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Fish biology

THE BIOLOGY OF THE AFRICAN LEAF FISH *POLYCENTROPSIS ABBREVIATA* BOULENGER, 1901 IN THE RIVER ETHIOPE, NIGERIA

BIOLOGIA AFRYKAŃSKIEJ RYBY *POLYCENTROPSIS ABBREVIATA* BOULENGER, 1901 Z RZEKI ETHIOPE W NIGERII

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Some aspects of the biology of *Polycentropsis abbreviata* Boulenger, 1901 in the River Ethiope were examined. *P. abbreviata* occurs commonly among the submerged bank vegetations throughout the year in the river. The species exhibits allometric growth pattern and the condition factor decreases with additional size. K–values are slightly higher in the wet season. The immature *P. abbreviata* feed essentially on microcrustaceans and a variety of alate insects while the adults feed principally on crayfish, fishes and detritus. All size groups utilize Nemathelminthes and algae as supplementary diets. The male : female ratio was 1 : 2 and the fecundity range from 72–362 eggs. An average of 2.9% of its body weight is put into egg production.

INTRODUCTION

The African leaf fish *Polycentropsis abbreviata* Boulenger 1901 is a popular aquarium fish (Innes 1972) of West African origin (Schiotz and Dahlstrom 1972). *P. abbreviata* is widely distributed in most clear and black fresh-water rivers of the Midwestern region of Nigeria (Ikomi, unpublished data).

Studies carried out on this species are sparse especially on its biology in its natural habitat. Available information on this species are either of a general nature (Schiotz and Dahlstrom 1972) or its distribution in natural habitats (Sydenham 1977; Victor and Tetteh 1989). Accordingly, the present paper examines aspects of the biology of *P. abbreviata* from the River Ethiope, a second order river in the Mid-western region of Nigeria and intends to fill a gap in the knowledge on this common aquarium fish.

Description of study area

The River Ethiope (6°30' – 6°30'N; 5°00' – 6°00'E) is located in the delta portion of the Mid-western region of Nigeria. It is a clear oligoionic freshwater river which took its

source at Umuaja (Fig. 1) and flows westwards for about 100 km where it discharged into the Benin River at Sapele.

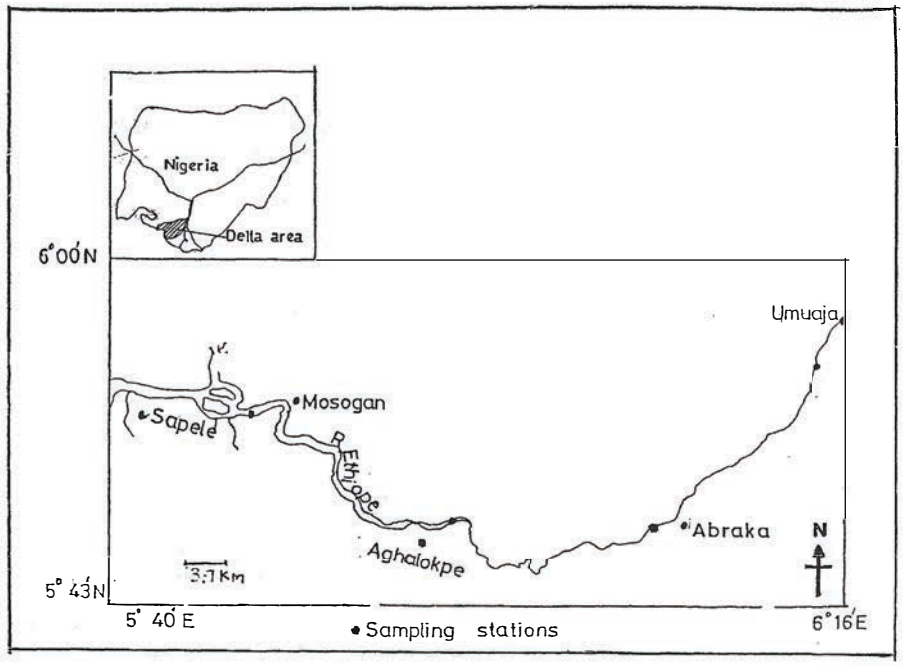

Fig. 1. Location of the delta area in Nigeria (inset), with a map showing the study area and sampling stations

Its width and depth range from 1.5 to 90 m and from 2 to 20 m respectively. The river flow is perennial with the highest level and discharge during the flood period (July–November). The substratum ist mainly sandy and vegetated in the nontidal zone and consisting muddy sand in the tidal area. Variations in some key physico-chemical parameters are: water temperature (24–27°C), pH (5.2–7.5), dissolved oxygen (5.0–6.5 mg L^{-1}), conductivity (9.6–57.5 Us). Transparency ranges between 20 m, on a bright day, and 11 m on a rainy day.

