دراسة علي مؤشرات وزن المناسل ووزن الكبد البنكرياسي بالنسبة لوزن الجسم في السرطان الأزرق بورتيونس بلاجيكس المنتشر في منطقتين ملوثتين على ساحل البحر الأبيض المتوسط لمدينة الإسكندرية، مصر

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المستخلص: تم في هذا البحث على مدار عام، دراسة التغيرات الموسمية في معاملي وزن المناسل ووزن الكبد البنكرياسي بالنسبة لجسم ذكور وإناث السرطان الأزرق "بورتونيوس بلاجيكس" الذي يتواجد وينتشر في منطقتي أبو قير والميناء الغربي الملوثتين على ساحل البحر الأبيض المتوسط لمدينة الإسكندرية، مصر. وقد أظهرت النتائج وصول الذكور ذروة مرحلة النضج الجنسي خلال فصل الشتاء في منطقتي الدراسة. بينما وصلت الإناث ذروة نضجها الجنسي خلال فصل الربيع في نفس المنطقتين. أما بالنسبة لمؤشر الكبد البنكرياسي فقد وصل إلى ذروته في موسم الربيع في كل من الذكور والإناث في منطقتي الدراسة. كما توضح النتائج وجود علاقة عكسية واضحة بين كلا المؤشرين أثناء المواسم المختلفة كانت أكثر وضوحا في الذكور بخلاف الإناث في منطقتي الدراسة. وأثبتت التحاليل الإحصائية وجود فروق معنوية واضحة بين قيم المؤشرات في كل من الذكور ونظرائها من الإناث داخل كل منطقة على حدة، إلا أن الفروق بين قيم تلك المؤشرات كانت غير معنوية إحصائيا عند مقارنتها ببعضها في منطقتي الدراسة.

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India in which gonadosomatic index showed high values when hepatosomatic index also had high values.

The statistical treatment also showed that in respect to sexes, the mean value levels of GSI at both regions had significant differences during most seasons (spring, summer and autumn), except for winter in which the difference was insignificant. Female GSI mean values were always higher than that of males, except during winter. According to the present study, this finding could be related to the fact that spawning in males increased significantly during winter. Regarding HSI mean levels, it was noticed that during spring and summer at both regions and during winter at Abu-Kir region only, female HSI levels were significantly higher than that of males during spring, summer and autumn indicating an increased energy demands for females over males for egg production. Based on the present results, egg production was a continuous process all the year round that seemed to be a costly process in females. Sastry (1983) and Magalhães *et al.* (2012) working on gonadosomatic and hepatosomatic indexes of the freshwater shrimp *Macrobrachium olfersii* from São Sebastião Island, Southeastern Brazil, revealed that during egg production process of the decapod species there was a

severe biochemical synthesis with increased mobilization of lipids and proteins for the oocytes development.

Further, the statistical treatment of the present data revealed insignificant differences in males and females GSI and HSI mean levels between the two study sites, during all seasons, except for spring in which the values of HSI in females at Abu-Kir region increased significantly over that of the Eastern Harbour. This result suggested that both areas are more or less of the same environmental conditions all the year round. An exceptional conditions could have taken place such that of spring at Abu-Kir region.

In conclusion, a clear inverse relationship was detected between GSI and HSI indexes in males of *Portunus pelagicus* occurring at two different polluted areas along the coast of Alexandria, Egypt. For females, an independent behavior between the two indexes could be observed with occasional synchronization. Additionally, significant differences were observed between males and females HSI values indicating an increased energy demands for females over males of this decapod species. In respect to regions, the present results showed that more or less both regions had similar environmental conditions with no drastic or significant differences in the

largest center of organic and inorganic reserves in crustaceans (Passano 1960, Magalhães *et al.*, 2012).

