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PROOF
RESEARCH PAPER

Parasites of African Catfish *Clarias gariepinus* and *Oreochromis niloticus* Polycultured in Earthen Ponds

Uchechukwu Enyidi[1,*], Princess Uwanna[1]

[1]Michael Okpara University of Agriculture Umudike, Department of Fisheries and Aquatic Resources Management, Umuahia Abia State Nigeria.

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Corresponding Author
Tel.: +23409027427974
E-mail: enyidiuche@yahoo.com

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Abstract

The prevalence, abundance and mean intensity of parasites of *Clarias gariepinus* and *Oreochromis niloticus* polycultured in three large earthen ponds in Nigeria were analyze in this paper. The ponds receive both water and fish from a dam fed by Anya River and Amaoba streams. The major ectoparasite of both fish was *Trichodina heterodentata.* There were no significant differences (P>0.05) in the prevalence of *Trichodina heterodentata* on both *O. niloticus* (34.71±0.01%) and *C. gariepinus* (34.5±0.04%). Abundance and mean intensity of *T. heterodentata* were significantly (P<0.05) were higher for *O. niloticus* than *C. gariepinus*. *Camallanus polypteri* was the major endoparasite associated with *C. gariepinus* and *O. niloticus*. There was higher prevalence, abundance and mean intensity of C. *polypteri* in *O. niloticus* (34.71±0.93%, 118.6±0.56 and 18.57±0.77) than *C. gariepinus* (22.5±0.33%, 9.6±0.11 and 11±0.21) (P<0.05). The feeding pattern of the fish seems to influence the type of parasite harboured. The infestation of *Lernaea cyprinacea* was more prevalent on *O. niloticus* (42.86±0.07%) compared to *C. gariepinus* (25.5±0.08%) (P<0.05). Nevertheless, the abundance and mean density of *Lernea cyprinacea* was significantly higher for *C. gariepinus* (5.1±1.03, 8.2±0.44) than *O. niloticus* (3.1±0.67,7.33±0.56) (P<0.05). *Dactylogyrus extensus* was more prevalent on the *O. niloticus* (42.86±0.31%) than *C. gariepinus* (25.5±0.66%) (P<0.05). *Gyrodactylus limnonephrotus* was more prevalent on *O. niloticus1* (14.29±.34%) than *C. gariepinus* (12.5±0.56%) (P<0.05). There were no leeches found on *O. niloticus* but there was 25±0.67% leech on the *C. gariepinus.* The absence of leeches on the tilapia maybe due to their pelagic life style compared to catfish.

Introduction

African catfish *Clarias gariepinus* and tilapia are major cultured fishes in sub-Saharan Africa. The polyculture of African catfish *Clarias gariepinus* with *Oreochromis niloticus* or other species of tilapia started drawing attention in Nigerian aquaculture over a decade ago (Fagbenro, 2000, 2004). There are about six species of cultured tilapia in Nigeria namely, *Oreochromis niloticus*, *Oreochromis aureus*, *Tilapia zillii*, *Sarotherodon galilaeus*, *Sarotheradon melanotheron, Tilapia guineensis*, out of over twenty-five species available in Nigeria (Idodo-Umeh, 2003; Adesulu and Sydenham, 2007). Catfish is polycultured with tilapia for two major reasons, to reduce precocious reproductive nature of the tilapia (Fagbenro, 2004, Shoko *et al.,* 2014; Limbu *et al.,* 2015) and to provide extra income for the farmers (Limbu *et al.,* 2016; Shoko *et al.,* 2016). Fish farms that receive natural water supply from sources like rivers and streams, can have influx of tilapia into ponds thereby creating unplanned polyculture.

