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# Review on parasites of commercially important tropical fishes: - Characteristics, Distribution, risk factors and Prevention approaches

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**Abstract**

This review has been made with the objectives of compiling the nature and characteristics of the most common fish parasites in the tropical regions of the world. The review was made with collection of published articles in the area of fish parasitology in tropical regions of the world. Fish 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, acanthocephalans, nematodes, and crustaceans. Over 40% of all known species on earth are parasitic with parasitism being ubiquitous in some taxa and either absent or rare in others. The knowledge of the status of parasite diversity in the tropics is still inadequate. Parasitic infestation frequently occurs in fish that causes retarded growth rate, reduced production, consumer rejection, low reproduction and mass mortality in fish. The most common symptoms of parasitic infestations in fish are weight loss, disruption of reproduction or impotency, blindness, abnormal behaviour, 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. Therefore, it is essential to conduct research on the major fish parasitic pathogens which will help for future aquaculture productivity and other environmental functions of the fish parasites in the aquatic environment.

Key words: - **Fish, Parasites, Protozoans, Helminth, Fresh water**

## INTRODUCTION

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, acanthocephalans, nematodes, and crustaceans (Marcogliese, 2004). 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 helminth 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 and Thurston, 1969). 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). Review in major economically and public health important fish parasites have not been documented from the ethiopian water bodies. Therefore, the aim of this review is to document common fish parasites general characteristics and to show research gaps in the area of fish health.

### Parasites in 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 behaviour, 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).

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).

**1. Protozoa (Goldfuss, 1808)**

Protozoans are single-celled organisms many of which are free-living in the aquatic environment. There are also several protozoans that act as external and internal parasites which infect fish, molluscs and amphibians (Martins *et al*., 2015). They damage the skin and gills and cause reduced growth of the host fish, favouring secondary bacterial infections and mortality which lead to constraints in global aquaculture production. Parasitic protozoan diseases are responsible great losses to the commercial fishing industry and small-scale aquaculture activities contributing to food production (Xu *et al*., 2012).

According to Basson & Van As, (2006) trichodinids are protozoan parasites with mobile ciliates having body covered by a slender membrane surrounded by ciliary spiral, a horse-shoe shaped macronucleus and an adhesive disc provided with a denticulate ring in which the denticles are found. They can be found in freshwater and marine fishes. Their predilition site in fish host is on the body surface, buccal cavity and gills (Lom & Dykova, 1992). Deteriorated water quality and ecological aspects of the fish species favours the proliferation of the trichodinis in the environment. High stocking density, high organic matter contents and increased water temperature aggravates their reproduction in fish farms (Basson & Van As, 2006). According to Yemmen *et al*., (2011), some trichodinid species were found to be suppressed with increased water temperature.

Trichodinids reproduce by binary fission and have direct life cycle on the host. They can reproduce rapidly in very short period of time and reach 100% prevalence when condition favours. Transmission can be by direct contact, contaminated water and contaminated fish farming utensils (Martins *et al*. 2010). Diagnosis can be made from scraps of skin, fins and gills of diseased fish observed under a stereomicroscope under a microscope. Silver nitrate impregnation and staining by Giemsa or haematoxylin (Van As & Basson, 1989) can be for specific diagnosis. Attachment and rotating movements of of trichodininds may cause serious irritation and damage to the epithelial or epidermal cells of fish. Martins *et al.,* (2015) stated that diseased fish may show darkness of the skin, whitish areas in the gills, hypoxia and flashing on the ponds or aquaria surface. But clinical signs are not specific to the parasites.

