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Biometric, Length–Weight Relationships and Condition Factor of the African Clam *Galatea paradoxa* (Born, 1778) in the Lower Sanaga River of Cameroon

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Abstract

Galatea paradoxa is the most economically important bivalve species in Cameroon. This study focused on biometric and length-weight relationships in the lower Sanaga River of Cameroon from March 2018 to March 2019. Samples were collected each month manually and randomly and their biometrics characteristics were recorded. The Von Bertalanffy equation was used to assess linear growth, while relative growth was done according to Goulletquer. Condition factor was also evaluated. A total of 2340 specimens were examined. The length and average weight were respectively 59.51± 12.96 mm and 37.40 ± 19.94 g. For biometric characteristics, individuals were more abundant for size intervals between 50 and 65 mm regardless of the sampling season with the highest values during the long dry season (16%). The metric and weight values showed little variations ($p<0.05$) between seasons, the metric data showed a low heterogeneity (CV <25%) while weight measurement showed high heterogeneity during the light rainy season (L = 59.9 ± 14.0 mm and P = 43.2 ± 23.9 mg). The Von Bertalanffy growth parameters obtained were $L\infty$ = 97.82mm and K = 0.26 year-1. Depending on the season, three forms of allometry growth model were observed, while the length-weight relationship showed negative allometry (b <3). Condition factors are significantly different ($P<0.05$) between seasons with the lowest (1.5±0.5) and highest (2.0±1.4) values recorded in the long dry season and light rainy season, respectively. Such data is valuable for establishing a monitoring and management system of clams of the genus *Galatea* in Cameroon.

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Introduction

The aquatic products sector is at the center of important environmental, food and socio-economic challenges (FAO, 2016a). The fisheries and aquaculture sectors are a source of income and livelihood for millions of people around the world. Estimates indicate that 59.6 million people worked in the primary capture fisheries and aquaculture industries in 2016, of which 19.3 million were in aquaculture and 40.3 million in fisheries (FAO, 2018). Today, shellfish are at the forefront of aquatic species whose culture is likely, in the short or medium term, to reach a commercial break-even point (IFREMER, 2009). The main species cultures are oysters and clams. However, clams of Africa and Cameroon particularly are poorly known. Among the clam's genus found in Cameroon, *Galatea* is the genus of commercial interest, its sustains viable commercial fisheries in Ghana (Ndiaga and Anis, 2010; Adjei-Boateng & Wilson, 2012; Adjei-Boateng *et al.,* 2012; Obirikorang *et al.*, 2013), Nigeria (Udoh & Umoh, 2007) and Cameroon (Tchamba, 2012). It is cherished by indigenous consumers because of its large size, pleasant taste and nutrient value with crude protein values of flesh and shell (Tchamba, 2012). The lack of knowledge on *Galatea* is worrisome, because of the intense fishing exploitation.

The main area where bivalves are found in Cameroon is the lower Sanaga River; it was recently found in Nkam River (Tekou, 2017; Ajonina *et al.*, 2005), with *Galatea paradoxa* the most abundant and economic important species. However, *Galatea*'s clams have constantly been decreasing over the years in the lower Sanaga River, unlike the human population, which is growing exponentially. This demographic boom has put pressure on the stock of natural clam's available, supply becoming less than demand. Production fell from 240 tons in 2005 to 127 tons in 2008, a decrease of 47.08% in 3 years (CWCS, 2009).

Previous studies on *Galatea* population have been done on nutritional and bacteriological quality (Tchamba, 2012), morpho-biometrics (Tekou (2015) in the lower Sanaga River and Tekou (2017) in Nkam River) and habitat (Dikoume *et al.*, 2016 and 2017). Concerning the study on morpho-biometrics, studies in the lower Sanaga River in 2015 and in Nkam River in 2017 took place over short periods (June-July and March-May, respectively) without taking all seasons into account. Suddenly, it is not yet possible to rule on the main factors likely to vary the morpho-biometry of clams in these rivers. According to Froese (2006) and Jisr *et al.* (2018), biometric studies should provide information about the growth pattern, general health, habitat conditions, as well as morphological characteristics of the species. This study was therefore undertaken to analyse the biometric and length-weight relationship of *Galatea paradoxa* clam in the lower Sanaga River throughout the year. It will provide all the information expected in biometric studies and will serve to design proper exploitation and management plan for *Galatea* in Cameroon.

