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Konan Amenan Marie Madeleine
22 Bp 584 Abidjan 22,
University Felix Houphouet Boigny, Hydrobiology laboratory.

N'ZI Konan Gervais
22 Bp 584 Abidjan 22,
University Felix Houphouet Boigny, Hydrobiology laboratory.

Goore Bi Gouli
22 Bp 584 Abidjan 22,
University Felix Houphouet Boigny, Hydrobiology laboratory.

Correspondence
N'ZI Konan Gervais
22 Bp 584 Abidjan 22,
University Felix Houphouet Boigny, Hydrobiology laboratory.

Weight-length relationships and condition factor of *Atya gabonensis* Giebel, 1875 in Bandama River – Côte d'Ivoire

Konan Amenan Marie Madeleine, N'ZI Konan Gervais, Goore Bi Gouli

Abstract
Growth characteristics for length and weight of *Atya gabonensis* Giebel, 1875 were calculated for a sample of 817 specimens collected along the Bandama River during 12 sampling surveys from August 2014 to July 2015. The relations between total length and weight of the females are determined by $W = 0.0483TL^{2.7338}$ for the dry season and by $W = 0.1315\ TL^{2.29}$ for the rainy season; for males $W = 0.0102\ TL^{3.4341}$ for the dry season and $W = 0.0181TL^{3.2089}$ for the rainy season. Allometric coefficient "b" according to Student *t*-test, and Condition Factor (k), males of *A. gabonensis* ($b > 3$; $k = 3.05 \pm 0.62$) are in better condition than females ($b < 3$; $k = 2.67 \pm 0.35$).

Keywords: *Atya gabonensis,* Allometric growth, Condition factor*,* Bandama River, Cote d'Ivoire

1. Introduction
In the studies on artisanal fisheries, particularly those conducted in West Africa, survey systems have largely favored the acquisition of information on sizes of species captured to the detriment of data on weight and biomass. However, fisheries management and research often require the use of biometric relationships in order to transform data collected in the field into appropriate indexes [1-5]. One of the most commonly used in any analysis of fishery data is the length – weight relationship ($W = aL^b$) and Condition Factor (k). According [8], length and weight data are essential for estimating growth rates, age structure; calculate the standing stocks biomass [10], condition indices [19] and several other aspects of species population dynamics [12]. This is particularly important to be investigated in species that might profitably be used for aquacultural purposes, where the main objective is to rapidly produce organisms with an optimal size at a reasonable cost [18].
In Côte d'Ivoire, the freshwater decapod *Atya gabonensis* Giebel, 1875, was first reported in Gabon and it inhabits is in clean waters, burrows on root masses, crevices and rocky bottoms [16], is heavily exploited. However, despite its ecological importance, basic aspects regarding the relative growth and condition factor of this species have not been satisfactorily evaluated.
For stock assessment and fisheries management, the present work, aimed to study weight-length relationships and condition factor (k) parameters of *Atya gabonensis* caught in Bandama River (Cote d'Ivoire) using shrimps nets and traps of various mesh sizes.

2. Material and methods
2.1. Sampling area
Bandama River has a main channel stretching over a distance of 1.050 km and a catchment area of 97.500 km². This river is located between 3°50′ - 7°00′W and 5°00′ - 10°20′ N, and rises in the north of the country, between Korhogo and Boundiali, and enters the sea at Grand-Lahou lagoon. It is two tributaries are Marahoue (550 km length) and N'zi (725 km length). Two hydroelectric dams, Kossou lake (drainage area: 900 km^2) and Taabo lake (drainage area: 69 km^2) were built on the main course of the river [9]. Data were collected in N'douci locality located between 5°50' - 6°00' W and 5°00′ - 10°20′ N where an artisanal exploitation of shrimp *Atya gabonensis* exists (Figure 1).

