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RESEARCH PAPER

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Prevalence of Internal Helminth Parasites of Fish in Gilgel-Gibe River and Three Selected Ponds in and Around Jimma Town, South West Ethiopia

Hailekiros Gebreegziabher[1], Hailu Degefu[2], Assefa Kebede Tsegay[3,*]

[1] Farmers and Urban Agriculture Development Office Kirkos Sub-city, Addis Ababa, Ethiopia.
[2] Jimma University, College of Agriculture and Veterinary Medicine, School of Veterinary Medicine, Jimma, Ethiopia.
[3] Mekelle University College of Veterinary Sciences, Mekelle, Ethiopia.

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Corresponding Author
Tel.: +251991674697
E-mail: assefa.kebede@ju.edu.et

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Abstract

In the current study, 308 Oreochromis niloticus and 76 Barbus species were subjected to standard postmortem and parasitological examinations. Of them, 30.9% of fish harbored at least one or more helminth parasites in their kidney, pericardial and brachial cavity. Parasite genera identified were Contracaecum (18.5%) Clinostomum (6.5%) and Euclinostomum (3.9%). The overall prevalence in O. niloticus was 38.6% but no parasite was identified in Barbus species. Despite higher prevalence was recorded in O. niloticus collected from Seka-Chekorsa pond (57.1%) and the least from Furustale ponds (30.9%), there was no statistical significance variation (P>0.05) among fishes collected from different ponds and Gilgel-Gibe River. Statistically significant differences were recorded among the different age groups of O. niloticus ($\chi2$ = 12.1, Df= 3; P<0.05), with high prevalence in fingerlings (55.5%) and juvenile (53.1%) as compared to young (36.5%) and adult fish (29.4%). In conclusion, fish parasitism constitutes a huge health threat to O. niloticus. Lastly, the current study revealed that Barbus species showed some resistance for parasitic helminthes at least identified in this study. Therefore, detailed study in Barbus immunity against the mentioned helminthes and awareness creation on the overall fish management is recommended.

Introduction

The internal parasites of fish inhabit the digestive tract or other organs in the body of fish (Murray, 2005). Parasitic diseases of fish are very common all over the world and are of particular importance in the tropics (Soliman & Nasr, 2015). These internal parasites of fish affect fishes negatively in several ways, which poses a potential threat to the sustainability of fisheries, which is a source of protein, and income to several communities in the world (Paperna, 1996).

Parasite infection in fish refers to a disease conditions resulting from organisms living in or on the fish and causes significant reduction in the production of the sector (Bassey, 2011). Severe parasitic infections are becoming threats for fish health management and production throughout the world. They cause decrease in growth rate, weight loss, affect yield of fish production, spread human and animal diseases, postpone sexual maturity of fish and increase fish mortalities (Chandra, 2006). Parasitic infection in fish is detrimental to the fish industry because it lowers the quality and quantity and the economic value of fish (Kaddumukasa, Kaddum, & Maranga, 2006). Moreover, parasite infections of fish are of great concern since they often produce a weakening of the hosts immune system thereby increasing their susceptibility to secondary infection by disease causing agents (e.g. fungi, bacteria and viruses) resulting in the nutritive devaluation of fish and subsequent economic losses by presenting marketing problems for commercially exploited species (Peterson, Palm, Moller, & Cuzi, 1993; Onyedineke, Obi, Ofoegbu, & Ukogo, 2010).

Furthermore, fish parasites spoil the appearance of fish and resulting in consumer rejection (Gulelat, Eshetu, Asmare, & Bekele, 2013). In Ethiopia, there are only few studies conducted on parasites of fish from different lakes and reservoirs found in different agro-ecology of the country such as Lake Tana (Tizie, Baye, & Mohamed, 2014), Lake Lugo (Amare, Alemayehu, & Aylate, 2014) and Koka reservoir (Gulelat *et al.*, 2013). There was also a previous report on prevalence of internal parasites of fish in Lake Ziway (Eshetu, 2000). In most of these research findings, several groups of parasites belonging to helminthes, arthropods, protozoan and other groups of miscellaneous taxa were identified (Eshetu & Mulualem, 2004; Zekarias & Yimer, 2007; Gulelat *et al.*, 2013). However; there was no so far any report on the prevalence of internal parasites of fish in Gilgel Gibe River and in the three selected ponds namely Seka chekorsa pond and the rest two ponds found in Furustale, Jimma sub-city. The most abundant and commercially important fish species in the above-mentioned water bodies are Nile Tilapia and *Barbus* species. Therefore, the present study was undertaken to determine the prevalence of internal parasitic helminthes affecting *Oreochromis niloticus* (Nile Tilapia) and *Barbus* species found in Gilgel-gibe River and the three selected ponds found in and around Jimma town.

