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MORPHOLOGICAL DESCRIPTION AND ABUNDANCE ESTIMATION OF SUDANONAUTES AFRICANUS IN THE AQUATIC ECOSYSTEMS OF MAKURDI, NIGERIA

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Article Info

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Abstract

Freshwater crabs are a vital macro-invertebrate group in tropical inland waters worldwide, serving as indicators of good water quality and playing a significant role in nutrient cycling in tropical freshwater ecosystems. The West African freshwater crab, belonging to the family Potamonautidae, consists of over 88 species that are found in various streams and river systems across Africa. These crabs have adopted freshwater, semi-terrestrial, or terrestrial modes of life, and studying the population structure and biology of freshwater crabs is crucial for understanding their ecological and economic importance. Morphometric analysis is a powerful tool for population studies and provides valuable information on size relationships, distinguishing characters, and growth patterns, which are essential for further studies on species life history and resource management. Despite their ecological and economic importance, there is a dearth of information on the population structure and biology of freshwater crabs, including the Sudanonautes africanus, in the Lower River Benue, Makurdi, Benue State, Nigeria. Therefore, this study aimed to determine the abundance and some aspects of the biology of S. africanus, such as length-weight relationship and condition factors, along the Lower River Benue, Makurdi, Benue State. The length-weight relationship in aquatic animals has wide application in delineating growth patterns during their developmental pathways. Information about individual body weight-length/width relationships in populations is important for estimating the population size of a stock. The length-width/weight relationships are more suitable for evaluating crustacean populations. This study utilized an innovative method by calculating the length of crabs from their weight by using length-weight regression, which is extensively used to estimate length from weight in crustacean studies. This study presents information that is critical in describing the biology and population structure of S. africanus in the Lower River Benue, Makurdi, Benue State, Nigeria.

INTRODUCTION

Crustaceans, including crabs, play a significant role in the food chain and have both ecological and economic importance. In many countries around the world, crabs are consumed as a delicacy, and their economic importance cannot be overemphasized. The West African freshwater crab, belonging to the family Potamonautidae, consists of over 88 species that are found in various streams and river systems across Africa.

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These crabs have adopted freshwater, semi-terrestrial, or terrestrial modes of life, and their ability to complete their life cycle outside the marine environment characterizes them as true freshwater crabs. Freshwater crabs are an essential macro-invertebrate group in tropical inland waters worldwide. They serve as excellent indicators of good water quality, and they play an important role in nutrient cycling in tropical freshwater ecosystems. Therefore, studying the population structure and biology of freshwater crabs is crucial for understanding their ecological and economic importance.

Morphometric analysis is a powerful tool used in population studies to complement genetic and environmental stock identification approaches. Morphological characterization of freshwater crabs can provide valuable information on size relationships, distinguishing characters, and growth patterns, which are essential for further studies on the life history of species and resource management. In studying crab species, measuring the length crab is often somewhat difficult, and during attempts to measure them, either the extremities of the crab can be broken or the investigator can be injured by the crab. Therefore, converting length into width when only the weight is known or length-weight regression is extensively used to estimate length from weight. The length-weight relationship in aquatic animals has wide application in delineating the growth patterns during their developmental pathways. Information about individual body weight-length/width relationships in populations is important for estimating the population size of a stock. The length-width/weight relationships are regarded as more suitable for evaluating crustacean populations.

Despite their ecological and economic importance, there is a dearth of information on the population structure and biology of freshwater crabs, including Sudanonautes africanus, in the Lower River Benue, Makurdi, and Benue State, Nigeria. Therefore, this study aimed to determine the abundance and some aspects of the biology of S. africanus, such as length-weight relationship and condition factors, along the Lower River Benue, Makurdi, and Benue State.

MATERIALS AND METHOD

Study Area

This work was carried out in Makurdi, the capital of Benue State Nigeria, located at Longitude 7°43°N and Latitude 8°32°E. The town is divided into the North and the South bank by the River Benue which exists year round with its water volume fluctuating with season.

