Research Article

Estimation of the indices of fecundity of the "near threatened" reed fish, *Erpetoichthys calabaricus*, Smith 1866 (Pisces: Polypteridae) in the Ibikpe Creek, Nigeria

Abstract

The fecundity indices of *E. calabaricus* were studied from April 2013 – March 2014 in Ibikpe creek, Akwa Ibom State, Nigeria. Fecundity was estimated for 124 females (total length range: 22.3 - 39.9 cm TL; total weight: 16.33 g -78.61 g TW) using gravimetric method. Average fecundity of *E. calabaricus* was 1,070±73 eggs (range 90 -3,877 eggs). Body weight was the best predictor of fecundity with correlation value of 0.8796. There were trade-offs between egg production, condition factor and hepatosomatic indices.

Keywords: *Erpetoichthys calabaricus*, fecundity, independent variables, reproductive indices, Nigeria

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Introduction

The reed fish, *Erpetoichthys calabaricus*,[1] is a "near threatened" member of the family Polypteridae which are small group of basal Actinopterigians restricted to few African fresh waters. Descriptions of reproductive strategies and the assessment of fecundity are fundamental aspects in the study of the biology and population dynamics of fish species.[2] Moyle & Cech[3] reported that fecundity of a species varies from one system to another due to differences in food abundance and other environmental factors that affect body size of fish. The size at which fish attain sexual maturity and the numbers of eggs they produce are important considerations in the management of such species. Studies pertaining to the fecundity reveal useful information about the reproductive potential of a fish species. Knowledge of the fecundity of fishes is important for the comprehension of their life history.[4] The current paper presents baseline information on the absolute, standard and relative fecundity of the species on a firsthand in-depth attempt.

Materials and methods

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. It is located west of the lower reaches of the Cross River System. The creek is a perennial forest tributary system and drains a catchment area of 318.9km^2 (liable to annual flooding) into the Cross River system at Nwaniba through Ikpa Uruan, with which it maintains a permanent mouth, thus exposing the system to tidal ebb and flow. It forms part of the Atlantic drainage system east of the Niger. The area is considerably 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*. It comprises dry (November-March) and wet (April - October) seasons.[5–7] Samples of *E. calabaricus* were obtained bi-monthly between April, 2013 and March, 2014 by means of non-return valve basket traps (baited with palm fruits) set on the fishing ground, at three locations which were 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.

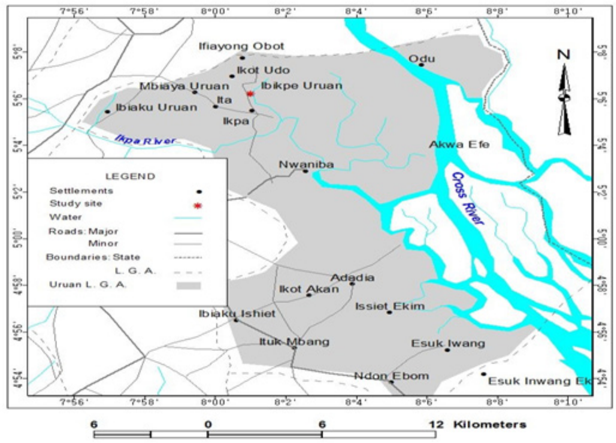

Figure 1 Location of study area on map of Uruan Local Govt. Area.

Laboratory procedure

Samples were immediately preserved in 10 % formalin solution. Each specimens was measured with a measuring board (scaled to ± 1 mm) to the nearest 0.1 cm to obtain total length (TL) and standard length (SL) 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). Each specimen was dissected and sex confirmed by inspecting its gonads. Colour, genital papillae and anal fin length were examined for possible dimorphism.

Ovaries from each specimen were measured to the nearest 0.1cm (length) and weighed to the nearest 0.001g (weight). Gonadosomatic index (GSI) was calculated using the formula:

$$GSI = GW.100 / SW \quad (1)$$

Where, GW = weight of gonad, SW = somatic weight of fish

The liver from each fish was weighed to the nearest 0.001 g and hepatosomatic index (HSI) calculated as:

$$HSI = LW.100 / TW - LW \quad (2)$$

Where, LW = weight of liver, TW = total weight of fish

The condition index or well-being of each fish was determined by computing Fulton's condition factor[8] as follows:

$$K = SW.100 / (TL)^3 \quad (3)$$

Where, SW = somatic weight, TL = the total length of fish.

