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ECTOPARASITE INFESTATION OF NILE TILAPIA (*Oreochromis niloticus*) IN CAGE CULTURE AT MPAKADAM, GHANA

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Abstract
The aim of the study was to identify and estimate the prevalence and intensity of the infestation of common ectoparasites on Nile tilapia (Oreochromis niloticus) from cage culture systems at Mpakadam in the Asuogyaman District of the Eastern Region of Ghana. A total of 210 individual fish samples were collected. The total length of the samples was measured and they were grouped into phases according to their sizes as Initial Phase (0.1cm - 7.0cm), Intermediate Phase (7.1cm - 12.0cm) and Final Phase (12.1cm - 18.0cm). Each sample was then examined for ectoparasites with the aid of a light microscope and hand lens. Specific parts of the fish, thus the skin, gills, fins and eyes were examined. Measurement of water quality parameters of the water in the cages were also taken bimonthly throughout the study period. The study was conducted from December, 2016 to April, 2017. Out of 210 fish samples examined, 94 samples representing 44.76 % were infested with ectoparasites. 42.30% of the 78 samples within the initial phase were infested, 43.75 % of 96 samples with the intermediate phase were also infested, while 52.80 % of 36 samples of final phase were infested. Six species of ectoparasites namely, Trichodina sp., Diplostomum sp., Argulus sp., Dactyogyrus sp., Lernaea sp. and Ichthyophthirius miltifilis were identified. Parasites were found on all examined parts of the fish with the skin being the most infested part of the host. The prevalence and the mean intensity (MI) of parasites on the host were relatively low. All physico-chemical parameters measured were within the optimum values for tilapia culture as compared to the standard requirement for tilapia culture under cage system. The level of intensity of ectoparasites observed in this study, arguably will not pose a major threat to the fish on the farm in the area. However, critical attention should be given to the farm by employing best aquaculture management practices to prevent disease outbreaks due to intensification of ectoparasites.

Key Words: *Tropo farms, Mpakadam, Cage culture system, Asuogyaman District, Nile Tilapia*

Introduction

The fisheries sector in Ghana has over the past twenty years suffered a slow growth of 3% per annum (FAO, 2016) and Ghana is presently not self-sufficient in fish production as demand for fish and fish products continue to increase with the increasing population growth. Efforts are now made by the government and other entities to promote and encourage aquaculture production in the quest to maximize fish production in the country as a means of ensuring food security and poverty alleviation (Water Research Institute, 2012).

The Cage Culture Technology of producing fish has become common in many parts of the world since it makes use of already-existing water resources and requires less investment than traditional aquaculture ponds (Ono and Kubitza, 2003). Common problems normally associated with cage-culture systems include nutritional deficiency, inadequate handling, and poor water quality. These problems caused stressful conditions in fish and can foster infectious and parasitic diseases (Cavichiolo *et al.,* 2002; Martins *et al.,* 2002) which have negative repercussions on fish growth and survival. The negative impact of parasites on host growth and survival has been demonstrated in several parasite-fish host systems both in aquaculture and in natural population (Bichi and Dawaki, 2010; Yanong, 2002). Fish related parasites causes profound pathological changes which lowers the growth rhythm of fish considerably, affects the quality of the fish and often leads to death of fish, resulting in enormous economic losses to the fish industry (Geets and Ollevier, 1996). Some parasites relating to fish are transmissible to man and other fish- eating domestic and nondomestic animals (Klinger and Francis-floyd, 2002).

According to Thatcher and Brites-Neto (1994) and Pavanelli *et al.* (2008), several diseases and parasites can affect *Oreochromis niloticus* production and some of such parasites that frequently parasitize this fish species, include the protozoan ciliates and the monogenoids. Monogenoids are considered to be responsible for the most important parasitic disease in Brazilian fish farming because they can cause high mortality rates. The presence of these parasites in fish gills can cause hypersecretion of mucus, cell hyperplasia, and even fusion of the filaments of gill lamellae, reducing the host's respiratory capacity (Thatcher and Brites-Neto, 1994 and Pavanelli *et al*., 2008).

