortality can often be obtained by analyzing pattern of age-prevalence and age intensity **(Kumar, 2012)**.Thus, a central theme of parasite studies over the years have been the development of a theoretical and empirical understanding of the stabilizing role of aggregation in the population dynamics of parasitic helminths and their hosts **(Anderson and May, 1978 and 1982)**.

Material and Methods

3.1-Sampling Site and collection

The fishes were collected randomly and periodically between the period of summer (April 1st to July30th) 2014. The live fishes were collected from the fish landing site, Gau Ghat, (Latitude 25^{o}26'46.04"N and Longitude 81^{o}51'24.005"E) at Allahabad, Uttar Pradesh (Plate 3.1) on the bank of river Yamuna with the

help of fishermen (Plate 3.2). Under the circumstances of unavailability of live fishes, freshly caught fishes were also brought from the fish market, Gau Ghat, near to bank of Yamuna river.

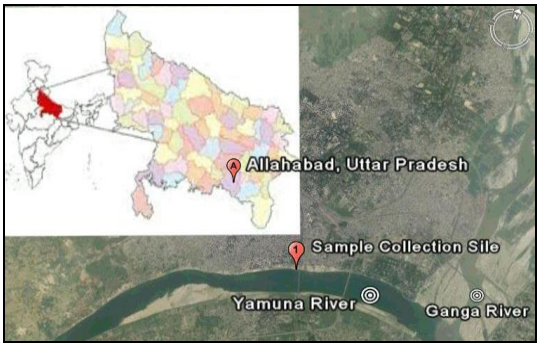


Plate 3.1-Satellite map of the sampling site, shows 1, as sample collection site, Gau Ghat, Yamuna river bank, Allahabad, Uttar Pradesh, India-211007.

Plate 3.2-Photograph showing the sampling of live fishes from fishing boats on river Yamuna bank site Gau Ghat, Allahabad, Uttar Pradesh.

3.2-Selection of sample (host fishes)

The four fishes have been selected for the examination of parasites in their desire parts of organs as given below-Common Carp Plate 3.3).Tilapia Plate 3.4).Cat fish Plate 3.5).Eel fish, Plate 3.6).

Plate 3.3- Common Carp fish (*Cyprinus carpio*) collected from river bank Yamuna at Gau Ghat, Allahabad, Uttar Pradesh, India.

Plate 3.4- Tilapia fish (*Oreochromis niloticus*) collected from river bank Yamuna at Gau Ghat, Allahabad, Uttar Pradesh, India.

Plate 3.5- cat fish, *Rita rita* collected from river bank Yamuna at Gau Ghat, Allahabad, Uttar Pradesh, India.

Plate 3.6- Eel fish (*Mastacembellus armatus*) locally call Baam, collected from river bank Yamuna at Gau Ghat, Allahabad, Uttar Pradesh, India.

3.3- Collection of Parasites

The techniques and methods of parasitic examination among the fishes has been supervised by Dr. Amithabh Diwedi, Senior Scientist, CIFRI, Allahabad and Dr. Sunil Kumar, Ex Guest Faculty, Department of zoology KAPG College, Allahabad in the laboratory of Central Inland Fish Research Institute, Allahabad, (Plate 3.7) Uttar Pradesh, India-211001.

3.4-Collection of Helminthes

The *Cestodes* and nematodes were directly collected from the intestine of fishes after sacrificing these before dissections and recovered examined under magnifying glassand using camera camera or with the aid of light microscope in the laboratory.

The recovered nematodes were washed with lukewarm water until the mucosal contents were removed and washed again in normal saline. The stretched nematodes were fixed in hot absolute alcohol and glycerine (95:5), and kept overnight. After 24.0 hours. Nematodes were preserved in Lactophenol solution and mounted in glycerol for microscopic examination by the methods after **(Rautela and Malhotra, 1984)**.

The cestodes were taken out from the G. I. tracts after dissecting these longitudinally. The whole worms were washed with lukewarm water, and then sacrificed. After removal of mucosal contents, the larger worms were cutted in suitable length of pieces for fixation in aqueous Bouin's fluids. The worms were fixed for 10-12 hrs. Bouin's fluid was washed under the running tap water until the worms attained their natural form. These washed cestodes were stained in freshly prepared Haemalum stain until the worms were stained dark. The stained cestodes were destained by their repeated transfer into acidic water and then these were kept in clean tap water to regain colour of Haemalum. This process was repeated several times until the shining of Haemalum appeared on the body of cestodes. After that, the cestodes were dehydraded through a series of increasing strength of alcohols ***i.e***., 50%, 70%, 90%,

100%, and cleared in xylol. For best morphological studies, the cestodes were mounted in Canada Balsam mounting reagent.

3.5- Collection of Protozoan and Arthropods –

Only the live fishes were used to examine for protozoan collections. Their gills, tails, fins and scales were carefully examined with the help of hand lens. Under the sign of protozoan infections, infected portions of gills, tails, fins and scale were scraped. Scraps were mounts temporarily in fresh saline solutions and examined under microscope. They were fixed to microscopic slides with methyl alcohol and then stained with Giemsa stain according to **Lucky (1977)**. The recovered protozoans were characterized and identified after **Das (1998).**

Under the availability of arthropods (*Ergasilus sp.*) in the examined gill were detached and recovered with the help of fine needle, forcep and recovered on slide. Sometime Rose Bengal solution was also used for collection of arthropods. They were washed in luke warm water and fixed in Bowins fluids for 2-5 minutes. The Bowins fluids were washed under continuous supply of tap water for twenty four hours. After that they were stained in Borex carmine and dehydrated in increasing gradation of alcohols. Slides were mounted in Canada balsam and examined under microscope.

3.6-Age Determination of fishes

The age of common carp (*Cyprinus carpio* Linnaeus 1758) and Tilapia (*Oreochromis Niloticus* Linnaeus, 1757) were determined by after **Das (1959)**. The scales were removed from the lateral side below the dorsal fin, above the lateral line, preferably from the second or third row of scales. Scales were kept in the ordinary envelops with the following data: Total length, standard length, weight, date of collection and place of collection. Scales were removed from envelops, washed in tap water and rubbed between the finger tips to remove the mucus and other extraneous matter. The cleaned scales were air dried

and again preserved in fresh envelopes. Each scale was mounted between the glass strips and studied under microscope at the magnification of 10X. From the magnified image of the scale, total scale radius and the distance between the focus and their respective annuli were measured. The reading of each complete annulus were count as age of the fish.

Frost and Kipling (1959) methods was applied in case of Cat fish (*Rita riat*) for treatment of opercular bones. The left opercular bone was removed from each specimen with a scalpel and immediately put into hot water and cleaned easily with a cloth. The age rings on the opercular bones were visible drying. The opercular bones were numbered and stored in envelops. The age rings on the opercular bones can be seen with magnifying glass but a more reliable count of them could be made holding the opercular bone against a narrow, sharp light source in a dark room. The maximum distance between the centre of the opercular bone and its margin was taken as the length of the opercular bone. But the age determination in *Mastacembellus armatus* was not processed due to its complexity and lack of time.

