STUDY OF THE RELATIVE GROWTH OF BIVALVE *CARDIUM COSTATUM* (LINNÉ, 1758) OF THE EXCLUSIVE ECONOMIC ZONE OF CÔTE D'IVOIRE

ABSTRACT

This study was to determine growth parameters in order to provide important data for better planning of the sustainable management of maritime resources and initiate shellfish farming.
A total of 400 individuals from the exclusive economic zone of Côte d'Ivoire were sampled monthly from November 2012 to October 2014. The measurements were carried out in order to study the allometric relationships concerning the height-length, height-thickness relationships, thickness-length, mass-length, mass-height, mass-thickness. The results reveal that linear growth exhibits negative allometry (b < 1) in *Cardium costatum*. This species grows faster in length than in height and thickness. The weight growth of *Cardium costatum* presents a positive allometry (b > 3). Which means that this species grows faster than it lengthens.

Key words: Bivalve, morphometric parameters, allometry, growth

1. Introduction

Bivalve molluscs play an important ecological role in the ecosystem by stabilizing the seabed by the formation of clumped shell beds that protect loose sediments against erosion [1] and by increasing benthic biodiversity [2]. In Côte d'Ivoire, the *Cardium costatum* species is the most frequent species (65.1%) in the landing at the fishing port of Abidjan. It is the most abundant species (73.37%, 48.63%, 66.49%, and 48.34% respectively the small hot and cold seasons, the great hot and cold seasons) in all the landings [3]. It is present all year round in large quantities and also has the largest shell dimensions. This presence in the catches in quantity makes it a potentially economical species and a significant source of animal protein for the populations. The fishing of this species is poorly known, and even absent from the reports of the Department of Fisheries and Aquaculture. The absence of management measures could therefore inevitably lead to an often irreversible degradation of the ecosystems involved in the event of intense exploitation of the natural stock. Certain biological parameters, in particular growth, are necessary for a better knowledge of stocks. This work provides information on the linear growth and the weight growth of *C. costatum* in order to make available to decision-makers, data likely to help in the development of an optimal and sustainable management policy of the stock.

2. MATERIAL AND METHOD

2.1. Determination of the physical characteristics of Cardium costatum landed at the fishing port of Abidjan

Fishing takes place in the coastline of Côte d'Ivoire, also known as the exclusive economic

zone (EEZ). This fishing area (Fig. 1), 550 km long, is located between 8 ° and 3 ° west longitude. It starts from Cap “des Palmes” (8 ° W) in the West to Cap “des Trois Pointes” (2 ° 30 W) in the East. The continental shelf is narrow and the slope is steep. It is characterized by a series of sandy and rocky areas. The seawater of the exclusive economic zone of Côte d'Ivoire has four marine seasons. The small cold season occurs during the months of January to February. The great cold season, for its part, takes place from July to October. The short hot season sets in from November to December and the great hot season from March to June [4]. A monthly sampling from the landings of the commercial trawl fishery of the fishing port of Abidjan was carried out from November 2012 to October 2014. The individuals landed are transported under ice from the fishing port to the laboratory, where the measurements are carried out. The various metric parameters recorded were measured using an electronic caliper at 1 mm. The weighings were carried out using a precision balance 0.01 g. For each individual studied, the following parameters were measured (Fig. 2).

- Total length (L): It corresponds to the greatest distance separating the anterior edge from the posterior edge of the shell;
- Height (H): It is the distance which goes from the dorsal hinge to the ventral edge. As for the total length;
- Thickness (E): It is the maximum distance of the convexity of the two united valves.

Tableau 1 : Paramètres de la relation longueur-poids des espèces de mérou pêchées sur le littoral ivoirien (traitement des données avec le logiciel Statistica 7.1).

espèce	a	b	R^2	r	p	N	équations
E. aeneus	0,02	2,92	0,7990	0,89	P < 0,05	3279	$P_t = 0,02xL_t^{2,92}$
E. caninus	0,03	2,83	0,8107	0,90	P < 0,05	1333	$P_t = 0,03xL_t^{2,83}$
E. guaza	0,03	2,81	0,7551	0,87	P < 0,05	1145	$P_t = 0,03xL_t^{2,81}$
E. marginatus	0,02	2,92	0,6684	0,82	P < 0,05	685	$P_t = 0,02xL_t^{2,92}$
E. alexandrinus	0,02	2,88	0,8135	0,90	P < 0,05	176	$P_t = 0,02xL_t^{2,88}$
E. taeniops	0,01	3,11	0,5362	0,73	P < 0,05	116	$P_t = 0,01xL_t^{3,11}$

P_t = poids total du poisson en (g), L_t = longueur totale du poisson en cm, L_f = longueur à la fourche,
a = constante qui est l'ordonnée à l'origine, b = coefficient d'allometrie caractéristique de chaque espèce,
r = coefficient corrélation, p = probabilité de lien, N = nombre d'individus.

