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Occurrence of ectoparasites on *Tilapia zillii* (Red belly tilapia) Gervais 1848 in the Tono reservoir, Navrongo, Ghana

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ABSTRACT

More than a billion people worldwide eat fish as their primary source of high-quality protein. Fish parasites have a direct impact on fish productivity, and a secondary impact on human health. This study was carried out to assess the occurrence of endoparasites in *Tilapia zillii* (Gervais, 1848) from Tono reservoir, Navrongo, Ghana. A total of 120 fish samples were collected from the up-stream, mid-stream and down-stream regions of the reservoir using cast nets. All the collected fish samples were transported to the research laboratory in the University for Development Studies and examined for ectoparasites during January 2022 to August 2022. Five ectoparasites namely *Trichodina* sp. of Protozoans ciliates, *Dactyolgyrus* sp. of Monogenean, *Argulus* sp. and *Lernaea* sp. of Crustaceans and the *Diplostomum* sp were identified. Overall prevalence of the fish parasites was 52.32 %. The intensity of the parasites observed ranged between 1.58% and 3.52%. Highest prevalence (70%) was reported in the dry season, while the lowest (31.67%) was reported in the rainy season. Female fish samples had a higher prevalence (64.47%) than males (27.27%). Fish of the down-stream had the highest prevalence (92.5%) than the up-stream (17.5%). Fish samples with maximum length and weight were highly (65.15%) infected than small-sized fish with low body length and weight (33.33%). This study shows that the dry season (January, February, March, and April) affects the fish business and results in poor quality fish meat with risk of disease infection.

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INTRODUCTION

Several millions of people around the world depend heavily on fish for their survival. Fish are an important food source for humans, providing necessary nutrients, and the global fisheries industry is crucial for providing jobs, money, and better living conditions for hundreds of millions of people (FAO, 2016). Nonetheless, from the estimated 777 million people who are chronically undernourished, global food insecurity has worsened (FAO, 2016) to 815 million people (FAO, 2016). While the world's population has been growing over the past few decades, capture fish stocks have decreased. This has resulted in an increased stress on wild fish stocks, endangering many people's access to food and nourishment. Since a few decades ago, fish parasites and their harmful effects have gained increased attention. Significant productivity and economic losses are being brought on by parasitic infections, which kill fish, stunt growth and reproduction, weaken fish's resistance to disease, and make them more susceptible to predators and

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disease (Ibrahim, 2009; Simon-Oke, 2017). Most of the host fish's tissues are susceptible to parasite penetration through the parenchyma or ecto-infestation. Ectoparasites are parasites that infest the host organism's outer surface or are mostly located there. One of the most harmful and extensively dispersed groups of pathogens impacting the health and production of freshwater fish is the ectoparasite community (Mitiku, 2017; Ogonna *et al*., 2017). Ectoparasites of freshwater fish can be single-celled protozoa, multicellular trematodes (flatworms), crustaceans, and arthropods. Ecto-parasites harm people's health and kill fish, in addition to lowering the market value of fish (Buchmann, 2022). Similarly, it is believed that approximately 18 million individuals have parasites carried by fish, and many more are in danger (Acosta-Pérez, 2022).

