Soundarapandian et al., 2:4
http://dx.doi.org/10.4172/scientificreports701

Open Access Scientific Reports

Research Article Open Access

Reproductive System of Flower Crab, *Charybdis feriata* (Linnaeus)

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Abstract

Information about the reproductive biology of a crab species is important for the successful seed production in captivity. Hence the present study was aimed to investigate the male and female reproductive system of *C. feriata*. The male reproductive system of *C. feriata* composed of a pair of testes, a pair of vas differentia and a pair of ejaculatory ducts. The testes are connected with the vas deferens through a short small duct called vas efferens. The vas differentia has been divided into three distinct regions, based on the morphological and functional criteria: Anterior (AVD), Median (MVD) and Posterior (PVD) vas deferens. The developmental stages of male gonads include immature, maturing and matured. The gonadosomatic index of the male crab was increased from immature crabs (0.48) to matured crabs (0.79). The female reproductive system composed of a pair of ovaries, a pair of seminal receptacles (or) spermatheca and a pair of oviducts. The ovaries of *C. feriata* are categorized into five stages according to the size, colour and external morphology of the ovaries. They are immature, early maturing, late maturing, ripe and spent. The GSI in females were increased from immature crabs (1.95) to ripened crabs (3.97). Based on the change in colour, increase in the size and change in the shape of the berry eggs, three different stages (I, II & III) of egg development was observed. The fecundity of the female was found to be from 2, 83,963 to 9, 67,293 eggs in the animals had the carapace width of 10.6 to 14.1 cm.

Keywords: Reproductive biology; Pair of testes; Pair of ovaries; Pair of oviducts; *C. feriata*

Introduction

Berried females are important to start a commercial hatchery, but berried females are not available throughout the year from the wild. So the production of berried females in a controlled condition is essential. Before that once should know the morphology of the reproductive system and reproductive biology of a particular crab is important [1-3]. Reproduction is the main mechanism to maintain species proliferation and continuity [4,5]. The recognition of biological data about reproduction is required for judicious management and exploitation of particular species resources. Hence in the present study an attempt has been made on the various aspects of reproductive biology of the male and female crabs of *C. feriata*, such as morphology of the reproductive tract, gonad development, gonado somatic index (GSI), size at maturity and fecundity.

Materials and Methods

The crabs for the present study was collected from Parangipettai landing centre (Lat.11°29'N; Long.79°46'E) and brought to the laboratory by using plastic container. The crabs were segregated as male and females. They were weighed individually and the size of the carapace width was measured. Sexes were determined by examining the abdominal morphology.

The pleopods and gonopores were analyzed to find out the mating and extrusion of eggs. Presence of the eggs or egg remnants or their absence on pleopods, colour of the egg mass was also noted. The crabs were dissected to study the morphology of the reproductive tract and stages of maturation, size, weight, colour of the gonads and gonadosomatic index (GSI).The dissected gonads were measured to the nearest 0.001g by using the electronic balance and subsequently gonadosomatic index was calculated by the following formula.

$$GSI = \frac{\text{Wet weight of the gonad}}{\text{Wet weight of the animal}} \times 100$$

Recently spawned females with bright yellow or orange coloured eggs were selected for egg counting (Fecundity). To estimate the fecundity, pleopods bearing eggs were removed carefully and the weight of the whole egg mass (berry) was taken to the nearest 0.001 g, then four subsamples of berried eggs (0.1 g) were cut from different locations of the egg mass. Number of eggs in each four sub samples was counted with the help of counting tray under stereomicroscope. Average no of eggs present in the samples was then calculated. In order to find out the total weight of the egg mass, the eggs were removed from the pleopods and weight of the pleopods was taken.This was subtracted from the weight of the whole egg mass. Fecundity was then calculated by the following formula [6].

$$N = W \times \frac{n}{W}$$

Where W= total weight of the egg mass only; w=average weight of the four egg samples; n = average number of eggs in the samples; N= total number of eggs (Fecundity).