Sample collection

A total of one hundred and sixty (160) samples of *Sudanonautes africanus* comprising of 98 male and 62 female were collected along the Lower River Benue for the period of four months (August 2016 to November, 2016) using local hand hoe in digging the holes of the crabs, basket traps, traditional gear such as earthen clay pots, and surrounding net. The samples were transported to the Department of Fisheries and Aquaculture Laboratory, University of Agriculture, Makurdi in clean buckets with water for analysis. Identification of the crabs was carried out using an illustrated guide by Headstrom (1979). The location of the bigger cheliped and its percentage occurrence in each species was determined. In addition, the number of teeth on the bigger cheliped and the sex of each crab were determined. The male and female sexes were identified after Headstrom (1979).

Length-weight determination

Body weight of the crab samples was measured to the nearest 0.1 g using a Golden Mettler balance 'MEAS: 217*115*317 mm, USA while carapace length and chelae diameter were measured with a vernier caliper to the nearest 0.1 cm. The length-weight relationship was estimated using the equation: $\mathbf{W} = aL^b$

where W is the weight, *a* is the intercept, L is carapace length and *b* is the slope. The parameters *a* (intercept) and *b* (slope) were estimated by linear regression based on logarithms: Log (W) = Log (a) + b Log (L) where W = weight (g) of the crabs, L = horizontal carapace length

Data Analysis

The significance of regression was carried out by analysis of variance (ANOVA). Width/lengthweight relationships of *S. africanus* were calculated in relation to sex using the linear regression routine of Microsoft Office Excel in PC windows (2003). In order to test possible significant (*P* > 0.01) differences between the sexes, Student's t test was used for comparison of the two slopes. To determine the relations between different morphometric characters in males and females, regression equations were calculated assuming an allometric growth equation ($Y = a + bX$).

The values of the correlation coefficient (r) were calculated Microsoft Office Excel in PC windows (2003) to know the pattern of association between propodus/abdomen and carapace dimensions (Snedecor and Cochran, 1967), with the aim of laying a mathematical relationship between the variables.

The Fulton's condition factor (CF) was calculated according to Bagenal (1978) with the formula; $\mathbf{K = 100W/L^3}$

Where K is the condition factor (cf), W is the total body weight, L is the carapace length (CL).

RESULTS Percentage abundance of *S. africanus* along Lower River Benue during the study period

Results of the percentage abundance of *S. africanus* collected along the Lower River Benue during the study period (August – November, 2016) are shown in figure 1. The highest percentage (35.63%) *S. africanus* was obtained in August while the lowest (12.50%) was obtained in November. In September and October, 23.75% and 28.13% were recorded respectively.

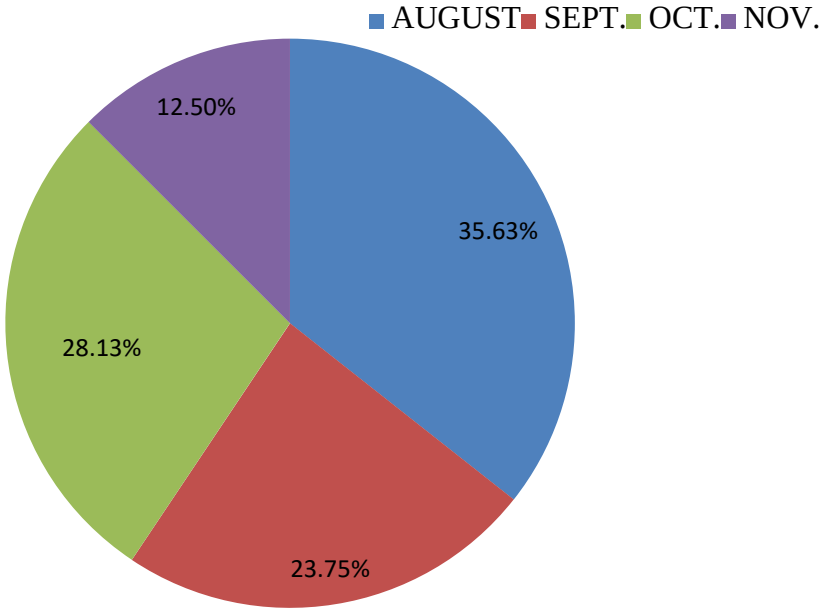

Figure 1: Percentage abundance of *S. africanus* during the study period (August 2016-Nov., 2016)

Results of the minimum, maximum and mean morphological characterization of *S. africanus* during the study period are shown in Table 1 while Table 2 shows the results of mean morphological variation of male and female *S. africanus* during the study period.

