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Prey/Predation Relationship of *Clarias gariepinus* on *Tilapia* (*Oreochromis niloticus*) Populations

O.A. Oyelese
Department of Wildlife and Fisheries Management, University of Ibadan, Ibadan, Nigeria

Abstract: This study was carried out to monitor the suitability of *Clarias gariepinus* as a predator on *Tilapia* (*Oreochromis niloticus*) populations. In order to (a) recommend a stocking ratio for *Tilapia-clarias* prey-predation relationship, (b) determine the size/level at which the prey is most vulnerable to predation and (c) to determine whether sudden cohabitation with or without feeding/sparing feeding will trigger predation. Four different treatments of (1) 10 *Clarias* juveniles/100 *Tilapia* fingerlings fed to satiation (2) 10 *Clarias* juveniles/100 *Tilapia* fingerlings fed sparingly (3) 50 *Clarias* fingerlings/50 *Tilapia* fingerlings fed sparingly (4) 15 *Clarias* fingerlings/90 *Tilapia* fingerlings fed to satiation and (5) 15 *Clarias* fingerlings/90 *Tilapia* fingerlings fed sparingly were monitored over a period of 12 weeks. Predation occurred only in Treatments 1 and 2 where the predator was bigger than the prey and the highest level of predation of 71% *Tilapia* fingerlings occurred in Treatment 2 compared to 26% in Treatment 1. The predation level was highest during the first 6 weeks of the study due to increasing size of the prey. Hence growth performance from 7th-12th week depended solely on the feed fed for Treatments 1 and 2. However, since virtually no predation was recorded for Treatments 3 (0%), 4 (0%) and 5 (2.22%) growth performance for these 3 treatments from weeks 1-12 was dependent solely on the feed fed whether fed to satiation or not. The analysis of variance test (ANOVA) to test significance in the predation level showed significant differences ($p<0.05$) among the treatments (at least for treatments 1 and 2) and Duncan's Multiple range tests puts the order of predation as Treatment 2 (71a)>1(26b)>3(0c)>4 (0cd) and > 5 (0cde), but there were no significant differences ($p>0.05$) among 3, 4 and 5 where the prey and predator were of similar sizes. Treatment 1 recorded the best growth performance in both species of fish with respect to mean weight gain, food conversion ratio and increase in total length. The order of growth performance is Treatment 1>2>4>3>5. The food conversion ratio among treatments 2 and 1 (where predation occurred) showed that it is higher in Treatment 1 where the level of predation was lowest. Analysis of variance (ANOVA) shows growth rate of prey and predator were significant at ($p<0.05$), respectively. The correlation coefficients 'r' between the size of the prey and predator in all the treatments were all positive viz: Treatment 1 (1.00), 2(0.96), 3(0.88), 4(0.95) and 5(0.81), this implying the size of the predator increased as the pray size increases. The sudden cohabitation of *Clarias gariepinus* and *Tilapia* (*Oreochromis niloticus*) with or without feeding did not trigger predation because the initial number stocked in Treatments 4 and 5 (each specie of fish raised separately and the two brought together at the end of 2 weeks) were recovered at the end of the 12 weeks experiment. The best level of growth performance and fairly balanced survival/predation level is achievable with Treatment 1 which gave the highest overall weekly mean weight gain and 90/74% *Clarias/tilapia* survival rate closely followed by Treatment 2 with 100/29% *Clarias/tilapia* survival rate. However if the intention of *Clarias/tilapia* polyculture is not to embrace predation, but to maintain at least about 100% survival of both species solely dependent on the feed fed Treatments 4>3>5 is recommended in that order.

Key words: *Clarias/tilapia* populations, cohabitation, predation level, fcr, survival rate, polyculture

INTRODUCTION

The main purpose of prey-predator relationship among fish lies in the need to control excessive reproduction of prolific fish species such as *Tilapia*. Ability of this fish to reproduce abundantly and at a very early age leads to heavy competition for food and space such that growth is virtually depleted. Predation could therefore be introduced as a process to regulate the population so that the environment do not become overcrowded (Moses, 1983).

Prey predator systems help to ensure a natural balance both within and between populations. This relationship expectedly have effects on growth and hence reproduction, in such a way as to stabilize the populations of both prey and predator.

Prey-predator control systems are based on certain principles such as the size of predators and size of prey. Boughey (1978) observed that there is a close relationship between size of predators and size of prey.