The Redbelly tilapia, also known as *T. zillii*, is a significant food fish in tropical or subtropical regions. The Tono reservoir in Ghana is home to a variety of fish species, including the Redbelly tilapia. It is used in numerous countries across the world for weed control, aquaculture, recreational fishing, and aquarium trade (Adesulu, 2008; López-Elías *et al.*, 2015). Redbelly tilapia is used in the management of aquatic plant species. It has also been applied to the control of harmful aquatic insects, chironomid midges, and mosquitoes. *T. zillii* may boost Ghana's aquaculture fish production, enhancing the lives of small-scale fish farmers and boosting the security of food and nutrition. A highly sought-after species for both commercial and recreational fishing is the redbelly tilapia. Redbelly tilapia is an important source of less expensive protein, making research on the frequency of parasites essential (Pariselle and Euzet, 2009); evidently, there is little knowledge on the dynamics of infections (Akoll *et al.*, 2012; Tombi et al., 2014; Blahoua *et al*., 2016). For people who depend on it, the Tono reservoir is a multipurpose fishery that offers food, nutrition, poverty alleviation, and work. Fish stocks, meanwhile, have been in decline for over ten years. Fishermen at the Tono reservoir have reported poor catches, the landing of smaller fish, and a decline in earnings (Akongyuure *et al.*, 2017). Also, there is no information available regarding the presence of ectoparasites on Redbelly tilapia in a reservoir's natural population of freshwater fish. The goal of the current study is to discover the ecto-parasitic infections that infest Redbelly fish, one of the most significant food and commercial species in the world, in the Tono reservoir in Ghana.

MATERIALS AND METHODS

Sampling Area

One of the greatest agricultural reservoirs in West Africa is the Tono reservoir (Figure 1), which is situated at latitude 10.60°N and longitude 1.07°W in the Kassena-Nankana district in Northern Ghana's Upper East Area. Short grasses and fire-resistant trees make up the dry guinea savannah vegetation in the research region. With mean minimum and maximum temperatures of 14 and 40 degrees Celsius, respectively, the climate is sub-Sahelian. The reservoir was constructed by the British engineering company Taysec in the late 1970s and early 1980s. The Upper East area irrigation company is in charge of running it. 2,490 hectares of land are irrigated by the reservoir, which is 2 kilometers long (Adams *et al*., 2014).

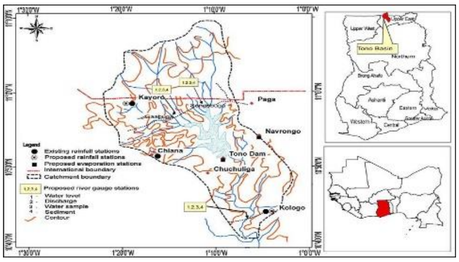

Figure 1: A Map of Kassena-Nankana District showing the Tono Reservoir

Physico- chemical evaluation of water

Using a multi-purpose probe, the reservoir water was tested for dissolved oxygen, temperature, turbidity, pH, and nutrients (nitrites, nitrates, ammonia, and phosphates). Turbidity was measured with a turbidimeter, and pH was measured with a Jenway 3510 pH meter. It was completed each time a sample was taken.

Fish collection and transportation

One hundred and twenty (120) live *T. zillii* (Red Belly Tilapia) of various sizes were taken from the Tono reservoir using a cast net method. The fish were stored in a container with water. They were then transported to the research lab in the University for Development Studies. As reported by Ayaz *et al.* (2013), samples were taken monthly from 7:00am to 10:00am. To prevent undue stress from the rising temperature, transportation was done in the morning.

Morphometric measurements

Using a dissecting board with a meter rule, the total length was measured from the tip of the snout to the farthest end of the caudal fin and recorded in centimeters. Each fish was placed on an electronic weighing scale, and readings were recorded to the nearest 0.1 grams to determine the weights of the fish. The samples were classified as adults and fingerlings. Fish with total length and body weight ranging from 12 cm to 30 cm and 20.1 g to 40 g, respectively, were classified as adults, while fish with total length and body weight ranging from 0.1 cm to 11 cm and 0. 1 g to 20 g, respectively, were classified as fingerlings. The sex of each fish was identified by pressing and observing the abdomen of the mature host fish. Eggs and whitish milt were used to differentiate between females and males.

Dissection, removal and identification of parasites

The exterior parts of the *T. zillii* samples were inspected for parasites using a prepared wet slide that was viewed under a Celestron microscope model 44340 and magnifying hand lens. The external components examined included the skin, skin mucus, fins, gills, eyes, and scales. The fish samples were evaluated using the Paperna (1996) technique and the Parasite Atlas (Barker and Cone, 2000).

