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COMPARATIVE ECOLOGY OF THE AFRICAN BONY TONGUE FISH *HETEROTIS NILOTICUS* AND THE CATFISH, *CLARIAS GARIEPINUS* IN THE LOWER OLUWA RIVER AND ADJACENT FLOODPLAINS

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Abstract

The ecology of sympatric African bony tongue fish, *Heterotis niloticus* and the catfish, *Clarias gariepinus* were compared during the dry and rainy conditions in the lower Oluwa River and its adjacent floodplains. Both species are common economic fish in Nigeria. There was no significant difference in the mean sizes of *H. niloticus* and *C.gariepinus* from the samples collected during the rainy season and the dry season.
The river channels had the least number of the sampled species for both fish under study. Approximately 65 % of the *H. niloticus* that were collected inhabited the Mahin floodplains while 74 % of *C. gariepinus* were found in the same habitat. During the rainy season, most of the Heterotis caught were juveniles in the middle floodplains while juveniles of Clarias were caught in the upper floodplains. Phytoplankton accounted for over 62.53 % of the total stomach contents of *H.niloticus* using the frequency of occurrence method, while fish parts constituted the highest percentage of components of *C.gariepinus* (16.62 %). By volumetric method, plant materials formed the bulk of the 29.55 % of food items observed in *H.niloticus* while fish parts also formed the highest portion of the diets (25.56 %) in *C.gariepinus*. Fish population of both species were high in all the locations of the study area, however analysis of the preponderance of male to female during the two seasons of the year shows that there were more females to males during the rainy season for both species.

Keywords: Ecology, *Heterotis niloticus, Clarias gariepinus,* Oluwa River, floodplains

1. Introduction

In Nigeria, over 181 species of fish were identified from the major river systems and Lake Chad, including some estuarine and marine species (Welman, 1948). Banks *et al.* (1965) and Reed *et al.* (1967) described and identified 139 species of fish along the Niger and 160 fish species within the northern region of Nigeria respectively. However, Ita *et al.* (1985) gave a more comprehensive checklist of the inland fish species of Nigeria. Out of these, only 38 are culturable fish species on the checklist of aquaculturists in Nigeria (Fagbenro, 2002). As of today only five finfish species and one shellfish species are vigorously cultured in Nigeria. These include the cichlids, *Oreochromis niloticus, Sarotherodon melaneuplora*; Clarias spp. (*C. gariepinus*); the Catfish, *Chrysichthys nigrodigitatus* and the oyster culture (*Crassostrea gasar*), with some *H. niloticus in* the coastal areas.

H. niloticus is the only species in the Family Osteoglossidae (Reed *et al.,* 1967; Holden and Reed, 1972). The adult fish is large with a long body covered with large bony scales. The long dorsal and anal fins have no spines, each extending for about half the body length. This species, which satisfies nearly all the criteria for culture (Huet, 1972) lives mainly in the slack water of rivers, lakes, lagoons and creeks, mostly in the coastal areas of Nigeria. In the Southwest region of Nigeria, it is a major component in the harvests of fisherfolks in Mahin lagoon, Lekki lagoon, Badagry creeks and the Bight of Benin where it supports a ₦94 million trade of both fresh and frozen stock (Akegbejo-Samsons, 1995). In the South-east region of the Niger Delta, Bight of Biafra and the Cross River, the species form the bulk of the artisanal catch going over 90 metric tones annually (Moses, 1986).

Catfishes (siluriformes) comprise an ecologically diverse component of most major river faunae in Africa. Catfishes occupy habitats ranging from upland streams to large river channels to seasonal floodplain lagoons. Catfishes are among the economically important groups of fresh and brackish water fishes of the world. In Nigeria they form a significant part of inland fisheries, with many of them already introduced into fish culture (Ita *et al.,* 1985). In some other countries they are of interest in the aquarium industry where they represent a substantial portion of the world trade.