This could mean that age/size structures of the prey populations are closely related to those of the predator populations. On addition, predators are greatly influenced by the growth and reproductive pattern of their prey and how rapidly they grow in size determine the length of critical period during which they are susceptible to predation (Boughey, 1978). This could mean that if a longtime elapses after a prey has been spawned before a potential predator comes in contact with it, the effectiveness in performing its desired function may be greatly jeopardized. Also, the slow growth rate of a prey could ensure is long exposure to predation.

Predatory fish have a number of distinctive structural features in their mouth apparatus and digestive tract (Popova, 1978; Weatherly, 1976; Holden and Reed, 1978). They described the modification in the shape of the mouth of the fish as being inferior (as it is the case with *Clarias gariepinus* in this study) or as being terminal. *Clarias gariepinus* in addition has fleshy modification of lips which enables them to swallow their prey alive.

Other features of adoption for predatory feeding on fishes are the distensibility of oesophagus, the gill rakers lips and teeth, shortened intestine, elastic, thickwalled and elongated stomach. The intestine is shortened because fleshy food materials get digested more readily than vegetable materials. Also the gill rakers are being modified to grasp, retain and crush prey.

The *Tilapia* are predominantly one of the most important groups of fishes for aquaculture because of their herbivorous feeding habits (Balarin and Hatton, 1979), hardiness, that is low tolerance to a wide range of environmental and management conditions (Balarin and Hatton, 1979; Dupree and Huner, 1984) reported high prolificity and early maturation of the red *Tilapia* is capable of yields up to 600 tons/ha/year under intensive culture. Also in terms of economics, *Tilapia*s are able to utilize cheap high fibre feeds properly with only slight impairment of growth (Viola *et al.*, 1988), although their major shortcoming is their early maturation and prolific breeding.

The ability of *Clarias gariepinus* to practice cannibalism depends on variance in size and differential growth rate of the fish in the population, (Dimitrov, 1987). Williams *et al.* (1987), Hecht *et al.* (1987) reported higher growth of *Clarias gariepinus* under husbandry conditions with *Tilapia* (polyculture) than under natural conditions (monoculture) even with artificial feeding.

Ita *et al.* (1990) recommended a stocking density of 40,000 *Tilapia* ha^{-1} and *Clarias* at 6,000 ha^{-1} at a ratio of 6: 1. They argued that if there is more of *Tilapia* fingerlings than *Clarias* the latter could be utilized effectively to control the population of *Tilapia*.

The menace of overpopulation of ponds by *Tilapia* necessitates its culture with other fish species. It is therefore the objective of this study:

- To recommend a stocking ratio for the *Clarias gariepinus*/*Tilapia* (*Oreochromis niloticus*) prey/predation relationship under polyculture.
- To monitor the suitability of *Clarias gariepinus* as a predator.
- To determine the size/level at which the prey is most vulnerable to predation.
- To determine whether sudden cohabilitation with or without feeding will trigger predation.

MATERIALS AND METHODS

Experimental fish, pond preparation and culture environment: The project was carried out at the departmental fish farm. The experiment was performed in five hapas installed in a nursery pond of size 10x10x1.5 metres. The dimension of each hapa is 1x1x1 metres. The nursery pond was richly supplied with constantly running springing water which was allowed to run into the ponds through PVC drainage pipes. The experiment was carried out for a period of 12 weeks.

The dykes of the pond were weeded and also the inside of the pond was cleared and desilted slightly after which the pond was left for about a week before the hapas were installed and eventually the fish were introduced.

The fingerlings and jurveniles of *Clarias gariepinus* were obtained from Oluana fish breeding centre here in Ibadan. The size of the juvenile catfish ranged from 10-10.5 cm in length with an average weight of about 14.50 gm. The length of the fingerling catfish was on the average 4.5 cm while the average weight was about 1.40 gm. The fingerlings of *Tilapia* (*Oreochromis niloticus*) was purchased collectively from Agodi fish farm with an average length of 3.5 cm and average weight of about 1.00 gm were recorded.

Experimental design:

- Treatment (1) 10 juveniles of *Clarias gariepinus* was raised along with 100 fingerlings of *Oreochromis niloticus* and *were fed to satiation.*
- Treatment (2) 10 juveniles of *Clarias gariepinus* was reared along with 100 fingerlings of *Oreochromis niloticus* and was *fed sparingly* in *contrast* to *treaztment (1).*

The above experiment that is (1) and (2) were in accordance with the recommended stocking ratio of that is 10 *Tilapia* to 1 *Clarias.*

- Treatment (3) 50 *Clarias* fingerlings and 50 fingerlings of *Oreochromis niloticus. The feeding level was sparing. This treatment served as a control* and the stocking ratio is proposed to simulate that of the natural environment.

