Life cycle of protozoan parasites infecting Labeo Rohita and Cirrhinus Mrigala in freshwater bodies of India

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Abstract

This systematic review was done to understand the life cycle and diversity of protozoan parasites infecting Labeorohita and Cirrhinusmrigala in Indian freshwater systems. A structured search was done using keywords across Google Scholar, PubMed, Web of Science, and other databases. Six studies were selected between 2010 and 2025. The findings showed common parasites like Myxobolus, Thelohanellus, Trichodina, and Ichthyophthirius, which infect gills, fins, skin, and internal parts. Life cycle stages such as spore formation, tissue tropism, and seasonal activity were discussed. Environmental factors, host size, sex and species influenced infection. The review gives useful insight on parasite development, host-parasite interaction, and helps in disease control and healthy aquaculture planning in India.

Introduction:

Indian freshwater aquaculture is one of the main drivers of inland fish production within the country and species of Labeorohita (rohu) and Cirrhinusmrigala (mrigal) form the core of Indian carp culture (Jayasankar et al., 2019). The species is highly preferred due to fast growth rate, adaptability and market demand in the vast areas of the country (Jayasankar, 2018). The productivity of carp aquiculture continues to be threatened due to numerous health-related issues and among them parasitic diseases caused by protozoan remain most dominant. The protozoan parasites not only inhibit the growth and survival of fish but also entail vast economical losses due to the prevalence of the disease (Patil et al., 2025).

Infection from protozoans such as Myxobolus, Thelohanellus, Trichodina, and Ichthyophthirius has been fairly prevalent in the Indian freshwater systems (Saha and Bandyopadhyay, 2016). The parasites infect mainly organs such as gills, skin, fins and intestine of the fish and affect the physiology of the fish as a whole. Analysis of the complete life cycle of the parasites is crucial as it offers information on the crucial stages of infection, transmission and the right intervention measures (Ziarati et al., 2022). The present research on the topic remains scattered and meager with minimal focus on the complete lifecycle components in specific fish hosts such as L. rohita and C. mrigala.

The aim of this paper is to analyse life cycle of protozoan parasites infecting Labeo Rohita and CirrhinusMrigala in freshwater bodies of India.

This systematic review will collect and synthesise existing scientific articles on the life

cycle of protozoan parasites infecting Labeorohita and Cirrhinusmrigala from the Indian freshwater systems. It will also highlight the identification of the species of the parasites, the infection patterns, seasonality and the environment that leads to the growth of the parasites. By reviewing articles that have been written from the various regions of India, the paper will try to show common outcomes and significant gaps for further research.

This is important in fish health management as biological information on parasites guides effective disease control measures in aquaculture. The information further guides the planning for preventive measures like pond sanitation, water quality management, and seasonality-specific treatments. The review will employ a systematic literature review methodology to consider credible and relevant research from peer-reviewed articles and research datasets.

Methodology

This systematic review was devised to gather and analyze published work on protozoan parasites infecting Labeorohita and Cirrhinusmrigala from the freshwater bodies of India. Systematic search procedures were employed to find the most relevant and scientifically credible studies.

Searching was conducted on various databases such as Google Scholar, PubMed, Web of Science, ResearchGate, and INFLIBNET, with various keyword combinations such as the following: “Labeorohita”, “Cirrhinusmrigala”, “protozoan parasites”, “life cycle”, “Myxobolus”, “Trichodina”, “Ichthyophthirius

Inclusion criteria were:

Studies published between 2010 and 2025

Focus on freshwater environments within India

Research involving protozoan parasites infecting L. rohita or C. mrigala

Data on infection sites, life cycle stages, transmission patterns, or seasonal trends

Exclusion criteria included:

Studies focusing on marine or brackish water species

Lack of clear host identification

Reviews without primary data

A preliminary the search produced several articles. After screening titles and abstracts, 9 studies were shortlisted. Through a review of the full text, six studies met all the inclusion criteria. Major data extracted from the studies covered the author(s), year of publication, place of study, species of hosts, parasitic species identified, infection localities, research design or methodology, life cycle information, and principal results. To capture patterns and commonalities and gaps in the literature, a descriptive and thematic analysis was conducted and used as the foundation for the discussion and thematic structure of the review.

