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## Sex ratio, size structure and condition index in the rope fish, *Erpetoichthys calabaricus* (Polypteridae) from a Niger Delta flood plain, Nigeria

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### Abstract

*Erpetoichthys calabaricus* is a near threatened species in the West African fresh waters, and a low density of the fish is noted at surveys. However, no record exist about important aspects of its ecology and biology in order to assist in efficient conservation and management of the species. The objective of this study was to evaluate some aspects of the ecology and biology of *E. calabaricus* with regards to sex ratio, size structure, and condition factor. A total of 634 specimens were collected between April 2013 and March 2014 by means of non-return valve basket traps (baited with palm fruits) set on the flood plains at Ibikpe creek, Nigeria. The overall sex ratio was 1: 0.79 (males: females) which shows significant deviation from the expected 1:1 ( $p < 0.05$ ). Dominance of males over the females was observed. Length frequency distribution of females and males of *E. calabaricus* showed no marked difference as both sexes occurred over the entire range of body size. The largest fish (TL<sub>max</sub>) examined was 39.9 cm TL female, while the smallest fish (TL<sub>min</sub>) was 21 cm TL male. Body condition index ranged between 0.078 and 1.1 (mean =  $0.1546 \pm 0.0444$ ) suggesting that *E. calabaricus* in Ibikpe creek has poor body condition. This study presents baseline data on basic aspects of the natural history of *E. calabaricus* on a first hand in-depth attempt. The results may assist in the management strategies and conservation of this special ornamental species in Ibikpe creek and elsewhere.

**Keywords:** Sex ratio, size structure, condition factor and *Erpetoichthys calabaricus*

### 1. Introduction

The rope eel, *Erpetoichthys calabaricus* is a unique creature caught in the shallow inshore waters of the Cross River estuary. It is a desirable fish species for food and commercial ornamental purposes<sup>[1]</sup>. Unlike other freshwater species, they are sparsely distributed and restricted to few African waters. In Nigeria, they are found mostly in Ogun, Queme, Niger and Cross River systems and sometimes in their adjoining tributaries<sup>[2]</sup>. According to<sup>[3]</sup>, they are assessed as “near threatened” owing to over-exploitation, habitat degradation and loss due to deforestation, agriculture, urban development as well as oil palm plantations in the coastal regions. They have been assessed as “vulnerable” in Western Africa<sup>[4]</sup> and as “endangered” in Central Africa<sup>[3]</sup>. They are demanded in the USA and Canada due to its unique position as pet fish in the ornamental fish trade industry<sup>[1]</sup>. It is a food fish as well, being popular in sport fishing and is very sensitive to poor water quality. A few surveys on the fish populations in the cross river estuary and its low representation in the ichthyofaunal collection suggests that it is a rare species with less populations<sup>[5]</sup>. It is the only member of the genus *Erpetoichthys*.

Knowledge on distribution, abundance, well-being and reproductive potential of the species is deficient and consequently the species is poorly understood and its future sustainability is unpredictable. Some aspects of the biology and ecology of species are critical to the reproductive potential and overall productivity such as sex ratio, size structure, and condition factor. Information on sex ratio in fishes is pivotal for the management and conservation of such fishery. It is important to ensure a proportional fishing of both sexes. Sex population estimation connotes the abundance of any sex at a particular time or the population in natural condition. It is generally known that in a healthy population, the sex ratio is expected to be 1:1. Several factors such as temperature, water velocity, and vulnerability of females to predators, migratory patterns and other ecological hazards, are known to probably change the sex composition and ultimately size structure in aquatic ecosystems<sup>[6]</sup>. Condition factor of

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different populations of the same species give some useful information on food supply and the timing and duration of breeding and can also be used in assessing the well-being of fish [7]. Different environments have influence on the body condition and development of species in any given system [8]. At present, no specific management and conservation arrangements is known or exist for *E. calabaricus*, no assessment of the status of its populations has been made and little is known of its body condition. Therefore, the objective of this study is to evaluate sex ratio, size structure, and condition factor of *E. calabaricus* in Ibikpe creek.

**2. Materials and Methods**

**2.1 Study Area**

The study was conducted in Ibikpe creek (Figure 1) situated (latitude 05° 6' N and longitude 08° 11' E) within the rainforest zone of South-eastern Nigeria, west of the lower reaches of the Cross River System. The creek is a perennial forest tributary system and drains a catchment area of 318.9 km<sup>2</sup> into the Cross River system. It experiences tidal effects as manifested in many intrusive species. It is shaded by overwhelming canopy of riparian vegetation mostly *Elaeis guinensis*, *Raphia hookeri*, *R. venifera* and other tropical forest trees. Aquatic macrophytes are mainly *Nymphaea*, *Vossia* and *Musanga crinium* sp. The area experiences dry (November-March) and wet (April - October) seasons [9].

