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Scienfic Note

Growth pattern and morphometric discrimination of two congeneric species of *Chrysichthys, C. nigrodigitatus* and *C. auratus* (Siluriformes, Bagridae), from a small tropical reservoir

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Abstract. This study reports the growth pattern and six percentage morphometric characters (relative to standard length) that could be used to discriminate small sizes of *Chrysichthys nigrodigitatus* and *C. auratus* from samples collected in Aiba Reservoir, Iwo, Nigeria.

Key words: length-weight relationship, allometry, isometry, Aiba Reservoir

Resumen. Patrón de crecimiento y discriminación morfométrica de dos especies congéneres de *Chrysichthys, C. nigrodigitatus, y C. auratus* (Siluriformes, Bagridae), en un pequeño reservorio tropical. Este estudio reporta el patrón de crecimiento y seis caracteres morfométricos porcentuales (relativos a la longitud estándar) que podrían ser usados para discriminar individuos de pequeño tamaño de *Chrysichthys nigrodigitatus* y *C. auratus*, con muestras colectadas en la represa de Aiba, Iwo, Nigeria.

Palabras clave: relación longitud-peso, alometría, isometría, Aiba reservoir

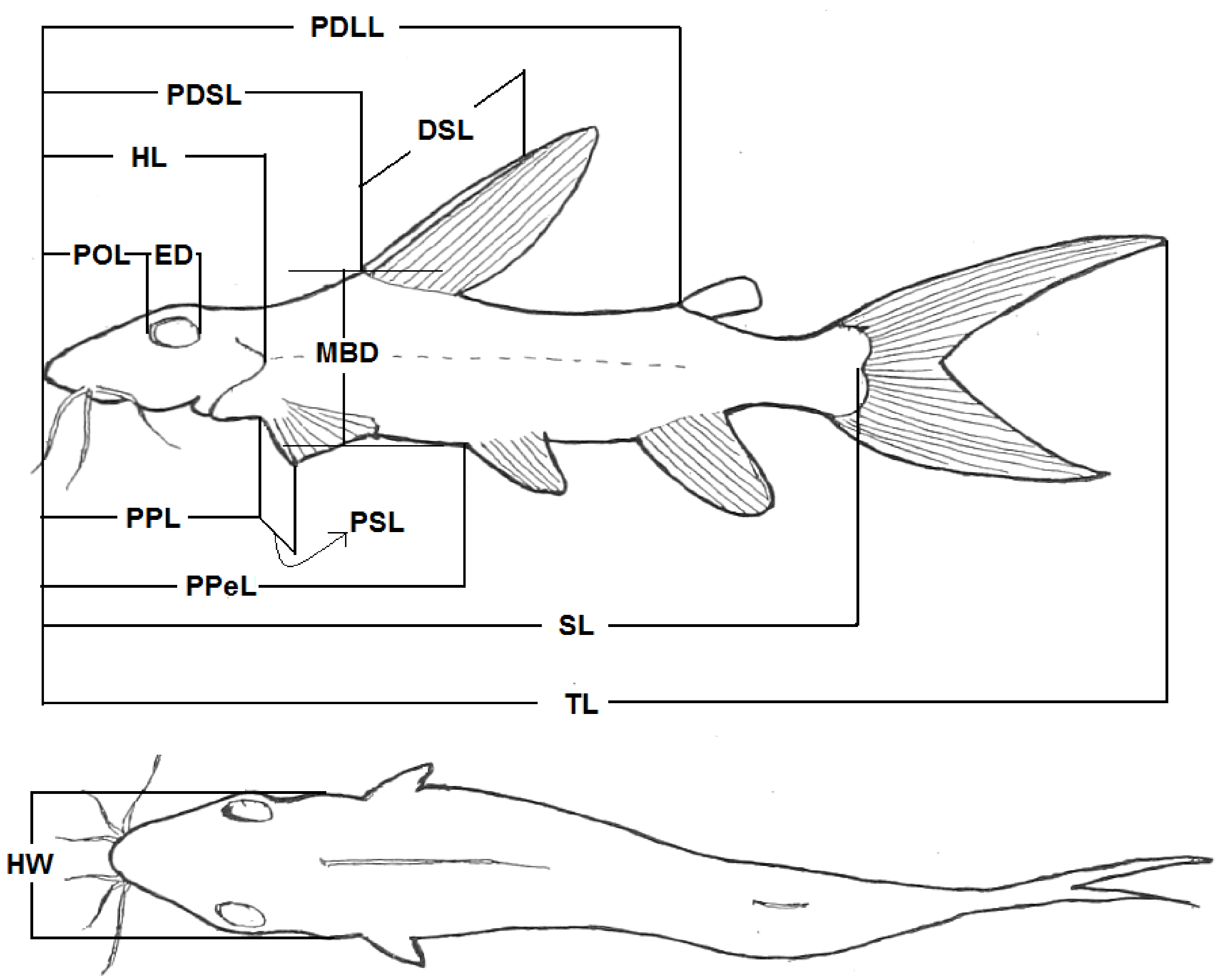
The genus *Chrysichthys* belongs to the family Bagridae and has been described by Reed *et al.* (1967), and Idodo-Umeh (2003). The genus exhibits great economic importance and several aspects of its biology have been studied by various authors in Nigerian water bodies: age and growth (Fagade, 1980 a, b, Ezenwa & Ikusemiju 1981), condition factor, diet and reproductive biology (Ikusemiju & Olaniyan 1977, Nwadiaro & Okorie 1987, Ajah *et al.* 2006, Oso *et al.* 2006, Offem *et al.* 2008, Yem *et al.* 2009, Atobatele & Ugwumba 2011) and diseases (Obiekezie *et al.* 1988). Morphometric studies on Nigerian fishes have been carried out to assess conspecific variation (Adedeji & Araoye 2006, Anyanwu & Ugwumba 2002) and congeneric variation (Eyo 2003, Anyanwu & Ugwumba 2003). Anyanwu & Ugwumba (2002) demonstrated that variations in morphometric characters of a species from different localities are attributed to environmental factors. It can also be attributed to the growth rate (Adedeji & Araoye 2006) which in turn could depend on their genotype, availability of food and rate of reproduction (Anyanwu & Ugwumba 2003). Eyo (2003) suggested the suitability of the ratio data set over the raw and residual data sets. Atobatele & Ugwumba (2011) reported that intensive fishing activity has impacted negatively on fish size as they are not allowed to grow to maximum size. These small sized fish species are difficult to differentiate externally except by meristic counts. The objective of this study is to determine the growth patterns and to establish, with some degree of confidence, morphometric characters that can discriminate smaller sized groups of the two co-habiting species of the genus *Chrysichthys* with regard to species and sex in Aiba Reservoir, Nigeria.