Materials and methods

Period, zone and study site

The study was carried out from March 2018 to March 2019 in the lower Sanaga, located in the Subdivision of Mouanko, Sanaga Maritime Division, Littoral Region in Cameroon. The geo-climatic characteristics of this area are summarized as follows: North Latitude: 3 ° 35'-3 ° 39 ', East Longitude: 9 ° 43'-9 ° 47', Equatorial type climate influenced by the Atlantic Ocean, two dry seasons (mid-November to mid-March (longer dry season) and May-June (shorter dry season)), two rainy seasons (July to mid-November (longer rainy season) and mid-March-April (shorter rainy season)), annual rainfall (2000 -3000 mm) and temperatures (25 and 30 ° C) (CWCS, 2006).

Animal material and sampling strategy

The animal material consisted of 2340 individuals *Galatea paradoxa* of length and the respective average weight of 59.51 ± 12.96 mm and 37.40 ± 19.94 mg. A total of 180 individuals were collected each month manually and randomly at low tide by professional divers. In the laboratory, the valves on each clam were opened with a knife to separate them from the flesh. The whole was drained, then examined according to the protocol described by Fernandez and Arnal (1977).

Studied characteristics

Biometric indices

Metric and weight data were taken monthly from 180 individuals for 13 consecutive months. The metric data were collected on the entire individual using a mechanical caliper precision of 0.02 mm. These data were the length (L: greater measurement in the antero-posterior lateral direction), the ventral length (L: greater measurement in the antero-posterior ventral direction), the width (La: from the dorsal hinge to the edge ventral in lateral view) and thickness (Ep: maximum thickness in ventral view) (Fernandez and Arnal, 1977; Caill-Milly *et al.*, 2012 a and b). The weight data were collected using an electronic precision 0.1 g scale and concerned: the total fresh weight (Pt), the weight of the drained meat (Pc), the weight of the valves (Pv), the weight of the left valve (Pvg) and the weight of dry flesh (Pcs) (Fernandez & Arnal, 1977; Caill-Milly *et al.*, 2012 a and b).

Linear growth

The growth parameters of the Von Bertalanffy (1938) equation were used to assess linear growth. Its formula is as follows: $L_t = L_\infty (1-e^{-K(t-to)})$ (1).

Where:

Lt: length at time t (mm);

L∞: asymptotic length (mm);

K: growth coefficient (year -1);

to: age that the clam would have had at size 0 (mm).

Relative growth (Allometric relationships)

The allometric relationships were established between the biometric characteristics and presented according to the formula proposed by Goulletquer (1983): $Y = aX^b$ (2)

Where:

Y and X are the characteristics considered;

"a" the index at the origin;

"b" the coefficient of allometry.

The latter is generally compared to the isometric value (b = 1) for all the pairs of biometric characteristics considered, except for the length-weight couple, where the isometric value is (b = 3). There is negative or positive allometry when "b" is respectively lower or higher than the isometric value. This work focused solely on determining the length-weight relationship. To develop this model, the total lengths and weights of the individuals were measured using a 0.02 mm precision caliper and a 0.01 g sensitive balance.

Condition factor

The condition factor (CF) was calculated to give the general health or well-being of the clams in each season. In order to be able to calculate the condition factor, measurements of length and the total weight of each clam were taken monthly on 180 individuals for 13 consecutive months. Jurić *et al.* (2012) and Peharda *et al.* (2012) offer this formula:

$CF = 10^4 \times (P/L^3)$ (3)

Where:

CF: condition factor (high CF results in favorable environmental conditions);

P: total weight;

L: total length.

Statistical analysis

The data were processed using a double approach: a descriptive and an inferential. The descriptive approach consisted of calculating the means, standard deviations and frequencies. It was done on Excel 2013 spreadsheet which was also used for tables and graphs presentations.

The inferential approach consisted in comparing the means of the variables as a function of the seasons using the 1-factor ANOVA test and the proportions using the χ2 test carried out on SPSS 20.0. When differences were significant between the means, the Turkey test was used to separate them at the 5% level. The growth parameters of the Von Bertalanffy equation were determined by the FISAT II software.