Results and Discussion

4.1-Parasites of Common Carp (*Cyprinus carpio*, Linnaeus 1758)

A total No. of 54 Common Carps (Plate 3.3) were examined during the study period from Yamuna River at Allahabad. Three species of ecto - parasites (protozoa) infections were observed predominantly. The infections of protozoa were investigated in the gill (Plate 4.1, tail 4.2, and scale4.3) of the fish. Three species of protozoan were characterized as *Ichthiophtheris sp*. (Plate 4.4-4.6), *Sarcodina sp*. (4.7) and *Tricodina sp.* (Plate 4.8). the infection was investigated in the gills (Plate 4.9 and 4.10) and under ventral side (Plate 4.11, Sample 52 and Table 4.1) of the carps and characterized as

pathogenic The occurrence of parasites, infections and infection sites (organs) *vs* body weight, body length and age of the fish were recorded and documented in Table 4.1. The body length, weight and age relationship of common carps was not found significant to correlate. Whereas arthropods (*Ergasilus sp.*) was recorded insignificantly to analysed, only in the gill of three fishes out of total examined (infection prevalence 0.06%, Table 4.1). Endo or Helminths parasites (cestodes, nematodes and trematodes) were unable to notice in all the observed common carp fishes. The body weight wise overall infection prevalence of protozoa are anlysed and tabulated in Table 4.2 and are.

The protozoan mean intensity was observed more in tail of male than female among the body weight classes of common carps in comparison to gills and scale (Table 4.3 and 4.4). The mean intensity of protozoan was observed more in gills of male than female whereas middle body weight class of both the sexes of fish was showed more protozoan infections in their tail.

The intensity of protozoan, *ichthiophtheris sp*. (I) was observed less in gill than tail and scales but their prevalence was versily proposal to the body weight classes of male fish (Table 4.3 and 4.4). Whereas female body weight of lower classes was harboured more infection of *Ichthiophtheris sp.* than male fish and intensity was recorded more in scales.

The mean intensity of protozoan *Sarcodina sp*. (S) was observed more in the body weight classes (100.1-200.0gm) male of than female. Their prevalence was more in tail, and scale than gill. The prevalence of protozoan *Tricodina sp.* (T) was observed more in the lower weight classes of male body whereas their intensity was more in the tail, scales. But Tail of female was recorded higher mean intensity than other observed body organs.

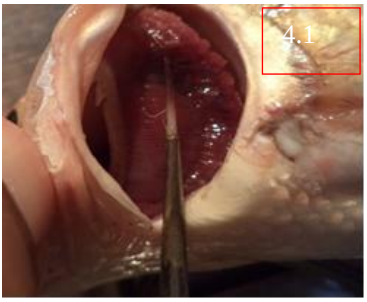
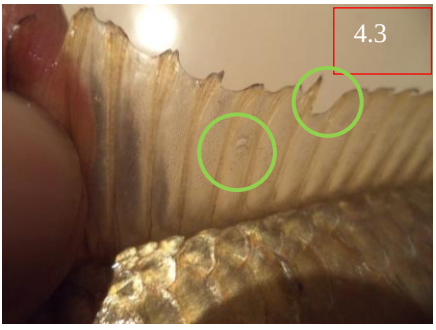


Plate 4.1 and Plate 4.2- Indicating the site of protozoan infection in the gills of Common Carp with pointer as brush and encircles and Plate 4.2 shows the infections of protozoans.



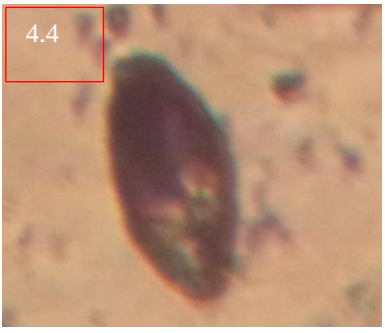
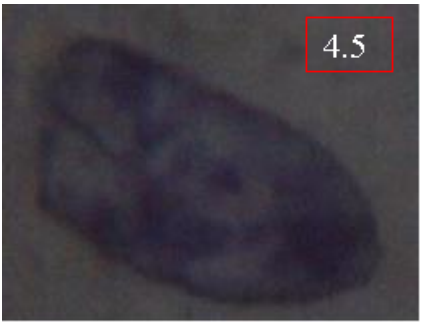


Plate 4.3 and 4.4-Encircled green line shows the deformity in doral fin due to protozoan infections and 4.4 Microphotographs of protozoans, *Ichthiophtheris sp* X100 recovered from tail of carp.



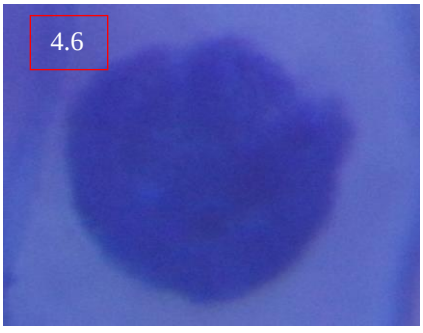
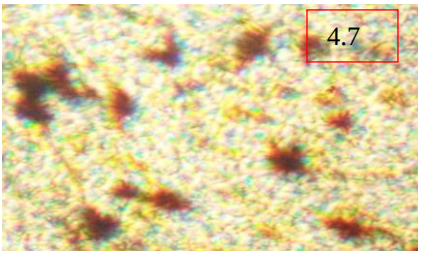


Plate 4.5 and 4.6 - Microphotographs of *Ichthiophtheris sp* protozoans X400 recovered from tail of Tilapia and common carp.



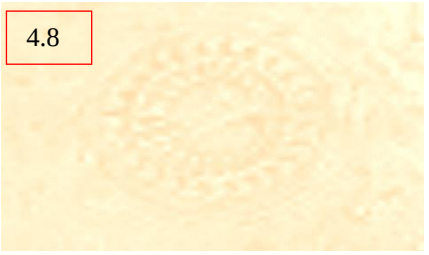
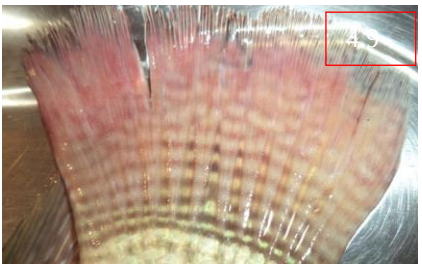


Plate 4.7 and 4.8-Microphotographs of protozoa, *Sancodina sp*. X100 and Plate 4.8 *Tricodina* X400.



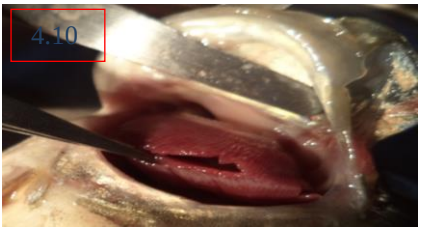


Plate 4.9 and Plate 4.10 Encircled red line shows the deformity in Tilapia tail due to protozoan infections.

