

Review On Parasites Of Fish And Their Public Health Importance, A Seminar Paper For The Course Seminar On Current Epidemiologic Topic (Vepi-752)

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Abstract: The main objective of this review is to know the parasitic fish disease and its public health significance. Fish have a full range of diseases like all animals and many of these are due to external agents and other arises internally. External agents that cause fish disease include viruses, bacteria, fungi and parasites are known to affect fish while internally they suffer from almost all the common organic and degenerative disorders. Parasitic infestation frequently occurs in fish that causes retarded growth rate, reduced production, consumer rejection, low reproduction and mass mortality in fish. There are many parasitic diseases of fishes in the world. Some of the parasitic diseases are protozoans, trematodes, nematodes, cestodes, acanthocephalans, parasitic crustaceans, and leeches. Fish parasites cause commercial losses in both the aquaculture and fisheries industries and may have human health, as well as socio-economic, implications both in developing and developed countries. Many marine and freshwater fishes serve as a source of medically important parasitic zoonoses that include trematodiasis, cestodiasis, and nematodiasis. Some of these infections are highly pathogenic and the diseases mainly acquired through eating raw or under cooked fish. To overcome negative effect on fish and public health, it is necessary to act upon every health constraint based on scientifically proven and recommended as well as locally applicable ways.

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List Of Abbreviation

AGD: Amoebic Gill Disease
FAO: Food and Agricultural Organization
UK: United Kingdom
WHO: World Health Organization

1. Introduction

Parasitic diseases of fish are of particular importance in the tropics. Parasites usually exist in equilibrium with their host as a survival strategy. However, in instances where hosts are overcrowded such as in aquaria or in fish farms, parasitic diseases can spread very rapidly causing high mortality. Although, this is usually not the case in the wild natural aquatic environments, it occurs when the environment is disturbed by human activity and interference especially with populations which alter the natural distribution of their parasite communities (Imam and Dewu, 2010).

Parasites are important components of host biology, population structure and indeed ecosystem functioning. They can be found in any fish species and within any type of aquatic and culture system. They range from protozoans such as flagellates, ciliates, and apicomplexans to metazoans including myxozoans, trematodes, cestodes, acanthocephala, nematodes and crustaceans (Marcogliès, 2004).

There are a number of different ways that fish can be parasitic. Some species are free-living as adults but have parasitic eggs or larvae, whereas other species such as lamprey, only become parasitic as adults, and there are some such as pearl fish which are parasitic for their entire lives. However, they all share a feature which they have in common with all parasites – they are dependent upon their hosts to complete their life cycle, which is a key feature of parasitism. It should not be surprising that some of the adaptations which have evolved in these fish share parallels with more traditional parasites as they face similar challenges when establishing on or in their host; these selection pressures have led to evolutionary convergence in morphology and function in different parasite taxa (Poulin, 2011).

Over 40% of all known species on earth are parasitic with parasitism being ubiquitous in some taxa and either absent or rare in others. In some well-studied helminthes taxa, the rate of discovery of new parasite species has grown linearly or exponentially.

The knowledge of the status of parasite diversity in the tropics is still inadequate (Dobson *et al.*, 2008).

The Food and Agricultural Organization of the United Nations (2009) reported that, to satisfy an increasing demand in freshwater fish, extensive research must include studies of their parasites for optimal production levels. The knowledge of fish parasites is of particular interest in relation not only to fish health but also to understanding ecological problems in tropical Africa. Fish parasites have long been recognized as serious threats of fish both in aquaculture and fisheries (Paperna, 1996). Because of this recognition, there has been in the recent past an increasing interest and an explosion of knowledge, reports and description of new species of parasites from the African continent (Řehulková *et al.*, 2013). However, much of the research has been mainly concentrated in Western and Southern African countries with very little work from Eastern Africa (Gillardin *et al.*, 2012).

