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BIOLOCIAL STUDIES ON NILE PERCH *LATES NILOTICUS* (L.) AND AFRICAN CATFISH *CLARIAS GARIEPINUS* (T.) IN REFERENCE TO THEIR FOOD HABITS AND PREDATION PATTERNS IN CULTURE PONDS

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Abstract

Predation preference and pressure of Nile perch *Lates niloticus* and African catfish *Clarias gariepinus* on tilapia, mullet, common carp and silver carp were evaluated. Stomach content analysis of Nile perch and catfish collected from culture ponds indicated their food habits under culture conditions. The smallest predator size found was 5.5 g and 13.0 g in Nile perch and catfish, respectively. Darkness fish was found to have simulating effect on the predatory process. Predation pressure and preference was determined from the information collected on the colour, weight and morphometric relationship between predator and prey. Fry recovered from control ponds were greater than those in ponds stocked with catfish. The morphometric data in regard to predation activities including length of intestine and buccal dimesions were obtained. A cone method was used which interpreted the buccal gape dimensions better.

Key words: *Lates niloticus*, *Clarias gariepinus*, tilapia, carps, food habits, predation.

INTRODUCTION

Uncontrolled reproduction of some fish species in fish culture ponds usually creates difficulties in the management of such ponds. Several aquaculture species are known to breed spontaneously in culture ponds. This is more pronounced in tilapias, probably due to their precocions maturation which leads to prolific breeding and, consequently, over population in culture ponds. Because of tilapia worldwide popularity in aquaculture, several approaches are practiced to overcome their unwanted reproduction.

Proper use of predator fish is considered a safe biological means for overcoming this problem. Guerrero (1982) has summarized a list of possible predators. Swingle (1960) recommended the use of local predatory species.

Huet (1970) pointed out the varying degrees of success upon using predators for the control of tilapia overpopulation. However, different ecological situations should be considered in order to select the appropriate predator for a particular situation. Nile perch *Lates niloticus* (L.) and African catfish *Clarias gariepinus* (T.) are predators with high potential in Africa.

El-Gamal (1992), through lab and field studies, investigated the possibility of using Nile perch in controlling tilapia recruitment. However, use of Nile perch as a predatory fish on commercial scale is hampered by spawning problems limiting their seed availability.

Using African catfish *Clarias gariepinus* as predators could lead to uncontrolled predation especially in non-drainable earthen ponds since they burrow in the mud resulting in possible incomple recovery of their stock. In addition, their ability to breed in culture ponds is another disadvantage. However, *Clarias* sp. are important food fish in Africa and are widely cultivated under various *culture* systems (Huisman & Richter 1987, Haylor 1989). Moreover, catfish are the only fish species normally sold alive at Egyptian fish markets with good marketability especially when farm-raised.

A significant amount of information about the biology of both Nile perch and African catfish were obtained from studies at natural environments which are different from pond environment, hence, results may not be applicable to aquaculture. Therefore, in order to achieve better management of such predators, more understanding of their biology under pond conditions is needed, especially their food habits and their effectiveness in controlling recruitment of other fish at different ecological situations.

The objective of the present study is to obtain more biological information on *lates niloticus* and *Clarias gariepinus* in order to employ this information in aquaculture management.

MATERIALS AND METHODS

Fish

a) *Lates niloticus* and *Clarias gariepinus* were seined from the production ponds of the Central Laboratory for Aquaculture Research (CLAR), where they were accidentally introduced.

b) *Oreochromis niloticus* fingerlings and *Sarotherodon galilaeus* brood fish were raised and maintained on CLAR facilities.

c) *Cyprinus carpio* (normal & dark colour) were raised and maintained on CLAR facilities.

d) *Hypopthalmichthys molitrix* were brought from Abbassa Fish Hatchery (General Authority for Fish Resources Development).

e) Mugil sp. fingerlings were obtained from collecting stations and reared in CLAR facilities.

MORPHOMETRIC DATA AND FOOD HABITS

Relationship between total length of fish specimens and length of the intestine was determined. Buccal dimensions for fish specimens were determined to the nearest mm. In some of the tests, buccal width and length were determined, whereas in other tests, buccal height was also considered. Vertical buccal gape was measured as the maximum vertical opening opening between the anterior ends of the upper and lower jaws. In the final part of the study, a cone method was developed to measure the mouth gape using a wax cone designed with suitable diameter. The cone was inserted into the mouth until a maximum stretched opening was obtained which was measured using a calliper. Fish specimens for this part of the study were collected from randomly chosen research and production ponds that were not subjected to any specific management protocol, although tilapias were almost the only group that existed. Food habits were determined based on stomach content analysis that was carried out immediately after catching. Morphometric data and food habits are presented in Tables 1, 2, 3.