**2. Monogenea (Carus, 1863)**

The class Monogenea is one of the largest groups of Platyhelminthes. They parasitize fish and other aquatic animals throughout freshwater and marine habitats (Paperna, 1996). Mongoneans are subdivided into several major taxa; Dactylogyroidea (Yamaguti, 1963), are the most common monogeneans found in inland water fish. They are usually having one or two anterior-dorsal pairs of eyes and are 0.3-2 mm long and a posterior-ventral attachment organ. Most dactylogyroids are gill parasites except Gyrodactylidae which are skin parasites (Paperna, 1996). Morphologically, Gyrodactylidae are viviparous where the parent worm contains a distinct well differentiated embryo. Intra-uterine embryos already contain second and often third generation embryos recognized by their developing marginal hook lets and anchors. They do not have eye spots and Gyrodactylus is a common genus which parasitizes fish. All the remaining Dactylogyroidea reproduce by laying eggs. They usually have one to two pairs of pigmented eyes (Bakke *et al*., 2007).

The life cycle of monogeneans is direct life cycle which involves only one host. Fish to fish contact and by infective stages (oncomiracidium) hatched from eggs shed in the environment is the mechanism of transmissions for viviparous species and oviparous ones respectively

(Öztürk and Özer, 2014). They mostly spread by way of egg releasing and free-swimming infective larvae. Monogeneans are often in equilibrium with their hosts in the natural environment but can cause serious morbidity and mortality when there is water quality deterioration and when fish are stressed in significant economic losses in aquaculture (Öztürk and Özer, 2014). Oviposition often accelerated by adverse living conditions and incubation time is temperature dependent. Larvae are either actively attached to the skin of the host fish and then migrate to the gills or become attached when washed with swallowed water through the gills. All monogeneans are hermaphrodites (Blahoua *et al*., 2016).

Monogeneans are attached to the host body by special posteriorly positioned attachment organs called opisthaptor. Their anterior end contains apical sensory structures, a mouth with or without accessory suckers and special glands or clamps for attachment (Whittington *et al.*, 2000). Those preferring gills cause more damage to the host due to the thin epithelium and results in excessive production of mucus and hyperplasia of epithelium leading to fusion of gill lamellae, which eventually cause clubbing and fusion of gill filaments and necrosis of tissues. This can finally lead to parasite induced fish mortalities. They are commonly found on fish gills and skin. However, some monogenean species invade the rectal cavity, ureter, body cavity, nostrils, intestine, stomach and even the vascular system (Buchmann *et. al.*, 2004).

Clinically, fish heavily infected with Gyrodactylus appear pale due to excessive mucus secretion and epithelial proliferation. There is skin erosion, desquamation of the skin epithelium, focal haemorrhagic lesions and loss of scales in the more heavily infected skin zones (Obiekezie and Taege, 1991). Species of dactylogyrids as well as gyrodactylids demonstrate different tolerances to water salinity. Taxonomical aspect, host specificity and biological cycle are mostly used for classification and identification purposes (Pariselle and Euzet, 2009). Some genera of monogenea demonstrate a high degree of host specificity and follow their respective specific fish hosts throughout their distribution range. Monogeneans are common and present in all inland waters of Africa (Paperna, 1980).

### 3. Trematoda (Rudolphi, 1808)

Trematodes also known as digeneans are flat worms morphologically characterized by a dorso ventrally flattened and oval body with a smooth. They have corrugated surface and a sucker around the antero-ventral mouth. Both suckers are used for attachment and locomotion (Schell, 1970). The digestive system consists of a pharynx connected to the mouth opening, a short oesophagus and two blind intestinal caeca. Most trematodes are hermaphrodite, containing both male organs (testes, adults and copulatory system) and female organs (ovary, vitelline glands, ducts and uterus). Some also contain a specialized copulatory organ (ovary, vitelline glands, ducts and uterus) which is useful for differential diagnosis. Eggs are evacuated to the genital opening and are usually oval and operculated (Schell, 1970).

Trematodes have a multiple host life cycle and most of them require molluscs as their first intermediate host. Fish can be an intermediate host harbouring metacercarial digeneans like *Diplostomum spathaceum* in eye lens, *Tylodelphys clavata* in vitreous humour of the eyes and *Postdiplostomum cuticola* ('black spot') on skin and fins. The final host are some fish-eating birds like herons. Fish can also serve as definitive host harbouring adult worms like *Sanguinicola intermis* in blood, *Bunodera luciopercae* and *sphaerostoma bramae* in intestine. The larval stages of Digenea generally include miracidium (free living stage), sporocyst, redia and cercariae in the digestive gland of the intermediate host (snails) and metacercariae which is the encysted stage. Blood flukes (Sanguinicolidae) are slender, spiny, and lack anterior ventral suckers and pharynx. The intestinal caeca are short, X- or H-shaped. Eggs are thin – shelled and lack an operculum (Smith, 1972).