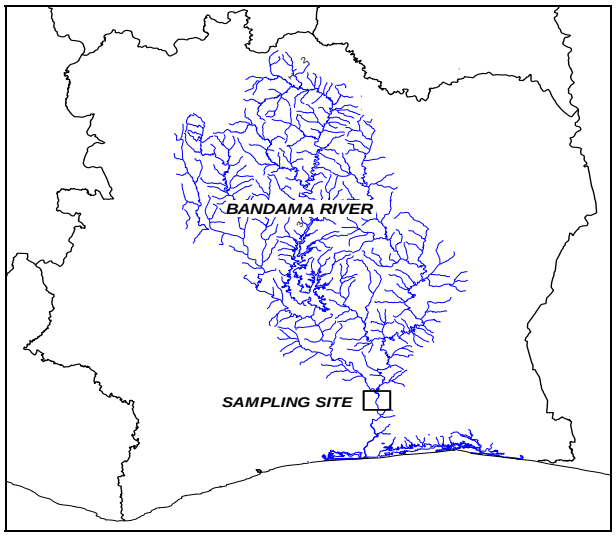


Fig 1: Sampling area of *Atya gabonensis* in the Bandama River (Cote d'Ivoire)

2.2. Data collection and analysis procedure

Shrimps were collected during 12 sampling campaigns from August 2014 to July 2015 using shrimps nets and traps of various mesh sizes. Species were identified according [16] and [17]. Data on Total Length (TL) in cm was measured to the nearest 0.01 cm for each shrimps using digital slide calipers (Mitutoyo, CD-15PS), and total weight (W) in g were recorded with a top loading Sartorius balance model BP 310S with 0.01 g accuracy.

The length-weight relationship was estimated using the equation $W = aLT^b$. The value of constants "a" or intercept and "b" or slope [21] were computed from the log transformed values of length and weight using the following formula Log W = Log a + b Log LT; where W = Weight of shrimps (g) and LT= Total length of shrimps (cm).

The condition factor (K) was calculated using Fulton's condition factor, to determine the well-being of the shrimps according [15]:

$$K = \frac{W}{LT^3} \times 10^2$$

In order to verify if calculated "b" was significantly different from 3, the Student's *t*-test for independent samples was employed [20]. Differences in the condition factor were examined between males and females, and among different populations in rainy and dry season with a one-way ANOVA. All statistical procedures were performed using STATISTICA software version 7.1.

3. Results

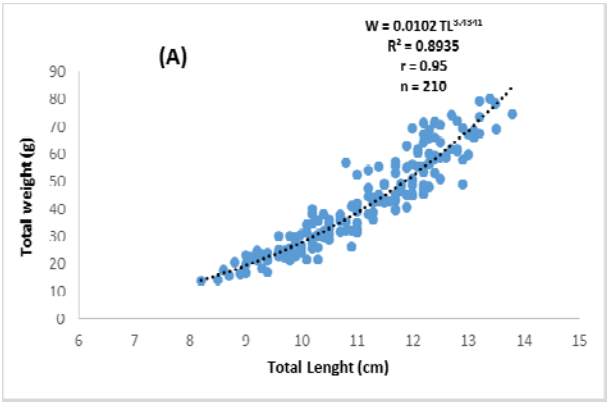
3.1 Length weight relationships

In this study, length of *Atya gabonensis* ranged from 7.3 cm to 12.9 cm and weight ranged between 11.35 g and 47.5 g with a mean of 23.79 ± 5.62 g for females. For males, length ranged from 8.1 cm and 13.8 cm, weight varies between 11.68 g and 86.8 g with a mean of 40.89 ± 15.47 g. The total length-weight relationships of *Atya gabonensis* are presented in figure 2 and 3. The r^2 values ranged from 0.6426, for females in rainy season (March to July and September to November) to 0.8935 for males in dry season (December to February and August), and all regression were found to be highly significant at $p < 0.01$.

For males, in rainy season length - weight relationships was $W = 0.0181TL^{3,2089}$ with a significant correlation ($r = 0.90$, $p < 0.001$) whereas in the dry season this relation was $W = 0.0102\ TL^{3.4341}$ ($r = 0.95$; $p < 0.05$). The allometric indices b was 3.2089 during the rainy season and 3.4341 during dry season (Figure 2).

