

Morphometric Relationships and Condition Factor of *Senilia senilis* (Linnaeus, 1758) from the Senegal River Delta, Senegal

Mamadou Lamine Diop¹, Alioune Faye^{2*}, Jeanne Elisabeth Diouf³, Malick Diouf³

¹Department of Fisheries Protection and Monitoring, Ministry of Fisheries, Maritime and Port Infrastructure, Dakar, Senegal

²Institute of Environmental Sciences, Faculty of Science and Technology, Cheikh Anta Diop University of Dakar, Dakar, Senegal

³Department of Animal Biology, Faculty of Science and Technology, Cheikh Anta Diop University of Dakar, Dakar, Senegal

Email: mamadouldiop@yahoo.fr, *alioune5.faye@ucad.edu.sn, malicknem@gmail.com, jeannethiabou@gmail.com

How to cite this paper: Diop, M.L., Faye, A., Diouf, J.E. and Diouf, M. (2025) Morphometric Relationships and Condition Factor of *Senilia senilis* (Linnaeus, 1758) from the Senegal River Delta, Senegal. *Open Journal of Applied Sciences*, 15, 3319-3328. <https://doi.org/10.4236/ojapps.2025.1510213>

Received: August 26, 2025

Accepted: October 25, 2025

Published: October 28, 2025

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Abstract

The aim of this study was to provide information on length frequency distribution, size-weight relationship and condition factor parameters of *Senilia senilis* exploited in Gandiol in the Senegal River Delta. The study was conducted from July 2017 to June 2018. Data collection was carried out using quadrats and a dredge. The length frequency distribution was multimodal and highlighted three distinct size groups ranging from 5.27 to 20 mm, 21 - 50 mm and 51 - 80 mm, respectively. The length-weight relationship showed a negative allometric growth with $b = 2.7728$. The highest value of the condition factor was obtained during the cold season ($K = 0.085 \pm 0.009$) while the lowest value was recorded in the warm season ($k = 0.072 \pm 0.007$). Knowledge of the morphometric relationship and condition factor of *S. senilis* are an important tool for managing its stock.

Keywords

Senilia senilis, Gandiol, Condition Factor, allometry, Senegal River Delta

1. Introduction

Senilia senilis is a taxodont lamellibranch mollusc living in lagoon or estuarine biotopes of the West African coast, from Western Sahara to Angola [1]. It is therefore a well-known species among West African coastal populations and is one of the most studied bivalve molluscs [2].

In Senegal, *S. senilis* is one of the most exploited bivalve molluscs. The existence of shell middens where *S. senilis* constitutes the dominant species, or even often

the only species present, attests to the very ancient exploitation of this species in Senegal. Recently, the opening of the breach at the Langue de Barbarie in Gandiol, to avoid the flooding of the city of Saint-Louis, disrupted several socio-economic activities such as fishing, tourism, flood recession crops, market gardening [3] [4]. The ecological disturbances caused by the development of the breach had the positive consequences of the appearance of certain species of bivalve molluscs such as *S. senilis*. The existence of ancient shells of this species in the area shows that it was present there in the past. Therefore, the opening of a breach could be the cause of the replenishment of the stock of this species in the area. The exploitation of this mollusc has become an income-generating activity in Gandiolais [5]. This is why the present work focuses on some morphometric aspects of this species with a view to its sustainable management in this part of Senegal.

2. Material and Methods

2.1. Study Area

The study was carried out in Gandiol, which straddles the Niayes of Senegal's northern coastline and the Senegal River delta [6]. The area lies downstream of the Diama dam, south of the city of Saint-Louis. Located at 16°15' north latitude and 16°25' west longitude, Gandiol borders the commune of Saint-Louis to the east, the commune of Fass Ngom, National Road 2 and the Toube area, and to the south, the rural commune of Léona in the department of Louga (Figure 1). It lies between the Senegal River and the Atlantic Ocean to the west, covering an area of around 360 km² [5].