**2.2 Field Sampling and Measurements**

Samples of *E. calabaricus* were collected from designated fishers bi-monthly between April, 2013 and March, 2014 by means of non-return valve basket traps (baited with palm fruits) set on the flood plains, located 2 - 7 m deep and 10 m close to the shore; where there were relatively dense macrophyte vegetation at low tides and retrieved before high tides. Traps were 42 - 50 cm in length, 14 - 17 cm diameter of opening with mesh sizes of 0.2 - 0.5 cm. Samples were immediately preserved in 10% formalin solution for further analysis and transported to Fisheries Laboratory, University of Uyo, Nigeria.

**2.3 Measurements of specimens**

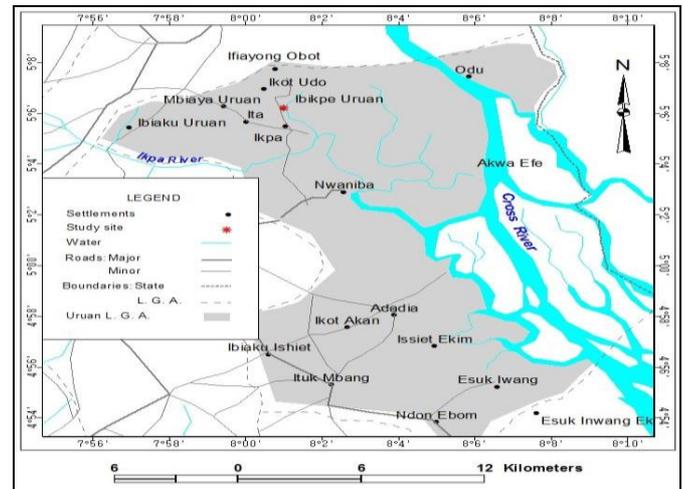
Each specimen was dissected and sex confirmed by inspecting its gonads. Specimens were measured with a measuring board (scaled to ± 1 mm) to the nearest 0.1 cm to obtain total length (TL) and weighed on a top loading electronic meter balance (scaled to ± 0.01 g) to the nearest 0.001 g to obtain total weight (TW). Somatic weight (SW) (g) of each specimen was calculated thus:  $SW = TW - GW$  ---Eqn. 1, where, TW = total weight of fish (g), GW = gonad weight (g).

**2.4 Condition factor**

The condition index or well-being of each fish was determined by computing Fulton's condition factor with the formular,  $K = SW.100/(TL)^3$  ---- Eqn. 2, where, SW = somatic weight and TL = the total length of fish [10].

**2.5 Data analysis**

Sex ratio was expressed as (the number of males)/(number of both sexes combined) and analyzed by Chi-square test, in order to verify whether the proportion of males and females differed from the expected ratio 1:1 [11, 12].



**Fig 1:** Location of study area on Map of Uruan Local Area

**3. Results**

**3.1 Size Structure:** Length frequency distribution of females and males of *E. calabaricus* showed no marked difference. Both sexes occurred over the entire range of body size. The largest fish (TL<sub>max</sub>) examined was 39.9 cm TL female, while the smallest fish (TL<sub>min</sub>) was 21 cm TL male. Median sizes were 28.0 cm (females) and 29.0 cm (males). Table 1 shows length frequency distribution of female and male in various size classes in Ibikpe creek.

**3.2 Sex Ratio:** A total of 634 specimens of *E. calabaricus* were examined. Of this population, 355 (55.99%) were males and 279 (44.01%) females giving a male: female ratio of 1: 0.79 which was different from the expected 1: 1 ratio ( $\chi^2 = 9.110$ ,  $df = 1$ ,  $p < 0.05$ ) in favour of males. Monthly/overall variation in sex ratio of female and male *E. calabaricus* in Ibikpe Creek is shown in Table 2, while Figure 2 shows variation in sex ratio of *E. calabaricus* in Ibikpe creek with size.

**3.3 Condition factor:** Body condition index of *E. calabaricus* ranged between 0.078 and 1.1 (mean =  $0.1546 \pm 0.0444$ ). Female body condition index ranged between 0.018 and 1.139 (mean =  $0.1655 \pm 0.0621$ ) with peak value of 0.2, while male body condition index ranged from 0.100 and 0.231 (mean =  $0.1461 \pm 0.0183$ ) peaking at 0.1. There was no significant difference in average monthly body condition index in both females and males ( $P > 0.05$ ). Monthly Condition Index for Females and Males *E. calabaricus* in Ibikpe Creek is shown in Table 3.

