Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 22(5): 473 - 482 (2018)
www.ejabf.journals.ekb.eg

Alpheus lobidens De Haan, 1849 (Decapoda, Alpheidae) as a new record to the Egyptian Mediterranean Coast

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ARTICLE INFO
Article History:
Received: Nov. 24, 2018
Accepted: Dec. 29, 2018
Online: Jan. 2019

Keywords:
Alpheus lobidens
Snapping shrimp
Egyptian Mediterranean
Alexandria
Eastern Harbour

ABSTRACT

Alpheus lobidens is one of the widely distributed snapping shrimps at different depths (up to 25m) on soft and hard bottoms of the warm coastal habitats. It has received great attention because it was previously misidentified and described as *Alpheus crassimanus*. The present study recorded *A. lobidens* for the first time in the Eastern Harbour of Alexandria on the Egyptian Mediterranean Coast in association with a recently described bryozoan species, *Calyptotheca alexandriensis*. The seasonal abundance, biometric parameters and the females' fecundity of *A. lobidens* in the Eastern Harbour were followed during the present study. A total of 76 individuals were collected, with the highest count during spring and the lowest in autumn. The biometric measurements showed that *A. lobidens* had lengths within the range of 9 - 32 mm and weight of 3 – 691 mg, for different maturity stages. In the meantime, Ovigerous females formed the highest percent of the population count during summer.

INTRODUCTION

Snapping shrimps of the genus *Alpheus* Fabricius, 1798 were found to inhabit soft and hard bottoms in estuaries, mangroves and coral reefs within variable depths in coastal tropical and subtropical regions (Anker *et al.* 2006). Some *Alpheus* species were associated with different types of benthic animals (e.g. Anker *et al*. 2008; Purohit *et al.* 2014). For Example, *Alpheus ikedosoma* was found in association with the annelid echiurian *Ikedosoma elegans* in the intertidal sandy zone of Boso Peninsula and Ariake Sea, Japan (Komai, 2015).

Alpheus lobidens is one of the widely distributed snapping shrimps in the world coasts and received great attention, as it was misidentified and described as *A. crassimanus* in several coastal areas, including Mediterranean coasts (Forest and Guinot, 1958; Holthuis and Gottlieb, 1958), and many areas in the Indo-Pacific (Bannr and Banner, 1974).

Alpheus lobidens was observed in the entire Indo-Pacific area from the Red Sea to Hawaii, from all warmer parts of Australian coast (e.g. Almeida *et al.* 2013; Purohit *et al*. 2014; Tan *et al.* 2017), the ROPME Sea Area (Naderloo and Türkay, 2012; Jahanpanah and Savari, 2013; Akbarian *et al.* 2014), intertidal zones of Oman Sea (Naderloo *et al.* 2015; Ansari and Maghsoodlou, 2017) and Juraid Island, Saudi Arabia (Banner and Banner, 1981).

Although *A. lobidens* was mentioned in the list of Red Sea species to Mediterranean Sea (Rodríguez and Suárez, 2001), it was reported as rare species from Israeli coast (Lewinsohn and Galil, 1982) and in Turkish Mediterranean waters (Kocatas *et al.* 2002; Bakir *et al.* 2015). However, it was not included in the lists of alien species in the Mediterranean (Galil, 2007; Abushaala *et al.* 2014; Ben Amor *et al.* 2016; Zenetos, 2017). This species could be considered as new record to the Egyptian Mediterranean coast as it was found for the first time among the fauna associated with a newly discovered bryozoan species, *Calyptotheca alexandriensis* in the Eastern Harbour of Alexandria by Abdel Salam *et al.* (2017).

The present study aims at following the seasonal variations of abundance, biometric parameters and fecundity of *A. lobidens* in the Eastern Harbour of Alexandria, Egypt.

MATERIALS AND METHODS

Study area

The Eastern Harbour of Alexandria has an international concern due to its historical importance, as a reservoir for thousands of ancient Egyptian artifacts. Regardless of being small shallow semi-closed basin on the southeastern Mediterranean coast (Fig.1) the Eastern Harbour represents one of the coastal areas of changeable environmental conditions.

