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# Identification of *Octopus Vulgaris* on the Algerian West Coast

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## Abstract

*Octopus vulgaris*, often called the common octopus, represents a cephalopod of the order of octopods; it's genuinely appreciated by humans and has long been a part of the coastal population's diet. Besides, it plays an interesting economic role in the area. Therefore, it seems essential to identify its populations and preserve this marine biological heritage. The objective of our study is the identification and morphometric characterization of the common octopus on the west Algerian coast, precisely in the region of Ghazaouet, Beni Saf, Oran and Arzew on 50 individuals. Seven morphological characteristics were measured using a tape, according to the proposed protocol by Roper and Voss (1983). To highlight the diverse and similar points of the sampled individuals, the study relied on the statistical analysis of the values of the measurements of the morphometric characters. It has revealed a significant variation in the morphometric characteristics of the octopus vulgaris on the west coast of Algeria and has supplied us with more information about the biological diversity of our country. It is therefore significant to adopt appropriate strategies to conserve and support this diversity.

**Keywords:** Algeria - Octopus vulgaris -Diversity- Morphometric measurements.

**الملخص**

الأخطبوط الشائع يمثل رأسيات الأرجل من رتبة الأخطبوط، إنه محل تقدير حقيقي من قبل البشر وكان منذ فترة طويلة جزءا من النظام الغذائي لسكان الساحل وله دور اقتصادي مثير للاهتمام في المنطقة. لذلك، يبدو من الضروري التعريف على هذا النوع من الحيوانات البحرية والحفاظ على الموروث البيولوجي البحري والحفاظ على هذا التراث البيولوجي البحري. الهدف من دراستنا هو تحديد وتوصيف مورفوميتريك الأخطبوط المشترك على الساحل الجزائري الغربي، وتحديدا في منطقة الغزوات وبني ساف ووهران وأرزيو على 50 فرد. تم قياس سبع خصائص مورفولوجية باستخدام شريط، وفقا للبروتوكول المقترح من قبل روبروفوس (1983). لتسليط الضوء على النقاط المتنوعة والمألوفة للأفراد الذين تم أخذ عينات منهم، اعتمدت الدراسة على التحليل الإحصائي لقيم قياسات الأحرف المورفومترية. لقد كشفت عن تباين كبير في الشخصيات المورفومترية للأخطبوط الشائع في الساحل الغربي للجزائر وزودتنا بمزيد من المعلومات حول التنوع البيولوجي لبلدنا. ولذلك، من المهم اعتماد استراتيجيات مناسبة للحفاظ على هذا التنوع ودعمه.

**الكلمات المفتاحية:** الجزائر - الأخطبوط الشائع - التنوع - القياسات المورفومترية.

## Introduction

The common octopus or *Octopus vulgaris* belongs to the class of cephalopods. They are the most evolved mollusks. They appeared in the oceans several hundred million years ago, in the Cambrian (-540 to -490 M years), well before the vertebrates. At that time, they had an external shell. They were probably the first animals of a certain size to swim in the oceans, and they enjoyed great freedom there for millions of years. Their situation began to deteriorate at the end of the Paleozoic (-250 M years) and even more so at the beginning of the Mesozoic (secondary era) when fish and later reptiles spread in the oceans. To survive, some cephalopods retreated to deeper waters, others became more mobile as their shell thickness reduced. At the approach of the Tertiary era (100 M years), it became internal or disappeared. Squid, cuttlefish, and octopus thus survived until today in coastal waters, dangerous but rich (Kluessendorf, J. and Doyle, P. 2000).

This species has long been considered abundant in Mediterranean, Atlantic, and Japanese waters (Mangold, 1983; 1998; Guerra, 1992); recently, its distribution has been expanded to include islands in the central Indian Ocean (Guerra et *al*., 2010). The fishing activity of the common

octopus constitutes a major economic resource for most countries (Faure, 2002). Among these countries, there is Algeria where octopus fishing is present along the entire Algerian coast (1622 km) but where most of the landings come from the western coastal fishery (signs of overfishing of octopus).