Predation efficiency

Aquaria study

A series of tests was conducted over several seasons ending on 1996 in aquaria in the wet laboratories at CLAR targeting to investigate the predatory preference and pressure of *Lates niloticus* and *Clarias gariepinus* when different sizes fry or fingerlings of *O.niloticus, C.carpio, Mugil* Sp. and *H.molitrix* were introduced as prey fish for different durations. Natural photoperiod was furnished throughout the study. Nine aquaria (60 x 50 x 78 cm) were assigned to the study. However, when the effect of darkness was investigated, walls of of three aquaria were totally paint-darkened. Dark thick covers were used as well. At this particular test, light was provided continously to other treatments for comparative purposes. Aquaria were equipped with constant with constant aeration. No artificial feed was offered throughout any particular test.

Before any test, predator fish were fasted for at least one day. At the end of test, fry or fingerlings recovered were counted by species and size group wherever applicable to determine the number of fish consumed. In comparative tests including multiple prey species, data were analyzed by the Chi-square test method. Data on predation efficiency in aquaria are presented in Tables 4 to 5.

Pond study

The objective of the study was to investigate the effectivness of catfish in controlling the recruitment of tilapia when stocked with tilapia brood fish at different ratios under pond environment. Females and males of *Sarotherodon galilaeus* stocked were selected based on ready-to spawn symptoms. Average size of stock was 96.3g for females and 123.6g for males. Six (3x6 m) ponds with concrete walls and soil bottoms were assigned to the treatments in a two-replicate experiment. The study took place during the natural spawning season for tilapia (August-October).

Ponds were fertilized to stimulate natural productivity. Supplemented feed was offered during the study. Water was only allowed to compensate for water losses through evaporation and seepage.

Harvesting took place after 80 days form stocking. Ponds were completely drained using fine screen on the outlets. Tilapia broodstock and catfish were identified and removed. Tilapia fry and fingerlings were removed, graded and enumerated. Statistical analysis were performed on numbers recovered by ANOVA according to Steel and Torrie (1980). Data of stocking and harvesting are presented in Table 6.

RESULTS

Morphometric data and food habits

Predation related morphometric data are presented in Tables1, 2, 3. In regard to the data obtained, it seems that, the cone method used in the last part of the

Table 1. Relationship between the size of *Lates niloticus* and their buccal dimensions and stomach contents.

no.	Weight (g)	T.L. (mm)	Buccal dimensions (mm) W	L	Contents of stomach
1	0.4	32	4	5	Different plankton groups
2	0.7	38	7	10	
3	4.0	70	11	17	
4	5.5	80	13	20	A small fish fry
5	22.3	123	20	28	
6	23.8	125	25	30	
7	24.9	125	25	31	5 tilapias (30,30,25,25 & 20 mm T.L. and one gambusia 27-mm T.L.)
8	382.0	300	39	42	3 tilapias (72,64,59 mm T.L.)
9	518.0	338	45	50	6 tilapias (94,88,85,77,51,44 mm T.L.)
10	636.0	352	45	50	
11	891.0	386	45	55	
12	1626.9	490	75	130	

Table 2. Relationship between the size and the buccal dimensions of *Clarias gariepinus*.

Specimens no.	Weight of specimens (g)	Total length (mm)	Buccal gape horizontal (mm)	dimensions vertical (mm)
1	200	300	30	25
2	215	315	33	25
3	203	300	30	25
4	142	270	25	20
5	144	280	30	23
6	126	255	25	20
7	309	350	35	30
8	233	320	30	25

Table 3. Relationship between size of *Clarias gariepinus* and their buccal gape and stomach contents.

no.	Weight (g)	T.L. (mm)	B.G (mm)	Intestine length (mm)	Contents of stomach
1	98.0	240	22.0	250	large number of tiny beetle
2	143.3	285	25.0	295	27 7-mm average length gambusia
3	147.4	285	25.0	280	one tilapia 26 mm T.L. & 2 dragon fly nymph
4	223.5	245	31.5	330	2 tilapias (20 and 60 mm T.L.)
5	254.8	360	32.0	335	2 tilapias (45 and 55 mm T.L. & 3 labios 60, 65, 70 mm T.L.)
6	273.3	370	33.0	340	7 tilapias (20, 20,20,30,30,47 and 50 mm T.L.)
7	337.2	395	33.7	357	5 tilapias (17,17,17,17 & 20 mm T.L. & one labeo 40 mm T.L)
8	374.0	405	34.5	365	4 tilapias (35, 35, 50 and 55 mm T.L.)
9	345.5	450	36.0	390	3 tilapias 15 mm total length each

T.L. = Total length; B.G. = buccal gape
Buccal gape was obtained using cone method

Table 4. The predatory action of a 80-mm T.L. *Lates niloticus* specimen on fingerlings of tilapia, mullet and dark coloured common carp over a 2-day test.

