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# **Review on Morphopathological Alterations of Some Parasitic Diseases in Fish**

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# ABSTRACT

Fish industry has been considered one of the most significant food manufacturing sectors in the world. Rapid growth, low fat, high quality protein and affordable price made fish aquaculture a suitable way for meeting human nutritional demands worldwide. However rapidly growing aquarium and fish aquaculture may result in unsuitable ecological conditions that may impact fish quality, marketability and causing diseases. Fish are susceptible to a wide range of parasitic diseases, which in turn can lead to significant financial losses. Blindness, emaciation, unusual behavior, gill deformity and impotence are common signs of parasitism. Fish can be infected by external and internal parasites, which can result in severe mortalities. External parasites include *Trichodina sp.*, *Ichthyophthirius multifiliis*, *Chilodonella sp.*, Isopoda and Monogeneans, while internal parasites include Anisakis simplex, digenic trematodes (Encysted metacercaria) and cestodes. Some internal parasites are of public health importance, causing severe human illness. Vomiting, diarrhea, fever and severe abdominal pain are common signs of consumption of infected fish. Health regulations must be managed in order to minimize the detrimental effects of diseases on fish and populations.

Keywords: Fish, Histopathology, Parasites, Signs

## 1. Introduction

Fish have become one of the world's dietary protein sources owing to the increasing demand for food sources, especially protein. Fish regarded as one of the most nutritious and readily digested proteins. In order to compensate the lack of high-quality animal protein, expansion of fish aquaculture has been developed. Intensification affected the fish ecology causing new diseases to arise. Fish are vulnerable to a variety of diseases, such as parasitic, bacterial and fungal infections. Parasites have a negative impact on fish survival, growth and health beside their zoonotic importance. Many control programs have been developed for controlling parasites.

## 2. Parasites in fish

## 2.1. Effect of parasites on fish

Globally, parasitism is thought to be a major cause of fish morbidity and mortality causing significant financial losses (**Khanum et al., 2015**). Fish may become more vulnerable to various diseases as a result of stressors caused by parasites (Hoffmann et al., 1990). Parasitic diseases can affect the effectiveness of feed conversion and influence the reproductive performance of the fish resulting in low marketability, low growth rate and even death. The extent of the damage may vary according to the size and age of the fish, parasitic activity and parasitic aggressiveness (**Sharaf et al., 2016**).Vital organs may be disrupted and compressed as a result of helminth invasion. External parasites can cause severe pathological lesions and tissue damage in fish.

# 2.2. Parasites affecting fish in Egypt

Aquaculture is a globally important industry that provides essential food to a growing world population, with a major role in the supply of cheap animal protein. Very rapid developments have been occurred in aquaculture sector of Egypt in recent year. Globally, Egypt ranks 9th in fish farming production and 1st among African countries. The main farmed fish is Nile tilapia, and Egypt is the world's second largest producer of farmed tilapia after China. In Egypt, the endemic of encysted metacercarial infection in *Oreochromis niloticus* and *Clarias gariepenus* fishes were reported (Abdallah et al., 2009). Ectoparasites including *Trichodina sp.*, *Chilodonella sp.*, isopoda, and monogeneans were reported in Egypt. Also, endoparasites such as Anisakidae and heterophyid have been reported. The prevalence of *Trichodina sp.* in Egypt is 14.1% in catfish (Mahmoud et al., 2018). While the prevalence of Contracaecum is 2%, Myxobolus is 2%, and macroscopic EMC is 37% in Upper Egypt (Abd-ELrahman et al., 2023).

## 2.3. Classification of parasites

Parasites can be classified into

a- Ectoparasites

Protozoan parasites which include Ciliates (*Trichodina sp., Chilodonella sp., Heteropolaria colisarum* and *Ichthyophthirius multifiliis*), Flagellates, Microsporidians and Myxozoans.

Monogeneans (Dactylogridae and Gyrodactylidae).

Isopoda, Copepod and Leech.

#### *b*-Endo parasites

Which include trematodes (Encysted metacercaria), cestodes (Diphyllobothridae) and nematodes (Anisakidae and Gnathostomidae).

