Biological Times

Volume No. 3 | Issue No. 8 | Pages 1-2

Ichthyophthirius multifiliis: A review of its impact on freshwater fish globally

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ABSTRACT

White spot disease (WSD) in freshwater fish is caused globally by the ciliated protozoan *Ichthyophthirius multifiliis*. Infected fish have 0.5-1.0mm white spots on their skin and fins leading to gill dysfunction, osmoregulation problems and mortality. *Ichthyophthirius multifiliis* goes through three stages in its life cycle including the trophont (feeding), tomont (reproducing) and theront (infective) stages. Diagnosis of white spot disease relies on microscopic identification of trophonts. Effective management and preventive measures involve prompt treatment, proper quarantine procedures and thorough sanitation practices. This review highlights the economic impact and importance of understanding the developmental stages of the parasite and implementing preventive measures to control white spot disease affecting freshwater fish populations.

Keywords: Parasitic infection, *Ichthyophthirius multifiliis*, White spot disease, Ichthyophthiriosis

Introduction

The parasitic ciliate ***Ichthyophthirius multifiliis*** infects a wide range of freshwater fish species worldwide, causing the disease ichthyophthiriosis and leading to high mortality (1). The disease, commonly known as white spot disease (WSD), is characterized by the distinctive white spots that appear on the skin of infected fish (2). These spots result from the trophont stage of the parasite, which triggers the proliferation of epidermal cells, appearing as light-reflecting blisters visible to the naked eye (2). The parasite infects the gills, skin and fins of fish, establishing itself in the epithelial tissue. As the parasites mature, they cause hyperplasia of epithelial tissue which appears as white spots ranging from 0.5 to 1.0 mm in size when viewed microscopically (3). Fish with severe infections have a high number of white spots which creates difficulty in breathing (respiration) and maintaining proper balance of salt and water (osmoregulation), leading to high mortality rates (4). This disease causes significant economic losses in aquaculture affecting species like grass carp (5), snow trout (6), striped catfish (7) and ornamental fish (8). A parasite within the epidermis indicates an internal microhabitat and classifies it as a true endoparasite, not an ectoparasite (9). The skin and fins of infected fish with white spot disease are characterized by visible trophonts up to 1 mm in diameter (10). The trophont, persistently spinning, is encapsulated by host cells, including epidermal cells and leukocytes creating small skin bumps and these reflective nodules are identified as white spots (11). Aquaculture is a rapidly expanding sector worldwide and plays a key role in food productivity, food security, poverty elimination and income generation. However, frequent disease outbreaks caused by pathogens result in reduced production, economic losses and hinder the sustainable growth of aquaculture (12).

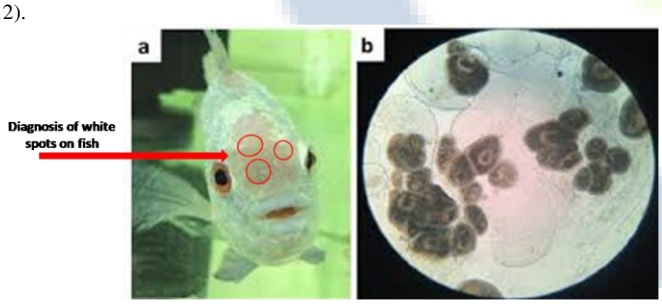

Fig. 1: (a) White spot disease in the ornamental fish *Amphilophus trimaculatus* caused by the protozoan *Ichthyophthirius multifiliis* **(b)** The mature parasite magnified 200 times, displaying a horseshoe-shaped core - photo by CARDOSO, PEDRO HENRIQUE MAGALHÃES (13)

Prevalence:

Scientists investigated the occurrence of a parasite called *Ichthyophthirius multifiliis* in fish living in natural bodies of water in the Lhasa and Nagqu regions of Tibet from September 2020 and August 2021. The findings revealed that the fish species *Schizopygopsis selincuoensis* was the most infected with a rate of 33.73%. Other fish species with high infection rates included *Triplophysa tibetana* at 30.00%, *Triplophysa brevicauda* at 27.91% and *Schizopygopsis thermalis* at 23.66% (14). Infections were not found in exotic fish species because of resistant to parasite. The infection rates were significantly higher in Boqu Zangbo River, Selincuo Lake and Cuona Lake in the Nagqu region compared to Lalu Wetland and Chabalang Wetland in the Lhasa region. The Lhasa River had a significantly lower infection rate than Cuona Lake (14).

Life cycle of *Ichthyophthirius multifiliis*:

Ichthyophthirius multifiliis exhibits a simple life cycle without intermediate hosts (15). The life cycle of a parasite is direct and consists of three distinct stages (16):

1. The feeding trophont stage occurs in the fish.
2. The reproducing tomont stage, which takes place in the environment.
3. The infective theront stage, which seeks out new fish hosts.