According to Lemma (2013), many fish diseases are causing huge mortality both in aquaculture and capture fisheries and some are also causing for human diseases in many areas of the world. Several authors also added that some of the detrimental effects of parasites in fish production are causing fish diseases and hence causing mass mortalities, increase farm inputs via increased treatment expenses and cause reduction in growth rate and weight loss during and after the period of parasitic disease outbreak and spoil the appearance of fish and hence lowers the quality and quantity of fish thus resulting in consumer rejection and affect marketability of commercially produced fish in different parts of the country (Gulelat *et al.*, 2013).

To overcome the effects of parasitic infection on fish and public health, it is necessary to act upon every health constraint based on scientifically proven and recommended as well as locally applicable ways and also epidemiological approaches needed in keeping aquatic animal health safe (Peeler and Taylor, 2011). Therefore, the Objective of this seminar review is:

➤ To review the parasites of fish and their public health importance.

2. Literature Review

2.1. Parasites of Fish

Fish have a full range of diseases like all animals and many of these are due to external agents and other arises internally. External agents that cause fish disease include viruses, bacteria, fungi and parasites are known to affect fish while internally they suffer from almost all the common organic and degenerative disorders. Parasitic infestation frequently occurs in fish that causes retarded growth rate, reduced production, consumer rejection, low reproduction and

mass mortality in fish (Claude *et al.*, 1998). The most common symptoms of parasitic infestations in fish are weight loss, disruption of reproduction or impotency, blindness, abnormal behavior, epithelial lesions, deformities of gills and others. These all eventually cause an economic loss in the fish farming sector and hence parasites are among the important factors responsible for production losses but fish parasites may be present in or on fish in subclinical state or carrier state and do not always cause disease in fish (Barber, 2007).

The study of fish parasitology has importance for many reasons. Fish parasites cause commercial losses in both the aquaculture and fisheries industries and may have human health, as well as socio-economic, implications both in developing and developed countries. A full understanding of the diverse effects of fish parasites on their hosts is therefore central to the development and maintenance of fisheries worldwide. The effect of parasites on the behavior of fish hosts is clearly an important aspect of this understanding. The subject is also of academic interest, as recent advances in the disciplines of behavioral and evolutionary ecology have given insight into the potential roles that parasites play in shaping the evolution and ecology of host species. Furthermore, and of current importance, parasites clearly have a role in the maintenance of biological and behavioral diversity of their hosts (Combes, 1996; Renaud *et al.*, 1996).

Parasites are divided into two distinct groups: ectoparasites and endoparasites. Within these two groups they are categorized by parasite type according to the physical characteristics of the parasite, life cycle, and host infection site. Some examples of these parasite types include fungi and algae, protozoans, trematodes, nematodes, cestodes, acanthocephalans, parasitic crustaceans, and leeches. Parasites can range in body size from small, microscopic organisms like bacteria and single celled organisms to large organisms such as tapeworms and copepods (Roberts and Janovy, 2005).

Fish parasites include parasitic protozoans, acanthocephalans, nematodes, digeneans, cestodes and crustaceans which are the most important parasites of fish. Helminths are highly specialized parasites that require specific definitive hosts. They frequently occur within the body cavity and viscera of fish. Due to their location in host fish, they may affect one or more important organ systems (Amlacher, 2005).

2.1.1. Endoparasites

The internal parasites of fish may in general be classified as flukes (Trematodes), tapeworms (Cestodes), spiny-headed worms (Acanthocephalans) and round worms (Nematodes). These parasites are

found in the body cavity, intestines, and various internal organs and sometimes in the flesh. They seldom seriously affect the health of the fish unless present in large numbers (Darwin and Stefanich, 1996).

The helminth parasites that infect vertebrates belong to two phyla, the Platyhelminthes (flatworms) and the Nematelminthes (roundworms). Flatworms of the class Monogenea are ectoparasitic on the gills and skin of the host while the flukes (Trematoda: Digenea), the tapeworms (Cestoda) and the nematodes infect the internal organs, with their intermediate stages sometimes encysting in various host tissues. In general, the endoparasitic helminths have a heteroxenous life cycle, i.e. one in which the parasite passes through at least one intermediate stage before developing into the adult. The latter stage, in some cases, usually develops in higher vertebrates that feed on the fish (e.g. piscivorous birds, mammals, man), in which case the larval stages in fish exhibit morphological and/or physiological adaptations that will enable them to survive in order to reach the adult stage and propagate (Roberts and Janovy, 2000).