The aquatic vegetation of the river consist principally of a floating higher plants such as *Nymphaea lotus* L., *Azolla africana* Desv., and *Pistia stratiotes* L. Plants partly or totally submerged include: *Scirpus jacobi* Fischer, *Salvinia* sp., *Pycreus lanceolatus* Poir. In addition, some of the dominant foshes in the river are the characids: *Brycinus longipinnis* Gunther, *Brycinus nurse* Ruppell and the cichlids: *Tilapia marias* Boulenger, *Chromidotilapia guntheri* Sauvage, *Hemichromis bimaculatus* Gill.

MATERIAL AND METHODS

Fish were captured from the River Ethiope on a monthly basis during day and night from May 1991 till April 1992 using a drag net (10–45 mm mesh size) and a locally woven crayfish basket (71 cm diameter, 60 cm deep). Day sampling was done between 6:30–11:00 h while the night sampling was between 23:00–5:00 h. The fish on capture were immediately killed and preserved in 10% formalin solution prior to examination in the laboratory. Information on spatial distribution and habitat preference were provided by the gears used and field observations. Biometric data taken for each fish are: standard length, measured to the nearest 0.1 cm and weight determined to the nearest 0.1 g. Fish stomachs were removed by dissection and the stomach fullness of each fish was ranked on a scale of 0/4 (empty) to 4/4 (full). Stomach contents were determined to the lowest convenient taxonomic level under the binocular microscope (10–100×) and its contents were analysed using the 'occurence' and 'point' method (Hynes 1950; Hyslop 1980).

The length–weight relationship was calculated using the method of LeCren (1951) while the condition factor of each specimen was determined according to Bagenal and Tesch (1978). The sexes were determined by visual observation of gonad and the gonadal maturity stages were classified using the scheme of Nikolsky (Lagler 1978). Preservation of the eggs was in Gilsons fluid and fecundity estimate was by direct count of all ripe eggs present in ovaries at maturity stages (III–V) (Lagler 1978). The gonadosomatic index (GSI) for each gravid female was calculated as the body weight, expressed as a percentage.

All other statistical procedures used in analysing the data obtained are adopted from Zar (1984).

RESULTS

Distribution

During sampling, *P. abbreviata* was commonly captured along with the crayfish *Macrobrachium dux* in all months of the year but with peak abundance in the high flood months of October and November. All size classes of *P. abbreviata* were encountered throughout the year but immature specimens dominated the catch of October and November. The horizontal distribution was almost even in the entire stretch of the River Ethiope. Both the immature (< 40 mm) and the adults (≥ 40 mm) occur mostly among the submerged riparian grass mats. They do not occur in the deep and swift flowing main stream sections of the river.

Length frequency and distribution

All of the 363 *P. abbreviata* ranging in length from 10 to 90 mm captured during this study were used to analyse the length frequency distribution as presented in Fig. 2. The figure shows that the length frequency distribution is approximately normal with the modal length at 50 mm.