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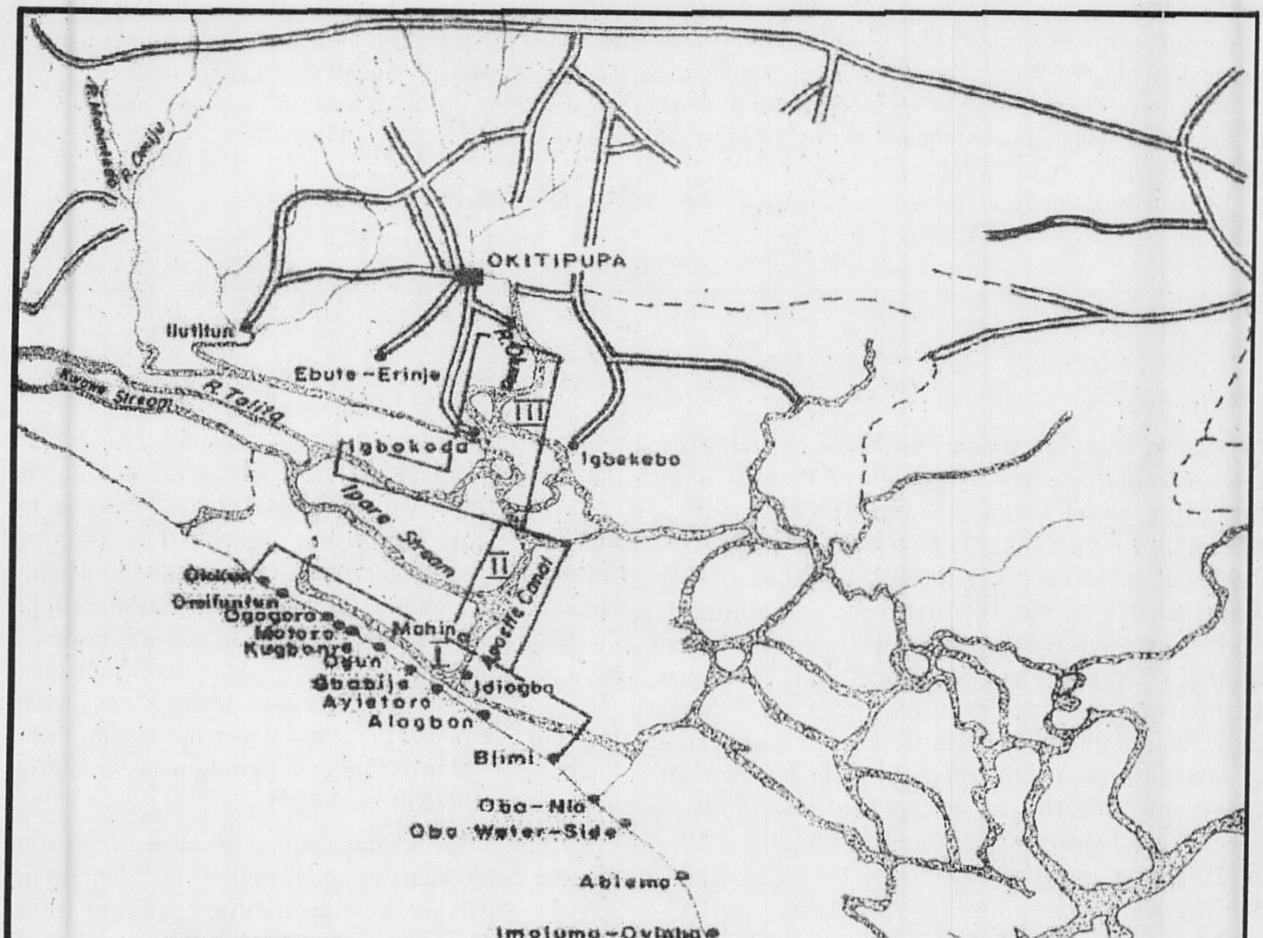
When compared to research on lakes and rivers of other countries, few studies have examined the ecological relationships of fishes in African rivers (Winemiller and Kelso-Winemiller, 1996). In recent years, ecological studies have been conducted in South-Central Africa, in Botswana (Merron and Bruton, 1988; Merron, 1993) and in the Upper Zambezi River (Winemiller, 1991; Winemiller and Kelso-Winemiller, 1994).

The coastal wetlands of Ondo State supply over 85 percent of the fingerlings and juveniles of *H. niloticus* to over 985 fish farmers in Oyo, Ondo, Ogun and Osun states of Nigeria (Akegbejo-Samsons, 1995). In this paper, the findings of an investigation that compares diet and habitat of *H. niloticus* and *C. gariepinus* in the Lower Oluwa River and its associated floodplains in southwestern coastal Nigeria is presented.