The life cycles of most helminth parasites are so complex, involving more than one intermediate host, including fish, that their study enables one to better understand the dynamics of aquatic ecosystems as a whole. Other aquatic animals, such as planktonic copepods and molluscs, play an important role in the development of parasitic helminths as intermediate hosts. Piscivorous birds, in which some helminths develop into adult stages, are important in that they can disseminate parasite eggs over long distances, making it difficult to control the spread of infections between water bodies in different catchments (Saayman *et al.*, 1991).

Trematodes

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

Monogeneans have direct life cycles (no intermediate hosts) and are host and size specific (Klinger and Floyd, 2002) throughout their distribution range (FAO, 1996). According to Whittington *et al.* (2000) monogeneans can live on the epidermis, scales, fins, lipfolds, nares, branchiostegal membranes and gills of their hosts. Their anterior end contains apical sensory structures, a mouth with or without accessory suckers and special glands and clamps for the attachment and they are all haemaphrodite (FAO, 1996).

Monogeneans are subdivided into three major taxa: Dactylogyroidea, Caspaloidae and

Polyopisthocotylea. Most monogeneans found in inland water fish are of the family Dactylogyroidea while the other two families usually larger in size, are predominantly marine fish parasites. Dactylogyroids are oviparous with one or two anterior-dorsal pairs of eyes, posterior-ventral opisthaptor and are mostly gill parasites of fish. Gyrodactylidae are viviparous with no eyespots, two pairs of anchor hooks and generally found on the skin and fins of fish (FAO, 1996).

Fish appear to co-exist with their specific monogeneans in natural habitats as well as in culture conditions even when infestations are intense (FAO, 1996). A few, especially the gyrodactylids are pathogenic to their fish hosts, usually to younger fish and in intense culture conditions (Chapman *et al.*, 2000). *Dactylogyrus vastator* infection in the gills of carp fry according to (Barker and Cone, 2000) induces severe hyperplasia of the gill filament epithelium, which interferes with respiratory function at extreme proliferation and seems to be the cause of death. *Dactylogyrus extensus* were found to be fatal to both young and fully-grown fish (Obiekezie and Taege, 1991).

Digenean trematodes are numerous and occurring in a variety of freshwater fish hosts in Africa. They have complex life histories involving larval stages, which infect mostly juvenile fish, bottom dwellers and shallow water habitats in inland water bodies of Africa and (FAO, 1996) stated that the life histories of trematodes which infect African fish have so far not been studied and their primary molluscan or intermediate hosts remain yet unknown. They are however heteroxenous with multiple host life cycles involving both bivalves and gastropod molluscs as intermediate hosts (FAO, 1996). Fish can also be the primary or intermediate host, depending on the digenean species and they can be found externally or internally in any organ (Shaw *et al.* 2005) reported several trematode metacercariae infecting more than one tissue or organ in the fish hosts. Metacercariae may be distributed throughout the host with mean intensity of several hundred per fish. Only the extra intestinal species are however potentially harmful to fish hosts (FAO, 1996).

Cestodes

Cestodes also called tapeworms are ribbon like flat worms. They infect the alimentary tract, muscle or other internal organ of fish. The clinical sign when fish is affected by cestode parasite are variable degree of dropsy, distended abdomen and reduced in activity. Cestoda are all endoparasites of vertebrates with over 5000 species so far described. Most of them require at least one intermediate host and complete their life cycle as adults in the definitive hosts. Two life cycle stages are represented in fish: adults inhabit the intestine, and plerocercoid larvae of the same or

different species are found in the viscera and musculature; the first-stage larvae (procercoids) are generally found in aquatic crustaceans (Woo, 1995).