And in two separate hapas, 30 *Clarias* and 180 fingerlings of *Oreochromis niloticus* respectively were reared for 2 weeks and were subsequently introduced ogether in 2 different hapas referred to as treatments (4) and (5).

- Treatment (4) from the above hapas, 15 fingerrlings of *Clarias* were introduced along side 90 fingerlings of *Oreochromis niloticus. Feeding level was to satiation*.
- Treatment (5). The above treatment (treatment 4) was repeated and the feeding level in this study, was sparing.

The stocking ratio were in accordance with that recommended by (Ita *et al*., 1990). That is, 6 *Tilapia* to 1 *Clarias*. It should be noted that the 30 *Clarias* fingerling and 180 *Tilapia* fingerlings were separately nursed for two weeks before separation into Treatment 4 and 5 (15 *Clarias* fingerlings/90 *Tilapia* fingerlings each).

Experimental feed preparation feeding level/feeding frequency: A supplementary feed of 35% crude protein was formulated and compounded to meet the protein requirement of both fish species (i.e., *Clarias* and *Tilapia*) in this study shown in Table 1.

The ingredients were weighed after grinding, mixed with hot water thoroughly till homogeneity was achieved to form a thick paste. The ;paste was then rubbed under pressure on a piece of circular iron plate bearing several holes around its circumference. Once done as described above, it emerged in pelletized form and was subsequently dried.

Feeding frequency in all treatments was twice daily. The total feed to be fed per day was divided into 2 equal parts, one part was fed in the morning daily around 8.00a.m. and the second part in the evening around 5.00 p.m.

Monitoring growth and survival: Growth and survival of fish in each of the hapas were carefully monitored by counting and weighing the two species of fish on a weekly basis.

The weekly mean weight gain was monitored as well as the trend in total length. The food conversion ratio for each species on a weekly basis was monitored as well. These were calculated as follows:

$$\text{F.C.R.} = \frac{\text{Total feed intake}}{\text{Total weight gain}}$$

Mean weight gain = Final mean weight-Initial mean weight. Survival and mortality rates were calculated by subtracting the final number of fish from the initial and multiplying by 100.

Water quality assessment: Water quality parameters such as dissolved oxygen, hydrogen ion concentration (pH) wre measured weekly adopting the method of (Boyd, 1979).

Temperatures were measured with a simple centigrade mercury thermometer graduated at 0.01°C. The dissolved oxygen level was also determined according to Winkler's method.

Statistical analysis: All data collected were subjected to ANOVA and correlation and regression analysis as described by Steel and Torrie (1960). The predation level was subsequently subjected to analysis with the aid of the Duncan's multiple range test.

RESULTS

Water quality: The results of the water quality parameters monitored are shown in Table 2 below. The highest temperature recorded during the period of this study was 28°C and the lowest was 27°C. The minimum dissolved oxygen concentration was 6.14 mg L^{-1} and the maximum was 7.02 mg L^{-1}. The hydrogen ion concentration (pH) ranged from 7.00-7.50.

As shown in Table 2 the temperature range 27- 28°C falls within the range for optimum growth of *Tilapia* and most warm water fishes (25.5-32°C) recommended by Winfree and Stickney (1981). Also the dissolved oxygen range (6.14-7.02 mg L^{-1}) is above the least tolerable limit of 3.0 mg L^{-1} recorded by Balarin and Hatton (1979), Balarin and Haller (1982). Also the pH range (7.0-7.5) is within the range 7.0-8.5 recommended for intensive fish culture by Boyd (1979).

As shown in Table 3 active predation was experienced in the first 6 weeks of experimentation especially Treatment 2 (10 Juvenile *Clarias* paired with 100 *Tilapia* fingerlings with sparing feeding) recording

Table 1: Gross composition of experimental diet

Feed ingredient	% Weight (kg)
Groundnut cake	24.21
Blood meal	3.07
Soyabeans	24.22
Wheat offal	17.50
Yellow maize	17.50
Oyster shell	1.50
Bone meal	1.50
Vitamin premix	1.25
Oil	4.00
Salt	0.25
Fish meal	5.00

Table 2:Water quality parameters during the experimental period

Parameters	Range	Mean
Temperature (°C)	27-28	27.50
Hydrogen ion concentration (PH)	7-7.5	7.25
Dissolved oxygen concentration (mg L^{-1})	6.14-7.02	6.58

Table 3: Weekly monitoring of the growth parameters, mortality and feeding rates (juv-juveniles, fing – fingerlings)