S.No.	Fish Parameters				Organs of fish infected by protozoan		
	Body Weight (g)	Body Length (cm)	Age Year	sex	Gills	Tail	Skin, and Fins
1.	1850	44	3	♀	-	-	-
2.	0550	36	1	♂	-	-	-
3.	0078	16	1	♂	-	-	-
4.	0066	15	1	♂	-	-	-
5.	0046	14	1	♂	-	-	-
6.	0046	14	1	♀	-	-	-
7.	0020	10	1	♀	-	-	-
8.	0120	11	1	♀		-	-
9.	0022	12	1	♀	T^{+} I^{+}	-	I^{++},
10.	0098	19	1	♂	T^{+}	-	-
11.	0090	16	1	♂	I^{+}	I^{++}, S^{+}, T^{+}	-
12.	0115	12	1	♀	-	-	-
13.	0076	16	1	♀	S^{+}	-	
14.	0056	15	1	♀	-	-	-
15.	0058	13	1	♂	-	-	-
16.	0360	16	1	♀	S^{+}	-	-
17.	0380	17	1	♀	-	-	I^{+++}
18.	0072	17	1	♂	T^{+}		T^{++}, I^{++}
19.	0158	21	1	♀	-	-	-
20.	0244	26	1	♀	-	-	-
21.	0100	18	1	♂	I^{++}	T^{++}	-
22.	0400	30	1	♀	-	S^{+}	
23.	0090	17	1	♀	-	-	-
24.	0240	23	1	♂	A^{+}	$I^{++}S^{+++}$, T^{+}	$I^{++}S^{++}$, T^{+}
25.	1000	33	2	♀		S^{+++}, T^{+++}	S^{++}, T^{++}
26.	0098	20	1	♀	-	-	T^{+}
27.	0193	20	1	♀	-	-	-
28.	0500	24	1	♂	A^{+}	-	-
29.	0500	26	1	♂	-	-	-
30.	0250	24	1	♂	-	-	-
31.	0300	29	1	♂	-	-	-
32.	0250	22	1	♀	I^{+}	$I^{++}S^{+++}$, T^{+}	$I^{+++}S^{+++}$, T^{+}
33.	0350	28	1	♂	-	-	-
34.	0370	30	1	♂	T^{+},I^{+}	-	-
35.	0200	22	1	♂	-	S^{+++}, T^{+++}	$I^{++}S^{++}$, T^{++}
36.	0150	22	1	♀	-	I^{++}	
37.	0220	20	1	♀	I^{+}	$I^{++}S^{+++}$, T^{+}	$I^{+}S^{++}$, T^{+}
38.	0150	22	1	♀	-	T^{++}	
39.	0100	18	1	♀			T^{++}
40.	0150	20	1	♂		-	-
41.	0130	20	1	♀	A^{+}	-	-
42.	0100	20	1	♂	-	-	-
43.	0100	17	1	♂		I^{++},S^{++},T^{+++}	-
44.	0110	18	1	♂		I^{++}, S^{++},T^{+++}	I^{++}, S^{++},T^{++}

Appendix of Table 1.0

45.	0120	22	1	♀		I^{++}, S^{+++},T^{+++}	I^{++}, S^{+},T^{++}
46.	0100	19	1	♀		T^{+++}	-
47.	0120	12	1	♀		T^{++}	
48.	0130	24	1	♂		T^{++}	-
49.	0120	18	1	♂		T^{++}	-
50.	0100	20	1	♂		T^{+}	-
51.	0130	16	1	♂		T^{+}	-
52.	0130	18	1	♂	S^{+++}	T^{++}	-
53.	0140	19	1	♂	S^{+} I^{+}	I^{++}, T^{++} S^{++}	T^{+}
54.	0160	20	1	♂	$I^{+}S^{++}$	T^{++} S^{++}	-

Table 4.1- Overall observed ecto-parasitic infections in common carp, (*Cyprinus carpio*, Linnaeus 1758) of river Yamuna at Gau Ghat, Allahabad during the summer season of 2014.

A, Ergasilus; more and occurred in more than two gill leafIet, I, *Ichthiophtheris*; S, *Sarcodina*; T, *Trichodina*; +, <5; ++, >10; +++, >20

Table 4.2- Weight wise percentage of infection in common carp during the study period.

	Body Weight	**Examined Total**			**% of Protozoan infection**		
		Total	♂	♀	Total	♂	♀
1	<100.0	20	11	9	55.0	54.0	55.4
2.	100.1-200.0	18	9	9	61.0	77.0	44.0
3.	200.1-300.0	6	4	2	33.3	25.0	50.0
4	>300	10	5	5	50.0	20.0	80.0
	Total/Mean	54	29	25	49.8	44.0	43.0

Table 4.3- Weight wise protozoan intensity of infection in male common carp during the study period.

	Body Weight	**Gill**			**Tail**			**Scale and Fin**		
		I	S	T	I	S	T	I	S	T
1	<100.0	3+	-	2+	2++	1+, 1++	3+, 2++	1++	-	1++
2.	100.1-200.0	2+	1+ 2+++	-	1++	2++, 1+++	4++ 1+++	2++	2++	2++
3.	200.1-300.0	1+		1+	1++	1+++	1+	-	-	-
4	>300	1+		1+	-	-	-	-	-	-

Table 4.4- Weight wise protozoan intensity of infection in female common carp during the study period.

	Body Weight	**Gill**			**Tail**			**Scale and Fin**		
		I	S	T	I	S	T	I	S	T
1	<100.0	1+	1+	1+			2++	1+, 2++		
2.	100.1-200.0	-	-	-	2++	1+++	2++, 1+++	1++	1+	1++
3.	200.1-300.0	1+	-	-	-	1+++	2++	1+	1++	T++
4	>300	-	1+	-	-	1+. 1+++	1+++	1+++	1++	T+++

occurred in more than two gill leafIet, I, *Ichthiophtheris*; S, *Sarcodina*; T, *Trichodina*; +, <5; ++, >10;
+++, >20.

4.2-Parasites of Tilapia (*Oreochromis niloticus*, Linnaeus 1757)

A total Number of 43 Tilapia fish (Plate 3.4) was examined during the study period in Yamuna River at Allahabad. The infections of protozoa were investigated in Tail (Plate 4.9), scale and in the gill of Tilapia (Plate 4.10). The infection investigated in the gills (Plate 4.16) and characterized as pathogenic The arthropods (*Ergasilus sp.*) have also been reported in the gills of Tilapia similar to the *Ergasilus sp.* of *Rita rita* (Plate 4.11 and Plate 4.12). Whereas, endo - parasites or *Helminths* parasites (*Cestodes*, *Nematodes* and *Trematodes*) were unable to notice in all the observed common carp fishes. The occurrence of parasites, infections and infections sites (organs) *vs* body weight, body length and age of the fish were recorded and documented in Table 4.5. The body length, weight and age relationship of Tilapia was not found significant on correlation. The protozoan and *Ergasilus* were analysed according to the body weight classes of fish Tilapia and given in Table 4.6 represented.