Systematic Literature Review

Summary Table

Author(s)	Study Title	Methodology	Region	Host Species	Parasite(s) Identified	Key Findings	Relevance to Topic
Kaur (2014)	*Myxozoan Infestation in Freshwater Fishes in Wetlands and Aquaculture in Punjab*	Field survey, morphological identification	Punjab (Harike, Kanjali, Ropar wetlands; aquaculture ponds)	*Labeorohita*, *Cirrhinusmrigala*	*Myxobolus spp.*, *Thelohanellus spp.*	L. rohita was infested with 18 species; C. mrigala with 14. Infection rate: 34.71% in wetlands, 26.28% in aquaculture. Gills, fins, gut were common sites.	Confirms high protozoan parasite diversity in both species; essential for taxonomy, host susceptibility, and life cycle studies.
Sanyal, Mukherjee and Dash (2018)	*Isolation and Identification of Different Parasites from Indian Major Carps and Exotic Carps*	Microscopy, histopathology, PCR (18S rRNA gene)	South 24-Parganas, West Bengal	*Labeorohita*, *Cirrhinusmrigala*	*Thelohanellusbifurcata*, *Myxobolusbhadrensis*, *Trichodina*, *Pisicola*, *Argulus*, *Gregarine*	Year-round parasite presence in gills, skin, kidneys; mixed infections common. Molecular ID confirmed Myxosporean species.	Provides detailed parasite identification methods and confirms mixed infections; important for understanding developmental stages and diagnostics.
Ramuduand **Dash (2014)**	*Prevalence, Morphology and Scanning Electron Microscopy of Myxozoan Parasites*	SEM, morphometry, field prevalence study	Garia, West Bengal	*Labeorohita*, *Cirrhinusmrigala*	*Myxobolusorissae*, *M. carnaticus*, *Thelohanellus caudatus*	51.6% infection rate. Parasites mostly in gills and fins. Rainy season showed higher infestation due to water quality and stress.	Morphological and SEM features give insight into development; seasonality links to environmental influence on life cycle.
Kamal, Singh and Suman (2024)	*Measurement of Infection Intensity of Microsporidi*	Visual inspection, Giemsa staining,	Lucknow, Uttar Pradesh	*Labeorohita*	Microsporidia (unclassified)	Higher infection in males (36%) vs	Establishes seasonal and sex-based

	an Parasite in Labeorohita	light microscopy				females (28%). Monsoon infection (39%) higher than winter (32%). Affected organs: gills, gonads, liver.	susceptibility and pathology, relevant to host factors and infection dynamics.
Majumder, Panda and Bandyopadhyay (2013)	*Effect of Temperature on the Prevalence of Different Parasites in Cirrhinusmrigala*	Seasonal sampling, microscopy	West Bengal	*Cirrhinusmrigala*	*Myxobolus*, *Thelohanellus*, *Henneguya*, *Trichodina*, *Ichthyophthirius*, *Dactylogyrus*, *Gyrodactylus*, *Ergasilus*, *Argulus*	High prevalence of Myxozoa and Monogenea during cooler months (Jan–April). Ciliates more common in winter.	Demonstrates temperature's role in parasite life cycles; essential for modelling seasonal prevalence in natural systems.
Vijaysundardeva et al. (2018)	*Histopathological Studies on Protozoan Parasites of IMCs*	Wet mount prep, histopathology, morphometric analysis	Tamil Nadu	*Labeorohita*	*Myxoboluspfeifferi*, *M. mehlhorni*, *M. rohitae*, *Thelohanellusrohitae*	Parasites found mainly in gills and fins; spores showed distinct size and shape. Histopathology revealed necrosis, plasmodia in tissue.	Highlights parasite-induced tissue damage and spore morphology; supports understanding of life cycle stages and host-parasite interaction.