*Clinostomum* spp. infections are caused by metacercarial stage of the digenean trematods. The metacercariae are large, yellow or white giving the fish unattractive appearance for consumers (Yimer, 2000). Clinostomatids are very widespread in Africa (Yimer & Mulualem, 2003) and most of the researches on fish, were carried out in Southern, Western and Central Africa and just few in the North and East part of Africa (Aloo, 2002; Florio *et al*., 2009).

The most common definitive hosts of Diplostomidae, Clinostomatidae and Heterophyidae encysting as metacercariae in fish are piscivorous birds. Mammalian hosts including dogs play an important part in dissemination of Heterophyidae. Heterophyidae notably *Heterophyes heterophyes* are very versatile in their choice of definitive hosts and will develop to maturity in both mammals and birds. Crocodiles are definitive hosts to metacercariae of the Clinostomatid *Nephrocephalus* and *Pseudoneodislostomum thomasi* which infect Bagrus and *C. gariepinus* (Fischthal & Thomas, 1990).

Herons are the common definitive hosts of Diplostomidae and natural infection of *B. levantinus* has been found in Ardea purpurea. Eggs of *D. spathaceum,* incubated at $29^0$C, hatched after 9-11 days, while infected snails (*Lymnaea peregra*) commenced shedding with 6-9 weeks. Cercariae of all diplostomatids are fork-tailed furocercariae). The vector of Neascus causing blackspot disease in Lake Victoria cichlids is the local bulinid, *B. ugandae*. Hyperparasitism, i.e., a cyst within another cyst of an apparently different species of Diplostomatidae has been revealed in *Clarias gariepinus* muscles in Israel and in Uganda (Whyte *et al.,* 1988).

Difinitive host for *Clinostomum spp*. and *Euclinostomum* sp. are herons, pelicans, cormorants and darters. In all of these the adult trematodes become attached to the wall of the posterior pharynx and in the laryngeal zone. Some species, however, may restrict their choice of hosts. Eggs shed by worms are either washed directly to the water habitat or swallowed and defected. Eggs shed undeveloped and like those of diplostomids require oxygen and light for development. Miracidia of *C. tilapiae* hatches following 10 days incubation at 25-$30^0$C (under constant illumination) and those of *C. marginatum* after 11-13 days (Paperna, 1996). According to the study carried out by Eshetu Yimer (2000), digenean trematodes of the genus Clinostomum were reported from *O. niloticus*, *T. zilli* and *C. gariepinus* in Lake Ziway. Although no evidence is available in Ethiopia, *Clinostomum complanatum* is known to cause laryngopharyngitis infection humans as was reported in the Near East resulting apparently from ingesting inadequately cooked infected fish (Paperna, 1980).

**4. Cestoda (Rudolphi, 1808)**

Cestodes also called tapeworms are ribbon like flat worms. They infect the alimentary tract, muscle or other internal organ of fish (Woo, 1995). The clinical sing 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). Morphologically the adult cestodes are strongly flattened dorsoventrally, the body consists of the scolex (head), neck, and strobila (body) and the latter generally made up of several serial sections (proglottids). Some unsegmented cestodes are also described from fish (*Caryophyllaeus*, *Khawia*, etc.). Scolex is an attachment organ used to fasten the parasite to the host's intestinal mucosa, so it is generally provided with holdfast structures such as suckers and bothria and additionally hooks and/or proboscids. Cestodes have no intestine, the nourishment being absorbed by the tegument covering the whole surface of the body. With a few exceptions, cestodes are hermaphroditic, each proglottid having its own set of male and female gonads (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).