Data collection

The traditional epidemiological measures (mean intensity, prevalence (%), and density of infection) were computed in accordance with the formulas of Bush *et al.* (1997). The severity of parasites in a species is determined by the number of individual parasites discovered in an infected fish or host. The following mathematical formulae were used.

$$\text{Mean intensity} = \frac{\text{Total number of parasites in fish species}}{\text{total number of infected fish species}}$$ (Bush *et al.*, 1997)

$$\text{Prevalence} = \frac{\text{Total number of infected with a particular parasite species}}{\text{total number of host examined}} \times 100$$ (Bush *et al.*, 1997)

$$\text{Relative density of infection} = \frac{\text{Number of parasites collected}}{\text{total number of sample examined}}$$ (Bush *et al.*, 1997)

Statistical analysis

Microsoft Excel was used to analyze data that was collected from the field and lab (2013). To ascertain significance in differences ($p < 0.05$), the measured indices were submitted to an IBM Statistical Package for Social Sciences (SPSS version 16.0) one-way ANOVA. The Duncan multiple range test was utilized to isolate mean differences ($p < 0.05$) when there were variations in treatment means.

RESULTS AND DISCUSSION

Overall parasite prevalence, intensity and relative density

The study of ectoparasites of the *T. zillii* in the Tono reservoir showed the overall prevalence (52.32%), intensity (2.57), and relative density (1.30) of fish parasites. From these 120 fishes of *Tilapia zillii*, the following ectoparasites were collected. 1. *Argulus* sp. 2. *Lernaea* sp. 3. *Diplostomum* sp. 4. *Dactylogyrus* sp. 5. *Trichodina* sp. High prevalence of the parasite *Trichodina sp*. was 17.5% and the lowest was recorded in *Dactylogyrus* sp., at 6.66%. The highest intensity of parasite *Trichodina* sp., 3.52, and the lowest was recorded for *Lernaea* sp., 1.58. High relative density of parasite *Trichodina* sp. 0.61, and the lowest was recorded for *Lernaea* sp. and *Dactylogyrus* sp. 0.15 (Table 1).

Monthly prevalence of ectoparasites

High prevalence of parasites was recorded in the months of January (86.67%), February (80 %) and March (80 %) while the lowest was in August (Table 2).

Water quality analysis in Tono reservoir

The physicochemical parameters of the reservoir were assessed during the study period. As indicated in Table 3, the water's temperature was highest in January and February relative to other months. Other observations made during the study period included low levels of dissolved oxygen in January and high levels in May and June, high pH levels in June and low levels in January, and low turbidity in January and high levels in May.

Season-wise prevalence, intensity, and relative density of ectoparasites

This record shows that prevalence, intensity, and relative density of ectoparasites in the Tono reservoir are high in the dry season while lowest in the rainy season (Table 4).

Prevalence, intensity, and relative density of ectoparasites in correspondence to sex

The results from this study show that female fishes of *T. zillii* in the Tono reservoir have a higher prevalence, intensity and relative density than males (Table 5). The findings further revealed that prevalence (%) for males and females were 27.27% and 64.47%, respectively, whiles intensity was 1.58 and 2.81, respectively. Similarly, relative density for males and females were 0.43 and 1.81, respectively.

Prevalence, intensity, and relative density of ectoparasites in relation to length and weight

T. zillii with maximum length (12 cm-30 cm) and weight (20.1 g - 40 g) in the Tono reservoir were found to be more highly infected than small-sized fish (0.1 cm-11 cm) with less body weight (0.1 g-20 g) (Table 6).

Locality-wise prevalence (%), intensity, and relative density of ectoparasites

Samples of *T. zillii* collected from down-stream were foundto be highly (92.5%) infected than the fish from mid-stream (42.5%) and upstream (17.5%) of the Tono reservoir (Table 7).

