Microhabitat distribution of some monogenoideans, parasitizing the gills of *Wallago attu* (Bl. and Sch., 1801) and their seasonal variation

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Abstract The parasitic microhabitat distribution of the monogenoideans *Thaparocleidus wallagonioides* Jain, 1952, *Mizelleus indicus* Jain, 1957 and *T. gomtius* Jain, 1957 parasitizing the gills of a fresh-water demersal *Wallago attu* and their seasonal variations were investigated in the present study. The microhabitat preferences of these species were observed. The gill segments and gill areas were the most important factors segregating the monogenoidean parasites on gills, not their abundance. Low niche overlap was found within each of the four gill arches and parasites were segregated in the same microhabitats within each gill arch. The distribution of parasites was independent of the left or right side of gill. The distribution plots in our study indicated that the anterior segment of first and fourth gill arches were more preferred site of infection. Seasonal variation of parasites, recorded during 2006 & 2007, in male and female hosts was also investigated. Due to ectoparasitic nature and high host specificity exhibited by the species of monogenoidea, studies on their seasonal dynamics are very significant as they could contribute significantly to the understanding of their biological adaptations to their environment.

Keywords Gill arch · Microhabitat · Monogenoideans · Seasonal variation

Introduction

Wallago attu, sometimes known as the freshwater shark, is a demersal and potamodromous “sheatfish” found inhabiting the standing and running inland waters of Indian subcontinent countries, from Afghanistan to Viet Nam and Indonesia (Froese and Pauly 2004). *W. attu* or “Padhan”, as it is known locally in India, has been studied extensively in India as well as in the rest of the Asian countries for its helminth parasites. Agrawal and Mishra (1992a, b) have observed the distribution pattern of *Mizelleus indicus* Jain, 1957 and *Thaparocleidus gomtius* Jain, 1957 (*Silurodiscooides gomtius* Gusev, 1974). In addition to the above two species, we focused here on the site selection of *T. wallagonioides* Jain, 1952, among the gill arches and sex of the fish and also analyzed their seasonal variation. The present work has been undertaken with a view to study the microhabitat distribution of monogenoidean parasites found on gill arches of *Wallago attu* and to study their prevalence, intensity and dominance index in different months for the three species infecting male and female hosts. Llewellyn (1956) found that *Diclidophora merlangi* Maccallum, 1917 preferred to attach to the first gill arch of *Gadus marlangus* and it also preferred second and third gill arch of *G. luscae*. The microhabitat distribution studies have also been carried out by Kadlec et al. (2003) and Matejusova et al. (2003) etc. These workers defined specific areas of attachment by dividing the gill arch into several regions. Due to ectoparasitic nature and high host specificity exhibited by the species of monogenoidea,

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studies on their seasonal dynamics are very significant as they could contribute significantly to the understanding of their biological adaptations to their environment. They are in direct contact and under constant influence of changes in the surrounding environment during its entire life-cycle. The short life-span allows it to react immediately to changes in environmental factors. The Monogenoidea, is a good bio-indicator species, being sensitive to the environment and provides valuable information about chemical, physical, biological and ecological state of the environment through its presence or absence. They also threaten food-chain in ecological communities and thus the environment by ensuing mass mortality. Result of infestation will result in decrease in the productivity of the lowest level that in turn makes it difficult for the secondary consumers to persist leading to the disruption of whole food-chain. *W. attu* is an ideal model for the study of ecological interactions between monogenoids as it often demonstrates a simultaneous infestation by several congeneric species. The Gomti river, one of the major tributaries of the Ganga river originates from natural reservoir in the swampy and densely forested area near Madho-Tanda (Mianko elevation of about 20 m; North latitude 28°34' and East longitude 80°07') about 3 km east of Pilibhit town in Uttar Pradesh and about 50 km south of the Himalayas foot-hills. The river flows through the district of Pilibhit, Shajahanpur, Sitapur, Lucknow, Barabanki, Sultanpur, Jaunpur and Ghazipur. It is characterized by a sluggish flow except during the monsoon period. The site of collection is bank of river Gomti near Mohan Meakins, Lucknow. The Gomti basin drainage tends NE-SW with similar climatic conditions. In the summer months, the temperature is recorded up to 47° and in winter months, up to 25°C, affecting the host as well as parasitic population. Narrow host-specificity is highly characteristic of these worms. The mature worms are mostly external parasites of gills and have a direct life-cycle. Eggs from these worms sink and lie at the bottom. They require stimulation before hatching to oncomiracidia which are poor-swimmers and cannot go very far. Infection would thus be on a chance factor and would depend very much on fish-behaviour. Synchronization of oncomiracidial emergence and availability of fish-host would be a necessary factor in infection. *Wallago attu* is a pre-monsoon summer breeder and hatching of monogenoidean larvae generally occurs at about 25–35°C (Pandey et al. 2003). Thus, by the time the free-swimming monogenoidean larvae hatch, fish fries appear in large numbers and infestation chances were therefore optimized.