*Amirthalingamia macracantha* is mainly characterized by its 20 hooks arranged in two rows in bilaterally symmetrical pattern (Bray, 1974). *Proteocephalus exiguous* (scolex with 4 lateral suckers), *Proteocephalus macrocephalus* and *Bothriocephalus claviceps* are some of cestodes fish as definitive host. Different fish species act as intermediate and pike as definitive host for *Triaenophorus crassus*. *Ligula intestinalis* uses fish as intermediate host (plerocercoids in body cavity of fish) and birds as final hosts. Plerocercoids of *D. latum* inhabit muscle and body cavity of fish (intermediate host) while the adults (broad ribbon worm or broad fish tapeworms) live in mammals. *Diphylobothrium latum* is typically a parasite of human with a worldwide distribution, mainly prevalent in cold lake regions where raw or undercooked fresh water fish is eaten (Merid *et al*., 2001).

Although tapeworms are widespread in Africa, there is only a few records of tapeworms from cichlid fish, e.g., *Proteocephalus bivitellatus* and several gryporhinchyd cestodes (Scholz *et al.*, 2009). *Ligula intestinalis, Proteocephallus* spp and *Bothriocephalus* spp. are those observed in natural fish habitat of Ethiopia (Yimer and Mulualem, 2003; Yimer *et al*, 2001). There several species of tapeworms which can seriously affect wild and cultured fish populations among which Ligula intestinalis, *Diphyllobothrium* spp, *Diphyllobothrium acheilognathi* and *Kwawia sinensis*. They affect not only the organ they infect but also induce pathological and physiological changes on fish (Pike and Lewis, 1994). The prevalence of fish tape worms and other helminthic parasites were studied from 150 male children less than 15 years of age who are involved in fishery and fish processing in Lake Awassa, Ethiopia. This study confirmed three cases of heterophid infections caused by eating raw fish (Merid *et al*., 2001).

**5. Nematoda (Rudolphi, 1808)**

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 (Grabda, 1991). 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).

Nematodes have acoelomate (false body cavity) and covered with a solid cuticle. Because of their resistant cuticle, these worms last longer than flatworms in post-mortem conditions. They have tubular digestive and reproductive organs to sustain hydrostatic pressure. The sexes are separate (dioeciouse) and mostly males are smaller than the females. Nematodes have mostly indirect life cycle including mammals, fish, copepods and piscivorous birds depending on their species. They have four moults in the life cycle; eggs hatch to produce first stage larvae ($L_1$), $L_1$ moult to $L_2$ then $L_3$, $L_4$ and final the fourth stage larvae moult to become adults (Moravec, 1974).

Copepods are first intermediate hosts to Camallanidae, Cucullanidae, Philometridae and Anguillicolidae. Larval stages of the Contracaecum species of the family Anisakidae that infect freshwater fish are usually found as adults in fish-eating birds such as cormorants and pelicans. Larvae in copepods or other invertebrate intermediate hosts will develop to fourth stage larvae and further into adult males and females when ingested by a suitable definitive host. Larvae ingested by "wrong" piscine hosts often survive as waiting stages (fourth stage larvae) in the gut or other tissues for a variable length of time and continue development into the adult stage if their carrier host (paratenic host) is predated by the compatible host. Nematodes occur worldwide in all animals. Larval nematodes, in addition to adults, occur either encysted in tissue or free in body cavities most often in pericardial cavity. Most notorious larval nematodes existent in our country lakes include are the genera Amplicecum, Contracecum and Porrocaecum (FAO, 2012). The clinical symptoms of Nematodiasis include anaemia and emaciation (Yimer and Mulualem, 2003).

In Africa, 40 species of adult nematodes which are representatives of 9 families from fish were reported by Khalil and polling (1997). Infections of the pericardia in cichlid fish by larvae of nematode *Contracaecum sp*. occurs in Ethiopia (Yimer, 2000; Yimer and Mulualem, 2003), in Lake victoria (Malvestuto & Ogambo ongoma, 1978) and in South Africa (Basson *et al*., 1983). *Amplicaecum* spp. was reported from Sudan (Khalil, 1969) and Ethiopia (Eshetu Yimer, 2000). Eustrongylides has only been found in the East African lakes, including Tanganyika (Paperna, 1996), Chamo and Tana (Yimer *et al*., 1999; Yimer and Mulualem, 2003).

