Egyptian Journal of Aquatic Research xxx (2017) xxx–xxx

HOSTED BY

Contents lists available at ScienceDirect

Egyptian Journal of Aquatic Research

journal homepage: www.sciencedirect.com/locate/ejar

Full length article

Hermaphroditism in *Brachidontes pharaonis* (Fischer, 1876) (Bivalvia: Mytilidae) from the Alexandria Coast, Egypt

Fatma A. Abdel Razek [a,*], Rabab S. El-Deeb [a], Karolin K. Abdul-Aziz [b], Hamdy A. Omar [a], Amal R. Khafage [a]

[a] National Institute of Oceanography and Fisheries, Cairo, Egypt
[b] Faculty of Science, Zoology Department, Damanhour University, Egypt

ARTICLE INFO

Article history:
Received 24 September 2017
Revised 5 October 2017
Accepted 7 October 2017
Available online xxxx

Keywords:
Hermaphroditism
Brachidontes pharaonis
Sex ratio
Histology
Alexandria
Egypt

ABSTRACT

Brachidontes pharaonis (Fischer, 1876) was widely reported to cover completely hard substrates especially rocky shores with higher density in mid-littoral zones forming mytilid beds along Alexandria Coast, Egypt. During our study on the reproductive cycle of this species, one case out of 307 examined specimens was found to be hermaphrodite representing only 0.33% of the total sample. It had a shell length 28.25 mm and was collected during January 2017. The sex ratio of this population is different from 1:1, although this deference was not significant ($X^2 = 11.118$, df = 11, $P > 0.05$). In this contribution, this case of hermaphroditism in *B. pharaonis* is described. The histological study showed the presence of male and female gametes in the same follicle and this was the most common situation in both lobes of the mantle. The male zone was showing different stages of spermatogenesis together with the female zones showed different stages of oogenesis with occurrence of young oocytes attached to the follicle wall.

Introduction

Brachidontes pharaonis is a species of mussel from the family Mytilidae which is native to the Indian Ocean and Red Sea (Gilboa, 1976). Considering its invasive potential and the recent warming trend of the Mediterranean, it has invaded more habitats, threatening indigenous bivalve species which may be, in the future, unable to compete with *B. pharaonis* in terms of reproductive effort and density as predicted by Sara et al. (2008).

B. pharaonis is widely reported from the Western Pacific Ocean, Indian Ocean and the Red Sea (Morton, 1988). Its migration to the Mediterranean Sea through Suez Canal and from the Eastern African Coasts to Southern Africa was reported by Barash and Danin (1986). Few studies were done on its ecology, age structure, distribution and biometric relationships in the Red Sea, Gulf of Suez and Eastern Mediterranean Coast of Egypt by Mohamed (1992, 1997), Radwan (2014) and El-Sayed et al. (2016). To the knowledge of the authors, the present study is considered as the first record of the presence of hermaphroditism in *B. pharaonis*.

Materials and methods

In the present study, three sites were selected along the coast of Alexandria City, as shown in Fig. 1. The three sites covered about 16 km along the coast. The sites (A) and (B) were of about 250 m and 100 m away from the coast, respectively. While site (C) is located in the Eastern Harbor in front of Kayed Bey Citadel at Alexandria.

Sampling was done during the period from spring 2016 to winter 2017 using 1 m × 1 m quadrat placed randomly along a 100 m × 100 m transect. Water depth ranged from 1 to 6 m. Shell length was measured by using a digital Vernier Caliper (0.01 mm accuracy).

For histological examination, monthly random samples with more than 8 mm shell length were collected. A total of 307 individuals were dissected, from each sample the mantle was removed and fixed directly into Davidson's fixative (1 part glycerin, 1 part glacial acetic acid, 2 parts 37% formaldehyde, 3 parts 95% ethanol, and 3 parts isotonic sodium chloride 20–30%) (Kim et al., 2006) for 24 h. They were then stored in 70% ethyl alcohol until processing. The tissue was dehydrated with an ascending series of alcohol concentrations (80%, 90% and 100%), cleared with xylene, and then embedded in paraffin wax (40–50 °C). Sections were done from the wax block at thickness 5 µm using a manual microtome (KD-2258). Sections were then mounted on glass slides for further

Peer review under responsibility of National Institute of Oceanography and Fisheries.
* Corresponding author.
E-mail address: fatma_abdelrazek@hotmail.com (Fatma A. Abdel Razek).