In the present study, females of *Portunus pelagicus*, showed maturation as a continuous process without prominent significant peak for spawning according to statistical analysis. During the four seasons, there were no significant differences between the mean levels of GSI. On the other hand, there was a gradual increase in HSI, which peaked significantly during spring. This peak coincided with HSI peak of males during spring, indicating that spring was the most favored season for increasing feeding activities and hence storing energy. Jewett and Feder (1982) reported that feeding increased during spring in the king crab, *Paralithodes camtschaticus*. On the other hand, Josileen (2011) reported that there was no significant differences between seasons in feeding activities of *Portunus pelagicus* from Indian Coasts, and related this to the fact that India is a tropical country with no sharp seasonal differentiation, which is not the case in Alexandria, Egypt. These findings in females of *Portunus pelagicus* excluded the hypothesis that hepatopancreas is the main organ that is responsible for providing energy during gonadal maturation cycle. If so, the

hepatopancreas was expected to mobilize some reserve during the ovarian development and no prominent could be detected for HSI. Alternatively, animals could be using another source of energy besides the hepatopancreas such as haemolymph and muscles. Several researches about biochemistry variations during reproduction have demonstrated that other tissues and organs, besides the hepatopancreas and ovary, can accumulate organic reserves, such as the haemolymph and muscles (Pillay and Nair, 1973; Spaagaren and Haefner, 1994; Palacios *et al.*, 2000; Cavalli *et al.*, 2001; Rosa and Nunes, 2002; Sokolowicz *et al.*, 2006). Instead, the two indexes peaked simultaneously in females during spring at Abu-Kir region and during summer at the Eastern Harbour region. Kyomo (1988) reported a synchronized increase GSI and HSI values in females of *Sesarma intermedia* and suggested that females crab accumulated reserves in the hepatopancreas and used these reserves for ovarian development, which suggested that there was a direct transfer of organic materials from the hepatopancreas to the gonads (Pillay and Nair, 1973). Similar results to the present results were reported by Rahaman, (1967) who reported a synchronization between GSI and HSI values of *Portunus pelagicus* from the east coast of

reserves of decapods (Adiyodi, 1969) and is also the largest organ of absorption and storage of lipid derived from food, which is crucial for their metabolism (Garcia *et al.*, 2002; Magalhães *et al.*, 2012).

Up to the present time, there is a lack of reproductive information addressing the important relationship between the hepatopancreas and the gonadal development, especially for *Portunus pelagicus*. It is expected that during gonadal development, the energy reserves of the hepatopancreas were used in this crucial process. Accordingly, gonadosomatic (GSI) and hepatosomatic (HSI) index values are expected to vary inversely to one another (Sokolowicz *et al.*, 2006) in the course of maturation of *Portunus pelagicus*. In that context, there is indeed a lack of information about the interrelationship between the two indexes in males and in females of this species.

Statistical treatment of the present data revealed that in males of *Portunus pelagicus*, there was a clear inverse relation between the two indexes as judged by their maximum and minimum fluctuations. By comparing the values of GSI mean levels during the four seasons, of *Portunus pelagicus* living at Abu-Kir and the Eastern Harbour regions, there was a significant increased value during winter,

when compared to GSI values of the other three seasons. At the same time, there was also a significant increase in HSI mean levels during spring over the other seasons, when comparing the values of HSI of males at both regions during the four seasons. These results clearly indicated that *Portunus pelagicus* males prepare for their maturation, which was to take place during winter, by storing food and energy sources starting from spring season. In other words, an inverse relationship between the two indexes could be detected. This pattern of inverse relationship was proven in many previous researches. In their study, Sokolowicz *et al.* (2006) demonstrated that in *Aeglap latensis* the pattern of utilization of the hepatopancreas reserves during gonadal development was the same for both males and females. HSI values decreased significantly in the months where GSI values were high. Also, Castille and Lawrence (1989) reported similar results in *Penaeus setiferus* (Linnaeus 1767). In addition, López-Greco and Rodríguez (1999) studying the crab *Neohelice granulata* (Dana, 1851), Sokolowicz *et al.* (2006) working on the aeglid *Aeglap latensis* (Schmitt, 1942) and Magalhaes *et al.* (2012) studying the shrimp *Macrobrachium olfersii*, all reported this inverse relationship. They also concluded that hepatopancreas was indeed the

Abbas appearing during July and August, which might indicate the influence of water temperature on ovulation and egg development of *Protunus pelagicus*. Low temperatures in this study were also of a recorded effect, especially on females. Females of *Portunus pelagicus* rarely appeared during winter months (December, January and February). Similarly, in South Australian waters, berried females very rarely appeared in the commercial catch between April and September, when the temperature is relatively low.

