



Observations on the Population Characters of Eared Horse Mussel, *Modiolus auriculatus* (Krauss, 1848) in the Red Sea, Egypt

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Abstract: The population analysis of 240 *Modiolus auriculatus* individuals collected from the Red Sea showed that its size ranged from 1.36 cm to 6.02 cm in shell length. During spring and summer seasons, most abundant shell size groups of average shell length 4.0 cm, 5.0 cm and 6.0 cm were observed. While during autumn and winter seasons the groups of 1.5 cm, 2.0 cm and 2.5 cm were found in the population. Sex ratio (males to females) being 1.2:1 and the proportion of sexes in all size groups did not differ significantly from 1:1. The seasonal meat yield values are higher in spring and summer than these values during autumn and spring seasons. This looked to be related to gonad condition more than the somatic growth of the animal.

Keywords: *Modiolus auriculatus*, Size Distribution, Sex Ratio, Meat Yield, Red Sea, Egypt

1. Introduction

Eared horse mussels of mytilidae are widely distributed in the world, they occur in several seas of the tropical and subtropical regions. *Modiolus auriculatus* is a sedentary organism and is subjected to a wide range of environmental conditions. It was recorded in the western Indian Ocean, the Red Sea and Palestine (Eastern Mediterranean Sea) according to Safriel et al. [1]. It is distributed along the Red sea coast of Egypt was reported by Abdel Razek et al. [2]. While Abu-Zaid et al. [3] studied the allometry of this mussel inhabiting the intertidal rocky substrate in Hurghada area of Red Sea coast. Also, *M. auriculatus* reproduction cycle and its spawning in the same area were studied by Abdel Razek et al. [4]. Moreover, the distribution have been studied by Fshelson [5], Oliver [6] and Zuschin and Oliver [7]. The present study concerning concurrent seasonal variation of the size distribution of *M. auriculatus* population and its sex ratio; also seasonal meat yield variations were studied in

Hurghada area, Red Sea, Egypt.

2. Materials and Methods

A total 240 individuals of *M. auriculatus* were collected monthly during the period (2011-2012) from Hurghada area (33° 46' 20"-29"E and 27° 17' 3"-22"N) of the Egyptian coast of Red sea (Fig. 1).

Measurements of shell length accurately done to 0.01 mm using Vernier Calipers and data grouped into 0.5 cm size classes see (Fig. 2). Shell weight of the hard shell after removing the soft part and weight of the soft part were weighted by using a digital balance to the nearest 0.01 g. Monthly sex ratios as well as the ratio according to the animal size were analyzed by using Chi-square test (χ^2). Meat yield analysis was measured monthly for 30 individuals according to Walne and Mann [8], as the ratio of the soft part

weight divided by weight of shell X 100.