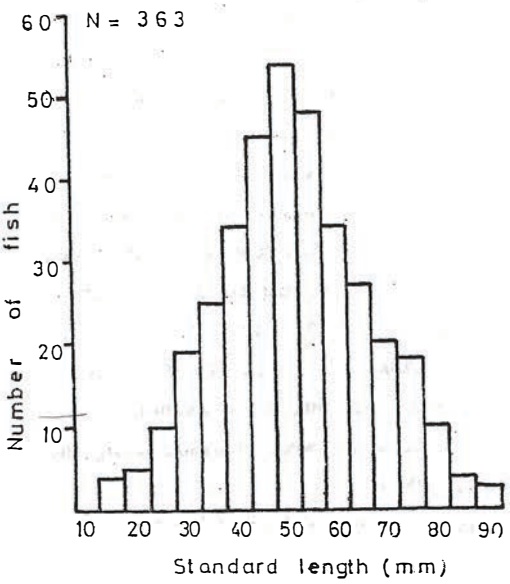

Fig. 2. Length frequency distribution of *P. abbreviata* in River Ethiope

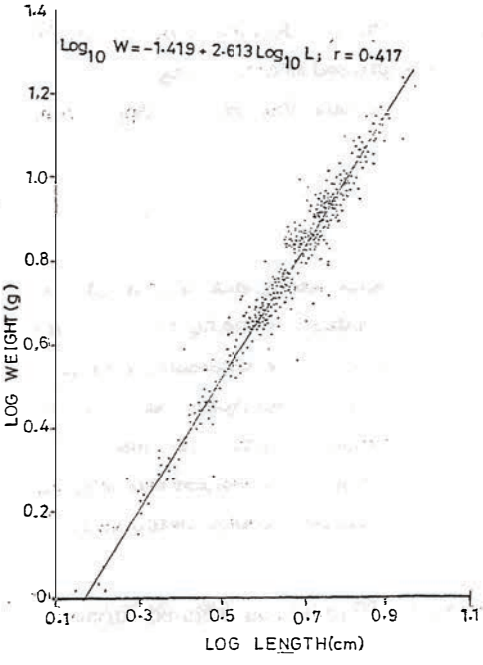

Fig. 3. Log length log weight relationship of *P. abbreviata* from River Ethiope

Length–weight relationship

P. abbreviata captured ranged between 10 and 90 mm in length and 1.0 and 18 0 g in weight. The log plot of the relationship between the standard length and weight of the species is shown in Fig. 3. The least squares common fit analysis of the logarithm transformed data of the length–weight relationship provides the linear regression equation:

$$\text{Log}_{10}w = -1.419 + 2.613 \log_{10}L$$

$n = 363$; $r = 0.417$

The regression coefficient b–value = 2.613 indicates allometric growth pattern and this b–value tested using ANOVA indicated no significance ($P > 0.005$). The correlation coefficient value (r) obtained based on computations of the length–weight relationship is low, thus indicating poor correlation in the growth in length and gain in weight of this fish.

To compare the size of the species under the dry and wet seasons growing conditions, the differences in the mean length and weight were examined using t–test (Tab. 1). The computed values of t with d.f. 362 were 1.34 and 1.38 respectively for the length and weight. The values are lower when compared with the tabulated, t–362, (0,05) = 2.58 (2 tailed test).

Table 1

Computerized t–test results of growth pattern in *P. abbreviata* in wet (May–October) and dry (November and December, January–April) seasons

	May–October 1991		November 1991 – April 1992	
	length	weight	length	weight
Mean	5.10	4.96	4.93	4.41
Sum of measurements	964.3	814.9	746.2	694.3
Sum of squares	4966.31	4343.52	3811.4	2943.23
Degree of freedom	212	212	150	150
Calculated value of t	1.34	1.38		

Table 2

Monthly variation in condition factor of *P. abbreviata*

Months	Range	Mean	Standard error
May 1991	3.00–4.31	4.00	0.46
June 1991	3.90–5.10	4.90	0.31
July 1991	2.40–4.00	3.87	0.11
August 1991	3.20–3.94	3.26	0.16
September 1991	3.41–4.00	3.16	0.25
October 1991	2.66–3.44	2.96	0.31
November 1991	2.64–3.56	2.93	0.11
December 1991	2.54–3.96	2.90	0.16
January 1992	2.44–3.14	2.85	0.56
February 1992	2.43–3.15	2.85	0.10
March 1992	2.81–3.45	3.01	0.21
April 1992	2.84–3.46	3.41	0.26

Condition factor

Table 2 presents the mean monthly condition factor of *P. abbreviata*. The values ranged from 2.85–3.41 in the dry season months (January–April, November and December) and from 2.96–4.90 in the wet season months (May–October). In general, K–values were slightly higher in the wet season than in the dry season. Data on the variations in the condition factor in relation to the size and sex show that K–values decreased with an increase in fish length irrespective of sex (Tab. 3). K–values are slightly higher in the females.

