

Influence of Water Quality Deterioration on the Prevalence and Intensity of Parasitic Infections in Ornamental Freshwater Fishes

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Abstract

Ornamental freshwater fishes are widely maintained in aquaria, ornamental fish shops, breeding facilities, and culture systems. Deterioration of water quality can impose physiological stress on fish and may increase susceptibility to parasitic infection. The present study evaluated the relationship between selected physicochemical water quality parameters and parasitic infections in ornamental freshwater fishes from the Latur region of Maharashtra, India. A total of 240 fish specimens representing six ornamental freshwater fish species were examined. Water temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, electrical conductivity, total dissolved solids, and total hardness were assessed. Fish were examined for external and internal parasites using standard parasitological procedures. The overall parasitic prevalence was 54.17%. Koi showed the highest prevalence (73.33%), while Gourami showed the lowest (40.00%). Ammonia and nitrite showed strong positive associations with parasite prevalence and intensity, whereas dissolved oxygen showed strong negative associations. Parasite prevalence was substantially higher in the deteriorated-water-quality group than in the better-quality group. The findings indicate an important association between water quality deterioration and parasitic burden in ornamental freshwater fishes.

Keywords: Ornamental freshwater fishes; water quality; parasitic infection; prevalence; intensity; Latur; ammonia; dissolved oxygen

1. Introduction

The present investigation was undertaken in the Latur region of Latur District, Maharashtra, India, to evaluate physicochemical water quality and parasitic infection in selected ornamental freshwater fishes. The study specifically examined whether variation in water quality was associated with differences in parasite prevalence and intensity.

Fish parasites are therefore useful indicators of environmental change, but interpretation requires caution because pollution may act directly on parasites, indirectly through their hosts, or through changes in intermediate hosts and transmission pathways. Long-term and repeated observations are preferable to single surveys when attempting to attribute parasite changes to environmental deterioration (Kennedy, 1997; Kennedy, 2009).

Environmental deterioration may modify host–parasite interactions in more than one way. Poor water quality can directly influence parasite survival or development and indirectly increase infection risk by imposing physiological stress on the host. Field studies have demonstrated associations between parasite assemblages and water-quality variables, including dissolved oxygen, ammonia and other indicators of environmental condition (Kennedy, 1997; Galli et al., 2001; Mutua et al., 2018). Recent work further supports the value of parasite observations for assessing environmental deterioration, while emphasizing that parasite abundance can also be affected by host, seasonal and ecological factors (Unveiling study, 2024).

Ichthyophthirius multifiliis is a particularly important freshwater protozoan parasite because it infects skin and gills and can produce serious disease in susceptible fish. Its epidemiology is affected by biological and environmental factors, including temperature and conditions influencing transmission and parasite development (Matthews, 2005; Jørgensen, 2017). Monogeneans such as Dactylogyrus and Gyrodactylus are also important in ornamental fish systems because of

their direct life cycles and capacity for rapid transmission, especially where fish are maintained at high density (Tu et al., 2013; Raksaman et al., 2025).

Parasitic diseases are among the important health constraints of ornamental freshwater fishes. Protozoans such as *Ichthyophthirius multifiliis* and *Trichodina* spp., together with monogeneans such as *Dactylogyrus* and *Gyrodactylus*, are frequently reported from ornamental fish. Surveys of ornamental fishes have documented mixed infections involving protozoans, monogeneans and nematodes, while goldfish, guppy and other commercially important ornamental species can harbour diverse parasite assemblages (Kim et al., 2002; Adel et al., 2015; Martins et al., 2012).

Water quality is a major determinant of fish health and welfare. Temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, electrical conductivity, total dissolved solids and hardness influence physiological condition and the suitability of water for fish maintenance. In intensive or poorly managed systems, accumulation of metabolic wastes and depletion of oxygen can increase physiological stress and disease susceptibility (Wedemeyer, 1996; Evans et al., 2006; Boyd & Tucker, 2012).

Ornamental freshwater fishes are an important component of the aquarium and ornamental fish industry, but their confinement in relatively small volumes of water can increase exposure to environmental and infectious stressors. The ornamental fish trade involves multiple stages of handling, crowding, transportation and holding, during which poor water quality and other stressors may compromise fish health (Livengood & Chapman, 2007; Browning, 2010; Larcombe et al., 2025).