**6. Acanthocephala (Koelreuter, 1771)**

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 posteriorly. 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).

**7. Crustacea (Lamarck, 1801)**

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 is 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 and van As, 1985).

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. The largest number of species was reported from the Congo basin followed by that of Lake Tanganyika (Fryer, 1968). 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 thoracopodes 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).

In the family Lernaeidae (copepod) rod-shaped, unsegmented, or partly segmented parasitic stage lernaeid female is anchored with the aid of a specialized holdfast organ to the host skin or buccal mucosa. Larval stages, copepodites and copepod-shaped males are attached to the gills. Differentiation to lernaeid genera and to species in the genus lernaea is based mainly on the morphology of the holdfast organ (anchors) of the parasitic females. Among crustaceans, *Dolops ranarum* was found on caudal fins of African catfish in Lake Tana, Ethiopia which was reported by Yimer and Mulualem (2003).

Factors influencing parasite communities of fish

Biotic and abiotic factors affect the parasites distribution and community structure in aquatic systems. Biotic factors such as distribution of infected hosts, immune status of the host, spatial and temporal distribution of infective stage and intermediate hosts are important determinants of parasite exposure (Byers *et al*. 2008). The distribution of infection can also be influenced by host diet or trophic position in a food chain (Valtonen *et al*. 2010).

Among the abiotic factors, water quality issues explained in section 2.4 can be an important determinant of parasite species diversity and infection intensity (Karvonen *et al.*, 2013). High and water temperature may directly influence release of infective stages and aggravating transmission in the population and vis versa in cold water and which consequently leads to seasonality of parasitism (Poulin, 2006). In addition, climate change, eutrophication and pollution are strongly affecting the parasite community structure (Karvonen *et al.* 2013).

**Controlling fish parasites**

The reliable way to manage parasites is to avoid introducing parasites to a new system which can be done by following a quarantine protocol. Another simple way to minimize the introduction of parasites and other external parasites is to dip fish in fresh or salt water depending on the fish species (Peggy *et al.*, 2012). Dipping saltwater fish in freshwater will reduce the number of many single-celled external parasites and freshwater fish can be dipped in sea water to accomplish the same goal. Dipping fish will not completely eliminate the risk of introducing parasites to an established tank or system but it may help minimize the numbers brought in. Unfortunately, the sticky eggs of monogeneans are resistant to changes in salinity and are easily transported into the new facility even when fish have been appropriately dipped (Hirazawa *et al*., 2004).

Fish should be quarantined for at least four weeks before they are placed into a new system. The design of a quarantine system should be very simple so that fish are readily accessible for observation and handling and so that water can be easily changed and treatments easily administered (Hirazawa *et al*., 2004; Peggy *et al*., 2012).

**Conclusion**

This review provides information on the recent evidence of ecologically and commercially important tropical fish parasites. The most common points considered in the review include the taxa, morphological characteristics of the fish parasites. The risk factors associated with each parasite, the prevention and treatment mechanisms of the parasites have also been reviewed in the paper. Therefore, based on the conclusions, it recommended that further research on the identification of fish parasites using molecular approaches will help to get the good image of fish parasites in the tropical regions. It also important to investigate the ecological importance of parasites as environmental bioindicator and study on the effect of fish parasites on the health and growth of fishes in culture condition.



**REFERENCES**

Aloo, P.A. (2002): A comparative study of helminth parasites from the fish Tilapia zilii and Oreochromis leucostictus in Lake Naivasha and Oloidien Bay, Kenya. *J. Helminthol*., 76: 95-102.

Amlacher E. (2005): Text book of fish disease. INDI, Narendra publishing House.

Avenant, A.N. and Van As, J.G. (1985): Occurrence and distribution of *Dolops ranarum Stuhlmann*, ectoparasite of freshwater fish in the Transvaal, South Africa. *Journal of fish biology*, *27*(4), 403-416.