Numerous cestodes cause disease in fish mainly due to the plerocercoid larval stage and in some cases they can be transmitted to humans as in the case of *Diphyllobothrium* spp. causing a serious fish-borne zoonosis called Diphyllobothriasis. Identification of the cestodes parasite can be made from wet mount of faecal contents having proglottides or organs. Identification of adult cestode parasite to species uses features of the scolex and organs of the mature proglotid; immature cestode might only be classifiable to order. A variety of adult and larval tapeworms (over 40 species occur in native African fish; unsegmented forms notably Caryophyllidae as well as one amphilinid representatives and the segmented pseudophyllideans and proteocephalidae (Scholz *et al.*, 2009).

Nematodes

The phylum Nematoda is one of the most common phyla of animals with over 80,000 different described species of which over 15,000 are parasitic and diffused in freshwater, marine and terrestrial environments. The phylum contains both free-living organisms and parasites of plants and animals, including fish. They are also called roundworms, as they have an elongated, cylindrical in shape with 1 mm to 1m length and circular in section. Nematodes are unsegmented, bilaterally symmetric with a complete digestive system consisting of three sections: anterior (esophagus), middle (intestine), and posterior (rectum) ending with the anus (Grabda, 1991).

Infect many different species of aquaculture and wild fish. Small numbers of nematodes often occur in healthy fish, but high numbers cause illness or even death. In aquaculture systems, brood stock infected with a small number of nematodes may not even show signs of illness, but they often have reduced reproductive capacity. On the other hand, juvenile fish infected by small numbers of nematodes are more likely to show signs of illness and also have reduced growth rates. In aquaculture situations, fish become infected with nematodes if they are fed live foods containing infective life stages or if they are raised in culture settings that promote the growth of other animals that carry the infective stages of the nematode (vector or paratenic host) or allow nematodes to complete their life cycle (intermediate hosts) (Hagasawa, 1989).

Some nematodes can be transmitted directly from fish to fish. Adult nematodes are typically found in fish digestive tracts. However, depending upon the species of nematode and the species of infected fish, adult and other life stages of nematodes can be found in almost any part of the fish, including the coelomic

(body) cavity, internal organs, the swim bladder, deeper layers of the skin or fins, and external muscle layers. Prevention, proper identification, and correct therapy for treatable infestations dramatically improve the health and productivity of affected fish (Hagasawa, 1989).

Acanthocephalans

Acanthocephalans also known as spiny or thorny-headed worms which belong to the separate distinct phylum with about 1200 species divided into three classes namely: Archiacanthocephala, Eoacanthocephala and Palaeacanthocephala. All are intestinal parasites of vertebrates including fish, amphibians, birds and mammals. They are cylindrical worms from few mm to 70 cm long with the anterior part provided with an eversible hooked proboscis, without digestive system. They absorb nutritive materials with the whole surface of the body (Grabda, 1991).

The worms have sac-like containing lemnisci connected to the proboscis and genital organs opening posterior. The sexes are separate and the male opening is within a membranous bursa. The number and arrangement of the hooks on the proboscis are the main criteria for differentiation of species. A wider range of anatomical details are considered for determination of higher taxa (Kabata, 1985).

They develop via one or more intermediate hosts (heteroxenous). Adult acanthocephalans are all gut parasites. Eggs are laid into the intestinal lumen and evacuated with faeces. First intermediate hosts of piscine acanthocephalan are amphipods, isopods, copepods or ostracods. The first larvae (acanthor) hatch from eggs after being swallowed by a suitable invertebrate host. Some species will develop to the adult stage when their larvae in the invertebrate host are ingested by the definitive vertebrate host (Madanire-Moyo and Barson, 2010).

The pathogenic effects of acanthocephalans are strictly related to the damage caused by the proboscis in the intestinal wall and to the infection intensity. Attachment of the adult acanthocephalans in the digestive tract and also to the encapsulation of larval stages in the tissues causes pathogenic effects on fish. In low to moderate infections, pathological effects are localized around the attachment of the adult worm. The extent of damage is proportional to the depth of penetration of the proboscis. The depth of penetration of some species may vary in different host fish (Madanire-Moyo and Barson, 2010).

