Internal parasites affecting freshwater and marine fish, and economic, health problems resulting from fish parasites in wild and farmed environments.

A Review paper

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Abstract

Fish are one of the main important of animal protein in human diets .The economic significance of fish is represented through their role a meals resource For numerous countries, fishes are significant for humans either through providing protein or by acting as a vector for human illness, Pathogens can infect fish or various animals. Fish parasites are divided into External parasites and Internal parasites . The internal parasites of fish inhabit the digestive tract or other organs in the body of fish such as Platyhelminthes (trematodes and cestodes, Acanthocephalans) and nematohelminths (nematodes). Helminths are an important category of pathogens, which cause infection and illnesses of fish both in marine and freshwater environments, their significance being associated directly at fish that could have an effect on the public health . parasitic infection debilitate their hosts, disrupt predator-avoidance behaviour depress their sexual display and reproductive abilities, and cause severe fish mortalities. In addition to the parasites play a critical role in determining the productivity, sustainability and to successful economic development. In conclusion, The aim of this review is highlight on some Internal parasites affecting freshwater and marine fish such as trematodes and cestodes, Acanthocephalans ,nematodes in addition to knowing, the Health, economic problems resulting from fish parasites in wild and farmed environments.

Keywords: fish parasites , nematodes trematodes, cestodes, Acanthocephalans.

الطفيليات الداخلية التي تؤثر على أسماك المياه العذبة والبحرية ، والمشاكل الصحية الاقتصادية الناتجة عن طفيليات الأسماك في البيئات البرية والمستزرعة

الملخص

تعتبر الأسماك من أهم البروتينات الحيوانية في النظم الغذائية البشرية ، وتتمثل الأهمية الاقتصادية للأسماك من خلال دورها كمصدر للوجبات بالنسبة للعديد من البلدان ، تعتبر الأسماك مهمة للإنسان إما من خلال توفير البروتين أو من خلال العمل كناقل للأمراض البشرية ، يمكن أن تصيب مسببات الأمراض الأسماك أو الحيوانات المختلفة. تنقسم طفيليات الأسماك إلى طفيليات خارجية وطفيليات داخلية. تعيش الطفيليات الداخلية للأسماك في الجهاز الهضمي أو الأعضاء الأخرى في جسم الأسماك مثل الديدان المسطحة (المثقوبات والديدان الشريطية ، ديدان شوكيات الرأس) الخيطيات (الديدان الخيطية). الديدان الطفيلية هي فئة مهمة من مسببات الأمراض ، التي تسبب العدوى والأمراض للأسماك في كل من بيئات المياه العذبة والبحرية ، وترتبط أهميتها مباشرة بالأسماك التي يمكن أن يكون لها تأثير على الصحة العامة. تضعف العدوى الطفيلية مضيفيها ، وتعطل سلوك تجنب المفترس ، وتقلل من عرضهم الجنسي وقدراتهم الإنجابية ، وتسبب نفوقًا شديدًا للأسماك. بالإضافة إلى أن الطفيليات تلعب دورًا حاسمًا في تحديد الإنتاجية والاستدامة والتنمية الاقتصادية الناجحة. في الختام ، تهدف هذه المراجعة إلى تسليط الضوء على بعض الطفيليات الداخلية التي تؤثر على أسماك المياه العذبة والبحرية مثل الديدان الخيطية، المثقوبات ،الديدان الشريطية ، ديدان شوكيات الرأس بالإضافة إلى معرفة المشاكل الصحية والاقتصادية الناتجة عن طفيليات الأسماك في البيئات البرية والمستزرعة.

الكلمات المفتاحية : طفيليات الأسماك ، الديدان الخيطية ، المثقوبات ، الديدان الشرطية ، ديدان شوكيات الرأس

Introduction

Fish are one of the main sources of animal protein in human diets (Hadyait *et al.*, 2018). Fish is a good source of food but also have high nutritional value which improves health (Chrysohoou *et al.*, 2007). Similar to different vertebrates, fish play a significant role as the intermediate or final hosts for numerous parasites, with a ability for the zoonotic transmission of these parasites to humans (Eissa *et al.*, 2013).

Parasites are significant category of pathogens which cause infection and illnesses in marine and freshwater fish . Parasite infestation can be found in most fish in natural environments. (Woo, 2006)..Fish parasites are divided into External parasites and Internal parasites (Tessema,2020).. The internal parasites of fish inhabit the digestive tract or other organs in the body of fish (Murray, 2005).

