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Original article

# Parasitic anomalies observed in snow trout due to anthropogenic stress in water bodies

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## ABSTRACT

There is interrelationship of the environmental conditions and fish health. Decrease or increase of pollution in aquatic ecosystem have direct impact on presence or absence of parasites. Fish living under optimum environmental, well-nourished conditions are more resistant to diseases than fish weakened by malnutrition caused by parasite infestation or due to deterioration of environmental conditions because of pollution. Fish encounters common parasites in wild and in culture systems. Parasites attach to the host through suckers and hooks and make their way inside the host through different means, which include skin, through mouth along with food, by means of gills. The hosts were collected during Jan 2019 to Jan 2020 from river Veshaw. During this study it was observed that presence of parasites causes some changes in fish which can serve as indicators of deterioration in aquatic habitat. Clinical signs were noticed in fish hosts collected from sites which received waste due to anthropogenic activities. Parasitic anomalies in the host collected from polluted site was observed to include body deformities, gastric distention, lesions in gut, increased mucus production, damage in gill filaments *etc.*

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## 1. Introduction

Presence of parasites in aquatic fauna depicts the degradation of the aquatic ecosystems. The waste (pollutants) added in water body comes out as plastic waste, fecal waste, fishery waste, water treatment waste *etc.* The suitable tool to trace the environmental health status were the comparison of ectoparasites and endoparasite ratio and endoparasite diversity (Rueckert *et al.*, 2009; Biswas and Pramanik 2016; Al-Hasawi 2019). Therefore during the study focus was on the presence of parasites and anomalies seen by

the naked eye due to infection of parasites. Parasites parasitize skin, gills, fins, gut, body cavities, muscle, *etc.* Although in most cases parasites don't kill the host when present, but they deteriorate fish health which is of economic importance. Parasites are organisms that live in or on another organism (the host), commonly exhibiting some degree of adaptive structural modification, and for all or some part of its existence, deriving food from it. Parasites include a diverse group of organisms with a large diversity, with different life history and host exploitation tactics. Parasites are involved in several food webs and are components of most ecosystems at all trophic levels. Many vertebrate species act as a host of single or several parasite species (Lagrue *et al.*, 2011). Changes in parasite density and community composition can be associated with fish kill (Dezfuli *et al.* 2017). Fish parasites *Gyrodactylus* sp. on skin causes superficial lesions on the epidermis as it attaches and feeds on the epidermis, causing an surge in the production of mucus which disturbs the respiratory function of the skin (Ferguson, 1989). Infection of monogenes in fish gills influences the ability of host to control its ion balance and causes reduc-

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tion in chloride cell number which act as the main site for secretion and absorption of ions (Pritchard, 2003). Study on health status and infection of juvenile *Catla catla* with histopathological and clinical observations showed pathological effects like fungal granuloma, necrosis, monogenean cyst and protozoan, hyperplasia, vacuolation, hypertrophy and haemorrhage in the organs examined. Among the investigated organs gills and skin were more affected followed by kidney and liver (Das and Chandra 2017; Sures et al. 2017). Class Hirudinea (leeches) are parasites with a fixed number of body segments. They have anterior and posterior suckers, leeches can attach to hosts by using this sucker. Leeches are rare in cultured fish but are occasionally seen in wild or pond-raised fish. Heavily infected fish often suffer from chronic anaemia (Noga, 2000). This group of parasites causes skin lesions of fish. They damages the skin and small round wounds are seen. At the other sites of infection, destruction of the fins and erosion of the epithelium of the isthmus region of fish are also reported. *Piscicola* spp. leads to epidermal hyperplasia and ulcerative dermatitis with hemorrhage hyperemia (Ferguson, 1989; Lagrue et al. 2011). Under stressed condition, fish immune responses get suppressed and more susceptible to parasitic infestations (Ramudu, 2013). Fish acts as an important genetic models and evaluation of genotoxicity assessment lies in the fact that higher vertebrates, along with humans feeding on fish, are exposed to the agents that are genotoxic trapped in the fish bodies (Pietroock and Marcogliese 2003; Dar et al., 2016). Behaviour changes in intermediate hosts lead to higher predation risk (Naggar et al. 2018), and also physical damage to molluscs is reported. Parasites indirectly serve as detectors to know the degree of impairment caused by human activities as a result of overexploitation of freshwater bodies and/or marine used as “dumping grounds” which pooled together with the influence of climate change on aquatic ecosystems refers a threatening signal (Palm, 2011). The purpose of the present study was to observe the clinical damage in aquatic fauna (Schizothoracine in Kashmir valley) due to parasites in the natural environment under the influence of human activities (anthropogenic stress).