Table 4.5 Overall observed ecto-parasitic infections in Tilapia, (*Oreochromis niloticus*, Linnaeus, 1757) of river Yamuna at Gau Ghat, Allahabad during the summer season of 2014

A, *Ergasilus*; infections (rotten gills or necrosis); more and occurred in more than

Two gill leafIet, A and P+, <5; ++, >10; +++, >20

S.No.	Fish Parameters				Organs of fish infected by protozoan		
	Body Weight (g)	Body Length (cm)	Age	sex	Gill	Tail	Skin, Fins
1	1380	41	5	♀	P+	P+++	P+
2	0414	28	2	♀	-		
3	0446	30	2	♂	-		
4	0776	35	3	♂	-	-	-
5	0786	22	2	♀	P+	-	-
6	0880	23	3	♀	A++	-	-
7	0060	11	1	♂	-	-	-
8	0080	13	1	♂	A+, P+	P++	-
9	0050	14	1	♀	-	-	-
10	1025	44	6	♂	A+, P+	P+++	P+
11	0550	30	4	♀	A++, P+	P++	P+
12	0030	14	1	♀	-	-	-
13	1020	42	4	♀			P+
14	0508	31	2	♀	A+, P+	P+++	-
15	0300	34	2	♂	-	-	-
16	1000	43	4	♂	A+++	-	-
17	1000	33	4	♂	A++, P+	P++	P+
18	0750	29	2	♀	-	-	P+
19	0800	24	2	♀	A+, P+	P+++	P+++
20	0755	29	4	♀	-	-	-
21	1010	32	2	♀	-	-	-
22	0850	32	2	♂	A++, P+	P++	P+
23	0900	33	2	♀	-	-	-
24	0750	28	2	♀	-	-	
25	1030	42	5	♂	-	-	P+
26	1000	44	5	♂	A++, P+	P++	P+
27	0620	30	3	♂	A+, P+	-	P++
28	0090	13	1	♂	P+	P++	
29	0100	15	1	♀	-	-	-
30	0120	18	1	♀	-	-	-
31	0170	19	1	♂	-	-	-
32	0100	15	1	♀	A++, P+,	P+++	P+
33	0135	18	1	♂	-	-	-
34	0180	24	1	♀	A++	-	-
35	0165	19	1	♀	-	-	-
36	0190	25	1	♂	A++, , P+	P++	P+
37	0214	26	1	♀			
38	0300	32	1	♀			
39	0265	26	1	♂			
40	0225	25	1	♀	A+++, , P+	P++	P+
41	0240	27	1	♂			
42	0280	29	1	♀			
43	0230	25	1	♂	A++, , P+	P+++	P+

Table 4.6 Weight wise infection percentage of protozoa in Tilapia during the study period.

	Body Weight	Examined Total			% of Protozoan infection		
		Total	♂	♀	Total	♂	♀
1	<100.0	7	3	4	75.0	66.6	25.0
2.	100.1-200.0	6	3	3	33.3	33.0	33.0
3.	200.1-300.0	8	4	4	25.0	25.0	25.0
4	>300	22	9	13	45.4	55.5	38.5
	Total/*Mean*	43	19	24	*44.7*	*45.3*	*30.4*

Table 4.7 Weight wise infection percentage of ergasilus sp. observed in Tilapia during the study period.

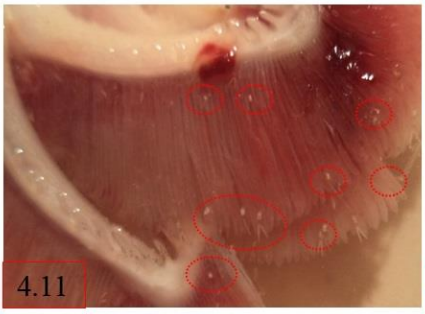
	Body Weight	Examined Total			% infection of Ergasilus		
		Total	♂	♀	Total	♂	♀
1	<100.0	7	3	4	28.0	33.3	33.3
2.	100.1-200.0	6	3	3	33.3	33.0	33.3
3.	200.1-300.0	8	4	4	50.0	25.0	25.0
4	>300	22	9	13	45.4	54.0	30.7
	Total/*Mean*	43	19	24	*39.2*	*36.3*	*30.6*

4.4- Parasites of cat fish (*Rita rita* Hamilton 1822)

A total No. of 32 *Rita rita* (Plate 3.5) was examined during the study period from Ymuna river at Gau Ghat, Allahabad. The occurrence of parasites, *vs* body weight, body length and age of the fish were recorded and documented in Table 4.8. The *Ergasilus sp*. in gill as ecto parasites (Plate 4.11 and 4.12) and *Dacnitoides sp.* (Plate 4.13) as endo parasites were investigated significantly. No other parasites or infections were observed to report significantly. The body length, weight and age relationship of *Rita rita* was not found significant on correlation. The infection prevalence *vs* body weight classes of cat fish was synthesized and given in Table 4.9 and represented . The mean intensity of *Dacnitoides sp.* and intensity of *Ergasilus sp*. was calculated and given in Table 3.2 and represented The linear regression correlation was analysed between body weight class of cat fish and infection prevalence

of *Dacnitoides sp.*, *ergasilus sp.* and mean intensity of *Dacnitoides sp.*

That mean intensity and body weight classes of cat fish was significantly correlated by linear regression value (r) and Poisson values. The overall 35.6% infection prevalence of *Ergasilus sp.* was observed in the examined cat fish Slightly sex wise polarity was noticed in the infection prevalence of *Ergasilus sp.* The total male fish was found infected at 33.3% and female at 39.0%. The maximum infection prevalence was noticed in the higher body weight classes of fishes and female was more infected in their higher growth than male (>200.1- Male 43.0-57.0%; Female 57-60%).The mean intensity of *Ergasilus sp.* was noted more in female than male in their higher body weight classes. That infection prevalence of *Ergasilus sp.* and body weight of cat fish was positively associated. But the female body weight and infection prevalence was linearly significant.



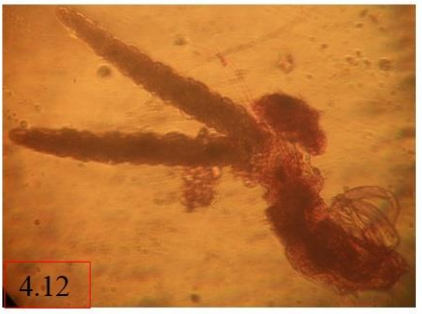


Plate - 4.11 Encircled red lines indicating *Ergasilus sp.* in gill of *Rita rita* under naked eye.
Plate 4.12- Microphotograph of an *Ergasilus sp.*X100.

Plate 4.13- the nematode (*Dacnitoides sp.*) in a dissected intestine of *Rita rita*.

Table 4.8 *Dacnitoides sp.* and intensity of *Ergasilus* in cat fish (*Rita rita,* Hamilton 1822) of riverYamuna at GauGhat, Allahabad during the summer season of 2014.

S.No.	Fish Parameters				Parasites	
	Body weight (g)	Body Length (cm)	Age (Year)	Sex	Number of worm	Intensity of *Ergasilus*
1	0538	33	3	♂	3	-
2	0394	29	2	♂	-	-
3	0334	28	3	♂	3	+++
4	0290	29	2	♂	3	++
5	0220	25	2	♀	-	+++
6	0566	36	2	♂	-	+++
7	0520	33	3	♀	-	+++
8	0566	36	3	♂	4	-
9	0500	31	2	♂	-	+++
10	1000	37	3	♂	16	+++
11	0330	28	2	♀	1	+++
12	1000	38	4	♀	7	
13	0490	33	2	♂	4	-
14	0382	29	2	♂	1	-
15	0320	27	2	♀	3	-
16	0400	26	2	♂	-	++
17	0200	28	1	♀	-	-
18	0300	25	2	♂	-	-
19	0150	23	2	♂	1	-
20	0100	20	2	♂	-	-
21	0450	30	1	♂	-	-
22	0250	22	1	♀	1	
23	0200	23	1	♂	-	-
24	0350	25	2	♂	1	+++
25	0400	28	2	♀	-	-
26	1000	38	5	♀	5	+++
27	0200	23	1	♂	-	-
28	0300	29	1	♀	3	++
29	0150	33	1	♀	-	-
30	0300	23	1	♀	2	++
31	0470	32	2	♀	2	+++
32	0450	30	1	♀	-	-

++, >10; +++, >20

Table 4.9 Weight wise infection percentage of *Dacnitoides* sp.and *Ergasilus sp*. in *Rita rita* during the study period.

