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REPRODUCTIVE SYSTEM AND FECUNDITY OF THE BLUE SWIMMING CRAB *PORTUNUS PELAGICUS* FROM THE NORTHWESTERN ARABIAN GULF, IRAQ

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ABSTRACT

It is possible to distinguish between males and females in types of crabs in general through the abdominal region, which is narrow in males and broad in females, as well as by opening the cover of the abdominal region. In males, a pair of peleopods can be seen, which are organs attached to the male reproductive system. It has two parts, the wide part, which is located at the bottom of the base of the abdominal cap, and the long tubular part. In females, when the abdominal cover is opened, eight pairs of feathers can be seen located below the base of the abdominal cap. The male gonads are distinguished by white color, located on the right and left of the abdomen, while the female gonads are internally colored. Yellow to orange, the absolute fecundity rate (egg/individual) for the female swimming blue crab ranged between (82711.7 - 2187239.74), and the relative fecundity rate of blue crab females was between (1416.9 - 9688.8) eggs/g.

KEYWORDS:

Gonado Somatic Index, Portunidae, Swimming blue crabs.

Introduction

The blue swimming crab *Portunus pelagicus* lives in salt water and prefers muddy and rocky areas near beaches, island coasts and some rivers. Adults are spread in tidal areas, coral Reef, and mangroves, while juveniles prefer estuarine areas (Corsini-Foka and Kondylatos, 2004).

The blue crab is characterized by the speed of movement by swimming when chasing prey, due to the transformation of the fifth pair of legs into what looks like an oar, and this allows it to swim for up 20 kilometers per day (Sompton and Smith, 1991; Chande and Mdaya, 2003).

Superficially, the males of the blue crab are distinguished by brown color with white spots covering the shield, and the chelapids are huge and long in size, blue to greenish-blue, while the females are reddish-brown and the shield is more rounded, and the chelapids are of a dull red-brown color (Josileen and Menon, 2004; Lie *et al*., 2010).

The blue crab matures sexually during the first year of life if the appropriate temperature is provided and mating occurs once a year in the tropical and subtropical regions, the females keep the sperm in an inner sac called the sperm sac until winter (Smith, 1982). Females usually migrate from inland estuarine areas to remote areas where appropriate environmental conditions are available for the growth and development of larvae in terms of food availability and oxygen levels. (Potter *et al* 1983).

In recent years, interest has been in recording crustaceans, especially crab in the Iraqi coast from the Arabian Gulf (Al Khafaji *et al*. 2017; Al Khafaji and Al Maliky, 2019; Al-Maliky *et al.*, 2020; Yasser *et al.*, 2021; Al-Maliky and Al-Maliky, 2021; Yasser and Naser, 2023). Also recorded *Lyphira perplexa* in the Gulf Arabian waters by Al-Maliky, (2020).

Jabbar *etal*. (2019) has been studying the gills area of two species of marine water crabs: Blue swimming crab *Portunus pelagicus* (Linnaeus, 1758), and Chinese mitten crab *Eriocheir sinensis* H. Milne Edwards, 1853 north west Arabian Guelf and Shatt Al-Arab. And Jabbar *etal*. (2021) studied some phenotypic characteristics of the Hepu mitten crab *Eriocheir hepuensis* olso they studied fecundity of the invasive Hepu mitten crab *Eriocheir hepuensis* from Shatt al-Arab and Arabian Gulf, Iraq in (2023).

The specific aims of this study were to measure the relationships between fecundity and body size, and the The relative Fecundity rate, also Average seasonal changes in Gonad Somatic Index (GSI) values during seasons.

Materials and methods

Samples of swimming blue crabs were collected seasonally from different regions of the northwest Arabian Gulf from December 2016 to November 2017 by trawling nets used in fishing. Samples were placed inside refrigerated boxes until they reached the laboratory. The crab's samples were explained from the dorsal side, using scissors to cut the shield circularly and remove it completely from the back area.