Salinity is another potentially important environmental factor (Kamrani *et al.*, 2010). The rare appearance of females during winter could be additionally attributed to the low salinity measured by the authors during winter (unpublished data) which seemed to be unsuitable for *Portunus pelagicus*. Kamrani *et al.* (2010) reported that in tropical regions like Bandar Abbas, the salinity of shallow coastal areas normally decreased in the rainy season due to the great amount of water runoff and this was unsuitable for *Protunus pelagicus* females. In the Peel-Harvey Estuary, Australia, crabs were not found during winter when the rainfall reduces the salinity to less than 10‰ (Potter *et al.*, 1983). Meagher (1971) suggested that

temperature and salinity play a key role in affecting the timing of the reproductive cycle.

During the maturation process in males of decapods, spermatogenesis is characterized by the development of germinative cells of spermatogonia, passing through primary and secondary spermatocytes until mature spermatids, and the latter into mature spermatozoa (Krol *et al.*, 1992). Similarly, during the gonadal development of females in decapods, there are modifications in the structure of the gonads, which include gonadal cell modifications, growth of gametes to maturation, ovulation, and oviposition (Sokolowicz *et al.*, 2006). All these modifications in the structure of gonads require a great amount of energy. Lipid deposition during maturation is crucial to gonad development and reproduction, and it is essential to the embryo growth. Yolk consists of water, protein, and lipids and therefore, it is a structural component in tissue formation and a necessary nutrient for the developing embryo (Krolet *et al.*, 1992). Hepatopancreas has an important role in the metabolism of the crustaceans, related to digestion and absorption, synthesis and secretion of digestive enzymes and carbohydrate metabolism (McLaughlin, 1983). Moreover, it is the largest center of organic and inorganic

females of *Portunus pelagicus* at two polluted areas of Abu-Kir and the Eastern Harbour along the Coast of Alexandria, Egypt, were investigated. The obtained results showed that maturation of males at the two study regions was attained during winter. On the other hand, spring and summer were the seasons during which females reached full maturation at both sites. These results conveyed that this species, especially female maturation was not restricted to one season but it could occur all year round. This result agrees with the findings of Bueno and Bond-Buckup (2000) and Sokolowicz *et al.* (2006) who reported that males and females of the decapod species *A. platensis* had gonads morphologically ready for reproduction throughout all months of the sampling period. However, in some other species such as *Macrobrachium borelli* (Nobili, 1896), *M. pottiana* (Müller, 1880), *Palaemon pandaliformis* (Stimpson, 1871), *Chasmagnathus granulatus* (Dana, 1851), *Cancer magister* (Dana, 1852) and *Uca lactea* (de Haan, 1835), reproductive periods were restricted to certain months of the year (Bond and Buckup, 1982; Muller *et al.*, 1996; Lopez-Greco and Rodriguez, 1999; Swiney and Shirely, 2001 and Yamaguchi, 2001).

Noticeably, variations in HSI values showed similar pattern of ups and down in

both sexes at the two study sites. They all showed maximum values during spring in which feeding activities of the species increased (unpublished data) and hence energy storage. Minimum values of HSI were attained during winter. This result suggested that both males and females consumed the accumulated reserves stored in the hepatopancreas to maintain themselves. It seemed that all energy stored was consumed either for spawning behaviour (as in males) or for other activities during winter as was found in females. Ituarte *et al.* (2006) attributed the reduction in feeding activity of semi terrestrial crabs during winter and hence the low values of HSI values to low air temperatures or due to a limited food supply (Wolcott, 1988).