Week	Treatment number	Stage of fish development		Agerage length (cm)		Average weight of fish (gm)		Mortality due to predation		Weight of total Feed consumed per treatment
		Clarias	*Tilapia*	*Clarias*	*Tilapia*	*Clarias*	*Tilapia*	*Clarias*	*Tilapia*	by *Clarias* and *Tilapia*
0 Intial	1	10 Juv	100Fing	10.50	3.50	15.00	1.50	-	-	-
	2	10 Juv	100Fing	10.00	3.50	14.00	1.35	-	-	-
	3	50Fing	50Fing	4.50	3.20	1.380	0.87	-	-	-
	4	30Fing	-	5.00	-	1.400	-	-	-	-
	5	-	180Fing	-	3.00	-	0.85	-	-	-
	1	10Juv	96Fing	10.50	3.50	16.50	2.00	-	4Fing	70.00
	2	10Juv	92Fing	10.00	3.50	14.70	1.50	-	8Fing	35.00
1	3	50Fing	50Fing	4.50	3.20	1.500	0.92	-	-	30.00
	4	30Fing	-	5.00	-	1.600	-	-	-	30.00
	5	-	180Fing	-	3.00	-	0.9	-	-	15.00
	1	10Juv	92Fing	10.50	3.50	17.70	2.50	-	4Fing	70.00
	2	10Juv	73Fing	10.00	3.50	15.20	1.59	-	19Fing	35.00
2	3	50Fing	50Fing	4.50	3.20	1.60	1.07	-	-	30.00
	4	30Fing	-	5.00	-	1.50	-	-	-	30.00
	5	-	180Fing	-	3.0	-	0.90	-	-	15.00
	1	10Juv	87Fing	10.80	3.60	19.10	2.80	-	5Fing	`65.00
	2	10Juv	60Fing	10.00	3.50	15.80	1.65	-	13Fing	32.50
3	3	10Fing	50Fing	4.50	3.30	1.650	1.10	-	-	30.00
	4	15Fing	90Fing	5.10	3.10	1.70	0.95	-	-	30.00
	5	15Fing	90Fing	5.00	3.20	1.70	0.95	-	-	15.00
	1	10Juv	82Fing	11.00	3.90	20.10	3.05	-	5Fing	65.00
	2	10Juv	45Fing	10.20	3.60	16.30	1.71	-	15Fing	32.50
4	3	50Fing	50Fing	4.60	3.30	1.72	1.18	-	-	30.00
	4	15Fing	90Fing	5.20	3.30	2.00	1.05	-	-	30.00
	5	15Fing	90Fing	5.00	3.20	1.80`	1.00	-		15.00
	1	10Juv	78Fing	11.00	3.90	21.00	3.22	-	4Fing	65.00
	2	10Juv	37Fing	10.20	3.60	16.90	1.77	-	8Fing	28.00
5	3	50Fing	50Fing	4.60	3.30	1.760	1.18	-	-	25.00
	4	15Fing	90Fing	5.20	3.30	2.500	1.12	-	-	30.00
	5	15Fing	90Fing	5.00	3.30	2.100	1.05	-	-	15.00
	1	10Juv	74Fing	11.10	400	22.20	3.50	-	4Fing	65.00
	2	10Juv	29Fing	10.40	3.70	17.40	1.83	-	8Fing	28.00
6	3	50Fing	50Fing	4.60	3.50	1.80	1.26	-	-	25.00
	4	15Fing	90Fing	5.30	3.40	2.80	1.16	-	-	30.00
	5	15Fing	88Fing	5.10	3.30	2.350	1.20	-	2Fing	15.00
	1	10Juv	74Fing	11.20	4.00	23.00	3.80	-	-	60.00
	2	10Juv	29Fing	10.50	3.80	18.10	1.88	-	-	28.00
7	3	50Fing	50Fing	4.60	3.50	1.88	1.30	-	-	25.00
	4	15Fing	90Fing	5.30	3.40	3.30	1.20	-	-	30.00
	5	15Fing	88Fing	5.10	3.30	2.50	1.35	-	-	15.00
	1	9Juv	74Fing	11.20	4.00	23.60	4.00	1Juv	-	60.00
	2	10Juv	29Fing	10.50	3.90	18.50	2.00	(Natural)	-	28.00
8	3	50Fing	50Fing	4.60	3.50	1.93	1.34	-	-	25.00
	4	15Fing	90Fing	5.30	3.40	3.70	1.35	-	-	30.00
	5	15Fing	88Fing	5.10	3.30	2.76	1.42	-	-	15.00
	1	9Juv	74Fing	11.30	4.20	24.50	4.30	-	-	60.00
	2	10Juv	29Fing	10.50	3.90	18.90	2.20	-	-	28.00.
9	3	50Fing	50Fing	4.70	3.50	2.00	1.37	-	-	25.00
	4	15Fing	90Fing	5.50	3.40	4.00	1.50	-	-	30.00
	5	15Fing	88Fing	5.10	3.30	2.93	1.45	-	-	15.00
	1	9Juv	74Fing	11.50	4.30	25.20	4.50	-	-	60.00
	2	10Juv	29Fing	10.50	3.90	19.20	2.50	-	-	28.00
10	3	50Fing	50Fing	4.70	3.50	2.040	1.42	-	-	25.00
	4	15Fing	90Fing	5.50	3.50	4.40	1.80	-	-	30.00
	5	15Fing	88Fing	5.20	3.30	3.10	1.48	-	-	15.00
	1	9Juv	74Fing	11.70	4.40	25.80	4.60	-	-	60.00
	2	10Juv	29Fing	10.70	4.00	19.80	2.60	-	-	28.00
11	3	50Fing	50Fing	4.80	3.70	2.10	1.45	-	-	25.00
	4	15Fing	90Fing	5.60	3.60	5.00	2.20	-	-	30.00
	5	15Fing	88Fing	5.20	3.40	3.30	1.50	-	--	15.00
	1	9Juv	74Fing	11.80	4.50	26.80	4.80	-	-	60.00
	2	10Juv	29Fing	10.90	4.00	20.50	2.90	-	-	28.00
12	3	50Fing	50Fing	4.80	3.70	2.250	1.50	-	-	25.00
	4	15Fing	90Fing	5.60	3.60	5.50	2.50	-	-	30.00
	5	15Fing	88Fing	5.20	3.40	3.50	1.65	-	--	15.00