Fish specimens (*Chrysichthys nigrodigitatus* and *C. auratus*) were collected from Aiba Reservoir, Iwo, Nigeria, between April 2005 and April 2006. The specimens were collected using gill nets with mesh sizes between 25 mm and 30 mm on the side. Specimens were procured from daily catch of fishermen using planked canoes at landing points and taken to the laboratory. In the laboratory, the specimens were weighed fresh using a digital balance (Adam Model AAA 250L) to the nearest 0.1g. All measurements were taken on the left side of the fish using a measuring board and rulers to the nearest mm. The characters determined are shown in Figure 1. Length-weight relationships of the fish species were also determined. The length-weight relationship in fishes is usually or always represented by: $W = aSL^b$ or $logW = loga + blogSL$, where W = total weight (g), SL = standard length (mm), log a = intercept of the line on the Y-axis (i.e. initial growth coefficient or condition factor), and b is the regression or growth coefficient (i.e. fish relative growth rate). The measures were log-transformed in order to eliminate any effect of "scale', to keep relations linear and their variances comparable. The least squares regression method was used in selecting the parameter estimates; slope (b) and intercept (a). In the case of slope (b) on length-weight regression analysis, the hypothesis that the parameter is equal to 3 was evaluated to determine if growth was either isometric or allometric (Fry 1993, Smith & Anderson-Cook 2000). The percentage of each morphometric variable to standard length was computed to compare variations due to sex, species and season. The proportions of the body variables contributed by the measured parts were calculated using the formula: $\frac{Lengthofpart(cm)x100}{Standardlength(cm)}$

Statistical analyses of significant difference between growth of the body parts for sex, species and season were determined using Student's t-test.