2. Materials and Methods

The field study was conducted from June 1994 to July 1995 on a monthly sampling schedule. Sampling was done in the lower Oluwa River (4°-6° N latitude) drainage of Ondo state coastal area (see Figure 1). The aquatic habitats were divided into three basic categories, namely the Oluwa main river channel, the floodplain (Igbokoda shallow pools and the feeder streams) and the Mahin floodplains. The regional environmental conditions are described elsewhere (Akegbejo-Samsons, 1997, 1999); therefore a brief description follows. The river is seasonally flooded between July and December. Annual rainfall ranges from 200-250 cm spreading over 8 to 10 months of the year. Flooding typically begins in August in the central areas of Okitipupa, peaks up in Igbokoda in September/October as it enters into the Mahin floodplains. The floodplains



are typically dominated by grasses along the Igbokoda axis and raphia palm at the Mahin lagoon end.

Fish collections were made from the main river channel and floodplain lagoons; however additional samples were taken from the tributaries (Ipare, Apostle Canal and Kurawe). Locations of sampling stations were randomly selected as described in Akegbejo-Samsons (1999). These locations, which were along the long river stretch, were 15 in number (Figure 1).

A variety of sampling methods were used at each site in order to reach every fish species. At the river channel and the floodplain sites, traps, cast nets (2.55 cm mesh), seine nets (25.5 m *x* 2 m, 2.55 cm mesh), monofilament nylon gillnets (15.55 cm mesh) and hook and line were employed. In most of the sampling stations, of various sampling methods were used in order to catch fish species in large abundance. Some sampled fish (dead) were collected and placed in cool boxes and examined within 18 h of capture, others were preserved in 15 % formalin and stored for later examination. The commercial fish catch of fishermen was in addition examined as available.

Standard length (SL), gonad condition and stomach contents were recorded for each dissected specimen. Methods for assessing gonad condition followed Winemiller (1989). Stomach contents were identified for most invertebrates and quantified volumetrically by water displacement as described by Ricker (1978).

3. Results and Discussion

(a) Population size structure

A total of about 321 *H. niloticus* and 5 species of the Claridae family were caught. The total number of individuals collected in the catfish family was 650 *Clarias gariepinus*, 472 *C. anguillaria*, 393 *Heterobranchus bidorsalis*, and 152 *C. longifilis*. The samples contained *H. niloticus* ranging in size from 120 to 500 mm standard length while *C. gariepinus* showed a wider distribution in standard length from 58 to 650 mm. The five species of the clariids showed similar population size structure during the rainy season (May - November) when compared with the dry season (December - March). The samples collected during the dry season were dominated by smaller size classes. During the wet season, the bulk of the *H. niloticus* were in the 350-500 mm size class. As the flood at the plains receded especially between December and March, the majority of the clarrids were in the intermediate size class (100-250 mm).

There was no significant difference in the mean sizes of *H. niloticus* and *C. gariepinus* in the specimens collected during the rainy season and the dry season (Table 1).

(b) Habitat selection

The river channels had the least number of specimens for both fish under study. Approximately 65 % of the Heterotis specimens collected was from the

Table 1: Percentages of *H. niloticus* and *C. gariepinus* collected in the sampled areas and the different locations of the floodplains of Oluwa River and adjacent floodplains

Location	*Heterotis niloticus*	*Clarias gariepinus*
Oluwa river channels	9.00	5.00
Igbokoda	26.00	21.00
Mahin floodplains	65.00	74.00
	X^2 =154.8, d.f. =2, P<0.0001	
Location	*Heterotis niloticus*	*Clarias gariepinus*
Lower floodplains	35.00	45.50
Middle floodplains	19.00	48.60
Upper floodplains	46.00	5.90
	X^2 =9.48, d.f. =2, P<0.05	

Table 2: Major diet categories by percentage and number (Frequency and Volumetric) of *H. niloticus* (n=388) collected in the sampled areas and the different locations of the floodplains of Oluwa river and adjacent floodplains

	Frequency		Volumetric	
Food Items	No.	%	Vol (cc)	%
Plant materials	149	12.3	42.03	29.55
Detritus	183	15.3	28.16	19.80
Algae	126	10.2	17.33	12.18
Rotifera	135	11.0	18.69	13.14
Sand grains	62	5.5	3.38	2.38
Insects	50	3.4	6.55	4.60
Fish parts	43	2.3	2.67	1.88
Diatoms	179	13.0	6.82	4.79
Crustaceans	120	9.3	4.69	3.30

Mahin floodplains (Table 1) while 74 % of Clarias were from the same habitat. Ninety percent of the Heterotis was collected in the slack areas of floodplains, most (about 85 %) of which appeared to be adults. The juveniles were mostly found in the middle floodplains. About 74 % of the sampled Clarias were found in the Mahin floodplains while 21 % were encountered in the Igbokoda shallow pools and feeder streams. Adults of Clarias were recorded in the middle floodplains than the upper floodplains. Generally, the different sections of the floodplains were found to be inhabited by the species being compared. For example, the upper section of the floodplains haboured 46 % of recorded *H. niloticus*, followed by the lower floodplains, while Clarias was found more in the middle floodplains followed by the lower floodplains.