In Algeria, we did not know the variability and genetic structure of this species as well as the geographical limits of the currently exploited stock. The inventory, morphometric analyses, and population genetics can therefore provide clear and basic information for better management and exploitation of this resource in our country (Gaouar, 2009). Thus, in order to ensure sustainable and credible management of this marine resource, we had to consider a genetic approach (through the inventory and morphometric tool) to verify if the local Algerian stock of common octopus belongs to one or several populations.

## Materials and Methods

The collection of samples was made in the maritime ports using fishing equipment and accompanied by the fishermen. Our study is concentrated on four main geographical points namely the city of Ghazaouet; whose coordinates are 35° 05′ 38″N, 1° 51′ 37″W, the city of Beni Saf; whose coordinates are 35° 18′ 08″N, 1° 23′ 01″W, the city of Oran; whose coordinates are 35° 42′ 10″N, 0° 38′ 57″W, and the city of Arzew; whose coordinates are 35° 52′N, 0° 19′W. The collection of samples started in February / March 2020 on 18 individuals in Ghazaouet and 9 individuals in Beni Saf and in April 2021 on 14 individuals in Oran and 9 individuals collected in the city of Arzew (n=50).

Our sampling work consists of taking measurements of the various body parts of the fish specimen by referring to the work of Roper and Voss (1983). The measurements were made with a tape measure. The measured characters are the length of the tentacles (T) in (cm), the length of the mental (M) in (cm), the length of the siphon (S) in (cm), the complete length of the specimen (Height) in (m), the diameter of the suckers (DS) in (cm), the distance between the two eyes (ED) in (cm). Finally, each individual is weighed with an electronic scale, the weight is registered (weight) in Kilograms (Kg). In total, for each animal 7 quantitative characters were taken into consideration for our study.

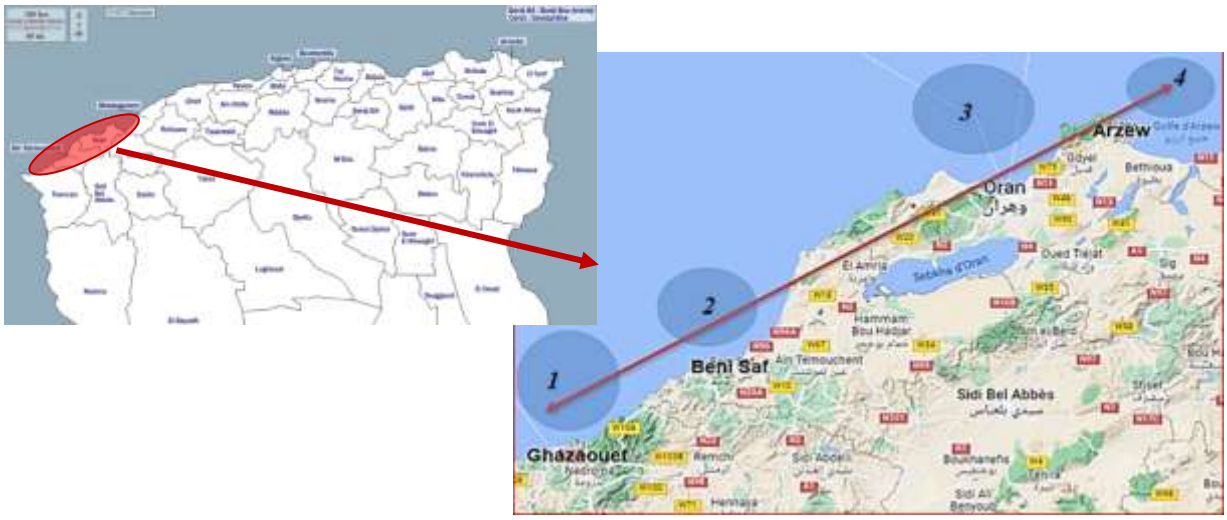


**Figure 1.** Map showing the location of the study areas. (GoogleMap.com)

## Results

### *Descriptive Analyses*

Before starting the descriptive statistics, it is necessary to test the normality of the distributions of each variable. This will help us to have a precise idea about the type of statistical tests (parametric or non-parametric) used for the analysis of the data. The normality of the distributions is analyzed by the Shapiro-Wilk test.

