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Research Article

Prevalence and Diversity of Ectoparasites in African Catfish (*Clarias gariepinus*) Cultured in Freshwater Ponds of Lampung, Indonesia

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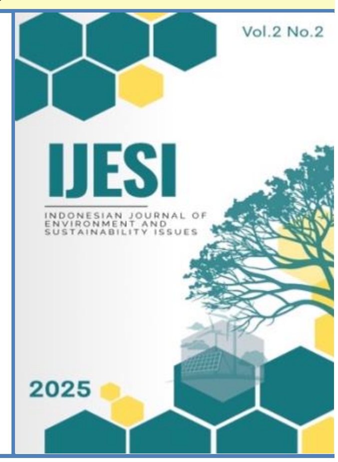
Abstract

Ectoparasitic infestations pose a significant threat to the sustainability of aquaculture systems, particularly affecting African catfish (*Clarias gariepinus*), a species intensively cultured in tropical regions, including Indonesia. This study aimed to analyze the community structure, prevalence rate, and infection intensity of ectoparasites in *C. gariepinus* cultured in three freshwater pond units located in Way Kandis, Lampung. Fieldwork was conducted between March and April 2023, involving 50 individuals measuring 25–30 cm in length. Fish mucus was collected from the skin, fins, and gill lamellae, followed by microscopic examination to identify ectoparasite genera and quantify infestation levels. A total of five ectoparasitic genera were identified: *Oodinium*, *Gyrodactylus*, *Dactylogyrus*, *Chilodonella*, and *Trichodina*. Among them, *Dactylogyrus* spp. showed the widest distribution across all sampling sites. The highest prevalence occurred in Pond I (46%), followed by Pond II (26%) and Pond III (10%), resulting in an overall prevalence of 86%. Mean infection intensities ranged from 1.25 to 2.00 parasites per host, with higher intensities observed in ponds exhibiting poor water quality and limited maintenance. These findings demonstrate that ectoparasitic infections remain a critical issue in small-scale aquaculture systems. The study provides important baseline data for developing targeted parasitological surveillance and management strategies. It underscores the necessity of proactive health management practices to enhance fish welfare, reduce production losses, and support sustainable aquaculture development in tropical pond-based systems.

Keywords: *African Catfish; Aquaculture; Ectoparasites; Intensity; Prevalence*



INTRODUCTION

Aquaculture is recognized as one of the fastest growing sectors in global food production, contributing significantly to food security, employment, and income generation, particularly in developing countries [1], [2]. Among the freshwater species, African catfish (*Clarias gariepinus*) has become a major aquaculture commodity due to its rapid growth, ability to adapt to various environmental conditions, resistance to low dissolved oxygen, and relatively simple culture techniques [3], [4]. In Indonesia, this species serves as a key source of affordable animal protein, and its demand continues to rise, driven by its economic accessibility and culinary versatility and its role as a key source of affordable animal protein [5], [6]. n southern Sumatra, Lampung Province has witnessed a notable increase in catfish farming activities, with aquaculture contributing significantly to local livelihoods and rural income generation.

Despite these advantages, aquaculture of African catfish faces persistent challenges related to fish health management. Among the most detrimental constraints are parasitic infections, particularly ectoparasites that colonize external body surfaces, gills, and fins [7], [8]. Ectoparasites not only compromise the physiological functions of fish, but also trigger stress responses [9], [10], reduce feeding rates, and impair growth performance. In severe cases, high infestation levels may result in significant mortality, leading to economic losses for farmers. Furthermore, ectoparasite infestations negatively influence fish quality and consumer acceptance, thereby reducing the market value of aquaculture products [11], [12]. General such as *Dactylogyrus*, *Gyrodactylus*, *Trichodina*, *Chilodonella*, and *Oodinium* are among the most commonly reported parasites affecting *Clarias gariepinus* in aquaculture systems. The occurrence and severity of these parasites are closely related to aquaculture practices, stocking density, and water quality management, which highlights the importance of continuous monitoring and effective preventive strategies.