	Body Weight(g)	Examined Total			*Dacnitoides* infection			*Ergasilus* infection		
		Total	♂	♀	Total	♂	♀	Total	♂	♀
1	<200.0	6	4	2	16.6	25.0	0	0	0	0

2.	200.1-400.0	14	7	7	64.3	57.0	71.4	57.0	57.0	57.0
3.	>400.1	12	7	5	58.3	57.0	60.0	50.0	43.0	60.0
	Total	32	18	14	46.4	46.3	43.8	35.6	33.3	39.0

Table 4.10 Weight wise mean intensity of *Dacnitoides sp*. and *Ergasilus sp*. in *Rita rita* during the study period.

	Body Weight (g)	Examined Total			Mean intensity of worm			Intensity of *Ergasilus* infection	
		Total	♂	♀	Total	♂	♀	♂	♀
1	<200.0	6	4	2	1.0	1.0	0.0	-	-
2.	200.1-400.0	14	7	7	2	2.0	2.0	3++, +++	2++, 2+++
3.	>400.1	12	7	5	5.9	3.9	2.8	3+++	3+++
	Total	32	18	14	3.5	3.9	2.8	3++, 4+++	2++, 5+++

4.5-Parasites of Eel fish, (*Mastacembellus armatus*, Lacepède 1800)

A total No. of 45 eel fish, *Mastacembellus armatus* (Plate 3.6) was examined (Table 4.11) during the study period from Yamuna river at Gau Ghat, Allahabad. The fish was only found infected with cestode. And it was characterized as cestode on the basis of ribbon shaped body, scolex and proglotids (Plate 4.14-4.16) and identified as *Polyonchobotrium sp*. reported by Kumar et al., (2007) in the intestine of similar fish (Plate 4.14-4.16). No other parasites were investigated during the study period in ell fish. The occurrence of cestode numbers *vs* fish body weight, length was recorded in Table 4.11.The *Ergasilus sp*. was only found in the gills of two fishes therefore their occurrence was not sufficient to analysed. The overall weight wise prevalence and mean intensity of cestode was analysed and documented in the Table 4.12 and represented .The linear regression correlation was analysed between infection prevalence, mean intensity and body weight of the fish. The overall 45.7% of infection prevalence of cestode, *Polyonchobothrium sp.*was noted during the study periods (Table 4.12). The total 48.5% male fishes was found infected which was maximum than female 43.0%. The middle body

weight classes (100.0-200.0gm) of eel harboured more infections prevalence 55.5% (Table 4.1)

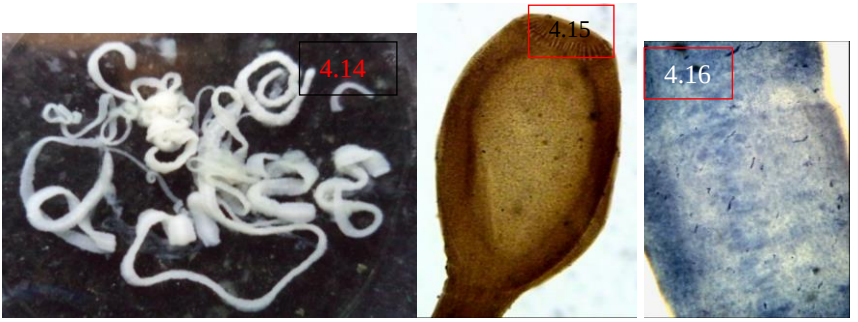


Plate 4.14-Photograph of *Polyochobothrium* sp. After taken out from intestine of *Mastacembellus armatus*. **Plate 4.15**- Microphotograph of their scolex X100. **Plate 4.16-** Microphotograph of their Mature proglottids X100

Table 4.11 Number of cestode, *Polyonchobothrium* sp. Intensity of ergasilus in fish, *Mastacembellus armatus* of river Yamuna at Gau Ghat, Allahabad during the summer season of 2014.

S.No.	Fish Parameters		Sex	Parasites	
	Body weight (g)	Body Length (cm)		Number of worms	*Intensity of Ergasilus sp.*
1	258	39	♀	2	-
2	394	29	♂	-	-
3	104	53	♀	2	++
4	320	38	♂	-	++
5	130	37	♀	-	-
6	112	36	♀	+	-
7	182	38	♂	-	-
8	150	35	♂	3	-
9	180	38	♂	-	-
10	300	47	♀	3	-
11	310	50	♀	+	-
12	200	40	♂	+	-
13	250	44	♂	3	-
14	172	39	♂	1	-
15	104	33	♂	2	-
16	184	41	♀	-	-
17	108	36	♂	-	-
18	094	32	♂	1	-
19	098	35	♂	1	-

20	084	32	♂	1	-
21	104	37	♀	-	-
22	148	40	♀	1	-
23	390	28	♂	4	-
24	172	38	♂	1	-
25	198	29	♂	1	-
26	160	22	♀	3	-
27	288	33	♂	-	-
28	062	22	♂	-	-
29	120	36	♀	-	-
30	024	16	♀	1	-
31	050	38	♀	-	-
32	050	33	♂	-	-
33	030	40	♀	-	-
34	058	45	♂	-	-
35	088	33	♀	-	-

++, > 10

Table 4.12 Weight wise infection percentage and mean intensity of *Polyonchobothrium sp.*In *Mastacembellusarmatus* during the study period.

	Body Weight	Total Examined			% of infection			Mean intensity		
		Total	♂	♀	Total	♂	♀	Total	♂	♀
1	<100.0	10	6	4	40.0	50.0	25.0	1.0	1.0	1
2.	100.1-200.0	17	9	8	47.1	55.5	37.5	1.8	1.6	2.0
3.	>200.1	18	5	3	50.0	40.0	66.6	3.0	3.5	2.5
	Total	45	20	15	45.7	48.5	43.0	1.9	2.0	1.8

Discussion

4.6.1- Ecto – parasites in observed fishes

Among the observed fishes (Table 4.1), protozoa (4.9), and *Ergasilus* (4.11), were investigated as ecto-parasites. The infections of protozoan parasites were only susceptible to the common carp and Tilapia whereas eel and cat fishes were found unsusceptible to the protozoa.