Results

Biometric variability of Galatea paradoxa from the lower sanaga river

Size frequency distribution according to the season

The size frequency distribution as presented in Fig. 1 is unimodal with mode [50-65 [mm. The collected individuals showed varying sizes from 21.7 to 97.1 mm. The lowest number was recorded in classes of sizes less than 35 mm and those greater than 85 mm.

Individuals between 50 and 70 mm in size made up the largest number in the collected clam population (Fig. 1A). As for the seasons, the SDS showed a peak between 60 and 65 mm, the LDS and LRS between 55 and 60 mm and the SRS between 50 and 55 mm (Fig. 1B).

Biometric characteristics according to the season

Biometric characteristics of lower Sanaga clams according to the seasons are summarized in Table 1. It appears that the clams of the Lower Sanaga River showed a low heterogeneity (CV < 25%) for metric data, average and high for weight data (40% <CV< 75%).

Table 1. Biometric characteristics values of *Galatea paradoxa* from the lower Sanaga River according to the season. a, b, c: in the columns the values assigned to the letters differ significantly (p <0.05) depending on the seasons LRS: long rainy season, LDS: long dry season, SRS: short rainy season, SDS: short dry season, Cv: coefficient of variation, avg: average, s: standard deviation, L: total length, Lvent: ventral length, Ep: thickness, La: width, Pt: total weight, Pc: flesh weight, Pv: valve weight, Pvg: left valve weight.

Seasons		Biometric Characteristics							
		L (mm)	Lvent (mm)	Ep (mm)	La (mm)	Pt (g)	Pc (g)	Pv (g)	Pvg (g)
LRS	avg±s	58.4 ± 12.7^{ab}	58.4 ± 12.6^{a}	29.3 ± 4.4^{a}	44.5 ± 8.7^{a}	35.5 ± 18.7^{a}	6.4 ± 3.8^{a}	29.1 ± 15.2^{a}	14.4 ± 7.5^{a}
	CV (%)	21.80	21.66	15.19	19.54	52.79	59.92	52.13	52.16
LDS	avg±s	60.5 ± 12.7^{b}	60.6 ± 12.7^{b}	30.3 ± 5.5^{b}	46.0 ± 9.2^{b}	35.2 ± 17.6^{a}	3.7 ± 2.1^{a}	31.6 ± 15.5^{b}	15.7 ± 7.7^{b}
	CV (%)	21.01	20.95	18.16	20.01	50.07	57.23	49.20	49.58
SRS	avg±s	59.9 ± 14.0^{ab}	60.0 ± 13.8^{ab}	30.3 ± 5.5^{b}	46.3 ± 9.4^{b}	43.2 ± 23.9^{b}	6.6 ± 3.8^{a}	36.6 ± 20.5^{c}	18.2 ± 10.3^{c}
	CV (%)	23.46	23.11	18.44	20.35	55.28	57.21	56.04	56.82
SDS	avg±s	58.8 ± 12.0^{a}	58.8 ± 12.0^{ab}	29.5 ± 4.3^{ab}	45.1 ± 7.9^{ab}	36.7 ± 18.3^{a}	6.9 ± 3.8^{b}	29.7 ± 14.7^{ab}	14.8 ± 7.3^{ab}
	CV (%)	20.51	20.49	14.56	17.61	50.08	55.37	49.41	49.36

Biometric characteristics recorded during the SRS were closer to those of the LDS and were significantly different (P<0.05) from those of the SDS. Characteristics of the LRS were comparable (P=0.05) to those of the SDS. Average lengths were significantly high during LDS, but the total weight was higher during SRS.

Linear growth of Galatea paradoxa from the lower sanaga river

Analysis of the *Galatea* clam data from the lower Sanaga River using FiSAT II software resulted in the growth parameter values reported in Table 2.

The plot of the growth curve made from these parameters is represented through the distribution of the restructured lengths in Fig. 2.

It appears that for *Galatea* clams in the lower Sanaga River, the maximum length observed is 90 mm while the maximum estimated length is 97.82 mm with a confidence interval which is 95%, i.e., 83.92 - 98.55.

Table 2. Growth parameters of the *Galatea paradoxa* from the lower Sanaga River.