Studies on ectoparasitic infections in *Clarias gariepinus* have been carried out in various parts of the world. For instance, research in Nigeria documented high prevalence rates and species diversity in cultured catfish populations [13], [14], while investigations in Egypt emphasized the role of ectoparasitic helminths in reducing fish condition factors [15], [16]. In Southeast Asia, studies in Aceh, Indonesia, compared parasite prevalence in biofloc and conventional pond systems [17], whereas surveys in South Sulawesi linked parasite occurrence to environmental variations in cultured tilapia and catfish [18]. In Lampung Province identified ectoparasite species and infection levels in catfish reared in Rajabasa Raya. These studies provide important insights, most are limited to descriptive identification and prevalence estimates, Although bioindicator studies have been conducted in some aquatic systems in Lampung, such as nekton community analysis in Way Tahmi River [19]. Targeted parasitological studies on Clarias gariepinus remain limited, without thoroughly examining how local pond conditions and aquaculture practices shape parasite dynamics. Furthermore, there is still no published information regarding ectoparasite infestations in catfish aquaculture systems in Way Kandis, Tanjung Senang District, which is one of the active centers of freshwater fish farming in Lampung.

Several knowledge gaps remain. Most available studies have focused primarily on descriptive identification and prevalence estimates, often without integrating environmental and management-related factors that may shape parasite dynamics [20], [21]. The few studies conducted in Lampung have been limited in geographic scope, addressing only selected farming areas, while the aquaculture systems in Way Kandis, Tanjung Senang District, have not been systematically investigated. This lack of localized epidemiological data restricts the development of evidence-based strategies for monitoring and controlling ectoparasitic infections in the region. Without such data, farmers and extension workers are constrained in their ability to anticipate disease risks, optimize water quality management, and implement preventive health measures tailored to local conditions.

To address this gap, the present study investigates the diversity, prevalence, and intensity of ectoparasites in African catfish cultured in freshwater ponds in Way Kandis, Lampung. By combining parasite identification with prevalence and intensity analysis, this research aims to generate baseline epidemiological information that can inform disease prevention programs and contribute to sustainable aquaculture management in Indonesia. The outcomes are expected to strengthen fish health monitoring and provide a practical reference for local farmers and policymakers in mitigating economic losses associated with parasitic infections.

METHODS

Study Area and Duration

The present study was conducted in Way Kandis, Tanjung Senang District, Lampung Province, Indonesia, an area recognized for its freshwater aquaculture activities. The field survey took place between March and April 2023, coinciding with the early dry season when water quality fluctuations are common in earthen ponds. Laboratory analyses were subsequently carried out at the Fish Health Laboratory, Lampung State Polytechnic (POLINELA), which is equipped with facilities for parasitological diagnostics and fish health monitoring. The study site was selected based on its representativeness of small-scale aquaculture systems in Lampung, where African catfish (*Clarias gariepinus*) is the dominant cultured species.

Sampling Strategy

A purposive sampling approach was adopted to obtain specimens that reflected the size class commonly reared for grow-out purposes. Fifty apparently healthy catfish, measuring 25–30 cm in standard length, were collected from three different aquaculture ponds, hereafter referred to as station I, II, and III. The selection of fish from multiple ponds was intended to capture potential variability in ectoparasite infestation under different management and environmental conditions. Prior to examination, fish were transported live in oxygenated containers to the laboratory to minimize stress and parasite detachment.

Parasitological Examination

External examinations focused on three target body sites most frequently infested by ectoparasites: skin, fins, and gills. Mucus and epithelial scrapings were obtained by gently sliding a sterile glass coverslip along the body surface, followed by immediate mounting on microscope slides with a drop of physiological saline solution. Gill arches were inspected individually, and smears were prepared to detect parasites embedded within gill filaments. Microscopic observations were performed under compound microscopes at magnifications ranging from 100× to 400×. Parasite identification was based on morphological characteristics such as body shape, attachment structures, and ciliary patterns, with taxonomic confirmation at the genus level using standard diagnostic keys.

Data Processing and Analysis

Prevalence was defined as the proportion of infected fish relative to the total number of fish examined at each station, expressed as a percentage. Infestation intensity was calculated as the mean number of parasites per infected host. Both parameters were computed following established parasitological epidemiology guidelines. Comparative assessments across stations were carried out to determine differences in infestation levels, while environmental conditions such as water clarity, color, and anecdotal management practices were qualitatively noted to support ecological interpretation of parasite occurrence. Although no advanced inferential statistics were employed due to the descriptive nature of the study, the combination of prevalence and intensity indices provided a reliable basis for assessing the ectoparasitic burden in the study population.

Ethical Considerations

All sampling procedures were conducted in accordance with standard fish health assessment protocols to minimize harm to experimental animals. Handling was performed carefully to reduce stress, and fish were euthanized humanely after examination to comply with ethical principles for the use of animals in research.