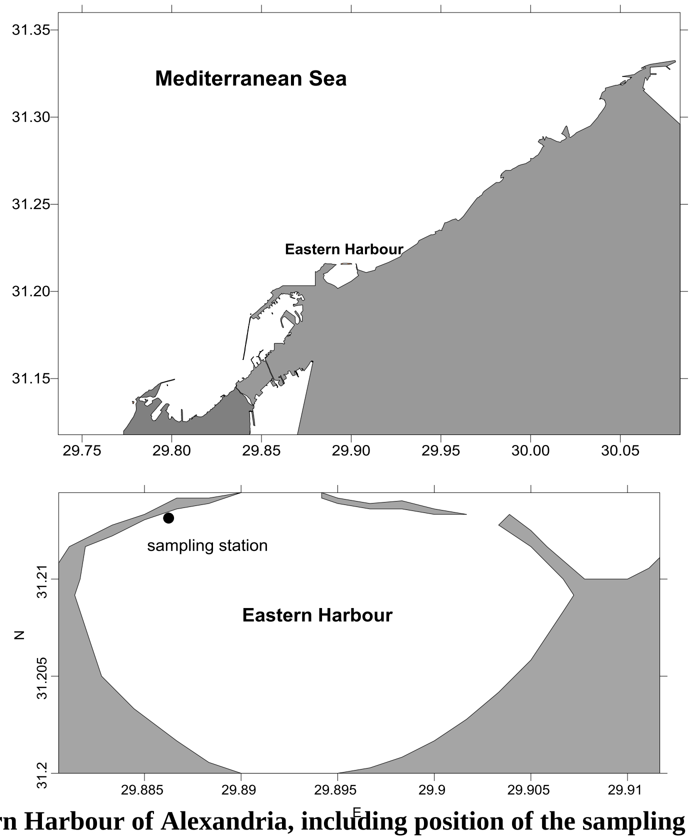

Fig. 1: The Eastern Harbour of Alexandria, including position of the sampling station.

These conditions are associated with fundamental changes during the past seven decades, including cessation of the Nile flood, modification of the sewer system of the Alexandria City, and variations in human activities. Other factors also impact the ecological characteristics of the Eastern Harbour , like the rapid water exchange with the sea during a flushing time of 1.3 - 2.9 days (El Bessa, 2011), seasonal current regime (Abdalla, 1979; El-Geziry and Maiyza, 2006), and remobilization of nutrients from sediments to the water column (Awad, 2004).

Samples collection

During the year 2018 bryozoan *C. alexandriensis* colonies were collected in three replicates during winter, spring, summer, and autumn, from rocky substrate at a depth of 1.0 -1.5 m in the Eastern Harbour of Alexandria (Fig. 1). The bryozoan shells were gently crushed in the laboratory and shrimp specimens were carefully collected, and preserved in 10% formalin.

Biometric parameters were measured for all the collected shrimps (76 specimens), including the total length (TL), total weight (TW), carapace length (CL: distance between tip of rostrum to the posterior margin of the carapace). The fecundity was determined by counting of all embryos of different developmental stages in the ovigerous females.

The relationships between the biometric parameters were assessed by using regression and Pearson moment correlation analysis. The length-weight relationship was determined according to the equation $W = aL^b$ (Hile 1936; Beckman 1948), where "W" is the total body wet weight (mg), "L" the body length (mm), "a" constant and "b" is the growth coefficient.

RESULTS

The physical chemical parameters in the study area are given in Table (1). The surface water temperature fluctuated between a minimum of 15.1°C in winter and a maximum of 29 °C in summer. Salinity sustained value between 33.9 ‰ and 36.5 ‰, that is mostly lower than the salinity of the offshore waters in the Egyptian Mediterranean Coast (usually > 38 ‰). This is mainly due to the direct and indirect effect of anthropogenic discharges from the adjacent lands. The pH was comparatively higher than that usually found in other areas and strongly correlated (r=0.67 - 0.81 in different seasons at p= 0.05) with the dissolved oxygen, that sustained high concentrations between 4.0 mg/l and 18.3 mg/l. The area was characterized by high nutrients accompanied by high phytoplankton biomass (Table 1).