Fecundity

Absolute Fecundity

The Fecundity of (130) females at the stage of maturity was studied. To calculate fertility, the eggs were separated. The weight of the egg mass was taken using a sensitive scale, then four samples were taken. Secondary from different places from the mass of eggs, the weight of each secondary sample is 0.1 g, then according to the number of eggs in each secondary sample, the average was extracted for it. Fecundity was calculated according to the following equation (kumar *et al*., 2003): $N=W\times n/w$

N = fecundity W = weight of egg mass w = average weight of the four secondary samples and n = average number of eggs in the sample

Relative Fecundity

Relative Fecundity represents the ratio of the number of eggs to the body weight of the female. The relationship between fecundity and the width of the carapace was expressed by the following equation: $F = aL^b$

F = Fecundity L = Width of carapace and a, b constants

As for the relationship between fecundity and body weight, it was represented by the following equation: $F=aW^b$ (Kumar *et al*., 2000; De Lestang *et al*., 2003).

F = fecundity W = body weight and a, b constants

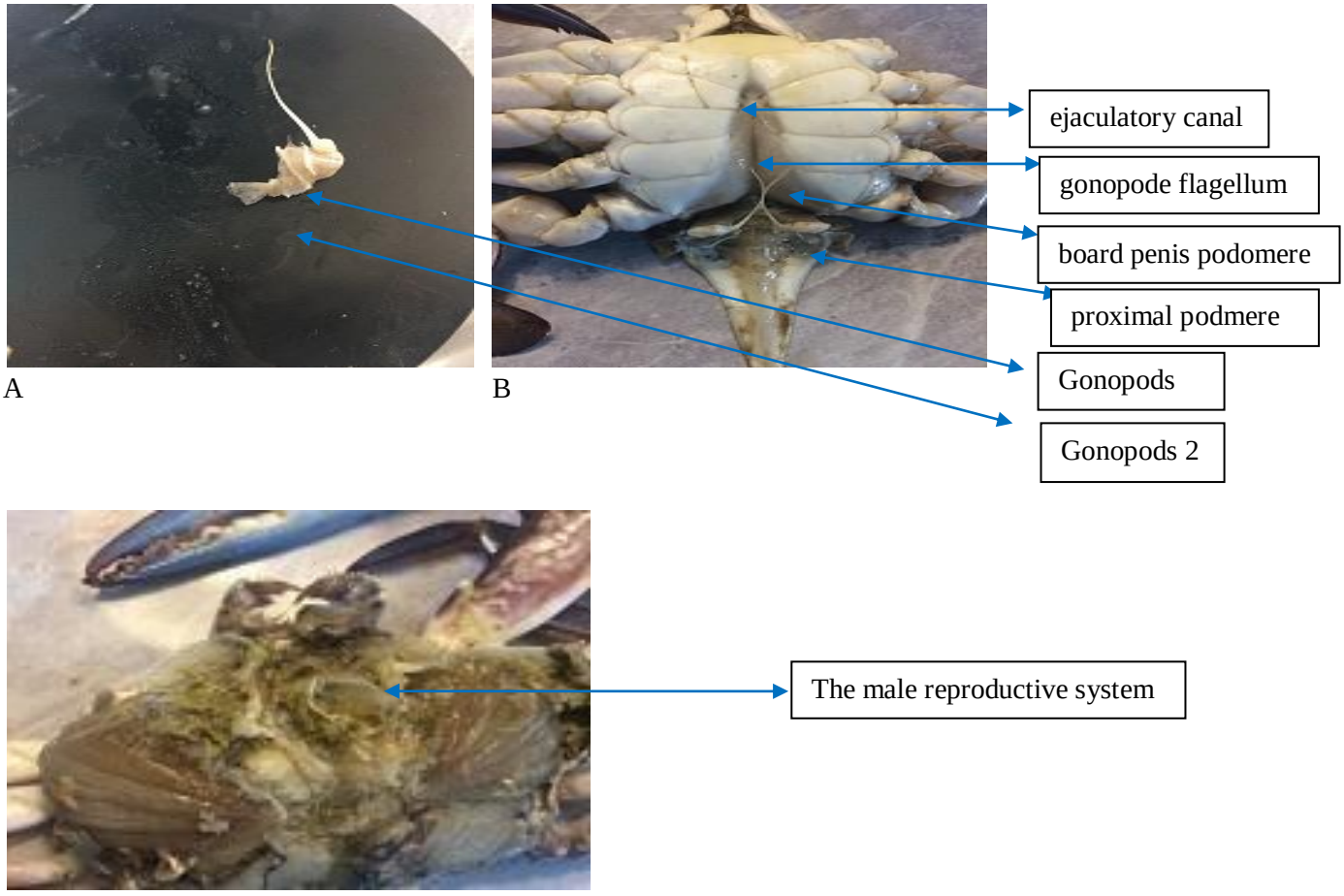
Gonado Somatic Index (GSI) Reproductive Function