Helminths are an important group of pathogens, which cause infection and diseases of fish both in freshwater and marine environments, their importance being related directly to the fish that may affect the general public health (Hoffman, 1967). Helminth parasites belong to Trematodes (Digenea) such as

Parahemiurus merus, Anahemiurus microcercus (Farag *et al.*, 2017), *Vitellibaculum girelia, Lecithocladium excisum* (Al-Bassel *et al.*, 2012) , Nematodes such as *Anisakis simplex*. (Mansour *et al.*, 2019) Hysterothylacium *aduncum* , *Contracaecum type III* (Seifalnaser *et al.*, 2022). Cestodes, Acanthocephalans(Schmidt, 1990). that causing intensive losses to the fish industry and its affect the diet, metabolism, and secretory functions of the digestive system, which causes severe damage to the nervous system and interrupts the normal reproduction of the fish. (Habib, 2007)

The degree of pathogenicity of the different fish endoparasitic helminths vary from one species to other and rely upon various factors such as theseverityof infection, the tissue or organ affected and the presence of other concomitant infections (Ribelin and Migaki ,1975). and may cause severe fish mortalities (Piasecki *et al.*, 2004). Pathological conditions resulting from parasites and illnesses suppose high volume of epidemics under other unnatural conditions and crowded and other unnatural conditions (Ravichandran *et al.*, 2010).

Parasitic infections in fish can lead to decrease in growth rate, weight loss and emaciation, (Woo, 2006). nervous system impairment, cardiac disruption, castration or mechanical interference .Other acute pathological disorders include atrophy of the viscera, resulting from compression of organs by the parasites, often together with accumulation of blood stained ascetic fluid (Poulin, 2006). affect yield of fish products, cause human and animal diseases, delay in sexual maturity and mortalities (Woo, 2006). in wild and cultured fish (Sindermann, 1987). In cultured fish, however, parasitic sicknesses are typically greater excessive, and might purpose crucial economic losses due to stock mortality, declined productivity and decreased marketability (Paladini *et al.*, 2017).

Consequently Obligate and opportunistic parasites play a crucial position in figuring out the productivity, sustainability and economic viability of worldwide finfish aquaculture enterprises .(Shinn et al., 2015). The aim of this review is highlight on some Internal parasites affecting freshwater and marine fish such as trematodes and cestodes, Acanthocephalans ,nematodes in addition to knowing, the Health, economic problems resulting from fish parasites in wild and farmed environments.

Internal parasitic infection of fish

1.Helminthic parasitic infection

Helminths, as parasites in overall, do not represent a monophyletic aggregation, since under that term members of phylogenetically not related phyla are included, i.e., Platyhelminthes ("flatworms") comprising monogeneans, digeneans, cestodes, and ; Nematoda ("roundworms"), previously located inside the the phylum Nemathelminthes (or Aschelminthes); and Acanthocephala ("thorny-headed worms"). (Roberts and Janovy ,2000).

Helminthes in fish can damage their hosts in a variety of ways, for instance causing mechanical harm inclusive of irritation , leanness of tissues and obstruction of the alimentary tract, blood vessels or different ducts, they insert toxic metabolic by-products that may produce changes (Poulin, and Valtonen, 2001). Parasites influence the persistence of their fish by reducing their size, changing the behavior of infected fish and making the vulnerable to different infections, causing in higher mortality. Therefore, Therefore, parasites can reason significant economic losses in fish produce due to mortality and tissue harm(Thomas *etal*.,2014;El *Aselyetal*., 2015)

Globally, helminth parasitic infections have a major effect on the fish production as a result of the pathogenic outcomes of numerous species affecting productiveness, as well as due to the zoonotic feasible of many species(Chai *et al*., 2005). some groups of parasites belonging to helminths such as , Nematodes Trematodes are known to infect fish and produce harmful effects on their hosts.

1.1. Nematodes

The category Nematoda represents a taxonomical and geographically varied, ecological helminth assemblage (Luque *et al*., 2011). ,Nematodes are commonly identified as roundworms as they're slim, , unsegmented worms and round in cross section, nematodes are abundant and succeeded animal group, specially inside the aquatic environment (Ashley and Robin, 2010). Nematodes infect various, species of both wild and farmed fish . When nematodes numbers is excessive, they reason illness or even death. Some nematodes may be transmitted directly from fish to fish. Their life cycle shapes is usually indirect, with at slightest one intermediate hosts, even though a some can be spread directly from one fish to another (Sures, 2008) .

Grownup nematodes are normally located in fish digestive tracts. However, relying upon the species of nematode and the species of infected fish, adult and other lifestyles stages of nematodes may be observed in nearly any a part of the fish, inclusive internal organs, the swim bladder, deeper layers of the skin or fins, and outer muscle layers(Yanong, 2002). In great fish, more than one infestation of the body organs outcomes in substantial fibrosis, irritation or maybe some visceral adhesions are visible however there is no huge effect on their body circumstance (Murrel, 2007).