Table 1: Variation ranges of physical chemical parameters in the area around the bryozoans during the sampling months (Shaban *et al.* personal communication, 2016).

	Feb.	Apr.	Jun.	Aug.	Oct.
Temp.	15.1 -18.1	18.5-23.5	25-29	29 -31.5	24.5 -27.5
Salinity	33.9 – 36.1	33.7 – 36.1	33.9 – 36.2	34.1 - 36.1	34.2 – 36.5
pH	7.85 – 8.28	7.94 – 8.4	7.92 – 8.71	7.89 - 8.49	8.04 – 8.72
DO	7.9-14.3	6.5 -18.3	6-17	4.35 -14.58	4.0 – 16.2
NO_2-N	0.5 – 14.2	0.3 -3.2	0.35 -1.57	0.46 - 1.73	0.24 -2.55
NO_3-N	7.99 -57.95	6 – 19.57	1.5 – 15.54	6.62 - 18.6	1.23 -42.05
PO_4-P	0.77 - 11.5	0.01-1.7	0.15 – 1.33	0 - 2.2	0.01 – 0.78
N/P	1.3 – 55.5	5.5-600.2	1.6 - 71	5.8 – 271.4	3.4 – 354.9
SiO_4-Si	0.01-14.8	0.4 – 8.7	0.8 – 4.9	0.8 - 12.1	0.6 – 9.1
Chl *a*	0.83 - 6.9	0.65 - 6.68	0.68 - 1.36	3.24 - 22.41	0.9 - 2.84

A total of 76 specimens of *A. lobidens* were collected during the present study, including 22 in winter, 43 in spring, 10 in summer (June and August), and one in autumn. As shown in Figure 2, the collected individuals had a total length between 9 and 32 mm, with the dominance (66.2%) of individuals with lengths between 10 - 20 mm. Meanwhile, the shorter (<10 mm) and longer individuals (>30 mm) showed pronouncedly low contribution to the total population (Fig. 2). The seasonal pattern of length distribution indicated the prevalence of the length group 15 -20 mm during winter and spring (Fig. 3 a, b), while the summer population was dominated by longer individuals, including 50% with length >25-30 mm and 30% with length between >20-25 mm (Fig. 3c). The autumn specimen had similar lengths of the summer individuals (30 mm).

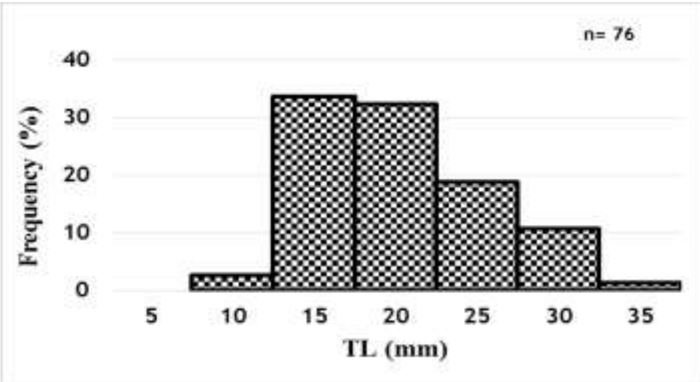

Fig. 2: Length frequency of *Alpheus lobidens* over the year.