Water temperature is the primary environmental factor influencing reproduction in *Portunus pelagicus* (Potter *et al.*, 1998). De Lestang *et al.* (2003) stated that the development of ovaries and eggs in *Portunus pelagicus* were controlled by water temperature. The present results showed that the highest GSI values for females at the two locations were recorded during spring (March, April and May) which could be attributed to the rise in water temperature during this season. Kamrani *et al.* (2010) reported high proportions of ovigerous females in Bandar

iii) With respect to study regions:

1. GSI mean levels in males and females of *Portunus pelagicus* with respect to study regions:

By comparing GSI values in males and females with respect to the two study regions, there was no significant difference in values between both sexes at Abu-Kir and the Eastern Harbour (Fig. 7).

Fig.7. GSI mean levels of males and females of *Portunus pelagicus* with respect to study regions; Abu-Kir (AK) (white columns) and the Eastern Harbour (EH) (black columns). * Denotes to: Statistically different from corresponding group ($p \leq 0.05$).

2) HSI mean levels of males and females of *Portunus pelagicus* with respect to study regions.

For HSI values recorded for males and females, the only significant difference was recorded between the two study regions during spring in favour of females at Abu-Kir, otherwise, there was no significant difference observed between the two regions during all other seasons in males and in females (Fig. 8).

Discussion

Study of the reproductive cycle of a species includes several peculiar aspects that require different lines of investigation. In the characterization of maturity, fecundity, moulting, life cycle, reproductive period, gonadal development and egg development, periodic population samples are needed (Gonzales-Gurriaran, 1985). Both gonadosomatic index (GSI) and hepatosomatic index (HSI) are common tools used as quantitative methods to verify the gonadal development (López-Greco and Rodríguez, 1999; Sokolowicz *et al.* 2006) and represent the percentage of these organs to the total weight of the animal (Magalhães *et al.*, 2012).

Fig.8. HSI mean levels of males and females of *Portunus pelagicus* with respect to regions; Abu-Kir (AK) (white columns) and the Eastern Harbour (EH) (black columns). * Denotes to: Statistically different from corresponding group ($p \leq 0.05$).

In the present study, seasonal variations of GSI and HSI of males and

Index	GSI	HSI	GSI	HSI	GSI	HSI	GSI	HSI
N	12		11		7		10	
$\bar{X}$	1.866	5.008	2.687	4.790	1.537	3.548	1.483	2.300
S.E	0.36	0.32	0.83	0.28	0.23	0.36	0.39	0.32
<i>p1</i>			0.266	0.608	0.693	0.004	0.610	0.0001
<i>p2</i>					0.180	0.015	0.122	0.0001
<i>p3</i>							0.950	0.017

p1: Comparison with spring.

p2: Comparison with summer.

p3: Comparison with autumn.

p- values were statistically significant at level ≤ 0.05

ii) With respect to sex:

1. GSI levels of *Portunus pelagicus* at Abu-Kir and the Eastern Harbour with respect to sex:

When comparing values of GSI in males and females at both study regions, females generally showed increased significant values during spring, summer and autumn, but no significant difference was recorded between GSI values of males and that of females at the two study regions during winter (Fig. 5).

2. HSI levels in *Portunus pelagicus* at Abu-Kir and the Eastern Harbour with respect to sex:

At Abu-Kir region, there was a significant difference in HSI values between males and females during spring, summer and winter, but no significant difference was recorded between males and females during autumn (Fig.6). At the Eastern Harbour, significant differences were recorded between males and females in HSI values during spring and summer seasons only (Fig.6). Autumn and

winter showed no significant differences in HSI values.

Fig. 5. GSI mean levels of *Portunus pelagicus* at Abu-Kir (AK) and the Eastern Harbour (EH) with respect to sex (males as white columns and females as grey columns) *Denotes to: Statistically different from corresponding group ($p \leq 0.05$).