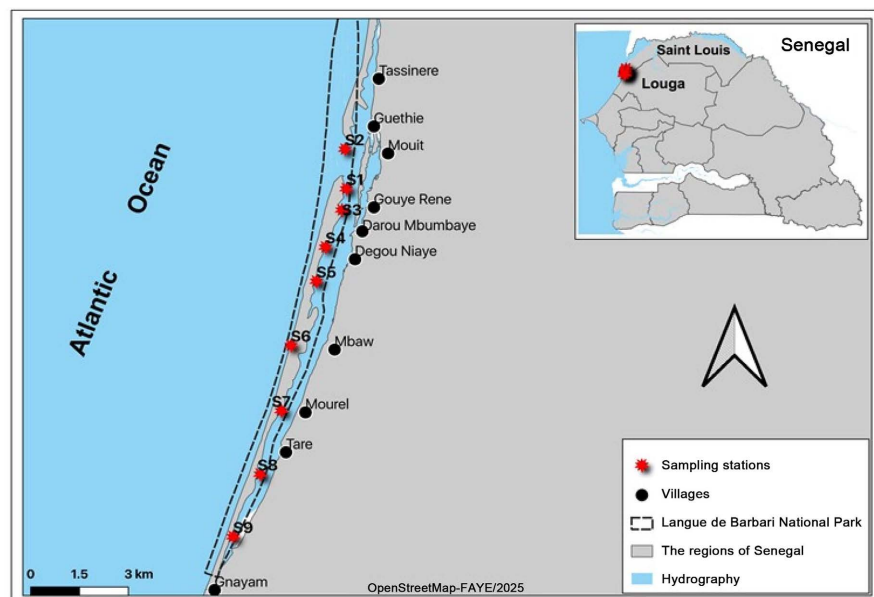


Figure 1. Location of sampling stations.

2.2. Sampling Strategy

Sampling was conducted monthly from July 2017 to June 2018. A total of 9 sam-

pling stations were selected (**Figure 1**). In order to ensure a comprehensive sample, two sampling methods were used: the transect method and the dredging method. In the subtidal zone, the transect technique was used, while in the subtidal zone, the dredging method was applied. For the first technique, quadrats of 25 cm on each side, spaced 5 m apart, were placed perpendicular to the bank to a depth of approximately 70 cm. The number of quadrats varied between 2 and 5 depending on the width of the bank. For the second technique, a cylindrical-conical dredge was used in the deep areas (in the middle of the river bed). This dredge, with an opening diameter of 5 cm and equipped with a metal bar, is wrapped in a net with a mesh size of 1 cm. Once at the bottom, the dredge was towed by a strong rope attached to a canoe and collected the fauna that accumulated at the bottom of the net. The dredge was towed using a canoe, with a turn every 5 minutes to collect the *S. senilis* individuals collected.

The individuals from each surface unit explored by both the dredge and the quadrats were collected and placed in numbered bags. For data processing in this study, individuals collected using both methods were combined. Indeed, combining data obtained from both methods hardly constitutes a bias, since the study of morphometric relationships only uses individual lengths and weights. In the laboratory, the *S. senilis* individuals were measured and weighed respectively using a caliper and an electronic scale with a precision of 0.01 g. For each individual, the length, height and bulge were measured and the animal weight with its shell was weighed.

2.3. Morphometric Parameters

2.3.1. Length Frequency Distribution

Size spectra are established from the total length of the sampled individuals. The study of the length frequency distribution provides an image of the exploited populations and the level of their recruitment, which can provide some information about the state of the exploited stocks [7] [8]. The frequencies were established with a length interval of 1 cm. The formula used to calculate length frequencies is as follows:

$$F_i = (100 \times n_i) / N \quad (1)$$

where F_i = frequency, N_i = number of specimens for a given Length, N = total number of *S. senilis* specimens

2.3.2. Length-Weight Relationship

The relationship between the total length and weight of *S. senilis* individuals is generally exponential. It is represented by the following relationship [9]:

$$W = a \times L^b \quad (2)$$

where W = total weight (g); L = total length of the fish (mm); a = exponent describing the rate of change of weight with length; b = slope of the regression line (also referred to as the allometric coefficient). The allometric coefficient b (slope of the regression line) varies between 2 and 4, but is often close to 3.

