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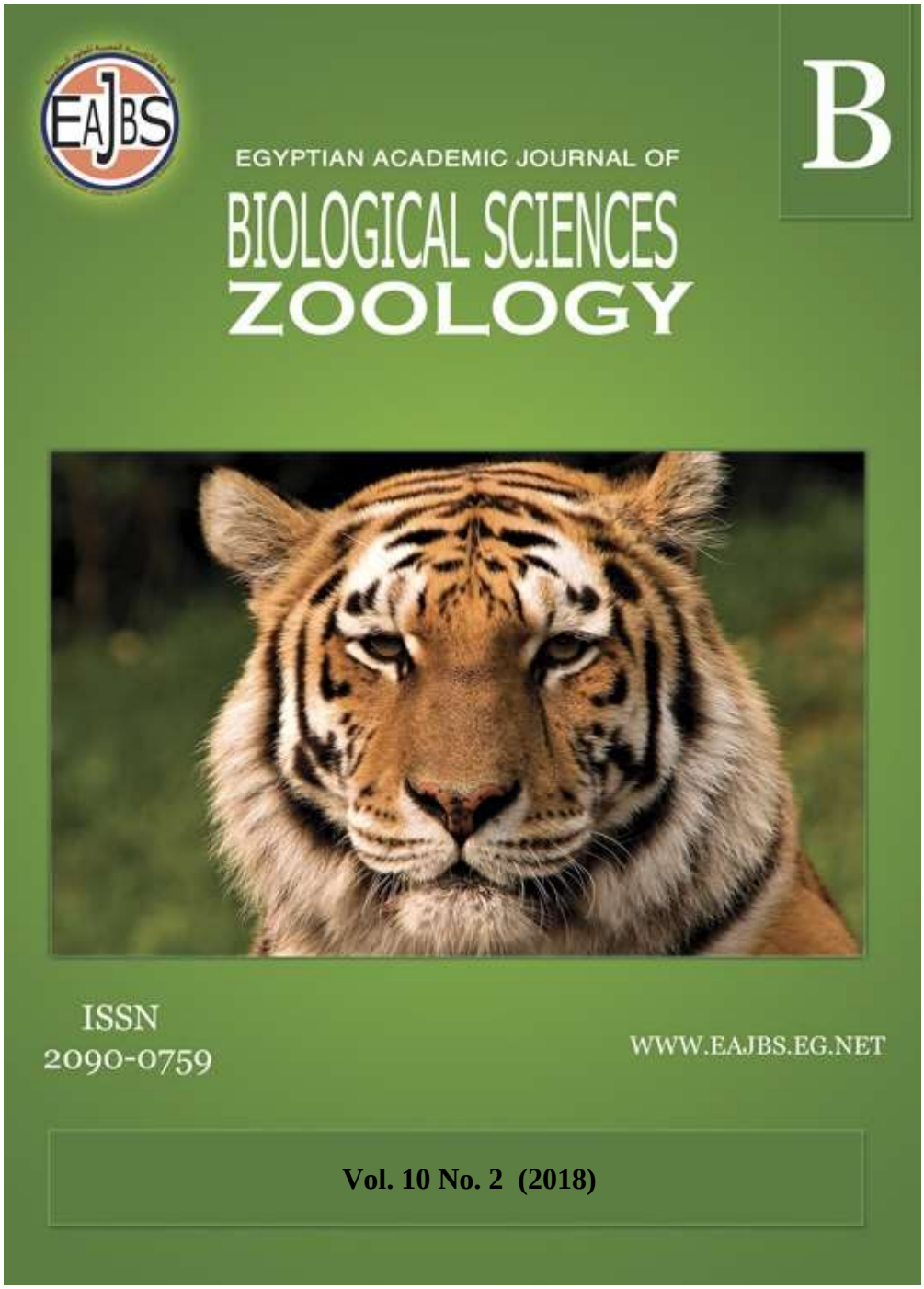

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Biological Aspects on the Blue Crab, *Callinectes sapidus* (Rathbun, 1896) Inhabiting the Bardawil Lagoon, Northern Sinai, Egypt

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ABSTRACT

A total of 161 specimens of *C. sapidus* were collected during the fishing season from November 2016 to July 2017, of the 100 specimens were males (62.1%) and 61 were females (37.9%). The number of obtained specimens has seasonally fluctuated. The highest number of individuals was 67 (41.6%) obtained during spring, compared with the minimum number of 28 individuals (17.4%) collected in summer. The present results showed that 87.3% of the population fell within 75 and 124.9 mm CW and was represented by two modes comprising the sub adults and adults. There were seasonal changes in the size frequency distribution of pooled samples of this species. Males over-dominated females and were represented by the general sex ratio of 1:0.61 males: females. This ratio was tested using the Chi-square (X^2) Test for Goodness ($P<0.05$, df=1) and recorded significant differences in autumn and winter (X^2 = 20.82 and 9.32, respectively), where males outnumbered females, but not significant in spring and summer. These results showed also that five maturity stages of females were determined based on morphological shapes called immature, maturing, mature, ripe and spent, but no ovigerous females were detected among the seasonally obtained specimens. The estimated size for 50% sexually mature females was 96 mm CW. There were seasonal changes in the percentage of females with regard to the different maturation stages. Gonad index indicated that males had the highest average in spring and exceeded females which had the highest in summer.

INTRODUCTION

The blue crab, *Callinectes sapidus* Rathbun, 1896 is a portunid crab inhabiting estuaries and shallow coastal waters to 90 m depth (Castriota *et al*., 2012). It is generally found over muddy and sandy bottoms and has a wide ecological tolerance. It is easily identified by its body color which is generally a bright blue along the frontal area, especially along the chelipeds. Blue crabs are blue because their shell contains a number of pigments, including Alpha-crustacyanin, which interacts with a red pigment, astaxanthin, to form a greenish-blue coloration (Abowei & George, 2009).