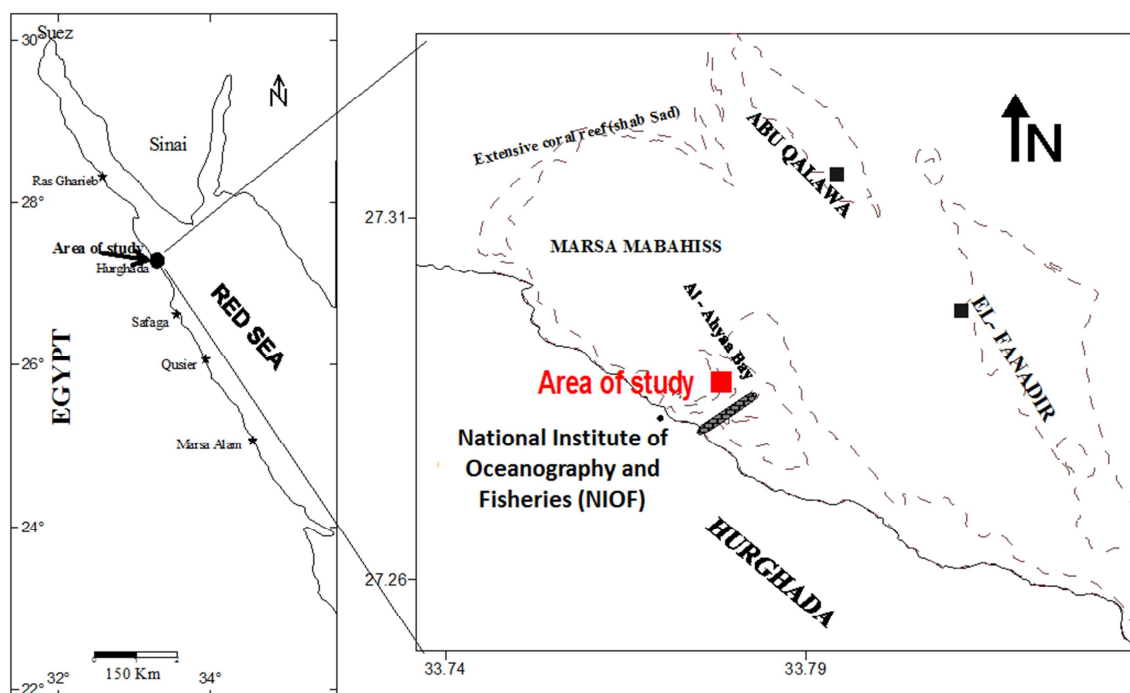


Fig. 1. The area of collecting samples, Red Sea, Hurghada, Egypt.

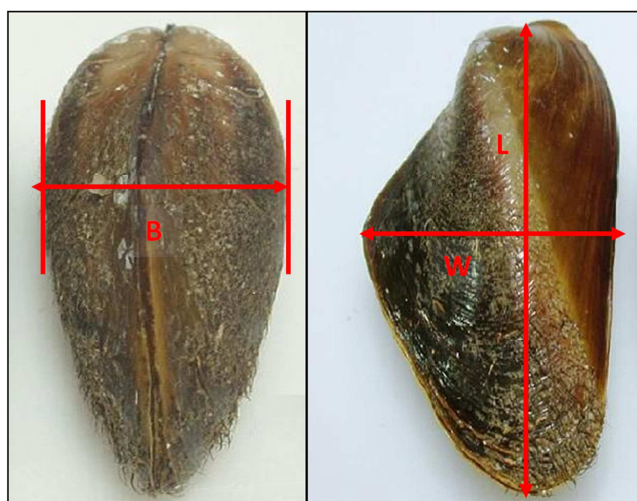


Fig. 2. Photographs showing *M. auriculatus* morphometric measurement. L (Length), W (Width), and B (Bottom).

3. Results

In the present study, the population structure of *M. auriculatus* was determined by size frequency distribution. (Fig. 3) showed the size frequency distribution (pooled data) of *M. auriculatus*. The major shell size of measured individuals ranged from 3.0 cm to 6.0 cm shell length with a maximum abundant size group of an average shell lengths 4.5 cm. This shell size groups were representing about 51% of the total studied population. Small individuals were found from 1.5 cm to 2.5 cm in average shell lengths, which represent about 5% of the total collected population as in (Fig. 3).

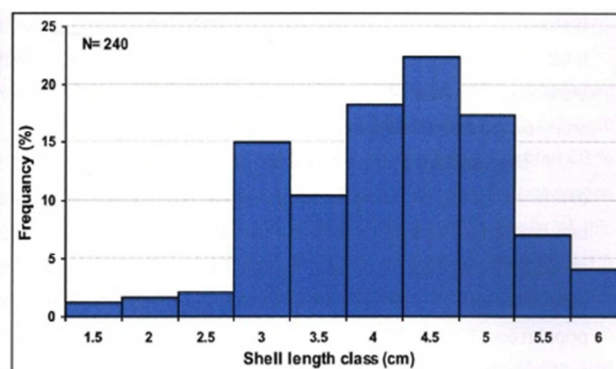


Fig. 3. Size frequency distribution of *Modiolus auriculatus* (pooled data).