Ripe ovaries were preserved in labeled vials containing Gilson's fluid for 4-8 weeks until the eggs were hardened. The vials were periodically agitated to ensure the separation of the eggs from the ovarian tissues. Eggs were then air-dried on absorbent paper for 24hours, at 27-30˚C ambient temperature, and fecundity was estimated according to Wilkinson & Jones.[9] This involved weighing all the eggs from each pair of ovaries using a sensitive top loading balance and then, a random sub-sample each. The ratio of total weight of eggs multiplied by sub-sample was then divided by the total weight of sub-sample to estimate absolute fecundity thus:

$$Fecundity = \frac{Total\ weight\ of\ egg \times sub-sample}{Total\ weight\ of\ sub-sample} \quad (4)$$

The relationship between F, fecundity; TL, total length; SL, standard length; TW, total weight; SW, somatic weight; OW, ovary weight; EW, dry egg weight; OL, ovary length; GSI, gonadosomatic index; K, condition factor; HSI, hepatosomatic index were calculated by the expression:[10]

$$F = a\ Xi^b \quad (5)$$

Where, a = constant, b = regression coefficient, both of which were determined by least square regression analysis using double-log transformed mode of data by the formula:

$$Log\ F = log\ a + b\ log\ TL \quad (6)$$

Results

Fecundity and length

Fecundity was estimated for 124 females (total length range: 22.3 - 39.9 cm TL; total weight: 16.33 - 78.61 g TW). Fecundity and fish total, standard and gonad lengths showed high degree of correlation with "r" values: 0.841, 0.872 and 0.782, respectively. The relationships were found to be Table 1:

Table 1 Relationships of fecundity and length

Total length	$F = 0.0000049\ (TL)^{6.8413}$
Standard length	$F = 0.0000016\ (SL)^{6.7653}$
Gonad length	$F = 0.000124\ (GL)^{5.0369}$

Fecundity and weight

Average fecundity per gram total weight was 22 ± 11 eggs g TW (range 4 - 64 eggs g TW). Fecundity increased with body weight (r = 0.8796), somatic weight (r = 0.8695), gonad weight (r = 0.808) and egg weight (r = 0.734). The respective equations were Table 2:

Table 2 The respective equations of fecundity and weight

Total weight	$F = 0.42354\ (TW)^{2.0516}$
Somatic weight	$F = 0.34673\ (SW)^{2.1534}$
Gonad weight	$F = 378.3554\ (GW)^{0.7729}$
Egg weight	$F = 758.4029\ (EW)^{0.7977}$

Fecundity and reproductive investments

Fecundity and gonadosomatic index was positively correlated (r = 0.6140). However, there was no strong correlation between fecundity and condition index (r = 0.1128) and hepatosomatic index (r = 0.1301) (Table 3).

Table 3 Fecundity and reproductive investments

Gonadosomatic index	$F = 177.950\ (GSI)^{0.7618}$
Condition index	$F = 2858.9068\ (K)^{-0.6914}$
Hepatosomatic index	$F = 821.1117\ (HSI)^{-0.2676}$

Fecundity indices

The indices of fecundity: standard fecundity, relative fecundity and reproductive investment were calculated and the range with values is presented in Table 4.