Diversity and Taxonomy of Protozoan Parasites

Diversity of protozoan parasites infecting Labeorohita and Cirrhinusmrigala is clear from the various studies unveiling tremendous numbers of species and genera infecting the various organs. One of the remarkable works on the report of various species of protozoan from the phyla Myxozoa and Ciliophora in Cirrhinusmrigala was conducted by Majumder, Panda and Bandyopadhyay (2013). Myxobolus, Thelohanellus, and Henneguya species existed among others. Myxobolus was the most dominant species. Ciliophorans like Trichodina, Tripartiella, and Ichthyophthiriusmultifiliis also existed and occurred the most during the colder months of the year with the existence of seasonality in the variety of parasites. Besides, the work on

Kamal, Singh and Suman (2024) involved microsporidian parasites infecting Labeorohita. These are unicellular and intracellular organisms previously lumped together with the protozoa. The spores were ovo-cylindrical in appearance and contained polar filaments and vacuoles just like

Ovipleistophoramirandellae and Pleistophoralongifilis. Although the genus was never specified through the absence of the molecular test, the morphology corresponds to identified species of microsporidian.

Furthermore, Ramudu and Dash (2014) documented Myxobolusorissae, M. carnaticus, and Thelohanellus caudatus in L. rohita and C. mrigala. The spores possessed distinctive sizes and forms. T. caudatus spores, for instance, were pear-shaped (12.84 × 8.5 µm), and two-polar-capsulated 17.25 × 6.70 µm spores belonged to the species M. orissae. The information aids species-level identification.

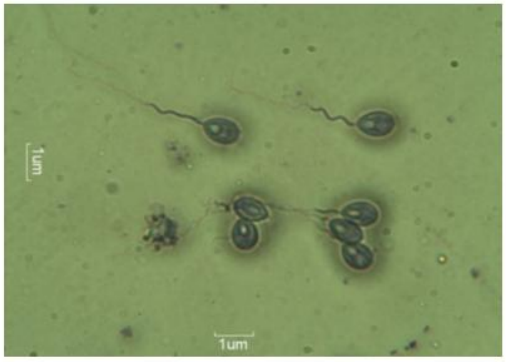


Figure 1Thelohanellus caudatus collected from the fins of Labeorohita

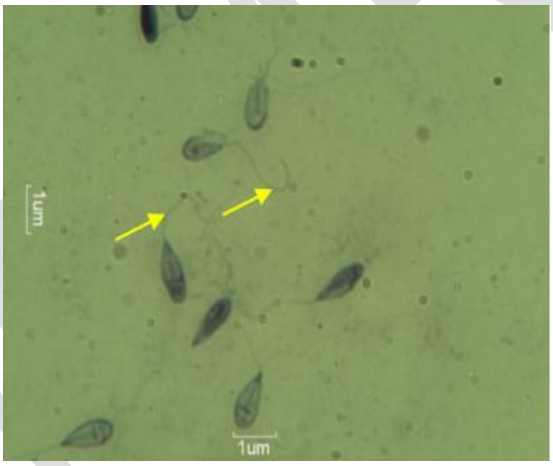


Figure 2Myxobolus orissae with distinct polar filament (arrows) in the gills of Cirrhinusmrigala