Table 3

Variations in condition factor values in the different length classes of *P. abbreviata*

Length class (mm)	Male			Female		
	range	mean	standard error	range	mean	standard error
40	3.01–5.63	4.25	0.43	3.60–5.72	4.26	0.11
50	2.96–5.51	3.91	0.16	3.10–5.63	4.10	0.64
60	2.91–5.47	3.74	0.63	3.10–5.54	3.96	0.32
70	2.85–4.95	3.11	0.51	2.96–4.96	3.52	0.11
90	2.85–4.93	2.96	0.32	2.83–4.86	3.52	0.06
90	2.86–4.96	2.96	0.64	–	–	–

Diel feeding pattern

Seventy specimens each from the diurnal and nocturnal samples obtained in the months of October and November were examined for stomach fullness (Tab. 4). Of these, 23 stomachs of the day-time samples were 2/4 full. While among the night-time catch, the stomachs of 58 specimens were 2/4 full. These values when tested using the chi-square,

Table 4

Diel variation in the stomach fullness of *P. abbreviata* in River Ethiope (October and November 1991 samples); and percentage empty stomach of the night and day time specimens; χ^2 – chi-square; P – probability

Period	No. of fish examined	No. of fish with 2/4 full stomach	χ^2 value	P	Empty stomach (%)
Day haul 6:30–11:00 h	70	23	15.12	< 0.001	8
Nigt haul 23:00–5:00 h	70	58			2

indicates significantly fuller stomachs among the night-time specimens ($\chi^2 = 15.12$; $P < 0.001$). Also the percentage of empty stomachs was higher in the day-time specimens (8%) than in the night-time ones (2%). Observations on the state of ingested food in the stomachs showed that specimens caught between 06:30 and 11:00 h were at advance stages of digestion as compared with those caught between 23:00–5:00 h.

The stomachs of 363 *P. abbreviata* with standard length range of 10–90 mm were examined. Three hundred and fourty fish had food in their stomach and 23 had an empty stomach. A summary of fish food items consumed by the species is given in Table 5.

Table 5

Gross trophic spectrum and seasonal variation in the percentage occurrence (%O) and percentage point (%P) of the dietaries of *P. abbreviata*

Food items	Gross composition		Wet season		Dry season	
	%O	%P	%O	%P	%O	%P
CRUSTACEAN						
Decapoda (crayfish)	45.6	17.7	27.4	18.3	46.3	28.2
Cyclopoda	11.3	4.3	7.4	2.7	9.1	3.6
Cladocera	19.0	3.6	12.1	2.4	25.1	4.1
Ostracoda	9.4	6.9	3.8	7.1	9.1	7.6
INSECTA						
Plecoptera	12.1	8.4	8.1	3.5	19.3	9.6
Hemiptera	4.1	3.7	3.6	0.0	4.1	3.7
Lepidoptera	3.7	3.6	3.7	3.6	0.0	0.0
Odonata	3.1	2.5	1.9	3.1	2.7	3.6
Coleoptera	8.5	5.6	5.6	4.2	7.8	3.1
Diptera	2.4	3.4	3.3	1.8	1.1	2.4
PISCES						
Tilapia sp.	16.3	9.8	38.9	17.3	11.4	4.3
Brycinus sp.	12.1	5.4	10.5	12.3	3.6	1.6
Hemichromis sp.	2.3	3.2	2.7	4.6	1.8	2.1
Fish remains	4.3	4.5	2.9	7.1	1.4	3.3
DETRITUS	33.1	12.6	19.0	9.9	21.1	17.4
ALGAE						
Chloropyceae	1.3	1.7	0.0	0.0	1.3	1.7
ROTIFERA	6.3	1.8	8.3	1.9	3.1	2.3
NEMATHELMINTHES	1.1	1.3	1.0	1.1	1.1	1.4
No. of fish examined	363		203		160	
No. of empty stomachs	23		9		14	
Categories of food items	18		16		18	