Bakke, T.A., Cable, J. and Harris, P.D. (2007): The biology of Gyrodactylid monogeneans: the "Russian Doll-killers". *In: Advances of Parasitology*. (eds), 64: 161-376.

Barber, I. (2007). Parasites, behaviour and welfare in fish. *Applied Animal Behaviour Science*, *104*(3), 251-264.

Basson, L., & Van As, J. G. (2006). Trichodinidae and other ciliophorans (Phylum Ciliophora). *Woo PTK. Fish diseases and disorders. 2nd ed. Cab International*, *1*, 154-182.

Blahoua, G. K., Yao, S. S., Etil&e, R. N. D., & N'Douba, V. (2016). Distribution of gill Monogenean parasites from *Oreochromis niloticus* (Linn, 1758) in man-made Lake Ayam I, Cte dIvoire. *African Journal of Agricultural Research*, *11*(2), 117-129.

Bray, R. A. (1974): A new genus of Dilepidid cestode in Tilapia nilotica (L., 1757) and *Phalacrocorax carbo* (L., 1758) in Sudan. *Journal of Natural History*, *8*(5), 589-596.

Buchmann, K., Madsen, K. and Dalgaard, M.B. (2004): Homing of *Gyrodactylus salaries* and *G. derjavini* (Monogenea) on different hosts and response post-attachment. *Folia Parasitologica* Vol. 51 pp. 263-267.

Byers, J. E., Blakeslee, A. M., Linder, E., Cooper, A. B., & Maguire, T. J. (2008). Controls of spatial variation in the prevalence of trematode parasites infecting a marine snail. *Ecology*, *89*(2), 439-451.Teferra, W. (1990): Parasites of fish from Lake Tana DVM.Thesis, Addis Abeba University Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.P.14.

Claude, E., Boyd, J. and Craig, S. (1998): Pond Aquaculture water quality management, Kluer Acakemic publisher, U.S.A. Pp. 87-152.

Dobson, A., Lafferty, K. D., Kuris, A. M., Hechinger, R. F. and Jetz, W. (2008): Homage to Linnaeus: How many parasites? How many hosts? *PNAS* 105 suppl.1.

FAO, (2009): The state of world fisheries and aquaculture 2008. Food and agriculture organization of the United Nations, Rome.

FAO, F. (2012). Yearbook 2010: Fishery and aquaculture statistics. *Food and Agriculture Organisation of the United Nations, Rome*, *78*.

Fischthal, J.H. and Thomas, J.D. (1990): Some metacercariae of digenetic trematodes in fish from Nungua Lake, Ghana. *Ann. Inst. Biol. Univ. Nat. Auton. Mexico*, 41: 73-80.

Florio, D., Gustinelli, A., Caffara, M., Turci, F., Quaglio, F., Konecny, R. & Matolla, G. K. (2009): Veterinary and public health aspects in tilapia (*Oreochromis niloticus niloticus*) aquaculture in Kenya, Uganda and Ethiopia. *Ittiopatologia*, *6*: 51-93.

Fryer, G. (1968): The parasitic Crustacea of African freshwater fish: their biology and distribution. *J. Zoology London*, 156: 35-43.

Gillardin, C., Vanhove, M. P. M., Pariselle, A., Huyse, T. and Volckaert, F. A. M (2012): Ancyrocephalidae (Monogenea) of Lake Tanganyika: II: description of the first *Cichlidogyrus* spp. parasites from Tropheini fish hosts (Teleostei, Cichlidae). *Parasitol Res* 110: 305-313.

Grabda, J. (1991): *Marine fish parasitology: An outline*. VCH Verlagsgesellschaft mbH.

Hirazawa, N., Mitsuboshi T., Hirata T. and Shirasu, K. (2004): Susceptibility of spotted halibut *Verasper variegatus* (Pleuronectidae) to infection by the monogenean *Neobenedenia girellae* (Capsalidae) and oral therapy trials using praziquantel, *Aquaculture* 238: 83-95.