In females, the corresponding relationship between length - weight was $W = 0.1315\ TL^{2.29}$ in rainy season and $W = 0.0483TL^{2.7338}$ during dry season. The allometric indices b was 2.29 during rainy season and 2.7338 during dry season (Figure 3).

In both season, *t*-value test revealed a significant difference between calculated b and it was superior of 3. This positive allometric, indicates that the weight of *Atya gabonensis* males grew at a faster rate than their total length (TL). However, in all season, population of females had a negative allometric ($b < 3$). Females increase in size than in weight.



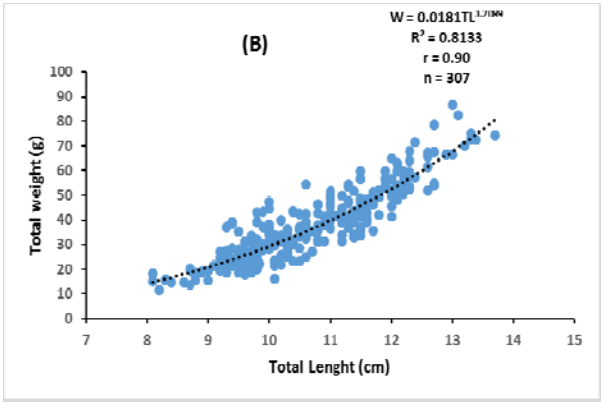
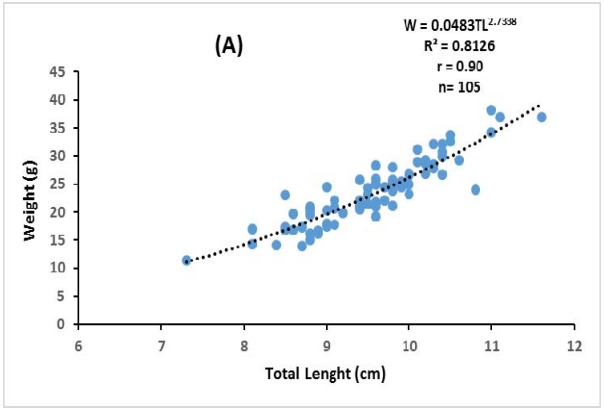


Fig 2: Total length and Weight relationships for *Atya gabonensis* males captured in the Bandama River during August 2014 to July 2015. (**A**) = Dry season; (**B**) Rainy season



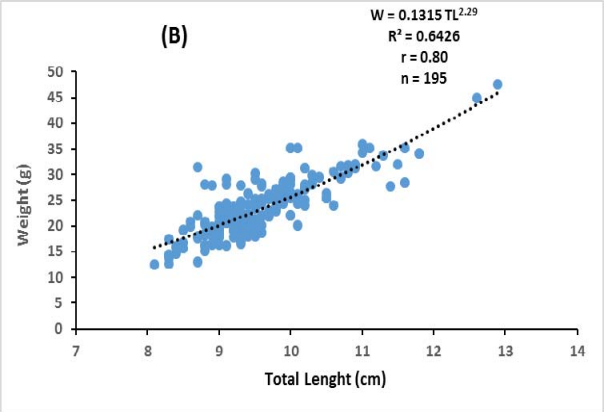


Fig 3: Total length and Weight relationships for *Atya gabonensis* females captured in the Bandama River during August 2014 to July 2015. (**A**) = Dry season; (**B**) Rainy season

3.2 Condition factor

Values of the condition factor (k) (Table 1) show that for females, in rainy season k ranged from 1.8 to 4.79 with a mean of 2.67 ± 0.42. In dry season value of k is between 1.9 and 3.75 with an average of 2.67 ± 0.29. For male's populations, k calculated in rainy season (March to July and September to November) varies between 1.58 and 4.72 with an average of 3.16 ± 0.80. During the dry season (December to February and August), this value is between 1.96 and 4.53 with a mean of 2.94 ± 1.43. The one-way ANOVA showed a significant difference in k (*F = 25.58* and *p = 0.00001*) among season and sexes.