Types of parasites	Parasites	Site	Prevalence	Reference
Ectoparasites	Trichodina sp.	Gills, skin	14.1%	(Mahmoud et al., 2018)
	Dactylogyrus sp.	Gills, skin	27%	(Gado et al., 2017)
	Isopoda	Gills, skin	19%	(Mahmoud et al., 2019)
	Ichthyophthirius	Skin	4%	(Abd-ELrahman et al., 2023)
	multifiliis			
Endoparasites	Anisakis simplex	Muscle, liver,	38.4%	(Kassem and Bowashi, 2015)
		stomach		
	Encysted	Muscle, liver,	58%	(Hussein and Morsy, 2019)
	metacercaria	stomach, heart		

## Table (1): Types of parasites

## Ectoparasites

Ectoparasites are believed to be the reason for serious economic issues in aquaculture since they can cause significant diseases that affects fish growth and leading to their mortality. Aquaculture farming environment may enhance ectoparasite transmission, according to epizootiological hypothesis, which may result in higher mortalities (Krkošek, 2017). Infected fish with ectoparasites are often recognized by body ulcers, scratches, skin hemorrhages and injured fins. The expansion of tilapia farming has contributed to the spread of tilapia ectoparasites. Ectoparasites mostly affect the body, gills and fins, causing noticeable alterations in gill epithelium as hyperplasia, hypertrophy and necrosis leading to difficulty in breathing and death (Del Rio-Zaragoza et al., 2010). Anemia may result from a large number of monogenean parasites affecting the skin and gills. *Dactylogyrus sp., Trichodina sp., Chilodonella sp., Ichthyophthirius multifiliis* and Isopods, are a frequent ectoparasites.

# Trichodina sp.

## Overview of Trichodina sp.

water currents can transport ectoparasites to gills as a result, these organisms adhere to or invade the gill tissue and acquire sufficient nutrients to proliferate and establishing new populations (El-Naggar and Reda, 2003).*Trichodina sp.* can multiply and infect the host under inappropriate environmental circumstances such as low water quality and lack of food (Huh et al., 2005). Owing to their rapid growth and using their adhesive discs for attachment and nourishment, these organisms can seriously damage the infected skin and gills causing severe mortalities. Secondary bacterial infections may arise as a result of *Trichodina sp.* invasion of the skin.

Table (2): Macroscopic and microscopic pictures of lesions caused by Trichodina sp.

Parasite	Macroscopic lesions	Microscopic picture
Trichodina sp.	Several Pathological alterations of gills were observed including, thickened gills, congestion of blood vessel, mucus accumulation, fusion and destruction of secondary lamellae. Hemorrhage and edema of gills were also observed ( <b>Chiraz et al., 2010</b> ).Multifocal areas of necrosis appeared on the gill surface ( <b>Valladão et al., 2013</b> ).	Microscopic examination of gills revealed thickening of gill filaments, sloughing and necrosis of gill epithelium with mononuclear infiltration (Sami et al., 2020). Trichodina spp. were seen attached to the supporting gill structure causing proliferative, inflammatory and degenerative alterations in gills. A light bluish mucous plug was observed between the secondary lamellae containing inflammatory cells. Accumulation of an amyloid-like material with mast cell were also observed.

Dactylogyrus sp.

Overview of Dactylogyrus sp.

Aquaculture practices have expanded globally in recent decades. Following this massive expansion, fish farms need sufficient space for adequate aquaculture. Although, farmers usually implement high stocking density rather than expanding space. These practices adversely affect the quality and welfare of fish life, causing stress, competition for food and also diseases. Diseases in fish have also been employed as markers of environmental stress (**Ozer, 2002**). Parasitic diseases can spread rapidly in areas with high stocking densities and inadequate water quality. Dactylogyrids are members of monogenean parasites which are ectoparasites present on fish gills or skin. They can infect fish causing disturbance in immunological (nitric oxide, complement 3 and lysozyme) and hematological values (MCHC, HB and MCH). These parasites can adversely affect fish respiration through destruction of gills, causing negative impact on fish health and even death.

Parasite	Macroscopic lesions	Microscopic picture			
Dactylogyrus sp.	Macroscopically, gills infected with	Microscopically, gills exhibited			
	Dactylogyrus sp. exhibited paleness	telangiectasia of secondary lamellae,			
	and congestion (marbling appearance)	hyperplasia of goblet cells and leucocytic			
	(Saad et al., 2024) . Gill lamellae	infiltrations (Saad et al., 2024). Congestion,			
	destruction and disorientation are also	hemorrhage and hypertrophy of chloride cells			
	caused by Dactylogyrus sp. Tissue	were also observed. Gills showed fusion of			
	damage at the site of parasite adherence	some parts to encyst the parasitic cysts inside			
	may also observed. Fusion of gill	them. At the site of parasitic attachment,			
	lamellae to the extent that they become	some necrotic cells present with hyperplasia			
	narrow and lost their shape may be	of gill epithelium, hindering water flow			
	seen.	between gill lamellae.			
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Table (3): Macrosco	pic and micro	scopic picture	s of lesions of	caused by I	Dactylogyrus sp.
		are property processors of			