Fig. 6. HSI mean levels of *Portunus pelagicus* at Abu-Kir (AK) and the Eastern Harbour (EH) with respect to sex (males as white columns and females as grey columns). * Denotes to: Statistically different from corresponding group ($p \leq 0.05$).

p1: Comparison with spring.
p2: Comparison with summer.
p3: Comparison with autumn.
p-values were statistically significant at level ≤ 0.05 .

For females at Abu-Kir region, there was no significant differences in GSI mean level values during the four seasons (Table 2). The same observation was recorded for GSI levels in females at the Eastern Harbour region.

during spring was of significant difference when compared to the other recorded values during summer, winter and autumn. Summer also showed an increased significant value compared to winter and autumn values. At the Eastern Harbour, spring showed an increased significant value when compared to autumn and winter. Whereas summer showed an increased significant value over that of autumn and winter (Table 2).

Table (2). Statistical analysis of the mean levels of GSI and HSI in *Portunus pelagicus* females at Abu-Kir and the Eastern Harbour regions with respect to seasons.

Seasons Items	Spring		Summer		Autumn		Winter	
Abu-Kir Region								
Index	GSI	HSI	GSI	HSI	GSI	HSI	GSI	HSI
N	24		22	11	9		8	
$\bar{X}$	2.536	6.976	2.448	4.935	1.309	3.753	1.937	1.690
S.E	0.77	0.46	0.52	0.35	0.38	0.32	0.20	0.20
$p1$			0.916	0.002	0.27	0.0001	0.604	0.0001
$p2$					0.311	0.130	0.662	0.0001
$p3$							0.648	0.016
Eastern Harbour Region								

(1.483 ± 0.39 and 2.300 ± 0.32) during winter, respectively (Fig. 4b).

(a)

(b)

Fig. 4. Seasonal variations in females GSI (solid line) and HSI (dotted line) of *Portunus pelagicus* at Abu-Kir Region (AK) (a) and the Eastern Harbour region (EH) (b).

II) Statistical treatments of GSI and HSI levels during seasons, sex and regions:

i) With respect to seasons:

1. GSI and HSI values in *Portunus pelagicus* males at Abu-Kir and the Eastern Harbour:

By comparing values of GSI during the four seasons in males at Abu-Kir region, it was clearly shown that the higher value of winter was significant compared with GSI values of the other three seasons at $p \leq 0.05$ level (Table1). Same result was observed for GSI values of males at the Eastern Harbour area.

Also, the comparison between the highest values of HSI of males recorded during spring at both regions with other season values showed significant differences than HSI levels recorded during summer, autumn and winter (Table1).

Table (1). Statistical analysis of the mean levels of GSI and HSI in *Portunus pelagicus* males at Abu Kir and the Eastern Harbour regions with respect to seasons.

Seasons Items	Spring		Summer		Autumn		Winter	
Abu-Kir Region								
Index	GSI	HSI	GSI	HSI	GSI	HSI	GSI	HSI
N	27		20		7		18	9
X ⁻	0.690	4.280	0.431	3.000	0.137	3.034	1.778	2.810
S.E.	0.22	0.17	0.14	0.12	0.01	0.15	0.19	0.25
p1			0.311	0.0001	0.134	0.0001	0.0001	0.0001
p2					0.440	0.914	0.0001	0.519

Results

1) Seasonal variations in GSI and HSI of *Portunus pelagicus* at the two study regions:

i) Males of *Portunus pelagicus* at Abu-Kir and the Eastern Harbour:

Results in Fig. (3a) show seasonal variations in males GSI values of *Portunus pelagicus* at Abu-Kir region. The maximum value of maturation was 1.778 ± 0.19 , recorded during winter, while the lowest value declined to 0.137 ± 0.01 , attained during autumn. For HSI seasonality, the highest value was 4.280 ± 0.17 , recorded during spring, whereas, the lowest value was 2.810 ± 0.25 , recorded during winter (Fig. 3a).

