



Research Paper

Seasonal Dynamics and Prevalence of Helminth Infection in Freshwater Fishes of Kelzar Dam, Maharashtra, India

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Abstract

Helminth parasites are one of the major challenges affecting the health, growth, and productivity of freshwater fishes, leading to economic losses in fisheries and aquaculture sector. This study investigated the prevalence, seasonal variation, and host-related factors associated with helminth infections in freshwater fishes from Kelzar Dam, Maharashtra, India. A total of 468 fishes representing eight species were collected and examined between June 2021 and May 2025. Among them, 176 fishes were infected, giving an overall prevalence of 37.6%. Six helminth species belonging to four major groups, namely nematodes, trematodes, cestodes, and acanthocephalans, were identified. Infection varied among fish species, with the highest prevalence recorded in carnivorous fishes (47.9%), followed by omnivorous (30.8%) and herbivorous (30.5%) fishes. Seasonal analysis showed that infection was highest during the monsoon season (54.5%) and lower during summer (28.8%) and winter (26.3%). Most parasites were recovered from the intestine (68.0%), followed by the body cavity (12.3%), stomach (11.0%), and liver (8.7%). The parasite community exhibited moderate diversity, with a Shannon–Wiener diversity index ($H' = 1.52$), indicating a relatively stable host–parasite relationship. Statistical analysis showed significant associations between infection prevalence, season, and feeding habits ($p < 0.05$). These findings provide baseline information for fish health monitoring and support sustainable fisheries management and freshwater ecosystem conservation.

1. Introduction

Freshwater fishes are an important source of nutritious food and livelihood for millions of people in India. They also play a major role in supporting rural economies, particularly in Maharashtra, where numerous reservoirs contribute significantly to inland fish production and sustain diverse fish populations (Kumar *et al.*, 2023). Despite their ecological and economic value, freshwater fishes are frequently affected by parasitic diseases that reduce their health, growth, and survival. Among these, helminths including nematodes, trematodes, cestodes, and acanthocephalans are commonly reported from Indian freshwater ecosystems (Kumar *et al.*, 2023). These parasites damage host tissues, compete for nutrients, and reduce the overall condition and productivity of infected fishes (Bandyopadhyay *et al.*, 2024). Helminth infections also have serious economic consequences for fisheries. Infected fishes often exhibit poor growth, reduced body condition, and lower market value, while heavy infections may cause mortality and financial losses to fishers and aquaculture farmers (Deshmukh *et al.*, 2021).

Recent studies have highlighted that parasitic diseases continue to threaten freshwater fisheries in India by affecting fish growth, survival, and production, emphasizing the need for regular disease monitoring and effective management practices (Mustafa *et al.*, 2024). In addition, helminth infections can induce oxidative stress and DNA damage, further reducing fish health and physiological fitness (Nabi *et al.*, 2022).

The occurrence and transmission of helminth parasites are influenced by seasonal conditions, environmental factors, and host-related characteristics (Poulin, 2020). Temperature, rainfall, and water quality affect parasite development and survival, while feeding behaviour influences the likelihood of infection because many helminths are transmitted through infected intermediate hosts (Prakash and Singh, 2020; Wogu, 2014). Recent international studies have shown that climate change, pollution, habitat degradation, and biological invasions alter parasite diversity, host susceptibility, and transmission dynamics, making parasite communities useful indicators of freshwater ecosystem health (Sures *et al.*, 2023).

Habitat alteration caused by reservoir construction, urbanization, and agricultural activities has also been reported to influence host–parasite interactions in freshwater ecosystems (Sures et al., 2026). Several studies from India have documented the diversity and occurrence of helminth parasites in freshwater fishes. A recent review summarized the distribution and host associations of these parasites in Indian freshwater fishes (Sultana et al., 2024). Other investigations have reported seasonal variation, environmental influences, and changes in parasite diversity across different freshwater ecosystems (Esposito et al., 2023; Reshu et al., 2024; Bandyopadhyay et al., 2024; Srivastava, 2024; Sahreen et al., 2024). Similar observations linking feeding behaviour and seasonal environmental changes with parasite transmission have also been reported by Wogu (2014) and Poulin (2020).