In Ghana, there is paucity of information on the distribution and abundance of pathogens in aquatic ecosystems. This makes it difficult to identify the groups of disease-causing organisms in aquaculture in order to develop preventive and control measures (Baidoo *et al.,* 2015). Concerns about fish diseases and parasitic infestation have existed for years yet little scientific evidence is available on the subject in Ghana. Parasitic infections of fish can be a major setback in achieving maximum production per unit area of culture. As the development of aquaculture is advancing, one essential issue that is yet to be addressed is the prevention of economic losses in cages due to improper management practices which has a direct link to parasite infestation. Therefore, knowing about ectoparasite infestation of fish in cage systems is something of greater concern but very little work has been done on parasite infestation in

Ghana. This study is however designed to identify and compile the various ectoparasites and their rate of infestation on the Nile tilapia, *O. niloticus* cultured in cages at Mpakadam in the Eastern Region of Ghana.

Materials and methods

Study Area

The study was conducted at Tropo farms, an aquaculture facility located at Mpakadam which is along the Lake Volta in the Asuogyaman District of the Eastern Region of Ghana. It is located on latitude 6° 34′ N and 6° 10′ N. the longitude is on 0° 1′ W and 0° 14′ E. The topography of the area is undulating and the climatic condition is within the Dry Equatorial Climatic zone. It has bi-modal rainfall. Tropo farms is the largest tilapia production facility in Ghana and the second largest in Africa. There are three (3) types of cages with different sizes and shape on the farm. These are 6 x 6 x 6 m, 12 x 12 x 12 m and the last type are a circular cages. The farm have offshore facilities which are mostly the circular cages and inshore facilities. The cages are arranged parallel to each other and grouped into nursery units and production units. There were about 240 cages on the farm at the time of study. These comprised of 195 cages with sizes 6 x 6x 6 m and 45 cages with sizes 12 x 12 x 12 m.

Sample Collection

A total of 210 live individuals of *Oreochromis niloticus* were collected with scoop nets from different cages at the farms and transported immediately in plastic container with the cage water to the laboratory of the Aquaculture Research and Development Center of the Council for Scientific and Industrial Research - Water Research Institute (ARDEC, CSIR-WRI) at Akosombo in the Eastern Region of Ghana for examination. The samples were collected from 6 m × 6 m ×6 m cages. The study was conducted within five months (December, 2016 – April, 2017). Sampling was carried out bimonthly within the study period.

Preparation and Processing of Samples

The total length of all 210 specimens were measured and they were grouped into phases according to their sizes as Initial Phase (0.1cm - 7.0cm), Intermediate Phase (7.1cm - 12.0cm) and Final Phase (12.1cm - 18.0cm). The total length was measured from the tip of the snout to the extreme end of the caudal fin and recorded in centimetre using a metre rule dissecting board. The weights of the fish were measured by placing the individual fish on weighing scales and the readings were taken to the nearest 0.1 grams. The fish samples were again separated into groups per their weight as follows: 0.1 g – 30.0 g; 30.1 g – 60.0 g; 60.1 g – 90.0 g; 90.1 g – 120.0 g.

Laboratory Examination of Samples

The external parts (skin and the skin mucus, fins, gills, eyes and the scales) of the *O. niloticus* samples were examined for parasites using a prepared wet slide which were viewed under light microscope and magnified hand lens. The fish samples were examined in accordance to the method describe by Paperna (1996) and parasites atlas (Barker and Cone, 2000).

Physico-chemical Analysis of the Cage Water

Temperature and Dissolved Oxygen (DO) of the cage water were measured on the farm using multi- purpose probe and the transparency was taken by secchi disc. The pH was measured *in-situ* using a pH meter (HANNA probe meter, version HI 83141). Samples of the cage water were taken in bottles, which were airtight to

prevent atmospheric oxygen dissolving into it before analysis and also place in an ice cube (< 4 °C) to prevent warming of the water to bring about dissolving of the nutrients. Ammonium – Nitrogen (Direct Nesslerization method), Nitrite – Nitrogen (Diazotization method), Nitrate – Nitrogen (Hydrazine reduction method) and Phosphate – Phosphorus (Stannous chloride method) was determined by the standard methods. All water samples were analysed at CSIR-Water Research Institute's laboratory according to standard methods (APHA, 2005).

Statistical Analysis of the Data

Data from the study were analysed for the prevalence, mean intensity (MI), index of infestation (II) and density of infection (DI) as follows.