Infective theronts penetrate the mucus surface of fish and reside within the epithelium (15). These theronts mature into feeding stages (trophonts), which grow and eventually leave the host as tomonts within 4 to 7 days (15). Tomonts then swim briefly before adhering to an inert support and secreting a gelatinous capsule (15). Inside this capsule, tomonts divide into hundreds of infective stages called tomites, which develop into infectious theronts within 18 to 24 hours at normal room temperature (15). If these theronts fail to infect fish within 1 to 2 days, they die off (15).

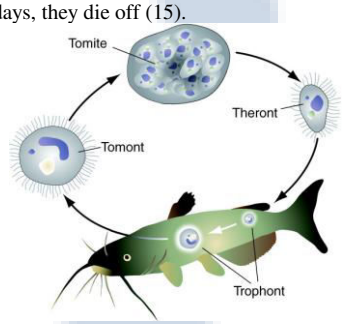

Fig. 2: Life cycle of *Ichthyophthirius multifiliis*

Sign and symptoms of white spot disease:

An infection caused by *Ichthyophthirius multifiliis*, commonly referred to as "Ich" is distinguished by the appearance of white-colored spots up to 1 mm on the skin and fins of affected fish (17). These spots are caused by penetration of trophont (adult parasite), appearing as small white dots, blisters or salt grains (16). Spots are less noticeable on white-colored and pale-colored fish. Fish with infection often exhibit symptoms such as irritation, weakness, loss of appetite and decreased activity before the spots appear. When the infection is located in the gills, white spots might not be evident, but the gills will appear pale and swollen (16).

Diagnosis of white spot disease:

To diagnose "Ich" in fish, observe for typical white spots and confirm by identifying the parasite in infected tissue under a microscope. Scrape some skin cells with white spots or clip a small piece of gill or fin and mount these samples in fresh water on a slide (18). The mature trophont stage appears large (0.5 to 1.0mm), dark in color and oval to round with a visible C-shaped nucleus under 40x magnification. Smaller, pear-shaped, translucent and rapidly swimming, theronts are young and free-swimming. Identify the mature trophont to confirm the diagnosis, as even one parasite requires treatment (18).

Treatment of white spot disease:

To cite this article: Shammas F, M Bibi, G Mobeen & N Nazish. *Ichthyophthirius multifiliis*: A review of its impact on freshwater fish globally. Biological Times. 2024 August 3(8): 1-2

The parasite has a complex life cycle and only the free-swimming theronts can be killed by chemicals, so treatments must be repeated to be effective. As more adult trophonts detach from the sick fish, the infection will be controlled (16). Copper and zinc either as pure metals or combined in brass lethal to the ciliated protozoa *Ichthyophthirius multifiliis* and its life cycle stages (tomonts, tomocysts and theronts) (19). Removing organic debris after treatment helps eliminate tomont cysts. Treatment depends on water temperature, fish species and tank system (16). Dead fish should be removed promptly to prevent the spread of the disease. At 75-79°F, treat daily with a minimum of 3 to 5 treatments (16). At 60°F, space treatments are 3 to 5 days apart with at least five treatments. Copper sulfate is effective and cost-efficient for ponds but highly toxic in low alkalinity water. For tank systems, formalin is suitable with products like Formalin-F, Parasite-S, and Formacide-B (16). The standard dose is 25 mg/L (1 ml per 10 gallons) with a half dose for sensitive species. Ensure vigorous aeration during use and flush with clean water if fish appear stressed. Salt treatment using 4-5 g/L for 7-10 days at 75-79°F is effective in smaller systems with most freshwater fish tolerating 5 ppt salinity temporarily and 3 ppt permanently (16). For pet fish, commercial preparations are available and cleaning the tank every alternate day helps eliminate cysts and prevent reinfection (16).

Preventive measures for white spot disease:

Quarantine new fish for at least 30 days to prevent ich and the introduction of a parasite (16). Stress from transport can cause asymptomatic fish to develop and spread the disease. After shipping, symptoms usually appear within 1 to 3 weeks. It is advised to implement a quarantine period of at least 30 days (16). This is crucial for aquaculture and public aquariums. The sticky tomont cyst can readily transfer between systems. Equipment such as nets, siphon hoses and other tools that have not been disinfected should not be used across different tanks. "Ich" can also be transmitted through water mist or spray, so it is important to closely monitor adjacent systems (16).

Conclusion:

Ichthyophthirius multifiliis is a serious hazard to freshwater fish health and can result in severe economic losses in aquaculture. Understanding the life cycle of parasites that invade in gills and fins of infected fish and implementing effective treatment protocols are vital for mitigating outbreaks. Preventive measures like quarantining new fish and maintaining good water quality are essential to minimize the risk of white spot disease. Continued research and awareness are crucial for improving management strategies and minimizing the impact of white spot disease on aquatic ecosystems and aquaculture industries.