In recent years, fish parasites have also been recognized as useful indicators of freshwater ecosystem health. Changes in parasite diversity and infection levels often reflect variations in environmental conditions, water quality, and the availability of suitable hosts. Therefore, studies on helminth parasites not only improve our understanding of fish diseases but also provide valuable information for assessing ecosystem health and biodiversity. Regular monitoring of parasite communities in freshwater reservoirs can support fish health management, biodiversity conservation, and the sustainable development of fisheries. Such region-specific investigations are particularly important in reservoirs where information on parasite diversity is still limited (Marcogliese, 2023; Selbach et al., 2024).

Although several studies have investigated helminth infections in freshwater fishes, information from Kelzar Dam in Nashik district remains scarce. Most previous investigations have focused on larger rivers, leaving many reservoirs insufficiently explored (Deshmukh et al., 2021). Recent reviews have also emphasized the need for regional surveys to improve knowledge of fish parasite diversity and strengthen fisheries health management (Longshaw et al., 2026). Therefore, the present study aimed to determine the prevalence of helminth parasites in freshwater fishes of Kelzar Dam, evaluate seasonal variation, examine the influence of host feeding habits on infection, and assess helminth diversity within the reservoir ecosystem.

2. Materials and Methods

2.1 Study Area

The present study was carried out at Kelzar Dam, locally known as Gopal Sagar, located in Baglan Taluka of Nashik district, Maharashtra, India (20°39'06"N, 73°58'24"E). The dam was constructed across the Aram River in 1981 and has a water spread area of approximately 4.5 km². The reservoir is an important

freshwater resource in the region and supports a variety of fish species that are commercially and ecologically important. The surrounding area is mainly influenced by agricultural activities, and the reservoir provides water for irrigation and fisheries. The reservoir experiences a tropical monsoon climate with three distinct seasons: summer (March–May), monsoon (June–September), and winter (October–February). These seasonal changes influence the environmental conditions of the reservoir and may affect the occurrence and transmission of fish parasites. Therefore, fish samples were collected throughout the study period to include seasonal variation in parasite infection.

2.2 Fish collection

Freshwater fishes were collected monthly from June 2021 to May 2025 from three sampling sites representing the inlet, middle, and outlet zones of Kelzar Dam. Sampling from different locations was carried out to obtain representative fish specimens from the reservoir. A total of 468 fishes belonging to eight species (*Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*, *Channa punctatus*, *Clarias batrachus*, *Mystus seenghala*, *Oreochromis niloticus*, and *Puntius sophore*) were included in the study. Fish samples were captured using cast nets and gill nets with the assistance of local fishermen. The collected fishes were transported alive to the laboratory in oxygenated containers to minimize stress and maintain specimen quality before examination. Each fish specimen was identified to the species level using standard taxonomic keys described by Jayaram (1999). Basic information, including the date of collection, sampling site, and fish species, was recorded before parasitological examination.

2.3 Parasitological Examination

During the study period from June 2021 to May 2025, all freshwater fish specimens collected from Kelzar Dam were processed individually in the laboratory soon after collection. A total of 468 fishes representing eight species were dissected through a mid-ventral incision for parasitological examination. Before dissection, each fish was examined for total length, body weight, and sex through gonadal observation. The external body surface and gill region were examined visually for any visible abnormalities before internal examination. The body cavity, liver, stomach, and intestine were carefully examined under a dissecting microscope for the presence of helminth parasites. Recovered parasites were washed in 0.75% normal saline and preserved in hot 70% ethanol for nematodes or AFA fixative for trematodes and cestodes. Permanent slides were prepared using Borax Carmine staining, and parasite identification was carried out using standard taxonomic keys described by Moravec (1994) and Gibson *et al.* (2002). The identified parasites were grouped according to their major taxonomic categories for further analysis.

2.4 Epidemiological Indices

The prevalence, mean intensity, and mean abundance of helminth parasites were calculated according to the methods described by Bush et al. (1997). These epidemiological parameters were used to assess the level of parasite infection among different fish species and seasons.

2.5 Statistical Analysis

Statistical analyses were performed using SPSS software. Differences in helminth infection prevalence among fish species, seasons, and feeding habits were analysed using the Chi-square (χ^2) test. A probability value of $p < 0.05$ was considered statistically significant. The statistical results were used to determine whether the observed differences in infection prevalence were significantly associated with fish species, seasonal variation, and feeding habits.