The male and female reproductive systems were examined, after determining the number of crabs, their weight and length, and the gonads were taken using a sensitive scale extract the value of the reproductive function GSI, which is calculated according to the following equation:

Reproductive function = (gonad weight (g) / total weight (g) x 100

Results

It is possible to distinguish between males and females in types of crab through the abdominal region, which is narrow in males and broad in females, as well as by opening the cover of the abdominal region. The broad, which is located at the bottom of the base of the ventral cover and the long tubular part, the male gonads are characterized by a creamy white color on the right and left of the abdomen. The semen is carried outward in the form of a Pic. 1. In females, when the abdominal cover is opened, eight pairs of feathers can be seen located below the base of the abdominal cover. There is also a pair of openings located to the right and left of the sixth ring of the abdomen and female gonads, which are internally yellow. It is orange and consists of a pair of ovaries, ducts and oocytes located on either side of the heads thoracic region. The ovaries are surrounded by connective fibers that separate them from the fluids Pic. 2.



A B

C

Picture 1. The male reproductive system in blue swimming crab portunus pelagicus (a-b-c).

A B

Absolute Fecundity

The absolute of Fecundity rate (egg/individual) of female swimming blue crab *P. pelagicus* range between (2187239.7-82711.7) eggs/individual. The results of the statistical analysis showed that there were no significant differences ($p>0.05$) in the amount of absolute fertility between Seasons in female Blue Crab (Fig. 3).

the direct relationship between carapace width (cm) and total weight (gm) with absolute Fecundity in blue crab females, as the correlation coefficient between Fecundity and carapace width was r = 0.92

and between fertility and total weight r = 0.89. The results of the statistical analysis showed the presence of Significant differences. (Fig. 4 and 5).

Relative Fecundity

The relative Fecundity rate of *P. pelagicus* female blue crab ranged between (9688.8-1416.9) egg/gm (Fig. 6).