This coefficient (b) expresses the relative body shape of the species. When it is equal to 3, the growth of individuals of the species is said to be isometric. When it is less than or greater than 3, growth is said to be allometric.

If $b > 3$, allometry is positive, individuals gain weight faster than they grow in length; if $b < 3$, allometry is negative, individuals grow faster than they grow in length.

2.3.3. Condition Factor (K)

Condition factor provides information on the physical condition of a species [10]. It is a tool often used to compare the overall physiological state of populations over a seasonal cycle or between basins with similar or different ecological conditions [11] [12]. Largely influenced by environmental parameters (biotic and abiotic), the condition factor can be used as an index to assess the level of disturbance in an aquatic ecosystem [13] [14].

The condition factor is obtained using the following formula:

$$K = (100 \times W) / L^3 \quad (3)$$

where K = condition factor; W = total weight (g), L = total length (mm).

2.4. Data Analysis and Processing

Statistical and graphical processing was carried out using Microsoft Office Excel 2010 and R software. Student's t-test was used to verify the significance of the results at the significance level $\alpha = 0.05$.

3. Results

3.1. Length Frequency Distribution

In the present study, the size frequency distribution was established in **Figure 2**. The length of the individuals varied between 1 mm and 82.17 mm with an average length of 24.27 ± 12.65 . The length frequency distribution of *S. senilis* was of a multimodal type with the appearance of three distinct groups. The first group was composed of individuals with a length between 5.27 and 20 mm. The individuals of the second group and third group had length between 21 - 50 mm and 51 - 80 mm respectively (**Figure 2**).

3.2. Length-Weight Relationship

The length-weight relationship of *S. senilis* was established in **Figure 3** and the parameters of this relationship were recorded in **Table 1**. The estimated value of the allometric rate ($b = 2.7728$) is significantly different from 3 ($p < 0.05$), thus illustrating a negative allometric growth for *A. senilis*.

3.3. Condition Factor

The monthly evolution of the condition factor of *S. senilis* was relatively variable (**Figure 4**). The overall average value of the condition factor was equal to $0.080 \pm$

0.008. The highest value was recorded during May ($Kc = 0.101 \pm 0.073$) while the lowest value of Kc is obtained in August ($Kc = 0.058 \pm 0.025$). Overall, the condition factor was higher in the cold season than in the warm season with values respectively equal to 0.085 ± 0.009 and 0.072 ± 0.007 with a non-significant difference ($p < 0.05$).

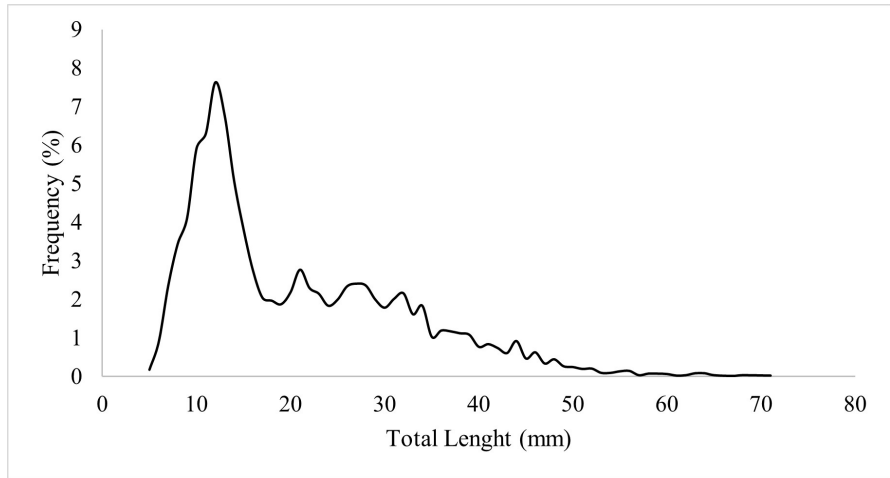


Figure 2. Length frequency distribution of *S. senilis* in the Senegal Delta River.