Prevalence = $\frac{Number\ of\ infested\ with\ a\ particular\ parasite\ species}{Total\ number\ of\ hosts\ examined} \times 100$ (Bush *et al*., 1997).

Mean Intensity (MI) = $\frac{Total\ number\ of\ parasite\ species\ in\ host\ species}{Total\ number\ of\ infested\ host\ species}$ (Bush *et al*., 1997).

Density of infection (DI) = $\frac{number\ of\ parasites\ collected}{total\ \ number\ of\ sample\ examined}$ (Bush *et al*., 1997).

Index of infestation (II) = $\frac{Number\ of\ infested\ host\ X\ number\ of\ parasites\ collected}{Total\ number\ of\ samples\ examined}$ (Bush *et al*., 1997).

The results were presented in tables and graphs using the Microsoft Office Excel (Version 2010).

Results

Two hundred and ten (210) individual fish samples were examined during the five-month study period. Out of that, 78 of the fish representing 37.14% were grouped under Initial Phase, 96, representing 45.71% were under Intermediate Phase and 36, representing 17.15% were under the Final Phase (Table 1). From Table 1, 94 specimens, representing (44.76%) of the total fish examined were infested with at least one parasite (Table 1).

Table 1: Frequency of ectoparasite infested and un-infested fish in the various phases

Parameters (cm)	Initial Phase (0.1cm - 7.0cm)	Intermediate Phase (7.1cm - 12.0cm)	Final Phase (12.1cm - 18.0cm)	Total No. of fish.
Infested fish samples	33 (42.30%)	42 (43.75%)	19 (52.80%)	94 (44.76)
Un-infested fish samples	45 (57.70%)	54 (56.25%)	17 (47.20%)	116 (55.24)
Total	78 (37.14%)	96 (45.71%)	36 (17.14%)	210 (100)

With regards to size of the fish samples, the Intermediate phase was infested with more parasites than the other phases with a percentage of 45.71%. The Initial phase followed with 37.14% and the Final phase with 17.14% (Table 2).

Table 2: Prevalence of ectoparasites of *Oreochromis niloticus* in relation to size

Size (Total length)	No. of fish examined	% of fish examined	No. of infested fish	% of infested fish	No. of parasites identified	% of identified parasites
0.1cm - 7.0cm	78	37.14	33	35.10	42	35.89
7.1cm - 12.0cm	96	45.71	42	44.68	52	44.44
12.1cm - 18.0cm	36	17.14	19	20.21	23	19.65
Total	210	100	94	100	117	100

With regards to the body weight of the fish, samples which were within the weight interval of 0.1 g – 30.0 g were the most infested group with a prevalence rate of 80%, followed by those within the weight interval of 30.1g – 60.0 g with 17% infestation rate. 2% and 1% prevalence rate were recorded by samples within 60.1 g – 90.0 g and 90.1 g – 120.0 g respectively (Table 3).

Table 3: Prevalence of ectoparasites of *Oreochromis niloticus* in relation to their body weight

Fish body weight (g)	No. of fish examined	% of fish examined	No. of infested fish	% of infested fish	No. of parasites identified	% of identified parasites
0.1 – 30.0	167	79.52	66	70.02	87	74.36
30.1 – 60.0	35	16.67	22	23.40	23	19.66
60.1 – 90.0	5	2.38	4	4.26	5	4.27
90.1 – 120.0	3	1.42	2	2.13	2	1.71
Total	210	100	94	100	117	100

Six ectoparasite species were identified at the end of examining all 210 fish specimens. The identified species were *Trichodina* sp. and *Ichthyophthirius multifilus* of Protozoans ciliates, *Dactyolgyrus* sp. of Monogenean, *Argulus* sp. and *Lernaea* sp. of Crustaceans and the *Diplostomum* sp. These parasites were recovered from the skin, fins, eye and the gills. The skin was the most dominant external part with high parasites occurrence followed by the fins. Table 4 shows the parasites and the body part from which they were retrieved.