2.1.2. Ectoparasites

Ecto-parasite infestation is one of the most hazardous threats to fish health. They have been noted by many researchers as a major problem in pond fish culture where high temperature and organic content

may accelerate the life cycles of these parasites and promote their spread (Tachia *et al.*, 2010).

Ecto-parasites are parasites that are located on the external surfaces of a host organism. In fish this would include the skin or scales depending on the fish species, fins, and other structures considered external such as gills, gill rakers, and the oral cavity. Clinical signs and symptoms vary with the type and severity of parasite infestation. Most parasites are not harmful to humans but can make fish unappealing to anglers (Roberts and Janovy, 2005).

External parasites of fish are easily seen and consists of four groups of organisms; flukes, leeches (blood suckers), copepods (fish lice) and lampreys. Some cling to the exposed body surfaces or live in the gill chambers, feeding on the body mucus or on blood (Darwin and Stefanich, 1996).

Flukes

Monogeneans are a class of parasitic flatworms that are commonly found on fishes and lower aquatic invertebrates. Most monogeneans are browsers that move about freely on the fish's body surface feeding on mucus and epithelial cells of the skin and gills; however, a few adult monogeneans will remain permanently attached to a single site on the host. Some monogenean species invade the rectal cavity, ureter, body cavity, and even the blood vascular system. They are found on fishes in fresh and salt water and in a wide range of water temperatures (Bakke *et al.*, 2007).

Though the terms monogenetic trematodes and flukes are often used to describe this group of parasites, both are incorrect because monogeneans are not trematodes or flukes. In fact, they are distinct from the other parasitic flatworms, which include turbellarians, tapeworms, and trematodes (the true flukes). Trematodes and tapeworms with rare exceptions only live internally in their host, and turbellarians occasionally parasitize the skin of marine fishes. At their posterior end monogeneans have a haptor, a specialized "holdfast organ" that has hooks or clamps that enable them to attach to their host. Turbellarians, tapeworms, and trematodes do not have a haptor. The life cycle of monogeneans also differs from the life cycle of tapeworms and trematodes. Monogeneans have a direct life cycle, which means they go directly from host to host (fish to fish). Tapeworms and trematodes have an indirect life cycle that often requires multiple hosts (different types of animals) (Hirmayama *et al.*, 2009).

Leeches

Leeches (Annelida: Hirudinida) are parasites with a worldwide distribution that live in a diversity of habitats (Burreson, 2006). They occur in both aquatic (freshwater and marine) and terrestrial environments and parasitize a variety of hosts (Hemmingsen *et al.*, 2005). Leeches periodically attach themselves to a

host and gain their nourishment from feeding on blood and body fluids, thereby depriving their hosts of important nutrients. Fish leeches (Glossiphonidae and Piscicolidae) commonly attach to various sites on the body of the host, including the pectoral, pelvic, dorsal, and caudal fins; the eyes; the interior of the gill chamber; the inside of the mouth cavity; and directly to the main body of the fish. Through their movement and breaching of skin and mucous membrane barriers, leeches facilitate the entry of opportunistic pathogens into the body of their host (Burreson, 2006). The major concern stems from the fact that leeches with intermittent parasitism can act as a vector for pathogens (Kikuchi and Fukatsu, 2005)

Approximately 10,000 species of copepods have been described out of which 2,000 species are reported to be parasites of fish. Among the copepod parasites, those belonging to Pennellidae are widespread and gonochoristic in marine fishes. All species of this family are known to depend on fish for larval development, and have a life cycle involving two hosts (dixenic cycle). Some of them penetrate only to a short distance on fish tissues; others burrow deeply into all organs, seeking areas rich with blood supply. Most of these parasites cause localized changes in adjacent tissues and responsible for reduced gonad development (Raibaut, 1996).

Crustacea

Crustaceans are a large group of arthropods comprising almost 52,000 described species and are usually treated as a subphylum. The majority of them are aquatic, living in either marine or freshwater environments. Most of crustaceans are motile, moving about independently, although a few taxonomic units are parasitic and live attached to their hosts such as sea lice, tongue worms and anchor worms (Grabda, 1991).