The weight of *Chrysichthys nigrodigitatus* and *C. auratus* ranged from 18.1 g to 288.7 g and 13.9 g to 131.0 g respectively (Table I). There was no significant difference between the mean weights for both sexes of both species, with males accounting for the lowest and the largest weights. The standard length of *C. nigrodigitatus* and *C. auratus* ranged from 98.0 mm to 256.0 mm and 89.0 mm to 198.0 mm respectively. There was no significant difference between the mean standard lengths for both sexes of both species and males accounted for the lowest and the largest standard lengths for both species. The equation for the length-weight relationship of *C. nigrodigitatus* show that the intercepts and slopes were significantly different ($p < 0.001$) from zero; the slopes were significantly different from 3 for male, female and sexes combined suggesting negative allometric growth (Table II). The equation for the length-weight relationship of *C. auratus* show that the intercepts and slopes were significantly different ($p < 0.001$) from zero, however the slopes were not significantly different ($p > 0.05$) from 3 for male, female and sexes combined suggesting isometric growth. The percentage morphometric variables in relation to standard length show no significant difference between sexes for both *C. nigrodigitatus* and *C. auratus* (Table III). However, five percentage morphometric variables in relation to standard length and one in relation to head length show significant differences between species. The mean percentage total length to standard length (TL) of *C. nigrodigitatus* (129.2 ± 0.5%) is significantly higher (t_{129}= -3.76, $p<0.001$) than that for *C. auratus* (126.3 ± 0.6%); the mean percentage pectoral spine length to standard length (PSL) for *C. nigrodigitatus* (17.9 ± 0.2%) is significantly higher (t_{117}= -2.17, $p<0.05$) than for *C. auratus* (17.1 ± 0.3%); and the mean percentage of dorsal spine length to standard length (DSL) for *C. nigrodigitatus* (19.2 ± 0.3%) is significantly higher (t_{127}= -2.91, $p<0.01$) than that for *C. auratus* (18.0 ± 0.3%). *C. auratus* (21.7 ± 0.2%) recorded a significantly higher (t_{129}= 2.14, $p<0.05$) percentage mean maximum body depth (MBD) compared to *C. nigrodigitatus* (21.0 ± 0.2%); the mean percentage head width to standard length (HW) for *C. auratus* (21.6 ± 0.3%) is significantly higher (t_{102}= 4.66, $p<0.001$) than for *C. nigrodigitatus* (20.1 ± 0.2%); and the mean percentage head width to head length (HW) for *C. auratus* (70.0 ± 1.0%) is significantly higher (t_{102}= -3.25, $p<0.01$) than for *C. nigrodigitatus* (66.4 ± 0.7%).

The slopes for *C. nigrodigitatus* were significantly different from 3 suggesting a negative allometric growth regardless of sex. However, the slopes for *C. auratus* were not significantly different from 3 suggesting isometric growth regardless of sex. Isometric growth implies that the shape of the fish does not change throughout life. Conversely allometric growth suggests that the weight of the fish increased faster or decreased in relation to the cube of their standard lengths, therefore adults may appear different from the young ones (Bagenal & Tesch 1978). Negative allometric growth shows that the fish favour increase in length than in weight, that is, the fish becomes slender as it increase in length. Haruna & Bichi (2005) opined that negative allometric growth means that the fishes could grow non-valuable parts such as fins and head at the expense of the valuable trunk.



Key:

DSL = Dorsal spine length
HL = Head length
PDSL = Pre-dorsal spine length
PPL = Pre-pectoral length
TL = Total length
ED = Eye diameter
MBD = Maximum body depth
POL = Pre-orbital length
PSL = Pectoral spine length
HW = Head width
PDLL = Pre-dorsal lobe length
PPeL = Pre-pelvic length
SL = Standard length

Figure 1. Morphometric variables measured for *Chrysichthys auratus* and *C. nigrodigitatus* from Aiba Reservoir, Nigeria.

There was no significant difference between sexes of the percentage morphometric characters of standard length for both species of *Chrysichthys.* However, the six characters that show differences between species (TL, MBD, PSL, DSL, HW and HW) suggest that *C. nigrodigitatus* is longer-bodied and had longer dorsal and pectoral spines in relation to standard length compared to *C. auratus,* while the latter was deeper-bodied with a wider head compared to the former. This shows that the spines of *C. nigrodigitatus* are better developed, making it better adapted for anti-predation. Spines function as defensive structures against unknown predators (Westermann *et al.* 1988, Bosher *et al*. 2006). This could also be a reason why it is more abundant throughout the year compared to its congener in the reservoir. Although Atobatele & Ugwumba (2011) reported similarity and overlap in the utilization of food items by both species of *Chrysichthys*, spatial separation in the reservoir was one of the suggested strategies by which they cope with interspecific competition. *C. nigrodigitatus* by its shape and comparatively well developed pectoral spine will be a better predator and therefore must expend a great deal of energy fending for food in the open waters compared to *C. auratus* with a more robust feature at the littoral region expending less energy in search of food. The adaptive significance of the difference in morphometric characters between these congeners is yet to be fully understood.

Table I. Mean, standard error and overall range for weight and standard length of *Chrysichthys nigrodigitatus* and *C. auratus* from Aiba Reservoir, Nigeria.

Species	Sex	Weight (g) Mean ± Standard Error (Range)	Standard length (mm) Mean ± Standard Error (Range)
Chrysichthys nigrodigitatus	Male (n = 39)	75.5 ± 8.8	155.0 ± 6.2
	Female (n = 34)	74.1 ± 8.8	154.5 ± 6.0
	combined (n = 73)	74.9 ± 6.2	154.8 ± 4.3
		(18.1 – 288.7)	(98.0 – 256.0)
Chrysichthys auratus	Male (n = 42)	66.1 ± 5.0	144.3 ± 3.9
	Female (n = 16)	66.8 ± 7.1	147.3 ± 5.1
	Combined (n = 58)	66.3 ± 4.1	145.1 ± 3.1
		(13.9 – 131.0)	(89.0 – 198.0)

Table II. Growth pattern of *Chrysichthys nigrodigitatus* and *C. auratus* from Aiba Reservoir, Nigeria, using the length-weight regression relationship between weight (W) and standard length (SL), with weight in grams and length in millimeters.