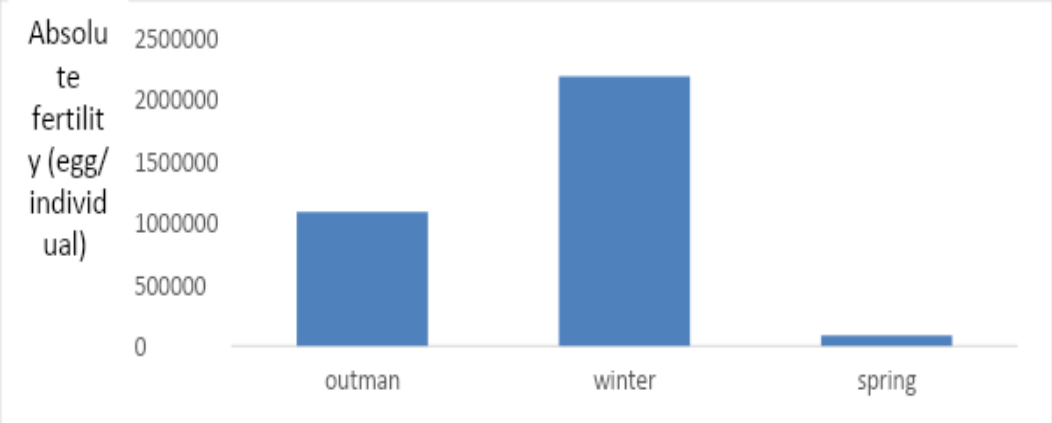


Figure 3. Absolute fertility (egg/ individual) in female swimming blue crab *P. pelagicus*.

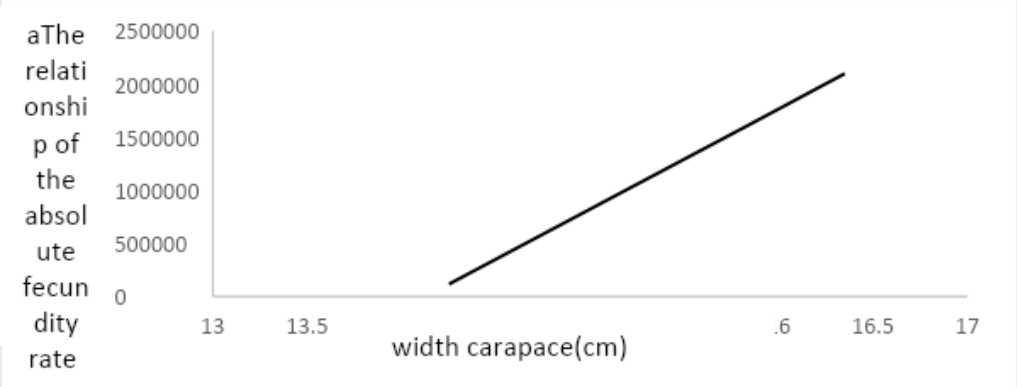


Figure 4. The relationship of the absolute fecundity rate with the width of the carapace (cm) in females blue crab *p. pelagicus*.

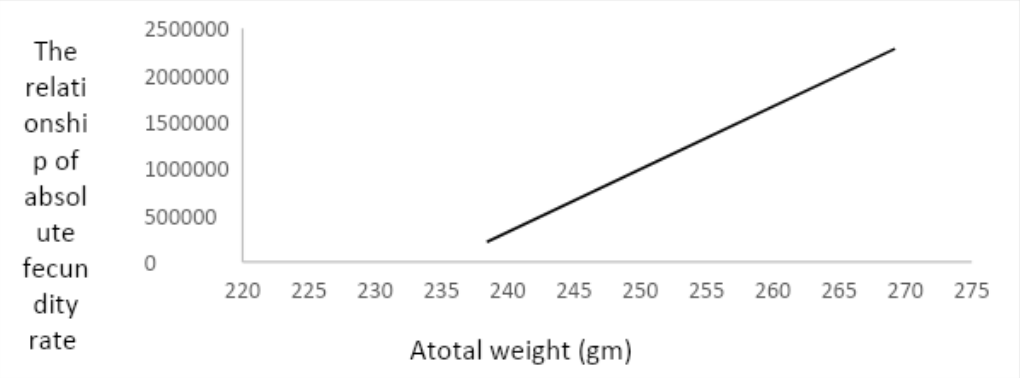


Figure 5. The relationship of absolute fecundity rate with a total weight (gm) in blue crab females *p. pelagicus*