Growth parameters	Lower Sanaga River
Asymptotic length $L\infty$ (mm)	97.82
Growth coefficient K (years-1)	0.26
Maximum length (mm)	90
95% confidence interval (mm)	83.92 - 98.55
Von Bertalanffy's equation	$L\infty$ = 97.82 (K) 0.26years-1

Relative growth of Galatea paradoxa from the lower sanaga river

Allometric relationships between biometric characteristics according to the seasons

The different allometric models established from biometric characteristics on 2340 clams according to the seasons (Table 3) revealed three types of allometry: negative, positive and isometric. The coefficient of allometry varied from 0.24 (SDS) to 1.33 (LRS). Negative allometries were observed between the weight of the left valve and the length, width, or thickness irrespective of the site or the sampling season, as well as the isometries between the weight of the left valve and the weight of the right valve. The coefficient of determination R^2 was less than 1 and varied from 0.49 (LDS) to 0.99 (SDS).

Table 3. Allometric relationships between some biometric characteristics of *Galatea paradoxa* from the lower Sanaga River depending on the season. La: width, L: length, Ep: thickness, Pv: valve weight, Pc: flesh weight, Pvg: left valve weight, Pvd: right valve weight, b: condition coefficient, a: allometry coefficient, R^2: coefficient determination, LDS: long dry season, LRS: long rainy season, SDS: short dry season, SRS: small rainy season.

Seasons	Characteristics	Allometric parameters				Allometry types
		Equations	a	b	R^2	
	La/L	$La = 1,3081L^{0,9995}$	1,3081	0,9995	0,821	Isometric
	Ep/L	$Ep = 0,6485L^{1,3291}$	0,6485	1,3291	0,8205	Positive
	Ep/La	$Ep = 0,765La^{1,2008}$	0,765	1,2008	0,8149	Positive
	Pv/Pc	$Pv = 0,1789Pc^{1,0553}$	0,1789	1,0553	0,94	Isometric
LRS	*Pvg/Pvd*	$Pvg = 1,1602Pvd^{0,941}$	1,0853	0,9719	0,9279	Isométric
	Pvg/L	$Pvg = 22,349L^{0,3708}$	22,349	0,3708	0,8464	Negative
	Pvg/Ep	$Pvg = 15,04Ep^{0,2603}$	15,04	0,2603	0,8979	Negative
	Pvg/La	$Pvg = 19,006La^{0,3293}$	19,006	0,3293	0,8123	Negative
	La/L	$La = 2,7603L^{0,8049}$	2,7603	0,8049	0,6413	Negative
	Ep/L	$Ep = 2,9047L^{0,8871}$	2,9047	0,8871	0,574	Negative
	Ep/La	$Ep = 2,775La^{0,8203}$	2,775	0,8203	0,4959	Negative
LDS	*Pv/Pc*	$Pv = 0,0947Pc^{1,0557}$	0,094	1,0557	0,8661	Isometric
	Pvg/Pvd	$Pvg = 1,2595Pvd^{0,9187}$	1,2595	0,9187	0,8541	Isometric
	Pvg/L	$Pvg = 23,129L^{0,3581}$	23,129	0,3581	0,7785	Negative
	Pvg/Ep	$Pvg = 14,512Ep^{0,2755}$	14,512	0,2755	0,6318	Negative
	Pvg/La	$Pvg = 19,287La^{0,3235}$	19,287	0,3235	0,6418	Negative
	La/L	$La = 1,0187L^{1,0603}$	1,0187	1,0603	0,7338	Isometric
	Ep/L	$Ep = 1,201L^{1,1423}$	1,201	1,1423	0,6499	Positive
	Ep/La	$Ep = 1,5109La^{1,0015}$	1,5109	1,0015	0,7653	Isometric
SRS	*Pv/Pc*	$Pv = 0,177Pc^{1,0031}$	0,177	1,0031	0,8773	Isometric
	Pvg/Pvd	$Pvg = 1,203Pvd^{0,9336}$	1,203	0,9336	0,869	Isometric
	Pvg/L	$Pvg = 21,578L^{0,3611}$	21,578	0,3611	0,6724	Negative
	Pvg/Ep	$Pvg = 15,04Ep^{0,2603}$	15,04	0,2603	0,8979	Negative
	Pvg/La	$Pvg = 19,061La^{0,3157}$	19,06	0,3157	0,7874	Negative
	La/L	$La = 0,8819L^{1,1014}$	0,8819	1,1014	0,9098	Positive
	Ep/L	$Ep = 0,7778L^{1,2752}$	0,7778	1,2752	0,8362	Positive
	Ep/La	$Ep = 0,9345La^{1,144}$	1,9345	1,144	0,8974	Positive
SDS	*Pv/Pc*	$Pv = 0,209Pc^{1,0266}$	0,209	1,0266	0,8993	Isometric
	Pvg/Pvd	$Pvg = 0,9987Pvd^{1,0009}$	0,9987	1,0009	0,9984	Isometric
	Pvg/L	$Pvg = 24,29L^{0,3359}$	24,29	0,3359	0,7335	Negative
	Pvg/Ep	$Pvg = 15,793Ep^{0,2397}$	15,793	0,2397	0,7265	Negative
	Pvg/La	$Pvg = 20,842La^{0,2946}$	20,842	0,2946	0,7524	Negative