Kabata, Z. (1985): Parasites and diseases of fish cultured in the tropics. Taylor and Francis, London and Philadelphia. pp. 153-166.

Karvonen, A., Kristjánsson, B. K., Skúlason, S., Lanki, M., Rellstab, C., & Jokela, J. (2013). Water temperature, not fish morph, determines parasite infections of sympatric

Icelandic threespine sticklebacks (Gasterosteus aculeatus). *Ecology and evolution*, *3*(6), 1507-1517.

Khalil, L.F. (1969): Studies on the helminth padrasites of freshwater fishes of the Sudan. *J. Zool. London*, 158: 143-170.

Khalil, L.F. and Polling, L. (1997): Check list of the helminth parasites of African freshwater fishes. Department of Zoology/Biology, University of the North Sovenga, South Africa.

Lom, J., & Dyková, I. (1992). *Protozoan parasites of fishes*. Elsevier Science Publishers.

Madanire-Moyo, G., and Barson, M. (2010): Diversity of metazoan parasites of the African catfish *Clarias gariepinus* (Burchell, 1822) as indicators of pollution in a subtropical African river system. *Journal of Helminthology*, *84*(02), 216-227.

Malvestuto, S.P. and Ogambo-Ongoma, A. (1978): Observation on the infection of Tilapia leucosticte (Pisces: Cichlidae) with Contracaecum (Nematoda: Heterocheilidae) in Lake Naivasha, Kenya. *J. Parasitol*., 64: 383-384.

Marcogliese, D. J. (2004): Parasites: small players with crucial roles in the ecological theatre. *Ecohealth* 1: 151–164.

Martins, M. L., Azevedo, T. M., Ghiraldelli, L., & Bernardi, N. (2010). Can the parasitic fauna on Nile tilapias be affected by different production systems? *Anais da Academia Brasileira de Ciências*, *82*(2), 493-500.

Martins, M. L., Cardoso, L., Marchiori, N., & Benites de Pádua, S. (2015). Protozoan infections in farmed fish from Brazil: diagnosis and pathogenesis. *Revista Brasileira de Parasitologia Veterinária*, *24*(1), 1-20.

Merid, Y., Hegazy, M., Mekete, G. and Teklemariam, S. (2001): Intestinal helminthic infection among children at Lake Awassa area, south Ethiopia. *Ethiopian Journal of Health Development*, *15*(1).

Moravec, F., (1974): The development of *Paracamallanus cyathopharynx* (Baylis, 1923) (Nematoda, Camallanidae). *Folia Parasitol. Praha*, 21: 333-343.

Obiakezie, A.I. and Taega, M. (1991): Mortality in hatchery reared fry of the African catfish Clarias gariepinus (Burchell) caused by *Gyrodactylus groschafti Ergens*, Bull. Eudr. *Ass. Fish Pathol.* 11: 82-85.

Öztürk, T., and Özer, A. (2014): Monogenean fish parasites, their host preferences and seasonal distributions in the Lower Kızılırmak Delta (Turkey). *Turkish Journal of Fisheries and Aquatic Sciences*, 14, 367-378.

Paperna, I. (1980): Parasites, infections and diseases of fish in Africa. CIFA Tech. Pap. 7: 216.

Paperna, I. (1996): Parasites, infections and diseases of fishes in Africa: An update. CIFA Technical paper No. 31, FAO publication, Rome, Italy.

Paperna, I. and Thurston, J. P. (1996): Report on Ectoparasitic Infections of Fresh Water Fish in Africa. *Bull Anim Health Prod Afr* 69 (7-8): 1197-1206

Pariselle, A. and Euzet, L, (2009): Systematic revision of dactylogyridean parasites (Monogenea) from cichlid fishes in Africa, the Levant and Madagascar. Zoosystema 31(4):849-898.

Peggy, R., Ruth, F. F., Ruth, E. K. and Denise, P. (2012): Monogenean Parasites of Fish University of Florida/ FAS extension FA28 assessed online on 23/03/2017 at 18:50hrs.

