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Relationship between Length, Weight, and Some Morphometric of the Cuttlefish *Sepia pharaonis* Ehrenberg, 1831 from the Coastal Waters of Hadhramout Governorate, Yemen.

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Abstract: The cuttlefish (*Sepia pharaonis*) is great economic importance to Yemen, due to their high commercial value in national and international markets. *S. pharaonis* is benthic species that live closely associated with the seabed. The relationship between total length, weight, body width, and circumference is crucial in estimating allowable catch and the appropriate mesh size for use in a particular fishery. Samples were collected from commercial catches at landing centers (Al-Shahr, Al-Haima and Al-Qarn) during the period from October 2023 to March 2024. Previous studies have mainly focused on classification, while biological studies on the commercial value of this species in Yemeni waters have been lacking. This study revealed that the R_2 values were high in all cases, and the length-weight relationship showed decreasing growth for 0.8209 males, 0.9661 females, and 0.9491 both genders together. Regarding the relationships of mantle length, mantle width, total body; Officinalis length, and Widths of The fragmocone, the quadratic equations had similar or equal R_2 values to linear equations. This provides valuable information for the Fish Base database and contributes to research and management of cuttlefish fisheries in the coastal waters of Hadhramout Governorate, especially, and Yemeni waters in general.

Keywords: Mantle width; Length-weight relationship; Mantle Length

1. Introduction

The coasts of Hadhramout Governorate are among the richest in fish and other marine organisms in the Republic of Yemen, characterized by biodiversity due to their high biological productivity resulting from exposure to upwelling currents during the Monsoon season and hence these waters are among the most important breeding and feeding sites for many marine organisms. [1] Cuttlefish are benthic species that live closely associated with the seabed. It is widely distributed in the Indian Ocean from northeast India to the Gulf of Aden, the Red Sea, and the Gulf of Suez. [2] and [3].

Sepia pharaonis Ehrenberg, 1,831 (pharaoh cuttlefish) is commonly distributed in the Indo-Pacific from 35_N to 30_S and from 30_E to 140_E and is present in shallow waters to a depth of 100 m [4]; [5] and [6]. It have a large geographic range, reaching as far east as Zanzibar, as far west as Australia and as far north as Japan. They span the Indian Ocean, the Persian Gulf, the Red Sea and the Andaman Sea [7].

S. pharaonis is fairly solitary creatures, most of them of their intraspecific communication is conducted during matig season. Their intraspecific communication is limited to escaping predators using ink or camouflage, and when changing their color and body position to approach their prey [8].

Sepia pharaonis is also an important species economically for local fisheries, especially in theYemeni Sea, Suez Canal, Gulf of Thailand and the northern Indian Ocean [9]. It is also economically important along the southeast coast of China, with an annual catch of approximately 150,000 tones. As a giant cuttlefish species, it can grow up to 42 cm in mantle length and 5 kg in weight.

S. pharaonis is the largest, most abundant, and exploited species of cuttlefish in the Gulf of Thailand and Andaman Seas accounting for 16% of the annual offshore cephalopods trawled and 10% of the offshore fixed net catches [10].
Studying the relationship between length and weight in fish and aquatic organisms is important for many other biological studies related to growth, age structure, and studying the dynamics of fish populations in different marine environments [11].

This research seeks to evaluate the relationship between length and weight and some morphometric characteristics of the Pharaoh cuttlefish *Sepia pharaonis* on the coasts of Hadramout Governorate to contribute to establishing an initial database about the Pharaoh cuttlefish in the study area.

2. Materials and Mehods

2.1 Collecting and study region

60 Individuals of *S. pharaonis* were collected monthly from the commercial catches landed at Al-Shahr landing center with coordinates (E 49°34'22.092", N 14°46'804.1514°), Al-Haima (14°50'6.134"N, 49°54'16.228"E), and Al-Qarn (14°50'24.560"N, 50°6'51.709"E), from October 2023 to March 2024 as shown in (Figure 1). The specimens were determined based on morphology, following the criteria of [12]. Afterwards, the individuals were taken to the laboratory of Biology, Faculty of science, University of Hadhramout, Yemen. To enhance visibility, the fish samples were washed with flowing water. Total length was measured to the nearest mm and total weight to the nearest 0.1 gm, then the data was entered to Excel package and the curve of the relationship between them was plotted as shown in (Figure 2).