At the Eastern Harbour region, GSI values showed a variation between a minimum maturation which was recorded during summer (0.206 ± 0.01), and a maximum stage of maturation attained during winter (2.338 ± 0.25) (Fig.3b). As for HSI variability throughout different seasons, its values had similar pattern as recorded at Abu Kir and reached its maximum value during spring (4.221 ± 0.20) and its lowest one during winter (2.749 ± 0.15).

(a)

(b)

Fig. 3. Seasonal variations in males GSI (solid line) and HSI (dotted line) of *Portunus pelagicus* at Abu-Kir region (AK) (a) and the Eastern Harbour region (EH) (b).

ii) Females of *Portunus pelagicus* at Abu-Kir and the Eastern Harbour:

The results of GSI and HSI for females of *Portunus pelagicus* at Abu-Kir reached are represented in Figure (4b). The peak values of these two indices were 2.536 ± 0.77 for GSI and 6.976 ± 0.46 for HSI, recorded during spring. However, these indices attained their lowest values (1.309 ± 0.38) during autumn for GSI and (3.690 ± 0.20) in winter for HSI (Fig.4 a). At the Eastern Harbour, GSI and HSI reached their maximum values (2.687 ± 0.83 and 5.008 ± 0.32) during summer and spring, respectively and their lowest values

Fig. 2. Map of the Eastern Harbour, Alexandria, Egypt.

Study samples

A total of 119 individuals of *Portunus pelagicus* were obtained from Abu-Kir Bay and Eastern Harbour along Mediterranean Sea Alexandria, Egypt during four seasons for one sampling year (2011-212). Upon arrival to the laboratory, crabs were sorted, cleaned, and sexed.

Determination of Gonadosomatic index (GSI) and Hepatosomatic index (HSI):

For determining the gonadosomatic (GSI) and hepatosomatic(HS I) indexes, males and females of *Portunus pelagicus* were weighed and dissected and had their gonads and hepatopancreas removed and weighed. GSI and HSI were calculated according to Grand and Tyler (1983); Vazzoler (1996) and

Sokolowicz *et al.*, (2006), respectively as follows:

For gonadosomatic index, the following equation was used:

$$GSI = GWW/TW \times 100$$

Where:

GSI: Gonadosomatic index.

GWW: is the gonad wet weight.

TW: is the total wet weight of the animal.

Whereas, hepatosomatic index was calculated using the following equation:

$$HSI = HPWW/TW \times 100$$

Where:

HSI: Hepatosomatic index

HPWW: is the hepatopancreas wet weight

TW: is the total wet weight of the animal.

Statistical analysis

Statistical analysis was carried out with SPSS 17.0 for windows. For multiple comparisons of the quantitative variables, one way ANOVA was used to compare between different studied groups. For comparing between two groups, student "t" was applied. Generally, (*p*) values were considered statistically significant at level ≤ 0.05 .

is a qualitative method of maturity determination that is often used (Sokolowicz *et al.*, 2006). Seasonality of gonadal development in the somatic tissues is related to the stocking of organic and mineral reserves that are carried to the gonads during gametogenesis (Sokolowicz *et al.*, 2006). Therefore, it is expected that during gonadal development, the energy reserves of the hepatopancreas are used, so that the gonadosomatic (GSI) and hepatosomatic (HSI) index values are expected to vary inversely to one another (Sokolowicz *et al.*, 2006).

Accordingly, in addition to detecting the seasonal variation in GSI and HSI, this study aimed to clarify the relationship between gonadal developments, as indicated by gonadosomatic index values of the blue crab *Portunus pelagicus* at two polluted areas and changes in hepatosomatic index throughout a whole year.

Materials and Methods

Study areas

In this study, crabs were collected from two regions along the Mediterranean Sea Coast of Alexandria, Egypt, namely: Abu-Kir Bay and the Eastern Harbour.