Results

Morphology of the male reproductive system

The male reproductive system of *C. feriata* is bilaterally symmetrical creamy to whitish in colour, composed of a pair of testes, a pair of vas differentia and a pair of ejaculatory ducts internally and a pair of pleopods externally as accessory reproductive organs, present

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Received March 18, 2012; **Published** May 27, 2013

Citation: Soundarapandian P, Ilavarasan N, Varadharajan D (2013) Reproductive System of Flower Crab, *Charybdis feriata* (Linnaeus). 2: 701 doi:10.4172/scientificreports.701

on the inner side of the abdominal flab. The testes are flat and highly coiled roughly in the form of "H" located on the dorsal portion of the hepatopancreas sandwiched between the hepatopancreas and the hypodermis of the carapace, and continuing laterally to the stomach upto vas deferens.Just before the posterior stomach and anterior to the heart the left and right testis are bridged by a commissure.

The testes are connected with the vas deferens through a short small duct called vas efferens. Vas differentia is a pair of elongated and coiled tubules which extend longitudinally from the posterior testes upto the posterior region of the body. The vas differentia has been divided into three distinct regions, based on the morphological and functional criteria: Anterior (AVD), Median (MVD) and Posterior (PVD) vas deferens. The AVD are white, tightly coiled and lying on either side of the median line of cephalothorax posterior to the dorsal part of the stomach. The coils of the AVD increase in size posterio-ventrally and lead into the middle vas deferens, which are milky-white meandering tubules of a higher caliber than both the testes and AVD. The posterior vas deferens are whitish in colour arises from the posterior end of the median vas deferens, which are massive for its proximal part, but gradually narrow before opening to the ejaculatory duct.Each posterior VD is connected with an ejaculatory duct, which is a smooth narrow duct extending between the musculature of the swimming peddles. The ejaculatory duct leads into the slender weak tube like genital papilla (or) penis, which are located at the base of the swimming legs. Each penis passes into the two pairs of abdominal appendages called pleopods (or) gonopods situated in the inner side of the abdominal flab. The first pleopod is made up of two segments, the basal one is broad to the sternal wall and the terminal one is long tube-like and tapering towards the tip, which is actually inserted into the seminal receptacle of the female during copulation. The second pleopod helps in passing the seminal fluids from the penis into the funnel like portion of the first pleopod (Figure 1).

Developmental stages of male gonads

Immature: The gonads of the immature crabs are small and creamy in colour on either side of the stomach. Testes and vas differentia are not clearly differentiated. Gonads of males measuring below 8.5 cm carapace width are in immature stage.

Maturing: Testes and vas differentia are well developed and clearly differentiated and creamy white in colour. Testes are large coiled tube which spreading laterally and posteriorly to the stomach. Anterior vas differentia becoming enlarged middle and posterior vas differentia straight and opaque extending to both the side of the heart.

Matured: Testes showed further enlargement as vas differentia are coiled and very much swollen occupying full body cavity. The AVD and MVD are enlarged and milky white in colour, PVD enlarged and convoluted but still opaque. Gonads of males measuring above 10.5 cm carapace width are in mature stage.

Gonadosomatic Index (GSI) in male crabs

The Gonadosomatic index of the male and female crabs was studied according to the size and weight of the crab. The GSI of the male crab (0.48) was increased from immature crabs to matured crabs (0.79).The size of the animals was ranging between 8.0 – 8.5 cm carapace width to 14.1–14.5 cm carapace width (Table 1).

Morphology of the female reproductive tract

The female reproductive system composed of a pair of ovaries, a pair of seminal receptacles (or) spermatheca and a pair of oviducts (open to the exterior through the female genital opening situated on the left and right sternites of sixth thoracic segment).The oviducts pass ventrally from the seminal receptacle.The ovary is surrounded by a fibrous connective tissue which separates the ovary from the surrounding hemocoel.The ovary is roughly in the form of a 'H' and lies on top of the hepatopancreas extending on both sides along the anterior margin of the cephalothorax is called anterior horns. The ovaries run in posterior cardial direction to the cardiac stomach and just posterior to the stomach, anterior horns are joined by a commissure.The posterior horns pass posteriodorsoventrally and laterally and applied dorsally to the seminal receptacles which are sandwiched on either side between the lateral wall of the body cavity and lateral part of the pericardium and the posterior horns extend up to posterior margin occupies all spaces of the body cavity. The posterior horns are equal in size at the posterior end (Figure 2).