The fish age, behavior, immunological status, and environmental change can affect fish (host)-parasite system. Sometime changes in these parameters is beneficial to the host whereas evasion of the host's immune response favors the

parasite. In fish, some infections of ecto-parasites that induce mortality are age and temperature dependent. Environmental change, especially habitat degradation by anthropogenic pollutants and oceanographic alterations induced by climatic change, can influence parasitic-host interactions **(Lafferty, 2008)**

The cat and eel fishes are bottom dweller (benthic zone) carnivorous fishes (eat- crustaceas, arthropods larvae and small fishes) that prefer to live between middle (Metalimnion) to bottom water (hypolimnion, temperature 4.0-20^{o}C). On the other hand the common carp and Tilapia are surface living (limnetic zone) and omnivorous fishes (feed on phytoplankton, periphyton, aquatic plants, invertebrates, benthic fauna, detritus, films), (**FAO, 2012)** prefer to live between middle to surface (epilimnion, temperature >20^{o}C), **(Teichert-Coddington, *et al.*, 1997)**. Immunologically, cat fish and eel fish has moderately thick skin and without scale than carp and Tilapia. That is, cat and eel are immunologically stronger than carp and eel. It can be argued that observed pattern of protozoan, infections in common carp and Tilapia would be the result of habitat selection, immunity and water thermal gradation that did not make susceptible to cat fish and eel fishes for protozoan infections (**Robert *et al.*, 2008 and Khan, 2012)**.

4.6.2-Protozoan Parasitic diseases in observed fishes

The infections of protozoan parasites were investigated positively in two fishes *Cyprinuscarpio*, Linnaeus 1758 and *Oreochromis niloticus* Linnaeus, 1757 among the examined of all the fishes during the study period of summers (Table 4.1 and Table 4.5) whereas eel fish *Mastacembellus armatus*, (Lacepède, 1800) and cat fish (*Rita rita*, Hamilton 1822) were unable to find any signature of protozoan infestation during this period of Study (Table 4.8 and 4.11).

Protozoans are single-celled organisms, many of which are free-living in the aquatic environment. Typically, no intermediate host is required for the parasite to reproduce (direct life cycle). Consequently, they can build up to very high numbers under diseased or favourable conditions or overcrowding of causing weight loss, debilitation, and mortality. The protozoan parasite has a worldwide distribution and is nonspecific on freshwater fishes. The life cycle, biology and aspects of the pathogenicity of this parasite are well known (**Hines and Spira, 1973**).

The above discussion evident that *Ichthiophtheris sp., and Tricodina sp.* were the common ecto-protozoan parasites of India freshwater. These are regularly reported from Tilapia and common carp. The above findings and discussion showed that their more prevalence is associated to higher temperature or summer seasons in Common carp and Tilapia fishes.

4.6.3-Ecology of Protozoan Parasites in Recovered fishes

The parasitic susceptibility to a definite host always influence by many factors. Broadly these factors are Environmental, biological and evolutionary. Evolutionary relationship between host and parasites are merely to be influenced by others two factors and it is long term association. Environmental and biological are interacting to each other and always to be sporadically influences the parasites-host relationships. The protozoan parasites-host system is severely influenced by a small change in environmental and biological parameters being microorganisms (**Bush *et al.,* 2001**, **Khan, 2012)**.

The current case study is a primarily and short duration, therefore it cannot be an evolutionary relationship under lacks of similar reports. The possibility of environmental-biological is more under reports of protozoan infestation in different species of fishes. The infected fishes by protozoan parasites are carps and Tilapia which has different biological activity than eel and cat fishes because carps are omnivorous whereas eel and cat fishes are carnivorous in their dietary

habitat. Their water environments are also different because cat and eel is benthic lover whereas carp and Tilapia is pelagic, vegetation lover.

Therefore observed protozoan infections in carp fishes (Tilapia and common carp) than cat and eel fishes might be occurred due to their different dietary habit and behavioral selection of habitat in the water (**Barber *et al.*, 2000**). Similar to the findings of **Lerssutthichawal (2008)** also reported variation of protozoan (*Myxiobolus sp*. and *Tricodina sp*.) infection prevalence in two species of Tilapia from a pond of Southern Thailand (Asia) and reported more (80%) in black Tilapa similar to discussing species except of other parasites.

4.6.4-Infection Prevalence of Protozoan *sp.Vs* Weight – sex wise relationship

The observed infection prevalence of protozoan in common carp showed less sexwise polarity. The total male was found 44.0% infected than female 43.0%. The male body weight was analysed negatively associated to the protozoan infections (Table 4.1, 4.7) whereas female was positively associated. The infection prevalence was more significant in male than female. Therefore male gonadotropin hormone rejected the protozoan infection at maturity whereas it was not opposed by female gonadotropin hormone at maturity. But observed less sexwise polarity showed that sex hormone less influenced the infection of protozoa in common carps.

The significant sexwise polarity was observed in Tilapia in their examined weight classes (Table 4.6, male 45.3%, female 30.4). The infection prevalence in male was analysed insignificant and negatively associated) where as it was positively significant in case of female body weight class The significant sex wise polarity showed that protozoan infections was influenced by the gonadal hormones of Tilapia and it opposed in case of male as higher infections in lower weight class, whereas it was favoured by female in more infection in

higher weight class.The above discussion showed that immunity of both common carp and Tilapia was associated with gonadal hormones against protozoan infections during the study periods. This was observed more in case of Tilapia than carp.

4.6.5-Mean intensity of *Protozoan infections Vs* Organ - sex wise relationship *in common carp*

The mean intensity of *Ichthiophtheris ssp*. in common carp was observed more in scale than tail and gill organs in lower weight class (Table 4.3). The intensity of *Tricodina sp*. was observed more in male tail of middle weight class than gill and scales. Female was observed less intensity of protozoan infections than male (Table 4.3, 1.3). The severity of *ichthiophtheris ssp*. was occurred more in scale in higher weight class and very less in gill and tail of lower weight class whereas *Tricodina sp*. also followed similar fashion of mean intensity but it was more in tail than scale. The overall observed protozoan mean intensity was more in male carp than female. It infected more in tail and scale than gills. The female Tilapia harboured more intensity of protozoans in gills of their higher weight classes It was enhanced more it tail than scale in both the sexes of higher weight. The above discussion. showed that protozoan intensity was observed more in lower weight class of common carp whereas it was more in higher in higher weight class of Tilapia. The scale and tail was found more infected than gill.

4-.6.10-Ergasilus infections (Arthropods disease) in observed fishes

Ergasilus sp. is a member of a small group of parasitic crustaceans (*Ergasilus*) that prey upon freshwater and marine fishes. They are most frequently found on the gills. They can cause significant morbidity and mortality when heavily infesting fish. They have also been implicated as vehicles for other fish diseases.It has a direct life cycle using only the fish

as a host. In *Ergasilus* only the female is parasitic, and is found on the gills of fishes. There is no significant sexual dimorphism. Males (1.0mm) are free-living and there is a prolonged, free-living larval development which includes three to six stages of nauplii and four to six stages of copepodites (lasting from 10 days to over a month). These free-living stages feed on nanoplankton **(Raibaut, 1985).** Females attached to gills produce eggs in two sacs which are attached to the genital segment. The number of eggs (20–200) is variable with species and apparently also with age and metabolic health as influenced by the location of attachment on the gills. The time required for hatching is temperature dependent, 3–6 days in optimal ambient temperature **(Raibaut *et al.*, 1975).** Before hatching, the nauplii have a conspicuous blue colour. The nauplii take 8-10 weeks to grow to a sexually mature stage and copulate. During this period both sexes (copepodites) live freely in the water. It is only after this period that the females change over to a parasitic mode of life and get infect the gills of encountered fishes.