C. sapidus originated from the western Atlantic, but now became common and occurs in the entire Mediterranean where it is considered an invasive species (Streftaris & Zenetos, 2006). After its first record in the Venice lagoon at northern Adriatic by Giordani Soika (1951), it has been widely reported from various different Mediterranean regions, especially in the eastern part (Galil *et al*., 2002). Several records have been published in recent years, with regard to the species' distribution in the Adriatic (Florio *et al*., 2008) and other parts of the Mediterranean Sea (Tuncer & Bilgin, 2008), relating this expansion to the increase of maritime transportation. The importance of the commercial and recreational fishing of this species is increasing, while its occurrence and ecological significance are receiving more interest along the Mediterranean coast of Egypt (Miller *et al*., 2011).

Bardawil Lagoon is one of the five northern lakes in Egypt. It is bordered from the north by a convex sand barrier that separates it from the Sinai Mediterranean coast and from the south by the sand dune belt. The extreme eastern part of this lagoon is a Zaranik Protectorate (Khalil *et al*., 2013). Although it is shallow and oligotrophic, it represents one of the most important lagoons in Egypt as a source of good quality fish as well as a good habitat for wildlife (Touliabah *et al*., 2002). It is the least polluted lagoon in Egypt and in the entire Mediterranean region which makes it the main ecological and economic natural resource of the North Sinai region (Khalil *et al*., 2013).

Callinectes spp. has been studied by several scientists all over the world. These studies provided a good understanding of the biology of this genus such as population dynamics in a sub-estuary of the central Chesapeake Bay, U.S.A (Hines *et al*., 1987 and Sharov *et al*., 2003) and in the Gulf of Nicoya, Costa Rica (Fischer & Wolff, 2006). Blue crabs are known as iteroparous, which mean they are characterized by multiple reproductive cycles over the course of their lifetime (Jivoff *et al*., 2007). This allows them to release eggs over an extended period to take advantage of favorable environmental conditions that may exist for only part of their spawning season.

However, detailed information on the biology of *C. sapidus* in Bardawil Lagoon is scarce. These studies are needed in order to document the intraspecific variations between populations from the different sites, as well as for the proper exploitation and management of the fishery of this economically important species. This paper aims to represent a comprehensive study in the biology of *C. sapidus* from Bardawil Lagoon comprising its abundance, frequency distribution and reproductive biology.

MATERIALS AND METHODS

Study Area:

Bardawil Lagoon is a natural lagoon located on the northern coast of the Sinai Peninsula, Egypt (Fig. 1). It is one of the least polluted lagoons in Egypt's Northern Lakes (Fanos *et al*., 1994**)** as well as in the entire Mediterranean Sea. The Egyptian authorities allow only very limited eco-friendly human activities in the surroundings of the lagoon. At the eastern part of the lagoon lies the Zaranik Protected Area (PA) in which all developmental and industrial activities are banned except for the salt production industry. The Lagoon's length is approximately 76.37 km (extending from 31°03′ 0" N to 31°14′ 0" N and 32°40′ 0" E to 33° 30′ 0" E) and has a maximum width of 16.65 km, occupying a total surface area of approximately 518.99 km^2 (Abd Ellah & Hussein, 2009).

Seawater enters the lagoon through three inlets, two artificial tidal inlets (western and eastern inlets) and a natural eastern inlet of Zaranik (PA) which is occasionally closed by silting. The water exchange in the lagoon is regulated by the Mediterranean Sea's tides and has a mean tidal excursion of 25 cm during neap tides and about 35 cm during spring tides, while the wind is responsible for internal circulation. Water temperature of the lagoon is low in winter (17.3-20.2ºC) and high in summer (27.2-30.5 ºC); salinity ranges from the lowest value of 38.3% in winter to the highest of 63% in summer (Emam, 2010).

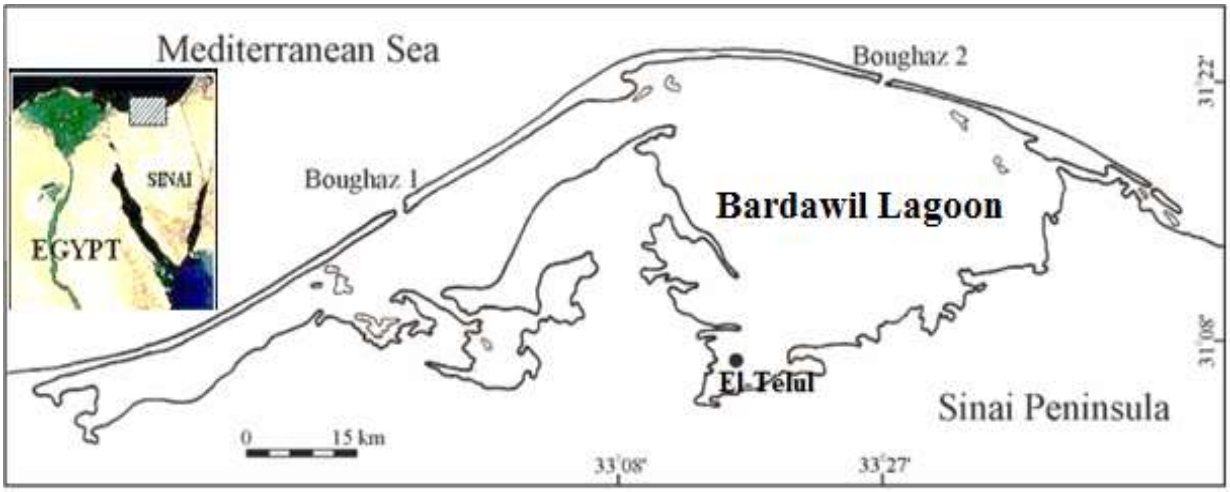

Fig. 1. Map showing Bardawil Lagoon.

Collection and Processing of Samples:

The fisheries in the Bardawil Lagoon are seasonal, extending from April or May to December of each year. Random samples of *Callinectes sapidus* were collected seasonally from the commercial catch at the landing site (El-Telul) on the lagoon during the fishing seasons of 2016-2017 (from November 2016 to July 2017). Fishermen used trammel nets (locally called Dabba and Dahabana) instead of bottom trawlers (Kalsa) which were banned by the military authorities. After capture, the whole catch was taken and placed in perforated cartoon box and transported back to the laboratory for further examination.