	Lates niloticus	*Oreochromis niloticus*	*Mugil sp.*	*Dark-coloured Cyprinus carpio*
Total length (mm)	270			
number stocked	1	10	10	10
number recovered	1	8	5*	10

* Five specimens were dead and thus not actually exposed to predation by Nile perch

study interpreted better the buccal gape dimensions. Simply, it reflects the maximum stretched opening taking into account both vertical and horizontal dimensions. As calculated from Table 3, average percentages of mouth gape and intestine length contributed 8.74±0.12 and 94.86±2.03% of *clarias gariepinus* total length, respectively, with a trend towards relative decrease with the increase in total length.

Based on the examination of stomach of *Lates niloticus*, it was found that, predatory activities start at their early stages. A small prey fry was found in the digestive tract of a 5.5 g, 80 mm T.L. Nile perch having a mouth length and width of 20 mm and 13 mm, respectively (Table 1). Also, five tilapia fry with 30,30,25,24 and 20 mm total length and a 27-mm gambusia fry were all found in the digestive tract of a 24.9-g Nile perch having a mouth length and width of 31 mm and 25 mm, respectively (Table 1).

Beetles, gambusia, Labeo and tilapia fry were found in the digestive tract of *Clarias gariepinus* as presented in Table 3. Small sizes of catfish such as 13.0-g were able to prey as effective as larger sizes whenever they found a prey size they could handle (Table 6).

It was also found that, dead specimens of prey fish were not actually susceptable to Nile perch feeding which preyed exclusively on live fish (Table 4). Based on perliminary test, artificial feed was not accepted by Nile perch having weight ranges from 26.4 to 35.0 g.

Predation preference and pressure

When 80-mm T.L. dark coloured *Cyprinus carpio* were introduced to a 270-mm T.L. Nile perch along with equal size of tilapia and mullet, no predation was observed on carp, while, mullet stocks experienced heavy predation followed by tilapia in a 2-day test (Table 4).

It seemed also that, the predatory pressure of catfish was considerably low during winter moths in Egypt at temperature below 15^{o}C (Table 4).

Although predation pressure of catfish varied throughout the test, however, the quick and high rate of predation observed in the dark regime excreted by medium size catfish suggest a stimulating effect of darkness on the rate of predation (Table 10).

In regard to the pond study, and as presented in Table 11, different predatory patterns were observed. However, considerable number of different fry sizes were collected out of ponds with no predators, where, the overall numbers of fry recovered out of control ponds were higher (P<0.05) than those stocked with catfish.

DISCUSSION

Hughes (1986) stated that *Lates niloticus* as predators are often totally piscivorous. They seemed to be highly selective predators; dead preys were not accepted by them in the present study. Similarly, they were not attracted to artificial feed.

On the other hand, Clariids in the wild feed principally on small invertebrates such as crustaceans and insects, but they are scavengers of dead vertebrates such as other fishes (NIFI 1981).

It appears that, there were other factors influencing predation preference in addition to what was found by El-Gamal (1992). In the present study, and as presented in Table 4, dark coloured common carp were less vulnerable to predation by Nile perch over a 2-day test compared to mullet and tilapia. This suggests elements other than spine structure, such as colour, to be influencing the predation preference.

Predation activity may be affected by the ability of prey to avoid predation as a result of inherent abilities (Johnson *et al.* 1993), feeding ecology (Haight *et al.*, 1993), prey colour (Tave *et al.* 1990) or prey availability and vulnerability, as well as the size of prey (Lewis *et al.* 1966). The ability of a 75-g specimen of catfish to consume 9 specimens of 23-25 mm T.L. of tilapia within 5 hours clearly shows the stimulat effect of darkness on the predatory activities when compared to different results in the light system.

In the pond study, catfish were observed consuming artificial feed which may have softened their predatory performance. On the other hand, the cannibalistic behaviour of tilapia fingerlings cannot be ignored in such systems that include different sizes of fingerlings and fry. Cannibalism became more intense as the size difference increased (Pantastico *et al.* 1988).

These findings, compared with those found by El-Gamal (1992), suggest the colour to be an influencing factor on the predation activity of *Lates niloticus*.

Table 5. Predation pressure of different sizes of *Clarias gariepinus* on different size groups of tilapia.