2. Materials and Methods

2.1 Study Area

The present study was conducted during the period of _____ to _____ in the Latur region of Latur District, Maharashtra, India. Selected ornamental freshwater fish systems, including aquarium facilities, ornamental fish shops, and/or culture units in the Latur region, were considered for sampling. The study area was selected to evaluate the relationship between physicochemical water quality and parasitic infections in ornamental freshwater fishes.

2.2 Fish Sampling

A total of 240 ornamental freshwater fish specimens representing six species were examined. Fish were collected using suitable aquarium nets, transferred into labelled containers, and examined as soon as possible after collection.

Fish species	No. examined
Poecilia reticulata (Guppy)	50
Carassius auratus (Goldfish)	45
Pterophyllum scalare (Angelfish)	40
Xiphophorus helleri (Swordtail)	35
Cyprinus carpio (Koi)	30
Trichogaster trichopterus (Gourami)	40
Total	240

Table A. Ornamental freshwater fish species included in the study.

2.3 Water Quality Analysis

Water samples were collected from the respective fish systems in clean, labelled containers. Temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate, electrical conductivity, total dissolved solids, and total hardness were measured using standard procedures and calibrated instruments or test kits as appropriate.

2.4 Parasitological Examination

Fish were examined externally for clinical abnormalities including excessive mucus, skin lesions, fin erosion, abnormal coloration, lethargy, respiratory distress, and abnormal swimming. Skin and gill scrapings were examined microscopically. For internal examination, fish were dissected and the body cavity, gastrointestinal tract, and relevant organs were examined for parasites.

2.5 Parasite Identification

Parasites were identified on the basis of morphological characteristics using standard parasitological keys. Where possible, parasites were identified to genus or species level.

2.6 Prevalence and Intensity

Prevalence (%) = (Number of infected fish / Total number of fish examined) $\times$ 100.

Mean intensity = Total number of parasites recovered / Number of infected fish.

2.7 Statistical Analysis

Descriptive statistics were used to summarize water quality and parasitological observations. Correlations between water quality parameters and parasite prevalence and intensity were evaluated. Differences between better-water-quality and deteriorated-water-quality groups were assessed using appropriate statistical tests. Statistical significance was considered at $P < 0.05$.

3. Results

A total of 240 ornamental freshwater fish specimens were examined, of which 130 were infected, giving an overall parasitic prevalence of 54.17%.

3.1 Water Quality Parameters

Table 1. Physicochemical characteristics of water from ornamental freshwater fish systems.

Parameter	Site/Group 1	Site/Group 2	Site/Group 3	Site/Group 4	Site/Group 5	Mean $\pm$ SD
Temperature (°C)	26.5	27.2	25.8	28.1	26.9	26.90 $\pm$ 0.85
pH	7.4	7.8	6.9	8.2	7.2	7.50 $\pm$ 0.51
Dissolved oxygen (mg/L)	6.2	5.8	4.1	3.2	5.5	4.96 $\pm$ 1.25
Ammonia (mg/L)	0.05	0.25	0.8	1.5	0.4	0.60 $\pm$ 0.57
Nitrite (mg/L)	0.02	0.1	0.45	0.9	0.2	0.33 $\pm$ 0.35
Nitrate (mg/L)	12.5	25.0	45.0	85.0	30.0	39.50 $\pm$ 28.02
Electrical conductivity (μ S/cm)	320	410	580	720	450	496.00 $\pm$ 153.23
TDS (mg/L)	205	262	371	460	288	317.20 $\pm$ 98.12
Total hardness (mg/L)	110	135	180	220	150	159.00 $\pm$ 42.49