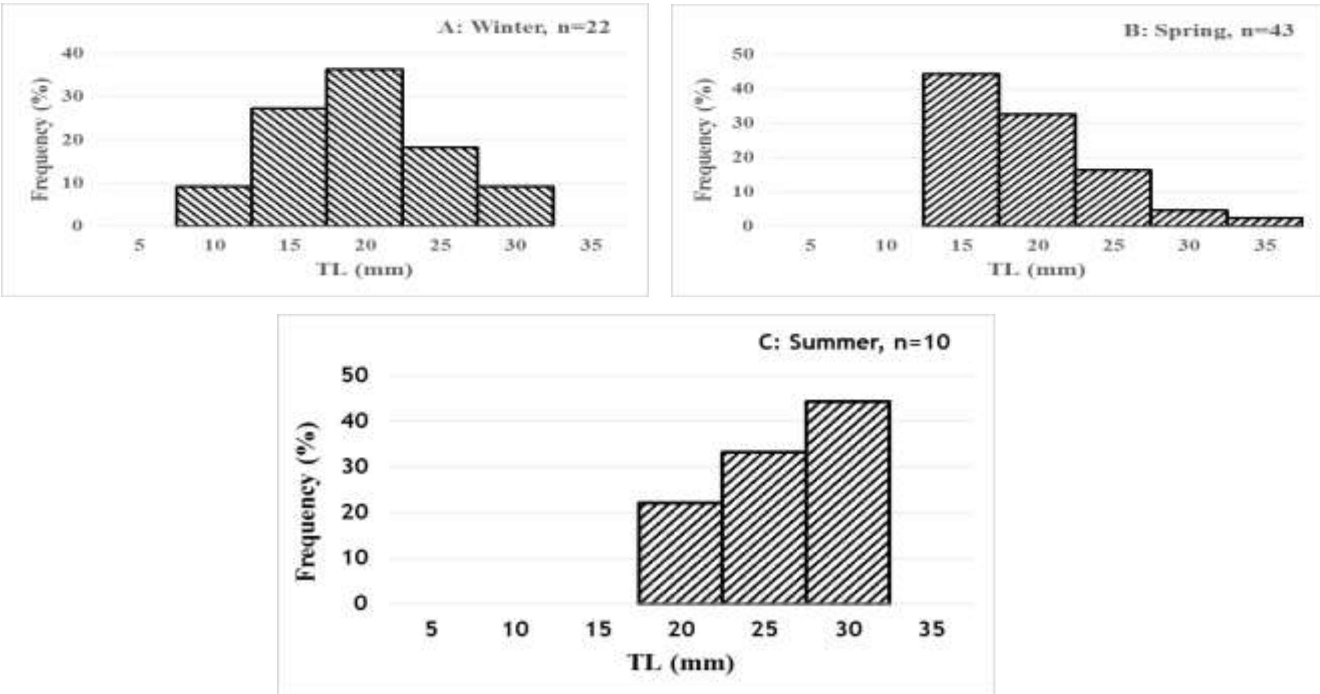

Fig. 3 Length frequency of *Alpheus lobidens* (n: number of specimens measured) in diferent seasons.

It is worth to mention that several specimen were weighed without one or both claws, because they were lost during the samples collection. The wet weight of shrimps without claws varied between 3 and 691 mg, and the majority of individuals (53%) displayed weight <100 mg, against 16% with 100-<200 mg and 12% with 200-300 mg (Fig. 4). The winter individuals without claws had weight between 18 and

418 mg, spring individuals between 25 and 691 mg and those of summer between 151 - 730 mg, while the single specimen of autumn weighed 715 mg.

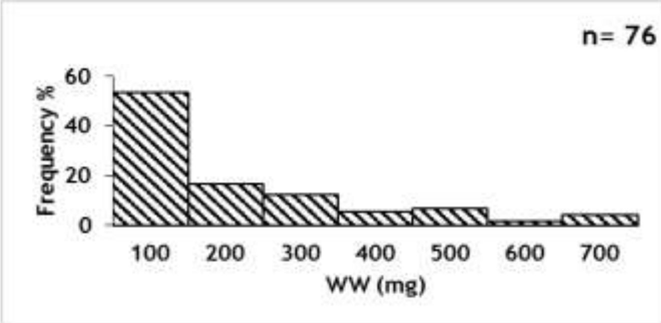

Fig. 4: Weight frequency of *Alpheus lobidens* over the year.

Based on the length and weight of individuals with the two chelipeds the formula of length-weight relationship for *A. lobidens* was calculated to be $W = 0.0175TL^{3.1899}$(r = 0.885, SE=0.06) (Fig. 5a), but when use carapace length with total weight the formula was $W = 0.2828CL^{3.4966}$ (r =0.877, SE=0.02) (Fig. 5b). Both equations revealed that the growth coefficient (b) was >3, indicating positive allometric growth. The regression relationship between the TL and the CL demonstrated a strong significant linear relationship at r= 0.966 (Fig. 6).