## 2. Methods

All the protocols used in the present study have been approved by Animal Ethical committee locally constituted by University of Kashmir registered with ethical no. F (IAEC-Approval)

KU/2017/13. The hosts were collected during Jan 2019 to Jan 2020 from different sites of river Veshaw based on difference in vegetation and anthropogenic activities. Fish samples for the present study were collected by using different techniques of fishing which included the use of cast nets and were also purchased from some local fishermen. For Euthanasia, live fish was dipped in 5% clove oil for 2 to 5 min. Then the hosts were kept in plastic coolers containing river water and were transported to the Parasitological Research Laboratory (Department of Zoology, University of Kashmir). Fish were examined to investigate any lesions and ectoparasites on the external body surface and internally for endoparasitic according to Conroy and Hermann, 1981.

## 3. Results

During the study, the extent of damage caused in wild habitat to different organs of fish due to parasitism was mainly focused. The hosts studied belonged to a group of Schizothoracine (snowtrouts native fish of Kashmir Valley). The young and juvenile hosts were examined quickly to observe for parasitic infestation, injury and other abnormal conditions of the fish body caused due to infection. External and internal body of the host were carefully observed with the aid of magnifying glasses and sometimes naked eyes. The parasites of different groups which included Cestoda, Acanthocephala, Nematoda, and Trematoda. Apart from these main parasitic groups, leeches were also seen clinging to the external skin. Fishes infected with parasites showed some signs like deformity and distention in the body, in other organs especially gut, kidney, and gills, nodules on skin or on muscles, discoloration. Such observations clearly depict that there can occur a decline in the health and nutritive value of fish. The common effects of parasites seen in the present study are shown in photographs (plate I) and the changes seen are listed below: In normal fish (uninfected host), all visceral organs were in normal state with gills and liver red in colour.

- Metacercaria of *Clinostomum* sp. was seen encysted in the skin and caused superficial lesions of the skin epidermis and focal reddening of skin. Clinical examination of naturally infected fish also showed whitish cysts in the musculature and discoloration of the body surface was noticed (Fig. 1 (A)). Skin surface was seen damaged and white nodules were present which depict the deterioration of skin in case of fishes due to worsen-

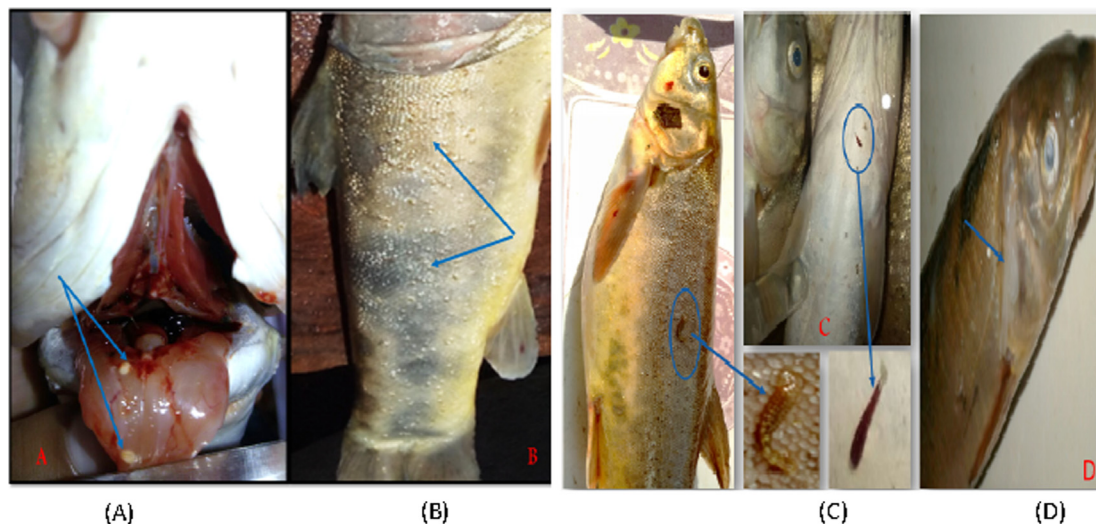


Fig. 1. (A) Metacercaria of *Clinostomum* sp. (B) White nodules on skin of fish. (C) Leeches attached to fish skin (D) Fish showing excess mucus on skin.

ing of aquatic habitat (Fig. 1 (B)). Heavily infected fish with leeches damage the skin, chronic anaemia, skin lesions, epidermal hyperplasia. Anomalies were detected on the external surface of the fish, host exhibited discoloration with an excess of mucus on the body compared to normal fish. (Fig. 1(D)).