Poulin, R. (2006). Global warming and temperature-mediated increases in cercarial emergence in trematode parasites. *Parasitology*, *132*(01), 143-151.

Řehulková, E., Mendlová, M., and Šimková, A. (2013). Two new species of Cichlidogyrus (Monogenea: Dactylogyridae) parasitizing the gills of African cichlid fishes (Perciformes) from Senegal: morphometric and molecular characterization. *Parasitology research*, *112*(4), 1399-1410.

Schell, S.C. (1970): How to know the trematodes. WM.C. Brown Comp. Pub. Dubuque, Lowa.

Scholz, T., Garcia, H. H., Kuchta, R., and Wicht, B. (2009): Update on the human broad tapeworm (genus Diphyllobothrium), including clinical relevance. *Clinical Microbiology Reviews*, *22*(1), 146-160.

Smith, J.W. (1972): The blood flukes (Digenea: Sanguinicolidae and Spirorchidae) of cold-blooded Vertebrates and some comparison with Schistosomes. *Helm. Abst. Ser. A.*, 41: 161-204.

Valtonen, E. T., Marcogliese, D. J., & Julkunen, M. (2010). Vertebrate diets derived from trophically transmitted fish parasites in the Bothnian Bay. *Oecologia*, *162*(1), 139.

Van As, J. G., & Basson, L. (1989). A further contribution to the taxonomy of the Trichodinidae (Ciliophora: Peritrichia) and a review of the taxonomic status of some fish ectoparasitic trichodinids. *Systematic Parasitology*, *14*(3), 157-179.

Whittington, I.D., Cribb, B.W., Hamwood, T.E. and Halliday, J.A. (2000): Host-specificity of Monogenean (Platyhelminth) parasites: a role for anterior adhesive areas? *Int. J. Parasitol.*30:305-320.

Whyte, S. K., Secombes, C. J., & Chappell, L. H. (1998): Studies on the infectivity of Diplostomum spathaceum in rainbow trout (*Oncorhynchus mykiss*). *Journal of helminthology*, *65*(03), 169-178.

Woo, P.T.K. (1995): Fish Disease and Disorder: Protozoan and Metazoan Infection volume1. *CABI international, walling ford*, UK. pp: 45- 46.

Xu, D. H., Shoemaker, C. A., Martins, M. L., Pridgeon, J. W., & Klesius, P. H. (2012). Enhanced susceptibility of channel catfish to the bacterium Edwardsiella ictaluri after parasitism by Ichthyophthirius multifiliis. *Veterinary microbiology*, *158*(1), 216-219.

Yemmen, C., Ktari, M. H., & Bahri, S. (2011). Seasonality and histopathology of Trichodina puytoraci Lom, 1962, a parasite of flathead mullet (Mugil cephalus) from Tunisia. *Acta Adriat*, *52*(1), 15-20.

Yimer, E. (2000): Preliminary survey of parasites and bacterial pathogens of fish at Lake Ziway. In: *SINET: ETHIOP. J.SCI*. 23(1): 25-33. Faculty of science, Addis Ababa University, Ethiopia.

Yimer, E. (2003): Preliminary survey of parasites and Bacterial pathogens of fish at Lake Ziway, *Ethiopia. Journal. Science* (23). Pp.25-33

Yimer, E. and Mulualem, E. (2003): Parasites of fish at Lake Tana, Ethiopia. Faculty of science, Addis Ababa University, Ethiopia. In: *SINET: ETHIOP.J.SCI,* 26(1): 31-36.

Yimer, E., Enyew, M., Hussien, I. and Kebede, A. (2001): Preliminary report on Eye fluke (*Diplostomum species*) in fish of Ethiopia water. *Ethiop. J. of Ana. Prod. (EJAP*) 1 (1): 63-66.

Yimer, E., Kebede, A. and Biruk, Y. (1999): Preliminary survey of parasites of fish at Lake Chamo. In: *Proceedings of 7$^{th}$ annual conference of the ESAP (Ethiopian Society of Animal Production);* Addis Ababa, Ethiopia.