The alpha risk of the Shapiro-Wilk test is $\alpha = 0.05\%$.

The result of the Shapiro-Wilk test is reported in the following table 1.

**Table 1.** Shapiro-Wilk normality test.

| Data | P-value |
|---|---|
| T | 0,001 |
| M | 0,00005 |
| S | 0,488 |
| ED | 0,030 |
| DS | 0,014 |
| Height | 0,004 |
| Weight | 0,001 |

*T: Tentacles. M: Mental. S: Siphon. ED: Eye Distance. DS: Diameter of the Suckers.*

From table 1, it can be concluded that the variables: tentacles, mental, distance of the eyes, diameter of the suckers, the size and the weight do not follow a normal distribution because of the difference between the value in measured characters of body parts, while the other variable the siphon tends towards normality.

In order to have a statistical description associated with each character, of the different sampled octopuses, we calculated the frequencies relative to the morphological characters which are: the average, the standard deviation, the minimum, and maximum values, the variance, and the standard error.

The total descriptive statistics of the body measurements are represented in table 2.

**Table 2.** Descriptive analysis of body measurements in the studied *Octopus vulgaris* population.

| | N | Minimum | Maximum | Moyenne | Std Error | SD | Variance |
|---|---|---|---|---|---|---|---|
| T | 50 | 26,0 | 98,0 | 60,03 | 3.372 | 23,843 | 568,488 |
| M | 50 | 8,0 | 22,0 | 12,52200 | 0,551631 | 3,900617 | 15,215 |
| S | 50 | 3,0 | 13,0 | 7,12200 | 0,298914 | 2,113638 | 4,467 |
| ED | 50 | 2,500 | 9,500 | 5,08800 | 0,230963 | 1,633156 | 2,667 |
| DS | 50 | 1,0 | 3,0 | 1,84900 | 0,072203 | 0,510551 | 0,261 |
| Height | 50 | 0,350 | 1,500 | 0,81166 | 0,043831 | 0,309930 | 0,096 |
| Weight | 50 | 0,153 | 3,300 | 1,48406 | 0,132786 | 0,938942 | 0,882 |

*T: Tentacles. M: Mental. S: Siphon. ED: Eye Distance. DS: Diameter of the Suckers.*

***ANOVA of the Study Population***

*1. Variation of Variables by Region*

The body measurements studied in the regions of the study population are presented in table 3. There is a significant difference in the studied traits between the populations of the studied regions ($p<0.05$).

**Table 3.** Variations in variables by region.

| Region | Ghazaouet | Beni Saf | Oran | Arzew | P |
|---|---|---|---|---|---|
| N | 18 | 9 | 14 | 9 | |
| T | 70,44±24,147 | 72,33±19,944 | 36,64±8,679 | 63,33±18,412 | 0,000031 |
| M | 14,588±4,123 | 13,888±4,128 | 9,214±0,847 | 12,166±2,799 | 0,00030 |
| S | 7,550±1,932 | 8,577±2,403 | 5,435±1,570 | 7,433±1,327 | 0,001 |
| ED | 5,122±1,500 | 6,288±1,990 | 3,914±1,050 | 5,644±1,187 | 0,002 |
| DS | 2,044±0,438 | 1,966±0,435 | 1,367±0,186 | 2,088±0,608 | 0,00012 |
| Height | 0,927±0,297 | 0,974±0,304 | 0,526±0,095 | 0,860±0,295 | 0,00017 |
| Weight | 1,958±0,883 | 1,994±0,660 | 0,517±0,158 | 1,528±0,910 | $3,882e^{-6}$ |

*T: Tentacles. M: Mental. S: Siphon. ED: Eye Distance. DS: Diameter of the Suckers.*

*1.1 Post-Hoc Test*

The Post-Hoc test or multiple comparisons test (Tukey) was used to determine significant differences between regions concerning morphometric parameters ($p<0.05$).