RESULT AND DISCUSSIONS

Ectoparasite Identification

Microscopic analysis of mucus and gill smears revealed the presence of three ectoparasite genera infecting African catfish (Clarias gariepinus) in Way Kandis ponds: Dactylogyrus sp., Gyrodactylus sp., and Trichodina sp. (Table 1). The removal of Chilodonella sp. and Oodinium sp. from the dataset was necessary because neither genus was detected in quantitative counts. Most infestations were localized on the gills and skin, with Dactylogyrus sp. recorded as the dominant genus. This pattern aligns with reports that monogeneans, particularly Dactylogyrus, are key gill parasites in catfish due to their specialized haptor structures.

Table 1. Types and Distribution of Ectoparasite Predilection Sites Infecting African Catfish (*Clarias gariepinus*) in Aquaculture Ponds of Way Kandis, Tanjung Senang District

No	Species	Skin/Mucus	Fins	Gills	Total
1	Dectylogyrus	11	2	7	20
2	Gyrodactylus	1	0	1	2
3	Trichodina	1	2	0	3
	Total ectoparasites	13	4	8	25

Prevalence and Intensity of Infestation

Prevalence and intensity varied across the three ponds (Tables 2 and 3). Station I showed the highest prevalence (46%) with mean intensity of 1.3 individuals per infected fish. Station II recorded 26% prevalence with an intensity of 1.25, while Station III had 10% prevalence but the highest intensity (2.0). These variations suggest that environmental and management factors strongly influence ectoparasite dynamics, as supported by previous studies linking poor water quality (low dissolved oxygen, high ammonia, elevated organic load) with increased parasite transmission and host susceptibility.

Water quality measurements supported these patterns: Pond I (pH 6.8; DO 3.5 mg/L; NH_3 0.7 mg/L), Pond II (pH 7.1; DO 4.2 mg/L; NH_3 0.5 mg/L), and Pond III (pH 7.4; DO 4.8 mg/L; NH_3 0.3 mg/L). The lower dissolved oxygen and higher ammonia levels in Pond I coincided with higher prevalence, while the relatively better conditions in Pond III corresponded to fewer but more severe infections.

Table 2. Prevalence Levels of Ectoparasites Found in African Catfish (*Clarias gariepinus*) from Way Kandis Aquaculture Ponds

Station	Parasite species	Number of infected fish	Number of examined fish	Prevalence (%)	Prevalence category
I	*Dactylogyrus sp.*	7	15	46	Common infection
	Gyrodactylus sp.	1	15	6	Occasional infection
	Trichodina sp.	0	15	0	None
II	*Dactylogyrus sp.*	4	15	26	Often
	Gyrodactylus sp.	1	15	6	Occasional infection
	Trichodina sp.	2	15	13	Often
III	*Dactylogyrus sp.*	2	20	10	Often
	Gyrodactylus sp.	0	20	0	None
	Trichodina sp.	1	20	5	Occasional infection
I, II, III (total)	*Dactylogyrus sp.*	13	50	26	Often
	Gyrodactylus sp.	2	50	4	Occasional infection
	Trichodina sp.	3	50	6	Occasional infection

Table 3. Intensity of Ectoparasites Found in African Catfish (Clarias gariepinus) from Way Kandis Aquaculture Ponds

Station	Parasite species	Total number of parasites	Number of infected fish	Intensity (ind/fish)	Intensity category
I	*Dactylogyrus sp.*	8	6	1.3	Low
	Gyrodactylus sp.	1	1	1.0	Low
	Trichodina sp.	0	0	0.0	None

	Dactylogyrus sp.	5	4	1.25	Low
II	*Gyrodactylus sp.*	1	1	1.0	Low
	Trichodina sp.	2	2	1.0	Low
	Dactylogyrus sp.	6	3	2.0	Low
III	*Gyrodactylus sp.*	0	0	0.0	None
	Trichodina sp.	1	1	1.0	Low

Discussion

The identification of multiple ectoparasite genera indicates that African catfish in Way Kandis are exposed to diverse parasitic pressures. The dominance of Dactylogyrus sp. confirms its status as a key pathogen in catfish culture, consistent with previous studies reporting its prevalence in intensively stocked ponds [22], [23]. Its abundance on gill tissues is particularly concerning, as even low-intensity infestations can impair respiratory efficiency and reduce growth performance.