Other parasites found on gills of *Wallago attu* are *Bychowskyella chauhani* Venkatnarsaiah, 1989, *B. wallagonia* (Jain, 1959) Gusev, 1961, *Thaparocleidus guptai* Pandey & Mehta, 1986 and *T. sudhakari* (Gusev, 1976) Lim, 1996. In the present work only three species are used

Fig. 1 Gill arch of *Wallago attu*

as model. They are found on gills only, rarely from mouth cavity, nasal cavity, body cavity, cloaca or uterus of fishes, although no report on *W. attu*. The spatial distribution on gills has been analyzed in such a way that the gill apparatus of each side was partitioned into four gill arches. Each arch was divided into three gill segments (dorsal, medial and ventral) and two gill surfaces (anterior and posterior) (Fig. 1).

Materials and methods

The data consisted of observations on three species *T. wallagonius*, *M. indicus* and *T. gomtius* infecting the host over 2 years 2006 and 2007. Mean values over 2 years were used for the analysis. 75 fishes were collected and examined per month from river Gomti from a single catch site to control for the climatological conditions. Length of the fishes ranged from 60 to 80 cm and they were adults. They were kept in the aquarium provided with aeration under laboratory conditions. The data is based on natural infection. To determine the prevalence and intensity of infestation of the parasites, they were gently scrapped from the gills of the sacrificed fish and counted manually. The worms were studied mostly live under a phase contrast microscope or after being fixed in 3% formalin diluted with lukewarm water. Worm burden on gill arches was used to understand spatial distribution of parasites. All the arches had been taken together and spatial distribution of parasites was analyzed. Prevalance, intensity and dominance index in different months for the three species infecting male and female hosts had been recorded. The distribution pattern on

various gill arches was depicted in graphical representation through bubble plots. An attempt had also been made to find relationship between index of infection, dominance index and relative density of three species. The analyses and graphical representations were done using S-Plus software.

Results

The microhabitat distribution of parasites (Figs. 2, 3) in various gill arches showed that *T. gomtius* had a dominating presence in the first and fourth gill arch while in the second and third arch it was negligible. *T. wallagonius* shows same level of infection in all the four arches. In *M. indicus*, the worm burden was markedly different and maximum in fourth gill arch. The monthwise index of infection and dominance index are almost perfectly correlated, in all the three species. Relative density in all the three species was independent of the sex of hosts and was highest in the month of October in *T. gomtius*, in the month of September in *T. wallagonius* and in the month of December–January in *M. indicus* (Fig. 4). The intensity in *T. gomtius* had a peak (Fig. 5) in the month of May and October infecting both male and female hosts. The intensity of infection was lowest in the month of July. *T. wallagonius* had maximum intensity of infection in the month of May and lowest in the month of October, December and January in male and female hosts. The peaks for *M. indicus*, were exhibited in the month of March and November in female *W. attu* while in male *W. attu*, highest intensity was found in the month of December–January. *T. wallagonius* had highest prevalence (Fig. 6) in the month of March and November in female *W. attu* while in male *W. attu*, peaks were obtained in the month of September and March and was lowest in the month of October and January. In *T. gomtius*, peaks were obtained in the month of

Fig. 2 Spatial distribution of worm burden for the three species on left and right gill arches