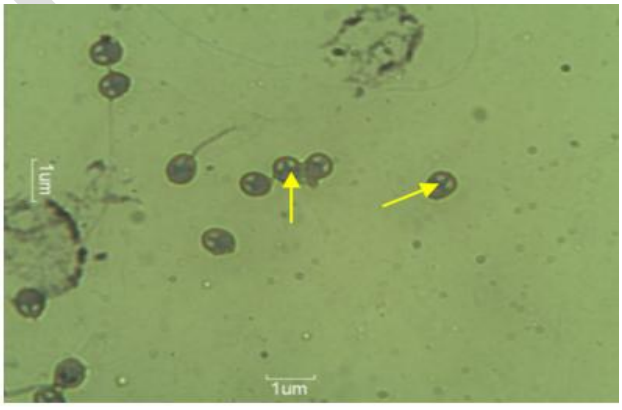


Figure 3Myxobolus carnaticus with distinct polar capsule (arrows) in the gills, fins of Cirrhinusmrigala

In addition, Sanyal et al. (2018) identified Myxobolusbhadrensis, Thelohanellusbifurcata, and Trichodina in L. rohita and Myxobolus in C. mrigala. Spores of the species M. bhadrensis were 10.75 × 6.36 µm in size, and T. bifurcata possessed. 18 species of myxozoans in L. rohita and 14 species in C. mrigala from Punjab were listed by Kaur (2014) in one of the most comprehensive studies. Parasites occurred in various tissues like gills, nasal cavity, and gall bladder.

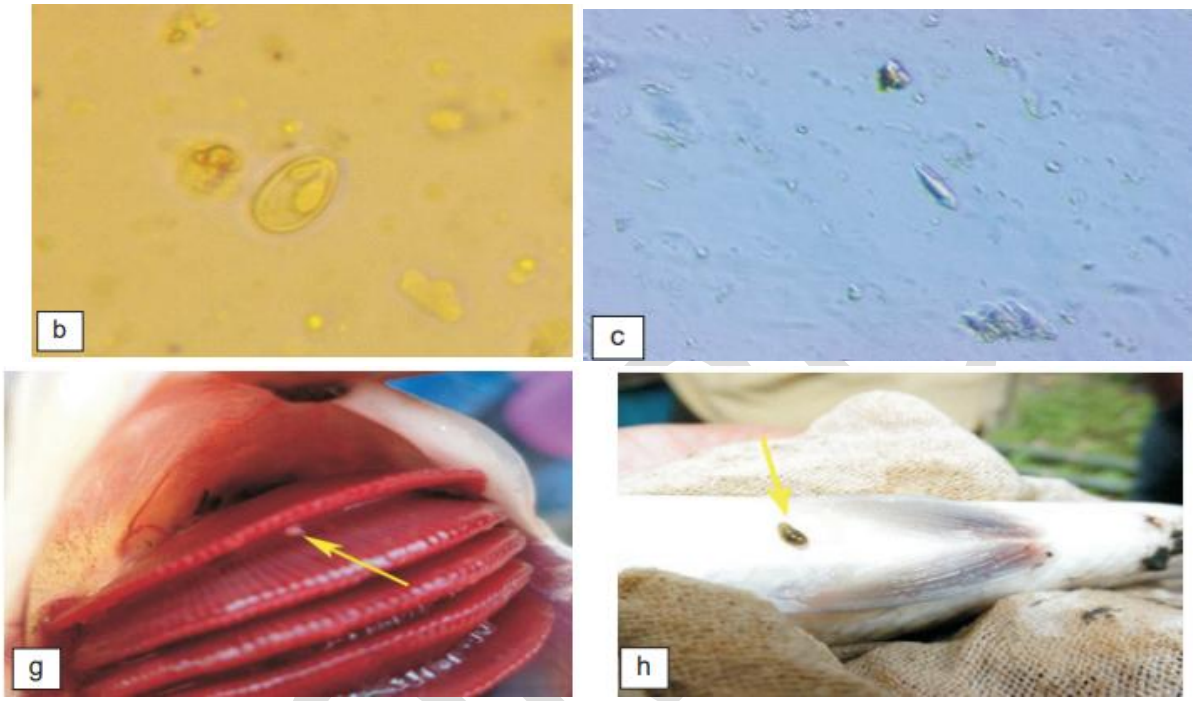


Figure 4Myxobolus bhadrensis isolated from kidney of Labeorohita (B), Thelohanellus sp. isolated from gill of Labeorohita (C), Myxobolus sp. cyst attached in gill (G) &Argulus sp. attached on body of Labeorohita (H)

Thirdly, Vijaysundardeva et al. (2018) recorded three species of Myxobolus infecting the gills, muscles, and kidneys of L. rohita. This concludes that the infections being tissue-specific also belong to their taxonomy. These findings prudently indicate clear evidence of the diversity of protozoans in Indian freshwater fish.