**Table 1:** Length Frequency Distribution of Females and Males *E. calabaricus* in Various Classes in Ibikpe Creek

Length class TL (cm)	Male	Female	Total	Male (%)	Female (%)	Ratio (M:F)	Cal. $\chi^2$
21	1	2	3	33.34	66.66	1: 2	0.333
22	4	1	5	80.00	20.00	1: 0.25	1.800
23	8	13	21	38.09	61.90	1: 1.62	1.190
24	12	21	33	36.36	63.63	1: 1.75	2.454
25	19	19	38	50.00	50.00	1: 1	-
26	21	29	50	42.00	58.00	1: 1.38	1.280

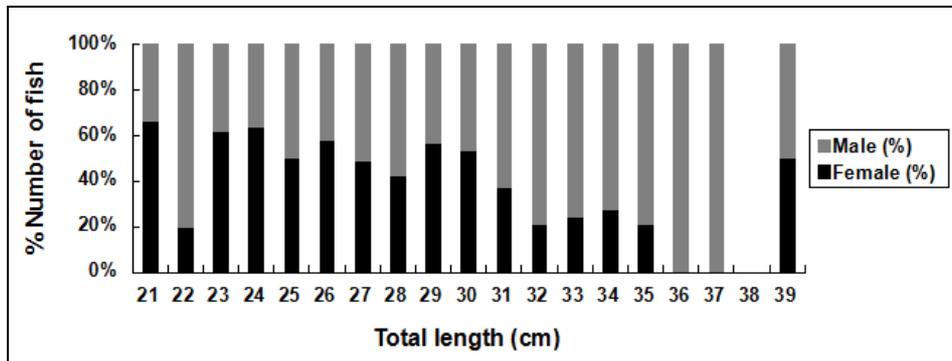
27	32	31	63	50.79	49.20	1: 0.96	0.015
28	49	36	85	57.64	42.35	1: 0.73	1.988
29	33	43	76	43.42	56.57	1: 1.30	1.315
30	29	33	62	46.77	53.22	1: 1.13	0.258
31	34	20	54	62.96	37.03	1: 0.58	3.629
32	52	14	66	78.78	21.21	1: 0.26	21.878
33	25	8	33	75.75	24.24	1: 0.32	8.757
34	13	5	18	72.22	27.77	1: 0.38	3.555
35	11	3	14	78.57	21.42	1: 0.27	4.571
36	8	-	8	100	-	1: 0	8
37	3	-	3	100	-	1: 0	3
38	-	-	-	-	-	-	-
39	1	1	2	50.00	50.00	1: 1	1
Total:	355	279	634	55.99	44.01	1: 0.78	9.110*

**Table 2:** Monthly/overall variation in sex ratio female and male *E. calabaricus* in ibikpe creek

Month	Male	Female	Total	M:F ratio	Male (%)	Female (%)	Cal. $\chi^2$
April 2013	19	15	34	1: 0.79	55.88	42.12	0.470
May	34	27	61	1: 0.79	55.74	44.26	0.803
June	34	24	58	1: 0.71	58.62	41.38	1.724
July	37	24	61	1: 0.65	60.66	39.34	2.770
August	37	25	62	1: 0.68	59.68	40.32	2.322
September	38	23	61	1: 0.61	62.30	37.70	3.688
October	28	33	61	1: 1.18	45.90	54.10	0.409
November	38	25	63	1: 0.66	60.32	39.68	2.682
December	31	29	60	1: 0.94	51.67	48.33	0.066
January 2014	33	25	58	1: 0.76	56.90	43.10	1.103
February	18	21	39	1: 1.17	46.15	53.85	0.230
March	8	8	16	1: 1	50	50	-
Season							
Wet	227	171	398	1: 0.75	57.04	42.96	7.879
Dry	128	108	236	1: 0.84	54.24	45.76	1.694
Overall	355	279	634	1: 0.79	55.99	44.01	9.110*

**Table 3:** Monthly Condition Index for Females and Males *E. calabaricus* in Ibikpe Creek

Month	Body condition index					
	females	min	max	males	min	max
Apr	0.1563 ± 0.0308	0.111	0.213	0.1444 ± 0.0135	0.126	0.169
May	0.1720 ± 0.0146	0.149	0.203	0.1486 ± 0.0199	0.104	0.231
Jun	0.1563 ± 0.0185	0.117	0.207	0.1510 ± 0.0231	0.117	0.197
Jul	0.1625 ± 0.0244	0.130	0.254	0.1466 ± 0.0138	0.124	0.192
Aug	0.1498 ± 0.0292	0.078	0.192	0.1426 ± 0.0233	0.101	0.194
Sep	0.1636 ± 0.0166	0.136	0.192	0.1491 ± 0.0169	0.101	0.186
Oct	0.1628 ± 0.0163	0.124	0.192	0.1436 ± 0.0158	0.100	0.173
Nov	0.1640 ± 0.0132	0.133	0.185	0.1479 ± 0.0192	0.104	0.195
Dec	0.1686 ± 0.0151	0.148	0.209	0.1432 ± 0.0174	0.103	0.190
Jan	0.1546 ± 0.0233	0.084	0.202	0.1369 ± 0.0139	0.109	0.168
Feb	0.2074 ± 0.2145	0.110	1.139	0.1513 ± 0.0176	0.126	0.192
Mar	0.1801 ± 0.0137	0.155	0.195	0.1550 ± 0.0109	0.142	0.173