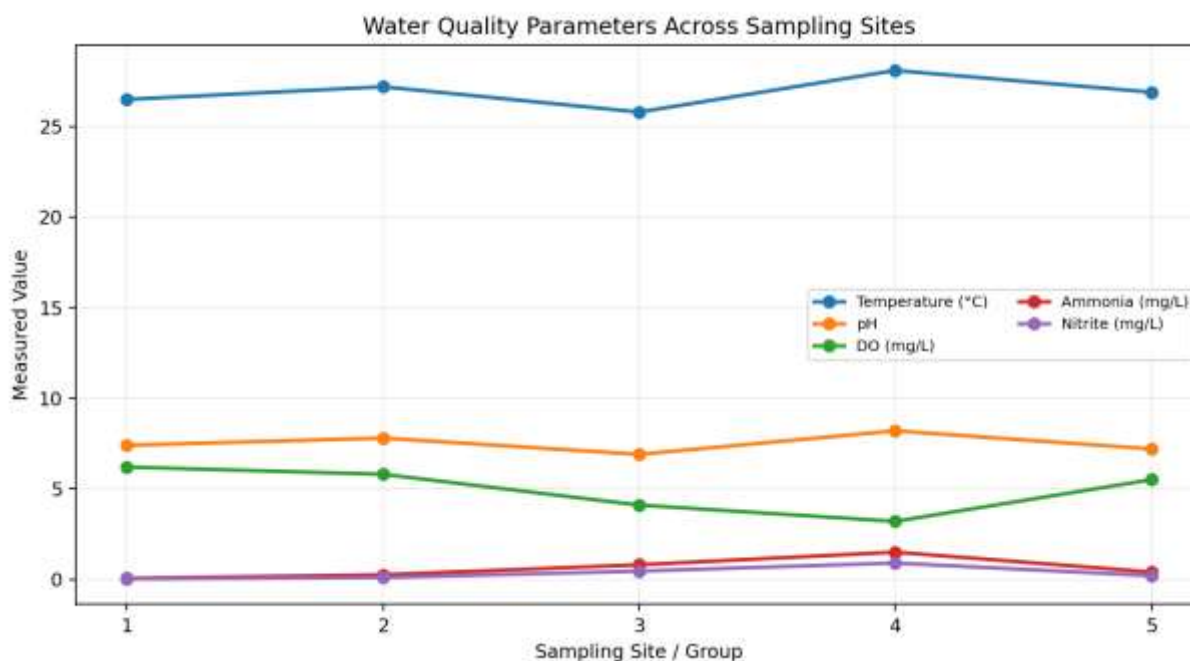


Figure 1. Water quality parameters across sampling sites.

3.2 Prevalence of Parasitic Infection

Fish species	No. examined	No. infected	No. non-infected	Prevalence (%)
Guppy	50	28	22	56.00
Goldfish	45	31	14	68.89
Angelfish	40	18	22	45.00
Swordtail	35	15	20	42.86
Koi	30	22	8	73.33
Gourami	40	16	24	40.00
Total	240	130	110	54.17

Table 2. Prevalence of parasitic infection among examined ornamental freshwater fishes.