Life Cycle Patterns and Developmental Stages

Information on the life cycle of protozoan parasites is very important in the control of transmission in Labeorohita and Cirrhinusmrigala. Most research offers informative content on the mode of growth and maturation of the parasites in the fish host. Kamal, Singh and Suman (2024) outlined the life cycle of microsporidia from the works of Ishihara from 1969. Microsporidia develop and mature in the cells of the fish as meronts and sporonts and then develop spores in a single host. Spores were found in organs like gills, liver, gonads, and even the brain. Since microsporidia do not need a second host on which to grow and reproduce, the life cycle is direct and is fulfilled entirely in the infected fish. Also, Ramudu and Dash (2014) found that the parasitic infection was most dominant during the time of the rainy season. Even though they didn't depict the appearance of

complete life cycle stages, the production of spores was observed in histozoic tissues like fins and gills, suggesting that maturation happens in specific organs. Also, they indicated that the rainy season is stressful to fish and perhaps increases the accessibility of the intermediate hosts and promotes the growth and spread of parasites like Myxobolus and Thelohanellus.

Additionally, Sanyal, Mukherjee and Dash (2018) cited plasmodia in kidneys and gills and showed spores matured in the host organs. The prevalence of cysts and mixed infections, especially in polyculture and sewage-fed systems, suggests that substandard water quality fosters the growth and completion of the parasites' life. They did not show the entire life cycles, but the evidence of sporulation and tissue damages proves important stages of the life within the fish. In addition, Vijaysundardeva et al. (2018) observed Myxobolusrohitae spores in gills covered with immune cells and revealed that infection causes inflammation of the cells. Also, this suggests the development of the parasites from plasmodia to mature spores within the host tissues. The histopathological evidence from the research proves the completion of important stages like spore formation within the host and validates our knowledge on the multiplication and existence of the parasites.

Environmental and Seasonal Influences on Infection

Environmental and seasonal parameters play an important role in the infection pattern of the protozoan parasites of Labeorohita and Cirrhinusmrigala. Several studies disclosed the effect of temperature, rainfall and pollution of the water and the habitat type on the growth and transmission of the parasites. Parasites such as Myxobolus and Thelohanellus proved most active and most infections occurred during the periods November and April by Majumder et al. (2013) in the species C. mrigala. Infection occurred most during the winter months like January and February when the water temperature was between 19°C and 26°C. Conversely, during the monsoon season (July-August), with the higher temperature, less infection occurred. This suggests optimum temperature aids the growth of parasites and higher temperature suppresses them or makes them inactive.

However, Kamal, Singh and Suman (2024) observed the opposite trend for microsporidia of L. rohita. They observed higher infection in monsoon (39%) than winter (32.25%). They attributed the reason that the environment components like temperature and humidity and also poor water quality might be favouring the infection of microsporidia during the rainy season. This implies that all the protozoans do not respond equally against the season. Besides, Ramudu and Dash (2014) also observed the rainy season (July-September) as most dangerous for the infection of myxozoan. They said that during the season, the quality of the water degrades and the fish get weak from the stress. These help the growth and transmission of the parasites more rapidly. Besides, the intermediate hosts might be present in abundance during the season and support the life cycle of the parasites.