Over 80 species of copepod and Argulid ectoparasites have been recorded from freshwater fish in Africa. The two most serious crustacean parasites which may become problematic under intensive aquaculture conditions in Africa are *Lernaea cyprinacea* and *Argulus japonicus* both of which have been introduced into South Africa together with carp and goldfish and *Dolops ranarum*. Most of the crustacean ectoparasites are found on the skin, mouth and on the gills. The erosion and degradation processes through external digestion cause lesions which can become secondarily infected by bacteria and fungi. Under natural conditions the rate of infection are low but can become chronic and acute under poor water quality and crowded conditions. Crustacean parasitic infections are particularly lethal to early juvenile fish (Avenant-Oldewage, 2001).

Argulids (fish lice) are dorso-ventrally flattened mite-like and covered dorsally by a rounded or horseshoe shaped carapace. Ventrally positioned head

appendages are developed for attachment, four thoracic segments each bear a pair of bifid swimming legs. The compound eyes are prominent and the mouth parts and antennae are modified to form a hooked, spiny proboscis armed with suckers as an adaptation to parasitic life. They leave their hosts for up to three weeks in order to mate and lay eggs and reattach afterwards behind the fish's operculum where they feed on mucous and sloughed-off scales, or pierce the skin and feed on the internal fluids. Twenty nine endemic species under family Argulidae occur in Africa in fish of diverse families. *Argulus africanus* and *Dolops ranarum* are opportunists and occur in diverse fish in all major systems of Africa (Paperna, 1996).

Allied species, *A. rhiphidiophorus* and *A. cunningtoni*, replace *A. africanus* in some East African lakes connected to the upper Nile and co-exist in others due to later artificial introductions of fish. In South African fish, *D. ranarum* is widespread as is the ubiquitous Eurasian species in addition to a few locally endemic species. *A. japonicus*, introduced apparently with carp (Avenant-Oldewage, 2001).

Only one species of the genus *Dolops*, *Dolops ranarum*, is present in Africa. It differs from *Argulus* sp. in having the second maxilla armed with a hook rather than a sucker, characteristic of the latter. Both genera *Dolops* and *Argulus* are in the family Argulidae (Paperna, 1996).

Ergasilidae (Copepoda) are common in fish of all major African water systems and only sub-adult and adult females of Ergasilidae occur on fish, mostly on the gills. The cephalothorax constitutes half or more of body length, the first of four thoracopods occurs at about mid-length. Segmentation of the thorax (except the first segment, fused with the head) and of the abdomen is distinct. The second antenna terminal segment is hook-like in *Ergasilus* and three clawed in *Paraergasilus*. Eggs are clustered in a bunch rather than arranged in a single line (Paperna, 1996).

Lampres

Some fish have evolved to attach themselves to larger aquatic vertebrates. Much like those that interact with invertebrates, they also show a gradation in their interactions, mainly in relations to their dependency on the host as a food source and the type of material that they ingest from the host. Of these, the lamprey is the most widely known and recognized example of an ecto-parasitic fish. There are 18 species of parasitic lampreys. While juvenile lampreys are filter feeders, adult lampreys are parasitic, attaching themselves to the body of their host with suction mouthparts, which are armed with rasping teeth (Gill *et al.*, 2003).

2.1.3. Protozoan disease

Most of the commonly encountered fish parasites are protozoans. They are single-celled organisms, many of which are free-living in the aquatic environment. Their ability to multiply on or within their hosts makes them in many instances very dangerous to fish. They have a direct life cycle and mostly reproduce by binary fission; some species have cyst form, off the host. Typically, these parasites are present in large numbers either on the surface of the fish, within the gills, or both. The general effect of these parasites is to irritate the epithelial surface, causing an increasing mucus production. There are three main groups of protozoan parasitizing the external tissues of fish: ciliates, flagellates, and amoebae (Chandra, 2004).

Ciliates

Protozoa belonging to the Ciliophora are equipped with cilia (short, fine cytoplasmic outgrowth), or a structure derived from cilia by secondary modifications, or both. Ciliated protozoa are among the most common external parasites which cause mortalities in a number of wild and farmed fishes. Ciliates can be motile, attached, or found within the epithelium. While they often occur as harmless ectocommensals, under poor environmental conditions or stress, some ciliates can rapidly increase in number, leading to morbidity and mortality (Dickerson, 2012).