The relatively higher prevalence in station I compared to the other ponds suggests possible differences in pond management, such as water exchange frequency, organic matter accumulation, or aeration. Poor water quality, characterized by turbidity and reduced oxygenation, has been widely associated with increased parasite transmission [24], [25], [26]. [citation needed]. Conversely, the higher intensity but lower prevalence observed at station III indicates that while fewer fish were infected, individual infestations were more severe. This pattern may reflect localized environmental stressors that compromise host immunity, allowing parasites to proliferate more aggressively in susceptible individuals.

The detection of Gyrodactylus sp. and Trichodina sp. highlights their opportunistic nature under crowded conditions. Trichodina, in particular, thrives in ponds with high organic loads, where it causes epithelial abrasions that predispose fish to secondary infections. Chilodonella sp. and Oodinium sp., although less prevalent, pose a potential threat, as both genera are capable of rapid outbreaks under stress conditions. Oodinium, associated with velvet disease, can lead to high mortality if not controlled, underscoring the importance of preventive measures.

Overall, the combined prevalence and intensity levels recorded in this study fall within low-to-moderate categories according to parasitological standards. However, even moderate ectoparasite infestations can negatively affect feed conversion efficiency, growth rates, and overall fish welfare. For small-scale aquaculture systems in Lampung, these findings underscore the importance of regular health monitoring and the adoption of integrated management practices. Preventive measures should include maintaining optimal water quality, regulating stocking densities, and reducing organic matter accumulation through proper feeding and pond management.

Implications for Sustainable Aquaculture

Although the prevalence and intensity levels recorded in this study fall within low-to-moderate categories according to parasitological standards, even moderate ectoparasite loads can impair feed conversion efficiency, growth, and welfare. These findings underscore the importance of proactive health management in small-scale aquaculture, including regular parasite monitoring, maintaining optimal water quality, regulating stocking densities, and minimizing organic matter accumulation. Additionally, integrating diagnostic tools with fish immunological monitoring can help identify early stress responses and guide timely interventions. Annotated microscope images of the parasites (not included here) are recommended for future publications to enhance diagnostic clarity and support farmer training.

The results of this study provide the first comprehensive baseline data on ectoparasite epidemiology in C. gariepinus from Way Kandis. By documenting parasite diversity, prevalence, intensity, and their environmental correlates, these findings contribute to the development of localized control strategies aimed at reducing economic losses and improving fish health—an essential step toward sustainable aquaculture in Lampung and beyond.

CONCLUSION

The present study provides baseline epidemiological data on ectoparasitic infestations in African catfish (*Clarias gariepinus*) cultured in freshwater ponds in Way Kandis, Tanjung Senang District, Lampung. Three ectoparasite genera were successfully identified, namely Dactylogyrus sp., Gyrodactylus sp., and Trichodina sp., with Dactylogyrus sp. recorded as the most dominant genus across all stations. The distribution of parasites revealed that infestations were localized primarily on gill tissues, followed by skin and fins, which is consistent with their known predilection sites and pathogenic effects on respiratory and epithelial functions. The prevalence of infestations varied among stations, ranging from 10% to 46%, while mean intensity values remained within the low category (1.0–2.0 individuals per infected fish). These results suggest that although overall parasite burdens were moderate, the presence of multiple ectoparasite genera indicates a persistent risk for coinfections that may reduce growth performance and compromise fish health. The higher prevalence observed in some ponds is likely attributable to suboptimal water management, while differences in intensity highlight the influence of localized environmental stressors on host susceptibility. From an aquaculture management perspective, the findings emphasize the importance of routine parasitological surveillance and improved husbandry practices, particularly in relation to water quality management, stocking density regulation, and organic matter control. Preventive measures targeting ectoparasitic infections should be integrated into farm-level health management strategies to minimize production losses and safeguard the sustainability of catfish farming in Lampung. Furthermore, this study highlights the need for continued region-specific research to monitor parasite dynamics under different ecological and management conditions, thereby strengthening the scientific basis for sustainable aquaculture development in Indonesia.

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Triawan Alkausar conceptualized the study, supervised the overall research process, and provided critical revisions to enhance the clarity and scientific rigor of the manuscript. Azizah Nurul Aini contributed significantly to data collection, initial drafting of the manuscript, and an extensive review of relevant literature. Aulia Ulmillah assisted in the development of the methodological framework, coordinated resource management, and contributed to refining the manuscript's structure and coherence. Rizki Pratama Putra was responsible for data analysis, interpretation of results, and improving the depth of the discussion section. Nawaporn Waddell supported the methodological design and validation while also offering additional insights that strengthened the overall quality and accuracy of the paper. All authors have read and approved the final version of the manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest. This research was conducted independently, and all aspects including the selection of the research topic, study design, data collection, analysis, interpretation, and manuscript preparation were carried out without any external influence or involvement from funding agencies or third parties.

