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Population dynamics of parasites as an evaluation metric to assess the trophic quality of fresh water bodies: A case study showing relationship of infection level of helminths in *Schizothorax* spp. of River Sindh, Kashmir

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Abstract
Parasites show a high degree of specialization, and reproduce at a faster rate than their hosts. The parasitic worms form the major portion of biodiversity on earth. Fish harbour a variety of parasites *viz*., Protozoans, cestodes, trematodes and acanthocephalans and the degree of damage by infection is influenced to a large extent by the type and numbers of parasites present. Present study considers the influence of tropical status of three different study sites of river sindh on the pattern of helminth infection in *Schizothorax* spp. from September 2011 to July 2012. Three study sites used for the collection of the samples include Mammar, Shallabugh and Shadipora. The fish specimens examined include *S. niger*, S. *plagiostomus*, *S. labiatus*, and *S. esocinus*. Our results showed that highest Prevalence and mean intensity of infection was at Shadipora followed by Shallabugh (Ghat) and least was found in Mammar. Sex was not an important factor influencing the helminth infection in different study sites. Considering the second parameter it was found that length showed significant positive correlation ($P<0.05$) with the prevalence of infection. It was finally concluded that the amount of pollution, host size, season influence the prevalence of infection.

Keywords: Fish, *Schizothorax* spp., Parasitism, river Sindh, Kashmir.

1. Introduction
Parasitism in fish has been a great concern since these parasites produce disease condition in fish thereby increasing their susceptibility to other diseases, causing nutritive devaluation of fish and fish loss [13]. In the past a number of workers have studied some of the ecological aspects of helminth parasites in Kashmir region [14, 15]. However, previous studies have not shown the integrated effect of various factors affecting the fish health.in order to find the combined effect of various factors on the parasitism and fish health, present study was overtaken.

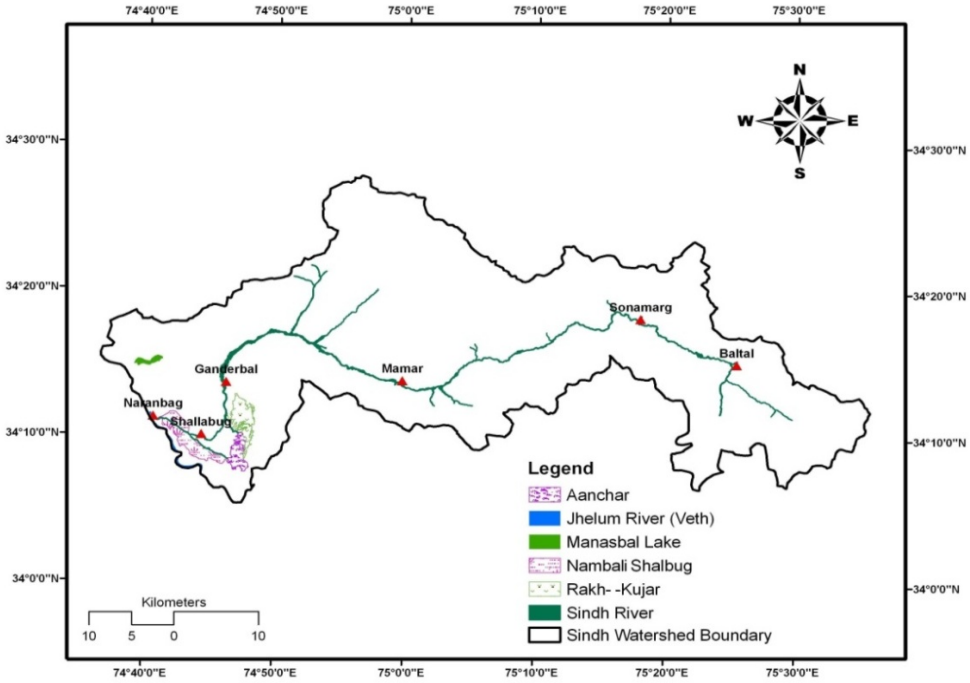
Hypothesis

It was predicted that the due to different levels of pollution at different study sites, prevalence of infection will be different. Factors like season and length should effect the prevalence and mean intensity of the parasitism.