Materials and Methods

Description of Study Area

Jimma is located 350 km south west of Addis Ababa ($7^0$41′ N, $36^0$50′ E) at an average altitude of 1780 m above sea level and is characterized by a temperate rainy climate with a warm summer (Köppen, 1936). The city had a population density of about 3521 persons per kilometer in 2015 and an average population growth rate of 4.9% per year (CDC, 2015). There are two major rivers flowing through the city: Awetu, which bisects the center of the city and Kito, which flows at the western end. At the eastern part of Jimma, some smaller rivers (Dipo, Seto, Kochi, University Stream, Aramaic, and Dololo) are present. South of Jimma, these rivers merge together and flow into Boye wetland, a large water body covered by vegetation. This was initially a pond but became overgrown by vegetation due to eutrophication (Abegaz, Legesse, & Tiku, 2005). Eventually, the water from Boye ends up in the Gilgel Gibe River below the intake point of the water treatment plant of Jimma (Haddis *et al.*, 2014). Gilgel Gibe River is sub-basin of the Omo-Gibe river system/basin which flows through the arc of Jimma town between Bore kebele and “Kerchele” (local prison) and it is located 4.30 km away from Jimma town (Ethiopian Roads Authority, 2016).

Two of the ponds included in this study are owned by Jimma University College of Agriculture and Veterinary Medicine, and are located in a place called Furustale. These ponds are established for research and production of fishes. At the end of the research, the results of the two ponds were merged together since there was no significant difference between them. The other pond selected for the study is found in Seka chekorsa district which is 20 km from Jimma town and geographically it is located between $36^0$33′ 53′′ to the E and $7^0$20′ to 7^0 45′ to the N. It is bounded by Gomma and Manna Woreda in the north, Gera Woreda in the south, Dedo and Jimma Town in the East and Shabe Sombo Woreda in the west. Currently, the Woreda covers an estimated area of 455 km^2 and divided in to thirty-six rural kebeles and one urban (town) kebele.

Study Population

The fish that inhabit Gilgel Gibe River are *Barbus*, *Garra, Labeo* and *Oreochromis* (Nile Tilapia) but only the Nile Tilapia and *Barbus* fish are known to be commercially important for some subsistence fishing at local level (Ethiopian Roads Authority, 2016). Currently Cat fish (*Clarias gariepinus*) inhabits in the Gilgel Gibe River but their number is small and the fish that inhabits the selected ponds are Nile Tilapia. The fish species included in the current study were *Oreochromis niloticus* (Nile tilapia) of all age, sexes and weight from the three selected ponds and Gilgel Gibe River and only *Barbus* species of all age, sexes and weight from Gilgel Gibe River. The other fish species were not included in the current study because their numbers were very small and they were not well known by the local fishermen present in the local area.

Study Design

A cross sectional study was conducted from October 2016 to April 2017 at Gilgel Gibe River and the three selected ponds; pond one in Seka chekorsa and pond two and pond three in Jimma University College of Agriculture and Veterinary Medicine Furustale research and production fish farm.

Sample Size Determination

The desired sample size was calculated using the Thrusfield (2005) formula with 95% confidence interval and 5% absolute precision and 50% expected prevalence of internal parasitic helminthes and the total numbers of samples considered in this study were 384.

Site Selection and Sampling Strategy

Purposively, Gilgel Gibe River and the three ponds namely Pond one in Seka chekorsa, pond two and pond three in Jimma University College of Agriculture and Veterinary Medicine Furustale Integrated Research and Fish Production Farm were selected. The study sites were selected due to presence of complains about the rejection of fish meat by consumers due to the presence of parasites from local fisher men's and due to the presence of commercially important fish species in those sites. All fish samples were randomly selected from the identified important fish species in the area and purchased from fishermen present around the lake and in the selected three ponds.

Sex and Age Determination

The sexes of each fish were determined after dissection and noting the presence of testes or ovaries according to Imam and Dewu (2010). The weight of each fish was measured and recorded following the procedures described by Paperna (1996) and the fishes were categorized into four age groups based on their weight. Accordingly, fish weighing 0.08-0.1 kg were classified as the fingerlings, 0.11–0.2 kg as juvenile, 0.21-0.3 kg as young and >0.31 kg as adult fish (Allumma & Idowu, 2011).