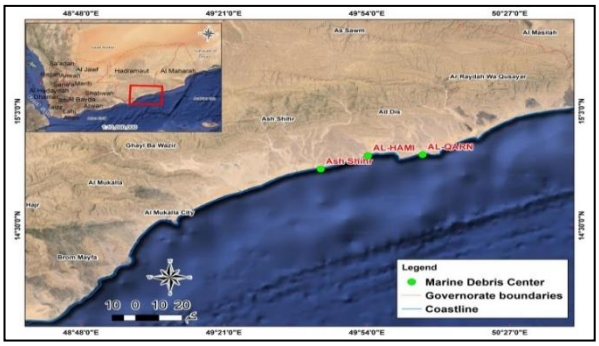

Figure 1. A map showing the Collecting sites of *S. pharaonis* specimens from the Coastal Waters of Hadhramout Governorate, Yemen.

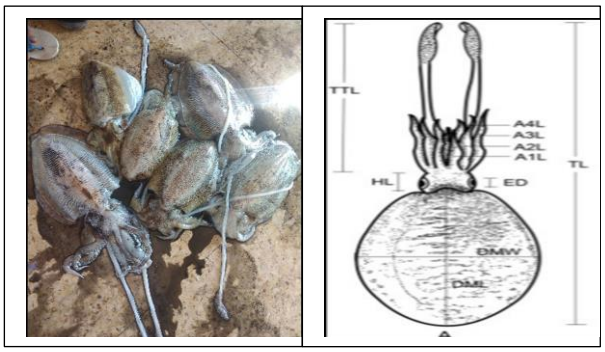

Figure 2. Morphometric measurements of *S. pharaonis*. TL: total length, FL Officinalis length, DML, mantle depth and DMW; mantle length.

2.2 Morphometric and measurements

Values of the constants (a) and (b) were obtained from the relationship according to [13] and [14] using the equation: W = a×L×b : Where: W = total weight in grams. L = total length in cm, b = a constant of the relationship represents the slope of the equation. a = a constant of the relationship represents the intersect part of the "y" axis. Total length, Manile depth, Manile length, Total length and Standard length of *S. pharaonis* were measured to the nearest mm then the data was entered to Excel package and the curve of the relationships between the four later parameters and total length were plotted. Values of the constants (a) and (b) for each relationship separately were obtained using power and linear equations as follow: B = a ×L×b (Power equation). B = a×L + b (Linear equation). Where: B = One of these parameters Manile depth, Manile length, total length and Standard length in cm.

3. Results

3.1 Sampling data

1. Length-weight relationship (LWR)

60 samples of *S. pharaonis* (37 females, 23 males, total 60 samples) with varying sizes were used to clarify the morphometric characteristics and their relationship. The R_2 value was high, reaching 0.9491, with a value of A=0.1387, while the value of (b) reached 2.8098, indicating an inconsistent growth as shown in (Figure 3 and Table 1).

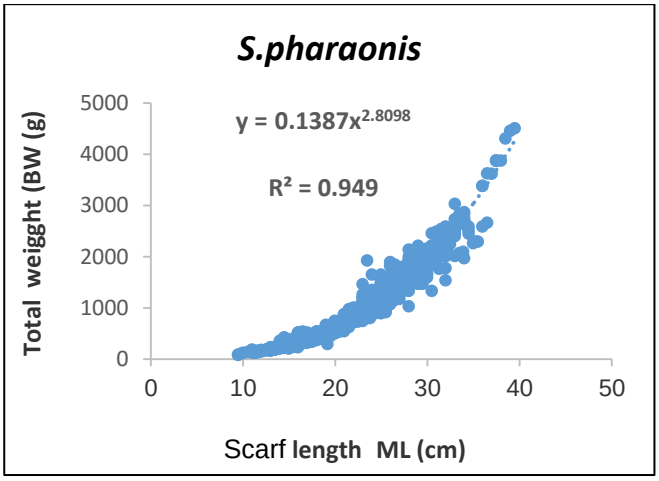

Figure 3. Length-weight relationship of *S. pharaonis* from the Coasts of Hadhramout Governorate – Yemen.