January and December, being lowest in the month of June for female *W. attu* while for male *W. attu*, peak was obtained in the month of September, being low in June and October. Highest prevalence in *M. indicus*, was obtained in the month of January and December in male and female *W. attu*. Peak of dominance index for *T. gomtius*, (Fig. 7) was obtained in the month of October, being lowest in the month of July in female *W. attu* and in male *W. attu*, results being the same. Peak for *T. wallagonius* was obtained in the month of May and trough was obtained in the month of October, December and January in female and male hosts. Peak for *M. indicus*, was obtained in the month of December–January for female *W. attu* and same result was obtained for male *W. attu*. Temperature playing a key role in determining monogenoidean population. (Temperature

Fig. 3 Index of infection and dominance index of three species by month

Fig. 4 Relative density for the three species infecting *Wallago attu* by month

Fig. 5 Intensity of infection in male and female *Wallago attu* by month

Fig. 6 Prevalence of infection in male and female *Wallago attu* by month

varies from 25 to 45°C during different months in Gomti river basin.)

Discussion

Microhabitat distribution may be the result of intra specific parasite interactions. Monogenoideans establishing small

Fig. 7 Dominance index in male and female *Wallago attu* by month

populations on the host generally choose the same microhabitat, even if there is much vacant space on the fish gills. Rhode (1977) proposed that active site selection by parasites lead to increased intra specific contacts for mating. It is still questionable if monogenoideans really choose specific gill sites for reproduction, or if the first parasite colonizing a host selects a microhabitat at random and other parasites aggregate for increasing the chances of mating. In the present work, mating was not observed. Very few juveniles were observed. Microhabitat specificity (Rhode 1991) was determined by the attachment organs of the parasite and preferences of monogenoideans could be the result of adaptations to the structure of host gills or to different conditions within the gills of one host depending on water currents or oxygen concentrations. Gill preference was the result of a complex process. Inter-specific interactions were related to high population density of potentially competing species. Generally, parasite communities were divided into isolationist and interactive in relation to their niches. Fundamental niches should be broad and realized niches reduced in the presence of other species in case of interactive communities. Relationship between overlap and competition could be misleading as there is an inverse relationship between the two (Pianka 1976). More the overlapping, less would be the competition, only if there is reproductive isolation and behavioral difference between the species co-existing at a time. Species co-existence within host is reinforced by reproductive isolation. At the infected sites, competition was not observed. Gill size and narrow microhabitats are expected to have a relation. When parasites lived in moderate abundance, their

niches increase as well as overlap. Moreover, gills present unsaturated space for parasite colonization and interspecific interactions were not thought to restrict niches. Random selection of niches could also contribute to increasing intra specific contacts. Competition could be the biotic mechanism considered responsible for a microhabitat distribution. Thus, intra specific factors determine parasite niches. Cerfontaine (1896, 1898) for the first time observed that some parasites have specific preferential sites. Observations made in the present work was similar to the one observed by Agrawal and Mishra (1992a, b). However, in the present study, distribution pattern of *T. wallagonioides* Jain, 1952, in addition to *M. indicus* Jain, 1957 and *T. gomtiensis* Jain, 1957 was observed on comparative basis. The preference for the first and fourth gill arch was probably to avoid their washing away as it had minimal flow of water current in these arches. The distribution of parasites was independent of the left or right side that is, it is same in each arch irrespective of whether it was the left or the right gill. Thus, microhabitat distribution plot indicates that the anterior of first and fourth gill arches were the most preferred sites of infection. Besides, we also found that the index of infection and dominance index were directly related to each other. Relative density in all the three species was independent of the sex of hosts. Due to ectoparasitic nature and high host specificity exhibited by the species of monogeneoidea, studies on their seasonal dynamics are very significant as they could contribute significantly to the understanding of their biological adaptations to their environment.

Female hormones, breeding cycle of the host and optimum temperature of the surrounding water play a pivotal role in determining monogeneoidean population. The factors instrumental in increasing the prevalence, intensity and dominance index comprise among other things, the life cycle of the fish host itself. Synchronization of oncomiracidial emergence and availability of fish-host would be a necessary factor in infection. *Wallago attu* is a pre-monsoon summer breeder and hatching of monogeneoidean

larvae generally occurs at about 25–35°C. (Peaks of prevalence, intensity and dominance index also obtained in pre-monsoon period). Thus, by the time the free-swimming monogeneoidean larvae hatch, fish fries appear in large numbers and infestation chances were therefore optimized.

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