https://doi.org/10.1016/j.ejar.2017.10.002
1687-4285/

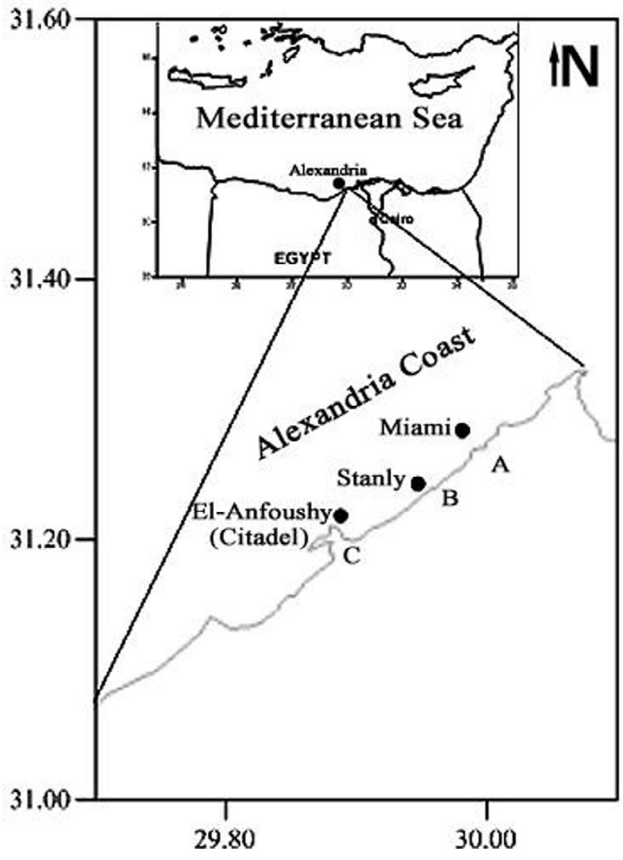

Fig. 1. Locations of the sampling sites for the mussel *Brachidontes pharaonis*.

Table 1
Percentage of the examined individuals of *B. pharaonis* during the study period.

Males	135 (44%)
Females	159 (51.8%)
Undifferentiated sex	12 (3.9%)
Hermaphrodite	1 (0.3%)
Total No.	307

staining with hematoxylin and eosin (Howard et al., 2004). Gonad sections were examined under a light microscope (OPTIKA B-150).

Chi-square test was used to determine if there was any monthly deviation in the sex ratio of the examined individuals from a 1:1 ratio.

$$X^2 = \sum (O - E)^2 / E$$

where, X^2 is chi-square test, (O) is the observed values in each month, and (E) is the expected values. Sections were photographed using a mounted digital camera (TOUCAM™ – UCMOS, 3.1 $MP^{1/2}$, Model No. 3.2).

Results

The gonad of *B. pharaonis*, as in other mytilidae, is very simple consisting of follicles in the mantle and in the visceral mass. During the present study one specimen out of 307 was found to be hermaphrodite, representing only 0.33% of the studied sample. The hermaphrodite individual had a shell length of 28.25 mm. We should note that all individual studied of *B. pharaonis* varied between 2 mm and 38 mm shell length. The sex ratio in Tables 1 and 2 did not differ much from 1:1 and chi-square value was (X^2 = 11.118, df = 11, P > 0.05), i.e. non-significant differences. The microscopic examination of the two sides of the mantle is shown in Fig. 2. The follicles in the hermaphrodite individual in *B. pharaonis* are of three kinds, testes, ovaries and ovotestis at different stages of gamete maturation together with connective tissue. Male follicles were at late developmental stage with full ripe spermatozoa and with remarks of partial emission. The female follicles were partially spawned. Few female follicles showed signs of resorption. The presence of male and female gametes in the same follicle was the most common situation in the two lobes of the mantle. In these follicles there were male zones having maturing spermatocytes, and few spermatozoa. The female zones showed different stages of oogenesis. We notice here that the egg diameters for the hermaphrodite individual ranged between (15–50) μm and had an average size of 34.5 μm. It is to be mentioned that, young oocytes were found attached to the follicle's wall as shown in Fig. 2.

Table 2
Monthly distribution of sex ratio of the examined individuals of *B. pharaonis*.

Chi-square test on the sex ratio for males and females of *B. pharaonis*

	Number of Individuals examined												
Month	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Total No.
Males	15	15	10	14	11	15	9	11	9	9	12	5	135
Females	8	11	16	11	16	18	13	19	19	13	11	4	159
Undifferentiated sex	1		1	1			2		1	4	1	1	12
Hermaphrodite											1		1
Total No.	24	26	27	26	27	33	24	30	29	26	25	10	307

Observed values:

Month	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Males	15	15	10	14	11	15	9	11	9	9	12	5
Females	8	11	16	11	16	18	13	19	19	13	11	4

Expected values:

Month	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
Males	10.5612	11.9387	11.9387	11.4795	12.3979	15.1530	10.1020	13.7755	12.8571	10.102040	10.5612	4.13265
Females	12.4387	14.0612	14.0612	13.5204	14.6020	17.8469	11.8979	16.2244	15.1428	11.897959	12.4387	4.86734

X^2 = 11.118, df = 11, p-value = 0.43344, P > 0.05, not significantly different.

Please cite this article in press as: Razek, F.A.A., et al. Hermaphroditism in *Brachidontes pharaonis* (Fischer, 1876) (Bivalvia: Mytilidae) from the Alexandria Coast, Egypt. Egyptian Journal of Aquatic Research (2017), https://doi.org/10.1016/j.ejar.2017.10.002