The primary dietary inclusions of the species were insects, crustaceans, fishes and detritus. Nemathelminthes and algae are of secondary importance. Among the principal diet items of the species, crustaceans appears the most important. The species fed heavily on 5 taxa (Tab. 5). Of these the decapods consisting mainly of the crayfish *Macrobrachium dux* were most frequently consumed. The ostracods, cyclopods, and cladocerans were taken in variable quantities. *P. abbreviata* also fed on a wide variety of insects which formed the second most important food category of the species. Among the taxa stated the most heavily consumed were Plecoptera, Hemiptera and Coleoptera. Lepidoptera and Odonata were sparingly consumed. In addition, *P. abbreviata* was found to consume in appreciable quantities some fishes (mainly *Tilapia* spp.) and detritial materials. The latter constitutes about 13% of the diet by the point method. The remaining food items were of secondary importance and contributed less than 2% to the total diet of *P. abbreviata*.

Table 6

Dietary composition of the different length classes of *P. abbreviata*

Food items	10–40 mm		> 40 mm	
	%O	%P	%O	%P
CRUSTACEA				
Decapoda (crayfish)	10.6	13.6	27.3	18.1
Cyclopoda	41.2	16.8	1.9	1.4
Cladocera	21.6	18.1	0.1	0.5
Ostracoda	6.2	5.1	3.6	2.7
INSECTA				
Plecoptera	11.1	17.4	10.1	6.0
Hemiptera	1.6	2.1	4.4	3.6
Lepidoptera	2.1	1.6	2.9	2.0
Odonata	3.0	2.1	0.1	0.6
Coleoptera	16.7	7.4	3.0	2.1
Diptera	0.9	0.9	0.1	0.6
PISCES				
Tilapia sp.	0.6	1.0	27.3	27.1
Brycinus sp.	0.7	1.1	18.2	14.2
Hemichromis sp.	0.3	0.6	9.3	4.1
Fish remains	0.5	0.9	4.2	3.3
DETRITUS	2.5	3.1	12.2	9.4
ALGAE				
Chloropyceae	0.1	1.1	0.1	0.6
ROTIFERA	14.6	6.0	2.1	1.8
NEMATHELMINTHES	0.7	1.1	0.3	1.9
No. of fish examined	195		168	
No. of empty stomachs	8		15	

Table 6 shows the feeding habit of *P. abbreviata* in relation to the length class of the fish. Qualitatively, all the length groups consumed basically the same type of food items. However, quanttatively a clear change in diet with age was observed. For example, with increase in length, the fish consumed more fishes, crayfish and detrital materials while at the same time, the preference for algae and insects decreased. The smaller fish consumed more of the microcrustaceans such as ostracods, cladocerans etc. The other food items were consumed with different intensities by the different length groups.

The data on the diet composition in Table 5 also shows the temporal variations in the ditary habits of *P. abbreviata*. The table demonstrates that only slight qualitative variation occured in the type of food items consumed. However, quantitatively, more fish diet

inclusions were taken during the wet season whereas in the dry season more insects and crustaceans were consumed.

Reproduction

The number of male and female *P. abbreviata* captured during sampling were 37 and 87 respectively. The observed male : female ratio was 1.0 : 2.4 and that is different from the expected ratio of 1 : 1 ($\chi^2 = 20.16$; $P < 0.001$).

Table 7
Variations in the distribution of gonadal maturity stages of female *P. abbreviata* during sampling period; stage I – immature, II – resting, III – maturation, IV – maturity, V – reproduction; the values shown are actual frequencies

Months	Developmental stages				
	I	II	III	IV	V
May 1991	1	1	5	2	0
June 1991	1	1	3	4	0
July 1991	2	2	5	2	21
August 1991	16	5	4	1	14
September 1991	20	14	2	1	2
October 1991	38	11	2	3	1
November 1991	28	10	0	0	1
December 1991	13	18	2	0	0
January 1992	11	15	2	1	0
February 1992	8	15	1	1	1
March 1992	9	14	1	1	0
April 1992	3	12	2	1	1

Using the Nikolsky's schems (Lagler 1978), five gonadal maturing stages were recognised and the monthly percentage frequency distribution of these stages are shown in Table 7. Gonads at different stages of development occur throughout the sampling period. The immature stage specimens with either stage I or II gonads dominated the catch and were available all year round. Specimens of maturation stage III were also readily available, but were recorded more in March, April, May and June. Maturity stage IV and reproduction stage V predominated the catch of June and July respectively.