Table 1. Parameters of the length-weight relationship of *s. Pharaonis* from the coasts of Hadhramout-Yemen.

Sex	n	a	b	R_2
Males	23	0.4193	1.859	0.8209
Females	37	0.8204	1.6982	0.9661
sexes combined	60	0.1387	2.8098	0.9491

The relationships between length and weight of *S. pharaonis* were relatively stronger in males than in females their sexes combined relationship was closely realty to the females one (Figs. 4, 5 &6).

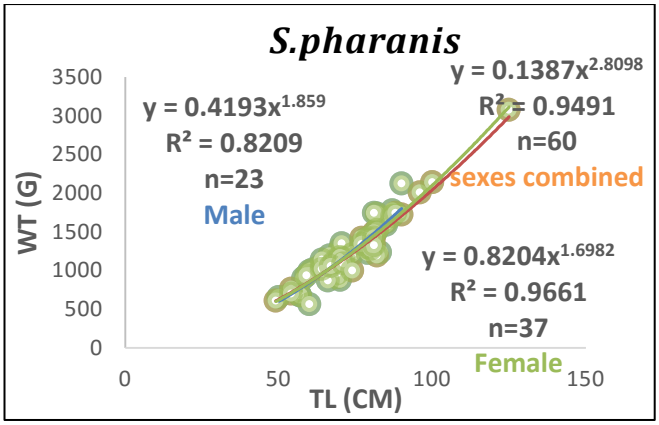

Figure 4. Length-weight relationship for males, females and sexes combined of *S. pharaonis* from the Coasts of Hadhramout Governorate – Yemen .

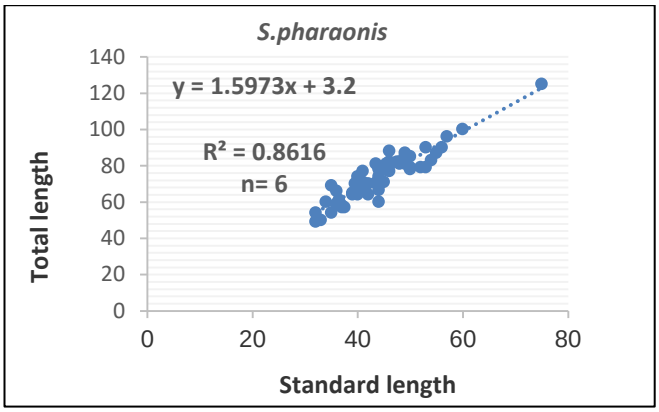

Figure 5. Straight-line relationship between officinalis length and widths the fragmocone (FW) of males and females of *S. pharaonis* from the Coasts of Hadhramout Governorate – Yemen.

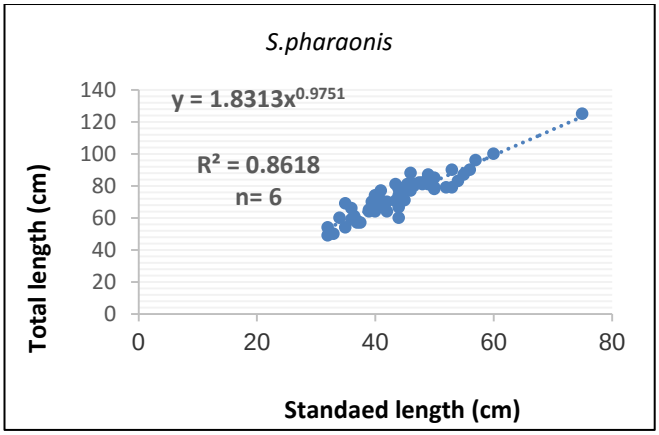

Figure 6. Power relationship between officinalis length (FL) and widths the fragmocone of males and females of S. pharaonis from the Coasts of Hadhramout Governorate – Yemen.