Specimens were sexed according to abdominal morphology. Crabs which were not in a healthy condition and those with missing legs and broken carapaces were not included as they may be a source of bias which may greatly affect the regression of weight.

Morphometric Measurements:

The following measurements were taken by means of Vernier Calipers with an accuracy of 0.1 mm according to Williams (1974).

1- Carapace width (CW): the distance between the tips of the ninth antero-lateral spines.
2- Carapace length (CL): measured dorsally along the midline, between the frontal marginal teeth and the posterior margin of the rear edge of the carapace.
3- Abdomen width (AW) for females: measured at the maximum width across the 5th segment.

Total body weight (TBW) of all specimens was determined to the nearest gram using a digital balance (0.01 g) (Sartorius GMBH).

Samples were dissected and gonads were examined. They were then removed and weighed to the nearest gram. The gonad index (G.I.) was calculated and

expressed as a percentage of the total body weight according to **Ansel (1961)** as follows:

$$\text{The gonad index (G.I.)} = \frac{\text{Ovary wet weight}}{\text{Total wet body weight}} \times 100 \qquad [1]$$

Gonad Examination:

Females' ovaries were examined and their maturation stages were determined and classified into immature, maturing, mature and ripe according to **De Lestang *et al*. (2003)**, but with some modification by adding spent stage.

The proportion of sexually mature females, based on the number of females exceeding the immature stage in the ovary development, was determined for each size class. A logistic curve can be fitted to the proportion (*P*) of sexually mature females by carapace width CW adapting Campbell (1985) gives:

$$P = 1/(1 + \exp[-(a + b\,CW)]) \qquad [2]$$

and the logarithmic transformation

$$\ln [(1 - P)/P] = (a + b\,CW) \qquad [3]$$

Where *P* is the predicted mature proportion, *a* and *b* are the estimated coefficients of the logistic equation and CW is the carapace width. The estimation of parameters of this equation was made by correlation analysis of variables *P* and CW after linearization. Size at sexual maturity (CW_{50}), corresponding to a proportion of 0.5 sexually mature females, was estimated as the minus ratio of the coefficients (CW_{50}= - (*a*/*b*) by substituting P = 0.5 in the equation [3].

RESULTS

Overall Abundance:

Between November 2016 and July 2017, a total of 161 individuals of *C. sapidus* were sampled. The sample included 100 males (62.1%) and 61 females (37.9%).Males remarkably outnumbered females during the course of this study. However, some remarkable seasonal fluctuations were noticed. The number of individuals fluctuated seasonally. The highest was 67 (42%) obtained during spring while the minimum was 28 (17%) in summer **(Table 1)**.

Size Composition:

The 161 individuals varied from 65.3 to 163.2 mm in CW, 33.1 and 72.9 mm CL, and from 16.7 to 278.3 g for body weight (Table 1). Males were larger than females and had their CW ranging between 65.4 and 163.2 mm, CL from 33.8 to 72.9 mm and total body weight (TBW) between 24.7 and 278.3 g. In contrast, females' dimensions ranged between 65.3 and 134.5 mm CW; 33.1- 57.6 mm CL and 16.7-119.99 g total body weight (Table 1).

Size Frequency Distribution:

The carapace width – frequency distribution is shown in Figure 2. A least 4 peaks are present. At least 87.3% of the population fell within 75 and 124.9 mm CW. This was represented by two modes comprising the subadults and adults. However, only 3.1% of the population was smaller than 75 mm (immature), and ≈ 9.6 % were found between 125-164.9 mm CW (fully mature individuals).

Table 1. Ranges and means of size and weight of *C. sapidus* collected from Bardawil Lagoon during the study period (November 2016 –July 2017).

Measurements / Seasons &sex		№.	%		Carapace width (mm)			Carapace length (mm)			Total body weight (g)		
					Min.	Max.	Mean ±SE	Min.	Max.	Mean ±SE	Min.	Max.	Mean ±SE
Autumn 2016	♂	31	22	88.5	83.1	163.2	119.24 ±20.89	43.1	72.9	57.20 ±8.49	53.71	278.3	142.89 ±63.64
	♀	4		11.5	85	126.6	107.74 ±16.20	47	57.49	52.13 ±4.59	42.57	79.24	64.73 ±13.62
Winter 2017	♂	24	19	77.4	81.6	127.3	103.85 ±11.47	41.5	60.2	50.01 ±5.4	37.49	169.92	87.40 ±35.14
	♀	7		22.6	84.4	124	100.04 ±13.68	39.5	54.6	46.26 ±5.77	39.2	119.9	67.31 ±28.05
Spring 2017	♂	32	42	47.7	65.4	109.2	88.56 ±10.53	33.8	54.3	43.49 ±4.77	24.7	122.6	58.36 ±22.95
	♀	35		52.3	65.3	134.5	86.87 ±15.39	33.1	57.6	41.51 ±5.71	16.7	98	43.04 ±17.32
Summer 2017	♂	13	17	46.4	78.2	114.1	93.68 ±12.09	37.3	56.5	47.48 ±4.51	31	113.4	65.71 ±28.75
	♀	15		53.6	85.6	121.1	101.84 ±10.37	34.9	52.4	44.3 ±4.98	27.5	93	52.75 ±17.74
All seasons	♂	100	62.1		65.4	163.2	102.4 ±19.62	33.8	72.9	49.84 ±8.5	24.7	278.3	92.49 ±55.85
	♀	61	37.9		65.3	134.5	93.43 ±16.31	33.1	57.6	43.44 ±6.08	16.7	119.9	49.64 ±20.91
	Total	161			65.3	163.2	99.01 ±18.89	33.1	72.9	47.41 ±8.26	16.7	278.3	76.25 ±50.29

Legend: SE= Standard error.