Polyculture also leads to cross infection and interspecies infectious diseases transmission (Eissa *et al.,* 2010). Polyculturing of tilapia and O. niloticus may

lead to disease outbreak (Ibrahem et al. 2011). A number of parasites have been noted to be associated with African catfish, for example in cultured systems *Procamallanus laevioncus*, *Ichthyophthirius multifiliis*, (Enyidi and Eneje, 2015; Enyidi and Maduakor, 2017). Procamallanus spp and Cleidodiscus spp have recently been found in *O. niloticus* farmed in Kenya (Mukwabi et al. 2019). Some common monogeneans that infect African catfish are *Gyrodactylus* spp (Mohamed *et al.,* 2010), and *Cleidodiscus* spp (Walakira *et al.,* 2014). Catfish found in the wild have also been parasitized by digenea parasites like *Orientocreadium batrachoides*, cestode *Polyonchobothrium clariae*, and nematode *Procamallanus laevionchus* and *Procamallanus polypteri* and most of the parasite inhabited the intestine (Abdel-Gaber, *et al.,* 2015).

Gyrodactylus is another group of ectoparasite that attacks both tilapia (Rubio-Godoy and Garcia-Vasquez, 2015) and African catfish (Mohamed *et al.,* 2010). *Gyrodactylus cichlidarum* has been noted to be the most common gyrodactylus attacking tilapia *O. niloticus.* The parasites can jump from one host to another (Paperna, 1980; Rubio-Godoy and Garcia-Vasquez, 2015). This parasite can easily be transmitted to cultured fish by wild fish if they penetrate culture systems. *Gyrodactylus* had been known to infect African catfish *C. gariepinus* causing serious damage to the mucus layer and the skin (Mohamed *et al.,* 2010). Monogeneans like Cichlidogyrus (C. halli, C. mbirizei, C. sclerosus, C. thurstonae, C. tilapiae) and Scutogyrus (S. longicornis) have been found as major parasites of both wild and cultured O. niloticus and red tilapia (Lim et al. 2016).

This research is aimed at examining the parasites of African catfish *C. gariepinus* and *O. niloticus* tilapia species polycultured in earthen ponds of Michael Okpara University of Agriculture Umudike Nigeria.

Materials and Methods

Study Farm

The study farm was earthen ponds of Department of Fisheries and Aquatic Resources Management (FISHARM) Michael Okpara University of Agriculture Umudike Abia State in South Eastern Nigeria. Umudike lies between latitude 50 29”N and 70 33”E. the average temperature of the area is 26^{o}C, maximum being 32^{o}C and minimum 22^{o}C. Umudike is 122m (400ft) above sea level (asl). It has an average rainfall of 2169.8mm within rain period range of 148-155days.The relative humidity falls between 50-59%. Umudike is within the humid rainforest zone characterized by long duration (7-12months) of rainfall and short period of dry season (NRCRI, 2007). Three large earthen ponds of about an acre each were used for this study. The farms receive ground water via a borehole and are also rain water fed. During the rainy seasons the ponds also receives runoff coming from nearby dam of National Root Crop Research Institute Umudike Umuahia Nigeria (Figure 1). The dam is fed by Anya River and Amaoba streams. As at the time of this research there were no restrictions to