Prevalence (%) and intensity of ectoparasites in relation to organs

Table 8 shows prevalence (%), and intensity of ectoparasites in relation to organs. The study's findings indicate that of the ectoparasites detected on *T. zillii's* skin, skin mucus, gills, and eyes in the Tono reservoir, *Trichodina* sp. was the most common. Other species were *Dactyolgyrus* sp., *Argulus* sp., *Lernaea* sp. and *Diplostomum* sp. Based on the data, *Dactyolgyrus* sp. was identified as having the highest prevalence on *T. zillii* scales in the Tono reservoir (Table 8).

Table 1. Overall and parasite wise prevalence, intensity and relative density of ectoparasites in the Tono reservoir

Name of parasite	Hosts examined	Host infected	Prevalence (%)	ectoparasites observed	Intensity	Relative density
***Argulus* sp.**	120	11	9.16	25	2.27	0.20
***Lernaea* sp.**		12	10	19	1.58	0.15
***Diplostomum* sp.**		9	9	21	2.33	0.17
***Dactylogyrus* sp**		8	6.66	18	2.25	0.15
***Trichodina* sp.**		21	17.5	74	3.52	0.61
Total		**61**	**52.32**	**157**	**2.57**	**1.30**

Ectoparasites observed* The individual number of parasites detected out of all the hosts that were examined

Table 2. Monthly prevalence of ectoparasites in the Tono reservoir

Month	Host examined	Host infected	Prevalence %
January 2022	15	13	86.67
February 2022	15	12	80
March 2022	15	12	80
April 2022	15	7	46.67
May 2022	15	4	26.67
June 2022	15	6	40
July 2022	15	4	26.67
August 2022	15	3	20

Table 3. Average physicochemical parameters of the Tono reservoir

Months	Temperature (°C)	Dissolved oxygen (mg/L)	Turbidity (NTU)	pH	Phosphate (mg/L)	Ammonia (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)
January	29.57	2.78	60.2	6.95	0.001	0.698	0.078	0.862
February	28.88	2.98	69.13	7.95	0.001	0.544	0.059	0.798
March	28.1	3.45	65.33	7.35	0.001	0.674	0.078	0.854
April	27.6	3.67	67.03	7.48	0.001	0.683	0.079	0.847
May	26.34	3.93	69.13	7.65	0.001	0.564	0.068	0.857
June	27.44	3.83	69.13	7.95	0.001	0.544	0.059	0.798
July	26.34	3.68	69.13	7.51	0.001	0.594	0.067	0.873
August	27.32	3.72	69.13	7.31	0.001	0.614	0.069	0.863

Table 4. Season-wise prevalence, intensity, and relative density of ectoparasites in the Tono reservoir

Seasons		Host examined	Host infected	Prevalence %	ectoparasites recovered	intensity	Relative density
Dry	**January** **February** **March** **April**	60	42	70	131	3.11	2.18
Rainy	**May** **June** **July** **August**	60	19	31.67	26	1.36	0.43

Table 5. Sex-wise prevalence, intensity and relative density of ecto-parasites in the Tono reservoir

Sex of host	Host examined	Host infected	Prevalence %	ectoparasites recovered	Intensity	Relative density
Male	44	12	27.27	19	1.58	0.43
Female	76	49	64.47	138	2.81	1.81

Table 6. Length and weight-wise prevalence, intensity and relative density of ectoparasites in the Tono reservoir

Standard length of host (cm)	Body weight (g)	Host examined	Host infected	Prevalence (%)	ectoparasites recovered	intensity	Relative density
0.1-11	0.1-20	54	18	33.33	23	1.27	0.42
12-30	20.1-40	66	43	65.15	134	3.11	2.03

Table 7. Locality-wise prevalence (%), intensity and relative density of ectoparasites in the Tono reservoir