From Table 1, the minimum total length, body weight, carapace width, carapace length, length of the teeth, abdominal length, number of legs and diameter of the eye socket of *S. africanus* were 2.50, 20.00, 0.40, 0.40, 2.10, 2.10, 8.00 and 0.40, respectively while the maximum total length, body weight, carapace width, carapace length, length of the teeth, abdominal length, number of legs and diameter of the eye socket were 4.50, 71.20, 6.00, 6.00, 5.00, 4.70, 8.00 and 0.80, respectively with the corresponding means of 3.39±0.04, 38.17±0.85, 4.68±0.06,3.41±0.05, 2.84±0.05, 8.00±0.00 and 0.67±0.01, respectively.

From Table 2, the mean total length, body weight, carapace width, carapace length, length of the teeth, abdominal length, number of legs and diameter of the eye socket of male *S. africanus* were 3.38±0.03, 38.52±0.84, 4.67±0.83, 1.44±0.18, 3.51±0.06, 2.91±0.06, 8.00±0.00 and 0.69±0.01, respectively while the female counterpart had 3.40±0.07, 37.63±1.77, 4.71±0.10,

1.43±0.15, 3.26±0.08, 2.72±0.08, 8.00±0.00 and 0.64±0.01, respectively as mean total length, body weight, carapace width, carapace length, length of the teeth, abdominal length, number of legs and diameter of the eye socket. There was no significant difference ($p>0.05$) between mean total length, body weight, carapace width, carapace length, abdominal length and the diameter of the eye socket.

Table 1: Minimum, Maximum and Mean morphological characterization of *S. africanus* during the study period

MORPHOLOGICAL CHARACTERS	MINIMUM	MAXIMUM	MEAN±SEM
Total length	2.50	4.50	3.39±0.04
Body weight	20.00	71.20	38.17±0.85
Carapace width	0.40	6.00	4.68±0.06
Carapace length	0.40	6.00	4.68±0.06
Length of the teeth	2.10	5.00	3.41±0.05
Abdominal length	2.10	4.70	2.84±0.05
No. of legs	8.00	8.00	8.00±0.00
Diameter of eye socket	0.40	0.80	0.67±0.01

Table 2: Mean morphological variation of male and female *S. africanus* during the study period

MORPHOLOGICAL CHARACTERS	SEX		P-value
	MALE	FEMALE	
Total length	3.38±0.03	3.40±0.07	0.82^{ns}
Body weight	38.52±0.84	37.63±1.77	0.62 ns
Carapace width	4.67±0.83	4.71±0.10	0.76 ns
Carapace length	1.44±0.18	1.43±0.15	0.96 ns
Length of the teeth	3.51±0.06	3.26±0.08	0.01
Abdominal length	2.91±0.06	2.72±0.08	0.06 ns
No. of legs	8.00±0.00	8.00±0.00	0.00
Diameter of eye socket	0.69±0.01	0.64±0.01	0.86 ns

ns = No significant difference

Parameters of the relationship ($W = a L^b$) between Weight -Carapace length (CL), WeightCarapace width (CW) and Condition factor (K) for *S. africanus* are shown in Table 3. From the length-weight relationship of *S. africanus*, the "b" values for male, female and combined sexes were 7.13, 16.56 and 10.44 with mean condition factors of 7.16±4.77, 36.18±1.22 and
4.52±2.92, respectively. Female *S. africanus* had better "b" value (16.56) and mean condition factor (36.18±1.22) than the male counterpart (7.13 "b" value and 7.16±4.77 condition factor). In addition, from the width-weight relationship, the "b" values for male, female and combined sexes were 2.00, 11.22 and 3.95 with mean condition factors of 1.07±4.45, 9.20±2.09 and 4.21±2.84, respectively. Female *S. africanus* had better "b" value (11.22) and mean condition factor (9.20±2.09) than the male counterpart (2.00 "b" value and 1.07±4.45 condition factor).