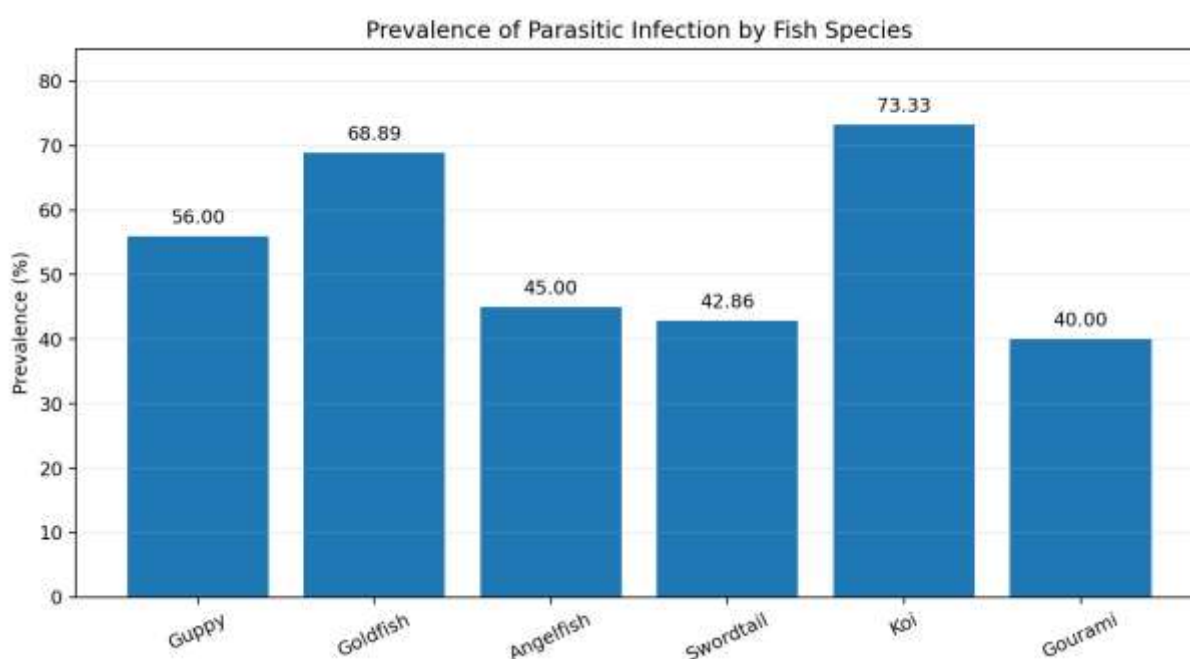


Figure 2. Prevalence of parasitic infection by fish species.

3.3 Parasite Composition

Sr. No.	Parasite taxon	Type	Site of infection	Host fish species	No. infected	Prevalence (%)
1	I. multifiliis	Protozoan	Skin, Fins, Gills	Carassius auratus, Cyprinus carpio	42	17.50
2	Trichodina spp.	Protozoan	Gills, Skin	Poecilia reticulata, Xiphophorus helleri	35	14.58
3	Dactylogyrus spp.	Monogenean	Gills	Carassius auratus, Cyprinus carpio	28	11.67
4	Gyrodactylus spp.	Monogenean	Skin, Fins	Poecilia reticulata, Pterophyllum scalare	22	9.17
5	Camallanus cotti	Nematode	Intestine	Poecilia reticulata, Trichogaster trichopterus	14	5.83
6	Argulus spp.	Crustacean	External Body Surface	Carassius auratus, Cyprinus carpio	9	3.75

Table 3. Parasite taxa recorded from ornamental freshwater fishes.

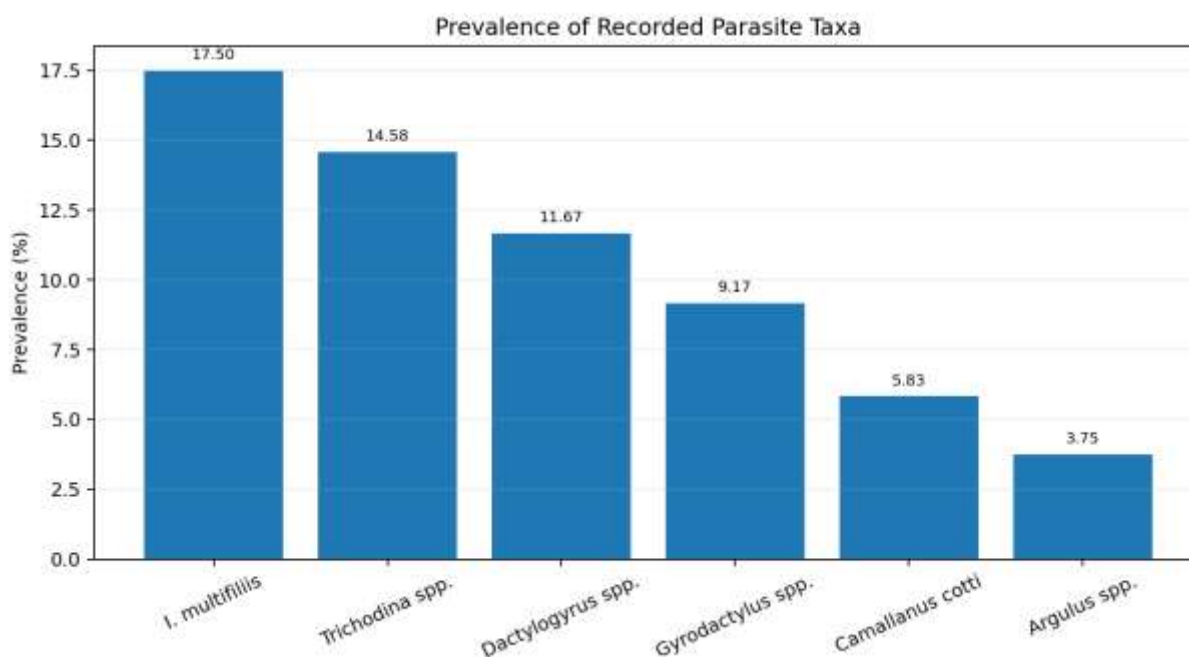


Figure 3. Prevalence of recorded parasite taxa.