2. Manile depth, Manile length relationship (DMW and DML). The relationships between total mantle length and mantle depth shown in Figs (7 &8), for the two sexes. R^2 (R^2= 0.941) is relatively high in all cases. The same is true for the relationships between total length and body depth.

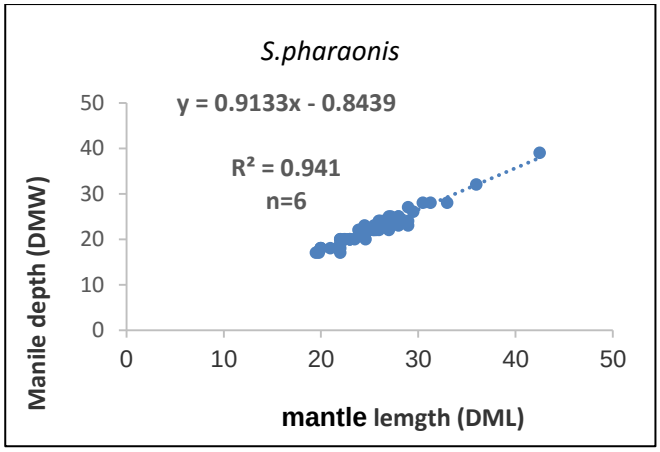

Figure 7. Straight-line relationship between mantle depth, mantle length of males and females of *S. pharaonis*.

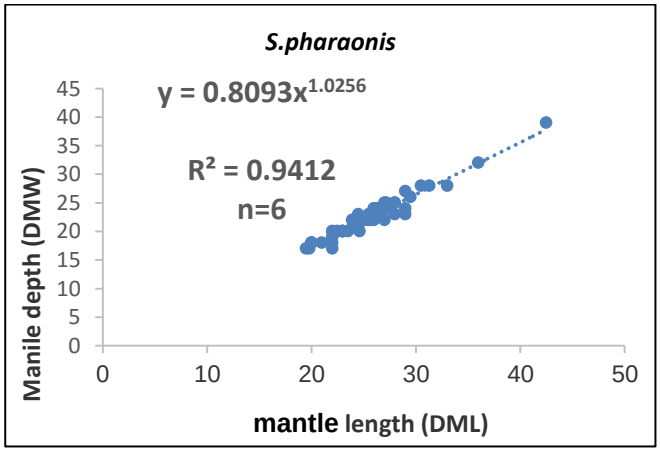

Fig.ure 8. Power relationship between mantle depth, mantle length of males and females of *S. pharaonis.*

4. Discussion

Length-weight relationship is an important parameter in the study of the biology of Cuttlefish. In spite of this fact there are many Cuttlefish species for which this relationship has not been determined. Cuttlefish of the genus *S. pharaonis* in the Coastal Waters of Hadhramout are not much studied and for *S. pharaonis* there is no any estimation for this relation in the literature.

In the present study the length-weight relationship for males and females of *S. pharaonis* were described by negative allometric growth (W= 0.8204 L1.859 for males, W= 0.8204 L 1.6982 for females and W = 0.1387L 2.8098 for sex combined). The relationship was very strong in males (R2 = 0.82029) and females (R2 = 0.9661). This agree with the results of [15] and [16]. This disagrees with the result of [17], [18] and [19]. The disagreement may be due to differences in environmental conditions [20] and [21]. [22] studied the length-weight relationship of four species of right eye flounder from south coast of Korea they found that all relations were highly significant ($P < 0.001$), with R2 values ranged from 0.934 to 0.989. [23] estimated length-weight relationship for Valamugil seheli from Abu Hashish area, Portsudan. He found that this relationship was significantly high in both sexes and the (b) value for females and males were 2.775 and 2.808 respectively. [24] estimated

this relationship for V. seheli from Mangalore region-India to be W=0.0373L2.6294 for males and W=0.0502L2.5283 for females.

The relationships between total mantle length and mantle depth very important in estimating the allowable catch and appropriate mesh size to be used in a fishery. They were relatively strong correlation(R_2 ranged from 0.941 to 0.942) for both males and females of S. pharaonis used in the present study. Values of body mantle length and mantle depth increased with the increase of total length. Their averages for females and males were 0.8204 and 0.4193 cm. This indicates that the two parameters do not differ much between the two sexes. The relationship of mantle length and mantle depth seems to be similar in males and females, but really differ to some extend between sexes. This may be due to the increase of females' girth before and during the spawning period.