A Newman-Keuls test showed a significant difference between males and females during dry season (*p = 0.0002*) and rainy season (*p = 0.0001*). Monthly variation of the Fulton condition showed that k of males is always higher than those of females (Figure 4).

Table 1: Values of Condition Factor k by sex and by season of *Atya gabonensis* caught in the Bandama River during August 2014 to July 2015.

		Condition factor (k)			
		Min	**Max**	**Mean**	**SD**
Females	Rainy season	1,82	4,77	2,67	0,42
	Dry season	1,90	3,75	2,67	0,29
Males	Rainy season	1,58	4,72	3,17	0,80
	Dry season	1,96	4,53	2,94	0,43

Min = minimum; Max = maximum and SD = Standard deviation

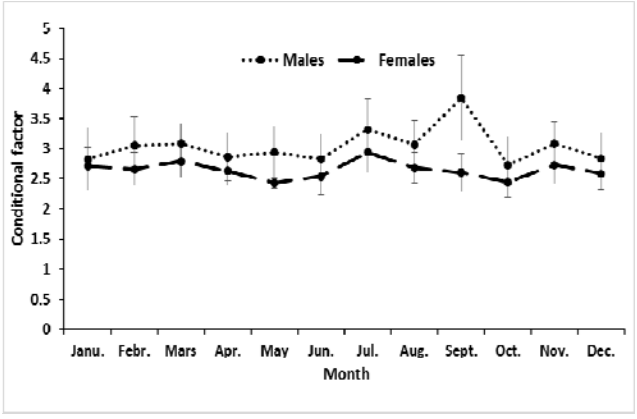


Fig 4: Monthly variation of condition factor k for males and females of *Atya gabonensis* caught in the Bandama River during August 2014 to July 2015

4. Discussion

In the present study, the smallest individuals of *Atya gabonensis* were having size of 7.3 cm in females and 8.1 cm for males. A maximum size recorded, was 12.9 cm for females and 13.8 for males. *Atya gabonensis* exhibit a sexual dimorphism which means the male's length size is always superior to females. This difference in size between the sexes was also observed in *Atya scabra* [4].

The results of the relation between total length-weight revealed positive allometric growth for males, and negative in females, according to the *t*-test. Males grew faster than size. This observation contrasts with females which increase in size than in weight. For [6], several factors could affect relationship between length–weight, habitat, seasonal effects, degree of stomach fullness, gonad maturity, sex, health, preservation techniques, differences in the observed length of specimens and ontogeny aspect.

Allometry for the growth relation between Total Length and Weight was also observed in West African shrimp, *Macrobrachium vollenhovenii* [7]. The males and females of *Macrobrachium vollenhovenii* exhibited negative allometry thus contradicts the present findings. Okayi and Iorkyaa [13] reported isometric growth for *A. gabonensis* with "b" value of 2.989 in River Mu. This difference could be the result of availability of food and sufficient space to support the biomass as reported [2].

In the present study, the condition factor varies significantly between males and females in all season. These results suggest that males are in a better condition than females. Also, this difference between males and females could be explained by the competition for food. This food competition was a factor that inhibits growth and therefore affecting the value of "b" in the length-weight relationship of any species as noted by [14]. Similar results have been observed in *Macrobrachium dux* [3] in Niger Delta (Nigeria).

Current study demonstrated that condition factor is higher, in both sexes and in all season, than those reported for *Atya gabonensis* (k = 1.014) [13] in Mu River. The difference could be attributed probably to difference in habitats prospected, selective capture by local people for human consumption as reported [11].

5. Conclusion

This study provides the basic information on *Atya gabonensis* in a lotic Bandama River. More research is needed to understand their reproductive biology so as to enhance their candidacy for aquaculture. Also, a regular monitoring of catches will be necessary to better assess fishing pressure on this species.

6. Acknowledgement

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