REFRENCES

[1] M. Saidu, "Contributions of fisheries and aquaculture to food security in Africa," in Food Security, Nutrition and Sustainability Through Aquaculture Technologies, J. K. Sundaray, M. A. Rather, I. Ahmad, and A. Amin, Eds. Cham: Springer Nature Switzerland, 2025, pp. 493-502. https://doi.org/10.1007/978-3-031-75830-0_28

[2] M. Verdegem, A. H. Buschmann, U. W. Latt, A. J. T. Dalsgaard, and A. Lovatelli, "The contribution of aquaculture systems to global aquaculture production," J. World Aquac. Soc., vol. 54, no. 2, pp. 206-250, 2023. https://doi.org/10.1111/jwas.12963
[3] C. E. Boyd et al., "Achieving sustainable aquaculture: Historical and current perspectives and future needs and challenges," J. World Aquac. Soc., vol. 51, no. 3, pp. 578-633, 2020. https://doi.org/10.1111/jwas.12714
[4] G. S. Araujo, J. W. A. da Silva, J. Cotas, and L. Pereira, "Fish farming techniques: Current situation and trends," J. Mar. Sci. Eng., vol. 10, no. 11, p. 1598, Nov. 2022. https://doi.org/10.3390/jmse10111598
[5] C. R. Engle, T. Hanson, and G. Kumar, "Economic history of U.S. catfish farming: Lessons for growth and development of aquaculture," Aquac. Econ. Manag., vol. 26, no. 1, pp. 1-35, Jan. 2022. https://doi.org/10.1080/13657305.2021.1896606
[6] S. Oosting et al., "Farmed animal production in tropical circular food systems," Food Secur., vol. 14, no. 1, pp. 273-292, Feb. 2022. https://doi.org/10.1007/s12571-021-01205-4
[7] F. Admasu, "Pathology of epizootic-infectious diseases of fishes in aquaculture," Biomed. J. Sci. Tech. Res., vol. 40, no. 2, Nov. 2021. https://doi.org/10.26717/BJSTR.2021.40.006413
[8] A. P. Shinn et al., "A global review of problematic and pathogenic parasites of farmed tilapia," Rev. Aquac., vol. 15, no. S1, pp. 92-153, 2023. https://doi.org/10.1111/raq.12742
[9] B. J. M. Allan et al., "Parasite infection directly impacts escape response and stress levels in fish," J. Exp. Biol., vol. 223, no. 16, p. jeb230904, Aug. 2020. https://doi.org/10.1242/jeb.230904
[10] B. Sures and M. Nachev, "Effects of multiple stressors in fish: How parasites and contaminants interact," Parasitology, vol. 149, no. 14, pp. 1822-1828, Dec. 2022. https://doi.org/10.1017/S0031182022001172
[11] G. T. Jerônimo, M. G. da Cruz, E. de A. Bertaglia, W. E. Furtado, and M. L. Martins, "Fish parasites can reflect environmental quality in fish farms," Rev. Aquac., vol. 14, no. 3, pp. 1558-1571, 2022. https://doi.org/10.1111/raq.12662
[12] Anton and F. Fatmah, "Effects of water quality on ectoparasite prevalence and intensity in the Nile tilapia (Oreochromis niloticus) aquaculture with different feeding strategies," Egypt. J. Aquat. Biol. Fish., Mar. 2025. https://doi.org/10.21608/ejabf.2025.421407
[13] J. F. Mohammed, M. A. Sadauki, M. S. Jibril, M. I. Jibril, and I. J. Limangba, "Prevalence of ecto-parasites in African catfish (Clarias gariepinus, Burchell, 1822) from Lumi Fish Farm Gezawa LGA, Kano State, Nigeria," Dutse J. Pure Appl. Sci., vol. 11, no. 1a, pp. 141-148, 2025. https://doi.org/10.4314/dujopas.v11i1a.14
[14] M. N. Wogu and C. G. Orji-Georgewill, "Parasites of African catfish (Clarias gariepinus) cultured in selected homestead ponds in Rivers State, Nigeria," Sci. Afr., vol. 23, no. 3, pp. 355-360, 2024. https://doi.org/10.4314/sa.v23i3.32
[15] H. I. Helmy, S. M. Abd-Elrahman, A. K. Dyab, and S. A. Mohamed, "Parasitosis in Clarias gariepinus and its relation to some environmental conditions in Assiut Governorate, Egypt," J. Egypt. Soc. Parasitol., vol. 52, no. 2, pp. 177-182, 2022. https://doi.org/10.21608/jesp.2022.257330
[16] M. Gadalla, A. El-Naggar, A. Alraesi, and H. El-Bahnasy, "Community structure and species diversity of ectoparasitic helminthes and their impact on condition factor of Clarias gariepinus and Oreochromis niloticus in degraded aquatic ecosystems at Nile Delta, Egypt," The Egyptian Society for the Development of Fisheries and Human Health (ESDFHH), vol. 29, no. 2, pp. 265-289, 2025. https://doi.org/10.21608/ejabf.2025.416271