The Ascaridoidea superfamily (Anisakidae and Raphidascarididae) from Parasite are commonplace in invertebrates, marine mammals fish-eating birds (Mattiucci *et al.*,2010), and teleostean fish worldwide (Santoro *et al.*, 2010). The species *Anisakis spp*. and *Pseudoterranova spp.* that belong to class nematodes Of the of the family Anisakidae, *Capillaria spp* and *Gnathostoma spp*. are the most usually reported fish-borne nematodes in humans worldwide , leading to gastro-intestinal lesions (Capillariidae and Anisakidae)or cutaneous larva migrans (Gnathostomatidae) (Bilska-Zając *et al.*, 2015).

Mature anisakid nematodes of the genus Hysterothylacium Ward et Magath, 1917 are usually parasites in the gastrointestinal tract of fishes in marine, fresh and brackish water environments (Moravec,2004). the massive infections can be visible because of intestinal impactions and mortalities can occur in those infections (Berland, 1961).

Contracaecum species is geographically broadly distributed, successfully using a vast diversity of vertebrate and invertebrate species as hosts, both earthly and aquatic organisms (Al-Zubaidy , 2009). Some of the most common fish hosts of Contracaecum species in freshwater systems include cyprinids, ictalurids, and cichlids, while whiting, cod, and capelin appear the most common fish hosts in marine systems (Yanong, 2002). Some papers article that *C. Rudolphii* may be also a incredible reason of mortality in birds (Abollo *et al.*, 2001)and give massive economic losses to the fish industry (Yang *et al.*, 2001).

According to Lymbery et al (Lymbery *et al.*, 2002) the excessive spread of Contracaecumin mullet can also have health implications for the fish.

Khalil (1971) stated 40 species of mature nematodes, representatives of 9 families from fish found in Africa with mostly occurring in the alimentary tract and little in inner cavities or tissues . In Libya (Mansour *et al.*, 2019)

conducted a survey of nematode parasites that infect the Atlantic chub mackerel (*Scomber colias* Gmelin, 1789), this fish has extremely large significance, each economically and ecologically within the Libya counitry . among of the all examined fish 15 (18.07%) were infected in the gastrointetinal tract of fishes with nematodes parasites, and recognized as a 3rd stage larvae belonging to the Anisakis simples. In addition to (Sharif and Negm-Eldin, 2013) examined 94 individuals of *Merluccius merluccius* fish from Libya Coasts have been recognized as a 3rd stage larvae for *Anisakis sp*

Heavy migration by large numbers of nematodes may motive huge bodily harm to a fish. Big larval stages of some nematode species, including Eustrongylides sp, may reason bodily pressure on organs and abdominal distension) (Yanong, 2002).

Presently , fish illnesses, specially the ones as a result of parasites, , constitute one of the most significant problems and challenges antagonizing fish farming (Costello, 2009). This happens because parasitism can be dangerous factor contributing to fish mortalities (Aunsmo *et al* ., 2008). In aquaculture systems, brood stock infected with alittle number of nematodes species might not even display symptoms of infection. but they often have decreased reproductive ability. On the other side , juvenile fish infected by little numbers of nematodes are more likely to display signs of diseases and also have decreased growth rates(Yanong, 2002).

Nematode reasons an economic danger to the market worth of fish, over consumer attitudes towards the existence of those parasites found in food products. Infected slice are rejected and might increase production expenses. As a end result, there may be a super threat to the fish industry inflicting a fall in manufacturing and fish infected by some parasites might be inconvenient for human consumption and elevating numerous public health worries(Abebe *et al*., 2001).

2.2 .Trematodes

The class trematoda include of monogeneans and the digeneans trematodes. Monogenean are also referred to as flukes or flatworms. (Klinger and Floyd, 2002) and usually invade the external surface such as skin, fins and gills of brackish water fish and freshwater fish from most families of Teleostei (Whittington *et al.*, 2000).

Digenians trematodes are Platyhelminthes with mutable morphology and non direct life cycle. Infections in fish are specially due of larval stages. strigeoids and Clinostomid are among the greatest numerous digenians . Their life cycle includes plenty of fish species as 2nd intermediate hosts and a gastropod as invertebrate first intermediate host (Laimgruber et al., 2005). Digenean trematodes are abundant. Above 50 species from 15 families have been recorded (Khalil, 1971).