From this test it appears:

- There is a similarity between Ghazaouet and Beni Saf of more than 0.95 ($p\geq0.95$) for the

Tentacles, The mental, The Height, and the Weight. Also, there is a similarity between Ghazaouet and Arzew for the Siphon with p=0.99

- There is a resemblance between Ghazaouet and Arzew for the distance of the eyes with p=0.81 and the diameter of the Suckers with p=0.99.
- Individuals from the region of Oran have a smaller size than the others.

*2. Variation of Variables by Gender*

The measurements studied in the areas of the study population are presented in Table 4. It is concluded that the variables: siphon and eye distance were not significantly different for the studied characteristics between the populations of the study area (p>0.05), however, there were significant differences for the other variables.

**Table 4.** Variation of variables by sex.

| Sex | Male | Female | P |
|---|---|---|---|
| N | 36 | 14 | |
| T | 69,67±20,743 | 35,29±8,232 | $2,106e^{-6}$ |
| M | 13,886±3,784 | 9,014±0,613 | $6,794e^{-7}$ |
| S | 8,008±1,720 | 4,842±1,047 | 0,120 |
| ED | 5,744±1,403 | 3,400±0,697 | 0,080 |
| DS | 2,055±0,439 | 1,317±0,199 | 0,002 |
| Height | 0,932±0,278 | 0,500±0,091 | $4,940e^{-6}$ |
| Weight | 1,842±0,851 | 0,562±0,318 | 0,001 |

*T: Tentacles. M: Mental. S: Siphon. ED: Eye Distance. DS: Diameter of the Suckers.*

*Variation of Individuels*

*Principal Component Analysis (PCA)*

The analysis was performed on the variables studied. The result of this analysis showed that these variables presented 92.79% of the total inertia on the two axes, which is important (Table 5).

**Table 5.** Eigenvalues of the principal component analysis (PCA)

| Component | Initial eigenvalues | | | Sums extracted from the load square | | |
|---|---|---|---|---|---|---|
| | Total | %Of variance | %Cumulative | Total | %Of variance | %Cumulative |
| 1 | 6,122 | 87,460 | 87,460 | 6,122 | 87,460 | 87,460 |
| 2 | 0,386 | 5,518 | 92,978 | 0,386 | 5,518 | 92,978 |

The analysis of the parameters studied shows that the two axes present 87.46% and 5.518% of the total inertia, respectively (Fig.2).

Axis 1 (87.46%): is represented by the following variables: Height, Weight, T, M and DS.

Axis 2 (5.51%): is represented by the following variables: ED, S.

The information to be noted from our correlation, which is presented in fig 2 are:

- No negative correlation is observed.
- We can see strong correlations between the variables Height, Weight, T, M, and DS, which are positively correlated to axis 1 and form group 1.
- We deduce that the correlation is average between group 1 and group 2, the variables ED and S are positively correlated, they are correlated to axis 2 and form group 2. The variables representing axis 1 are positively correlated with each other because they are probably controlled by a number of genes in common and the variables representing axis 2 have different genetic characteristics.