Sample Collection and Parasites Identification

All samples of fishes were clearly labeled with the date of sampling and species of fish, and transported immediately in ice box to Jimma University College of Agriculture and Veterinary Medicine, Parasitology and Pathology Laboratory. Each sample of fish was evaluated visually and postmortem examination was done using appropriate postmortem kits using standard evisceration technique previously described by Zhokhov, Mironovsky, and Miretskaya (2007). All the collected parasites were preserved in 70% ethanol and fixed in Alcohol Formalin Acetic Acid (AFA) and glycerin for further identification (Marcogliese, 2001). The parasites were identified under stereo-microscope by using the standard keys in the literature (Paperna, 1980; Paperna, 1996; Hoffman, 1999; Roberts, 2001; Klinger & Francis-floyd, 2002; Roy, 2002; Amlacher, 2005; Pouder, Curtis, & Roy, 2005). In both study sites and in the laboratory, the age, the species, sex and site of infection were identified and recorded.

Data Management and Analysis

The collected data were entered and managed in Microsoft excel and it was analyzed using STATA software (version 11). Descriptive statistics was applied for the analysis of the data obtained. Chi-square and Fisher exact test were used to examine whether the species, sex, area and age of fish were associated with prevalence of internal parasites. For all statistical analysis, 95% of confidence interval and P value less than 0.05 was considered statistically significant.

Results

Out of the 384 examined fish, 119 (30.9%) of them were found to harbour internal parasitic helminthes inside their internal organs like kidney, pericardial and brachial cavity. Despite both *Oreochromis niloticus* and *Barbus* species of fish were examined, only the former fish species were found to be infected by one or more of internal parasitic helminthes.

Out of 308 examined Nile tilapias, 119 (38.6%) were infected by internal parasitic helminthes. The prevalence was higher in male than in female fish; however, the difference was not statistically significant (P=*0.34*). In the current study, higher prevalence was recorded in fingerlings and juvenile age groups of fish as compared to young and adult groups and the variation was statistically significant (χ^2*=12.1, Df=3,* P=*0.007*). Furthermore, the prevalence of internal parasites of fish was found to be higher in Seka chekorsa pond (57.1%) followed by Gilgel Gibe River (39.9%) and Furustale Ponds (30.9 %) but the differences were not statistically significant (P=*1.47*) (Table 1).

In the present study, three genera of internal parasitic helminthes of *Oreochromis niloticus* were identified and these were: *Contracaecum* (Nematoda), *Clinostomum* (Trematoda) and *Euclinostomum* (Trematoda) and out of them, the most abundance genus was *Contracaecum* and their respective prevalence was found to be *Contracaecum* (18.5%), (6.5 %) and (3.9%) (Table 2).

Table 1. Prevalence of internal parasitic helminthes among examined *Oreochromis niloticus* (n =308) in different sex, study sites and ages during the study periods

Variables	No. Examine	No. Positive (Prevalence= %)	95% CI	χ^2	P-value
Sex					
Male	213	86 (40.4)	[34-47.1]	0.88	0.34
Female	95	33 (34.7)	[25.9-44.7]		
Age					
Fingerlings	18	10(55.5)	[33.7-75.4]		
Juvenile	66	35 (53.1)	[41.8-65.4]	12.1	0.007
Young	115	42 (36.5)	[28.3-45.6]		
Adult	109	32 (29.4)	[32.6-38.4]		
Study sites					
Seka Pond	14	8(57.1)	[32.6-78.6]		
Furustale Ponds	71	22 (30.9)	[21.4-42.4]	3.8	1.47
Gilgel Gibe River	223	89(39.9)	[33.7-46.4]		

Table 2. Prevalence of different genera of helminthes in examined *O. niloticus* (Nile Tilapia) from Gilgel-gibe River and ponds of Seka and Furustale (n=308) during the study periods

Genera of helminthes	No. Positive (Prevalence= %)	95% CI	χ²	p-value
Contracaecum	57(18.5)	[14.3-23.3]		
Clinostomum	20(6.5)	[40.1-98.5]	42.9	0.00
Euclinostomum	12(3.9)	[2.0-6.7]		

Table 3. Prevalence of genera *Contracaecum*, *Clinostomum* and *Euclinostomum* among different sex, age and study sites (n= 308) during the study periods