Component	Fish examined	Fish infected	Prevalence (%)	ectoparasite recovered	Intensity	Relative density
Upstream	40	7	17.5	13	1.85	0.32
Midstream	40	17	42.5	32	1.88	0.8
Downstream	40	37	92.5	112	3.02	2.8

Table 8. Prevalence (%) and intensity of ectoparasites in relation to organs in the Tono reservoir

Parasites	Part infected	Number of fish infected	Prevalence (%)	Intensity
Trichodina sp.	Skin	25	20.83	1.19
	Skin mucus	17	14.17	0.80
	Fins	-	-	-
	Gills	19	15.83	0.90
	Eyes	11	9.17	0.52
	Scales	2	1.67	0.09
Dactyolgyrus sp.	Skin	-	-	-
	Skin mucus	-	-	-
	Fins	2	1.67	0.25
	Gills	8	6.67	1
	Eyes	3	2.5	0.38

	Scales	5	4.17	0.63
Argulus sp.	Skin	11	9.17	1
	Skin mucus	6	5	0.54
	Fins	-	-	-
	Gills	9	7.5	0.82
	Eyes	-	-	-
	Scales	1	0.83	0.09
Lernaea sp.	Skin	7	5.83	0.58
	Skin mucus	3	2.5	0.25
	Fins	5	4.17	0.42
	Gills	4	3.33	0.33
	Eyes	-	-	-
	Scales	-	-	-
Diplostomum sp.	Skin	7	5.83	0.77
	Skin mucus	2	1.67	0.22
	Fins	8	6.67	0.89
	Gills	4	3.33	0.44
	Eyes	-	-	-
	Scales	-	-	-

This study was carried out from January 2022 to August 2022 to assess ectoparasites of *T. zillii* in the Tono reservoir. In this study, 120 fish of *T. zillii* were collected from various localities of the reservoir and were examined for parasites. The prevalence of the infection was determined based on the months, seasons, sex, length, weight, location, and type of parasite. It was shown that 52.32% of fish parasites were present overall. A similar study was carried out by Ahmad *et al*. (2021); they studied 88 specimens of *S. plagiostomus* from the river Panjkora Dir (L) for the prevalence of parasites and found out an overall infection of 60.22%. In the present research work, the highest prevalence value (17.5%) was calculated for *Trichodina* sp., and the lowest was recorded in *Dactylogyrus* sp. 6.66%. The research of Alhassan and his colleagues supports our findings regarding the patterns of taxonomical structure of freshwater fish parasites and the confirmation that protozoans, namely ciliates, were more abundant than monogeans and crustaceans, which were less abundant (Alhassan *et al*., 2018). In our study, the highest relative density of parasite *Trichodina* sp., at 0.61 and the lowest was recorded for *Lernaea* sp., and *Dactylogyrus* sp., at 0.15 (Table 1). Several regions of the world also reported data that was similar. Two species of *Rhabdochona*, *R. schizothoracis* with a 22.8% infection rate and *R. charsaddiensis* with a 10.8% infection rate, were reported by Ahmad *et al.* (2014). In their 2014 study on goldfish in India, Leela and Rao reported an *R. garuaiin* infection rate of 40.6%, a mean intensity of 3.14, and relative densities of 1.40. In comparison to all other organs observed, except scales (Table 8), *Trichodina* sp. was found to be the most prevalent ectoparasite. This could be due to the varying sizes and the skin trapping these ectoparasites. Generally speaking, the severity of most ecto-parasitic infections increases with the age of the host fish, possibly because of the longer accumulation period and/or the larger space for feeding and breeding of the parasite. Furthermore, the Tono reservoir's *T. zillii* gills have been infected by a variety of ectoparasites, with *Trichodina sp*. being the most common. This could be due to the gill rakers' ability to sieve certain organisms, which may help to trap them, and this could be related to the protozoan parasites' presence (Table 8). In the present study (Table 1), high intensity of parasite (3.52) for *Trichodina* sp.,and the lowest (1.58) were recorded for *Lernaea* sp.In this study, high prevalence of parasites was recorded in the months of January (86.67%), February (80%), and March (80%) while the lowest was in August (Table 2). Unlike Ahmad *et al*. (2021), who recorded a high prevalence in the months of July and August while the lowest was in February. Seasonal variations and environmental factors were the causes of the variations in prevalence.