Ichthyophthirius multifiliis, referred to as Ich is the causative agent of Ichthyophthiriasis or white spot disease. It is the most common pathogen of protozoan parasites of freshwater fish's worldwide. It causes particularly devastating infections in farm-raised fish, where it spreads rapidly within dense populations, leading to extensive morbidity and mortality. Ich infection can occur at any of the growth stages of fish, from fry, fingerling, table size, to brood fish (Dickerson, 2012).

Trichodiniasis is one of the major protozoan diseases found in fish worldwide. The disease is caused by a large assemblage of peritrichous ciliates of trichodinids. The trichodinid group includes *Trichodina*, *Trichodinella*, and *Tripartiella*, which are important ectoparasites of freshwater and marine fish worldwide. They are capable, in some cases, of causing heavy damage to their hosts, resulting in mortalities. Infestations caused by trichodinids are particularly significant in aquaculture because they are responsible for causing decreased growth, chronic mortality during cage production and changes in vision and swimming in larvae, culminating in acute mortality (Valladao *et al.* 2014).

Chilodonella is a highly pathogenic holotrich ciliate, ectoparasite on the skin and gill of a wide range of temperate and tropical freshwater fish. The parasite has a flattened, ovoid shape, is up to 80 µm in

length, and is covered by rows of cilia which move it in a steady gliding manner over the epithelial cells of its fish host. Heavy infections of *Chilodonella* are often associated with poor water quality. Carps, salmonids, and catfish are the species most commonly affected. *Chilodonella hexasticha* is most likely to be problematic at lower water temperatures, and is reported as a serious pathogen in overwintered carp. *Chilodonella piscicola* (= *C. cyprini*) infects cyprinids particularly, but can be found on other fish, where it can cause problems at higher temperatures. Fingerlings can be especially vulnerable (Rintamaki *et al.*, 1994).

Flagellates

Flagellated protozoans are small parasites that can infect fish externally and internally. They are characterized by one or more flagella that cause the parasite to move in a whip-like or jerky motion. Flagella are longer and more powerful than cilia and are always few in numbers (Isaksen, 2013).

Ichthyobodosis the disease is caused by heavy infections on skin and gills of fish by parasitic flagellates belonging to the genus *Ichthyobodo*. It is an important disease that has caused severe loss among farmed and ornamental fish worldwide for more than a century. *Ichthyobodo* is regarded as one of the most damaging parasites among farmed salmon, and is probably the major cause of mortality among salmonid fry and fingerlings. The flagellate that is perhaps best known as a serious fish pathogen is *Ichthyobodo necatrix* (*Costia necator*), which causes the disease known as *costiasis* (Isaksen, 2013).

Hexamitiasis is caused by excessive numbers of flagellated protozoa of the genus *Hexamita* in the alimentary tract of farmed and wild freshwater fishes. *Hexamita* sp. is a small (10 µm) pear-shaped, pyriform organism with three anterior and one posterior pair of flagella. *Hexamita truttae* is common in North American trout hatcheries, which cause mass mortality of fish. Clinically, the young fish have anorexia, debilitated with reduced growth, have trailing faecal casts, excessive nervousness, and the abdomen may be distended. The fish develop an acute enteritis, yellowish watery gut contents with numerous organisms present in the faeces or bile from the gall bladder. Transmission is by ingestion of an infective cyst (Woo, 2006).

Amoebae

Some free-living amoebae may change their mode of life and become harmful. Several species of amoeba have been implicated in gill disease in salmonids. Amoebic gill disease (AGD), caused by the free-living, facultative amoeba *Paramoeba* (*Neoparamoeba*) *perurans*, is a major issue in marine salmon farming, which leads to gill damage and death of infected fish (Mitchell and Rodger, 2011).

