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Occurrence of fish louse (*Argulus* sp.) on Indian snow trout (*Schizothorax richardsonii*) and golden mahseer (*Tor putitora*) in subtropical Himalayan Lake of Bhimtal, Uttarakhand, India

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ABSTRACT

Indian snow trout (*Schizothorax richardsonii*) and golden mahseer (*Tor putitora*) from cage culture unit of Bhimtal Lake were examined for fish louse (*Argulus*) infestation from August 2008 to January 2009. The percentages of *S. richardsonii* infected were 51.21, whereas abundance and mean intensity of infestations were 1.05 and 2.06 respectively. Maximum prevalence (70.1%) was observed in September with least in December. Percentages of host infected in *T. putitora* were 25 with abundance and mean intensity of 0.34 and 1.36 respectively. One to two percentage of fish stock was fungal infected. Measurement of crustacean parasite illustrated carapace length (CL) comprised 75% of average total body length (5.4 mm). Prevalence was positively correlated (*S. richardsonii:* r = 0.88; and *T. putitora*: r = 0.91) with decrease in water temperature. The results of mean intensity of *Argulus* infestation indicated an initial stage of infection in both the species. So the present study draws immediate attentions of fish health management towards enhancement of fish production in coldwater aquatic resources of India.

Key words: Argulus, Coldwater, Fish health

The crustacean ectoparasite fish louse (*Argulus*), is one of the major threats for fish health management and aquatic crop production in fisheries in tropical and temperate regions (Costello 1993). This crustacean parasite punctures the skin of the hosts with modified mouthparts and feeds on blood by releasing anticoagulants into fish (Hakalahti *et al*. 2004). Thus in *Argulus* infestation (Aurgulosis), the chance of fish death due to secondary infection increases. Aurgulosis (Crustacea: Branchiura) was observed in many European freshwater lakes and fish farm (Buchmann and Uldal 1995, Grignard *et al.* 1996, and Valtonen *et al*. 1997). Trout and carp stocks were severely damaged by epizootics of this parasite (Menezes *et al*. 1990, Rahman 1996). *Argulus* infestations have been reported round the globe (Shimura 1983, Gusev 1987, Menezes *et al*. 1990, Gault *et al*. 2002, Hakalahti and Valtonen 2003 and Bhuiyan *et al.* 2008).

In India, fish louse mainly infested inland capture and culture fisheries of cyprinids, as temperatures of these water bodies provide optimum environment for life-cycle of *Argulus*. There was report of *Argulus* infestation in carps from West Bengal (Clers *et al*. 1992). Present study is the first report on incidence of *Argulus* in cage reared Indian snow trout (*Schizothorax richardsonii*) and golden mahseer (*Tor putitora)* from Bhimtal Lake of Uttarakhand in India.

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MATERIALS AND METHODS

Description of study site

Bhimtal lake (29°20′35″ N 79°33′33″ E) is a sub-tropical lake, situated 4494.7 feet (1370 m) above the mean sea level, with an area of 44 ha (Kumar *et al*. 2007). It is situated in Nainital district of Uttarakhand in India. This lake is perennial in nature and a habitat to a large variety of aquatic flora and fauna. Bottom is muddy with high organic load.

Sample collection

Live specimens of *Schizothorax richardsonii* and *Tor putitora* were collected from cage culture unit of Bhimtal lake, from August 2008 to January 2009. Sampling was done once in a month. Collected specimens were examined externally for *Argulus* infestation.

Data collection

Total of 2187 numbers of *S. richardsonii* and 186 numbers of *T. putitora* were examined during the study period. The external surface of host (skin, fins, base of the fins and opercula region) was examined thoroughly for presence of *Argulus.* Parasites were easily seen with naked eyes and were

picked from the infested host with help of a blunt forceps and needle, and fixed in 70% ethanol for identification and measurements. Then they were examined by light microscope at 40X and 100X for identification. *S. richardsonii* stock was divided into 2 groups (4.5–5.5 cm and > 5.5 cm in length) depending on their size to find out the effect of host size on prevalence, abundance and mean intensity of *Argulus* infestation as per Margolis *et al*. (1982) and Abdus *et al.* (2008). Surface water temperature of the lake at cage culture site was measured by mercury thermometer (Accuracy 0.1°C).

Data analysis

The statistical program SPSS 15.0 for Windows was used for Spearman rho correlation analysis.