Table 4: Weekly fish mean weight gain (gm)

Week	Treatment 1		Treatment 2		Treatment 3		Treatment 4		Treatment5	
	Clarias	*Tilapia*	*Clarias*	*Tilapia*	*Clarias*	*Tilapia*	*Clarias*	*Tilapia*	*Clarias*	*Tilapia*
1	1.50	0.50	0.70	0.15	0.12	0.05	-	-	-	-
2	1.20	0.50	0.50	0.5	0.15	0.15	-	-	-	-
3	1.40	0.30	0.60	0.15	0.05	0.04	0.20	0.05	0.20	0.05
4	1.00	0.25	0.50	0.06	0.07	0.08	0.30	0.10	0.10	0.05
5	1.00	0.23	0.60	0.06	0.04	0.03	0.50	0.07	0.30	0.05
6	1.20	0.28	0.50	0.06	0.04	0.05	0.30	0.04	0.25	0.15
7	0.80	0.30	0.70	0.05	0.08	0.07	0.50	0.04	0.15	0.15
8	0.60	0.20	0.40	0.12	0.05	0.04	0.40	0.15	0.26	0.07
9	0.90	0.30	0.40	0.2	0.07	0.04	0.30	0.15	0.17	0.04
10	0.70	0.20	0.30	0.3	0.30	0.04	0.050	0.40	0.30	0.04
11	0.60	0.10	0.60	0.1	0.06	0.03	0.60	0.40	0.20	0.03
12	1.00	0.20	0.30	0.3	0.15	0.05	0.50	0.30	0.20	0.26
Overall	11.90	3.36	6.10	2.05	1.18	0.67	3.65	1.34	1.86	0.69
Total mean Weight gain	1st (*Clarias*)	1st (*Tilapia*)	2nd (*Clarias*)	2nd (*Tilapia*)	5th (*Clarias*)	5th (*Tilapia*)	3rd (*Clarias*)	3rd (*Tilapia*)	4th (*Clarias*)	4th (*Tilapia*)

the highest number of 71 *Tilapia* fingerlings predated upon. This is followed by Treatment 1 also with (10 Juvenile *Clarias* paired with 100 *Tilapia* fingerlings but with feeding *ad libitum* to satiation) recording 26 *Tilapia* fingerlings predated upon. Treatment 5 (15 *Clarias* fingerlings paired with 90 *Tilapia* fingerlings and also fed sparingly) recorded a predation of 2 *Tilapia* fingerlings only at the end of the sixth week. While only 1 *Clarias* juvenile died naturally in Treatment 1 (10 *Clarias* Juvenile/100 *Tilapia* fingerling) at the end of the 8th week of the 12th week experimental study.