3. Results

3.1 Species-wise Prevalence of Helminth Infection

The prevalence of helminth infection differed among the examined freshwater fish species, indicating variation in their susceptibility to parasitic infection (Table 1). Carnivorous fishes generally exhibited a higher level of infection than herbivorous and omnivorous species, suggesting that feeding behaviour may influence exposure to infective stages of helminth parasites. Among the examined fishes, *Channa punctatus* showed the highest infection, whereas *Cirrhinus mrigala* recorded the lowest prevalence. The remaining fish species displayed moderate infection levels, reflecting differences in their ecological habits and host-parasite interactions. Statistical analysis confirmed that the variation in prevalence among the fish species was significant ($\chi^2 = 18.64$, $df = 7$, $p < 0.05$). The overall distribution pattern of helminth infection across the eight freshwater fish species is clearly illustrated in Figure 1, while the detailed prevalence data for each species are presented in Table 1.

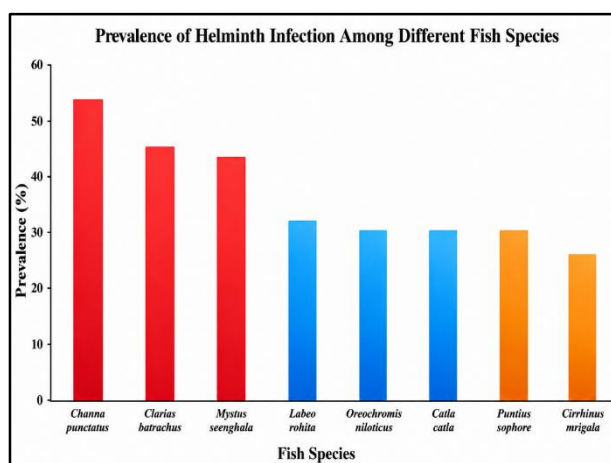


Figure 1: Prevalence (%) of helminth infection among freshwater fish species collected from Kelzar Dam, Maharashtra, India

3.2 Seasonal Variation

The prevalence of helminth infection showed clear seasonal variation among the freshwater fishes examined from Kelzar Dam (Table 2). Infection was highest during the monsoon season, whereas comparatively lower prevalence was observed during summer and winter. A similar seasonal trend was also observed for mean intensity, with infected fishes harbouring a greater parasite load during the monsoon than in the other two seasons. Statistical analysis demonstrated that the seasonal differences in helminth prevalence were highly significant ($\chi^2 = 22.41$, $df = 2$, $p < 0.01$), indicating that season had a significant influence on parasite occurrence in the reservoir.

The graphical representation in Figure 2 clearly illustrates the seasonal fluctuation in helminth prevalence, showing a marked increase during the monsoon followed by a decline during winter and summer. This pattern suggests that environmental conditions prevailing during the rainy season may favour parasite transmission and increase the probability of host exposure.

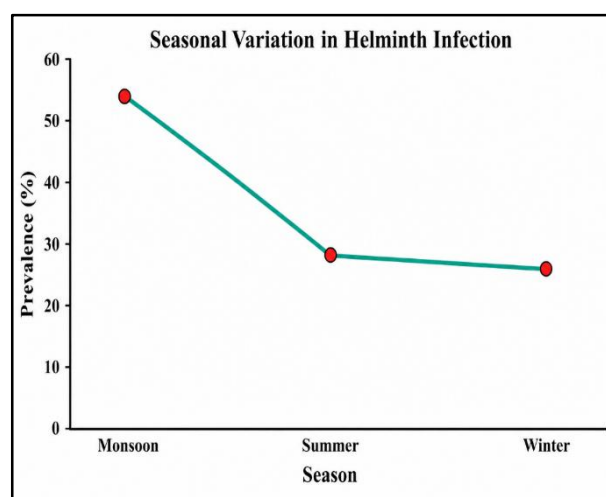


Figure 2: Seasonal variation in the prevalence (%) of helminth infection among freshwater fishes collected from Kelzar Dam, Maharashtra, India