RESULTS AND DISCUSSION

Prevalence, abundance and mean Intensity of Argulus sp. *infestation on* Schizothorax richardsonii

A thorough observation of collected sample showed that, these ectoparasites were generally attached to the base of the fins, operculum, dorsal and ventral surface of the fish body and caudal peduncle regions. The incidence of parasitic attachment was maximum in the operculum and base of the pectoral fins of the parasitized fishes. Total numbers of *S. richardsonii* examined for parasite infestation were 2187. Out of 2187 hosts, 1120 fishes were infested with *Argulus* sp. The number of *Argulus* sp. recorded from all the infested hosts was 2312. Prevalence (percentages of fish infested), abundance and mean intensity (number of parasite per infested host) were 51.21%, 1.05 and 2.06 respectively. The mean intensity is low, which indicates that fish are of parasite infestation at initial stage. Data on month-wise abundance and mean intensity of *Argulus* infestation are shown in Table 1.

Prevalence, abundance and mean intensity of Argulus *sp. on* Tor putitora

Total number of *T. putitora,* examined during study period was 186. Out of this, 47 number of host were infected with parasite. The month-wise percentages of host infected, abundance and mean intensity are given in Table 2, which showed 25% of stocks were infected with *Argulus* sp., whereas mean intensity revealed initial stage of infection. During sampling period, authors could not sample more numbers of hosts due to sampling difficulty, which explained a relatively small sample size of *T. putitora*.

Monthly patterns of prevalence of Argulus *sp. on* S. richardsonii *and* T. putitora

Maximum prevalences of *Argulus* sp. on *S. richardsonii* (Fig. 1; 70.1%) as well as on *T putitora* (Table 2; 42.2%) were recorded in September 2008. During winter in January, fishes of both the stocks were almost free from *Argulus* (Figs 2 and 3).

Argulus *free hosts*

The hosts (Indian snow trout and Golden Mahseer), which did not show the infestation of *Argulus* sp. at the time of sampling, were observed with presence of small patches of grey-blue colour lesions on the skin, operculum and dorsal surface of their body. It may be due to the irritation and tissue

Table 1. Abundance and mean intensity of *Argulus* infestation on *S. richardsonii* from August to December, 2008

Month of sampling	Total number of host		Total number of parasite recorded	Abundance	Mean intensity
	Examined	Infected			
August	505	343	780	1.54	2.27
September	426	299	627	1.47	2.09
October	411	266	576	1.40	2.16
November	402	179	291	0.72	1.62
December	443	33	38	0.08	1.15
Total	2187	1120	2312		

Table 2. Prevalence, abundance and mean intensity of *Argulus* infestation on *T. putitora* from August to December, 2008

Month of sampling	Total number of host		Total number of parasite recorded	Prevalence (%)	Abundance	Mean intensity
	Examined	Infected				
August	40	13	18	32.5	0.45	1.38
September	45	19	27	42.2	0.60	1.42
October	42	8	11	19.04	0.26	1.37
November	33	5	6	15.15	0.18	1.2
December	26	2	2	7.6	0.07	1
Total	186	47	64			

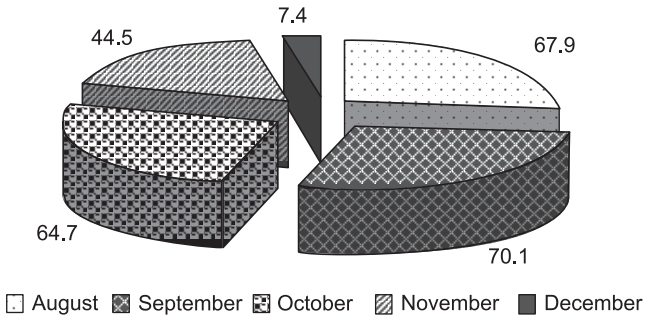

Fig 1. Monthly (August to December 2008) prevalence (%) of *Argulus* infestation on *S. richardsonii* from cage culture unit of Bhimtal lake.

damage by detached parasites, which left the host with small patches of grey-blue and lesions on their body. Alexandre *et al*. (2002) reported that once the mating is over on fish body, the female *Argulus* swims away from hosts and lays eggs on plants, stones, nets and other submerged objects. So, it may form one of the reasons why observed fish were left with small patches of grey-blue and lesions. One to two percentage of total stock was also found infected with cottony wool like appearance on base of the dorsal, pelvic and caudal fins, which most likely a fungal disease. This infestation of *Argulus* sp. may be the possible cause of the secondary infection such as fungal diseases. The attachment of *Argulus* paves the way for entry of opportunistic pathogens (Ravichandran *et al*. 2001 and Alexandre *et al.* 2002). Mortality of the fishes was not observed during sampling. Fish infected with cotton wool like growth, were sampled and brought to laboratory for identification of fungi. With application of hemp-seed method (Pottinger and Day 1999, Sati and Mer 1989) it was found to be *Saprolegnia* sp., which caused this secondary infection (cottony-wool like growth) on fish body. On experimental basis, the entire host (*S. richardsonii*) in one cage was examined thoroughly; *Argulus* sp. were removed from the infected host and *Argulus* free stock was allowed to restock in the same cage. After 10 days the cage was lifted and sampled again and it was found same stock heavily infested with *Argulus* sp. again. It is reported that an adult *Argulus* can survive without a host for up to 15 days, while a newly hatched larva for 1 or 2 days. The life cycle of this ectoparasite depicts a newly hatched larva actively seeks host and continues its development on fish (Alexandre *et al.* 2002). The netted cage wall forms a suitable submerged object for egg laying, hatching and completion of life-cycle of *Argulus* sp. As fishes were restocked in the same cage, as said above, the adult *Argulus* sp. and newly hatched one might have re-infested the stock.