Table 3: Length-weight, Width-weight relationship parameters and mean condition factor of *S. africanus* during the study period

SEX	Length -weight relationship parameters				Width-weight relationship parameters			
	A	B	r2	Mean K $\lceil K = (W*100)/CW^3 \rfloor$	A	B	r2	Mean K $\lceil K = (W*100)/CL^3 \rfloor$
Male	5.22	7.13	0.50	7.16±4.77	35.63	2.00	0.18	1.07±4.45
Female	-40.35	16.56	0.82	36.18±1.22	21.61	11.22	0.85	9.20±2.09
Combined	-10.72	10.44	0.59	4.52±2.93	32.49	3.95	0.32	4.21±2.84

a = Intercept, b = Slope, r^2 = Regression coefficient, K = condition factor, W = Weight, CW = Carapace width and Cl = Carapace length.

Results of the correlation analysis of *S. africanus* during the study period are shown in Table 4. Strong correlation existed among the morphological characters of *S. africanus* except for the number of legs which could not be computed because at least one of the variables was constant. There was no significant difference ($p>0.05$) among these parameters.

Table 4: Correlation Analysis of *S. africanus* during the study period

PARAMETER	TL	WT	CL	CW	TEETL	ABD	NOL	ES
TL	1							
WT	0.827**	1						
CL	0.659**	0.770**	1					
CW	0.659**	0.770**	1.00	1				
TEETL	0.475**	0.582**	0.453**	0.453**	1			
ABD	0.380**	0.624**	0.477*	0.477**	0.665**	1		
NOL	.a	.a	.a	.a	.a	.a	.a	
ES	0.367**	0.359**	0.349**	0.349	0.292**	0.233**	.a	1

**Correlation is not significant at the 0.05 level (2-tailed).

.a Cannot be computed because at least one of the variables was constant

Note:

TL = Total length, WT = Weight, CL = Carapace length, CW = Carapace width, TEETL = Teeth length, ABD = Abdominal width, NOL = No. of legs and ES = Diameter of Eye socket

DISCUSSION

Measuring the length of freshwater crab species such as the *S. africauns* is often somewhat difficult and in studying them and in attempts to measure them, either the extremities of the crab can be broken or the investigator can be injured by the crab. It is therefore convenient to be able to convert into length (width) when only the weight is known or length-weight regression may be extensively used to estimate length from weight (Oluwatoyin, *et al.*, 2013).

The exponential values (b) of the length-weight relationship of male and female were 7.13 and 16.56 whereas in width-weight relationship of male and female crabs was 2.00 and 11.22, respectively indicating an allometric pattern of growth. Length-weight relationship parameters (a and b) are affected by a series of factors such as season, habitat, gonad maturity, sex, diet, stomach fullness, health, preservation techniques and annual differences in environmental conditions (Bagenal and Tech, 1978). Differences in value 'b' could be ascribed to one or a combination of most of the factors including differences in the number of specimens examined, area/season effects and distinctions in the observed length ranges of the specimens caught, to which duration of sample collection can be added as well (Moutopoulos and Stergio, 2002).

The variations of K-values in the male and female *S. africauns* could be an indication of food abundance, adaptation to the environment and gonad development. This agrees with the reported findings of Soyinka and Adekoya (2011), Frota *et al.*, (2004) and King (1996) who reported that variations of K may be indicative of food abundance, adaptation to the environment and egg/gonad development in fish.

The important of Length/width-weight relationships in this present study is to enable crab biologists derive length estimates for are *S. africauns* that are weighed but not measured. In the study, the sex ratio (1:1.58) of the crabs was in favour of the males than the female counterpart, implying that males were found mostly roaming in search of food and mating due to their reproductive period which is usually at the beginning of rainfall. The length-weight relationship showed that the crab's growth was allometric, indicating that, as the length of the crab increased so was the weight. The length-weight relationship showed that *S. africauns* is a good candidate for aquaculture though other factors need to be considered apart from reproductive biology. It is also essential for proper assessment and management of resources in the West African freshwaters. The crab, *S. africauns,* can be bred in captivity, which means that selective breeding can take place to forestall extinction of the population in the near future.

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