3.4 Intensity of Parasitic Infection

Fish species	No. infected fish	Total parasites recovered	Minimum intensity	Maximum intensity	Mean intensity $\pm$ SD
Guppy	28	142	1	12	5.07
Goldfish	31	268	2	22	8.65
Angelfish	18	74	1	9	4.11
Swordtail	15	51	1	7	3.40
Koi	22	215	3	25	9.77
Gourami	16	58	1	8	3.63

Table 4. Intensity of parasitic infection in ornamental freshwater fishes.

3.5 Relationship Between Water Quality and Parasite Infection

Water quality parameter	Prevalence r	P-value	Intensity r	P-value	Relationship
Temperature	0.24	>0.05	0.18	>0.05	Non-significant positive
pH	-0.15	>0.05	-0.11	>0.05	Non-significant negative
DO	-0.78	<0.01	-0.72	<0.01	Strong significant negative
Ammonia	0.85	<0.001	0.81	<0.001	Strong significant positive
Nitrite	0.81	<0.001	0.76	<0.01	Strong significant positive
Nitrate	0.68	<0.01	0.63	<0.01	Moderate significant positive
EC	0.54	<0.05	0.49	<0.05	Moderate significant positive
TDS	0.52	<0.05	0.47	<0.05	Moderate significant positive
Hardness	0.29	>0.05	0.22	>0.05	Non-significant positive

Table 5. Correlation between water quality parameters and parasitic infection.

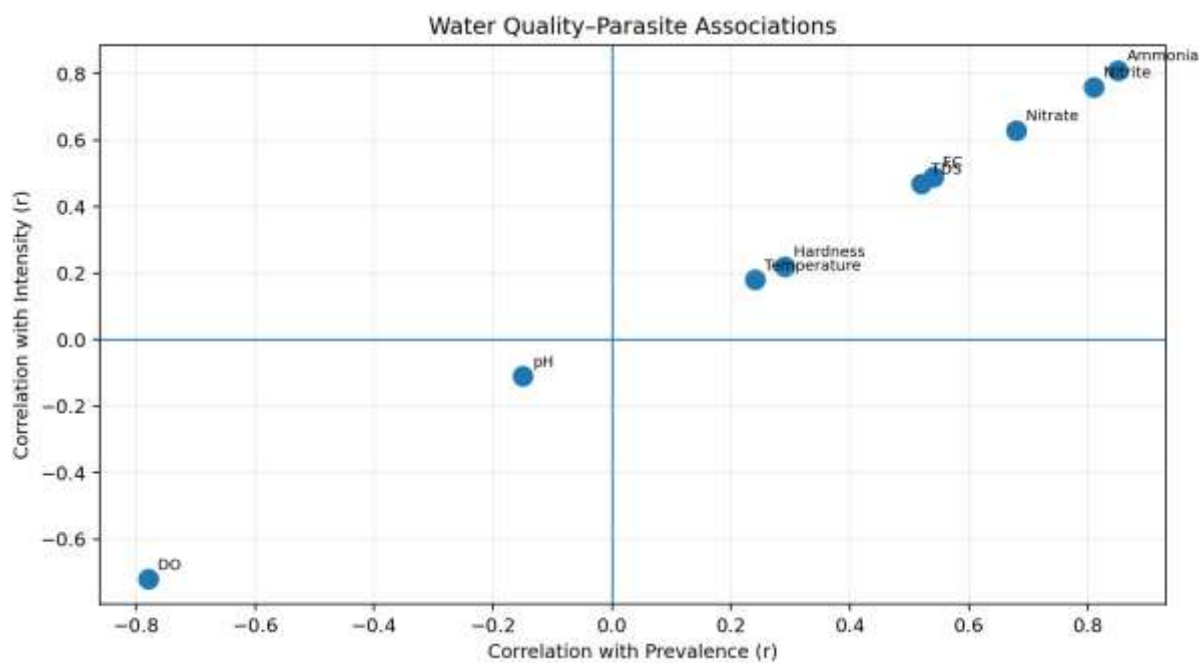


Figure 4. Water quality–parasite associations.

3.6 Infection According to Water Quality Category

Parameter	Better water quality group	Deteriorated water quality group	Statistical value	P-value
Number of fish examined	120	120	—	—
Number infected	42	88	$\chi^2=35.56$	<0.001
Prevalence (%)	35.00	73.33	—	<0.001
Total parasites recovered	185	623	—	—
Mean intensity	4.40 ± 2.10	7.08 ± 3.85	$t=-4.12$	<0.001

Table 6. Comparison of parasitic infection between water quality groups.