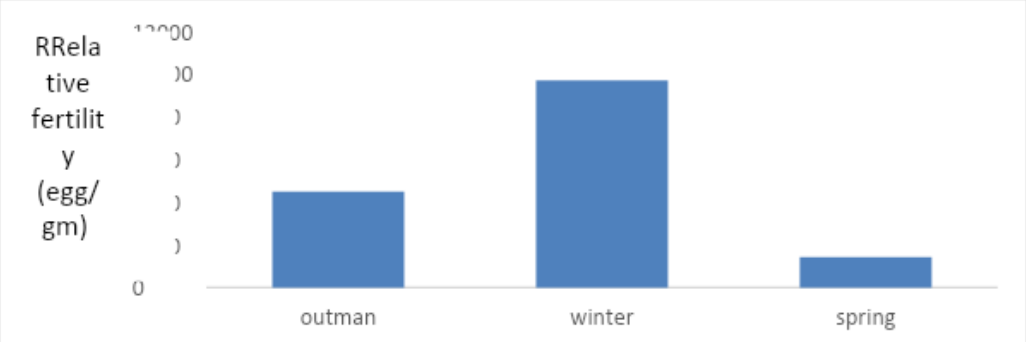


Figure 6. Relative fertility (egg/gm) in females swimming blue crab *P. pelagicus*

Gonad somatic index (GSI)

Seasonal changes in the values of the reproductive function of blue crab males and females are shown in Table 1, as the highest values was recorded in males (0.45 + 0.36) during the summer, while the lowest were (0.28 + 0.17) during the winter, while in females, the highest values of the function were (2.61 +1.22) in summer, while the lowest values were (0.89 + 0.30) in winter. The results of the statistical analysis showed a significant difference between the values of the reproductive function of males and females between summer and winter.

Table 1. Average seasonal changes in Gonad Somatic Index (GSI) values in blue crab males and females

Seasons	**The number of males**	**average body weight**	**range**	**GSI value**
outman	30	178.2	1.03-0.76	0.29±0.18
winter	33	229.8	0.58-0.11	0.28±0.17
spring	32	219.8	0.13-0.86	0.44±0.23
summer	35	200.3	0.77-0.10	0.45±0.36
Seasons	**The number of females**	**average body weight**	**range**	**Value**
outman	30	241.2	1.82-0.44	1.02+0.35
winter	31	239.59	1.52-0.45	0.89+0.30
spring	30	265.53	3.93-0.74	1.76+0.97
summer	38	228.6	1.13-4.76	2.61+1.22

Discussion

Crustaceans are similar in the structure of the reproductive system in general and members of the order Brachyura in particular. The phenotypic shape of the male reproductive system is composed of a pair of testes, a pair of venous vessels, and a pair of ejaculatory ducts (Almeida, 2000).

The male reproductive system is tubular and lobed with white color and consists of several of microtubular ducts, which is a characteristic of members of the Brachyura families such as (portundae, Grapsoidea, Xanthoidea, verenodea), (Simon *et al*., 2009). The male reproductive system in blue crab is divided into three parts: the upper part, called the testes, the middle part, and the lower part (Corgos and Freire, 2006). These parts differ according to the different species, depending on the nature of living, fertility, functions, shape, and composition of the device (Garcia and Silva, 2006).

Transmission ducts (genital appendages) through which seminal fluids move are important secondary parts of the male reproductive system, and this is a distinctive feature in Brachyura families. It was also recorded in the current study (Emmerson, 1994; Litulo, 2004), as males possess two pairs of ducts. And they both work together as a complex mating apparatus whose main function is to push the sperm and deliver them to the female, the first pair is long, and the second pair is short, and this trait is present in most members of the families of crabs Portunidae, Majoidae, Varunidae, Ocypodidae, Pinntheridae, pairs of vectors extend from the base of the fifth pair of legs inside Abdominal fold (Soundarapandian *etal*., 2013). Gonopods differ between different types of crustaceans, especially among brachyuran individuals. In blue crab, the gonopods have a thin, white, smooth, foldable tube with an open end (Valcina *et al*., 2014). The first pair of Gonopods is movable. While the second pair appears strong, and has very little movement compared to the first pair due to the presence of the thick and compact cuticle that covers it. As the first pair of the genital foot, it is flexible and unbreakable due to the presence of contractile muscles (Beninger *et al*., 1991).