Table 1. Parameters of the length-weight relationship of *S. senilis* in the Senegal Delta River (N = Number of individuals, a = Exponent describing the rate of change of weight with length, b = slope of the regression line; r^2 = correlation coefficient; A- = negative allometric).

N	Parameters			Equation	Type of growth
	a	b	r^2		
9939	0.0014	2.7728	0.9274	$W = 0.0014 \times L^{2.7728}$	A-

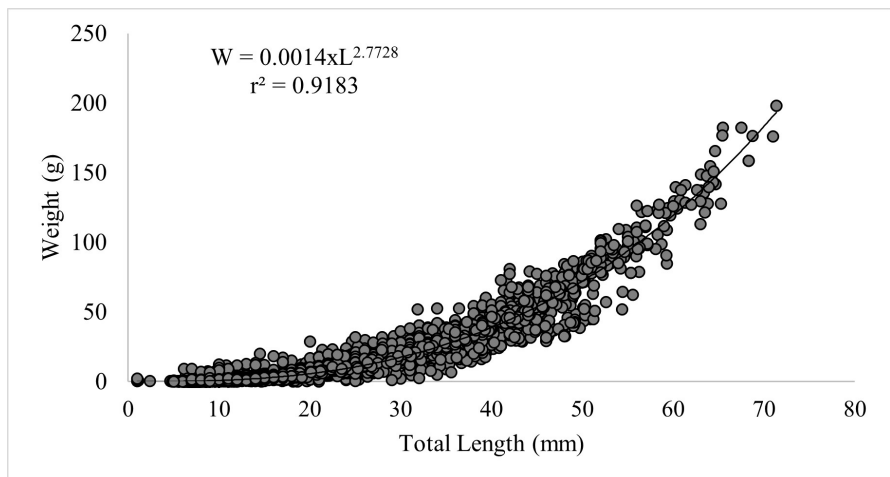


Figure 3. Length-weight relationship of *S. senilis* in the Senegal Delta River.

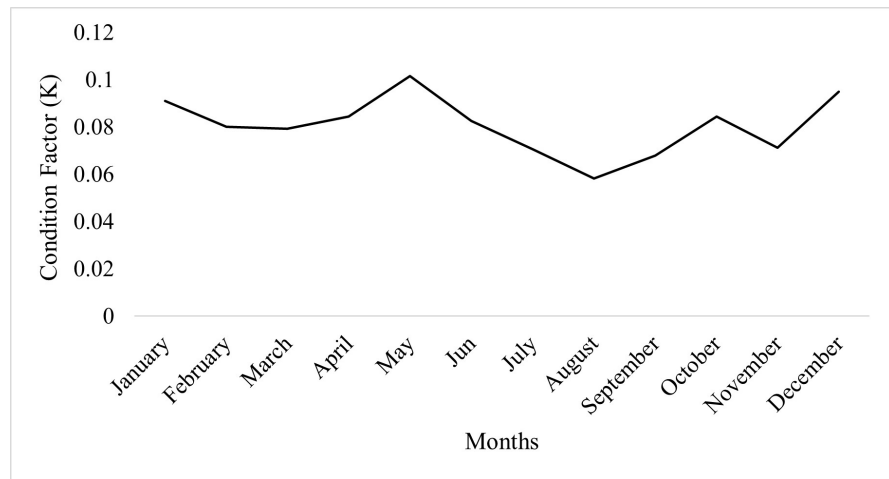


Figure 4. Condition factor of *S. senilis* in the Senegal Delta River.