Stages of ovarian development

The ovaries of *C. feriata* are categorized into five stages according to the size, colour and external morphology of the ovaries. They are immature, early maturing, late maturing, ripe and spent.

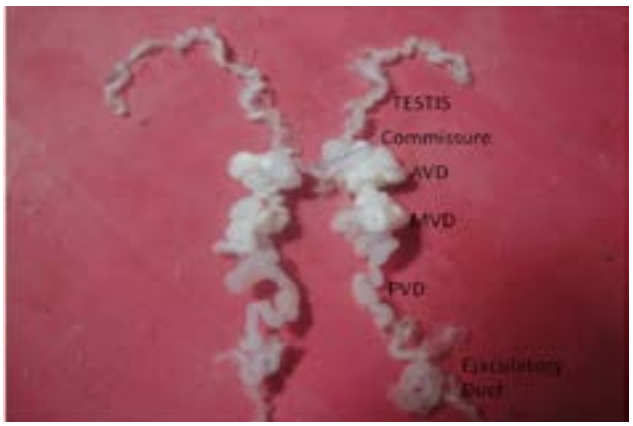

Figure 1: Male Reproductive System.

S. No.	Carapace width (cm)	Mean body weight (g)	Mean gonad weight (g)	GSI
1	8.0 – 8.5	29.93 ± 0.61	0.145 ± 0.28	0.48 ± 0.04
2	8.6 – 9.0	34.50 ± 2.35	0.178 ± 0.04	0.51 ± 0.02
3	9.1 – 9.5	41.35 ± 1.97	0.226 ± 0.07	0.54 ± 0.04
4	9.6 – 10.0	49.18 ± 2.42	0.313 ± 0.09	0.63 ± 0.18
5	10.1 – 10.5	57.73 ± 2.92	0.370 ± 0.11	0.64 ± 0.17
6	10.6 – 11.0	65.90 ± 5.37	0.431 ± 0.17	0.65 ± 0.24
7	11.1 – 11.5	70.0 ± 2.51	0.460 ± 0.08	0.65 ± 0.09
8	11.6 -12.0	79.33 ± 4.36	0.523 ± 0.29	0.65 ± 0.12
9	12.1 – 12.5	102.76 ± 2.67	0.690 ± 0.47	0.67 ± 0.62
10	12.6 – 13.0	118.83 ± 1.22	0.834 ± 0.05	0.70 ± 0.04
11	13.1 – 13.5	121.43 ± 4.97	0.880 ± 0.46	0.73 ± 0.08
12	13.6 – 14.0	131.1 ± 1.01	1.01 ± 0.13	0.77 ± 0.29
13	14.1 – 14.5	140.2 ± 2.17	1.10 ± 0.47	0.79 ± 0.46

Table 1: Mean body weight, Mean gonad weight and Gonadosomatic index (GSI) of the male crab (Values are Mean ± SD).

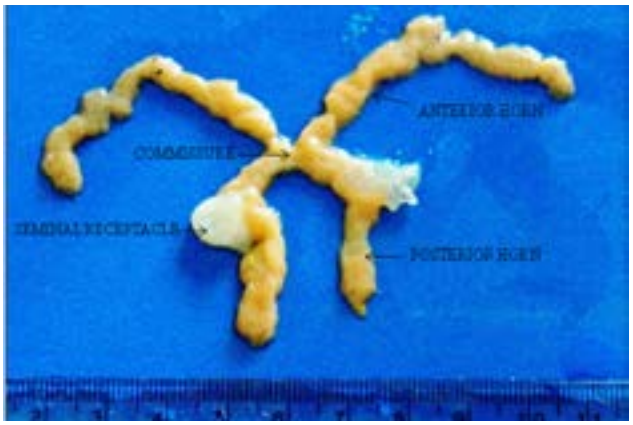

Figure 2: Female reproductive system

Immature

Small, flattened ovaries, white (or) translucent in colour, occupy small areas of the body cavity.

Early maturing

Ovary is larger than previous one, light orange in colour, slightly nodulated not extending into hepatopancreatic region.