Table 8
Variations in mean egg production and gonado-somatic index (GSI) with size of *P. abbreviata*

Standard length (mm)	Body weight (g)	Sample size (n)	GSI (%)	Number of eggs
40	5.2	2	1.4	96
43	5.3	7	1.9	70
56	7.4	10	2.0	162
58	7.1	8	2.0	172
65	9.3	4	2.1	210
69	11.5	4	2.7	264
70	12.0	5	2.7	298
77	14.4	3	3.2	279
80	18.0	2	4.0	362
86	17.3	1	3.9	342

The number of eggs in the ovaries of *P. abbreviata* in maturity stage (III – IV) (n = 46) varied with the different length of fish. The number of eggs ranged from 70 in a 43–mm, (SL) fish (5.3 g) to 362 in a 80–mm, (SL) fish (18.0 g). The minimum standard length of female at maturity stage (IV) was 40 mm and generally the fecundity appeared to increase with additional length of individual fish (Tab. 8). The mature eggs were pale to deep yellow in colour and their diameter ranged from 0.7 to 1.1 mm.

The relationship between the number of ripe eggs in a mature ovary and fish length was calculated and the linear regression equation derived from the logarithm transformed data is:

$$\text{Log Fecundity} = 0.316 + 1.1181 \log \text{length}$$

r (correlation coefficient) = 0.5826

The equation can be rewritten thus:

$$F = 2.070\, L^{1.1181}$$

The gonadosomatic index (GSI) values of the species ranged from 1.4 to 4.0% with an average of 2.9%. The GSI – values appeared to increase with additional length of the fish (Tab. 8).

DISCUSSION

P. abbreviata occurs in the entire longitudinal stretch of the River Ethiope but prefers the shallow, calmer vegetated banks of the river. As with many other stream fishes that are poor swimmers, this behavioural adaptation protects them against being carried away by swift water current as is typical of the middle and deeper portions of the river.

The length frequency distribution showed only one modal length (40–50 mm). Fish within this modal length class were mainly young adults which dominated the catch throughout the sampling period.

The regression coefficient (b = 2.613) evaluating the length–weight relationship of the species indicated negative allometric growth pattern (Bagenal and Tesch 1978). The growth in length and gain in weight are weakly correlated. The computed values of 't' at 362 d.f. (1.34 and 1.38) for the length and weight respectively and the higher tabulated value (t. 362 (0.05) = 2.58) indicated no significant seasonal effect on the gain in length and weight for *P. abbreviata* in the River Ethiope.

The condition factor (K) values varied with the size of fish. The K–values showed an inverses relationship to increasing length of the fish. It would appear that the habitat conditions are not favourable to the larger fish. The monthy mean values of K in this study varied considerably and this appears to be related to the feeding regime and breeding activities of the fish. For example, on the overall, relatively higher K–values were recorded during the wet season months (May–October) than in the dry season months (November–April). This could partly be attributed to the relatively rich rainy season food resources of the river (Odum 1992) from which *P. abbreviata* was able to utilize fewer categories of food items (Tab. 5) to improve its well–being.

In addition, higher K–values were observed in May and June and this coincided with the periods when most of the matured fish carried ripes gonads. The drastic drop in K–values in July to September probably reflected the main spawning period of the fish (Tab. 7).

The diel variations in the feeding habit shows that *P. abbreviata* more actively feed during the nights than in the day time. This perhaps explains their abundance in the night–time samples as it seems reasonable to assume that more fish are caught when active than during periods of inactivity.

Of the 363 stomachs of *P. abbreviata* examined, a high percentage (>90%) contained food and this seem to emphasize the versatile nature in food habits of the fish. The main dietary inclusions of the species were insects, crustaceans, detritus and fishes. These food items contribute significantly (both by the occurrence and point methods) to the diet of *P. abbreviata*. These food items are found in the surface, mid and bottom water columns; thus indicating that *P. abbreviata* fed freely in these media but preferred the substratum as evidenced by the significant contributions of crayfish and detritus to the diet of the species (Tab. 5). *P. abbreviata* fed minimally Chlorophyceae and Nematheminthes.