(Fig. 4) describes the seasonal distribution of size frequency for both males and females, both sexes were distributed with higher percentages with an average shell length of a range from 4.0 cm to 5.5 cm during summer, autumn and spring seasons.

Young individuals were observed during autumn months with average shell lengths, 1.5 cm and 2.5 cm, which may indicate the entrance of small population during this period. Sex ratio as in (Table 1) shows that *M. auriculatus* is dioecious species with a ratio of males to females being 1.2:1 which 55% of the populations were males and 45% females. Also, the proportions of sexes of all size groups did not differ significantly from 1:1. The seasonal expressing of the meat yield data were illustrated in (Fig. 5) which shows the maximum values for both sexes during spring and summer seasons with an average values of 34.8 ± 3.62 and 35.2 ± 1.64 for males and females respectively and then these values

decreased during autumn and winter seasons in the same pattern in both sexes.

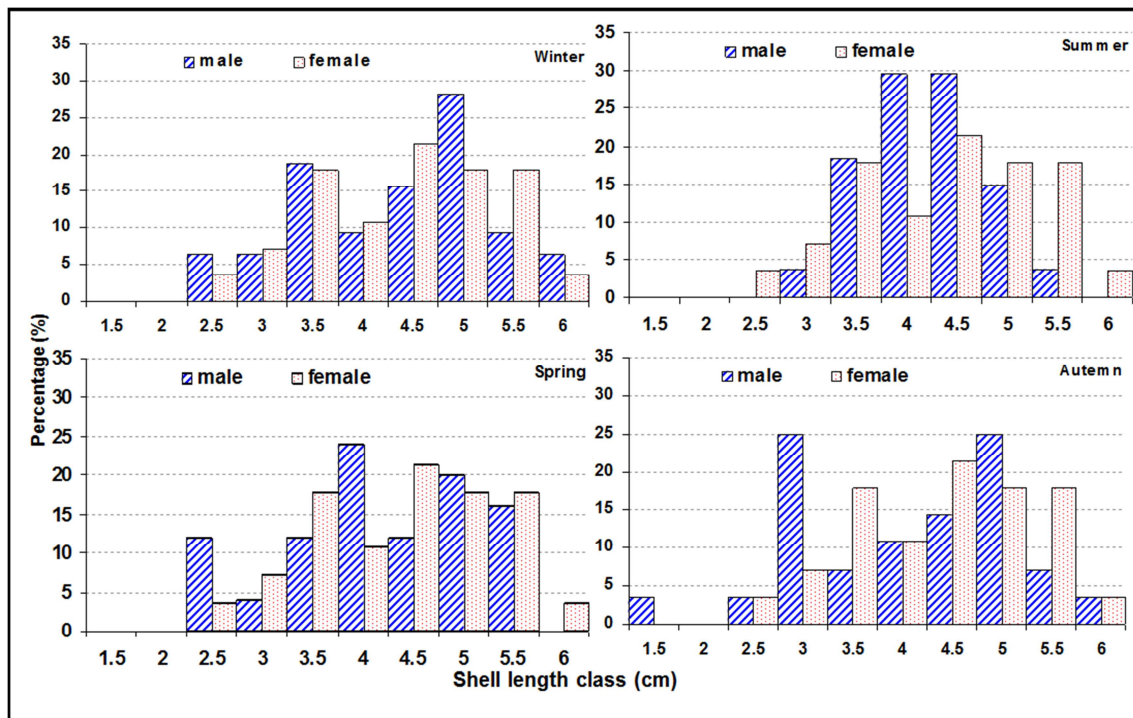


Fig. 4. Seasonal Variability in shell Size distribution of *M. auriculatus* collected from Hurghada, Red sea, Egypt (2011-2012).