The female reproductive system in members of the Brachyuran group is similar in structure and shape, as the ovary is yellow to orange in color and consists of four parts: the upper, lower, and center, and the sperm storage bag. The right part of the ovary is longer than the left part, and this difference in length is due to the presence of a cyst Storage in blue crabs, and this is a distinctive feature in some individuals of crabs (Sukumaran and Neelakantan, 1998) to absorb the largest amount of sperm through the one-time mating process.

The study of fecundity and the number of eggs carried by females is very important in the life of a living organism. The fertility of an individual is related to the size of the eggs he carries. In general, the species that produce smaller eggs have more fertility than the species that produce large eggs (Kangas, 2000).

The environment in which the individual lives affect the amount of fertility through its effect on the size of the eggs. Species that live in fresh water have less fertility than those that live in salt water because they carry larger eggs. This is what Ramirez, 2002 indicated as one of the most influential factors that may accelerate or slow down the reproductive activity which is closely related to the geographical location environmental factors food abundance temperature salinity age at the first spawning season and metabolism. Whereas Fischer *et al.*, 2009 mentioned that the width of the carapace the size of the claws and the size of the quills are the main factors affecting fecundity.

Values of fecundity rates for swimming blue crab in some previous studies with the current study Table 2 Comparison with some previous studies. Through the results, the absolute fecundity was estimated in the swimming blue crab *p. pelagicus* at about (82711.7- 2187339.7) eggs/individual. The

reason for the high fecundity rates may be due to the different species presence and spread among marine and estuarine waters and this was confirmed by Lai *et al*. (2010), as in Brachyuran species fecundity rates vary according to the different seasons during the year and the areas of presence in the coasts of Southeast Asia.

Table 2. Comparison of the values of fecundity rates for swimming blue crab in some previous studies with the current study

Species	Values of fecundity	Researcher name
P.pelagicus	569842	Oniam *et al* (2012)
p.segnis	521.027 – 6.656.599	Safaie *et al*. (2013)
P.pelagicus	1534538	Zairion and Fahrudin (2015)
P.pelagicus	2187339	The present study 2017

The relationship between female weight and ovary weight is one of the important relationships to estimate the expected production volume, which is related to fisheries management (Cooper *et al.*, 2013)., Muino, 2002) explained that relative fecundity is affected by several factors, including female size, environmental factors and food, gonad development and formation Yolk depends mainly on the quality and quantity of the natural food consumed, as it affects the quantity of eggs produced (Darnell *et al*., 2009). Through the results, a direct relationship was found between the weight of the ovary and the weight of females (relative fecundity), and this may be attributed to the fact that the heavier individual can direct the food energy to build the ovaries, while the smaller individual directs a part of this energy to growth (Dickinson *et al*., 2006), in contrast to some studies on the Brachyuran, which showed that the increase in female size is not necessarily followed by the increase in Fecundity, as in the study of Litula (2004) On the species *Uca annulipes*, this is due to the large differences between fecundity and size, different environmental conditions, availability of food sources, predation and competition. The fecundity values ranged from 229,468 to 2.236.355 numbers of eggs in *P. pelagicus* with (mean 926.638 ± 30.975) stated by Zairion and Fahrudin (2015). Showed of results This study increased fecundity compared with the study Ali and Al-Maliky (2017) which refers to the low by reason difference between crabs and the environment.

Conclusion

There is a direct positive relationship between the weight of the ovaries in female *P.pelagicus* and the relative fertility, as the individual with the largest weight can direct food energy in the production of eggs, while the smaller individual directs part of the energy in growth. There is a positive relationship between Gonad Somatic Index (GSI) values, female size, and ovarian size. The regression equation between reproductive function and egg size is used to determine reproduction times. It has very high fertility and a long breeding season that extends to about seven months.

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