3.3 Organ-wise Distribution

The distribution of recovered helminth parasites varied among the different organs examined (Table 3). The intestine was the principal site of infection, accounting for the majority of the recovered parasites. Adult nematodes and acanthocephalans were predominantly associated with the intestinal region, indicating that this organ provides favourable conditions for parasite attachment and development. In contrast, larval nematodes were mainly recovered from the body cavity and liver, while comparatively fewer parasites were detected in the stomach. The observed organ-specific distribution demonstrates that different helminth groups exhibit distinct site preferences within the host, reflecting differences in their biology and

Table 1: Prevalence of helminth infection in different freshwater fish species

Fish Species	Feeding Habit	Number Examined	Number Infected	Prevalence (%)
<i>Channa punctatus</i>	Carnivorous	82	42	51.2
<i>Clarias batrachus</i>	Carnivorous	61	28	45.9
<i>Mystus seenghala</i>	Carnivorous	47	21	44.7
<i>Labeo rohita</i>	Herbivorous	64	21	32.8
<i>Oreochromis niloticus</i>	Omnivorous	59	18	30.5
<i>Catla catla</i>	Herbivorous	58	18	31.0
<i>Puntius sophore</i>	Omnivorous	45	14	31.1
<i>Cirrhinus mrigala</i>	Herbivorous	52	14	26.9
Total		468	176	37.6

Table 2: Seasonal variation in helminth infection of freshwater fishes

Season	Number Examined	Number Infected	Prevalence (%)	Mean Intensity
Monsoon	176	96	54.5	2.30
Summer	132	38	28.8	1.60
Winter	160	42	26.3	1.76

Table 3: Organ-wise distribution of recovered helminth parasites

Organ	Parasites Recovered	Percentage (%)	Dominant Parasite Group
Intestine	242	68.0	Nematodes, Acanthocephalans
Body cavity	44	12.3	Larval nematodes
Stomach	39	11.0	Nematodes
Liver	31	8.7	Larval nematodes
Total	356	100.0	—

developmental stages. Overall, the intestine served as the most important habitat for helminth parasites in the examined freshwater fishes.

3.4 Diversity Indices

The diversity analysis indicated that the helminth community of Kelzar Dam consisted of six parasite species with moderate species diversity (**Table 4**). The Shannon–Wiener diversity index reflected a moderately diverse parasite assemblage, while the Simpson diversity index suggested that no single parasite species dominated the community. Similarly, the evenness index indicated a relatively uniform distribution of parasite species among the examined hosts. The Margalef richness index further demonstrated moderate species richness within the reservoir ecosystem. Collectively, these diversities

indices indicate a relatively stable and balanced helminth community in Kelzar Dam, providing valuable baseline information for future investigations on fish health, parasite ecology, and freshwater ecosystem monitoring.

Table 4: Diversity indices of helminth parasites recovered from freshwater fishes

Diversity Parameter	Value
Total parasite species	6
Shannon–Wiener diversity index (H')	1.52
Simpson diversity index (D)	0.73
Margalef richness index	0.84
Evenness index	0.69

4. Discussion

The present study recorded an overall helminth prevalence of 37.6% in freshwater fishes from Kelzar Dam, indicating that helminth infections are common in this reservoir. Comparable observations have been reported from several freshwater ecosystems in India. Sahreen et al. (2024) reported a prevalence of 26.39% of *Isoparorchis hypselobagri* infecting *Wallago attu* in Uttar Pradesh, while Srivastava (2024) recorded endoparasitic infections in 291 out of 1,019 fishes collected from Chikaldongri Lake. Bandyopadhyay et al. (2024) also reported seasonal variation in helminth abundance in fishes from the Mundeswari River. Variations in prevalence among different studies may be associated with differences in fish species, environmental conditions, reservoir characteristics, water quality, and the availability of intermediate hosts. Temperature and rainfall are also known to influence the development, survival, and transmission of helminth parasites in freshwater ecosystems (Poulin, 2020). The present findings showed that carnivorous fishes had a higher prevalence of helminth infection than herbivorous and omnivorous fishes. This may be because carnivorous fishes frequently consume infected intermediate or paratenic hosts, increasing their exposure to helminth parasites. Wogu (2014) also reported a significant association between feeding behaviour and gastrointestinal helminth infections in freshwater fishes. In contrast, herbivorous fishes generally showed lower infection levels because their feeding habits reduce the chances of ingesting infective parasite stages. Similar observations were made by Srivastava (2024), who also reported that feeding behaviour plays an important role in influencing parasite infestation in freshwater fishes. Recent evidence also indicates that host characteristics and seasonal changes can influence helminth prevalence and host–parasite interactions in freshwater fishes. Das et al. (2026) reported significant differences in helminth infection among freshwater fish hosts between pre-monsoon and post-monsoon periods, highlighting the combined influence of host characteristics and seasonal environmental conditions on parasite transmission. Seasonal differences were evident in the present study, with the highest prevalence observed during the monsoon season. Recent studies have also documented strong seasonal variation in helminth infections of freshwater fishes. Kumar et al. (2026) reported seasonal fluctuations in gastrointestinal helminth infections among freshwater fishes from the Gomti River and associated wetlands in India, with substantial differences in prevalence among fish groups and seasons. Similarly, Abdu and Shah (2025) recorded significantly higher helminth prevalence during the rainy season than during the dry season, emphasizing the role of rainfall and seasonal ecological conditions in parasite transmission. Rainfall during this period increases water availability and supports the growth of aquatic organisms that act as intermediate hosts, thereby favouring parasite