Isopoda

Overview of Isopoda

Parasitic infections make fish more vulnerable to contaminants like crude oil and inhibit host growth (**Moles**, **1983**).Parasites may cause adverse effect on host leading to death. Isopoda are a large vigorous blood suckling crustacean parasites infect freshwater and marine fish. Pressure exerted by parasites on fish is the primary cause for tissue damage. Using their mouthparts, Cymothoid Isopods damage the host skin then consumed the muscular tissue underneath. This demonstrated that the fish body surface served as an ideal habitat for isopoda causing significant tissue damage.

Table (4): Macroscopic and microscopic pictures of lesions caused by Isopoda

Parasite	Macroscopic lesions	Microscopic picture
Isopoda	Damaged area appeared hemorrhagic or pale indicating anemia (fig1). Fish infected with isopods revealed significant muscular fibers damage along with decreased amount of collagen matrix ( <b>Rameshkumar</b> <b>and Ravichandran, 2013</b> ). Inflammation, hyperplasia, metaplasia and necrosis were also observed.	Granulomas formation containing macrophages and epithelioid cells encircled by a thin rim of fibroblasts, is the main tissue reaction Rather than being encapsulated, Granulomas seemed to follow myomeres (Rameshkumar and Ravichandran, 2013). Infected fish showed larger erythrocytes with lower hemoglobin. Fusion, hyperplasia of secondary gill lamellae and leucocytic infiltration were also observed. Complete destruction of gills, hemorrhage, degeneration and tissue necrosis may be seen(fig1).



Figure.1. Gills of tilapia infected with Isopoda. A: Isopoda of gills (purple arrow). B: hemorrhage (blue star), loss of gill rakers (purple star). C&D: hemorrhage and desquamation of gill epithelium (black arrows) (H&E stain C& D:X10) (**Saad et al., 2024**).

# Ichtyophthinus multifilis

Overview of Ichtyophthinus multifilis

Ichtyopthiariasis or white spot disease is one of the economically significant diseases affecting fish aquaculture. It is caused by *Ichtyophthinus multifilis*. The disease adversely impacts fish health, resulting in high mortality rates (**Klinger and Floyd, 1998**).Opposite to other parasites, it can cause asymptomatic infection. Infected fish showed irritability, respiratory distress and emaciation. Diagnosis depends on identification of parasites from skin scraping of white spots present on the skin.

Table (5): Macroscopic and microscopic pictures of lesions caused by Ichtyophthinus multifilis

#### **Endo parasites**

Fish are frequently infected with parasites, which have a direct impact on hosts at the individual and population levels, inhibiting their growth and reproduction (**Ochoa and Jaffe, 1999**). They also have in direct impact through behavior alterations. Parasitized fish may show reduced activity levels in order to conserve their energy. Numerous endoparasites, including cestodes, nematodes, trematodes and acanthocephalan can affect fish, causing alterations in their body structure and have a negative impact on organ functions. Digenetic trematode metacercaria are known as some of the most significant endoparasites, causing serious financial losses in fish aquaculture. Numerous fish parasites, especially trematodes, are important zoonotic parasites, which can cause diarrhea and gastrointestinal pain in human. The most frequent way for human to acquire infection is by consuming uncooked or inadequately prepared fish. Extended periods of favorable sunny climate encourage growth of certain parasites.

#### Anisakis simplex

#### **Overview** of Anisakis simplex

Anisakis simplex is a one of fish-borne parasitic helminth which has serious food safety impact and influence the economy and public health. It causes Anisakidosis, which is a gastrointestinal disease affecting human being. People acquire the illness through ingestion of infective third-stage larvae which present in fish muscle or viscera (Sakanari and Mckerrow, 1989). Nausea, vomiting, diarrhea, allergy and fever are symptoms of the illness. Treatment depends on removing of Anisakis larvae attaching to the stomach wall without the need of additional pharmaceutical treatment.