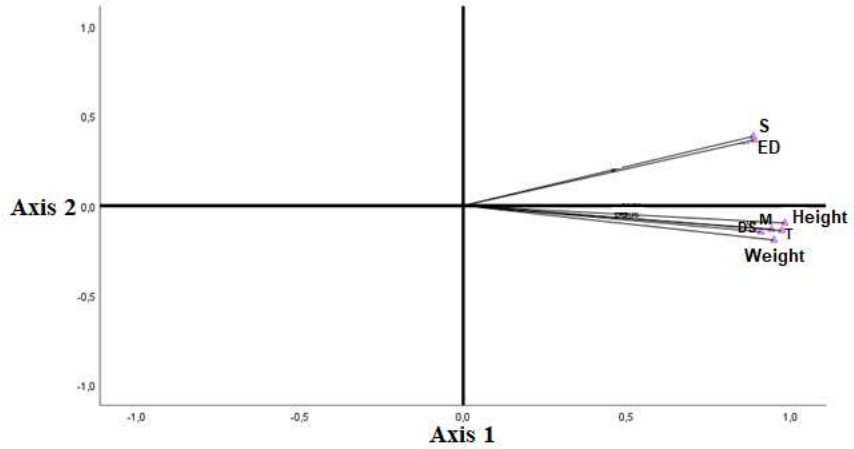


**Figure 2.** Presentation of body measurements by PCA.

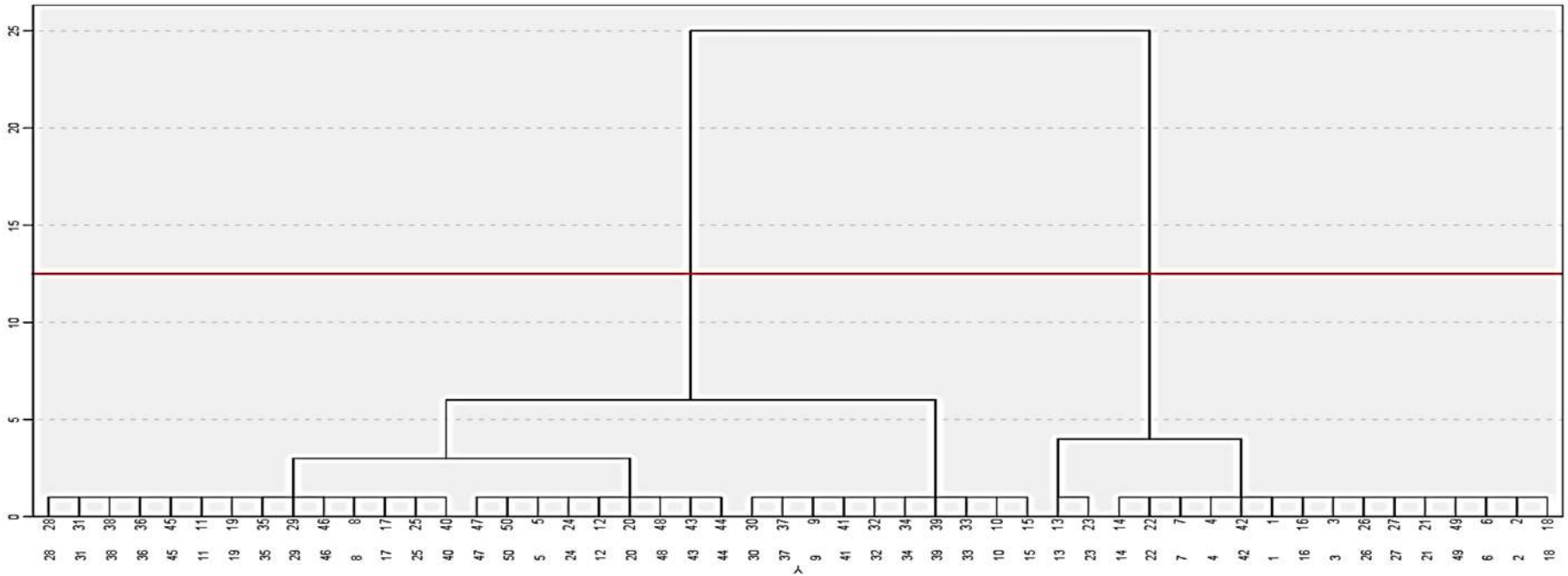

**Figure 3.** Dendrogram of the hierarchical ascending classification (HAC).

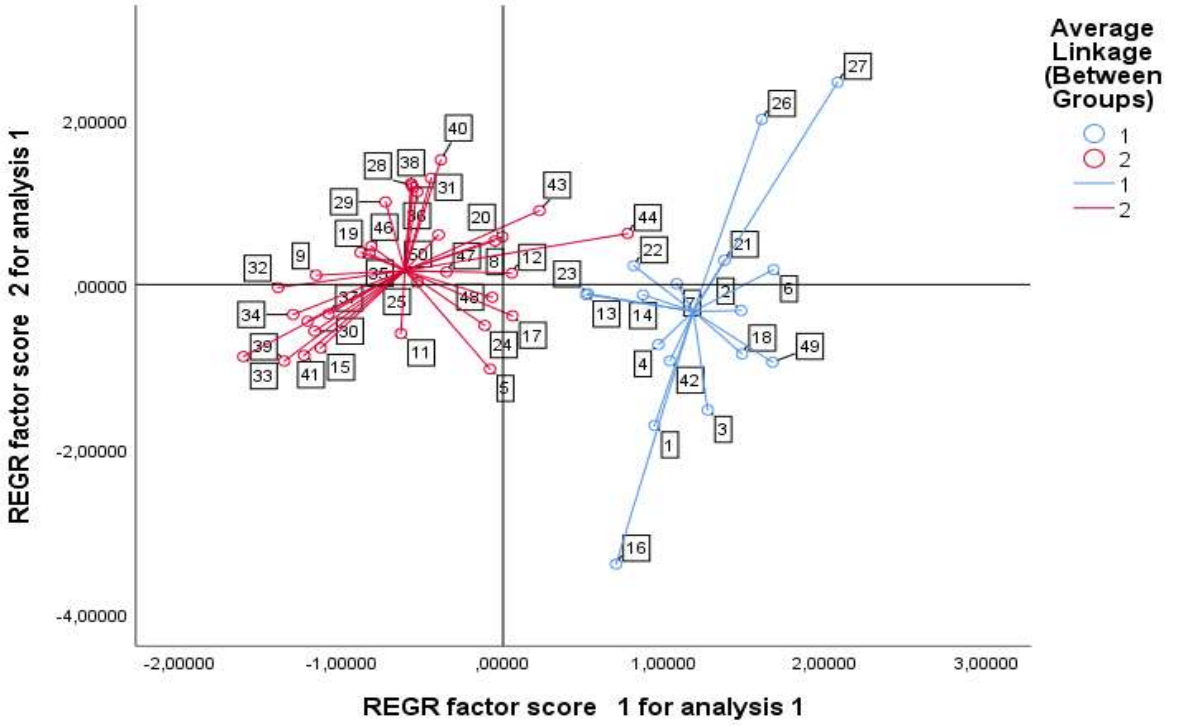


**Figure 4.** Hierarchical ascending classification of individuals.

*Hierarchical Ascending Classification (HAC)*

The hierarchical ascending classification (Fig.3) and (Fig.4) identified two classes.

The classification performed on the individuals shows 2 clusters. These results can be due to:

- Genetic heterogeneity.

- Size differences between males and females.

- Size differences between individuals within the study area: Ghazaouet, Beni-Saf, Oran and Arzew (Fig.5).