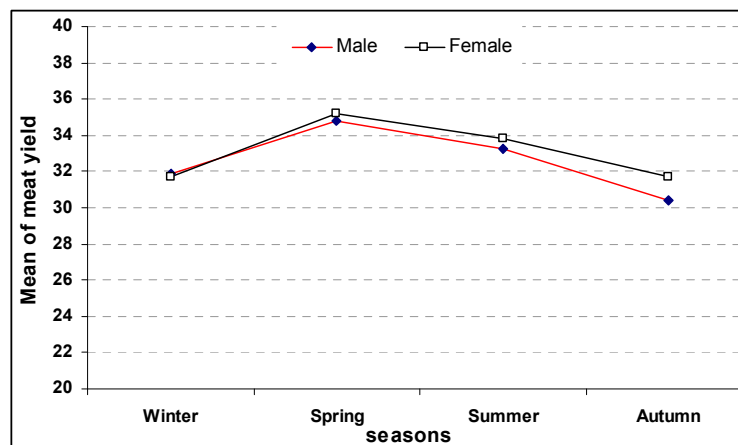


Fig. 5. The seasonal values of meat yield for *M. auriculatus* males and females collected from Hurghada, Red sea, Egypt.

Table 1. Summarize the difference between male and female of *M. auriculatus* during the study.

Average shell length (cm)	Male	Female	Sex ratio (male: female)	d. f	X ²	p- value
1.5	1	1	1:1	1	0	1
2	3	0	-	1	0.69	0.41
2.5	8	5	1:0.63	1	0.69	0.41
3	15	11	1:0.73	1	0.6153	0.43
3.5	14	15	1:1.07	1	0.034	0.85
4	22	20	1:0.91	1	0.095	0.76
4.5	32	21	1:0.66	1	2.28	0.13
5	19	21	1:1.1	1	0.1	0.75
5.5	11	12	1:1.1	1	0.043	0.84
6	7	2	1:0.29	1	2.77	0.10

4. Discussion

The results of spawning season of the studied mussels

showed that spawning starts in March, April and May but some spawning individuals continued until June and July [2]. This may describe the occurrence of the smallest individuals (1.5 & 2.5 cm shell length) in the population during autumn,

which indicate a prolonged settlement period in these mussels. This prolonged settlement comes in agreement with the case of *M. barbatus* in Mali Ston Bay as mentioned by Peharda et al. [9].

On the other hand, the disappearance of small size shells in the present study during the other seasons maybe due to predation or the decrease of individual growth in this period, Holt et al. [10] proved that predators play an important role in the population structure of horse mussel beds and limit the survival of juveniles to adulthood. The results also indicate that *M. auriculatus* is a dioecious species with the ratio of males to females as 1.2:1. Moreover, the sex ratio in all size class did not differ significantly from 1:1. Seed [11] explained the deviation from an equal sex ratio may be related to age or size which can result from sex-specific differences from equal sex-ratio as observed in the present results.

The present results exhibited a clear pattern in the value of the meat yield followed a pattern similar to that of the reproduction. The values ranged from 27.92 during January and 38.9 in May for males and from 28.65 to 40.56 for females. These variations may be related to gonad conditions than to somatic growth and resulted from the complex interactions of a variety of factors including food, temperature, salinity and metabolic activities of the mussels as reported by Hickman and Illingworth [12]. On the other hand, the metabolic processes of some individuals showed different weights which may be related to their physiological conditions of mussels and environmental factors [13- 14].

5. Conclusion

The size frequency of *M. auriculatus* population ranged from 1.36 cm to 6.02 cm shell length. The most abundant size groups were animal with shell lengths 4.0, 5.0 and 6.0 cm. These groups comprised about 51% of the total population studied and were found in winter and spring seasons. Young of these groups were observed in Autumn comprised about 5%. Sex ratio of males to females was 1.2:1. The values of meat yield were observed to relate to gonad conditions i.e. the maximum values in spring and summer for both sexes.

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