Table 4 Indices of fecundity of *E. calabaricus* in Ibikpe creek

Indices	Mean ± SD	Range	
		min	max
Standard fecundity			
No. of eggs per centimeter TL	35.596±23.275	3	120
No. of eggs per centimeter SL	36.741±23.448	4	122
No. of eggs per centimeter GL	43.572±26.647	4	143
Relative fecundity			
No. of eggs per gram BW	22.588±11.013	4	64
No. of eggs per gram SW	25.040±12.854	4	75
No. of eggs per gram GW	343.040±178.889	44	1258
No. of eggs per gram EW	830.860±604.924	219	6864
GSI	8.759±4.847	0.947	24.989
K	0.162±0.019	0.078	0.202
HIS	1.128±0.351	0.073	2.245

Abbreviations: TL, total length; SL, standard length; GL, gonad length; BW, body weight; SW, somatic weight; GW, gonad weight; EG, egg weight; GSI, gonadosomatic index; K, condition factor; HSI, hepatosomatic index

The number of eggs per centimeter length varied from 3 – 120 for total length, 4 – 122 standard length, and 4 – 143 gonad length. The number of eggs per gram weight ranged from 4 – 64 body weight, 4 – 75 somatic weight, 44 – 1258 gonad weight and 219 – 6864 egg weight.

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Discussion

No previous fecundity estimates for *Erpetoichtys calabaricus* were available for comparison with current findings. The present absolute fecundity estimate is thus said to be moderately high, considering the determined median size at maturity (28.0 cm TL: 70% TL_{max} = 39.9 TL cm) of female reed fish.[10] Disparities in fecundity among populations of a given fish species may be considered as adaptations to different environmental conditions that produce higher or lower survival opportunities for the species.[11] This contention probably explains the moderate fecundity of *E. calabaricus* in the Ibikpe creek which is under succession. The fecundity and lengths (total, standard, gonad) relationships for *E. calabaricus* at Ibikpe creek gave respective regression coefficients of b = 6.3406, 6.762 and 5.036) indicating that the findings are slightly similar to the works of[12] and[13] who reported that the fecundity relationship increased above the fourth power of the length. The present findings fall also within (b-value: 2.3 – 5.3[8]) and beyond (b-value of 6.7 – 6.8). The implication of the relatively high "b" value in the Ibikpe creek population is obscure but could be explicable, for species with a high value of "b" are likely to profit more in terms of life - time fecundity by maintaining some investments in somatic growth and survivorship than species with a relatively low "b" value.[14] The regression coefficient for fecundity and total and somatic weight relationship were b = 2.0516 and 2.1534 respectively; the findings are consistent with other reports by other workers who suggest that fecundity should increase proportionally to the square of its length.

There was a positive relationship between fecundity and gonad length. This implies that, since the fecundity of E. calabaricus increased with fish length and gonad length as a function of fish length, the gonad length is proportional to the female length and can be assumed to be a reproductive drain on the fish, i.e. if at any time a female invests energy in growth rather than egg production, this will subsequently be reflected in a higher fecundity.[15] It can be reasonably conjectured that egg production of *E. calabaricus* in Ibikpe creek was in response to abundant food resources. This assertion is supported by the positive correlation between fecundity and gonadosomatic index; which demonstrates that development of oocytes was indicatively trade-offs in the soma.[16] Using the condition index as a morphometric interpretation of the overall physiological state of a fish, the inverse relationship in fecundity-condition index of *E. calabaricus* denotes that egg production is at the expense of both body condition and energy reserves of the liver index. This difference is probably due to the state of maturity of females of *E. calabaricus* apparently which because of their energy requirements fed to grow to a larger size and become more fecund.[15] Such a strategy is attuned to habitats providing food for both larvae and maturing gonads.[17–21] The comparison of the coefficients for the relationships between fecundity and total length (70.7 %), standard length (76.0 %), total weight (77.3 %), somatic weight (75.6 %), gonad length (65.2 %), egg weight (53.3 %), gonadosomatic (37.6 %), hepatosomatic (1.6 %) and condition indices (1.2 %) revealed that total weight is the most vital morphometric index for explaining variations in fecundity of *E. calabaricus*, followed by somatic weight, standard length, total length, total weight, gonad weight and length. The GSI, HSI and k contributed < 40 % to explain the observed variance in fecundity.

Conclusion

This is first in-depth study of the reed fish. Data generated would provide knowledge and dire need for more understanding of the biology and ecology of this creature for rational utilization and protection of *E. calabaricus* in Ibikpe creek and elsewhere. That the reed fish should continue to exist in our fresh water ecosystems is something to cherish and be protected jealously.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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