Depending on the season, the La / L, Ep / L and Ep / La ratios presented negative allometries during LDS unlike SDS where they presented positive allometries. The Pv / Pc ratio showed isometry regardless of the sampling season. The length-width relationship showed an isometry during the long and the short rainy season. During the long rainy season, positive allometry was observed between the EP / L and EP / La ratios.

Length-weight relationship according to the season

The length-weight relationship depending on the seasons, as shown in Table 4, shows that: Whatever the season considered, this relationship was significant ($P<0.05$) and the coefficient of determination R^2 was less than 1.

Table 4. Length-weight relationship of *Galatea paradoxa* in the lower Sanaga River according to the season. Long dry season (LDS), short dry season (SDS), long rainy season (LRS), short rainy season (SRS), total: total population Pt: total weight, L: total length, N: effective, R^2: coefficient of determination.

Seasons	N (Sample size)	Allometric parameters				Allometry types
		Equations	a	b	R^2	
LDS	720	$Pt = 0{,}0037L^{2{,}2096}$	0,0037	2,2096	0,7866	Negative
LRS	720	$Pt = 0{,}0022L^{2{,}3564}$	0,0022	2,3564	0,8888	Negative
SDS	360	$Pt = 0{,}0038L^{2{,}2301}$	0,0038	2,2301	0,7563	Negative
SRS	540	$Pt = 0{,}0165L^{1{,}8989}$	0,0165	1,8989	0,7355	Negative
Total	2340	$Pt = 0{,}0051L^{2{,}154}$	0,0051	2,154	0,7795	Negative

The allometric coefficient "b" was lower than the isometric value b = 3, whatever the season. However, it was lower ($p<0.05$) during the short rainy season (SRS).

Variation of the condition factor of Galatea clams in the lower sanaga river according to the season

Variation of the condition factor of *Galatea paradoxa* in the lower Sanaga River according to the seasons is shown in Table 5. Disregard the seasons, the means values of condition factors obtained in this study were >1. There were significant differences ($P<0.05$) between the seasons with the lowest values (1.5±0.4) recorded in the long dry season and the highest value (2.0±1.4) registered in the short rainy season.

The values recorded in the long rainy season and the short dry season were comparable ($P=0.05$).

Table 5. Variation of the condition factor of *Galatea paradoxa* from the lower Sanaga River according to the season. a,b, c on the same column, the values assigned to the letters differ significantly depending on the seasons ($P<0.05$). Standard deviation (SD), long dry season (LDS), short dry season (SDS), long rainy season (LRS), short rainy season (SRS), Intervalles: maximum and minimum.