Parasite genera	Variables	No. Examined	No. positive (Prevalence %)	95% CI	χ² (Fisher exact)	P-value
Contracaecum	Sex					
	Male	213	33 (15.5)	[10.9-21.0]	4.2	0.04
	Female	95	24 (25.5)	[16.9-35.2]		
	Age					
	Fingerlings	18	7 (38.8)	[17.2-64.2]	12.7	0.005
	Juvenile	66	6 (9.1)	[3.4-18.7]		
	Young	115	17 (14.7)	[8.8-22.6]		
	Adult	109	27 (24.7)	[17.0-33.9]		
	Study sites					
	Seka pond	14	8 (57.1)	[28.9-82.3]	Fisher exact	0.000
	Furustale ponds	71	0 (0)	-		
	GilgelGibe River	223	49 (21.9)	[16.7-28.1]		
Clinostomum	Sex					
	Male	213	19 (8.9)	[5.5-13.6]	Fisher exact	0.010
	Female	95	1 (1.05)	[0-5.7]		
	Age					
	Fingerlings	18	0 (0)	-	Fisher exact	0.093
	Juvenile	66	7 (10.6)	[4.4-20.6]		
	Young	115	10 (8.7)	[4.2-15.4]		
	Adult	109	3 (2.3)	[0.6-7.8]		
	Study sites					
	Seka pond	14	0 (0)	-	Fisher exact	0.004
	Furustale ponds	71	11 (15.5)	[0.8-26.8]		
	Gilgel Gibe River	223	9 (4.04)	[1.9-7.5]		
Euclinostomum	Sex					
	Male	213	10 (4.7)	[2.3-8.5]	Fisher exact	0.355
	Female	95	2 (2.1)	[0.3-7.4]		
	Age					
	Fingerlings	18	1 (5.55)	[0.1-27.3]	Fisher exact	0.021
	Juvenile	66	4 (6.06)	[1.7-14.8]		
	Young	115	7 (6.08)	[2.5-12.1]		
	Adult	109	0 (0)	-		
	Study sites					
	Seka pond	14	0 (0)	-	Fisher exact	0.000
	Furustale ponds	71	11 (15.5)	[8-26]		
	Gilgel Gibe River	223	1 (0.45)	[0.0-2.5]		

The differences in prevalence's of the three parasitic helminthes among different sexes, ages and study sites were statistical significance (Table 3). The present study also revealed mixed infection of *Contracaecum* and *Clinostomum,* and *Contracaecum* and *Euclinostomum* with a prevalence of 8.77% and 0.97%, respectively.

Discussion

The overall prevalence of internal parasitic helminthes of fish in Gilgel Gibe River and the three selected ponds was found to be 30.9 %. The finding was relatively higher than the finding of Gebawo (2015), Bekele and Hussein (2015) and Uneke (2015) who had reported a prevalence of 10.6%, 20.83% and 20% from Lakes Élan and Ziway, Ethiopia and Cross River Flood System, Southeastern Nigeria, respectively. However, the finding of the present study was lower than the finding of Akinsanya, Hassan, and Adeogun (2008), Gulelat *et al.* (2013) and Amare *et al.* (2014) who had reported 38.7%, 66.3% and 47.8%, from Lekki Lagoon, Lagos, Nigeria and Koka reservoir and Lake Lugo (Hayke) from Ethiopia, respectively. Those differences might be due to the differences in composition of the water (dissolved oxygen, temperature, salt content, pH and eutrophication), climatic conditions of the areas, season and host parasite relationships (Edma, Okaka, Oboh, & Okogub, 2008; Bagherpour, Afsharnasab, Mobedi, Jalali, & Mesbah, 2011; Qasim and Ayub, 2012; Amare *et al.*, 2014).

Even though, the differences in prevalence among the different study sites were not statistically significant, the highest prevalence was recorded in Seka chekorsa pond (57.1%) followed by Gilgel Gibe River (39.9%) and Furustale Ponds (30.9 %). This difference might be due to differences in overcrowding, poor environmental conditions and pollution levels of the different study sites which often result in reduced immunity of fish and higher susceptibility to parasites and other diseases (Biu, Diyaware, Yakaka, & Rita, 2014). The authors also observed similar differences in overcrowding and pollution levels of the different study ponds and river during their study time. In the current study, males had higher prevalence of internal parasitic helminthes (40.4%) than female fish (34.7 %), but the difference between sexes was not statistically significant. This finding agrees with the finding of Bekele and Hussein (2015) in Lake Ziway, Ethiopia; Reshid, Adugna, Redda, Awol and Teklu (2015) in small Abaya Lake, Silte Zone, Ethiopia; Gebawo (2015) in Lake Elan, Ethiopia and Uneke (2015) in the Mid Cross River Flood System, Southeastern, Nigeria. This might be due to the exhaustion of male's immunity by frequent insemination of females in the fish stock. However, the result was contradicted with the findings of Amare *et al.* (2014) in Lake Lugo (Hayke) and Tizie *et al.* (2014) in Lake Tana as it was justified by Emere and Egbe (2006) to be due to female fish especially the gravid once are susceptible to helminth infections as the physiological state could reduce their resistance.