Abu-Kir Bay (AK) is a shallow semi-closed basin that lies about 20 km east to Alexandria City, between longitudes 30° 03' and 30° 22' E and latitudes 31° 16' and 31° 28' N. It is bordered at the northeastern side by the Rosetta mouth of the Nile River and at the southwestern side by Abu-Kir head, which recently was extended further seaward through the construction of Abu-Kir Harbour (Shams-El-Din and Dorgham, 2007). The bay occupies an area of 500-600 km² with an average depth of 10-12 m (Fig. 1). It is subjected to several land-based sources such as, freshwater from the Rosetta Branch of the Nile River, loaded by nutrients, Lake Edku effluents loaded with trace metals, pesticide and nutrients, and El-Tabia Pumping Station that pours industrial and domestic wastes into the bay in addition to

the oil pollution resulting from fishing boats activities. Finally, the bay receives the effluents of Abu-Qir Fertilizers Company and Abu-Qir Electrical Power Station (Shams-El-Din and Dorgham, 2007).

Fig. 1. Map of Abu-Qir Bay, Alexandria, Egypt.

Eastern Harbour (EH) is a shallow semicircular basin, covering an area of about 2.8 km² with a water volume of 1.5x10⁷m³ (Fig. 2). The harbour is also sheltered from the sea by a middle breakwater leaving two openings where the exchange of seawater between the harbour and the Mediterranean Sea takes place, the western inlet (El-Boughaz) and the eastern inlet (El-Selselah) (Lotfy and Badr, 1999; El-Naggar *et al.*, 2006). Sewage wastes from the northern side of Alexandria are discharged through some outlets into the coastal line of the Mediterranean Sea including EH which receives about 1.5-6.3 x 10⁴ m³.d⁻¹ of the domestic sewage (Said and Maiyza, 1987; Ismael and Khadr, 2003).

Study on GSI and HSI of *Portunus pelagicus* at two polluted areas along the Coast of Alexandria, Egypt

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Abstract: Seasonal variations of gonadosomatic index and hepatosomatic index of *Portunus pelagicus* at two polluted sites along the Mediterranean Coast of Alexandria, Egypt, were investigated. Males at Abu-Kir and the Eastern Harbour reached their full maturation during winter, while females reached their peak during spring. Maximum hepatosomatic index values were attained for males and females at both regions during spring. A clear inverse relationship was detected between GSI and HSI indexes in males of *Portunus pelagicus* at the two different polluted areas along the coast of Alexandria, Egypt. An unclear relation between the two indexes was observed in females during different seasons. With respect to sexes, significant differences were observed between males and females in GSI and HSI values. With respect to regions, the present results showed that more or less both regions had similar environmental conditions with no drastic or significant differences.

Keywords: Mediterranean Coast; Alexandria; Egypt; Aquatic pollution; Blue crab; Gonadosomaticindex; Hepatosomaticindex.

Introduction

The blue swimming crab, *Portunus pelagicus* (L.) represents a valuable component of small-scale coastal fisheries in many countries in the tropics (Batoyet *et al.*, 1980; Josileen and Menon, 2007; Nasr Alla *et al.*, 2012; Lorenzenet *et al.*, 2012). The distribution of this species extends from the southern Mediterranean Sea, the east coast of Africa and across the Indian Ocean to Japan and the western Pacific Ocean (Potter *et al.*, 1983; Hosseini *et al.*, 2012). Blue swimmer crab is one of crab species that have economic value (Gokoolu and Yerlikaya, 2003).

As a fact, the main storage organ of organic and inorganic reserves in decapods is the hepatopancreas. It is used in the synthesis and secretion of digestive enzymes and in carbohydrate metabolism, among other functions (Sokolowicz *et al.*, 2006). Moreover, it is the largest center of organic and inorganic reserves of decapods (Adiyodi, 1969). Also, it is the largest organ of absorption and storage of lipids derived from the food, presenting an important role in their metabolism (Garcia *et al.*, 2002).

In the study of gonadal development and the estimate of maturity, the gonadal index