Catfish	Large	Medium	Small	Large	Medium	Small	Large	Medium	Small
W (g)	90.5	77.5	45.0	94.9	70.2	42.5	102.0	72.6	43.2
T.L. (mm)	230	220	180	230	210	180	240	205	176
W.M. (mm)	30	28	20	32	27	20	32	27	20
H.M. (mm)	26	24	18	26	22	18	25	23	18
Tilapia stocking									
Size groups	20-23mm T.L.)			30-33mm T.L.)			40-43mm T.L.)		
no.stocked	10	10	10	10	10	10	10	10	10
Predation data									
	Cumulative consumption (by numbers)								
day 1	10	10	10	8	6	3	4	1	0
day2	10	10	10	10	10	4	7	4	2

T.L. = total length; W = weight; W.M. = width of mouth; H.M. = Height of mouth

Table 6. Predation pressure of different sizes of *Clarias gariepinus* on different sizes of tilapia within 48 hours.

Stocking data					Predation data		
Catfish		Tilapia			Tilapia		
weight (g)	total length (mm)	total length (mm) 20-25	30-35	40-45	total length (mm) 20-25	30-35	40-45
		number stocked			number stocked		
117.5	300	5	5	4	4	4	4
109.0	230	5	5	4	5	4	3
58.9	200	5	5	4	4	5	1
45.0	180	5	5	4	5	4	0
44.0	165	5	5	4	5	2	1
39.0	155	5	5	4	5	4	0
31.7	150	5	5	4	4	3	0
16.4	130	5	5	4	4	3	1
13.0	120	5	5	4	5	4	0
04.0	100	5	5	4	0	0	0

Table 7. Predation of *Clarias gariepinus* on *Cyprinus carpio* and *Oreochromis niloticus* in a one-day test.

Total length (mm)	Catfish Buccal gape dimensions (mm)		Prey fish Number of consumed specimens		
	length	width	*C.carpio*	*O.niloticus*	T.L. (mm)
265	30	26	4	0	80
260	25	25	2	1	60
220	25	20	1	2	65
205	25	20	1	1	60

(X2 = 1.334; P>0.05)

Table 8. Predation of different sizes of *Clarias gariepinus* on different sizes (Large, L; Medium, M & Small, S) of tilapia and silver carp fingerlings in a 4-replicate experiment.

Stocking			Cummulative consumption (numbers)							
Catfish wt (g)	Tilapia	Silver carp	Tilapia	Silver carp	Tilapia	Silver carp	Tilapia	Silver carp	Tilapia	Silver carp
			Hour/day							
	14/one		18/one		22/one		03/two		07/two	
596.5	5 L	5 L	1	1	1	1	1	2	1	2
309.0	5 M	5 M	0	2	0	2	0	3	0	3
233.0	5 S	5 S	0	1	0	1	0	1	0	1
Total			1	4	1	4	1	6	1	6
(X 2 = 3.571; p>0.05)										
215.0	10 L		2	-	3	-	4	-	4	-
213.0	10 M		3	-	3	-	4	-	4	-
200.0	10 S		0	-	0	-	0	-	0	-
Total			5		6		8		8	
144.0	10 L		-	4	-	7	-	10	-	10
142.0	10 M		-	0	-	0	-	1	-	1
126.0	10 S		-	0	-	2	-	2	-	2
Total				4		9		13		13

Average water temperature during the experiment was 21.0°C: no artificial light was provided. Large (L) = 65-70 mm total length (T.L.); Medium (M) = 50-55 mm T.L., Small (S) = 40-45 mm T.L.

Table 9. Predation pressure of Clarias gariepinus on different size groups of tilapia fingerlings over an 8-day test during winter season in Egypt .

	Replicates								Temp.
	1	2	3	4	5	6	7	8	°C
catfish									
weight (g)	660	282	425	433	347	276	453	282	
total length (mm)	450	300	400	400	350	300	400	350	
mouth width (mm)	50	35	35	40	40	35	38	39	
mouth height (mm)	40	30	30	35	35	30	34	30	
tilapia	6.5	8.0	9.0	2.0	2.0	2.0	4.2	1.8	
weight (g)	6.8	9.0	9.5	2.4	3.0	4.7	4.9	3.8	
	12.0	9.5	9.7	4.4	5.4	9.3	5.3	7.4	
	14.0	10.0	10.0	8.5	9.8	10.7	12.8	9.3	
	28.0	29.0	27.0	16.0	29.0	29.0	28.0	29.0	
Predation data									
Day 01		---	---	---	---	---	---	---	15.6
Day 02		---	---	---	---	---	---	---	10.5
Day 03		---	---	---	---	---	---	---	11.8
Day 04		[illegible]	---	---	---	---	---	---	13.0
Day 05		---	8.0	9.7	2.0	---	---	---	11.2
Day 06		---	---	---	2.4	2.0	---	1.8	11.2
Day 07		---	---	---	---	---	---	---	11.5
Day 08		6.8	---	---	---	---	---	---	11.3

In replicates wherever close sizes of tilapia were stocked, such individuals were identified by fin clipping for easy observation.