During the rainy season, most of the Heterotis caught in the middle were juveniles while juveniles of Clarias were caught in the upper floodplains. This distribution pattern has supported a huge fingerlings trade amounting to over ₦15 million in the coastal area of Ondo State (Akegbejo-Samsons, 1995). Adults of both species were captured frequently from the floodplains in the dry season when gill nets, cast nets and seine nets were used. It was also observed that juveniles of both species moved towards the lower floodplains during the dry season.

During the rainy season, dense vegetation and thickets made it impossible to sample for small and juveniles of both fish species, except of the juveniles of Clarias through the use of traps.

Reproductive migration upstream and laterally onto floodplains is an ecological strategy employed by larger fish species (Winemiller and Kelso-Winemiller, 1996). This was very prominent in the habitat selection of the large groups of the two species under study. Fishermen choice of harvesting methods and locations were found to be based on the above phenomenon. There was no significant seasonal variation in the size variation of the two species over the three sections of habitats considered.

(c) Feeding habits

A total number of 388 specimens of *H. niloticus* were analysed for stomach contents. This number was reduced due to constraints of time and materials. In all the analyzed specimens, 62 had empty stomachs (15.98 %) while 326 (84.02 %) had food in their stomachs. Table 2 shows the major food items recorded in the stomachs examined. Using the frequency of occurrence method, plant materials, detritus, algae and diatoms accounted for 57 % of the total stomach contents. The mass of unidentified materials constituted 5.99 %. By volumetric method, plant materials formed 29.55 % of food items observed. This result agrees with the observations of Huet (1972) that *H. niloticus* is a phytophagous feeder, depending on a large variety of plant and detritus materials for growth.

Due to the importance of the frys and fingerlings of *H. niloticus* as a stocking pool for aquaculture (as of now, artificial production of the frys is yet to be done) the analysis of the food contents was further carried out with regard to two specific range of fish sizes. These were 0-10 cm and 10-20 cm as presented in Table 3. Out of the 348 small size group of 0-10 cm, 26 were found with empty stomachs. Based on the frequency of occurrence method, rotifers constituted the largest items (21.71 %) followed by crustaceans (17.83 %), detritus (15.50 %), algae (13.95 %) with fish parts and sand grains constituting the least. The volumetric method shows that detritus formed 17.9 % followed by plant materials (15.72 %). The least was protozoa (4.01 %) while unidentified mass constituted 7.36 %.From the above, it could be

Table 3: Food contents of H. niloticus of two varying size groups collected in the sampled areas and the different locations of the floodplains of Oluwa River and adjacent floodplains

	Size group = 0 - 10 cm (n=348)				Size group = 10 - 20 cm (n=422)			
	Frequency		Volumetric		Frequency		Volumetric	
Food items	No	%	Vol (cc)	%	No	%	Vol (cc)	%
Plant materials	9	6.98	1.88	15.72	16	7.55	1.63	10.77
Detritus	20	15.50	2.14	17.89	24	11.32	1.46	9.65
Algae	18	13.95	0.91	7.61	26	12.26	1.17	7.73
Rotifera	28	21.71	1.15	9.62	24	11.32	0.93	6.15
Sand grains	2	1.55	0.88	7.36	20	9.43	1.88	12.43
Insects	4	3.10	1.01	8.44	15	7.08	1.02	6.74
Fish parts	2	1.55	0.56	4.68	10	4.72	0.93	6.15
Diatoms	14	10.85	0.85	7.11	18	8.49	1.85	12.23
Crustaceans	23	17.83	1.22	10.20	26	12.36	2.00	13.22
Protozoa	6	4.65	0.48	4.01	10	4.72	0.63	4.16
Unidentified mass	3	2.33	0.88	7.36	5	2.36	0.44	2.91
Mollusca	-	-	-	-	18	8.49	1.19	7.87

suggested that when frys and juveniles of this species is stocked in ponds, feeds that are rich in fibre and energy constituents should be incorporated.