2. Material and methods
2.1 Collection of hosts
A through survey of the study areas will be done to collect the hosts. The samples will be collected from each study site. Host materials will be procured from study areas with the help of local fishermen. Fishes will be caught alive from study site.

2.2 External examination
After blood collection, external surface of the fish will be examined and the gills will be carefully recovered soon after death of fish and kept in a petri dish containing normal saline. Then after this gills will be searched for parasites. The attached parasites will be detached carefully by teasing the filaments with the help of brush. All the information collected will be maintained in a proper way [20].

2.3 Study sites



2.4 Collection of Endoparasites

The organs like Lungs, Liver and Urinary bladder will be collected and placed in normal saline (0.65%), for collection of parasites. The intestines would be opened by making a slit end to end in normal saline. The contents of the intestines will be allowed to stand for some time after which it will be scanned for parasites. Methodology of [9] will be adopted.

2.5 Statistical analysis of the results

For Statistical analysis, both parametric as well as the non-parametric tests will be used for analysing mean species richness. A computer program (SPSS 10.05 for windows) will be used for data analysis. The descriptive data will be given as a mean ± standard deviation (SD). Chi-Square analysis will be used to see the statistical significance in prevalence of helminth infections between different study sites. Pearson's correlation will be used to find correlation between different physicochemical features and parasitic infection. Correlation analysis of data will be carried out by using SPSS 16.5 package programme. Scatter plot and trend line will also be used to show the relationship between water temperature and the prevalence of helminth parasites in different months. Student's *t-test* will be used to test the differences which will be considered to be significant when the p-value obtained would be less than 0.05.

3. Results and discussion

3.1 Prevalence of helminth infection indifferent fish hosts

Mean prevalence of helminth infection was calculated and it was found that significant variations in the prevalence of infection were observed between three different study sites (chi square= 35.4, p=0.000). Prevalence of infection was higher in case of Shadipora study site (35.7) and least in Mammar (4.3). Mean intensity and mean abundance also showed significant difference (Table 1).

Table 1: Showing overall prevalence of *Schizothorax* in river Sindh (September 2011- July 2012)

Host	No. examined	No infected	%	No. of parasites	MI	MA
Mammer	115	5	4.3	11	2.2±1.2	0.09±0.12
Shallabugh	97	25	25.7	113	4.52± 0.21	1.16±0.51
shadipora	112	40	35.7	284	7.1±1.35	2.53±0.52
			DF=2, P=0.000		DF=2, P= 0.044	DF=2, P= 0.000

The above findings thus clearly demonstrate that there exists a significant positive difference in the prevalence of infection in different study sites on the same water body (River Sindh). The present results are in accordance with Skinner (1982) [17] who stated that the parasitic infection can increase from moderate to severe levels depending upon the quality of water. Sures (2004) [18] also reported that the pollution of water bodies have led to more parasitic infestation of the host due to the presence of more intermediate hosts which subsequently affected the growth, development and survival of fish. Maclntyre (2008) [13] also stated that quality of water has a potential to affect the health of a fish directly. Kirse (2010) [11] while working on Tenderfoot Lake and Morris Lake also found that, Tenderfoot Lake being more polluted have much higher content of chlorophyll A, providing a much better habitat for snails which act as the intermediate hosts for most of the parasitic diseases thus having more parasitic infection as compared to Morris Lake. Francis and Kester (2013) [8] also stated that increase in parasitism in the channid fish species due to increase in the organic pollution status of the river.

They stated that human impacts on the aquatic environment affect the health of the resident fish fauna, eventually causing disease and associated mortalities. They reported an increase in prevalence and intensity of acanthocephalans in the cunner - *Tautogolabrus adspersus* exposed to municipal and industrial effluents an orogodo river of Nigeria.

3.2 Effect of season on the prevalence of infection

To study the impact of seasons on the helminth parasitism of fresh water fishes of River Sindh data of one year September 2011 to July 2012 was pooled. A total of 324 fishes was examined in River Sindh out of which 70 (21.60%) were found to be infected. When the data were grouped in four seasons, the following results were observed.