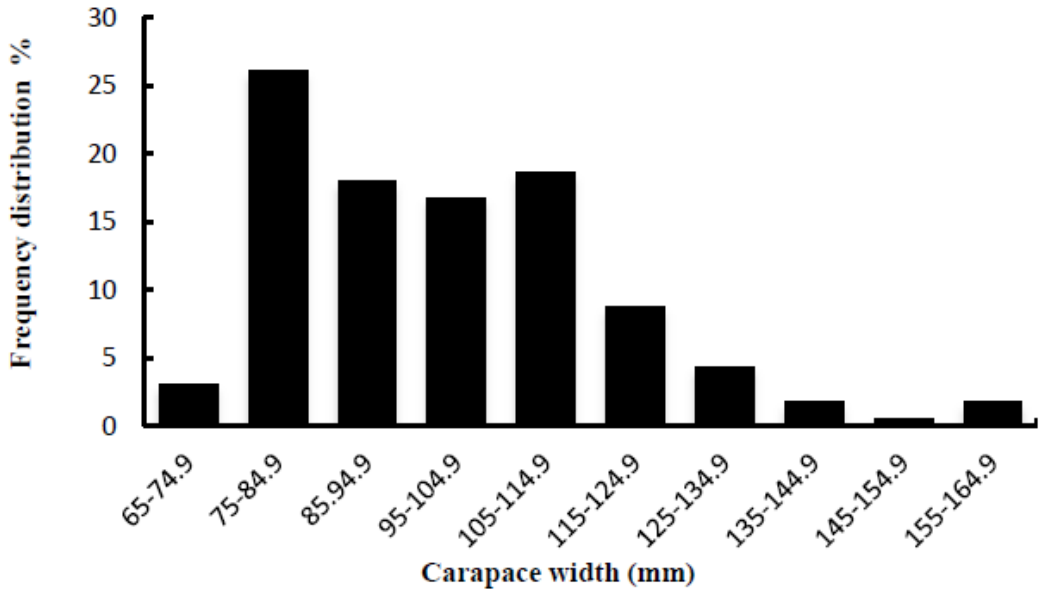

Fig. 2. Carapace width – frequency distribution of the whole population of *C. sapidus* from Bardawil Lagoon during 2016 – 2017.

Figure 3 shows the seasonal changes in the size frequency distribution of pooled samples of *C. sapidus*. Four peaks were noticed during autumn, comprising all size classes. Adults disappeared during winter, and the whole population was represented by medium-sized individuals. By the onset of spring, recruitments of the juvenile were observed with a distinct peak at 75 mm in addition to few medium sized individuals. However, during summer, all population was represented by medium-sized individuals ranging between 85 and 105 mm.

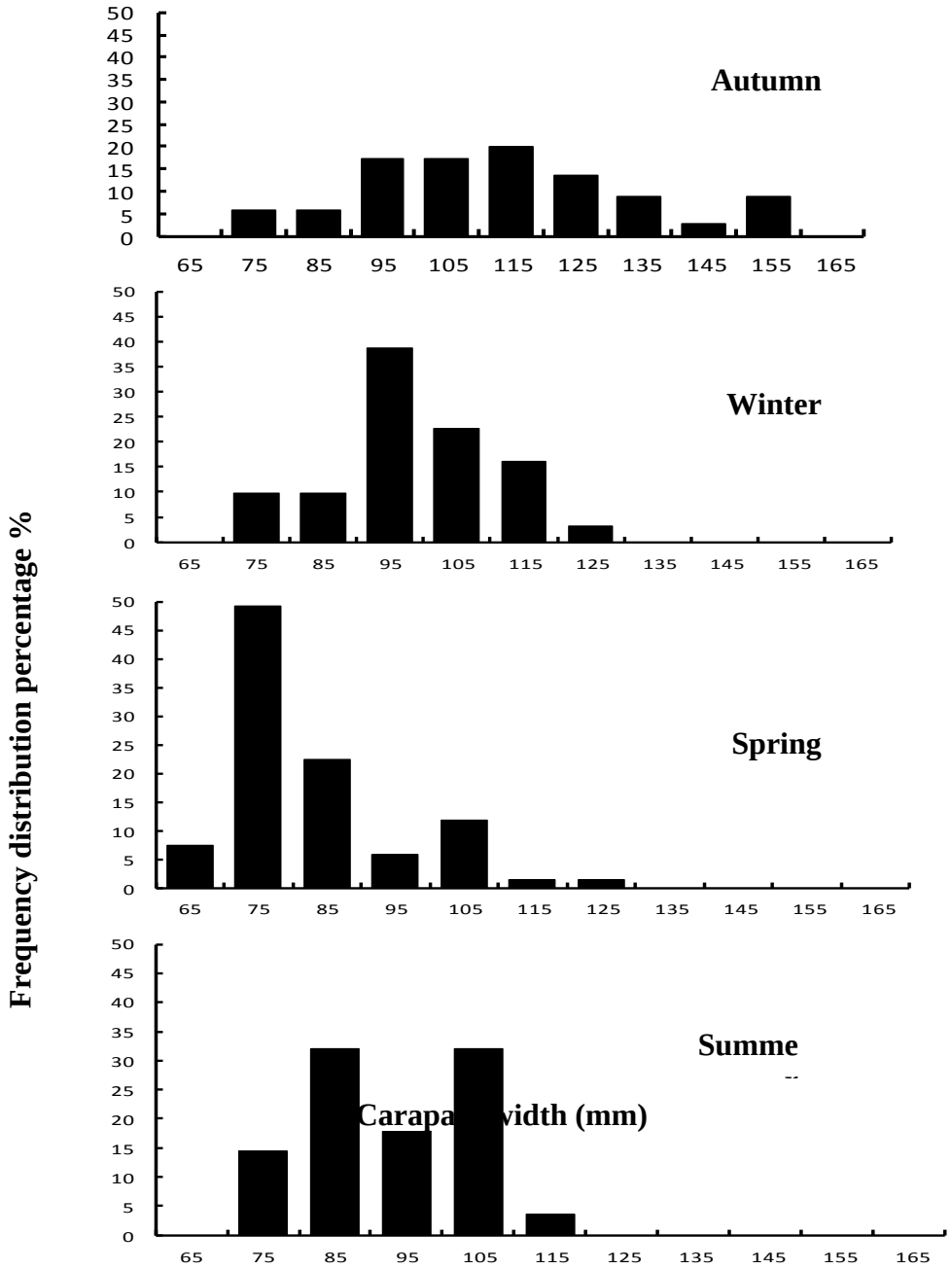

Fig. 3. Seasonal frequency histograms for the carapace width of pooled samples of *C. sapidus* in Bardawil Lagoon during the period of study.