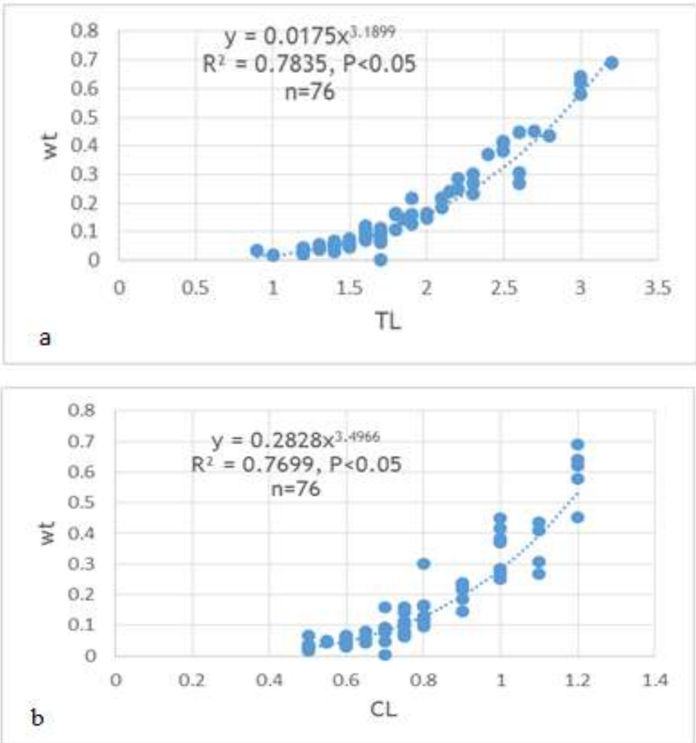

Fig. 5: Length-weight relationship of *Alpheus lobidens;* a: with total length (TL), b: with carapace length (CL).

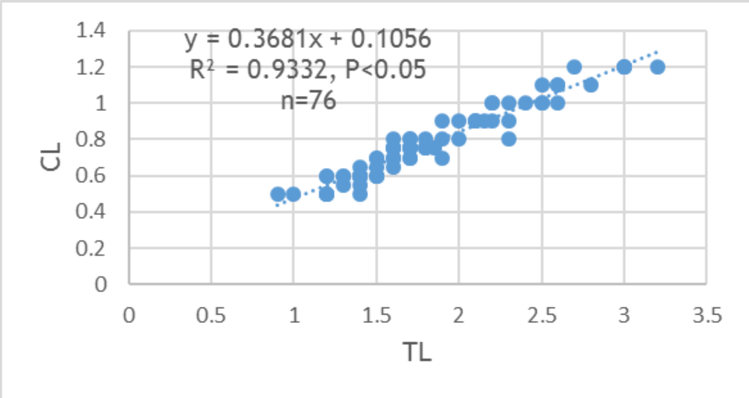

Fig. 6. Relationship between total length (TL) and carapace length (CL).

Of the total number of collected shrimp (76) during the present study, only 13 ovigerous females were observed with TL of 18 - 32 mm and CL of 8 - 12 mm. The fecundity of these females was estimated at 3 different embryonic developmental stages. The first stage included females carrying spherical eggs and had length range of 20-22 mm without clear embryos, these females showed a fecundity of 273±102 egg/female. The second stage was represented by females with TL of 23 mm and CL of 9 mm, carrying ellipsoidal eggs with young embryos and their fecundity was 302 embryos/female. The third stage comprised females with TL of 30-32 mm and carried ellipsoidal eggs with embryos near hatching, these females recorded fecundity of 563±112 embryos/female.

DISCUSSION

Alpheus lobidens exhibited ability to exist in the intertidal zone and deeper to about 25 m (Banner and Banner, 1982) in widely different substrates, like carbonate sand horizontal tunnel (Farrow, 1971), jumble of boulders shores, small stones, loose bedrock, coarse sand, dead coral reef and oil polluted muddy sediment (Hosseini, 2009). In the Eastern Harbour of Alexandria, *A. lobidens* was found in association with the calcareous shells of the bryozoan *C. alexandriensis* on hard shallow bottom at depth range of 1-1.5m.