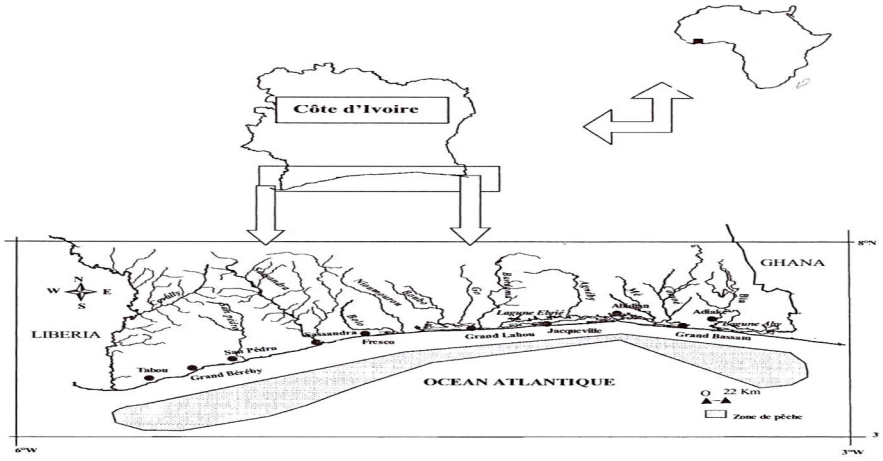


Figure 1 : Zone de pêche des mérous (*Epinephelidae*) sur le littoral ivoirien avec Abidjan le principal lieu de débarquement.

Fig. 1: *Fishing zone for bivalve molluscs* [5]

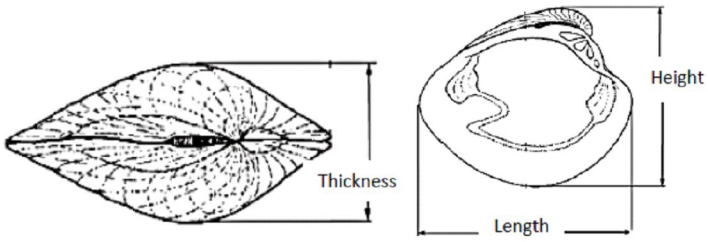


Fig. 2: *Different measurements of C. costatum*

2.2. Expression of results and analysis of statistical data

The measurements obtained made it possible to study the overall allometric relationships linking the various linear and weight parameters. The allometric relationships retained in this study concern the height-length, height-thickness, thickness-length, mass-length, mass-height, mass-thickness relationships. The relations were expressed by a power function of the form:

$Y = aX^b$ (1) [6]
With: Y: dependent variable, dimension or mass of the studied body.
X: independent variable, it represents the reference length.
a: constant.
b: allometric coefficient.
After a logarithmic transformation, equation (1) is written:
Ln y = Ln a + b Ln x (2)

In order to determine the nature of allometry, we compared the observed value of the slope (b) with the theoretical value 1 (if it is allometric relations linking two linear parameters), or 3 (if it is is a linear measure and a weight measure).
When using linear animal measurements, three cases may arise:
If b = 1: the growth is isometric
If b <1: the growth is a lower bound
If b>1: growth is major.

Regarding the relative growth of mass over a measure of length, it has been shown that mass generally increases in proportion to the cube of length. For the weight relationship, three cases can arise:
If b = 3: the growth is isometric
If b<3: the growth is lower.
If b>3: growth is major.

The correlation coefficient (r) is determined from the square root of the coefficient of determination (R^2). It made it possible to measure the intensity of the linear relationship that exists between two biometric variables.

The statistical significance of the coefficient of determination (R^2) was estimated and the student's t-test was used to check whether the values of b were significantly different from the isometric value b = 3 at the 5% threshold.