In the 10-20 cm range category in which 422 specimens were examined. Twenty one (21) fish specimens had empty stomachs. Algae and crustaceans formed the highest food items (12.26 %) as revealed by the frequency of occurrence method. Plant materials were the least (7.55 %). By volumetric analysis, the largest food items were crustaceans (13.22 %) while the least were protozoans (4.16 %).

It was evident that fish species in these two sizes had preference for crustaceans, detritus rotifers, and algae as major feeds in the wild. This result will be of useful to feed formulators and fish nutritionists in the culture of *H. niloticus.*

Table 4 shows the components of stomach contents of *C. gariepinus.* Based on frequency of food items, fish parts constituted the highest percentage of food items of the *C. gariepinus* (16.62 %). This was followed by detritus (12.27 %) and whole fish (11.34) (mostly fry of tilapia and fingerlings of *C. anguillaris).* About 3.5 % of the whole fish diet components included fingerlings of *H. niloticus.* On analysis based on volumetric method, fish parts also formed the highest portion of the diets (25.56 %). The result of this study further confirms the observation of Ikusemiju and Olaniyan (1977) who noted that catfishes of which *C. gariepinus* is a member are voracious flesh eaters, depending on frys and fingerlings as preys in their diets. Unidentified mass accounted for about 12.81 % in *C. gariepinus* compared to 2.24 % in *H. niloticus*. This is probably due to the difference in the digestive system of the fish species. However, dietary overlaps between the two species include crustaceans, insects, fish parts and protozoans. The diet breadth of both species ranged from plant materials to detritus. This work shows that the two species can be cultivated on a polyculture system, with minimum competition for food.

(d) Sex ratio and reproductive seasons

A total number of 300 specimens of *H. niloticus* were examined for the determination of the sex ratio. Results show that 80 were males while 220 were females, giving a sex ratio of 1 male to approximately 3 females. However for *C. gariepinus* 60 out of the 305 specimens examined for sex ratio had no observable gonads, 130 were males and 175 females. This gave a sex ratio of 1 male to 1.3 females. These two results indicate that females of both species were slightly in excess of the males. Analysis of the preponderance of male to female during the two seasons of the year shows that there were more females to males during the rainy season for both species under consideration (Table 5). Fish population for both species seems to attain their highest densities during the end of the flooding season as orchestrated by the rains.

Spawning activities were observed to be very high during the months of the heavy rains. These were between May and September. Adults of *H. niloticus* were found in pairs (male and female) in preparation for spawning in the months of June and July. Adults of C. *gariepinus* did not exhibit the 'pairing method' of reproduction like the other species under study, however most of them were observed to congregate at the littoral fringes of the lower floodplains. Reproductive activities were generally observed during the rainy season.

3. Conclusion

In summary, *H.niloticus* and *C. gariepinus* exhibit very little differences in habitat utilization. The work reveals that *C. gariepinus* is an omnivorous feeder tending towards carnivorous, while *H. niloticus* is purely a plankton feeder. However, diets showed

Table 4: Components of stomach contents of C. gariepinus by percentage and number (frequency and volumetric analysis (n=596) collected in the sampled areas and the different locations of the floodplains of Oluwa river and adjacent floodplains

	Frequency		Volumetric	
Food items	No	%	Vol (cc)	%
Crustacea	92	5.06	5.10	2.07
Insecta	169	9.30	6.35	2.57
Rotifer	91	5.01	10.90	4.42
Fish parts	301	16.62	63.03	25.56
Detritus	223	12.27	40.16	16.28
Fish eggs	157	8.64	26.44	10.72
Protozoa	56	3.08	10.50	4.26
Whole fish	206	11.34	6.38	2.59
Nematode worms	189	10.40	2.44	0.99
Arthropod parts	124	6.82	3.24	1.31
Algae	20	1.10	25.10	10.18
Plant materials	33	1.82	15.39	6.24
Unidentified mass	156	8.59	31.60	12.81

some level of similarity, may be due to food availability in the different habitats across the study sites.

While the culture of *C. gariepinus* has been fully established in both tropical and sub-tropical regions, the culture of *H. niloticus* has since been confined to West and Central Africa, especially Benin, Burkina Faso, Cameroon, Central African Republic, Cote d'Ivoire, Ghana, Nigeria and Zaire (see Bard *et al.*, 1976). In Nigeria, this species has been observed to grow very well under aquacultural conditions

Perhaps the need for adequate feeding and adherence to conditions in the wild that will make the growth of *H. niloticus* profitable requires further assessment. This work is an effort in this regard. The knowledge of the behaviour of culturable fish species in the wild will go a long way to solving some of the problems encountered during their controlled cultivation.

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