The current study revealed that there is statistical significant difference in infection rate between *O. niloticus* (38.6%) and *Barbus* sp (zero prevalence) by parasite helminthes. This finding disagrees with the finding of Gulelat *et al.* (2013) who had reported 42.27% prevalence internal helminth parasites from Koka reservoir, Ethiopia from *Barbus intermedius* and Eshetu and Mulualem (2004) from Lake Tana, Ethiopia who had reported 24.64%, 9.44% and 12.84% prevalence of *Contracaecum* nematode from *Barbus acutirostris, Barbus tsanensis and Barbus brevicephalus,* respectively. The highest parasitic infections in Nile tilapia in the present study could be associated with the highest number of sampling Nile tilapia (n=308) during the study period and with the prevalence and intensity dependent on factors of parasite species and their biology, host and its feeding habits and presence or absence of the intermediate hosts in the study ponds and rivers (Hussen, Tefera, & Asrate, 2012). Similar finding had been reported from Lake Lugo (Hayke), Ethiopia with the highest number of parasites was recovered from *Oreochromis niloticus* (61.95%) than in *Cyprinus carpio* (5.15%) by Amare *et al.* (2014).

In the present study, the highest prevalence was recorded in fingerlings and juvenile age groups as compare to young and adult groups. This finding agrees with Akinsanya, Otubanjo, and Ibidapo (2007) who stated that the low level of immunity in the smaller sized fish could explain the high prevalence of helminthosis, but contradicts with the findings of Allumma and Idowu (2011) and Amare *et al.* (2014) who had explained that the older the fish, the more exposed to parasite infection, as adult fish consumes a great variety of foods and exhibit a great variety of feeding styles that leads them to the ingestion of intermediate or paratonic hosts harboring infective stages of helminth parasites inside their body.

The most common parasite genera encountered in the present study were *Contracaecum* (18.5%) followed by *Clinostomum* (6.5%) and *Euclinostomum* (3.9%). Similar results were reported by Gulelat *et al.* (2013) who had documented a prevalence of 24.8% for *Contracaecum* followed by *Clinostomum* (27.4%) and *Euclinostomum* (2.73%) in *Oreochromis niloticus* from Koka reservoir, Ethiopia and Amare *et al.* (2014) who had also reported a prevalence of 42.6% for *Contracaecum* and 38.6% for *Clinostomum* in Lake Lugo, Ethiopia. Bekele and Hussein (2015) also reported a prevalence of 62.50% from *Contracaecum* and 31.25% from *Clinostomum* from Lake Ziway, Ethiopia. The higher prevalence of *Contracaecum* might be due to the fact that the parasite has a wide host range of aquatic birds that can serve as final and intermediate hosts (cormorants and pelicans) and larval stages are known to occur in most African fresh water fish, including carp and related species, channel catfish and tilapia (Paperna, 1980; Eshetu, 2000; Yanong, 2002). In the present study, single infection was the predominant case. Mixed infection was common due to the fact that the environment supports several parasites species thereby exposing the host to concurrent infections. It might also be due to the presence of one parasite and its activity within the host weakens the resistance of the host fish which leads to concurrent infection development (Allumma & Idowu, 2011).

Conclusion and Recommendations

The current study revealed that fish internal parasitic helminthes are important parasitic helminthes in and around Jimma town ponds and rivers; mainly in *Oreochromis niloticus* (Nile Tilapia) found in Gilgel Gibe River and two Furustale and One Seka chekorsa ponds. The most common genera of internal parasitic helminths identified in this study were: *Contracaecum*, *Clinostomum* and *Euclinostomum.* Some of them are potential zoonotic parasites. Furthermore, there were also concurrent infections among several fish. Age, sex and sites of study were some of the risk factors contributing for the presence and absence of the parasites in different fish samples. Therefore, the following recommendations are forwarded:

- Awareness creation for fishermen on general fish management, and fish diseases prevention and control should be promoted in the area.
- Further species level identification based on advanced diagnostic tools should be performed.
- Comprehensive study comprising water composition such as amount of availability of dissolved oxygen and other physicochemical properties and seasonal variability of the biodiversity of the water flora should be studied so as to clearly understand the major risk factors contributing to fish parasitic infection in the area.
- There should be nationwide strategy and policy that focuses on fish diseases and veterinary service delivery so as to help the efforts of fishermen.
- Some of the identified genera of parasite are known to have a zoonotic importance; therefore, public awareness creation on risk of infection by consumption of raw or undercooked fish meat should be initiated.
- Further study focusing on economic and public health impact of fish parasites and identification of intermediate hosts circulating in different ponds and rivers of the study area should be done.

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