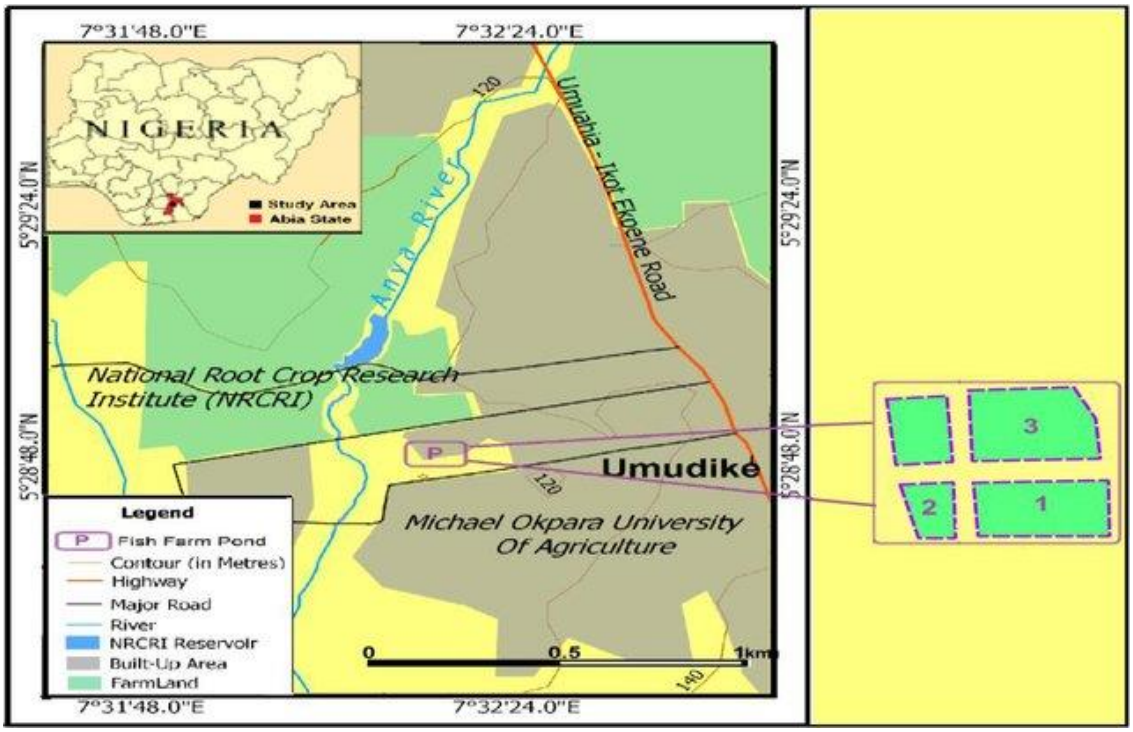

Figure 1. Map of study area showing locations of the National Root Crop Research Institute and reservoir dam, Michael Okpara University of Agriculture and the earthen ponds (Inset in green color) of Department of Fisheries and Aquatic Resources Management Michael Okpara University of Agriculture Umudike Umuahia Nigeria that was used in this study

inflow of water from the dam especially during and after heavy down pour of rain. The annual rainfall in South Eastern Nigeria is about 4000mm year^{-1} (Enyidi, 2017).

Collection and Analysis of Water Samples

Water samples were collected with amber colored bottles of 250 ml capacity from the three earthen ponds of Michael Okpara University of Agriculture Umudike Umuahia Abia State Nigeria. The water samples were collected from three levels of the pond water, surface, midwater and above the bottom. Sampling started in April and ended in June 2016. This period covered the late dry season and early rainy season in Nigeria. Water analysis was done at the site and immediately after collection, on a table set beside the ponds and results recorded. Water parameters analysed were dissolved oxygen, bicarbonates (HCO_3), pH, conductivity, turbidity, total alkalinity and hardness. The Physio-chemical parameters were measured using portable Hannah DO_2 kit model 3810 for dissolved oxygen, model 9813 for pH and DO_2, model 3811 and 3812 for alkalinity and hardness (HANNA instruments Woonsocket, Rhode Island USA).

Fish Sampling

Fish samples in this study were collected from earthen ponds of FISHARM department Michael Okpara University of Agriculture Umudike Umuahia Abia State Nigeria. Most of the tilapia species *Sarotherodon galilaeus*, *S. melanotheron* (bi-parental mouth-brooders, micro-phytophagous, planktophagous, *O. niloticus*, *Tilapia zillii*, *T. guineensis* (substrate spawners), and *O. aureus* (maternal mouth-brooders, omnivorous) come from the dam into the fish ponds. There is no restriction to the entrance of wildfish into earthen ponds. A total of 35 African *Clarias gariepinus* and tilapia *Oreochromis niloticus* were collected from the ponds with a seine net. The fish were transported to the wet laboratory of Department of Fisheries and Aquatic Resources management Michael Okpara university of Agriculture Umudike.

Data Collection

The data collection were based on examination of fish parasites, examination of stomach contents, examination of intestine, and examination of skin and scales. The methods of data collections followed published standard methods as stated in Laboratory manuals NWFHS laboratory procedure manual fifth edition May 2009. (National Wild Fish Health Survey (NWFHS) USA. The Fifth edition May of 2009).

Examination of Fish and Parasites

The whole body of the *C. gariepinus* and *O. niloticus* samples were examined for the presence of ectoparasite and endoparasites. The operculums of the fish were excised using a scalpel and placed in a petri dish containing 5ml of water. The operculums were examined for possible presence of ectoparasite. The whole gill arch were cut off and examined per lamella by placing them in a petri dish with 5ml of saline water. The fishes were examined for endoparasites by gently cutting the fish from the ventral side, between the pectoral and pelvic fin exposing the whole internal organs.