Chervinski *et al.* (1989) suggested that, the predatory preference of striped bass on common carp, compared to redbelly tilapia is due to morphological characteristics. Common carp have only one dorsal spine to protect them from predation, whereas, redbelly tilapias have multiple spines.

On the other hand, catfish did not show significant preference (P>0.05) to predate on common carp (Table 7), or silver carp compared to tilapia, even though the differrence was slightly higher than the 0.05 probability level when silver carp and tilapia were compared (Table 8).

Whenever the control of the small size reproduction is the target, and based on the findings in regard to the predation activities exerted by the relative small size catfish (<20 g), may suggest using of a large number of such small size rather than using smaller numbers of larger sizes to avoid potential danger to the original stocks. Fortunately, the technology for breeding *Clarias gariepinus* has been established. Thus, different sizes of their fingerlings could be produced.

Table 10. Predation pressure of *Clarias gariepinus* on tilapia fingerlings at different light protocols.

	Light Weight of catfish (g)			Light Weight of catfish (g)			Light Weight of catfish (g)		
	43	46	47	93	100	102	43	46	47
Tilapia stocking									
No. stocked	10	10	10	10	10	10	10	10	10
T.L. (mm)	23-25	33-35	47-50	23-25	33-35	47-50	23-25	33-35	47-50
Predation Cumulative consumption after:									
5 hours	0	0	0	2	2	0	9	3	0
7.5 hours	1	0	1	2	2	0	10	3	0
12 hours	1	1	1	4	4	0	10	5	0
18 hours	2	1	1	5	7	0	10	6	1
22 hours	2	1	3	5	7	1	10	6	1

T.L. = total length.

Table 11. Number of fry and/or fingerlings of *Sarotherodon galilaeus* recovered when tilapia brood fish were stocked with *Clarias gariepinus* at different ratios in concrete ponds over 80-days during the spawning season.

	one catfish & 10 tilapia females & 3 tilapia males resplicate		one catfish & 20 tilapia females & 6 tilapia males resplicate		no catfish & 10 tilapia females & 3 tilapia males resplicate	
	1	2	1	2	1	2
Weight of catfish (g)	361	307.8	450	284		
	Number of tilapia fry/fingerlings recovered					
Total length (mm)					1	
71-80					1	
61-70		1			1	4
51-60		2			44	2
41-50	4	20	4	2	178	122
31-40	2	28	20	3	41	100
21-30	4	2	3	121	24	120
11-20		10	1	20	600	
<11						

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دراسات بيولوجية لاسماك قشر البياض والقرموط الافريقى بالنسبة للعادات الغذائية وأساليب الافتراس فى أحواض الاستزراع

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المعمل المركزى لبحوث الثروة السمكية بالعباسة - مركز البحوث الزراعية - الجيزة - مصر .

تم اجراء هذه الدراسة فى المعمل المركزى لبحوث الثروة السمكية بالعباسة لدراسة العادات الغذائية لاسماك قشر البياض والقرموط الافريقى فى احواض الاستزراع والاستفادة من هذه المعلومات فى دراسة كفاءة الافتراس للنوعين على أسماك البلطى، البورى، المبروك العادى والمبروك الفضى وذلك تحت ظروف بيئية مختلفة وفى ظل علاقات حجمية مختلفة. وجد فى هذه الدراسة أن أصغر مفترسات الاسماك من النوعين كانت ٥.٥ من الجرامات بالنسبة لقشر البياض و ١٣ جراما بالنسبة للقراميط، كما ثبت ان هناك من العوامل التى تشجع على الافتراس مثل الاظلام بينما هناك من العوامل ما يثبط الافتراس مثل لون الفرائس.

عندما اختبرت كفاءة القراميط فى السيطرة على التكاثر غير المرغوب لاسماك البلطى وجدت فروق بين وحدات المقارنة وبين تلك التى تم تخزينها بالقراميط وذلك بالنسبة لاعداد الزريعة الناتجة. تضمنت الدراسة استخدام طريقة القمع والتى أمكن من خلالها توصيف أبعاد الفم بصورة أفضل.