The physico-chemical characteristics assessed on the Tono reservoir in the current study were generally favorable for *T. zillii* growth. Together with the proper physico-chemical parameters, the environment's favorable characteristics may have had a role in the low levels of ectoparasite prevalence and intensity (Suliman and Al-Harbi, 2016). Because of low-water levels in January and high-water levels in May and June throughout the sample period, the prevalence of ectoparasites was higher in January and decreased in other months. High temperatures during dry seasons affect the solubility of dissolved oxygen, exposing fish to much stress and subsequently parasite infections (Ngodhe, 2021).

In the current study, prevalence of ectoparasites was high in the dry season (70%) and lowest in the rainy season (31.67%), similar to Ahmad *et al*. (2021), when they had noticed a highest prevalence in the dry season and lowest in the rainy season. The presence of these ectoparasites may be caused by fish-eating birds, horizontal transmission (which occurs when fishermen set up fishing nets at different landing spots where parasites are present), or cattle drinking from the water. The Tono reservoir's declining water quality during the dry season may be caused by an increase in pesticides, fertilizer levels, and chemical residues from agricultural operations. According to Imran *et al*. (2021) and Mitiku and Adisu (2021), fish-eating birds and agricultural workers are the primary vectors of parasite transmission; they carry the parasites in their mouths and excrete the parasites into bodies of water when they consume or defecate. In the present study, sex-wise prevalence of *T. zillii* was noted. This record showed that females (64.47%) had a higher prevalence than males (22.27%) (Table 5). Findings of the present research are similar to those of Omeji *et al*. (2014). In the recent study, adult fish specimens were found highly infected (82.25%), followed by sub-adults (60.0%) while no infection was observed in juvenile fish specimens. Similarly, Bendryman *et al.* (2017) studied a catfish (*Sperata sarwari*) from Mangla Lake for Helminth parasite and noted that the large-sized fishes showed a higher prevalence (39.13%) rate than the small-sized fishes (28.85%). Length and weight are directly related to the prevalence of parasites. In the present study (Table 6), it was observed that fish specimens with maximum length and weight were found to be highly (65.15%) infected, and small-sized fish with less body length and low weight show little prevalence i.e (33.33%). According to Omeji *et al.* (2014), parasitic infection increases with the increase of length and weight. In the current study (Table 7), fishes collected from down-stream were highly infected (92.5%), compared to the mid-stream (42.5%) and up-stream (17.5%) reaches of the reservoir. Samples of *T. zillii* collected from downstream were found highly 92.5% infected than the fish from midstream and upstream, 42.5% and 17.5% of the Tono reservoir (Table 7); this could be as a result of the multipurpose use of the reservoir and inadequate education from extension services for safe practices (Ayisi *et al.*, 2016). Similar work was carried out by Crisp and his co-workers in southeast Mexico. They concluded that the infection rate of various helminth parasites shows variation in the river Papaloapa basin to the Yucatan Peninsula (Khan *et al*., 2021).

CONCLUSION

A total of five parasites identified in this study were *Trichodina* sp. of Protozoans ciliates, *Dactyolgyrus* sp. of Monogenes, *Argulus* sp. and *Lernaea* sp. of Crustaceans, and *Diplostomum* sp. of trematode. The prevalence and the mean intensity of parasites on these selected parts were relatively low. These parasites might be present as a result of the water's multiple uses. This study's average level of ectoparasite intensity suggests that the fish in the reservoir may not be seriously threatened. To avoid infections caused by ectoparasite intensification from other water use, however, special care should be paid to the reservoir's multi-purpose use.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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