Examination of Stomach Contents

The gastro intestinal tracts were examined by cutting the fish through the oesophagus to the anus.

The stomach was opened and scrapped into a petri dish that contained 5mls of normal saline water. The stomach content was probed for presence of parasite by a thorough search of the content under light microscope. The stomach contents were mixed with 15mls of normal saline and centrifuged. The supernatant were poured and the presence of any parasite was analyzed.

Examination of the Intestine

The intestines were also cut open for the whole length and examined for the presence of parasites. The contents were scrapped unto a petri dish and the contents were examined for presence of parasites. The contents were placed in a petri dish containing 10mls of water. The intestinal contents were mixed with water, centrifuged and the supernatants were poured into a petri dish. The contents were examined for presence of parasites under light microscope at 10 X magnifications and 40 X magnifications for shaper resolution.

Examination of Skin and Scale

The skin of the fish was gently sliced and placed in 5% normal saline water and examined for possible parasites. The skin slice was then teased and placed on a glass slide and examined under 10 X magnifications and 40 X magnifications of microscope. The scales of the tilapia were plucked with forceps, placed in distilled water and examined also under same magnification as previously stated.

Identification of Parasites

The parasites were identified using standard keys and guides according to Paperna, (1980), Smith, (1980) and pictures of fish parasites. The parasites were recorded accordingly and stored for reference. The pictorial identification of parasites were according to the pictures and guides from Common Freshwater Fish Parasites Pictorial Guide:University of Florida IFAS extension by Deborah B. Pouder, Eric W. Curtis, and Roy P.E. Yanong (2017), FA-113, 114, 115 etc-series, series of

the Tropical Aquaculture Laboratory, Program in Fisheries and Aquatic Sciences, School of Forest Resources and Conservation, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida USA. EDIS website at http://edis.ifas.ufl.edu.

Data Analysis

The prevalence, mean intensity and abundance of the parasites were calculated for the parasites.

Abundance=Number of parasites recovered/number examined

Prevalence=Number of fish infected /number examined * 100

Mean intensity = Number of parasites recovered /Number of fish infested

The means of these variables were subjected to independent sample t test analysis to find possible significant differences between the parasites prevalence, abundance and mean density of *C. gariepinus* and *O. niloticus*. The null hypothesis formulated for these analyses is:

Ho= there is no significant difference in the prevalence, abundance and mean intensity of the parasites harboured by *C. gariepinus* and *O. niloticus*

Ha= there is significant difference in the prevalence, abundance and mean intensity of the parasites harboured by *C. gariepinus* and *O. niloticus*

Results

The results of the independent t test analysis shows that there is significant difference in the prevalence, abundance and mean intensity of the parasites harboured by *C. gariepinus* and *O. niloticus,* therefore we discard the null hypothesis. There were ectoparasites found on the African catfish *C. gariepinus* and *O. niloticus* in the studied earthen ponds. The major ectoparasite of both fish was *Trichodina heterodentata.* The ectoparasite *Trichodina heterodentata* was prevalent on *O. niloticus* of weight range 13.69g to 25.8g. It was also prevalent on C. *gariepinus* of weight range 85-103g (Table 1). *Trichodina heterodentata* were identified as large Trichodinit species having disc-shaped body, cell diameter 76.9 (62.2-92.5). Diameter of adhesive disc was 67.1 (49.0-83.7). Diameter of denticulated was 39.2 (28.7-47.5). Number of denticles was 27 (24-27) and the number of radial pins per denticle 10 (9-10). The length of denticle was 8.9 (7.5-10.0); length of thorn was 8.9mm (6.2-11.2) and the length of blade was 6.9mm (5.0-8.7). *Trichodina heterodentata* were also found on *O. niloticus* of size ranges 20.86g -25.8g, length 19.8cm. There were also trichodinids found on *O. niloticus* frys of 13.69g. There was no significant difference (P>0.05) in the prevalence of *Trichodina heterodentata* on *O. niloticus* 34.71±0.01% and *C. gariepinus* 34.5±0.04% (Table 2). However, there were significant differences (P<0.05) in the abundance and mean intensity of *T. heterodentata* on *O. niloticus* (11.1±0.10, 13±0.02) than on *C. gariepinus* (9.6±008, 11±0.09) respectively**.**