Table 4: Parasite species with corresponding body parts they were retrieved

Parasite species	Family nomenclature	Location on the fish
Ichtyophthirius multifilus	Ichthyopthiriidae	Skin and fin
Trichodina sp.	Trichodindae	Skin, fins and gill
Argulus sp.	Argulidae	Skin
Lernaea sp.	Lernaeidae	Skin
Diplostomum sp.	Diplostomatidae	Eye
Dactyolgyrus sp.	Dactyolgyridae	Gill

Out of the six parasites identified on the farm during the study period, *Ichthyophthirius multifilus* infestation was observed to be the most parasitic infestation on the farm with 15.70% prevalence, followed by *Trichodina* sp. with 15.20% and *Argulus* sp. with 2.90%

being the least prevalent parasite. Figure 1 shows the details of the prevalence levels of the various parasite species.

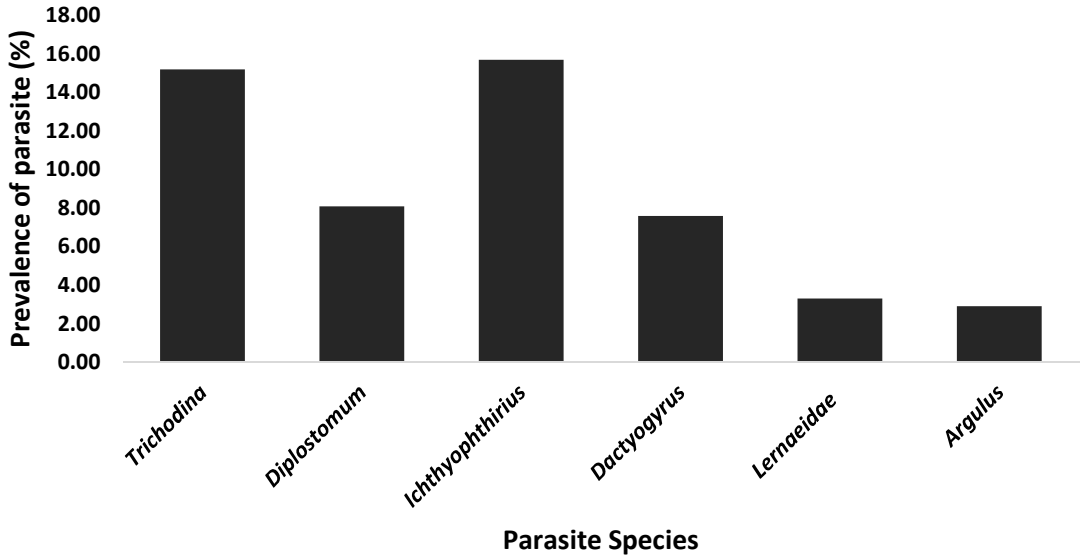

Fig. 1: The prevalence of identified parasites from *O. niloticus* from cages at Mpakadam

The study was conducted within five months from December, 2016 – April, 2017. The month of January, 2017 recorded the highest parasite infestation of 46 parasites, with *Ichthyophthirius multifilis* dominating among the species identified. January was followed by April, 2017 with 22 recorded parasites. *Trichodina* sp. was observed in all the months during the study period and recorded its highest in January, 2017. *Diplostomum* sp. was absent in December and its highest was recorded in February, 2017. In the month of April, 2017, all the six parasite species were identified. December, 2016 recorded only two species - *Dactyolgyrus* sp. and *Trichodina* sp. It also recorded the least parasite occurrence on the farm with 10 parasites while March and February, 2017 recorded 21 and 18 parasites respectively. These are all shown in Figure 2.