- As fish, gills are in direct contact with the external environment and they become a target for many contaminants transported by the water sensitive organs. Among Monogenes, *Diplozoon* sp. (Fig. 2) it was seen attached to the host gills with the help of opishaptor as it gets nourishment from the superficial layers of the gills. Presence of the parasite caused excess mucus production, distortion of gill structural design, pale and darkening of gills which may lead to impaired gill function resulting in accumulation of toxic substances.
- While examining the internal organs, it was discerned that parasites belonging to different groups infected specific sites of different organs such as cestodes were seen blocking the upper part of the gut, acanthocephalans were seen penetrating the gut. Infected hosts showed colour change in various organs like discoloration of gut, paleness in liver, and kidney. Inflammation of the intestine with blockage leading distention of fish gut due to heavy infestation of cestodes and congestion with hemorrhage in the gut was seen which leads to weakness in the host



Fig. 2. *Diplozoon* sp. Infestation on gill filaments.

and makes it susceptible to secondary infections. Predominantly a parasite of the intestine during heavy infestation spread throughout the body and sometimes infection was seen on gill lamellae (Fig. 3).

- Acanthocephala, known as spiny headed worms, cause damage to fish intestine as they make perforations in the tissue to get attached. During this study, these parasites were seen perforating the posterior part of gut lining to insert their proboscis inside the gut lining to absorb nutrients. Microscopic examination of wet mounts of gill filaments revealed disruption damage in the gill rakers due to the presence of Acanthocephala around the gills. Heavy infection in the host caused paleness of the liver with areas of hemorrhage in the liver, kidney, and gills. *Pomphorhynchus kashmirensis* showed an unusual site of infestation in gills of the host, which may be due to an increase in parasite infection (Fig. 4).
- Changes in water quality may weaken the fish resistance to pathogens and the host will be an easy target of parasites in deteriorated water bodies. The samples were taken from the sites with indication of addition of pollutants from different sources.

#### 4. Discussion

Presence of ectoparasites, leeches, and endoparasites in hosts at different polluted sites during the study revealed that environmental deteriorations affect the health of fish and on the presence of different parasites which further lead to worsening of fish health. Postmortem examination of infected fishes with different parasitic infestations exhibited observable features such as paleness of the liver with areas of hemorrhage and blocking of the gut with hemorrhage (Fig. 3). Similar observations were made in other studies carried on fish (Eissa et al., 2010). Changes due to parasitic infection cause melding of gill lamellae, replacement of tissue (mechanical impairment), proliferation of cells, immunomodulation, alteration of growth, negative behavioral reactions (physiological damage) and damage in reproduction (Buchmann and Lindstrom, 2002; Knudsen et al., 2004; Al-Jahdali and Hassanine, 2010). Distension around the proboscis and bulb of acanthocephalan by the host *Pomphorhynchus laevis* leads to safe and strong attachment, and increased production of mucus by the host reduces the immune damage to the parasite is one of the reactions to the ciliate *Ichthyophthirius multifiliis* (Matthews, 2005). During the study, presence of parasites in hosts revealed excessive mucus secretion, abrasions on skin, muscles and on

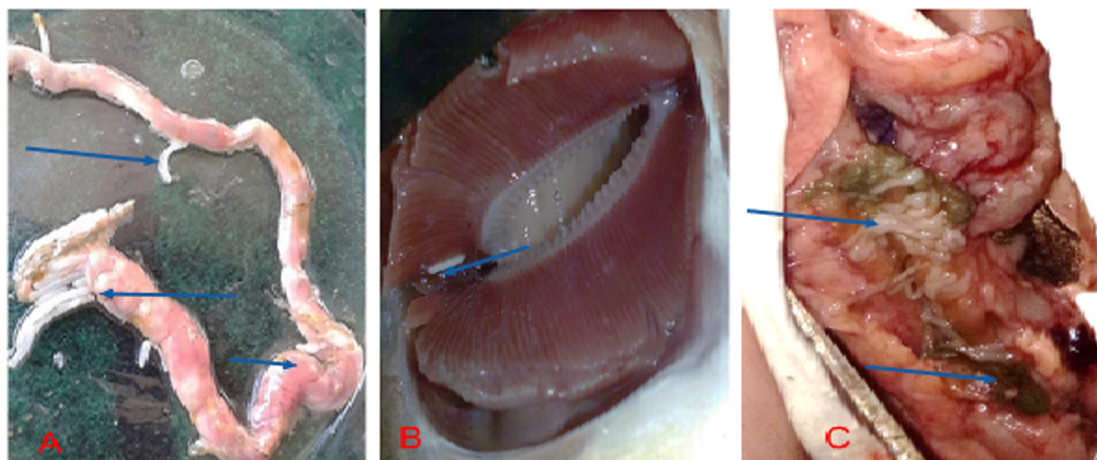
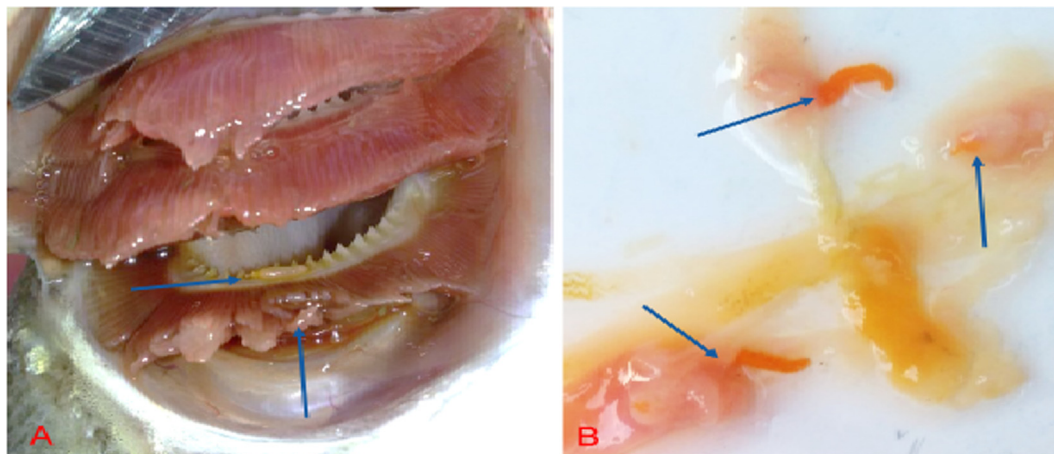