Late matured

Larger ovaries yellowish or orange in colour, nodulated extending into hepatopancreatic region and occupies almost all the space of the body cavity.

Ripe

Very large ovaries, dark yellow or orange in colour, highly nodulated, hepatopancreas is completely hidden or immersed, ovary fills up all the spaces of the body cavity.

Spent

Small, translucent and greatly reduced ovaries unspawned ova are visible throughout the fibrous connective tissue.

Gonadosomatic index in females

The GSI in females were increased from immature crabs (1.95) to ripened crabs (3.97) however in spent crab has low value of GSI as similar to immature crabs (1.26) (Table 2).

Size at first maturity: Fifty percent of the female crabs attained sexual maturity when they reached the size of 9.1- 9.5 cm carapace width. Fifty percent of the male crabs attained sexual maturity when they reached the size of 9.5-10.0 cm carapace width. However, the smallest berried female attained sexual maturity in the present study was measured at 8.6 cm carapace width.

Ovigerous females: At the time of spawning the eggs from the ovary of female crabs were extruded through their gonopores and get attached to the cluster of long and very smooth setae on endopodite of the pleopods.Based on the change in colour, increase in the size and change in the shape of the berry eggs, three different stages of egg development was observed.

Stage-I

Pale yellow to deep yellow coloured egg mass, no eyespots was visible in the eggs, the mean size of the eggs was 260.16 ± 0.24 µm (Table 3).

Stage-II

Yellow to grey coloured egg mass, eyespots were observed, mean size of the egg was 290.2 ± 0.31 µm (Table 3).

Stage-III

Deep grey to black coloured egg mass, eyespots and chromatophores were discernible, the mean size of the egg was 340.32 ± 0.34 µm (Table 3).

Fecundity

Seventeen ovigerous females were used for the calculation of fecundity. The fecundity was found to be from 2, 83,963 to 9, 67,293 eggs in the animals had the carapace width of 10.6 to 14.1 cm.

Discussion

The morphology of the male reproductive system of *C. feriata* consisting of an "H" shaped structure with a pair of testes, pair of vas deferentia and ejaculatory ducts was similar to the reproductive systems described for other decapod crustaceans in general [4] and portunid crabs in particular [5-9]. The descriptions of the testes and commissure of *C. feriata* matched the descriptions of *P. marmaratus* [10], *P. sanguinolentus* [1,2], *C. sapidus* [11], *Thenus* orentalis [12], P.*pelagicus* [3], *Panulirus laevicauda* [13] and *Goniopsi cruentata* [9]. However [14,15] did not report the existence of a commissure between the testes of *C. opilio* and *M. branchyodactyla* respectively. Testes of *C. feriata* are tubular organs composed of numerous microscopically visible lobules connected to the semniferous duct; consequently, they have been classified as lobular testes according to the categories (lobular and tubular) established by [16] and are similar to the previous reports of some other brachyurans [2, 8,9,17]. Whereas in few species of Brachyura have tubular testes, such as *Menippe mercenaria* [18], *Eriocheir sinensis* [19], *C. opilio* [20], *Pachygrapsus crassipes* [21] and

S.No.	Carapace width (cm)	Mean body weight (g)	Mean gonad weight (g)	GSI
1	8.0 – 8.5	29.60 ± 1.3	0.88 ± 0.09	2.97 ± 0.37
2	8.6 – 9.0	33.8 ± 1.38	1.21 ± 0.05	3.57 ± 0.12
3	9.1 – 9.5	37.3 ± 3.08	1.48 ± 0.13	3.98 ± 0.10
4	9.6 – 10.0	40.7 ± 3.47	1.78 ± 0.23	4.37 ± 0.06
5	10.1 – 10.5	47.5 ± 4.60	2.10 ± 0.27	4.42 ± 0.09
6	10.6 – 11.0	60.2 ± 2.54	2.95 ± 0.19	4.90 ± 0.17
7	11.1 – 11.5	76.7 ± 7.61	3.27 ± 0.39	4.26 ± 0.24
8	11.6 -12.0	87.15 ± 4.94	3.46 ± 0.17	3.97 ± 0.31
9	12.1 – 12.5	99.67 ± 2.67	3.64 ± 0.47	3.65 ± 0.36
10	12.6 – 13.0	114.96 ± 8.30	3.97 ± 0.27	3.45 ± 0.18
11	13.1 – 13.5	129.8 ± 8.43	4.45 ± 0.13	3.42 ± 0.27
12	13.6 – 14.0	137.85 ± 7.46	1.74 ± 0.18	1.26 ± 0.21

Table 2: Mean Body weight, Mean gonad weight and Gonadosomatic index (GSI) of the female crab (Values are Mean ± SD).