4. Discussion

The length frequency distribution of *S. Senilis* is multimodal with the appearance of three distinct groups (5.27 and 20 mm, 21 - 50 mm and 51 - 80 mm). These results are different from those obtained by [15] in the Niger Delta where four groups were highlighted with respectively a group 1 (1.0 to 3.00 cm), a group 2 (3.01 to 5.00 cm), a group 3 (5.01 to 7.00 cm) and group 4 (7 to 9.00 cm). [16] in Nigeria reported for the same species a range between 22 and 93 mm.

The allometric coefficient of the length-weight relationship calculated for all *S. senilis* individuals grouped together was equal to 2.7728. This result was consistent with that of [17] in Nigeria and close to that of [18] in Mauritania. However, it differed slightly from those of [19] and [20] respectively in Senegal and Ghana where allometric growth was relatively slower (Table 2). These differences in weight growth could be related to differences in environmental parameters of the sampling areas, such as salinity. Indeed, salinity is one of the most important physical parameters affecting the physiological responses and survival of aquatic organisms [21] [22]. In cases of extreme salinity, bivalve molluscs close their shells when salinity drops too low or rises too high [23]. This could explain the relatively low allometric growth for the results of [19] and [20], whose studies were carried out in the Saloum Delta (Senegal) and Benya Lagoon (Ghana). In these ecosystems, salinity is relatively high and can reach 40 psu in Benya Lagoon [24], and more than 100 psu in certain places in the Saloum Delta [25]. On the other hand, in the Banc d'Arguin, salinity is around in the 35.2 - 36.2 psu [26].

The monthly values of the condition factor ranged from 0.101 ± 0.073 to 0.080 ± 0.025 with a mean of 0.080 ± 0.008 . All the condition factor values were less than 1. This would have suggested that the *S. senilis* individuals were not in good growth condition [27]. Indeed, the condition factor is a constant that can provide an indication of the “well-being” of a given species, so it can be considered as an indicator of the abundance of food for the given species in a given area or period [28]. The decrease in condition factor in the warm season could be attributed to

Table 2. Length-weight relationship parameters of *S. senilis* from different regions.

Country	Study area	Parameters			Authors
		a	b	r ²	
Senegal	Senegal Delta River	0.0014	2.7728	0.9183	Present study
Senegal	Saloum Delta (constantly submerged area)	0.000	2.580	0.950	[19]
Senegal	Saloum Delta intermittently submerged area	0.0005	2.530	0.956	[19]
Ghana	Benya Lagon	0.0018	2.550	0.940	[20]
Nigeria	Niger Delta	0.0005	2.942	0.997	[17]
Mauritania	Banc d'Arguin	0.24 × 10 ⁻⁴	2.686	-	[18]

a decrease in food or to the reproduction of the species. Indeed, [29] explained that condition factors can vary depending on the abundance of food and the average reproductive stage of the stock. Previous studies have shown that the reproduction of *S. senilis* occurs in October and November [30]. Studies on other species of the genus *Anadara* such as *A. subcrenata*, *A. bringoni* and *A. ursi* in subtropical regions have shown that spawning occurs from June to September [31]-[38]. This drop in the condition factor during the warm season suggests that the *Anadara* genus uses its energy reserves contained in its muscles and intestines to ensure its reproduction. However, in the present study, the identification of sexual maturity stages was not done. Thus, the explanation of the decrease in condition factor due to reproduction is based on existing literature.

5. Conclusion

In conclusion, this study provides the first basic information on the morphometric aspects of *S. senilis*, which recently appeared in Gandiol. Knowledge of the length-weight relationship and the condition factor constitute important basic information for the management of *S. senilis* in this northern part of Senegal. Given the rate at which the species is currently exploited by local populations, it would be better to take urgent measures towards a sustainable exploitation of this species.

Acknowledgements

The authors thank the riverside populations and all those who helped with data collection.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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