Inspite of the fact that the highest predation levels of 71/26 *Tilapia* fingerlings were recorded in Treatment 2 and 1 (as shown in Table 3). Treatment 1 recorded the highest overall fish mean weight gain 11.90 gm for *Clarias* and 3., 36 for *Tilapia*. Also this is closely followed by Treatment 2 with 6.10gm overall mean weight gain recorded for *Clarias* and 2.05gm recorded for *Tilapia* (Table 4). Coincidentally both treatments 1 and 2 had a stocking of 10 Juvenile *Clarias* to 100 *Tilapia* fingerlings although Treatment 2 fish were fed sparingly, hence the high predation level of 71 *Tilapia* fingerlings in 12 weeks of experimentation. The third best treatment is 4 (15 *Clarias*/90 *Tilapia* fingerlings) fed to satiation fingerlings while the 4th best treatment is 5(15 *Clarias* fingerlings/90 *Tilapia* fingerlings) fed sparingly. The worst treatment is 3(50 *Clarias* fingerlings/50 *Tilapia* fingerlings) even with feeding them to satiation. The fishes in this group (Table 3 and 4) not only relied on the feed fed (since they were all fingerlings) also no mortality was recorded throughout the 12 weeks experiment.

A 35.07% crude protein diet was prepared adequate for *Clarias* and *Tilapia* growth also coupled with 16.29% ether extract (fat).

Treatment 1 (10 Juvenile *Clarias*/100 *Tilapia* fingerlings) with feeding to satiation is the best polyculture combination of Juvenile *Clarias* and *Tilapia*

Table 5: Proximate composition of experimental diet fed the 5 treatments

Proximate composition	Percentage composition
Moisture	12.36
Crude protein	35.07
Crude fibre	11.94
Ether extract	16.29
Ash	13.64
Nitrogen free extract	10.70

to enhance (a) Optimum predation level that will not totally wipe out the *Tilapia* populations and (b) that will ensure optimum growth and optimum representation of both fish species for table size fish production. As could be seen from Table 4 predation of *Tilapia* seized in both Treatments 1 and 2 at the end of the 6th week implying the *Tilapia* fingerlings have reached adulthood and has overgrown predation. Therefore both species depended on feeding to satiation from the 6-12th week. The superiority of Treatment 1 over Treatment 2 (also with the same *Clarias*/*Tilapia* combinations but with sparing feeding) is further confirmed since a slightly higher overall Total Food Conversion Ratio (FCR) of (80.20-70) 11.20 in Treatment 1 is compensating for the excess loss of (71- 26) of 45 *Tilapia* fingerlings which could have also grown to adulthood in Treatment 2 (Table 4).

Treatment 3 (50 fingerlings of *Clarias*/50 Fingerlings of *Tilapia*) is the worst polyculture combination since this treatment recorded the highest overall FCR of 104.85 with no incidence of *Tilapia* production because there is no initial size differential, both species were growing at their own rate solely dependent on the feed fed. This is closely followed by Treatments 4 and 5 with overall FCR's of 52.60, respectively. The above stated reasons for Treatment 3 also applied although with different combinations of 15 *Clarias* fingerlings/90 *Tilapia* fingerlings in both cases (Treatment 4 and 5) although Treatments 5 fish were fed sparingly (Table 4).

In all the 5 treatments *Clarias* (Juveniles and Fingerlings) recorded 100% survival except in Treatment

Table 6: Mortality and survival rates of *Clarias* and *Tilapia* under polyculture at different stages of developmen

	Initial number of fish		Final number fish		Mortality		Survival		Mortality rate %		Survival rate %	
Treatment description	CLA	TIL	CLA	TIL	CLA	TIL	CLA	TIL	CLA	TIL	CLA	TIL
10 *Clarias* juvenile/100 *Tilapia* fingerlings fed to satiation	10	100	9	74	1	26	9	74	10	26	90	74
Clarias juveniles/100 *Tilapia* fingerlings fed sparingly.	10	100	10	29	0	71	10	29	0	71	100	29
50 *Clarias* fingerlings/50 *Tilapia* fingerlings fed sparingly.	50	50	50	50	0	0	50	50	0	0	100	100
15 *Clarias* fingerlings/90 *Tilapia* fingerlings fed to satiation	15	90	15	90	0	0	15	90	0	0	100	100
15 *Clarias* fingerlings/90 *Tilapia* fingerlings fed sparingly	15	90	15	88	0	2	15	88	0	2.22	100	97.78

Table 7: Weekly Food Conversion Ratio (FCR) for the predator (*Clarias*)/predation level of *Tilapia*