Description of isolated Argulus sp.

In present study the collected *Argulus* sp. was identified based on their external characteristics. The measurement was based on 20 specimens. Morphometry of crustacean parasite illustrated 5.4 mm average total length (TL), 4.1 mm carapace length (CL), which comprised 75% of total body length, 4.0 mm carapace width (CW) and 2.1 mm abdominal length (ABL). Yildiz and Kumantas (2002) reported that total body length of *Argulus foliaceus* ranged from 6 mm to 7 mm, whereas *Argulus japanicus* and *Argulus coregoni* are from 4 mm to 8 mm and 12 mm respectively. Tam *et al.* (2005) reported 5.5 mm average body length, 3.03 mm average length of carapace (53% of overall body length), 2.9 mm of average width of carapace and 2.1 mm of average length of abdomen in male *Argulus personatus* (measurement based on 8 male specimens of *Argulus personatus*). In female *Argulus personatus*, the total body length, carapace length, carapace with and abdomen were 5.6 mm, 3.7 mm, 3.4 mm and 1.5 mm respectively (measurement based on 1 female

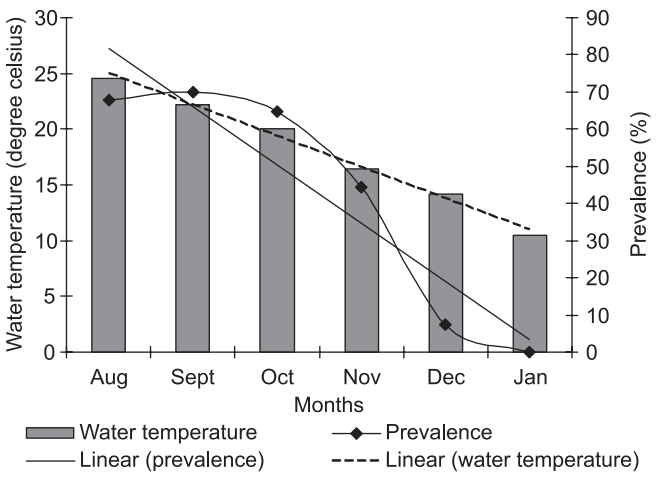

Fig 2. Decreasing trend of prevalence with decrease in water temperature, Stock: *S. richardsonii* (August 2008 to January 2009).

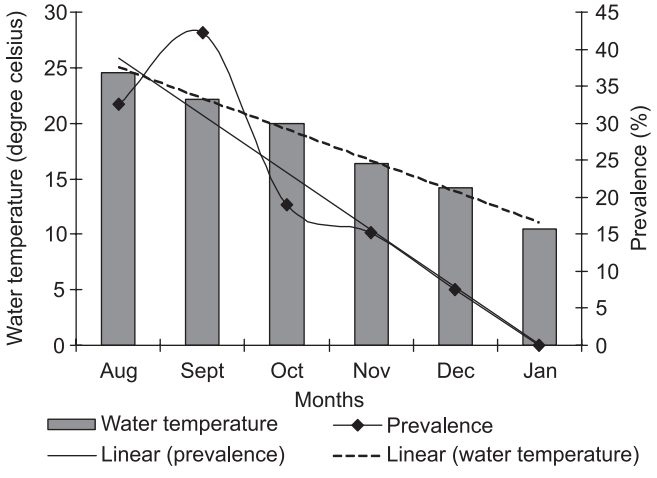

Fig 3. Decreasing trend of prevalence with decrease in water temperature, Stock: *T. putitora* (August, 2008 to January, 2009).

specimen of *Argulus personatus*). Wadeh *et al*. (2007) observed total body length ranged from 4.9 mm to 8.2 mm with an average of 6.5 mm and abdomen length 1.2 mm to 1.7 mm with an average of 1.4 mm in adult female *Argulus japanicus* Thiele 1900 (Crustacea: Branchiura) collected from Shunde of Guangdong, China. They have also reported average total body length 3.6 mm of male *Argulus japanicus* Thiele, with carapace length comprising 75% of total body length.