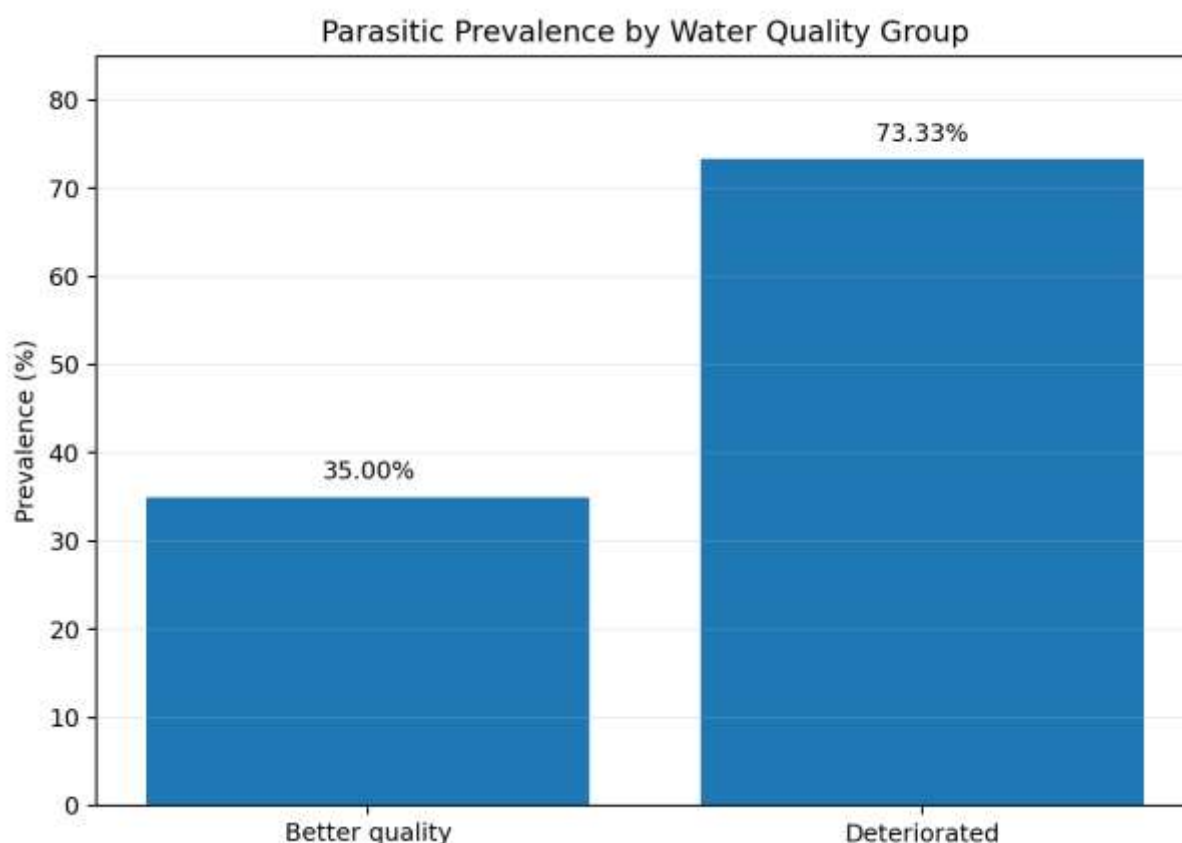


Figure 5. Parasitic prevalence by water quality group.

4. Discussion

From a practical perspective, the results emphasize the importance of routine water-quality monitoring, biological filtration, controlled stocking density, appropriate feeding, regular removal of organic waste, quarantine of new fish and periodic parasitological examination. Recent reviews of the ornamental fish sector similarly emphasize prevention, welfare, water-quality management and improved disease-control practices rather than reliance on repeated chemical treatments alone (Larcombe et al., 2025).

Despite the strength of these associations, parasite prevalence is influenced by several interacting variables. Stocking density, host species, age, nutrition, introduction of infected fish, previous treatments, seasonal temperature and management practices may all affect infection. Kennedy (1997) emphasized that parasite responses to environmental disturbance can be complex because environmental effects may act directly on parasites or indirectly through their hosts and transmission pathways. Therefore, the present findings support an important relationship between water quality and parasite burden but should not be interpreted as definitive evidence of causality.