	Treatment 1		Treatment 2		Treatment 3		Treatment 4		Treatment 5	
Weeks	FCR for the Predator	Predation level of *Tilapia*	FCR for the Predator	Predation level of *Tilapia*	FCR for the Predator	Predation level of *Tilapia*	FCR for the Predator	Predation Level *Tilapia*	FCR for of the Predator	Predation Level *Tilapia*
1	4.70	4	4.20	8	5.00	-	-	-	-	-
2	5.80	4	7.00	19	6.00	-	-	-	-	-
3	50	5	5.80	13	12.00	-	7.50	-	7.50	-
4	6.50	5	6.50	15	8.50	-	6.60	-	6.60	-
5	4.20	4	5.00	8	15.00	-	4.00	-	4.00	-
6	5.40	4	5.60	8	12.50	-	6.60	-	6.60	-
7	7.50	-	4.00	-	6.25	-	4.00	-	4.00	-
8	10.00	-	7.00	-	10.00	-	5.00	-	5.00	-
9	6.60	-	7.00	-	5.50	-	6.60	-	6.60	-
10	8.50	-	9.30	-	12.50	-	5.00	-	5.00	-
11	10.00	-	4.60	-	8.30	-	3.30	-	3.30	-
12	6.0	-	4.00	-	3.30	-	4.00	-	4.00	-
Total	80.20	26	70.00	71	104.85	0	5260	0	52.60	0

1 which recorded 90%. The 10% mortality recorded is attributed to the death of 1 juvenile *Clarias* (Treatment 1) due to natural occurrence (or selection) (Table 5).

The intense predation as a result of sparing feeding of fishes in Treatment 2 resulted in the high mortality rate of *Tilapia* fingerlings (71%) being consumed by the juvenile *Clarias* which is possibly preferred to compensate for the inadequate feeding.

Treatments 3, 4 and 5 recorded almost 0% mortality/100% survival except in Treatment 5 with 2.22% mortality/97.78% survival recorded for *Tilapia* fingerlings. This is because the 3 treatments contained fingerlings of *Clarias* and *Tilapia* growing to adulthood almost at the same rate initially and both depending solely on supplementary feeding whether to satiation or sparingly (Table 6).

The regression analysis (Table 7) showed that there is no significance difference between Food Conversion Ratio (FCR) of the predator and predation level employing that the choice of what the predator takes depends on what is available (i.e., is either feed fed or predation on *Tilapia* fingerlings). This is further confirmed by the negative correlations r = - 0.695 and r = - 0.007 recorded for Treatments 1 and 2, respectively.

However the stronger negative correlation (r = 0.695) recorded for Treatment 1 indicates that there is a higher tendency for as FCR to increase as predation level decreases and vice versa than it is the case with Treatment 2 (r = - 0.007) (Table 8).

Table 8: Regression analyses between the Food Conversion Ratio (FCR) of the predator and predation level

Treatment	R-value	Prediction equation	Test of significance
1	- 0.695	Y = 7.24 - 0.695X	N.S (p>0.05)
2	- 0.007	Y = 6.21 - 0.007X	N.S (p>0.05)

Table 9: Regression analyses between the treatment body weight of the predator and the prey

Treatment	R-Value	Prediction Equation	Test of Significance
1	0.27	$Y = -2.47 + 0.27X_1$	NS
2	0.224	$Y = -1.935 + 0.224X_1$	NS
3	0.76	$Y = -0.146 + 0.76X_1$	NS
4	0.39	$Y = 0.12 + 0.39X_1$	NS
5	0.38	$Y = 0.32 + 0.38X_1$	NS

There is no significant difference in the treatment body weight of the predator and prey (Table 9). That is both responded to the diet treatments steadily and that there is a tendency for both *Clarias* and *Tilapia* to increase in size as the experimental days increases. This is confirmed by the positive (r) correlations in all the 5 treatments.

In all the 5 treatments there is a positive correlation between prey and predator size, this further confirms that the prey size increases as the predator size increases (Table 8) with length of study period. reatments with the

Table 10: Correlation between the prey and the predator size

Treatment	Correlation coefficient
1	r = 1.00
2	r = 0.96
3	r = 0.885
4	r = 0.95
5	r = 0.81

Table 11: ANOVA for growth rate of predator

Source of Variation	Degree of freedom	Sum of squares	Mean of squares	F-calc.
Treatment	4	5.98	1.495	74.75
Error	51	1.32	0.0259	
Total	55	7.3039		

U_1 =4, U_2 = 51=2.56 (Ftab),...... Fcal > Ftab, Test is significant at $p<0.05$

Table 12: ANOVA for predation level

Source of Variation	Degree of freedom	Sum of squares	Mean of squares	F-calc.
Treatment	4	345.69	86.42	8.72
Error	51	545.17	`9.91	
Total	55	890.86		

U_1 = 4, U_2 = 51=2.53 (Ftab),...... Fcal > Ftab:, Test is significant at $p<0.05$

Table 13: Duncan's test on the predation level

Treatment	Mean
2	71a
1	26b
3	0c
4	0cd
5	0cde

same superscripts are not significantly different from each other. Treatment 2 ranked highest (71a) in terms of *Tilapia* fingerlings predation as shown in Table 11.