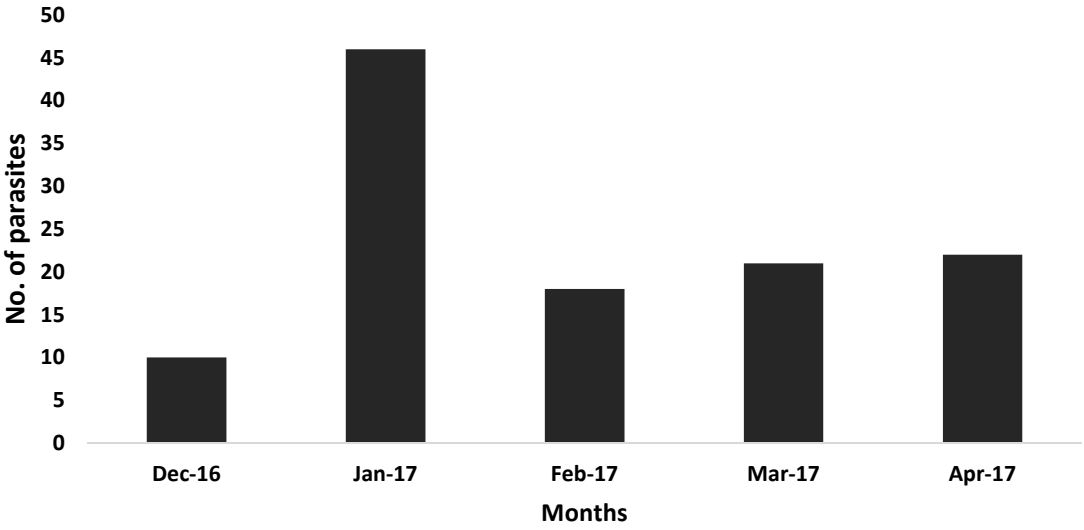

Fig. 2: Monthly number of parasites recovered during the five-month study period at Mpakadam

The Mean Intensity of the Parasites

The mean intensity of *Ichthyophthirius multifilis* was 0.37 follow by *Trichodina* sp. of 0.36. Both *Lernaea* sp. and *Argulus* sp. had the same mean intensity of 0.07. *Diplostomum* sp. was 0.02 which was less than that of *Dactyogyrus* sp. of 0.17 (Figure 3).

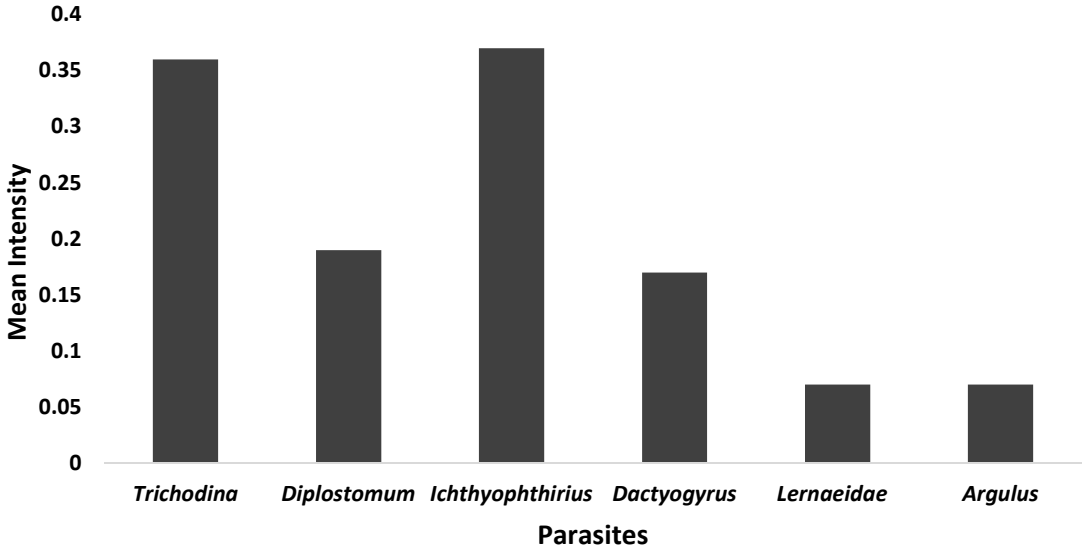

Fig. 3: The mean intensity of identified ectoparasites from cage culture systems at Mpakadam

The highest mean intensity was observed in January with *Ichthyophthirius multifilis* been the highest with a value of 0.8. *Trichodina* sp. was high in the month of December of 0.7. *Lernaea* sp. was zero in the month of December and 0.1 for the rest of the four months (Table 5).

Table 5: The monthly mean intensity of the ectoparasites from cage system at Mpakadam

Months	*Trichodina sp.*	*Ichthyophirius multifilus*	*Diplostomum sp.*	*Dactyolgyrus sp.*	*Argulus sp.*	*Larnaea sp*
Dec-16	0.3	0	0	0.7	0	0
Jan-17	0.4	0.8	0.1	0	0.1	0.1
Feb-17	0.5	0.1	0.4	0	0	0.1
Mar-17	0.2	0.3	0.3	0.3	0	0.1
Apr-17	0.3	0.2	0.2	0.2	0.2	0.1

The estimated density of infestation and index of infestation were 0.56 and 52.4 respectively.