Brackish water fish and Freshwaterfish play a main role as the exporter of human infections with food-borne parasitic trematodes, and these parasites are getting increasing attention as facts on their variety andspread emerges in some Asian countries (Murrell and Fried, 2007). The habitat of maximum adult digenean trematodes parasites in fish is almost exclusively limited to the digestive tract, either free within the paramucosal lumen or connected to digestive tissues (Paperna and Dzikowski, 2006).

Digeneans trematodes of the superfamily Hemiuroidea Looss, 1899 are typically parasitic of the digestive system of fishes, specially the stomach of marine teleosts, although they also appear in freshwater elasmobranchs ,teleosts and sometimes in amphibians and reptiles (Gibson, 2002). Parahemiurus sp (Digenea, family : Hemiuridae) are originate over a huge region, specially intemperate and subtropical waters (Bray 1990). *Parahemiurus spp* particularly *Parahemiurus Merus* (Linton, 1910), have been commonly recorded that infecting moderate pelagic fishes (e.G. salmonids Clupeids, engraulids and carangids) from utmost oceans (Bray, 1990)

The digenean trematodes groups of the Hemiuridae family, which include the Lecithocladium genus are generally dominant in the digestive system of marine fishes because the Hemiuridae family has a completely wide spreading worldwide (Cribb *et al.*, 2002). in addition Overstreet *et al.* (2009) stated *Anahemiurus microcercus* Manter, 1947 that found in the intestine of marine fish(*Calamus bajonado*) inside the Gulf of Mexico. In 2013 *Podocotyloides brevis* was added by Michael and Overstreet that found in Grey Conger Eel from the Caribbean Sea.

From Libya (Farag *et al.*, 2017) *Anahemiurus misrocercus* recorded 23.0% in *Scomber scomber*, *Sardinella aurite* infection rates were 19.0% by *Parahemiurus merus* and the overall rate was 42.0%. The samples were collected from the port

of Qasr Ahmed, located in the northwest, and extending from Zreg , 30 km west of Misurata, to Qasr Ahmed, 10 km east of Misurata. (Dayhoum *et al.*, 2019). Fifty specimens of marine *Epinephelus guaza* fish from Misurata fish market were examined and the highest percentage (94%) was recorded by *Podocotyloides petalophallus* Yamaguti, 1934 and the lowest (20%) by *Anahemurus microcercus* Manter, 1947. With re-descriptions of the two different species. additional to (Al-Bassel et al., 2012) examined 81 individuals of *Mugil cephalus* fish from Missurata were found infected by two genera of trematodes (*Vitellibaculum girelia* and *Lecithocladium exisum*).

Only a few were observed to cause problem in fish of fish culture systems. Adult parasitic trematode might also infect the gut or gall bladder of fishes and are normally harmless as the pathology is restricted to infection and irritation at the location of attachments. However, larval parasitic trematode, the metacercaria, which foray and encysts in different organs, causes lot of harm (Jithendran, 2014).

Metacercaria of digenetic parasitic trematodes are considered to be one of the maximum significant endoparasites and are accountable for large economic losses across various fish species, in terms of both open water assets and culture fish in Egypt (Abd-ELrahman *et al.*, 2023). Shaw et al. (2005) stated several parasitic trematode metacercariae infesting more than one tissue or organ inside the fish hosts. Metacercariae maybe spread all over the host with mean density of several hundreds per fish. Only the specially intestinal species are however doubtlessly harmful to fish hosts (FAO, 1996).

Parasites can also have an effect on the host fish groups via inflicting reproductive and physiological harm, that could diminish wild fish stocks. But, harm to the host fish depends on the parasite abundance, character of the consequences and environmental factor.(Yasumoto *et al.*, 2018) It has been a decline in the availability of fish as protein-rich sources (Barber, 2005). The digenean parasitic infestations most cause strong economic loss in mullets(Kotb *et al.*, 2014) On the other side , some of digeneans trematodes are considered potential zoonotic agents (Nguyen *et al.*, 2021).

lastly , Besides direct losses caused by fish mortality, which in role, increases costs, and reduces profit that effects on foreign exchange earnings.

Conclusion

Fish is one of the most important animal protein in human diets . Similar to different vertebrates, fish play a significant role as the intermediate or final hosts for numerous parasites, Parasites are an important group of pathogens that cause infection and diseases in both marine fish and freshwater . The internal Parasitic infections in fish can lead to decrease in growth rate, weight loss , emaciation , muscles degeneration, liver dysfunction, interference with nutrition, cardiac disruption, nervous system, , delay in sexual maturity and mortalities in wild and cultured fish. The parasites play a crucial position in figuring out the productivity, sustainability and economic viability of worldwide.

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