Effect of host size on prevalence, abundance and mean intensity of Argulus *infestation on Indian snowtrout*

In present study, prevalence, abundance and mean intensity of *Argulus* infestation did not vary significantly between fish size groups in length (Stock: *S richardsonii*, Table: 3). The apparent result indicated infected hosts in size class 45 to 55 mm acquired more *Argulus* (mean intensity 2.14) as compared to size class > 55 mm (mean intensity 1.87). Poulin (1999) demonstrated prevalence and mean intensity correlate positively with host body size for copepod ectoparasite. Grutter (1994) also found a positive correlation between host fish length and gnathiid parasite loads. According to island biogeography theory (MacArthur and Wilson 1967), larger hosts are likely to harbour more parasite species and higher number of individual parasites than smaller host. The fact that parasites attached to body surface of larger host may mean that they provide greater surface area and are attacked more often than smaller host (Cochran 1985). Clers *et al*. (1992) also recorded the similar observation of increase abundance of *Argulus* infestation with increase in host size, but the observation recorded in the study for effect of host size group on prevalence, abundance and mean intensity did not concur with the reports stated above. As fishes were stocked in cage net and reared in a confined environment, which hardly allow them flee to open water, the parasites might have easily accessed the stock for infestation irrespective of size of the hosts. The effect of host size on prevalence, abundance and mean intensity of *Argulus* infestation was not studied in Golden mahseer, *T. putitora* because of a relatively small sample size of the fish.

Effect of water temperature on percentage of host infected (*stock:* S. richardsonii *and* T. putitora)

The effects of water temperature on prevalence showed positive correlation (Fig.2; *S. richardsonii:* r = 0.88; Fig. 3, *T. putitora*: r = 0.91) in the observation. The maximum prevalence for both fishes (*S. richardsonii* 70.1% and *T. putitora* 42.2%) was monitored in September. Then a decrease in percentage of host infection from October onwards was recorded with fall of water temperature in the present study. As optimum water temperature for completion of *Argulus* life-cycle ranges between 18 and 22°C, lessen in prevalence in November and December may be the due to unfavorable water temperature during the said months. The whole life cycle may take 30–100 days depending on the water temperature of the rearing unit. So eggs can over-winter and hatch later when water temperature starts increasing (Alexandre *et al.* 2002). Clers *et al.* (1992) also observed that high water temperature promotes the increase in *Argulus* population.

There is marked deterioration of water quality of Bhimtal lake with recession of its margin and shallowing in the past few years by anthropogenic activities. There is also a marked decrease in depth of the lake during summer with increase in water temperature, appearance of aquatic weed infestation and muddy fauna. All these may be the basis for infestation of *Argulus* sp. on coldwater fish in cage culture system. The present infestation of *Argulus* sp. may be at initial stage, but it can be categorized in high-risk group, where organism is termed as typically pathogenic and requires immediate treatment and mechanical removal. Because this crustaceans infestation not only retards the growth of the fish, but also acts as a vector for entry of certain fish viruses (Clers *et al*. 1992) and secondary infections such as bacterial and fungal diseases. Lester and Roubal (1995) also reported that growing *Argulus* sp. juveniles may expose fish to fungal and bacterial infections by irritating the skin that can affect the fish's feeding habit, which results in retarding growth and sometimes death of the host. Thus a periodical monitoring program on fish health is considered necessary to keep the stock in healthy state. The present study sensitized us to examine the fish culture tank at higher altitude raceways culture system. The Indian snowtrout and Rainbow trout stock at coldwater fish farm, Champawat, which is situated at 5688.97 feet (1734 m) above the sea level, were examined for Argulosis. But the stocks did not show any sign of *Argulus* infestation. During sampling period, the average water temperature of Champawat fish farm was 11.5 °C.

Virtually no extensive survey of parasites in coldwater aquatic resources of mid-Himalayan region of India has been done so far. As there is no information on distribution and abundance of *Argulus* infestation in coldwater bodies of India, this occurrence of *Argulus* sp. on coldwater fishes, Indian snowtrout and critically endangered Golden mahseer in cage

Table 3. Prevalence, abundance and mean intensity of *Argulus* infection on *S. richardsonii* in different length group

Size group (length in mm)	No. of host examined	No. of host infested	Number of parasite recorded	Prevalence (%)	Abundance	Mean intensity
45–55	459	227	486	49.45	1.05	2.14
>55	312	151	283	48.39	0.90	1. 87

culture unit of Bhimtal Lake draws immediate attentions of fish health management and extensive survey of parasites towards enhancement of fish production in coldwater aquatic resources of hilly states of India.

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