Table (6): Macroscopic and microscopic pictures of lesion	ons caused by Anisakis simplex
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Parasite	Macroscopic lesions	Microscopic picture
Anisakis simplex	"Stomach crater syndrome "is the term used to describe tissue reaction resulted from infection by <i>Anisakis</i> <i>simplex</i> . The stomach revealed structural deformity, significant inflammatory reactions, allergy and mononuclear infiltrations. Some worms may have observed in the stomach. Parasitic cysts were present in the liver. "Red vent syndrome "is a syndrome resulted from severe infection with <i>Anisakis simplex</i> . Inflammation and hemorrhage around the vent were observed.	Fibrous connective tissue capsules surrounding the parasites are present in the coelomic cavity surrounded by mast cells, eosinophils, macrophages and heterophils. At the site of parasite attachment, inflammatory cells and erythrocytes were observed. The pharynx showed granuloma surrounding <i>A. simplex</i> larvae.

#### Encysted metacercaria

## Overview of Encysted metacercaria

Aquatic fish with metacercarial infections have a higher potential for other infections. Beside their severe impact on fish health, they usually have an adverse effect on fish marketability and poses serious health issues to consumers. Infection occur through contaminated streams, oceans and lakes. Fish serve as intermediate and definit host of larvae for numerous parasites. They affect fish by growth retardation, lowering immunity and increasing their susceptibility for infection (**Elamie, 2001**). Encysted metacercaria also reduce fish marketability because of their abnormal appearance (hemorrhagic patches, tore cornea, white spots). Encysted metacercaria can disrupt fish muscular function and limit their ability to move causing severe emaciation. Scales detachment, increasing mucus production, respiratory distress, erosion, ulcerations and darkening of skin are other signs appeared on infected fish.

Table (	7):	Macrosco	ppic a	nd mic	oscopic	pictures	of lesions	caused by	/ Encysted	metacercaria
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Encysted metacercaria Fish infected with Encysted metacercaria exhibit orange to black nodules, abundant mucus secretions and detached scales. Grayish-white nodules were observed in heart, muscle, kidney, gills and liver during internal examination. Necrosis, ulceration and erosions were observed in infected skin (Saad et al., 2024). Hemorrhagic areas in infected liver and heart were also observed (fig 2).	Parasite	Macroscopic lesions	Microscopic picture
	Encysted metacercaria	Fish infected with Encysted metacercaria exhibit orange to black nodules, abundant mucus secretions and detached scales. Grayish-white nodules were observed in heart, muscle, kidney, gills and liver during internal examination. Necrosis, ulceration and erosions were observed in infected skin ( <b>Saad et al., 2024</b> ). Hemorrhagic areas in infected liver and heart were also observed (fig 2).	Microscopically, gills showed parasitic cysts surrounded by edema, congestion, and mononuclear infiltrations. Some of infected fish revealed desquamation and sloughing of gill epithelium, while others showed hyperplasia and hypertrophy and fusion of gill lamellae. Infected heart showed, connective tissue capsule containing the encysted metacercaria. The larval remnants were found in parasitic cysts. Some mononuclear cells infiltrated in the capsule there were mild swelling and hemorrhage surrounding the parasite cyst. Adjacent heart muscles showed localized hyaline degeneration and pressure atrophy. Kidney also showed congestion, tubular nephrosis and melanomacrophages proliferations. Affected liver revealed numerous hemorrhagic patches, steatosis (signet ring appearance), degeneration and necrosis. Fibrous connective tissue capsules surrounding parasitic cysts caused pressure atrophy on surrounding hepatocytes. Muscles exhibited destruction and damage due to pressure caused by connective tissue capsules containing parasitic cysts of various sizes (Fig 3) ( <b>Saad et al., 2024</b> ). Hyaline degeneration, edema and leukocytic infiltrations were also seen in infected muscles. Abundant melanomacrophages with mononuclear infiltrations and edema were present in affected skin.



Figure.2. Liver of tilapia showing hemorrhage (red arrows).



Figure.3. Encysted metacercaria in muscles of tilapia showing multiple parasitic cysts with different shape and size (black arrows) (H&E stain X10) (Saad et al., 2024).

#### Conclusion

On conclusion, the present work provides those parasitic diseases in fish still a major concern to the Egyptian fish sector with sever pathological lesions leading to alterations in normal histology of fish liver (macro and micro steatosis, congestion of central vein and necrosis), stomach (desquamation of epithelium), skin (erosions and ulcerations), muscles(degeneration) and gills (hyperplasia and hemorrhage) so a revision of control should be applied.

## Disclosure

The author reports no conflicts of interest in this work.

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