3. RESULTS AND DISCUSSION

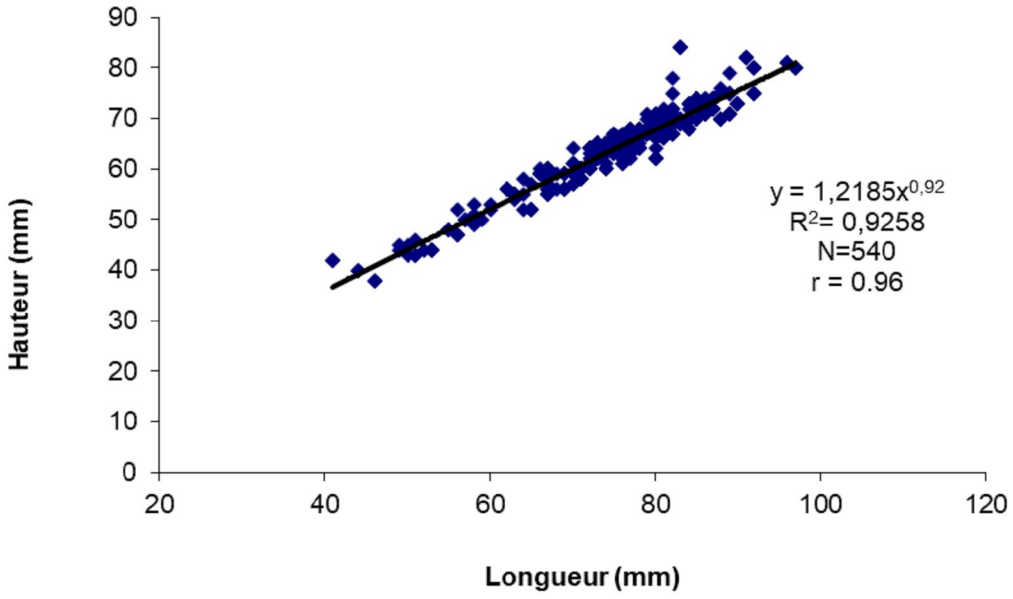
3.1. Height-length relationship, Height-thickness relationship and Thickness-length relationship

As part of the study of the height-length relationship, the fit line obtained from the logarithmic coordinates is shown in Figure 3. The correlation coefficient (r = 0.95) between height and length is very high. The allometric coefficient (b = 0.91) is less than 1 (Student's t-test: p = 0.02). *Cardium costatum* therefore has a proportionately greater growth in length than in height.

Concerning the height-thickness relationship, the adjustment line obtained from the logarithmic coordinates is presented in Figure. 4. The allometric coefficient 0.87 is statistically less than 1 (Student's t-test: p = 0.01). Growth in thickness is proportionately faster than that in height. The value of the correlation (r) is 0.95.

Regarding the thickness-length relationship, the fit line obtained from the logarithmic coordinates is shown in Figure 5. The allometric coefficient 0.98 is statistically less than 1 (Student's t-test: p = 0.02). The increase in length is proportionally faster than that of the thickness. The correlation value is 0.94.

The height-length, height-thickness, thickness-length pairs show that the linear growth presents a lowering allometry (b <1) in *Cardium costatum*. This species grows faster in length than in height and thickness. The growth in length could be explained by the fact that the length (the greatest distance separating the anterior edge from the posterior edge of the shell) represents the zone of dehiscence. The Bivalve will therefore tend to lengthen the opening area in order to feed, breathe and emit its gametes to the outside.


Hauteur (mm)
Longueur (mm)
y = 1,2185x^0,92
R2= 0,9258
N=540
r = 0.96
0
10
20
30
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120