Species	Sex	Regression equation *(LogW = Log a + bLogSL*	Coefficient of determination (R^2)	Growth Pattern
Chrysichthys nigrodigitatus	Male	LogW = -4.23 + 2.76LogSL	0.98	Negative allometry
	Female	LogW = -4.33 + 2.81LogSL	0.98	Negative allometry
	combined	LogW = -4.27 + 2.78LogSL	0.98	Negative allometry
Chrysichthys auratus	Male	LogW = -4.66 + 2.99LogSL	0.97	Isometry
	Female	LogW = -4.60 + 2.95LogSL	0.94	Isometry
	combined	LogW = -4.65 + 2.98LogSL	0.97	Isometry

Table III. Mean and standard error for the percentage morphometric characters of standard length for both sexes and combined sexes of *Chrysichthys nigrodigitatus* and *C. auratus* from Aiba Reservoir, Nigeria. Morphometric variables abbreviations are explained in Figure 1.

Morphometric variables as percentage of standard length	***Chrysichthys nigrodigitatus***			***Chrysichthys auratus***		
	Male	Female	combined	Male	Female	combined
	Mean ± Standard Error (%)	Mean ± Standard Error (%)	Mean ± Standard Error (%)	Mean ± Standard Error (%)	Mean ± Standard Error (%)	Mean ± Standard Error (%)
TL	129.3 ± 0.6	129.0 ± 0.7	129.2 ± 0.5	126.2 ± 0.8	126.6 ± 1.1	126.3± 0.6 ***
FL	109.4 ± 0.2	108.9 ± 0.3	109.2 ± 0.2	109.2 ± 0.3	109.5 ± 0.3	109.3 ± 0.2
POL	8.7 ± 0.2	8.6 ± 0.2	8.7 ± 0.1	8.8 ± 0.2	8.8 ± 0.3	8.8 ± 0.2
HL	30.3 ± 0.3	30.1 ± 0.3	30.2 ± 0.2	30.9 ± 0.3	30.2 ± 0.3	30.7 ± 0.2
MBD	20.8 ± 0.2	21.3 ± 0.4	21.0 ± 0.2	21.5 ± 0.2	22.1 ± 0.7	21.7 ± 0.2*
PPL	25.6 ± 0.3	25.9 ± 0.4	25.7 ± 0.2	26.2 ± 0.3	25.6 ± 0.4	26.0 ± 0.2
PSL	17.6 ± 0.3	18.3 ± 0.4	17.9 ± 0.2	17.1 ± 0.3	17.4 ± 0.4	17.1± 0.3 *
ED	8.5 ± 0.2	8.5 ± 0.2	8.5 ± 0.1	8.8 ± 0.2	8.7 ± 0.2	8.8 ± 0.1
PDSL	34.1 ± 0.3	34.6 ± 0.2	34.4 ± 0.2	34.5 ± 0.4	34.5 ± 0.5	34.5 ± 0.3
DSL	18.8 ± 0.4	19.6 ± 0.4	19.2 ± 0.3	17.9 ± 0.4	18.2 ± 0.6	18.0 ± 0.3**
PDLL	72.8 ± 0.3	72.7 ± 0.4	72.8 ± 0.2	73.5 ± 0.3	73.0 ± 0.5	73.4 ± 0.3
PPEL	52.1 ± 0.3	52.3 ± 0.3	52.2 ± 0.2	52.2 ± 0.3	52.6 ± 0.5	52.3 ± 0.2
HW	20.2 ± 0.2	19.9 ± 0.3	20.1 ± 0.2	21.7 ± 0.3	21.2 ± 0.4	21.6± 0.3 ***
POL	28.8 ± 0.5	28.6 ± 0.5	28.7 ± 0.3	28.3 ± 0.6	29.0 ± 1.0	28.5 ± 0.5
ED	28.1 ± 0.6	28.2 ± 0.5	28.1 ± 0.4	28.7 ± 0.6	28.7 ± 0.7	28.7 ± 0.4
HW	67.1 ± 0.8	65.4 ± 1.0	66.4 ± 0.7	70.0. ± 1.1	70.2 ± 1.8	70.0 ± 1.0**

* = significant at $p \leq 0.05$ ** = significant at $p \leq 0.01$ *** = significant at $p \leq 0.001$

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