Fig. 3. (A) Gut blockage and rupturing of gut wall due to heavy infestation of *Adenoscolex oreini* (B) Unusual site of infestation by *Adenoscolex oreini* in gills. (C) Occurrence of *Bothriocephalus achelognathi* in other visceral organs as heavy infestation caused rupturing of gut wall and discoloration in internal organs.





**Fig. 4.** (A) Unusual site of infestation on gills by *Pomphorhynchus* sp. causing disruption of gill filaments. (B) *Acanthocephala* inserting their proboscis inside gut lining causing perforations in gut wall.

internal organs, which gives an indication of deteriorating environmental conditions. Parasites depend on their host for their nutrition, survival, and reproduction. The parasite number and development of the infestation are directly proportional to degree of lesion development. Among all parasite fauna analyzed during the study, cestode *Lacistorhynchus sorididus* (sand dab) was reported as a good indicator of pollution as it consistently showed a response to sewage pollution than other parasite taxa (Hogue and Swig, 2007; Leite et al. 2017). An intensity range when parasites can be seen with the naked eye is often used to describe the infectivity level within the fish host. Both natural environmental factors and pollutants discharged into the environment through anthropogenic activities can influence the existence of the free-living stages of parasites (Ashmawy et al. 2018; Pietrock and Marcogliese, 2003). Several studies show that there exists a close interaction among environmental conditions and parasitism and this link is highly vulnerable to the aquatic population (Williams and MacKenzie, 2003; Bayoumy et al. 2015). Fish parasites have been recognized as important sentinel organisms that are able to detect changes in environmental conditions (Palm and Ruckert 2009; Palm, 2011, Palm et al., 2011; Combes 1996). Under eutrophic water conditions parasitic infection increases, however parasitic load might decline under high eutrophic conditions, thus representing the harmful effect of increased eutrophication on the parasite load (Gilbert and Avenant-Oldewage 2017; Zargar et al., 2012).

## 5. Conclusion

Parasites reflect the health status of fish as well as indicate the ecological condition of the water body. Presence of parasites during the study, which included both ectoparasites and endoparasites, provides information that fish health is degrading due to environmental deterioration. The study shows the involvement of different organs of fish get affected by the presence of parasites causing mechanical damage which eventually leads to physiological damage (including nutrient deprivation). Often the damage linked to these fish is associated with the rate of infestation with the parasite; a fish that is lightly infected with parasites will show little clinical signs, while as heavily infected fish may grow as a physiologically impaired organism and even die as seen in case of choking of fish gut by cestodes during the present study. Damage was noticed first time in gill filaments due to heavy infection of *Acanthocephala* sp. on gills. During this study parasites were seen piercing the gut, causing pores to the intestinal wall and

infecting other visceral organs. Parasites serve as good indicators of the deteriorating aquatic ecosystems. Therefore, there is a need to take steps to stop further addition of waste material in water bodies of Kashmir Valley to avoid the decline and health deterioration of native fish (snowtrouts) which is the most important fauna of water ecosystem in Kashmir Valley.

## Ethical approval

Not Applicable.

## Consent to publication

All authors approved the manuscript to be published.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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