**Fig 2:** Variation in sex ratio of the *E. calabaricus* in Ibikpe creek with size

#### 4. Discussion

The unbalanced sex ratio reported in the study is difficult to explain as there was no data on previous studies on the species to compare current results, but however findings from this study agrees with the results of [13], who observed the dominance of males to females in the study of *P. jubelini* in the Lagos coast. Although for *O. niloticus*, preponderance of females has been attributed to sexual segregation during spawning activity, differences in gear type and nature fishing site [14]. Hence, further study is required to ascertain if the same factors could be responsible for sex ratio results for *E. calabaricus*. Male dominance maybe due to migration of the male from spawning grounds after fertilization to feeding grounds in shallow parts (where they are easily captured) while females go towards submerged vegetation and rocky areas to avoid gears and carry out incubation and protection of offspring [15]. Though sex ratio varies considerably from species to species, in the majority of species it is close to one. When this trend is not observed in a population, it should be noted that some factor may be distorting the trend. The sex ratio may be influenced by a number of factors including sex differences in longevity, growth, and sometimes sampling methodology [16, 17]. Sex ratio might also be affected by differential fishing factors related to seasons and schooling in feeding and spawning grounds. Skewed ratios may also occur as a result of the differences in natural and fishing mortality between sexes and food availability [18]. An in-balance in sex ratio can as well be caused by the growth rate differentiation between sexes. The gender with faster growth rate may go through the most vulnerable smaller size phase quickly, and therefore reduces the proportion of predation. Meanwhile, the gender displaying slower growth rate may probably encounter predation, with its abundance reduced out of proportion in the next development phases [19].

Taking the median maturity size as a rough estimate of the optimum maturity size in the populations, the values for *E. calabaricus* were 28.0 cm TL (female) and 29.0 cm TL (male). Since fish species that attain maximum sizes mature at smaller size and where life span of the fishes are less, they tend to mature at very small sizes [20]; it is therefore possible to suggest that individuals of the species grow more rapidly. However, considering that this species can grow to 39.9 cm TL as revealed in the present study, it is clear that it attains sexual maturity early in life [5]. Length of maturity in many fish species depends on demographic conditions, and is determined by genes and the nature of the habitat [21]. Thus, the smaller length at maturity of the fish could also be attributed to its poor body condition which was significantly very low. The study showed that females mature at a relatively smaller length than males. This could be due to the fact that the onset of sexual maturity is more triggered in females than in males [22, 23, 14]. This findings corroborate that of [24] who reported the value of 31.4 cm at maturity for same species from Cross River estuary. The authors also noted their largest specimen to be 60.4 cm. Generally, fish in poor body condition mature at smaller size than those in good body condition [23].

The value for condition factor of female and male *E. calabaricus* was significantly close. The reason could be uncertain, but could be associated with the notion that probably the energy partitioning and protein deposition for the reproductive build-up seemed to have no differential influence on females and males *E. calabaricus* and/or is attributed to state of maturity of the female [22, 25], as

facilitated by food abundance. The mean value of condition index for the species was very low suggesting that the species in Ibikpe flood plain had a poor body condition. The poor body condition could have been caused by anthropogenic perturbations in ecosystem which in turn affected the species [5]. Considering that condition factor expresses the relative robustness of a fish which may vary due to growth, maturity, gut fullness and other environmental factors, it is could be thus suggested that, the poor body condition of *E. calabaricus* in Ibikpe creek revealed that, as the fish becomes progressively mature at successive length, their condition still remained 'poor' despite their feeding level.

#### 5. Conclusion

The study revealed that the population of *E. calabaricus* in Ibikpe flood plains indicated a significantly higher proportion of males against females from the expected and a difference in size structure was observed. The poor body condition of *E. calabaricus* suggests that, as the fish become progressively mature at successive length, their condition still remained 'poor' despite their feeding intensity. This study present original baseline data on basic parameters of the aspects of the biology and ecology of *E. calabaricus* on a first hand in-depth attempt. The observed results may be useful in the development of conservation strategies and efficient management of this unique ornamental creature and its habitat.

#### 6. Acknowledgement

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