Additionally, Sanyal, Mukherjee and Dash (2018) discovered that sewage-fed water and filthy fish farms had more parasites. Dirty waters holding organic materials offer good habitats for parasites to inhabit and reproduce. Poor farming practices and climate also added infections, mostly in the overcrowded systems. Kaur (2014) discovered that the natural wetlands had higher parasite than the aquaculture ponds. The fish from the Kanjali wetlands exhibited the greatest infestation. This suggests that the various water body and

its condition have the potential to affect the level of infection the fish obtain. The above studies clearly show that the environment and season characteristics play a significant role in the parasitic infections among the Indian freshwater fish.

Host-Specificity and Susceptibility Factors

Understanding host-specificity is important when studying protozoan parasites in Labeorohita and Cirrhinusmrigala, because it shows which fish are more likely to get infected and how badly. Different studies explain the role of fish species, size, sex, and immunity on parasitic infections. In Kaur's (2014) research work, Labeorohita was very susceptible and became infected with 18 species of myxozoans and Cirrhinusmrigala with 14 species. This displays the susceptibility of L. rohita and possibly the condition or environment of its immune system. Parasites co-existed in differing body parts like the gills, fins, and intestines and signify the level to which they affect the fish.

Apart from this, Kamal, Singh and Suman (2024) also noticed L. rohita and the males were more infected (36%) than females (28.25%). The authors highlighted that it possibly due to hormonal or differences in the immune system. Parasites noticed in the liver, kidney, gonads, brain and gills and clinical signs like white spots on the gills and discoloration disclosed the impact of the parasite took place on a large scale on the body.

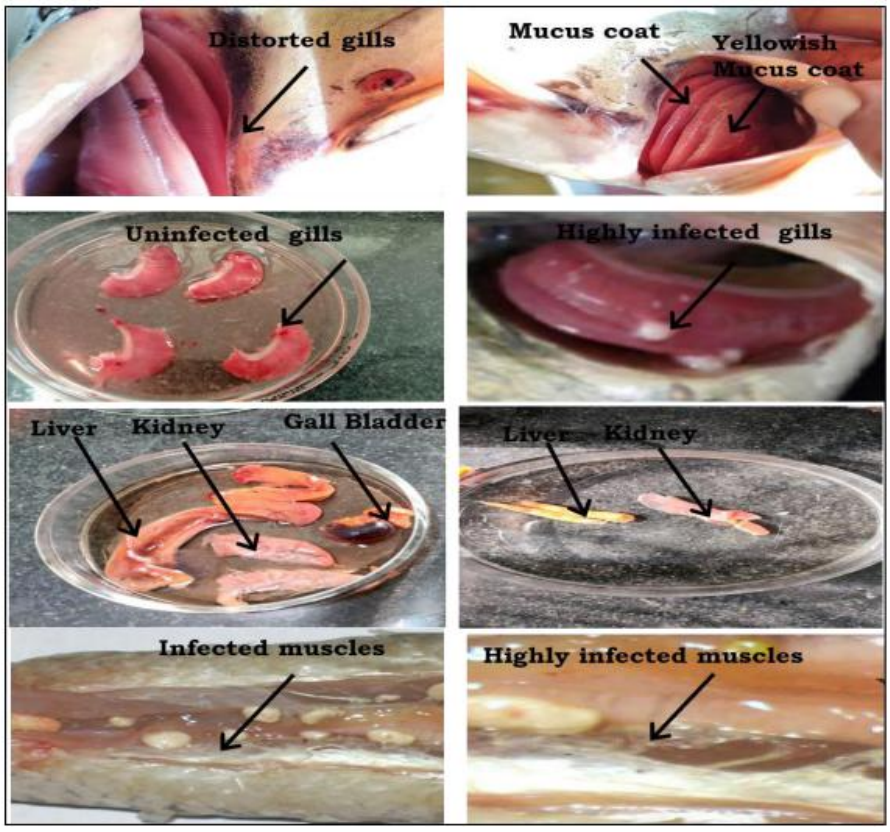


Figure 5Dissected organs of Labeorohita for the visual inspection of microsporidian intensity

Ramudu and Dash (2014) found L. rohita and C. mrigala infected, but smaller fish (32g) and medium fish (62g) were more infected than larger fish. This is likely due to tiny fish having poor immunity. Parasites mostly appeared from the gills and fins, disclosing the preference of parasites to body surface parts.