Sex Ratio:

Figure 4 shows the seasonal change in the sex ratio for *C. sapidus* in the study area. The ratio was significantly different (1 male: 0.61 female, X^2 = 9.44, d.f.=1, *P*>0.05). The significant difference was recorded between autumn and winter (X^2 = 20.82 and 9.32, respectively), where males outnumbered females, but no significant difference was detected in spring and summer.

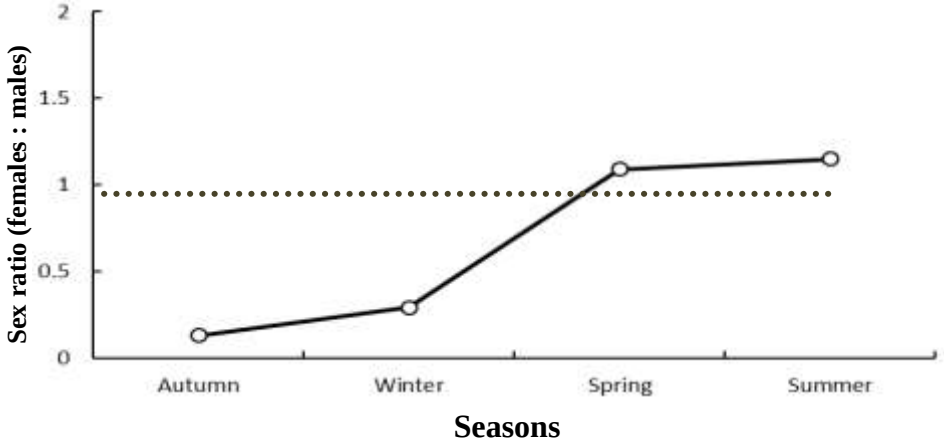

Fig. 4. Seasonal variations in the sex ratio of *C. sapidus* in Bardawil Lagoon. The dotted line indicates the ratio of 1:1(females**:** males).

Female Maturity Stages:

Figure 5 describes the seasonal percentage occurrence of the different five maturity stages of females *C. sapidus* during the present study. Immature females were found during the different seasons with a high percentage in spring. On the other hand, the high percentage of individuals in the maturing stage appeared during spring, while females with mature ovaries were recorded in spring and summer with a high peak in spring. Finally, females with ripe ovaries were observed in winter, spring and summer with a high peak in summer, followed by the appearance of the spent stage in autumn and winter. No ovigerous females were detected during the study period.

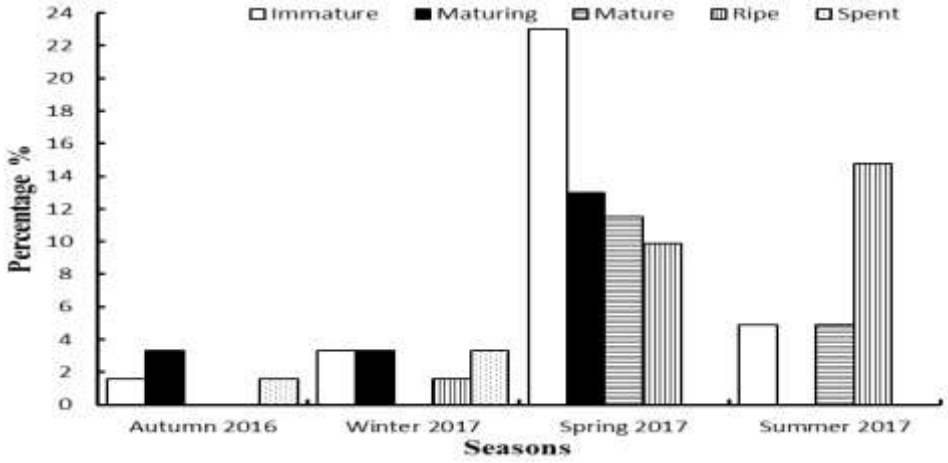

Fig. 5. Seasonal variations in maturity stages of *C. sapidus* females from Bardawil Lagoon.

Size at First Sexual Maturity:

The 61 females *C. sapidus* examined ranged from 65.3 to 134.5 mm CW. Of these, 29 females were in sexually mature condition. **Table 2** shows the proportions of sexually mature females within each 10 mm carapace width (CW) size class. The relationship between carapace width (CW) and the proportion of mature female (*P*) by 10 mm CW classes were represented by the cumulative maturity curve in **Figure 6**. The estimated size for 50% sexually mature females was 96 mm CW.

Table 2. Number of total and mature females of *C. sapidus* by size classes, and the corresponding proportion of mature females in Bardawil Lagoon.

Size classes **Carapace width (mm)**	**Total number of females in sample**	**Number of mature females**	**Proportion mature**
65 – 74.9	4	0	0
75 – 84.9	18	0	0
85 – 94.9	8	1	0.13
95 – 104.9	11	9	0.82
105 – 114.9	12	11	0.92
115 – 124.9	6	6	1
125 – 134.9	2	2	1
Total	**61**	**29**	