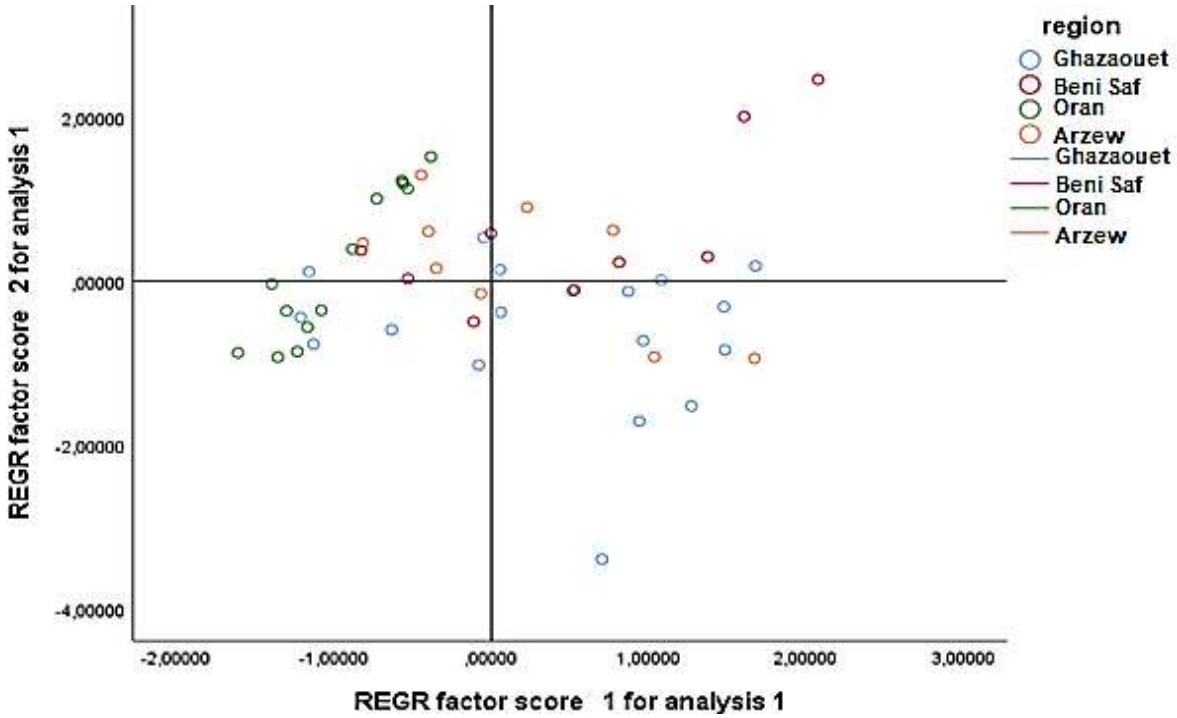


**Figure 5.** The distribution of individuals by region.

- Class 01 in blue: It includes 17 individuals from the region of Ghazaouet, Beni Saf and Arzew. With a height of (1.194±0.148) m and a weight of (2.565±0.353) Kg. The first class is longer and heavier than the second class. The tentacles are (90±7) cm, the mental (17.294±2.359) cm, the siphon is (9.018±1.686) cm, the eye distance is (6.629±1.553) cm and the diameter of the suckers is (2.365±0.223) cm.
- Class 02 in red: The animals of this class are 33 individuals from the region of Oran, Arzew, Beni-Saf and Ghazaouet. They have a smaller size than the animals of the first class (Table 6).

**Table 6.** Classification of octopuses studied.

| | Class 01 | Class 02 |
|---|---|---|
| N | 17 | 33 |
| T | 90±7 | 45±12 |
| M | 17,294±2,359 | 10,064±1,478 |
| S | 9,018±1,686 | 6,145±1,589 |
| ED | 6,629±1,553 | 4,294±0,983 |
| DS | 2,365±0,223 | 1,583±0,400 |
| Height | 1,194±0,148 | 0,615±0,136 |
| Weight | 2,565±0,353 | 0,927±0,590 |

*T: Tentacles. M: Mental. S: Siphon. ED: Eye Distance. DS: Diameter of the Suckers.*

## Discussion

Our work focused on the study of morphometric characters of *octopus vulgaris* at the level of the west coast of Algeria (Ghazaouet, Beni Saf, Oran, and Arzew). This makes our study the first in Algeria. The morphometric methods used during this study are classical morphometry. Indeed, the analysis of octopus populations begins with the description of their morphology. The results obtained from the classical morphometry, allowed us to note that great morphological variability exists inside the studied populations of octopus. The study of 07 morphometric characters (tentacles, mental, siphon, the distance of the eyes, diameter of the suckers, the height, and the weight) carried out on the octopuses allowed us to define the average standards for these measured characters in the region of our study.

From the analysis of the variations of the variables according to the region, we conclude that the size of the octopus changes as we move away from the western zone towards the east of Algeria. This means that there is an environmental adaptation or overfishing in the east region. According to the sex of the animal, we note that there is a difference between males and females of octopus in both parameters (body size and body weight) from 35 cm to 150 cm and from 153 g to 3300 g, respectively. We also note that there is a difference in the studied areas, and this is due to the mechanism of fishing at sea.

The principal component analysis (PCA) revealed that all the characters studied are most likely regulated by a number of common genes. However, these characters are subdivided into two groups. The first one, representative variables of axis 1 have a positive correlation with each other. The second group; representative variables of axis 2 have probably some different genetic characteristics. The Hierarchical ascending classification (HAC) was constructed based on the values of the measurements of the morphometric characters, which allowed the separation of the studied populations into the 02 groups. This separation makes the sampled animals have different sexes and size. We notice that the sizes of our sample of the two regions Ghazaouet and Beni Saf are bigger than the two other regions Oran and Arzew. This difference means that the environmental factor has a positive impact on the lifestyle of octopuses or the overfishing in the east area has a negative impact on the size of animals.