The infections of *Ergasilus sp.* is worldwide in distribution and is a major parasitic disease for aquaculture **(The world of copepods, 2002; Wojciech *et al.*, 2013).** The best known ergasilids are representatives of the genus *Ergasilus*, which contains 153 nominal species **(The World of Copepods, 2002)** and more than 80 valid species **(Kabata, 1985)**. The best known species is *Ergasilus sieboldi*, similar to the reporting species of Asia which is 1.7 mm long and attaches to fish gills using its 2nd antennae (Plate 4.12). The antennae, transformed into powerful hooks, hold the gill filaments tightly and can cause tissue damage and obstruct blood flow. Parasites feeding on epithelial cells stimulate hypertrophy and consequently a coalescence of secondary gill lamellae. This in turn drastically reduces the surface available for gas exchange. Lesions on gills are often attacked by secondary pathogens such as a fungi. Feeding of *E. sieboldi* was described in detail by

(Einszporn, 1965). This particular species attaches to the outside of the gill allowing some of its congeners to explore the space between the gill filaments. In cases of extremely heavy infections of fish, the parasite attaches not only to gill filaments but also to the fins **(Kozikowska, 1975)**. **Wojciech, *et al*., (2013)** discussed that *Ergasilus sieboldi*is not host-specific and can infect a majority of freshwater fishes (*Cyprinus carpio*) has been reported less infective to it. In Southeast Asia including India, *Ergasilu s*sp. occurs on the gills of cultured fishes including *Osteophilus hasselti*, *O. gouramy* (in Indonesia), *Ctenopharyngodon idella* (in Malaysia), and on *Oxyelotrismar moratus* (in Thailand). The parasite has the potential to adversely affect on aquaculture in this region, but so far, no major outbreak attributed to *Ergasilus* sp. has been reported **(Kabata, 1985)**.

4.6.11-Ecology of Ergasilus infection pattern in observed fishes

The infection prevalence of *Ergasilus* was observed very less (0.06%) in common carp for discussion (Table 4.1). But local fisher men did not agree to the findings of *Ergasilus sp*. in common carp whereas tilapia and cat fishes were observed heavily infections at the percentage of 39.2 and 35.6 respectively and it was unable to report any *Ergasilus sp.* in the gills of eel fish during the investigation.

The observed infection pattern of *Ergasilus sp*. in different class of fishes can be explained on the basis of fish dietary behavior and habitat selection and life cycle of parasites. As discussed earlier the cat fishes are carnivorous (feeds on zooplanktons) and prefer to live at the bottom (Benthic zone) of the river. They also used to visit the middle habitat (Metalimnion zone) of the river due to their dietary behavior (feeds on zooplanktons). The Tilapia and common carps are omnivorous and prefers to live above middle of water (limnetic zone) but used to meet the middle vegetation habitat

of water (Metalimnion zone). The eels are benthic and bottom dwelling in habit. Copepodites stage of *Ergasilus* is zooplanktons and abundantly found in the middle (Metalimnion zone) of water due to their locomotors behavior. Therefore, it can be concluded that Tilapia and cat fishes were observed infections of *Ergasilus* due to their frequent visit into the habit of the middle zone of water body (Metalimnion zone) where Copepodites stage of *Ergasilus* were found to infect. It may be possible that common carp were not found infected with *Ergasilus* due to its higher immunity or temperature gradation or early sampling of fishes at the time of nauplius hatching **(Belland and Burt, 1991; Robert *et al* 2008, and Khan, 2012)**.

The above discussion concluded the presences of *Ergasilus sp.* in Indian inland water but their host specificity was not found in fishes. reported as sporadic which was correlated with water temperature and vector mediated in pond culture.

The above discussion shows that infections of *Ergasilus* in freshwater fishes were sporadic, non-host specific and seasonal in nature. In case of reported Tilapia and cat fish, it was associated to the water temperature and habitats of the fishes. Its severity of infection prevalence was influenced by size and sex of both the fishes.

4.6.13-Endo – parasitic diseases in observed fishes

Among the observed fishes (Table 4.1, 4.5, 4.8, 4.11), the nematodes (Plate 4.13) and cestodes (Plate 4.14-4.16) were investigated as endo-parasites only in the cat fish (*Rita rita*, Plate 3.5) and eel fish (*M. armatus*, Plate 3.6) respectively. These helminthes were recovered from the intestine of these two fishes. Tilapia and common carps were not found any infections of endo-parasites. As earlier argued that observed pattern of helminthes (nematodes and cestodes) in cat fishes and eel fishes (bottom habitat) would be the result of habitat

selection, immunity and water thermal gradation that did not make susceptible to Tilapia and common carp (limnetic, epilimnion and metalimnion habitats) fishes for the infection of helminthes **(Belland and Burt, 1991, Robert *et al.*, 2008 ., Khan, 2012)**.

Bristow and Berland (1991) reported the loss of potential growth in Salmosalar fish of a pond by the infection of cestode, *Eubothrium sp*. The parasitic infections are sometimes very fatal and can cause high mortalities **(Ahmed, 1994)** when intermediate hosts (cyclops, flea, zooplanktons as in feed) supports their life cycles. Therefore the carnivorous fishes (similar to examined) are more infected by helminthes due to their feeding habits on intermediate hosts like small arthropods and crustacean. Among fresh water fishes, there are 1211 species of different parasites representing 5 phyla and 11 classes of invertebrates **(Bykovskayaet *et al.*, 1964)** have been reported. The major parasitic groups found in freshwater fishes are trematodes, cestodes, acanthocephalans and nematodes that complete their life cycles through intermediate hosts like piscivorous birds **(Schmidt, 1990)**. The need to assess the parasitic infection arises because the fish suffering from parasitic infection or disease result into severe damage to fisheries industry *vis-à-vis* weight loss of fishes. For successful prevention and elimination of such infections, it is extremely important to achieve early and correct diagnosis of the larval stages of the parasites for which fish constitute the final host. Interestingly high fish mortality occurs in river, ponds, lakes etc. in spite of closed ecosystem system due to heavy accumulation of parasitic infection thereby decreasing the aqua resource production **(Shah *et al*., 2012).** Environmental factors also influence the fish health in response of their parasite **(Shresta, 1990).** They become serious to our food stuff fishes in spite of economy due to their infection and debilitated host health **(Ogbulie *et al.*, 2011).**

4.6.14-Ecology of *Cestodes* (*Polyonchobotrium sp.*) in Eel fish (*M. armatus*)

Overall percentage of 45.7 eel fish (Table 4.12) was found infected with *Polyonchobothrium sp.* during the investigations. A total No. of 1.9 warm was recorded per fish (Mean intensity). Only eel was investigated with the infection of *Polyonchobothrium sp.* among the observed fishes. The observed infection in eel fish would be resulted due to their dietary behavior and specific habitat (bottom dwelling behaviour) and it was found very specific to its host eel fish and evolutionary related by other workers **(Vankara, *et al.* 2011, Pardeshi and Hiware 2011, Kumar *et al.*, 2007).** The eel fish presumed to be highly depended on the arthropods that are infected by the larva of *Polyonchobothrium sp.* Therefore, the only eel fish was found infected by these cestodes.