Seasons	N (Sample size)	Mean±SD (Condition Factor)	Intervalles
LDS	720	$1.5^{a}\pm0.4$	0.1-5.0
LRS	720	$1.7^{ab}\pm0.3$	0.3-3.3
SDS	360	$1.8^{b}\pm0.7$	0.1-9.6
SRS	540	$1.9^{c}\pm0.5$	0.6-4.1
Total	2340	1.7±0.5	0.1-9.6

Discussion

With regard to biometric characteristics, the maximum length and maximum weight values were similar to the results found by Obirikorang *et al.* (2013) and lower than those obtained by Tekou (2015) in the lower Sanaga River which recorded 112 mm and 300 mg and by Adjei- Boateng and Wilson (2012) in the Volta River in Ghana. This could be due to the fishing effort linked to the increase in fishermen in the Mouanko subdivision (Essome, 2016). This difference could also be due to the burial nature of adult clams, which does not allow fishermen to reach these depths (www.pac.dfo.mpo.gc.ca). Individuals between 50 and 65 mm in size represented the largest number. These results are similar to those of Benchikh (2009) for *Perna perna* mussels.

The samples studied showed an asymptotic length of 97.82 mm and a growth coefficient (K) of 0.26 years-1. No estimate of *Galatea*'s growth has previously been made in Lower Sanaga River. However, studies have been carried out in the Itu and Cross river region of Nigeria on *Galatea paradoxa* species.