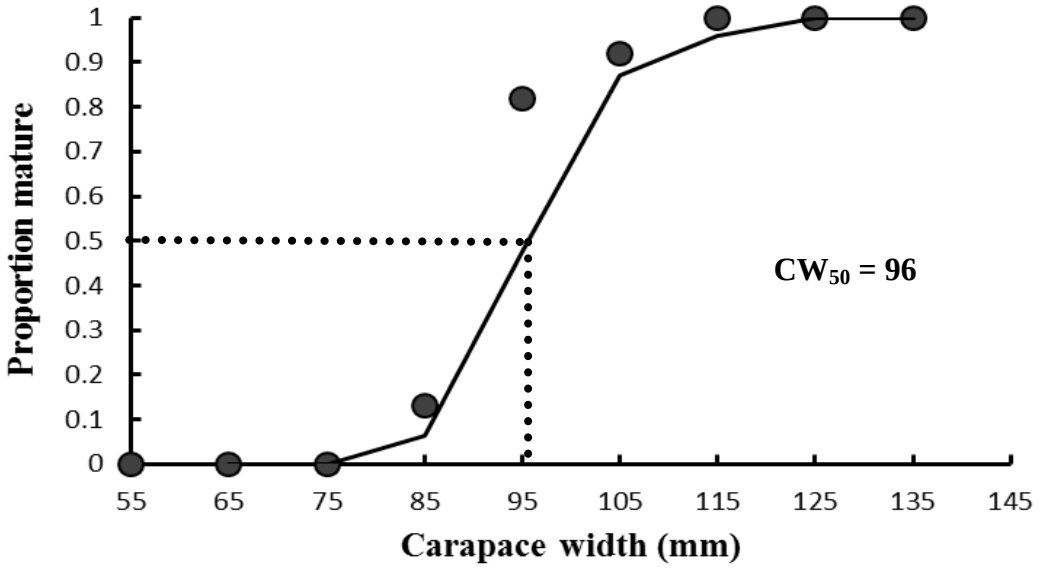

Fig. 6. Size of 50% maturity in different size classes of female *C. sapidus* estimated by evaluating the cumulative curve. The value of CW_{50} which corresponds to a proportion of 0.5 is indicated.

Seasonality of Spawning:

Over 50% of the female population was mature in spring compared to 5% in autumn **(Figure 7). Figure 5** shows the seasonal changes in the percentage of females with regard to the different maturation stages. Females with undeveloped ovaries (immature) occurred most commonly in the spring season. Females in the maturing stage occurred all year except in summer where there were none. The beginning of the ovarian development (females in mature stage) was seen mainly in spring and summer, with a pronounced peak in spring. Females with ripe ovaries were seen all year except in autumn with a marked peak in summer.

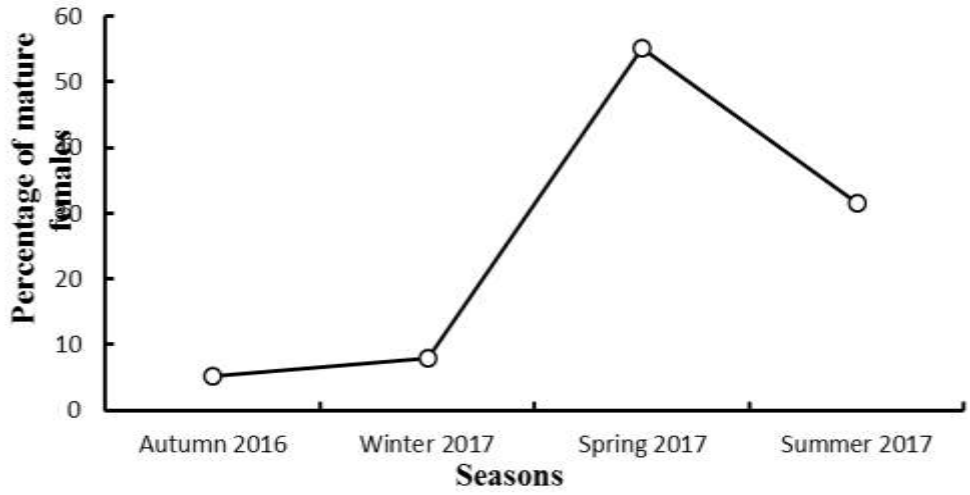

Fig. 7. Seasonal changes in the percentage of mature females of *C. sapidus* in Bardawil Lagoon.

Gonad Index:

Mean Values of female gonad index (G.I.) showed their minimum in winter and their maximum in summer (1.29, 3.4) respectively (Figure 8). On the other hand, males G.I. values displayed their highest in spring and lowest in autumn (1.5, 0.96) respectively.

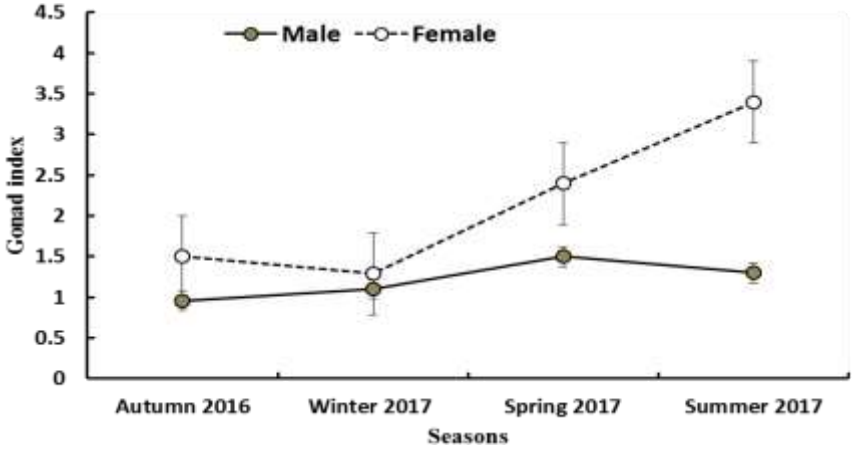

Fig. 8: Seasonal variations in the mean values of G.I. of males and females of *C. sapidus* collected from Bardawil Lagoon during the period of this study. Vertical lines indicate standard deviation.

DISCUSSION

Abundance of Collected *C. sapidus* Specimens:

In the present study males of *C. sapidus* existed in greater number than females. Similar results were reported by Emam (2010) for *Portunus pelagicus* in Bardawil Lagoon and Jivoff *et al.* (2017) for *Callinectes sapidus* in Barnegat Bay, New Jersey. However, Sforza *et al*. (2010**)** for *Callinectes danae* in a tropical Brazilian Estuary, stated that the number of females was higher than the number of males.