4.6.15-Weight-sex wise relationship of *Polyonchobothrium sp.* *Vs* Infection prevalence and mean Intensity

The observed all weight classes of eel were found 45.7% infections of *Polyonchobothrium sp.* (Table 4.12). The infection was observed more in higher weight class of total fishes. The sex wise polarity in infection prevalence was also recorded. The male fish harboured more infection prevalence 48.5% than female 43.0% in their all weight classes

The parasitic susceptibility to host varied influenced by infection, including age, sex, genetics, physiology, immunology of host and environmental factors **(Robert *et al.*, 2008)**. The occurrence of heavier incidence of *Proteocephalus ritae* plerocercoids in heavier fish of *Sciaena coitor* in tropical water at Allahabad had been recorded by **Chatterjee (1991)** similar to identical trends exhibited in study in same habitat. The positive infection prevalence with body size had also been statistically analyzed by many earlier workers **(Zar, 1996, Scholz, 1986, Olurin and Somorin, 2006)**. The physiological

and dietary differences between the sexes of the host were argued to be the principle factors that influenced infectivity patterns depicting sex wise differences to show higher infection prevalence in one sex or the other **(Chauhan, Malhotra and Capoor, 1981)**. Bell and **Burt (1991)**, **Guegan and Kennedy (1993)** explained that heavier accumulation of heavier infections in larger host would be responsible for the eating of smaller infected host. The conclusion of **Chaurasia (2002)** on continuous supply of infective stages of parasites or intermediate hosts (secondary host= Cyclops, arthopods) throughout the life cycle of definite host were in conformity with patterns of larger fish being heavily infected by *Senga rostellata*n. *sp*., *Polyonchobothrium humidii sp*. and *Gangesia pauciarmatus sp*. in pond fish *Wallago attu* at Ballia (U.P) Furthermore, **Wilson, *et al*., (2002)** explained that parasite loads tend to increase with age and may plateau in older animals, though if acquired immunity is then they may ultimately decline again, so reducing the degree of parasite aggregation. Genetic differences in susceptibility to infection may also be important in aggression of parasite in larger size of host. Other factors that may contribute to the Mean intensity are the condition of the host, behavior, parasite's genetics and seasonality. The observed pattern of infection prevalence and mean intensity of *Polyonchobothrium sp*. was more in higher weight classes of fishes with slightly polarity in their sexes. The similar pattern of infection prevalence and mean intensity of *Polyonchobothrium sp*. were also reported by **Kumar (2012)** in similar host of similar habitat. He agrued that enhanced prevalence occurred in larger body size of fish due to ferocious dietary habit in larger fish and less overall mean intensity in all size explained that the host has acquired immunity against the parasite to carry along its life cycle for nutrition during the investigating period of study.

4.6.16-Infections of Nematode (*Dacnitoides sp.*) in cat fish (*Rita rita*)

Among the observed fishes, only cat fish was found 46.4% infected (Tables 4.8, 4.9) with nematode (Plate 4.13) in their intestine. It was characterized as nematode on the basis of cylindrical, threads shaped body (Plate 4.13). It was identified as *Dacnitoides sp.* on the basis of stout-bodied worms with females a little larger than males, dumbled shaped oesophagus, enlarged head anteriorly, conical tail terminating into a hook-like terminal horn posteriorly (**Jagerskiold, 1902; Yamaguti, 1941)**.

Malhotra *et al.,* (2013) reported ***Dacnitoides sp***. in *B. bagarius* fish of similar water habitat, Yamuna river. He also emphasized that its infestations was observed new to cat fishes under the current environmental changes. ***Dacnitoides teleostei*** n.sp. was reported by **Jaiswal (2007)** in the river Ganga to the adjacent habitat. Literatures showed that various nematodes species are found infecting to many different species of fishes all over the world and are serious to aquaculture. Small numbers of nematodes often occur in healthy fish, but high numbers cause illness or even death. **Roy and Yanong (2011)** argued that severely infected fished by nematodes caused diseases loke emaciation (wasting or significant loss of body mass), nodules or masses formation in skin or muscle, stunted growth, abnormal swimming, lethargy, or death of the fishes. **Klinger and Floyd (2013)** mentioned Camillanus, Capillaria, Eustrongylides species of nematodes are serious to aquaculture.

Ahmad *et al.* (2012) from northern India came to know experimentally that *Eustrongylides sp. larvae* of nematode manifested severe pathological symptoms in fish *Clarias gariepinus* in the laboratory. He significantly noted decrease in the gonadotropin hormone (LH) in the blood stream of fish and reduction was recorded to be the 50% less as compared to the normal fishes. Histopathologically testes was found

disorganized testicular structure, disruption of germinal epithilium and reduction in spermatozoa whereas infected ovaries was found inter follicular spaces, degeneration of follicular wall tissues and ruptured egg envelops under infected condition of fish.

4.6.17-Ecology of nematodes (*Dacnitoides sp.*) in cat fish (*Rita rita*)

The overall 46.4% of nematode (*Dacnitoides sp.*) was recorded in the intestine of cat fish, *Rita rita* during the investigation Only *Rita rita* was observed with the infection of gastro nematode (Plate 4.13) due to their dietary habit and habitat behavior as discussed earlier. Its overall mean intensity was recorded 3.5 (Table 4.10). **Jaiswal (2007)** was closer to the higher infection of *Dacnitoides sp.* in *C. garua* in the similar season of observation of the above findings.

Summary and Conclusion

► The Fish and fisheries provide important contributions to poverty and food security. Therefore world as well as Indian government is focusing on its as future demand of food. Without disease management, fish and fisheries also cannot achieve the above discussed goal. Fish diseases may cause severe losses on fish farms through: reduced fish growth and production, increased feeding cost caused by lack of appetite and waste of uneaten feed, increased vulnerability to predation; increased susceptibility to low water quality, death of fish.

►The fishes were collected randomly and periodically between the period of summer (April 1st to June 15th) 2014 from collection site, Gau Ghat, (Latitude 25°26'46.04"N and Longitude 81°51'24.005"E) at Allahabad, Uttar Pradesh. These fishes were measured and weighted. Their gills, body surface were investigated, protozoan and arthropods infections.

The overall observed protozoan infections in carp fishes (Tilapia and common carp) and helminthes (Nematodes and cestodes) in cat and eel fishes might be occurred due to their different dietary habit and behavioral selection of habitat in the Yamuna river. Because carp and Tilapia are omnivores and share similar habitat (Surface to middle) whereas eel and cat fishes are carnivores fishes and share similar bottom habitat.

Conclusion

1 - The gills and body surfaces were infected be protozoan helminthes, aschelminthes, arthropod, and annelids. in fishes in common carp and Tilapia aquatic system of the Yamuna river at Gau Ghat, Allahabad.
2 - The intestine and visceral organs for were infected with cestodes (Polyonchobothrium) in Eel fish and nematodes (Dacnitoides).
3 - The distribution pattern of infection percentage and mean intensity was observed according to the weight of fishes and their relation was corroborated with sex hormones and physiological changing

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