Physico-Chemical Parameters of the Cage Water

All the physico-chemical parameters measured on the farm were ideal for Nile tilapia culture in fresh water ecosystem. Temperature was at its apex in the month of April, 2017 with a reading of 29.7 °C and least in February with 28.0 °C and mean of 28.9 °C ± 0.55 °C. Dissolved Oxygen (DO) ranged from 3.6 mgl^{-1} in January to 4.65 mgl^{-1} in March with a mean of 4.15 mgl^{-1} ± 0.35 mgl^{-1}. The pH was from 5.88 to 6.59 with a mean of 6.22 ± 0.3. Ammonium-nitrogen ranged from 0.227 mgl^{-1} to 0.410 mgl^{-1} with a mean of 0.3364 mgl^{-1} ± 0.06399 mgl^{-1}. Nitrite-nitrogen was observed to be the same through the five-month study. The nitrate-nitrogen ranged from 0.003 mgl^{-1} to 0.044 mgl^{-1} with a mean of 0.0134 mgl^{-1} ± 0.01539 mgl^{-1}. Phosphate-phosphorus ranged from 0.017 mgl^{-1} to 0.182 mgl^{-1} with a mean of 0.1064 mgl^{-1} ± 0.052 mgl^{-1}.

Table 6: Monthly records of physico-chemical parameters of the cage water in relation to parasite infestation

MONTHS	TR (cm)	T (°C)	DO (mg/l)	pH	NH_4	Nitrite (mg/l)	Nitrate (mg/l)	P-P (mg/l)	NP
Dec-16	180	28.9	4	6.59	0.333	0.001	0.003	0.107	10
Jan-17	250	29.2	3.6	6.01	0.39	0.001	0.008	0.121	46
Feb-17	260	28	4.2	5.88	0.41	0.001	0.044	0.182	18
Mar-17	170	28.9	4.65	6.58	0.322	0.001	0.005	0.105	21
Apr-17	265	29.7	4.3	6.06	0.227	0.001	0.007	0.017	22
MEAN	225	28.94	4.15	6.22	0.336	0.001	0.013	0.106	23.4
S.D.±	41.231	0.554	0.346	0.3	0.064	0	0.015	0.053	12.06

TR=Transparency, T=Temperature, DO=Dissolved Oxygen, NH_4=Ammonium –Nitrogen, P-P=Phosphate-phosphorus and NP= Number of Parasites.

Discussion

Out of 210 fish samples examined, 94 (44.76%) were infested with ectoparasites. Six ectoparasites were identified at the end of the study. These identified species were *Trichodina* sp. and *Ichthyophthirius multifilus* of Protozoans ciliates, *Dactyolgyrus* sp. of *Monogenean, Argulus* sp. and *Lernaea* sp. of Crustaceans and the *Diplostomum* sp. Unlike this study, Baidoo *et al*. (2015) and Amoako (2006) identified three ectoparasites. Baidoo *et al*. (2015) who worked on ectoparasite infestation on *O. niloticus* in concrete

ponds in Tamale, Ghana identified two protozoans, *Trichodina* sp. and *Ichthyophthirius multifilis* and monogeneans. Amoako (2006) on the other hand work on ectoparasite infestation on *O. niloticus* in aquaculture production in the Ashanti Region of Ghana found two protozoans, namely, *Trichodina* sp. and *Tetrahymena* sp., and monogeneans.

The prevalence and the mean intensity (MI) of parasites on the host were relatively low. Amoako (2006) and Baidoo *et al*. (2015) also recorded low rate of prevalence and intensity of parasites on *O. niloticus* from fish ponds. Baidoo *et al*. (2015) attributed their result to the moderately good pond water and proper management practices which was the case of our study. This has further been confirmed by Suliman and Al-Harbi (2016) that there is a clear relationship between ectoparasites and water quality and with nutritional quality. Moraes and Martins (2004) have also indicated that the presence of ectoparasites is directly related to water quality and pond management.