Clinical AGD most often occurs at water temperatures of 10–20°C, and is sometimes associated with higher than normal temperatures. Gross pathology in infected fish is characterized by raised, multifocal, white mucoid patches on the gills, which represent regions of epithelial hyperplasia of the primary and secondary lamellae. This phase is followed by desquamation of the epithelium, local disturbances of blood circulation, and progressive changes represented by inflammation. All the above mentioned changes result in decrease or loss of gill respiratory surface area. Significant cardiac changes and acid-base disturbances may occur in AGD affected fish, which may result in acute cardiac dysfunction and death (Powell *et al.* 2002).

3. Public Health Importance

A large number of parasites infect fish, but only a few cause illnesses in humans. Many marine and freshwater fishes serve as a source of medically important parasitic zoonoses that include trematodiasis, cestodiasis, and nematodiasis. Some of these infections are highly pathogenic. These diseases are mainly acquired through eating raw or under cooked fish. Generally, fish can either be intermediate host of parasites involving man as the definitive host, or harbor larval parasites of other animals which can invade human tissues. However, the larval stages of a few species of parasite can mature both in animals and man. The reported incidence of these fish-borne zoonoses has increased in recent years due to the development of improved diagnosis, increase in raw fish consumption in those countries in which such dishes have commonly been eaten, increased consumption elsewhere of regional fish dishes based on raw or poorly processed fish, the growth in the international market in fish and fish products, and the remarkable development of aquaculture (Robinson and Dalton, 2009).

Food-borne parasitic infections have recently been identified as an important public health problem with considerable economic impact in terms of morbidity, loss of productivity and healthcare costs. Poor sanitation and traditional methods of food preparation have accelerated the spread of food-borne trematode infection (Phan *et al.*, 2010).

Fish are a good source of quality protein, but various diseases including parasitic infections pose a threat to fish cultivation, which is a valuable source of food and employment in developing countries (Yooyen *et al.*, 2006). In addition to the economic loss to farmers, many of the parasites, particularly trematodes, are also of zoonotic importance. Eating raw or improperly cooked or processed fish is the main source of these infections for humans, and this has been reported from various geographical regions

(Park *et al.*, 2009). The World Health Organization (WHO) has estimated that the number of people currently infected with fish-borne trematodes exceeds 18 million, and many more are at risk (WHO, 1995).

4. Conclusion And Recommendation

According to review stated that globally fish constitutes almost half of the total number of vertebrates in the world. They live in almost all conceivable aquatic habitats and exhibit enormous diversity of size, shape and biology, and in the habitats they occupy. Fish have a full range of diseases like all animals and many of these are due to external agents and other arises internally. External agents that cause fish disease include viruses, bacteria, fungi and parasites are known to affect fish while internally they suffer from almost all the common organic and degenerative disorders. Parasites are important components of host biology, population structure and indeed ecosystem functioning. They can be found in any fish species and within any type of aquatic and culture system. Parasitic infestation frequently occurs in fish that causes retarded growth rate, reduced production, consumer rejection, low reproduction and mass mortality in fish.

Parasites that affect fish include parasitic protozoans, acanthocephalans, nematodes, digeneans, cestodes and crustaceans which are the most important parasites of fish. Helminths are highly specialized parasites that require specific definitive hosts. They frequently occur within the body cavity and viscera of fish. Due to their location in host fish, they may affect one or more important organ systems.

As a review a described that large number of parasites infects fish, but only a few cause illnesses in humans. Many marine and freshwater fishes serve as a source of medically important parasitic zoonoses that include trematodiasis, cestodiasis, and nematodiasis. Some of these infections are highly pathogenic. These diseases are mainly acquired through eating raw or under cooked fish. Therefore, based on the above conclusion of review the following recommendation was forwarded:

✓ There should be a clear nationwide policy and strategy concerning fish disease prevention and control at large and endo and ecto-parasites in particular.

✓ Establishment of research centers or sector units that focuses on fish health and production are needed.

✓ Further comprehensive study on the economic and public health impact of parasites and molecular level characterization of them is recommended.

✓ Awareness should be raised about fish born zoonotic parasites and consumers should not eat raw or undercooked fish.

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