Stages of development in berried females	No of specimens observed	Colour of the berry	Shape of the eggs	Mean size of the eggs (µm)
Stage I	20	Pale yellow to deep yellow	Spherical	260.16 ± 0.24
Stage II	15	Yellow to Grey	Spherical	290.2 ± 0.31
Stage III	10	Grey to Black	Elliptical	340.32 ± 0.34

Table 3: The colour, shape and size of the berried eggs (Values are Mean ± SD).

C. bairdi [22]. However, they seem to be distributed along different groups of brachyura. Simeo et al. [23] studied that lobular testes are very common in portunid crabs. This is the reasons why some brachyurans have a tubular testicular arrangement whilst others have a lobular one, is unknown [14,15,23]. The testes connected to the vas deferens by means of a small duct known as vas efferens has been described in *C. sapidus* [3,17] and *P. pelagicus* [8]. Vas deferens (VD) is a pair of elongated and convoluted tubules which extend longitudinally in the posterior region of the body [1, 24]. In *C. feriata* the vas deferens was divided into three distinct regions, the anterior, middle and posterior vas deferens as has been reported in other crabs based on their morphological and functional criteria in *P. sanguinolentus* [1,3], *C. sapidus* [11], *T.* orentalis [12] and *M. branchydactyla* [23]. However other studies characterized two in *G. cruentata* [9], four in *S. chacei* [25] and *D. puligator* into as many as eight regions [26]. Different criteria and different microscopic and macroscopic foci may account for this diversity [9]. The presence of diverticula in the VD of brachyura has been widely described [1,8,9,23] particularly in spider crabs, which present numerous ramified diverticula in the posterior region of the VD [10]. Diverticula play an important role in increasing the secretion, absorption and storage of spermatophores and seminal fluids [27,28]. The terminal portion of the reproductive system is the ejaculatory duct, which is a smooth duct extending between the musculature of the swimming pedals, as already described in brachyura [29]. Very few works have been described for the maturity stages in male crabs. Haefner [30] has described six maturity stages in the males of *C. irroratus* [31] observed five stages of maturation in *C. irroratus* based on a modified version of [30] who indicated six stages of gonad development. [32] indicated five stages of maturation in male crab *C. amnicola*. [33] reported four different morphometric categories of male gonads in *M. branchydactyla*. Boopathi, Anand and Sukumaran et al. [2,3,33] recognized three stages of maturation based on the testis development in *P. pelagicus* and *P. sanguinolentus*. In *P. pelagicus* three stages of maturation was reported based on the development of vas deferens by Lestang et al.[34].

The female reproductive system of *C. feriata* is more or less similar to that of other Portunid crabs. It is closely related with the structure observed by Ryan [1] and George [8] in *P. sanguinolentus*. Estampador EP [7] observed similar structure in *S. serrata* and [11] in *C. sapidus*. Boopathi [2] and George [8] noticed that the posterior prolongation of the right side ovary is shorter and narrower than the left side in *P. sanguinolentus*. This condition is also observed in *C. feriata* at the present study. George [35] in *C. pagurus* and Estampador [7] in *S. serrata* observed that the posterior prolongations of the ovary are connected at the posterior end. In *C. feriata* differ from such species by posterior prolongation of the ovaries are permanently separated.In many species of brachyurans, fresh mating female crabs are indicated externally by hardened mass of spermatozoa called sperm plug together with associated secretions producing from the vulva. Similar observation was made in the present study as well as the study of Estampador [36]. The mated females inhibit further copulation with other males [38,39] by prevent the loss of sperm or keep deletrous materials from entering the female reproductive tract [11].