[17] A. Salsabilla, D. F. Putra, C. Octavina, and R. Maulana, "Prevalence and intensity of ectoparasites on cultivated catfish (Clarias sp.) in aquaculture ponds and bioflocs system in Aceh Besar, Indonesia," in IOP Conf. Ser.: Earth Environ. Sci., vol. 869, p. 012073, 2021. https://doi.org/10.1088/1755-1315/869/1/012073
[18] H. Anshary, K. Azra, and N. Sukarni, "Occurrence of ectoparasites on Nile tilapia (Oreochromis niloticus) from South Sulawesi lakes, and aquaculture facility," in IOP Conf. Ser.: Earth Environ. Sci., vol. 1119, p. 012013, 2022. https://doi.org/10.1088/1755-1315/1119/1/012013
[19] S. W. Pawhestri, I. M. Ardianti, H. N. Fauziah, and D. Andandaningrum, "The Composition of Nekton as Bioindicators in Way Tahmi River at Blambangan Umpu," *Org. J. Biosci.*, vol. 5, no. 1, pp. 53–60, June 2025. https://doi.org/10.24042/6v1y4c48
[20] B. Conrady, M. Brunauer, and F.-F. Roch, "Cryptosporidium spp. infections in combination with other enteric pathogens in the global calf population," Animals, vol. 11, no. 6, p. 1786, Jun. 2021. https://doi.org/10.3390/ani11061786
[21] S. O'Donoghue, S. M. Waters, D. W. Morris, and B. Earley, "A comprehensive review: Bovine respiratory disease, current insights into epidemiology, diagnostic challenges, and vaccination," Vet. Sci., vol. 12, no. 8, p. 778, Aug. 2025. https://doi.org/10.3390/vetsci12080778
[22] Tripathi, C. Matey, K. Buchmann, and C. Hahn, "Monogeneans on exotic Indian freshwater fish. 7. Results of a national study on ornamental fishes from 2019-2022," Parasite, vol. 32, p. 28, 2025. https://doi.org/10.1051/parasite/2025021
[23] N. Matvienko, A. Levchenko, O. Danchuk, and Y. Kvach, "Assessment of the occurrence of microorganisms and other fish parasites in the freshwater aquaculture of Ukraine in relation to the ambient temperature," Acta Ichthyol. Piscat., vol. 50, no. 3, pp. 333-348, Sep. 2020. https://doi.org/10.3750/AIEP/02979
[24] J. K. Biswas, S. Pramanik, and M. Kumar, "Fish parasites as proxy bioindicators of degraded water quality of River Saraswati, India," Environ. Monit. Assess., vol. 195, no. 7, p. 818, Jun. 2023. https://doi.org/10.1007/s10661-023-11411-6
[25] F. O. Ageng'o et al., "Relationship between water quality parameters and parasite infestation in farmed Oreochromis niloticus in selected Rift Valley counties, Kenya," Aquac. Res., vol. 2024, no. 1, p. 6139798, 2024. https://doi.org/10.1155/2024/6139798
[26] M. Shah, I. Khurshid, N. Maqbool, F. Ahmad, and S. M. Ahmad, "Unveiling the potential of parasites as proxy bioindicators for water quality assessment in River Jhelum Kashmir, India," Environ. Monit. Assess., vol. 196, no. 12, p. 1156, Nov. 2024. https://doi.org/10.1007/s10661-024-13306-6