Table 1. Infection of polycultured catfish *C. gariepinus* and tilapia *O. niloticus* in earthen ponds of FISHARM department Michael Okpara University of Agriculture Umudike Nigeria with ecto and endo parasites according to weight and length of the fish

Species	Weight (g)	S. Length (cm)	Endoparasite	Ectoparasite
C. gariepinus	03	27.4	*Camallanus spp*	*T. heterodentata*
	01	25.3	*Camallanus spp*	Leech
	85.86	24.6		*L. cyprinacea*
	85.86	24.6		*T. heterodentata*
	75.60	20.2	-	*I. multifilis*
	75.60	20.2	-	Leech
	46.10	19.5	-	*G.limnonephrotus*
	45.30	19.5		*L. cyprinacea*
	45.30	19.5		Leech
	45.30	19.5	-	*D. extensus*
	13.69	12.6	*Camallanus spp*	*T. heterodentata*
	13.67	12.6	-	*D. extensus*
	13.67	12.6	-	*I. multifilis*
O. niloticus	25.8	19.8	*Camallanus spp*	*T. heterodentata*
	23.6	20.6		*T. heterodentata*
	23.6	20.6		*L. cyprinacea*
	22.76	19.3	*Camallanus spp*	*T. heterodentata*
	20.86	19.5	-	*G.limnonephrotus*
	20.86	19.5	-	*D. extensus*
	19.26	10.7		*L. cyprinacea*
	13.69	12.6	*C.polypteri*	*T. heterodentata*
	10.56	9.7	-	*D. extensus*
	10.56	9.7	-	*I. multifilis*

The endoparasite *Camallanus polypteri* was notably associated with *O. niloticus* and *C. gariepinus* of almost all sizes (Table 1). The *C. polypteri* were easily identified as red worms protruding through the anus of the fish or in the intestine. The worm had thin cuticle and lateral valve of buccal capsules with longitudinal ridges that differ between male (8-14) and female (8-9). The male tail was bifid and female was long with three notable spikes and then vulva at the end. There was significantly (P<0.05) higher prevalence of *Camallanus polypteri* (34.71±0.93%) in *O. niloticus* than in *C. gariepinus* (22.5±0.33%). Similarly, there were also higher abundance and mean density (P<0.05) of *C. polypteri* in *O. niloticus* (118.6±0.56, 18.57±0.77) compared to *C. gariepinus* (9.6±0.11, 11±0.21) (Table 3). We recovered more of *C. polypteri* from African catfish of weight range 85-103g compared to lower weight groups (Table1). *Camallanus polypteri* was the most abundant of the parasites on the African catfish. The parasitic infection with highest mean intensity on the *O. niloticus* was also the *C. polypteri* (18.57). The monogenean parasite *Dactylogyrus extensus* was noted to be cohabiting *O. niloticus and C. gariepinus* in the earthen ponds. There was higher prevalence of *Dactylogyrus extensus* on *O. niloticus* (42.86±0.31%) than *C. gariepinus* (25.5±0.66%). Conversely we noted higher abundance and mean intensity of *D. extensus* on the *C. gariepinus* (5.1±1.23, 8.2±0.19), than *O. niloticus (*3.1±0.12, 7.3±0.32) (P<0.05) (Table 4). Juvenile African catfish *C. gariepinus* of weight range between 13.67g to 45.30g were notable harboring *D. extensus* on their gills. Among the *O. niloticus*, *D. extensus* were extracted from fish of weight range 10.56g to 20.86g and length 12.6-19.5 cm (Table 1). African catfish *C. gariepinus* and *O. niloticus* were noted to be cohabited by the monogenetic trematode *Gyrodactylus limnonephrotus.* G*. limnonephrotus* were identified by considering the morphology of hard parts of the attachment apparatus (opisthaptor). The species is also characterized by anchor, ventral bar, dorsal bar, marginal hooks, and cirrus (male sexual organ of older females) (Malmberg, 1970). The prevalence of *G. limnonephrotus* was significantly (P<0.05) higher on *O. nilticus* (14.29±.34%) compared to *C. gariepinus* (12.5±0.56%). However, there was no significant difference (P>0.05) in the abundance of the parasite on both fish (Table 5). Throughout the period of this research *Gyrodactylus limnonephrotus* parasites were extracted only from medium size catfish 46.10g and total length 19.5cm and *O. niloticus* of weight 20.86g and length 19.5cm (Table1). The infection of copepod *Larnea cyprinacea* was more prevalent on the *O. niloticus (*42.86±0.07%) than on *C. gariepinus* (25.5±0.08%) (P<0.05). Although *L. cyprinacea* was more prevalent on *O. niloticus* we noted that it was significantly more abundant with higher intensity on the *C. gariepinus* than *O. niloticus* (Table 6). There were no leeches found on *O. niloticus* throughout the period of this research. However, the prevalence of leeches on African catfish *C. gariepinus* was 25±0.67%, (Table 7). The abundance and mean intensity of leeches on *C. gariepinus* were 4.8±0.01% and 6.33±1.23 respectively. We noted higher prevalence of