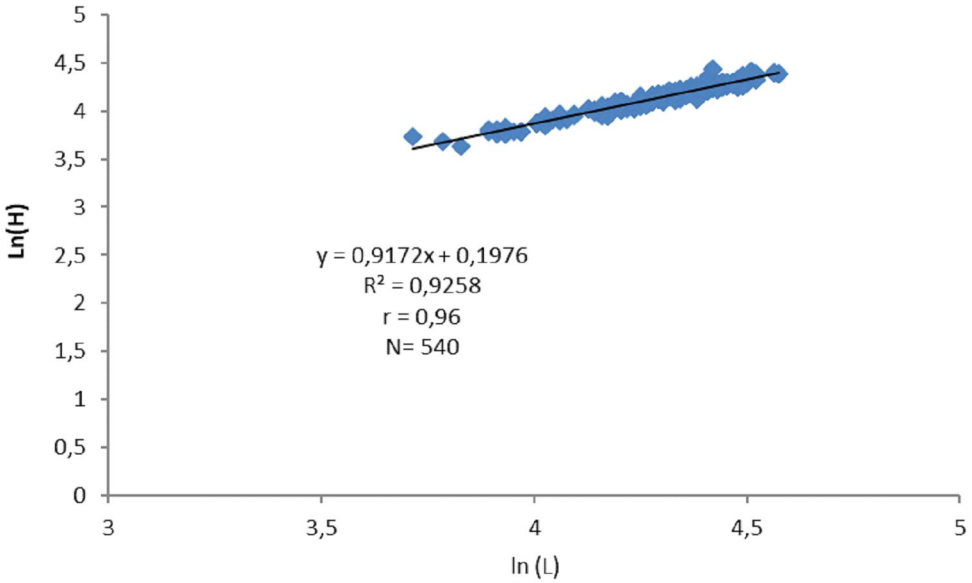

Fig. 3: Height-length relationship in Cardium costatum

a- Power trend curve; **b**- Linear trend curve; R^2: Regression; N: number of individuals; L: length; H: height

Fig 4: Height-thickness relationship in Cardium costatum caught in the exclusive economic zone of Côte d'Ivoire.

a- *Power trend curve;* ***b****- Linear trend curve;* R^2*: Regression; N: number of individuals; E: thickness*

Fig.5: Thickness-length in Cardium costatum caught in the exclusive economic zone of Côte d'Ivoire.

a- *Power trend curve;* ***b****- linear trend curve.* R^2*: Regression; N: number of individuals*

3.2. Mass-length relationship, Mass-height relation, Mass thickness relationship

As part of the study of the mass-length relationship, the adjustment line obtained from the logarithmic coordinates is presented in Figure 6. The allometric coefficient 3.19 is statistically greater than 3 (Student's t-test: p = 0.00). The increase in mass is

proportionally faster than that of the length. The correlation value is 0.83.

Regarding the mass-height relationship, the adjustment line obtained from the logarithmic coordinates is presented in Figure 7. The allometric coefficient 3.13 is statistically greater than 3 (Student's t-test: p = 0.01). The increase in mass is proportionally faster than that of height. The correlation value is 0.82.

Concerning the mass-thickness relationship, the adjustment line obtained from the logarithmic coordinates is presented in Figure 8. The allometric coefficient 3.32 is statistically greater than 3 (Student's t-test: p = 0.02). The increase in mass is proportionally faster than that of the thickness. The correlation value is 0.85.

The mass-length, mass-height and mass-thickness pairs show that the weight growth of *C. costatum* is allometric major (b> 3). Which means that this species grows faster than it elongates. This could be explained by the fact that it has access to the calcium necessary for the constitution and solidification of these shells **[7]**. This calcium could be obtained through food or through absorbed marine sediments. This result does not agree with those of certain authors who have studied the growth of mussels and oysters in farming **[8]**, of mussels in the Gulf of Annaba **[9, 10]**, and the *Cerastoderma glaucum* shell **[11]**. According to these authors, the evaluation of the intensity of the bond between the total length and the total mass reveals a negative allometry between these two parameters (b <3). This difference in idea could be explained by the difference in the biotope of burrowing and fixed molluscs. Mussels and oysters attach themselves to a substrate during their development. They will therefore not be able to take advantage of the calcium contained in the sediments, unlike the family of cardiids which live in the sediments. This difference in idea could be explained by the difference in the biotope of burrowing and fixed molluscs. Mussels and oysters attach themselves to a substrate during their development. They will therefore not be able to take advantage of the calcium contained in the sediments, unlike the family of cardiids which live in the sediments. This difference in idea could be explained by the difference in the biotope of burrowing and fixed molluscs. Mussels and oysters attach themselves to a substrate during their development. They will therefore not be able to take advantage of the calcium contained in the sediments, unlike the family of cardiids which live in the sediments.

Also, there are strong correlations between the different couples with regard to the high values of the correlation coefficient r. For all the graphical representations, the experimental points are ordered around the theoretical curve as demonstrated by the values of the correlation coefficients which are all high. This result means that the elongation of the shells and the enlargement of *Cardium costatum* are closely related and occur in the same direction.

Fig. 6: Mass-length relationship in Cardium costatum

- *Power trend curve; **b**- Linear trend curve. R^2: Regression; N: number of individuals; P:mass*

Fig. 7: Mass-height relationship in Cardium costatum caught.

a- Power trend curve; **b**- Linear trend curve**;** R^2: Regression; N: number of individuals.

Fig. 8: Mass-thickness relationship in Cardium costatum caught in the exclusive economic zone of Côte d'Ivoire.

a- Power trend curve; **b**- linear trend curve; R^2: Regression; N: number of individuals.

4. CONCLUSION

The species *Cardium costatum* of the Exclusive Economic Zone of Côte D'Ivoire grows faster in length than in height and thickness, and it grows faster than it elongates.

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