[11] suggest that the both power and linear equations were found to describe with relatively equal strength (have comparable R2) the relationship of total length with weight, body girth, and length of anal and dorsal fins for males and females of Lutjanus ehrenbergii. For the relationship of total length with depth power relations were stronger. Our results revealed that the R2 values were high in all cases, and the length-weight relationship showed decreasing growth for 0.8209 males, 0.9661 females, and 0.9491 both genders together. Regarding the relationships of mantle length, mantle width, total body length, and Officinalis length, and Widths of The fragmocone,the quadratic equations had similar or equal R2 values to linear equations.

5. Conclusion

In conclusion, this study is the first to document the relationship between length and weight and some morphometric of the sepia pharaonis. This research lays the groundwork for effective management and conservation of coastal s. pharaonis stocks in coastal waters Hadhramout Yemen.

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Biography

Kamal A. Baaoom graduated in biology from Aden University, Yemen. He has been awarded a scholarship by King Abdulaziz University (Saudi Arabia) to pursue a M.Sc. in Biology. He obtained his M.Sc. in biology in 2005 from the Department of Biology, University of King Abdulaziz. He received his Ph. D. from Assiut University, Egypt in 2012. Currently he is working as vice dean for student affairs at the Faculty of Sciences-Hadhramout University. He is working on fish biology and techniques of tissues of different organs of fishes.

Taha Saleh Baker graduated in zoology, specializing in fish biology and fisheries, from Egypt. He obtained a bachelor's degree in chemistry and biology from the College of Education, University of Aden. In 2004. In 2008, he obtained a master's degree in zoology, specializing in vertebrates, from the Department of Biology, College of Education, University of Aden. He then received a scholarship to Egypt to pursue a Ph.D. in zoology, specializing in fish biology and fisheries, from the Faculty of Science, Sohag University, graduating in 2018. He is currently working as an associate professor at Shabwa University, Yemen.

العلاقة بين الطول والوزن وبعض الخصائص المورفومترية للحبار *Sepia pharaonis* Ehrenberg, 1831 من المياه الساحلية لمحافظة حضرموت، اليمن

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الملخص: الحبار Sepia pharaonis له أهمية اقتصادية كبيرة لليمن، نظرا لقيمته التجارية العالية في الأسواق الوطنية والدولية. يعتبر الحبار من الأنواع القاعية التي تعيش مرتبطة ارتباطا وثيقا بقاع البحر. تعتبر العلاقة بين الطول الإجمالي والوزن وعرض الجسم والمحيط أمراً بالغ الأهمية في تقدير المصيد المسموح به وحجم الشبكة المناسب للاستخدام في مصايد معينة. تم جمع عينات من المصيد التجاري في مراكز الإنزال (الشحر، الحامي والقرن) خلال الفترة من أكتوبر 2023 إلى مارس 2024. ركزت الدراسات السابقة بشكل أساسي على التصنيف، بينما كانت الدراسات البيولوجية حول القيمة التجارية لهذا النوع في المياه اليمنية غير موجودة. كشفت هذه الدراسة أن قيم R2 كانت عالية في جميع الحالات، وأظهرت علاقة الطول والوزن نموا متناقصا ل 0.8209 ذكور و 0.9661 أنثى و 0.9491 من كلا الجنسين معا. فيما يتعلق بالعلاقات بين طول الوشاح وعرض الوشاح وطول الجسم الكلي والطول القياسي، كان للمعادلات التربيعية قيم R2 مماثلة أو متساوية للمعادلات الخطية. يوفر هذا معلومات قيمة لقاعدة بيانات الاسماك ويساهم في البحث وإدارة مصايد الحبار في المياه الساحلية لمحافظة حضرموت بشكل خاص والمياه اليمنية بشكل عام.

الكلمات المفتاحية: عرض الوشاح، العلاقة بين الطول والوزن، طول الوشاح.