Infection level was rated from 0.5 to 2 based on the intensity of severity fish were infected.

Majumder, Panda and Bandyopadhyay (2013) noticed C. mrigalaand found extreme infection in colder seasons. Parasites mainly targeted gills and skin, and whitish spots and sluggish fish behaviour were observed as initial symptoms of disease. This suggests C. mrigala is equally vulnerable during certain seasons. Also, Vijaysundardeva et al. (2018) also confirmed L. rohita as the host of Myxobolusrohitae infecting gill filaments. Inflammatory reaction around spores was also noticed by them, suggesting the fish body responds to parasitic attack. This supports the indication that certain species of fish like Labeorohita are vulnerable to specific protozoan parasites. This confirms tissues and species-specific disease do exist in Indian major carps.

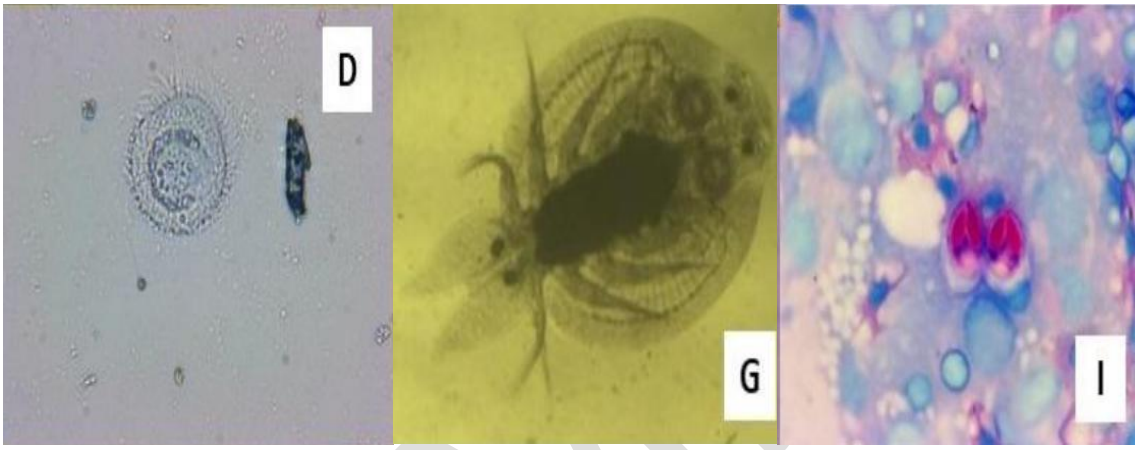


Figure 6G- Trichodinasp.withciliapresentinthegillsofLabeorohita (D) Argulus sp. present inLabeorohita (G) and Myxobolus sp. present on the gills of Cirrhinusmrigala

Diagnostic Techniques and Parasite Identification

Different studies used various diagnostic methods to identify protozoan parasites from Labeorohita and Cirrhinusmrigala. Kamal, Singh and Suman (2024) used light microscopy and Giemsa staining to study microsporidian spores. Two spore forms of different sizes and dark blue polar filaments were observed but the species remained undetermined as no PCR test was performed.