The world wide geographic distribution of *A. lobidens* indicates its ability to exist under different ecological conditions, like temperature, salinity, water movement, food availability and others. However, its numerical abundance appeared to be largely affected by these conditions as indicated from the great differences in the abundance of this species among the studied world regions (Table 2). During the present study, *A. lobidens* occurred at comparatively low salinity (33.7 – 36.5 ‰), relatively wide pH range (7.85- 8.71), and high phytoplankton biomass (chl *a*: up to 6.9 µg/l). Despite the high fertility of the Eastern Harbour as favourable habitat for *A. lobidens* it hosted pronouncedly low count of this shrimp as compared to other world areas (Table 2). This may be explained by the rapid change in the environmental conditions due to the short flushing time, the effect of anthropogenic discharges, and the strong wave action on the sampling site.

Table 2: The individual count of *Alpheus lobidens* in different coastal regions.

Area	Count	Reference
Malayo-Thai waters	180	Soledade and Almeida, 2013
Red Sea	200	Soledade and Almeida, 2013
Australia	500	Soledade and Almeida, 2013
Irani Coast on the Gulf of Oman	872	Burukovsky *et al*. 2017
Omani Coast, Gulf of Oman	58 females	Ansari and Maghsoodlou, 2017
Eastern Harbour of Alexandria	76	Present study

On the other hand, the individuals of *A. lobidens* in the Eastern Harbour are shorter than in some areas of the Pacific Ocean, South African coast, and Iranian Coast on the Gulf of Oman. However, these individuals had close length to those in the western Pacific and Indian Ocean, but they are longer than individuals collected from Thailand, Red Sea, Kaneohe Bay, and Hawaii (Table 3).

Table 3: Maximum total length of *Alpheus lobidens* in different coastal regions.

Area	TL (mm)	Reference
Hawaiian area, Pacific Ocean	44	Banner & Banner 1982
South African coast	55	Barnard, 1950
Iranian Coast	59	Burukovsky *et al.* 2017
western Pacific and Indian Ocean	36	Soledade and Almeida, 2013
Thailand and Red Sea	20	Soledade and Almeida, 2013
Kaneohe Bay, Hawaii	24	Banner and Banner, 1974
Eastern Harbour of Alexandria	32	Present study

According to the regional differences in its length, two populations of *A. lobidens* were distinguished, one with higher growth from the central Pacific (Banner, 1959) and the other with lower growth (up to 36 mm) from Malayo-Thai waters, Australia, and the Red Sea (Banner and Banner, 1974). This means that specimens of *A. lobidens* in the Eastern Harbour could be referred to the population of lower growth. Banner and Banner (1974) supposed that a slight difference in gene pools of the two populations permits the western form to reach greater size. Remarkable colour variations were observed among different specimens from the Red Sea (Banner and Banner, 1981) and in the Persian Gulf specimens (Naderloo and Türkay, 2012). The specimens of the present study were characterized by greenish-brown, pale longitudinal stripes on abdomen, chela brownish, fingers of larger chela orange apically violet, while in formalin preserved specimens the colour turned orange.

The distribution with time of mature females in the Eastern Harbour indicated that summer was more suitable for reproduction of *A. lobidens* as they formed 62.5% of the total number of summer shrimps, against 14% in spring and 9% in winter. This agrees with Ansari and Maghsoodlou (2017), who recorded high percentage of ovigerous females (82.7%) during summer on Omani Coast. Also, the carapace length of the ovigerous females in our study (8 - 12 mm) was close to that (6-15 mm) recorded by Ansari and Maghsoodlou (2017). The occurrence of highest number of individuals in spring in the Eastern Harbour may indicate that water temperature in spring (18-23^{o}C) was more suitable for the best growth of Juvenile shrimp, while summer temperature (25-29^{o}C) seems to be better for egg production and embryo development. Ansari and Maghsoodlou (2017) reported 5 developmental stages among 48 females of *A. lobidens* in Omani coast, but only 3 stages were recognized during our study among 13 ovigerous females collected from the Eastern Harbour.

It is to be noted that this research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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