The comparison of water-quality groups provided further evidence of an environmental association: prevalence increased from 35.00% in the better-quality group to 73.33% in the deteriorated group, while mean intensity increased from 4.40 ± 2.10 to 7.08 ± 3.85 . These differences were statistically significant in the supplied analysis. The direction of the findings agrees with studies showing that water-quality conditions can structure parasite assemblages and influence infection levels (Mutua et al., 2018; Unveiling study, 2024).

Dactylogyrus and Gyrodactylus were also detected. Monogeneans are important in ornamental fish because their direct life cycles facilitate transmission within confined populations. Studies of goldfish and imported ornamental fishes have demonstrated substantial diversity of Dactylogyrus and Gyrodactylus, highlighting the importance of quarantine and health screening in ornamental fish movements (Tancredo & Martins, 2019; Paterson et al., 2018; Tripathi et al., 2025).

Ichthyophthirius multifiliis was the most prevalent parasite recorded in the present study (17.50%). This finding is biologically plausible because *I. multifiliis* is a globally important pathogen of freshwater teleosts and is particularly relevant to aquarists and ornamental fish producers (Matthews, 2005; Jørgensen, 2017). *Trichodina* spp. were also common (14.58%), consistent with reports of trichodinids from ornamental freshwater fishes, including goldfish, guppy and platy (Martins et al., 2012).

The strongest association in the present dataset was observed for ammonia, which showed a positive correlation with prevalence ($r = 0.85$) and intensity ($r = 0.81$), both at $P < 0.001$. Nitrite also showed strong positive correlations, while dissolved oxygen showed strong negative correlations with both prevalence and intensity. Similar relationships between parasite assemblages and water-quality variables have been reported in fish populations, supporting the interpretation that environmental conditions can influence parasite dynamics (Mutua et al., 2018; Kennedy, 2009). However, these correlations should be interpreted as associations rather than proof that an individual water-quality variable directly caused the observed infections.

The water-quality results showed clear deterioration at Site/Group 4, where dissolved oxygen was lowest and ammonia, nitrite, nitrate, conductivity and TDS were highest. Such conditions are compatible with environmental stress in confined fish systems. The ornamental fish literature identifies poor water quality, waste accumulation, crowding and reduced dissolved oxygen as important stressors that can predispose fishes to disease (Browning, 2010; Larcombe et al., 2025).

Koi showed the highest prevalence (73.33%), followed by Goldfish (68.89%), whereas Gourami showed the lowest prevalence (40.00%). Species-level differences in prevalence can arise from differences in host susceptibility, gill and skin characteristics, behaviour, stocking density, exposure history and husbandry. Goldfish are known to support diverse parasite assemblages, including *Ichthyophthirius*, *Argulus* and *Dactylogyrus*, and monogeneans have also been documented in commercially traded ornamental fishes (Poulin & Morand, 2004; Paterson et al., 2018; Tripathi et al., 2025).

The present study recorded an overall parasitic prevalence of 54.17% among 240 ornamental freshwater fish examined in the Latur region. This level of infection is consistent with the broader literature showing that ornamental fishes may harbour a range of protozoan and metazoan parasites, including *Ichthyophthirius*, *Trichodina*, *Dactylogyrus*, *Gyrodactylus* and nematodes (Kim et al., 2002; Adel et al., 2015; Martins et al., 2012). The occurrence of multiple parasite groups in the present investigation therefore reflects patterns previously documented in ornamental fish production and trade.

5. Conclusion

The findings indicate a clear association between deteriorated water quality and increased parasitic infection in the examined ornamental freshwater fishes from the Latur region. Elevated ammonia and nitrite, increased nitrate, conductivity and TDS, together with reduced dissolved oxygen, were associated with greater parasite prevalence and intensity. Maintaining suitable water quality, adequate filtration, appropriate stocking density, proper feeding, quarantine of new fish, and routine parasitological surveillance should form the basis of effective ornamental fish health management.

9. Declarations

Ethical Statement

Fish collection, handling, examination, and euthanasia, where applicable, should be conducted in accordance with relevant institutional and national guidelines.

Conflict of Interest

The authors declare that there is no conflict of interest associated with this study.

10. References

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