The blue crab population of the present study fluctuated in abundance with seasons. However, these changes in relative abundance did not reveal an interesting feature of this population. The highest numbers of *C. sapidus* were recorded in spring and the lowest numbers in summer. These results are in accordance with Cetin and Hasan (2013) in the Beymelek Lagoon, Southwestern Coast of Turkey.

The low number of specimens collected during this study is attributed to the restriction imposed by the Egyptian General Authority for Fish Resources Development as well as the Military Authorities that are managing and regulating the fishing effort in Bardawil Lagoon. Fishing activities are banned between January and March of each year. This period (called biological rest period) has been chosen in consistent with the spawning season of resources in order to allow them to reproduce safely without any fishing pressure.

Size Composition:

In most true crabs, males are larger and heavier than females (Pinheiro & Fiscarelli, 2009). In the present work, males are larger and heavier than females and exhibited more variation in size than females did. This could be explained by the differential reproductive effort between sexes. Males present a mate-guarding behavior during and after copulation, providing protection to the recent post-molt females (Pinheiro & Fransozo, 1999). On the other hand, females direct a large portion of the energy budget to the eggs production (Kotiaho & Simmons, 2003). Therefore, the somatic growth is reduced in detriment of the reproduction (Ferkau & Fischer, 2006).

Size Frequency Distribution:

Size frequency distribution usually provides evidence of continuous recruitment in the size classes and mortality rates (Negreiros-Fransozo *et al*., 1999). In the present study, the size frequency distribution of the whole sample showed four modal size distributions but the majority of the crabs (87.3%) were in the medium-sized group (75-124.9 mm CW). Similar results were reported in Nigeria by Arimoro & Idoro (2007) and Lawal-Are & Kusemiju (2000) for *Callinectes amnicola*, Doi *et al*. (2008) for *Charybdis bimaculata* and Lawal-Are & Bilewu (2009) for *Portunus validus*. Large sized individuals were recorded in autumn while recruitment appeared in spring. This trend has been previously reported for C. *sapidus* of Bardawil Lagoon (Abdel Razek *et al*., 2016). The trammel net that is being used for crab's fisheries in Bardawil Lagoon has a mesh size that ranges between 100-120 mm. This interprets the complete absence of juveniles from the samples. This fishery regulation does not only help with the survivorship of young in the lagoon but also reduces the fished amounts of juveniles which are considered a by-catch and have no economic value.

Sex Ratio:

The sex ratio for *C. sapidus* was strongly skewed towards male dominance over females during autumn and winter. However, the ratio was more balanced in spring and summer. This agrees with other regions where sex ratio is more

equilibrated or even in favor of males such as Santa Catarina isle, Brazil (female to male ratio 1:1.19; Branco & Masunari, 2000; 1: 3.88; Pereira *et al*., 2009) and Venezuela (0.8:1; Carmona-Sua´rez and Conde, 2002). Other authors found females dominating over males as reported by Keunecke *et al*. (2008) at Guanabara Bay and Severino-Rodrigues *et al*. (2009) in the lagoon-estuarine system of Iguape-Canane´ia (3.9:1 and 1.94:1, respectively). The sex ratio in *C. sapidus* population in Beymelek Lagoon was in favor of females (Cetin and Hasan, 2013). Such differences are difficult to explain because each local area has its own peculiarities, such as salinity and fishing pressure, the longevity and growth of crab populations (Sforza *et al*., 2010). Berglund (1981) suggested several hypotheses to interpret variation in sex ratio within palaemonid species. He supposed that males presented a reduction in energy investment for growth so as to lower predation risks. The variation in sex ratio could be explained by the different total mortality's rates between sexes, different migration pattern in the lagoon system and these parameters seem to affect their relative occurrence.

Seasonality of Spawning:

In brachyuran crabs, size at which sexual maturity is attained may vary from place to place and within individuals of the same species at the same location (Sukumaran & Neelakantan, 1997). The reproductive and growth patterns within the life cycle of a given aquatic species depend on season and are typically faster in warmer months but slower in colder months (Bembe *et al*., 2017). Hence, many aquatic species undergo seasonal migration to areas with permissive and suitable environmental conditions for reproduction, spawning and juvenile growth (Thongda *et al*., 2015). Some decapod crustaceans, including *C. sapidus*, adopt an export strategy specifically for spawning and larval development, which take place in an area with higher salinity (Epifanio & Garvine, 2001). Moreover, blue crab spawning is dependent on water temperature, with a required minimum of at least 15°C (Archambault *et al*., 1990).

Females *C. sapidus* of Bardawil Lagoon matured at smaller sizes during late autumn – early winter and at larger sizes during spring – summer. Also, females with ripe ovaries were recorded in winter, spring and summer with a high peak in summer, which give evidence that females of this species are spawning multiple times per year. This result concurs with those reported for *C. sapidus* in U.S.A. (Fisher, 1999), Chesapeake Bay (Gelpi *et al*., 2009), Atlantic Ocean (MacCanaugha, 2010), the Atlantic coast of Florida (Ward, 2012) and the northern Gulf of Mexico (Perry & van der Kooy, 2015). Also, the highest spawning period of *C. sapidus* was in summer in the Beymelek Lagoon, Southwestern Coast of Turkey (Cetin & Hasan, 2013). On the other hand, females of *Callinectes danae* in a tropical estuary, Santa Cruz Canal, northeastern Brazil were reproductively inactive in winter and beginning of spring and the first spawning season occurred in summer (Shinozaki-Mendes & Lessa, 2017). The reproductive season for *C. sapidus* begins during spring and summer where immature and mature individuals are abundant. Females in the spent stage were noticed in autumn and winter, indicating the end of the spawning season.

Kangas (2000) stated that in temperate regions, female crabs of *P. pelagicus* suspend ovary development during winter but ovary development did not complete at the previous autumn. Females actively feed and develop ovules until the temperature becomes limiting in late autumn. The maturation of the ovary is then suspended throughout winter until temperatures rise again in spring and ovule maturation is completed.