Table 2. Prevalence, abundance and mean intensity of *Dactylogyrus extensus* harboured by African catfish *Clarias gariepinus* and *Oreochromis niloticus* polycultured in earthen Ponds in Nigeria

	No	Prevalence	Abundance	Mean intensity
O.niloticus	22	42.86 ± 0.31^{b}	3.1 ± 0.12^{b}	7.3 ± 0.32^{b}
C.gariepinus	41	25.5 ± 0.66^{a}	5.1 ± 1.23^{a}	8.2 ± 0.19^{a}
	T. tab=1.771	T. cal= 64.59, P<0.05	T. cal =14.83, P<0.05	T. cal= -19.68, P<0.05

Table 3. Prevalence, abundance and mean intensity of *Trichodina heterodentata* harboured by African catfish *Clarias gariepinus* and *Oreochromis niloticus* polycultured in earthen Ponds in Nigeria

	No	Prevalence	Abundance	Mean intensity
O.niloticus	78	34.71 ± 0.01^{ns}	11.1 ± 0.10^{a}	13 ± 0.02^{a}
C.gariepinus	77	34.5 ± 0.04^{ns}	9.6 ± 008^{b}	11 ± 0.09^{b}
	T. tab=1.777	T. cal= 0.114, P<0.05	T. cal =18.98, P<0.05	T. cal= 17.09, P<0.05

Table 4. Prevalence, abundance and mean intensity of *Gyrodactylus limnonephrotus* harboured by African catfish *Clarias gariepinus* and *Oreochromis niloticus* polycultured in earthen Ponds in Nigeria

	No	Prevalence	Abundance	Mean intensity
O.niloticus	4	$14.29\pm.34^{a}$	0.6 ± 0.03^{ns}	4 ± 0.12^{b}
C.gariepinus	5	12.5 ± 0.56^{b}	0.6 ± 0.32^{ns}	5 ± 0.27^{a}
	T. tab=1.777	T. cal=50.62, P<0.05	T. cal=-0.229, P<0.05	T. cal=-20.78, P<0.05

Ichthyophthirius multifilis on the *O. niloticus (*14.29±1.26%) than the *C. gariepinus (*12.5±0.35%) (P<0.05). There was also higher abundance of the *I. multifilis* on the *O. niloticus* than the *C. gariepinus* (P<0.05), (Table 8). Based on sampling results, *I. multifilis* infested mainly small size tilapia of weight 10.56g and total length 9.7cm.