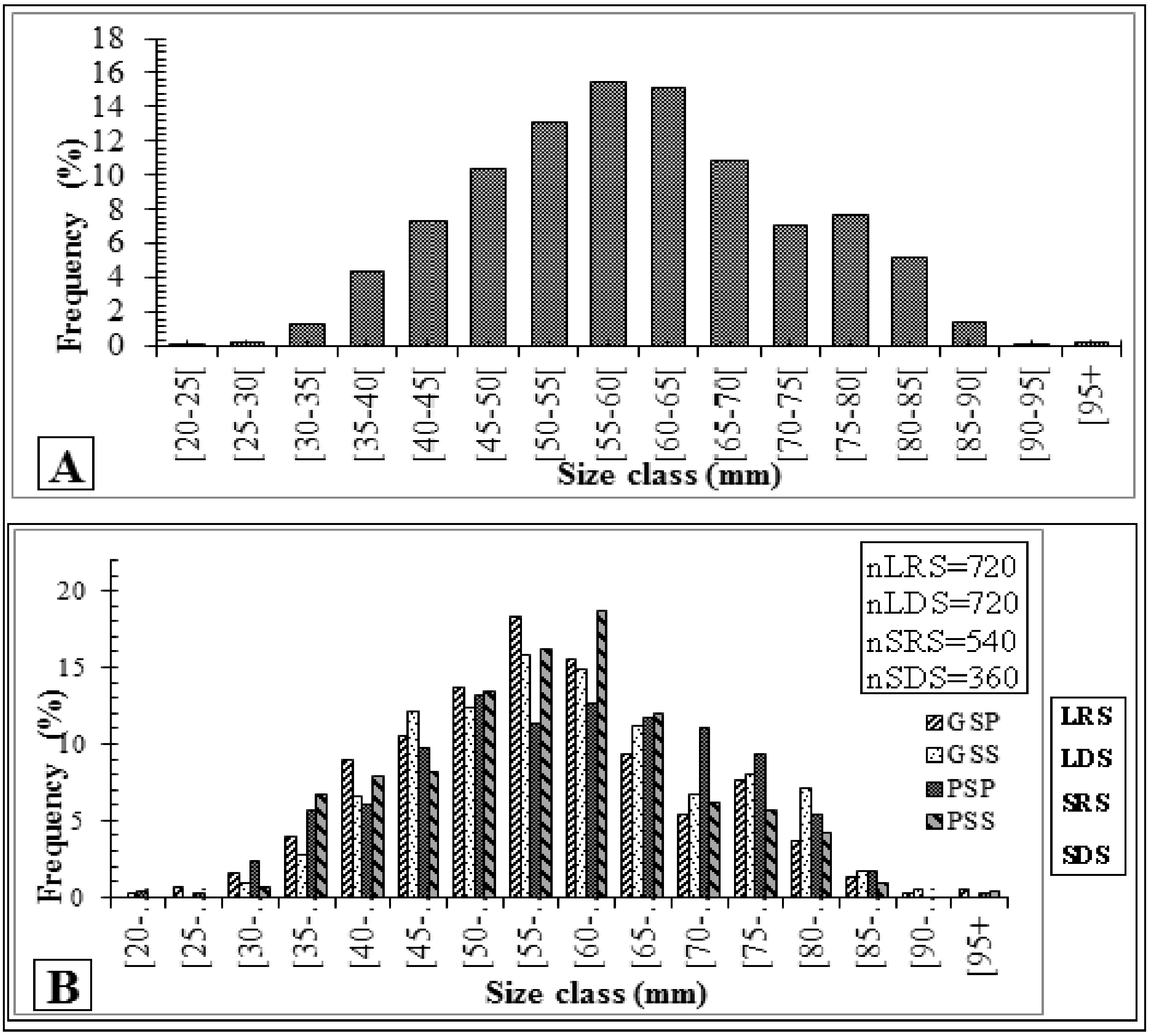

Fig. 1. Distribution of size frequencies of *Galatea paradoxa* from the lower Sanaga River: a) Population, b) Depending to the season. LRS: long rainy season, LDS: long dry season, SRS: short rainy season, SDS: short dry season.

These studies respectively estimate the parameters of Von Bertalanffy's equation: Asymptotic length = 93 mm and K = 0.36 years-1 (Moses, 1990) and Asymptotic length = 111 mm and K = 0.30 years-1 (King *et al.*, 1992) which are in accordance with those obtained in this study. These results are also close to those of Laudien (2002) in the bivalve *Donax serra* at the Benguela upwelling system with an asymptotic length (LJ of 82 mm and a growth constant (K) of 0.274 years-1 in both intertidal populations. However, all these results are different from those of Trisyani *et al.* (2016) in razor clams *Solen regularis* (L∞ = 8.0 cm and k = 0.7year-1).

The results of this study showed positive allometry between thickness and length and isometrics between width and length. These results are contrary to those of Benchikh (2009) for *Perna perna* mussels in the Gulf of Annaba and the coast of El Kala, which had obtained negative allometries showing that the length grows faster than the width and the thickness. Some authors (Grangnery, 2001) have shown that growth in length is related to variations in abiotic factors such as temperature, pelagic and benthic habitat and biotic factors such as age, sex, or the maturity stage of the gonads.

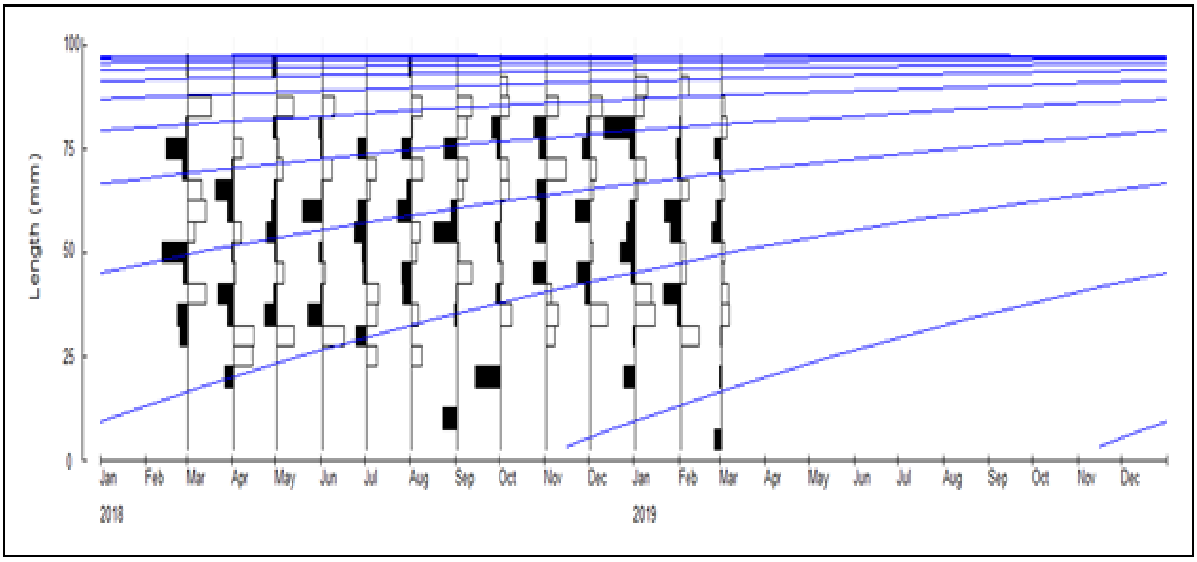

Fig. 2. Distribution of restructured length frequencies and growth curve in *Galatea* clams from the lower Sanaga River (data obtained for L∞= 97.82 mm and K=0.26 years-1).