Darnell (1959) reported that *C. sapidus* mates in low salinity areas but females migrate to higher salinity areas for egg laying and incubation. This explains the absence of ovigerous females from the catch. Berried females migrate to the Mediterranean Sea to lay and incubate their eggs. *C. sapidus* has been reported to settle in saline areas where the larvae have developed then migrate into shallower areas (Darnell, 1959).

Size at First Sexual Maturity:

The knowledge of size at first maturation is fundamental to the management of portunid crabs stocks (Branco *et al*., 2002), but differences in size at sexual maturity can be found both intraspecifically and latitudinally due to environmental factors such as salinity, temperature, or luminosity (Baptista-Metri *et al*., 2005). De Lestang *et al*. (2003) stated that there would be an advantage in determining the M_{50}'s for female *C. sapidus* at maturity by using data on gonadal state obtained by the simple and direct procedure of examining the ovaries, rather than relying only on data obtained by an allometric method that is indirect and relies on a careful measurement of the appendage lengths and carapace dimensions of a considerable number of individuals.

In the current study, the estimated size at maturity (M_{50}) based on the gonadal state of the female is about 96 mm CW which lies within the range of the morphological maturity. In Western Australia, Smith *et al*. (2004) reported 50% of females *P. pelagicus* became mature at 101 mm CW which is close to the finding of the present study. Rather, a higher M_{50} of 106 mm CW at first maturity was recorded by Ingles and Braum (1989) for *P. pelagicus* in the Philippines. At Conceic¸a˜o Lagoon, Santa Catarina, the mean size of *Callinectes danae* at first maturation is larger (84 mm) (Branco and Avila, 1992). However, at Babitonga Bay, sexual maturity for *Callinectes danae* and *Callinectes sapidus* was lower (71 mm) (Pereira *et al*., 2009). The differences in size at maturity among populations of the same species of crab may be attributed to seasonal and annual variations in temperature and salinity (Fisher, 1999) as well as latitudes as reported by Zaghloul (2003) and Abd El-Razek (1988).

Gonad Index:

In the present investigation, the gonad index of females showed its maximum value in summer and its lowest in winter. The incidence of the spent stage in autumn and winter indicated that gonad development and subsequent spawning take place in the preceding months. On the other hand, males showed a far less pronounced seasonal trend than that of females with its highest peak in spring indicating that males reach sexual maturity before females. These results agree with Fahimi *et al*. (2017) on xanthid crab *Leptodius exaratus* in the Persian Gulf, Iran, Wong & Sewell (2015) on the invasive Asian paddle crab, *Charybdis japonica* in northeastern New Zealand and Emam (2010) on *Portunus pelagicus* in Bardawil Lagoon.

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ARABIC SUMMERY

الجوانب البيولوجية لسرطان البحر الأزرق كالينيكتيس سابيديس (راسبن، ١٨٩٦) القاطن فى بحيرة البردويل، مصر

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تم خلال هذه الدراسة فحص ١٦١ عينة من أفراد السرطان الأزرق " كالينيكتيس سابيديس" جُمّعت موسميا من بحيرة البردويل خلال الفترة من نوفمبر ٢٠١٦ (موسم الخريف) إلى يوليو٢٠١٧ (موسم الصيف) ، وقد أوضحت النتائج ارتفاع عدد أفراد الذكور حيث سجلت ١٠٠ عينة (٦٢,١%) مقابل ٦١ عينة من أفراد الإناث (٣٧,٩%)، إلا النتائج المتحصل عليها أوضحت أن هناك تأرجحا موسميا فى أعداد العينات المجمعة من الشقين، حيث تم الحصول على أعلى عدد من الأفراد(٦٧ عينة) خلال الربيع تمثل ٤١,٦ % من العدد الكلي للأفراد المجمعة، مقارنة بالحد الأدنى الذي وصل إلى ٢٨ عينة (١٧,٤ %) تم الحصول عليها في موسم الصيف. ولقد أسفرت النتائج عن تسجيل ٨٧,٣% من العشيرة تقع عرض الدرقة لها بين ٧٥,٠- ١٢٤,٩ ملم و الذى يمثل الأفراد البالغة و الأفراد قبيل مرحلة البلوغ، إلا أن هناك تغييرات موسمية واضحة في توزيع وتيرة حجم العينات المجمعة من هذا النوع . وأظهرت النتائج الحالية أن نسبة أعداد الذكور تجاوزت أعداد الإناث حيث سجلت النسبة الشقية العامة ١: ٠,٦١ (ذكور: إناث). ولقد تم اختبار هذه النسبة إحصائيا باستخدام اختبار كاى^{٢} (درجة الحرية = ١) حيث تم تسجيل فوارق فى فصلى الخريف والشتاء (٢٠,٨٢ و ٩,٣٢ على التوالى) حيث تفوقت أعداد الذكور على الإناث، بينما لا توجد فوارق ذات دلالة فى موسمى الربيع و الصيف. ولقد أظهرت هذه النتائج أيضا أن هناك خمس مراحل لنضج المبايض في إناث هذه النوع تم تحديدها على أساس الشكل المورفولوجي للمبيض في العينات المتحصل عليها هي: ١- مرحلة الأفراد غير الناضجة ، ٢- مرحلة قبيل النضج ، ٣- مرحلة الأفراد الناضجة ، ٤- مرحلة الأفراد تامة النضج ، ٥- مرحلة المبايض الفارغة، ولكن لم يتم الحصول على أفراد من الإناث حاملة للبويضات المحضنة على أرجل البطن من بين العينات التي تم الحصول عليها. ولقد تم تحديد عرض الدرقة التقديري للإناث الناضجة جنسيا بنسبة ٥٠٪ عند ٩٦ ملم، مع تسجيل تغييرات موسمية في النسبة المئوية للإناث فيما يتعلق بمراحل النضج المختلفة. كما أوضح مؤشر المناسل أن الذكور تبلغ أعلى متوسط لها فى الربيع والذى يسبق أعلى متوسط في مناسل الإناث الذي سجل فى موسم الصيف.