There was generally good farm management practice with respect to water quality during the study, which might have reduced the occurrence of these parasites. Those present were likely to be caused by accidental internal husbandry practices (transporting, grading of the fish and the use of the same equipment in both infected and un-infected cages), and presence of fish eating birds on the farm. With respect to transport, it was observed, a week or two after a cage under study had been transported, and it records the highest infestation that particular month. This was of the view that during bagging and transporting of the fish, they go through a lot of stress which makes them vulnerable to parasite infestation. According to Chappell *et al*. (1994) parasite vectors can also be spread by fish eating birds which carry the parasite in their mouth and release them during feeding or through their faeces into the water body. These were observed on the farm as fish eating birds were always present.

These parasites were found to be in mixed infestation on the host as reported by Otachi (2009). Specific parasites infest particular parts of the host and dominates in a particular growth phase. For example, *Diplostomum* sp. is a trematode ectoparasite of fish that infest only the eyes (Stewart and Bernier, 1999) and you should not expect to find it in any part of the fish's body. This fact was confirmed by the result of this study. The study also indicated that apart from *Diplostomum* sp. which was recovered from only the eye balls, *Dactyolgyrus* sp. was found only on the gills, *Argulus* sp. and *Lernaea* sp. were found on the skin while *Trichodina* sp. and *Ichtyophthirius multifilus* were found on more than one part of the fish (i.e. skin, fins, fin and gill). Similar assertion was made by Bychowsky (1957) and Malmberg (1990) that primitive monogenean infests primitive fish. The skin therefore was the most infested part of the fish during the study. This may be attributed to injuries on the skin as a result of stress or the exposed nature of the skin to the environment.

The month of January, 2017 recorded the highest prevalence of 76% followed by April, 2017 with 45%. The month with the least recorded prevalence was December, 2016 with 24%. These values did not follow any particular pattern and cannot be related to any factor. Prevalence with respect to total length saw the intermediate phase to the highest infestation with a

prevalence of 45% followed by the initial phase with 35% and lastly, the final phase with 23%. With the weight range, 70% prevalence was observed among the fish with body weight ranging from 0.1g – 30g, followed by 24% for 30.1g – 60g, 4% for 60.1g – 90g and 2% for 90.1g – 120g. These may have been because most of the samples examined were within the size range of the intermediate phase and weight range of 0.1g – 30g. *Ichthyophthirius multifilis* had the high mean intensity on the farm during the study period. This may be because it is the largest protozoan parasite of fish and one of the most commonly encountered as reported by Koyuncu and Toksen (2010).

The values for physico-chemical parameters measured on the farm were generally good for the cultivation of Nile tilapia in freshwater cage systems. Temperature for instance, was within the desired range as suggested by Svobodova *et al*. (1999) and was very good for Nile tilapia culture. All the nutrients measured were also within preferable values for culture of *O. niloticus*. Example, Ammonium-Nitrogen was from 0.22mgl^{-1} to 0.41mgl^{-1} which was within the standard reported by APHA, AWWA, and WPCF, (1992). Nitrate-Nitrogen, Nitrite-Nitrogen values were below the 0.5mgl^{-1} optimum value as reported by Svobodo *et al*. (1999). These may have contributed to the low prevalence rate and intensity of parasites on the fish from the Tropo farms.

Conclusion

Six species of ectoparasites namely, *Trichodina* sp., *Diplostomum* sp., *Argulus* sp., *Dactyogyrus* sp., *Lernaea* sp. and *Ichthyophthirius miltifilis* were identified. Parasites were found on all examined parts of the fish with the skin being the most infested part of the host. The prevalence and the mean intensity of parasites on the host were relatively low. The presence of these parasites might result from accidental daily management practices. Environmental conditions of the water had no serious relationship with the prevalence and the intensity of the ectoparasites. Physico-chemical parameters measured were within the optimum values for tilapia culture as compared to the standard requirement for tilapia culture under cage system.

The level of intensity of ectoparasites observed in this study, arguably will not pose a major threat to the fish on the farm in the area. However, critical attention should be given to the farm by employing best aquaculture management practices to prevent disease outbreaks due to intensification of ectoparasites. There should be improvement of internal husbandry practices on the farm since it could reduce the rate of handling the fish during transportation and grading as these practices make the fish weak and vulnerable to parasites infestation. Also equipment used on infected cage should be treated before using in un-infested cage. Also, a measure must be put in place to prevent fish eating birds from entering into the cage since these birds serves as agents that carry parasites to the fish.

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