Results on the qualitative variations in the food habit of *P. abbreviata* shows variation with fish sizes. It is a well known fact that food preferences of fishes changes as individuals grow older (Welcomme 1979). This is clearly shown by *P. abbreviata* in the River Ethiope. The smaller fish fed mainly in the surface and midwater columns, utilizing mainly microcrustaceans and insects diet inclusions while at the same time feeding less on crayfish and fishes. The adults, on the other hand, fed more in the midwater column and substratum, consuming principally fishes and crayfish and less on microcrustaceans. Observed qualitative variations in food habits of this species appears to be related to changes in feeding behaviour and food preferences and not mainly governed by the size of the gap of the fish as in most piscivorous fishes. According to Dutta (1964), *P. abbreviata* has a very flexible gap and can swallow food (including fishes) of large size. In general, while the immature *P. abbreviata* can be described as microcarnivores, the adult ones are macrocarnivores.

The temporal variations in the food habits of the species were minimal. The fish fed on almost the same categories of food items in both seasons. However, quantitatively more fishes and crayfish were consumed in the wet and dry season respectively. The greater consumption of fishes coincided with the periods when they flourish in the River Ethiops (Ikomi, unpublished data).

As in other aspects of the biology of *P. abbreviata*, very little is known about its reproductive biology, In the River Ethiope, the male : female ratio of the species was unbalanced. There were significantly more females than males. The distribution of the gonadal stages of *P. abbreviata* during this study suggests that spawning activities are confined to the months of rising flood (June to October).

The mean number of eggs in a mature ovary of *P. abbreviata* ranged from 70 to 362. This appears low when compared with the cichlids (Fryer and Iles 1972; Fagade et al. 1984) on which comparative data are available. Low fecundity is associated with parental care in

fishes (c.f. Fryer and Iles 1972). It has not been ascertained whether *P. abbreviata* exhibits parental care of the young. However, Schiots and Dahlstrom (1972) established that this species in their aquarium habitats builded bubble nest in which their eggs were laid.

Fecundity values varied with the length of fish. It is well known that fecundity values vary even among fishes of the same size, age and species (Bagenal 1957). Variation in fecundity here might be attributed to differential feeding success among the female fish in the population. *P. abbreviata* utilized an average of 2.9% of its body weight for the egg production. The GSI value of *P. abbreviata* in River Ethiope annot be classified as low or high as no comparative data on the GSI value of this species from any other water body is available.

CONCLUSION

Some aspects of the biology of *P. abbreviata* in the River Ethiope has been examined. This study reveals that *P. abbreviata* has a wide distribution in the river and flourished commonly among the submerged grass mats. The general well–being of the fish appears to be governed by the rainfall regime of the study area. The species was able to utilize the abundant food resources provided by the heavy precipitation of the wet season to improve on its condition. Additionally, the expanded habitat resulting from the heavy rainfall of the wet season provided favourable environmental conditions for *P. abbreviata* to spawn and increase in number. These in addition to the diet flexibility habit of the fish probably accounted for the success of the species in the River Ethiope.

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BIOLOGIA AFRYKAŃSKIEJ RYBY *POLYCENTROPSIS ABBREVIATA* BOULENGER, 1901 Z RZEKI ETHIOPE W NIGERII

STRESZCZENIE

Zbadano wybrane aspekty biologii *Polycentropsis abbreviata* Boulenger, 1901 w rzece Ethiope. *P. abbreviata* powszechnie występuje w ciągu całego roku pośród zanurzonej roślinności brzegowej tej rzeki. Gatunek ten wykazuje allometryczny charakter wzrostu, a współczynnik korelacji zmniejsza się wraz ze wzrostem wymiarów. Wartości K są nieco wyższe w wilgotnej porze roku. *P. abbreviata* przed osiągnięciem dojrzałości płciowej odżywia się głównie mikroskorupiakami oraz rozmaitymi owadami, podczas gdy osobniki dorosłe żywią się przeważnie rakami, rybami i detrytusem. Wszystkie grupy wielkościowe traktują Nemathelminthes i glony jako dodatek do swojej diety. Stosunek samców do samic wynosi 1:2, a płodność waha się od 72 do 362 jaj. Jaja stanowią średnio 2,9% masy ciała.

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