DISCUSSION

Clarias gariepinus was able to thin down the population of *Oreochromis niloticus* (*Tilapia*) but its efficiency as a predator as evident in this study is dependent on the size ratio of the prey/predator on hand and the availability of supplementary feed on the other hand. This findings is in accordance with (Hecht *et al.*, 1987) that *Clarias gariepinus* do practice cannibalism which depends on variance in size and differential growth rate of the fish in the population, as it is shown in Treatments 1 and 2. (Boughey, 1978) also observed that there is a close relationship between size of predators and size of prey, as in this study *Tilapia* fingerlings are of small sizes than *Clarias* fingerlings and juveniles.

The reduction and eventual stoppage of predation at the end of the 6th week especially for Treatments 1 and 2 was due to the increased size (weight and length) of the prey as from the end of the 6th week that rendered them not vulnerable to predation by the juvenile *Clarias.* This is in line with (Boughey, 1978) that the critical period of predation on a prey is influenced by the growth and reproductive pattern of the prey and how rapidly they grow in size; and also the slow growth rate of a prey could ensure its long exposure to predation. Predation level was lowest in Treatment 1 compared to Treatment 2 because fish in Treatment 1 were fed to satiation.

There was however, no occurrence of predation in the other 3 treatments (i.e., Treatments 3, 4 and 5 which were all *Clarias*/*Tilapia* fingerlings combinations). This is attributed to the fact that the proposed predator (*Clarias* fingerlings) though bigger than the prey (*Tilapia* fingerlings) had a smaller mouth size that could not predate on the *Tilapia* fingerlings at that stage. This findings is in line with (Das and Moitra, 1956) cited by Weatherly in 1976 who noted that young *Clarias gariepinus* feed on zooplankton but after few months, feed on other live food as large as their buccal cavity can permit. This is because the fingerlings of the prey (*Tilapia*) even with different stocking ratio, density and feeding ratio (as it is the case with Treatments 3, 4 and 5) was not vulnerable to predation by virtue of their size ratio.

The analysis of variance to test significance (ANOVA) in the predation level showed that there were significant differences among the treatments at $p<0.05$ and the Duncan's multiple range test showed the degree of predation in the order of Treatment 2>Treatment 1 and that there are no significant differences among treatments 3, 4 and 5.

Increase in weight and size was observed in all the 5 treatments but at different rates. Treatment 1 (10 *Clarias* juveniles stocked with 100 *Tilapia* fingerlings and fed to satiation) recorded the best growth performance in both species of fish as regard the mean weight gain, Food Convesion Rate (FCR) and increase I n total length (Table 3 and 4).

The growth performance of the 5 treatments is in the order of Treatment 1>2>4 >3>5. This is so because there was no occurrence of predation in treatments 3, 4 and 5. However it could be inferred that if no predation is targeted in the polyculture of the two fish species they are better stocked at the fingerlings level with feeding to satiation but a higher weight gain etc. should not be expected as it is the case for Treatments 1 and 2.

There are no significant differences in the food conversion ratio and the predation level for all the 5 treatments. Also, no significant differences exists between body weights of the predator and prey. However, there are significant differences in the growth rate of the predator and prey at ($p<0.05$). The correlation coefficients between the size of the prey and predator in all the treatments were positive. This indicates that as the size of the prey increased so does the size of the predator. All these are as shown in Table 8-13.

There was significant difference at ($p<0.05$) in the survival rates of the prey and predator among treatments. Table 5 shows the survival and mortality trends in each of the treatments. Highest survival rates of 100% was recorded in treatments 3 and 4, followed by treatment 5 (97.78%) >treatment 1 (74%) >treatment 2 (29%).

CONCLUSION

The best level of growth performance and fairly balanced survival/predation level is achievable with Treatment 1 (i.e., polyculture of 10 *Clarias* juveniles with 100 fingerlings of (*Tilapia*) *Oreochromis niloticus*) which gave the highest overall weekly mean weight gain (as shown in Table 3) and 90/74% *Clarias/tilapia* survival rate in this study followed by Treatment 2 with 100/29% survival rate. However, if the intention of *Clarias/tilapia* polyculture is not to embrace predation, but to maintain at least about 100% survival of both species solely dependent on the feed fed Treatments 4, 3 and 5 is recommended in that order.

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