Discussions

It is important to know the prevalence, abundance and mean intensity of the parasite communities in aquaculture systems for proper planning and disease management strategies (Subasinghe *et al.,* 2001). This research recorded that *Trichodina heterodentata* was the main ectoparasite of the polycultured *O. niloticus* and *C. gariepinus.* Trichodina species are major parasites of *O. niloticus* (Jerônimo *et al.,* 2011; Akoll *et al.,* 2011). Similarly, Martin and Ghiraldelli (2008); Pantoja *et al.,* 2012), noted that *Paratrichodina africana* were specific parasites of tilapia. In the present research we noted that there is high prevalence of *Trichodina heterodentata* among the *O. niloticus* 34.71% and also *C. gariepinus* 34.5%. This is in line with findings of Arkol *et al.,* (2011) who noted that in Uganda, trichodinids were the most prevalent parasite on *O. niloticus* and *C. gariepinus*. Moreover, with regard to intensity, 18.2% (2/11) of the parasites recorded from *O. niloticus* occurred with a mean intensity of greater than or equal to five individuals per fish. The parasitic copepod *Larnaea cyprinacea* were prominent on the African catfish but normally attack the catfish from scaled fish. According to this research there was higher prevalence of *L. cyprinacea* on the *O. niloticus* (42.86±0.07%) compared to that of *C. gariepinus* (25.5±0.08%) suggesting a co-hosting of parasites by the fishes. In previous researches high prevalence of *L. cyprinacea* had been noted on tilapia and cyprinids (Barson *et al.,* 2008. Although polyculture of *O. niloticus* and *C. gariepinus* is common, it had been previously noted that polyculture could lead to parasite transmission (Sasal *et al.,* 1999, Cribb *et al.,* 2002). Polyculturing of the *O. niloticus* and the African catfish *C. gariepinus* could have enhances parasites co habiting of both fishes. In a previous research, Eissa *et al.,* (2008) reported that

Table 5. Prevalence, abundance and mean intensity of *Camallanus polypteri* harboured by African catfish *Clarias gariepinus* and *Oreochromis niloticus* polycultured in earthen Ponds in Nigeria

	No	Prevalence	Abundance	Mean intensity
O.niloticus	130	34.71 ± 0.93^{a}	118.6 ± 0.56^{a}	18.57 ± 0.77^{a}
C.gariepinus	77	22.5 ± 0.33^{b}	9.6 ± 0.11^{b}	11 ± 0.21^{b}
	T. tab=1.777	T. cal=20.1, P<0.05	T. cal=1086.45, P<0.05	T. cal=85.77, P<0.05

Table 6. Prevalence, abundance and mean intensity of *Larnea cyprinacea* harboured by African catfish *Clarias gariepinus* and *Oreochromis niloticus* polycultured in earthen Ponds in Nigeria

	No	Prevalence	Abundance	Mean intensity
O.niloticus	28	42.86 ± 0.07^{a}	3.1 ± 0.67^{b}	7.33 ± 0.56^{b}
C.gariepinus	16	25.5 ± 0.08^{b}	5.1 ± 1.03^{a}	8.2 ± 0.44^{a}
	T. tab=1.777	T. cal=1096, P<0.05	T. cal=-68.95, P<0.05	T. cal=-42.88, P<0.05

Table 7. Prevalence, abundance and mean intensity of Leech harboured by African catfish *Clarias gariepinus* and *Oreochromis niloticus* polycultured in earthen Ponds in Nigeria

	No	Prevalence	Abundance	Mean intensity
O.niloticus	0	0	0	0
C.gariepinus	38	25 ± 0.67^{a}	4.8 ± 0.01^{a}	6.33 ± 1.23^{a}
	T. tab=1.777			

Table 8. Prevalence, abundance and mean intensity of *Ichthyopthirius multifilis* harboured by African catfish *Clarias gariepinus* and *Oreochromis niloticus* polycultured in earthen Ponds in Nigeria

	No	Prevalence	Abundance	Mean intensity
O.niloticus	7	14.29 ± 1.26^{a}	1.0 ± 0.11^{ns}	7 ± 0.87^{ns}
C.gariepinus	7	12.5 ± 0.35^{b}	0.9 ± 0.77^{ns}	7 ± 0.19^{ns}
	T. tab=1.77	T. cal =83.97, P<0.05	T. cal.=0.62, P<0.05	T. cal.=0.74

polyculture system encourages trans pathogen transfer among fishes.