References

[1] de Lima Araújo B, Moyses CRS, Spadacci-Morena DD, Xavier JG, Lallo MA. White spots amidst the gold: ultrastructural and histological aspects of the chronic inflammatory response of goldfish with ichthyophthiriasis. Journal of Comparative Pathology. 2024;211:21-5.
[2] Buchmann K. Immune response to Ichthyophthirius multifiliis and role of IgT. Parasite immunology. 2020;42(8):e12675.
[3] von Gersdorff Jørgensen L. The fish parasite Ichthyophthirius multifiliis–host immunology, vaccines and novel treatments. Fish & shellfish immunology. 2017;67:586-95.
[4] Matthews R. Ichthyophthirius multifiliis Fouquet and ichthyophthiriosis in freshwater teleosts. Advances in parasitology. 2005;59:159-241.
[5] Yulin J. A review of traditional and innovative aquaculture health management in the People's Republic of China. FAO Fisheries Technical Paper (FAO). 1996(360).
[6] Mallik SK, Shahi N, Das P, Pandey N, Haldar R, Kumar B, et al. Occurrence of Ichthyophthirius multifiliis (White spot) infection in snow trout, Schizothorax richardsonii (Gray) and its treatment trial in control condition. Indian Journal of Animal Research. 2015;49(2):227-30.
[7] Mamun M, Nasren S, Srinivasa K, Rathore S, Abhiman P, Rakesh K. Heavy infection of Ichthyophthirius multifiliis in striped catfish (Pangasianodon hypophthalmus, Sauvage 1878) and its treatment trial by different therapeutic agents in a control environment. Journal of Applied Aquaculture. 2020;32(1):81-93.
[8] Zhang Q, Chen D, Liu Q. Protective immunity of goldfish against Ichthyophthirius multifiliis infection induced by different trophont vaccine preparations. Journal of the World Aquaculture Society. 2009;40(4):561-6.
[9] Azimzadeh K. Ichthyophthiriasis (White Spot disease) alters plasma levels of Homocysteine, Heat Shock Protein-27, Cholinesterase, Adenosine deaminase and some blood parameters in Rainbow Trout (Oncorhynchus mykiss W., 1792). Turkish Journal of Fisheries and Aquatic Sciences. 2020;20(11).
[10] Buchmann K, Nielsen T, Mathiessen H, Marana MH, Duan Y, Jørgensen LV, et al. Validation of two QTL associated with lower Ichthyophthirius multifiliis infection and delayed-time-to-death in rainbow trout. Aquaculture Reports. 2022;23:101078.
[11] Chen H, Wang Y, Zhang J, Bao J. Intestinal microbiota in white spot syndrome virus infected red swamp crayfish (Procambarus clarkii) at different health statuses. Aquaculture. 2021;542:736826.
[12] Qu S-Y, Liu Y-H, Liu J-T, Li P-F, Liu T-Q, Wang G-X, et al. Catechol compounds as dual-targeting agents for fish protection against Ichthyophthirius multifiliis infections. Fish & Shellfish Immunology. 2024:109717.
[13] Cardoso PHM, da Costa AR, de Carvalho Balian S. Ectoparasitic fauna in freshwater ornamental fish acquired by a wholesaler in the city of São Paulo. Brazilian Journal of Veterinary Research and Animal Science. 2018;55(4):e144086-e.
[14] Qin T, Hu G, Cheng J, Chen F, Fu P, Zhao W, et al. Investigation of Ichthyophthirius multifiliis infection in fish from natural water bodies in the Lhasa and Nagqu regions of Tibet. International Journal for Parasitology: Parasites and Wildlife. 2024;23:100894.
[15] Coyne RS, Hannick L, Shanmugam D, Hostetler JB, Brami D, Joardar VS, et al. Comparative genomics of the pathogenic ciliate Ichthyophthirius multifiliis, its free-living relatives and a host species provide insights into adoption of a parasitic lifestyle and prospects for disease control. Genome Biology. 2011;12:1-26.
[16] Francis-Floyd R, Yanong R, Pouder D. Ichthyophthirius multifiliis (White Spot) Infections in Fish: CIR920/FA006, rev. 12/2016. EDIS. 2016;2016(10).
[17] von Gersdorff Jorgensen L, Puspasari K. Infection by Ichthyophthirius multifiliis. Aquaculture Pathophysiology: Elsevier; 2022. p. 493-503.
[18] Floyd RF, Reed P. Ichthyophthirius multifiliis (White Spot) infections in fish. Fisheries and Aquatic Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, CIR. 2009;920.
[19] Al-Jubury A, Yin F, Abusharkh T, Fuad MH, Kania PW, Buchmann K. Stationary metal sheets (copper, zinc or brass) in fish tanks prevent Ichthyophthirius multifiliis Fouquet, 1876 infection of rainbow trout: In vivo and in vitro effects. Aquaculture. 2023;577:739945.