However, negative allometries were observed during the long dry season and positive allometries during the short dry season and the long rainy season between width and length, thickness and length and between thickness and width. These results would be due to the fact that the short dry season and the long rainy season correspond to the reproduction period in clams. The period during which the shell is more voluminous because it contains energy reserves and contains eggs. The isometries between the weight of the shell and the weight of the flesh, irrespective of the season, would also be explained by this same phenomenon testifying that as the volume of the flesh increases, the shell also evolves in the same proportions.

The evaluation of the level of relationship between the total length and the total weight from the whole population and from the different seasons reveals the existence of negative allometry between these two parameters (b <3), testifying to the faster evolution of individuals in size of rather than weight. These results are similar to those obtained by Tekou (2017) in the Nkam River on the genus *Galatea* , by Obirikorang *et al.* (2013) between March and June for *Galatea paradoxa* in the Volta River in Ghana and Trisyani *et al.* (2016) for razor clams (*Solen regularis*) in Surabaya east coast of Indonesia. This result may be due to a reduction in the weight of the tissues resulting directly from the spawning process. According to Trisyani *et al.* (2016), this is related to the monthly fluctuations in the physiological state of the animal. It is generally accepted that growth is characterized by an increase in size and weight as a function of time and environmental variables. However, in bivalve mollusks, reproductive processes disrupt this pattern through the temporary accumulation of important reserves which are then converted to gametes and expulse during egg-laying leading to an abrupt weight loss (Deval, 2009;

Trisyani & Hadimarta, 2013). The length-weight development is influenced by several factors, such as food and environmental adaptation. Food supply in the sandy substrate in the intertidal area is relatively low and depends on the streams carrying planktons as clams are benthic organisms and suspension feeders (Trisyani *et al.*, 2016). In fisheries science, the condition factor is based on the hypothesis that heavier fish of a particular length is in a better physiological condition (Froese, 2006; Schwarz da Rocha *et al.*, 2015). The highest condition factor in this study was recorded in the light rainy season; this implies that *Galatea paradoxa* in the light rainy season was in better condition compared to individuals in the long dry season.

The high k during the light rainy season may be related to the larger food availability or to a higher feeding activity of *Galatea*. This could also be explained by environmental conditions which are unfavorable throughout the long dry season ((Chl a 0.3±0.2; temperature (30.9±1.9°C), salinity (0.01±0.00 ppm), TDS (20.2±2.8 ppm)) and start directly to improve in the light rainy season ((Chl a 0.8±0.9; temperature (31.0±1.9°C), salinity (0.02±0.00 ppm), TDS (20.5±3.0 ppm)). Then, environmental conditions in the high dry season turn out to be unfavorable and explain the drop in the condition factor. The study also showed a decrease throughout the heavy rainy season. This is due to the fact that in the reproductive cycle of this population, spawning takes place during the heavy rainy season and causes a reduction in the weight of the tissues. As in Fisheries science, it is well known that clam usually decreases their feeding activity and use their lipid reserves during spawning which results in a decrease in condition (Lizama and Ambrosio, 2002). According to Jurić *et al.* (2012), the condition factor in bivalves takes into account both environmental conditions (storage density, richness in phytoplancton, temperature and salinity), the physiological state and the growth of individuals. Similarly, Amedzro (2015), who studied the growth and management of *Galatea paradoxa* clam stock in the lower Volter River of Ghana, observed that the condition factor is influenced by growth and decreases with an increasing storage density of individuals.

Conclusion

The values of the biometric characteristics of the study population showed metric homogeneity and weight heterogeneity. Allometric models of clams were of the three types: negative, positive and isometric allometries. The length-weight relationship showed negative allometry regardless of the season observed. Condition factors were more than one showing an overall state of well-being of the study population. With the negative allometric growth during the spawning season, it will be important to institute a close season during the spawning period to enhance the recruitment of *Galatea paradoxa* stock. These findings will be resourceful for better management of this increasing exploited clam species in Cameroon and Africa at large. However, studies on the evaluation of the effect of age and sex on biometric characteristics would complete this study.

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