transmission. Increased water movement during the monsoon may also enhance contact between infective stages and susceptible hosts. Similar relationships between environmental conditions and parasite transmission have been described by Sures et al. (2023). Comparable seasonal trends were also reported by Reshu et al. (2024) and Bandyopadhyay et al. (2024). In contrast, Sahreen et al. (2024) observed the highest infection during winter, suggesting that seasonal patterns differ according to parasite species, host biology, and local environmental conditions. The intestine was the principal site of helminth infection, accounting for most of the recovered parasites. This finding agrees with the observations of Bandyopadhyay et al. (2024) and indicates that the intestine provides favourable conditions for parasite attachment, feeding, and development. Larval nematodes recovered from the liver and body cavity suggest that some fish species may serve as paratenic hosts, thereby contributing to the persistence of parasite transmission within the reservoir.

The Shannon–Wiener diversity index ($H' = 1.52$) indicated moderate helminth diversity in Kelzar Dam. According to Prakash and Singh (2020), parasite diversity is an important indicator of ecological stability and environmental change. Similarly, Esposito et al. (2023) highlighted the usefulness of parasite communities in assessing freshwater ecosystem health. The evenness index further showed that no single parasite species dominated the community, which is consistent with the findings of Bandyopadhyay et al. (2024). Overall, the present study provides useful baseline information on helminth diversity and infection patterns that can support future fish health monitoring and sustainable management of freshwater fisheries.

The findings of the present study provide important baseline information on the occurrence and distribution of helminth parasites in freshwater fishes of Kelzar Dam. Understanding seasonal patterns of infection and the influence of feeding habits can help in planning appropriate fish health monitoring programmes and disease management strategies. Regular surveillance of helminth parasites is important for maintaining healthy fish populations, particularly in reservoirs that support commercial and local fisheries. The observed parasite diversity also reflects the ecological condition of the reservoir and may serve as a useful indicator for monitoring changes in the aquatic environment over time. Therefore, continuous assessment of host–parasite interactions, together with environmental monitoring, will contribute to the conservation of freshwater biodiversity and the sustainable management of fisheries resources in the region. Similar recommendations have also been emphasized in recent studies on environmental parasitology and freshwater ecosystem health (Sures et al., 2023; Selbach et al., 2024).

5. Conclusion

The present study confirms moderate helminth

prevalence (37.6%) in fishes of Kelzar Dam. Monsoon season and carnivorous feeding habits emerged as major risk factors. The intestinal region serves as the primary infection site. These findings provide baseline data for future fish health monitoring and sustainable reservoir fisheries management in Maharashtra. Long-term monitoring of hosts and their parasites is recommended to better understand their interaction with changing environmental conditions. The findings of the present study provide useful baseline information for future monitoring of fish parasites and support sustainable fisheries management in freshwater reservoirs of Maharashtra.

6. Statements and Declarations

Ethical Approval: Fish collection, handling, and parasitological examination were carried out following standard ethical guidelines for fish research. No endangered or protected fish species were used during the present investigation.

Conflict of Interest: The authors declare that they have no conflict of interest.

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