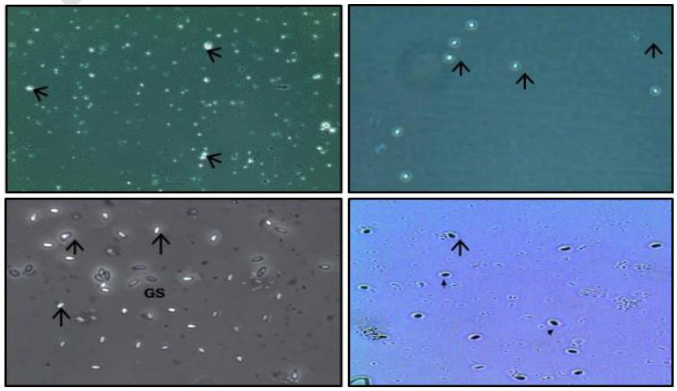


Figure 7 Light microscopy and Giemsa stain observation of microsporidian infection intensity in Labeorohita.

Ramudu and Dash (2014) used Scanning Electron Microscopy (SEM), and clear images of the spore surface material enabled the identification of three Myxozoa species precisely. Sanyal, Mukherjee and Dash (2018) combined the use of wet mounts, morphometric research, histopathology and PCR to identify parasites like Myxobolusbhadrensis. The PCR test yielded a 1.6 kb band and the amplicon was deposited in NCBI. Extensive damage of the kidney and gill tissues was observed from histopathology. Kaur (2014) asserted that Punjab still suffers from improper diagnostic work and insisted on the use of morphology and molecular instruments simultaneously. Vijaysundardeva et al. (2018) also used histopathology and found clear Myxobolus infection characteristics and enabled species identification and tissue damage in fish.

Discussion

This review brings together different relevant studies that have aided in the comprehension of the life cycle and infection pattern of protozoan infection in Labeorohita and Cirrhinusmrigala reared in Indian freshwater aquaculture. The studies clearly show the existence of extensive diversity of protozoan parasites comprising dominant genera like Myxobolus, Thelohanellus, Trichodina, and Ichthyophthirius. The parasites affect principal body parts like gills, skin, fins and even internal body parts like liver and kidney and generally lead to the deterioration of tissues and the decline of fish health.A recurring pattern of all the studies was the overriding effect of environment and season. Rainy season and cool months also tended to elevate levels of infection, almost certainly due to alterations in water quality and stress imposed on the host. Infections tended to be higher during the monsoon or winter season in most species' studies. This implies temperature and rainfall and water pollution all contribute large role in the survival and transmission of parasites.

Research also uncovered the impact of the host factors on infection. Smaller males and smaller fish became increasingly infected perhaps owing to weaker immunity. Labeorohita was more vulnerable than Cirrhinusmrigala in several cases with greater numbers of species infecting the former. This implies host-specific relationships between the fish and the parasite.From the diagnostic point of view, the use of various methodologies like light microscopy, SEM, histology and also molecular procedures like PCR contributed towards the improvement of species-level identification. Multi-diagnostic tool-assisted studies yielded more credible results and also indicated the establishment of parasites in fish tissues.

While very few documented the entire life cycle, the majority offered significant insights on developmental stages like sporulation, tropism to tissues, and infection routes. As a body of work, such information lends appreciable support to the objective of the review. The information is useful in informing the efficient control of the disease and sustainable practices during aquaculture.

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Conclusion

This systematic review enabled the comprehension of the life cycle, diversity and infection pattern of the protozoan parasites infesting Labeorohita and Cirrhinusmrigala in the freshwater habitats of India. Parasites like Myxobolus, Thelohanellus, Trichodina and Ichthyophthirius have been observed to be prevalent and infect major organs of the fish like gills, fins, skin and even internal organs. Seasonal variation and water parameters like temperature and rainfall have also been observed to influence the extent of infection with higher numbers during winter and during the monsoon. The host parameters also played a role and these included fish species, size and sex and Labeorohita was the most infected in most cases.

Molecular techniques and histopathology and SEM that were applied as the diagnostic tools facilitated the identification of the parasites with accuracy. Although the data on the complete life cycle proved incomplete in some cases, the review suggests the principal developmental insights and infection trends that provide invaluable data on the parasites' biology. The findings also facilitate the researchers and fish farmers to plan in a better manner control and treatment measures that are essential for healthy and successful fish farming in India.

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