Table 2: Season wise Prevalence of helminth infection in *Schizothorax* spp.

Season	*S. niger* (%)	*S. esocinus* (%)	*S. labiatus* (%)	*S. curvifrons* (%)
Spring	20.4	12.1	13.7	15
Summer	40.4	42.3	39.5	44.6
Autumn	28.5	27.5	19	22.5
Winter	2.5	3.0	3.8	5.7
P- value	DF = 3, P-Value = 0.008	DF=3, P value = 0.004	DF=3, P Value= 0.002	DF=3, P value= 0.003

From the above results it is clear that the highest prevalence recorded during the present endeavour of infection occurred in summer and lowest in winter in all fish species.

These findings of high prevalence during summer agree closely with the agro climatic conditions of Kashmir valley. The valley has a temperate climate marked by well-defined seasonality, consisting of four different seasons with wide variations in temperature and other weather conditions that influence the occurrence of parasitic infection in fishes. Majidah and Khan (1998) [13] reported the distribution pattern of the helminth populations in different fish hosts, which exhibited a regular seasonal trend and the infra-population concentration was relatively greater during summer. *Rhabdochona kidderi* occurred in fishes with the highest values of prevalence and mean intensity in April and June, respectively [3], which is in agreement with the present study. The variation in prevalence rates depends on the life cycle pattern of the parasite, availability of intermediate and definitive host and the climatic conditions mainly water temperature. Vincent and Font (2003) [24] while working on seasonal and yearly population dynamics of two exotic helminths observed that in *Carnalanus cotti* prevalence and mean abundance were higher in Hawaiian summer (47.7%) than in winter. Shomorendra and Jhaan (2005) [14] reported that the prevalence of helminths in cyprinid fish *Labeo rohita* at river song Jharkhand was highest in June/ July and lowest in winter. Ehab and Faisal (2008) [7] studied the interactions between *Protocephalus ambloplitis* and *Neoechinorhynchus* spp. in largemouth bass collected from inland lakes in Michigam, USA. They found the highest prevalence of these parasites in summer and least in winter. Hamida *et al.* (2011) [10] examined 122 individuals of *Macrognathus aculeatus* popularly known as Tara Baim, collected monthly, from the river Buriganga during March, 2007 to February, 2008 revealed 77 fishes were infected with various Helminth parasites with an infection rate of 63.11% and parasitic infection is more abundant in summer (62.5%) and least in winter (31.81). Singh and Mishra (2013) [20] carried seasonal study from October 2008 to September 2010, to study the impact of helminth parasites of catfishes of Lucknow. The fish fauna *viz*., *Clarias batrachus, Heteropneustes fossilis, Wallago attu, Mystus vittatus* and *Rita rita* were examined for helminth parasites. Trematode, cestode, nematode and acanthocephalan parasites communities singly or mixed were recovered from these fishes. The collected parasitic species include two monogenean species (*Gyrodactylus* and *Dactylogyrus*), seven digenean species (*Clinistomum, Euclinostomum, Gastrohtylax, Paramphistomum, Opisthorchis, Aspidogaster and Fasciola*), one cestode species (*Taenia*), one nematode species (*Trichinella*) and one acanthocephalan species (*Pallisentis*). The data showed significant highest parasitic communities during the summer season, moderate in monsoon and lowest in winter season.

4. Conclusion

The differences in density and infection intensity of parasite are probably due to a difference in the intensity of pollution at different study sites as the immune function of fish is compromised in stressful situation, including those that involve pollution and high temperatures. Climate change in aquatic systems will affect most organisms and their functional roles in the ecosystem. Changes in these roles may be difficult to detect, but examination of parasite communities in fish may provide insight into any structural and functional alterations in the system.

Secondly prevalence of infection is higher in summer and least in winter may be due to availability of more intermediate hosts in summer and least in winter. Rainy season which starts in spring and continued to early summers made the environmental conditions more favourable for the development and survival of the pre parasitic stages of helminth parasites and lead to increase availability of infective stages in post rainy seasons, thus resulted in higher prevalence of parasitism in summer.

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