The abundance of nematode parasite *C. polypteri in both the C. gariepinus and O. niloticus* is another indicator of cross sharing of parasites. *Camallanus polypteri* was noted as major parasite of *O. niloticus* in the research but this has not been previously reported in literature. Conversely *Camallanus polypteri* are major parasite of *C. gariepinus.* In this research a comparative analysis of prevalence and the abundance of parasites in both *C. gariepinus* and *O. niloticus* showed that *Camallanus polypteri* is a major parasite. Cammalanids have been noted to be major parasites of African catfish (Akinsanya and Otubanjo, 2006, Abdel-Gaber *et al.,* 2015; Enyidi and Eneje, 2015; Enyidi and Maduakor, 2017). Based on the results it seems that the nematode parasites could easily attack the polycultured fishes despite their trophic levels in the ponds. Clarias usually feeds at the bottom and tilapia in the water column or edges. The earthen ponds analyzed were of two types in terms of water parameter. One of the ponds was majorly humic and constantly brownish while the rest of the two were mild with little fertilization. The earthen ponds harboured much blood sucking parasite leech that were attacking the catfish but could not be found on the *O. niloticus*. The reason for absence of leech infestation on the *O. niloticus* could be due to their pelagic life style compared to the bottom dwelling life pattern of the African catfish *C. gariepinus*. Culturing of fish in earthen ponds simulate natural conditions especially with aquatic vegetation, riparian and verge vegetation or emergent vegetation. Such vegetations often become habitats to fish parasites example leeches and crustacean copepods like *Larnaea cyprinacea*. The earthen ponds at Michael Okpara University have much vegetation which may have served as habitats for fish parasites and vectors. The presence of parasites like leeches among the big size African catfish in the research shows the susceptibility of the fish to the parasite. Big size catfish are not very fast swimmers like juvenile catfish and can easily be infested by leeches.

The monogenean parasites (*Dactylogyrus extensus* and *Gyrodactylus limnonephrotus*) were more prevalent on the *O. niloticus*. *D. extensus* had been known to be non host specific and tolerant to wide water parameters. In a previous research Rubio-Godoy and Gacia-Vásquez (2015) noted that *Gyrodactylus cichlidarum* is a very popular parasite of tilapia *O. niloticus*. Recent researches of *O. niloticus* in Uganda (Akoll *et al.,* 2012); and in Rwanda (Lulijwa, 2018) also noted that *Gyrodactylus* spp and *Dactylogyrus* spp are major parasites of *O niloticus.* In this research there was very low abundance of *G. limnonephrotus* on African catfish *C. gariepinus* compared to *O. niloticus*. The prevalence and abundance of the parasites on the catfish and *O. niloticus* could as well be related to the polyculturing, Amare *et al.,* (2014) and feeding habits of the fish Arkoll *et al.,* (2011). Arkoll *et al.,* (2011) noted that the feeding habits of *C. gariepinus* and *O. niloticus* cultured in same pond could affect the exposure to parasites. In our research we noted that the catfish prefers to feed on the bottom, edges and vegetation areas of the water while the tilapia are pelagic and feed in higher water column and edges or water. Consequently, specific parasites like leeches and nematode easily attack the catfish while the trichodidnids and *L. cyprinacea* are more prevalent in the tilapia. The relationship of diets and feeding habits and parasites had been highlighted by Marcogliese, (2002); Nunn *et al.,* (2008). The *Ichtyophthirius Multifilis* did not seems to be very serious parasite in this research. However, infestations of *I. multifilis* were confined small size *C. gariepinus* and *O. niloticus.* The low infestation of *I. multifilis* could have been due to high water volume in the earthen ponds and estimated stocking density of about 3000 fish ha^{-1}. It was not easy to estimate density of tilapia since the population was dwindling were coming in with the water inflow from NRCRI dam.

Conclusions

The disadvantages of polyculturing *C. gariepinus* and *O. niloticus* in terms of abundance, prevalence and intensity of parasite seems to be more serious than controlling precocious breeding of tilapia. The polyculturing of *C. gariepinus* and *O. niloticus* in earthen pond with water supplies from stream or river enhances influx of parasites. The cross infection of parasite from one species to the other can have serious effects on fish welfare and production. Natural water supply makes monitoring of disease and parasite hard and exposes fish to unwanted exposure to parasites. The growth of submerged and all aquatic weeds should be prevented in earthen ponds to reduce hide out for fish parasites and disease vectors.

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