The average size of the mantle of *Octopus vulgaris* octopuses from the Algerian west coast was 12.52 cm corresponding to a weight of 1.48 kg. Studies made on the same species and in different areas have given different results (Table 7).

In the present study, the catch weight was lower compared to the results of JURADO-RUZAFA et *al.*, (2014), with a weight between 128.6 g and 8,086.6 g. Otherwise, in the Northeast Atlantic in Galician watersOTERO et *al.*, (2007) obtained a maximum LM of 35 cm for males and 30 cm for females; a maximum weight of 6,000 g for males and 6,303 g for females these animals are much larger than those obtained in this study. Therefore, height and weight values at the first maturation vary among regions and species. According to FERNÁNDEZ-NÚNEZ et *al.*, (1996), the differences observed are

probably due to the different maturity scales used and the methods used by different authors to calculate maturity magnitudes, in addition to geographical variation. More importantly, the observed differences in maturity weights between regions may be related to the sampling strategy followed by each author. Thus, these differences in height and weight at maturity, especially in females, occur not only in populations from different regions, but also in the same population due to various environmental variables such as light, temperature and processes affecting food within the same population (SILVA et *al*., 2002). Consequently, the three main factors of food, light, and temperature may intervene in a complementary (additive or multiplicative) or opposite manner in octopus maturation. However, as has been discussed by LOURENÇO et *al*., (2012) the equipment applied to the sample of the octopus, the sampling strategy, and the proportion of the sample corresponding to the breeding season can have an important impact on the results.

**Table 7.** Spatio-temporal variation of octopus size in different catches.

| Country, Region | Species | Sex | Size variation | | | | Reference |
|---|---|---|---|---|---|---|---|
| | | | LM (cm) | | W (g) | | |
| | | | m - M | Avg | m - M | Avg | |
| North West Africa, Mauritania | *O. vulgaris* | M | 5,7 - 25,7 | 15,5 | 128,6 - 8086,6 | 1977,4 | JURADO -RUZAFA et *al.*, 2014 |
| | | F | 6,3 - 24 | 13,8 | 129,2 - 4338,8 | 1137 | |
| Northeast Atlantic, Galician w aters | *O. vulgaris* | M | 8,5 - 35 | nd | 136 - 6000 | nd | OTERO et *al.*, 2007 |
| | | F | 8 - 30 | | 206 - 6303 | | |
| North West and South of Portugal | *O. vulgaris* | F | nd | nd | nd - 2548,01 | nd | LOURENÇO et *al.*, 2012 |
| Golf of Cadiz, South West Spain | *O. vulgaris* | F | nd | 17,6 | nd - 2023 | nd | SILVA et *al*., 2002 |
| Northeast Africa | *O. vulgaris* | F | nd | 16,3 | nd - 1792 | nd | FERNÁNDEZ-NÚNEZ et *al.* (1996) |

*M: males; F: females; LM: mantle length; W: weight; m: minimum; M: maximum; Avg: mean; nd: not defined*

## Conclusion

The present work dealt with the identification and morphometric characterization of *octopus vulgaris* at the level of the Algerian west coast in four different wilayas, precisely in the stations following Ghazaouet, Beni Saf, Oran and Arzew. The aim is to identify the existing octopuses in this geographical area, for the protection of this marine species threatened by overfishing and the conservation of the Algerian genetic heritage. The study of morphometric characters of the sampled octopuses allowed us to define the average standards of 50 of them measured with the help of statistical analysis. The description of the data obtained revealed to us a certain variability of the shape and size in most of these studied characters. This differentiation may be due to some biological and ecological factors, such as the different ages of octopuses, genetic heterogeneity, and size differences between males and females. This original work is only a preliminary study about the genetic diversity and population identification of *Octopus vulgaris* in the area of the Algerian west coast. It deserves to be expanded and deepened to better develop the national potential.

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## Author contributions

*Soufiane SEBOUAI* contributed: on Gathering data; Data or analytical tools contributed; Performing the analysis; Writing the paper and Contributing ideas.

*Semir Bechir Suheil GAOUAR* supervised the work, and contributed on the interpretation of results

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