Stages of ovarian development have been determined based on the morphological and histological analysis of the ovary. In the present study, the morphological analysis of the ovaries of *C. feriata* demonstrated that a gradual development of the ovaries confirmed the maturation into five maturation stages. Among different workers who have studied the maturation of ovaries in brachyuran's crabs, there is a little consistency as to the number of maturity stages recognized. Six stages of maturation were recorded by Haefner [30] in rock crab *C. irroratus* and five stages in *Chaceon quinquedens*. Haefner [39] recorded five maturity stages in *P. pelagicus*; similarly [40] classified five ovarian developmental stages. Sukumara [41] was reported four maturity stages except the spent stage in *P. sanguinolentus*. In the deep sea golden crab, *C. fenneri* the developmental stages were classified into six stages by Erdman [42]. The microscopical analysis of the ovaries of *C. feriata* in the present study demonstrated that a gradual development of the ovaries confirmed the maturation into five maturity stages. The examination of gonad is one of the most accurate techniques, but precise estimates rely on some previous knowledge about specific patterns of growth and reproduction to aid the interpretation of the results, as well as knowledge of short-term breeding cycle to avoid confusion between spent and immature specimens [43]. In the present study the GSI was studied only based on the size and weight of the crab but not in seasonal wise. The GSI has the great relationship with the size and weight of the crabs.

The reproductive capacity of certain crustacean species can be assessed by the study of sexual maturity [44]. The size at onset of sexual maturity in brachyurans can be evaluated considering different criteria, including growth allometry, gonad development stages, presence of spermatic bags or sperm in spermathecas, vestige eggs on the ovigerous areas or the presence of eggs in the abdomen as was analyzed by several authors [27,31,35] .Sexual maturity in brachyurans has been determined in various ways, based on the analyses of morphological maturity, relative growth criteria and physiological and functional maturity [45,46]. According to Parker [37], the consecutive changes observed during gonadal development are important because besides enabling and estimate of physiological sexual maturity [47,48]. In brachyuran crabs chela in males and abdomen in females are considered as secondary sexual characters because of their functions in reproduction [49]. The male crab uses its chela for territorial defence, combat, mating and courtship as well as in carrying and holding the female during copulation. The abdomen in adult females forms an incubation chamber for the developing eggs, which are attached to the setose pleopods. The increase in relative growth of the male chela and female abdomen at the puberty moult brings these structures to full functional size at sexual maturity. Hence the relative growth of chela in males and abdomen in females has been used to determine size at which puberty moult occurs or functional maturity attained. Pillai [50] from Cochin, west coast of India reported that the size of the smallest berried *P. sanguinolentus* as 8.5 cm CW and the size at maturity range was 8.1-9.6 cm. Sumpton [51] who worked out physiological maturity in both male and female *P. sanguinolentus* from Queensland, Australia, reported that the males and females attain sexual maturity at 8.3 and 7.4 cm respectively. Reeby [52] reported that male *P. sanguinolentus* attains full sexual maturity (meaning functional as well as physiological) at 8.1-8.5 cm CW from Karwar, west coast of India.

In south west coast of India the male and female may undergo a pupertal moult at a size ranging between 8.0-8.5 cm and 8.0-9.0 cm CW respectively. Rasheed and Mustaquim, (2010) reported that male and female attain full maturity at 8.3-8.9 mm CW and 8.1-9.3 mm CW, respectively.In the present study the smallest berried female attained sexual maturity at 8.6cm CW while the male and female crab attained sexual maturity when those reached the size of 9.5- 10.0 cm CW and 9.0–9.5 cm CW respectively.According to the present investigation it was observed that the functional and physiological maturities occur almost at the same size.

The size at which maturity occurs can vary with latitude or location

[53] and within individuals at any location. Hines [54] compared geographic variation in the size of sexually mature females in five species of crabs along the east and west coast of North America.Four of the five species show significant geographic variation in size at onset of maturity. The differences in size at maturity among population of the same species of crab may be attributed to variation in moult increment and in the number of moults [54]. Environmental factors such as temperature and salinity can also affect size at sexual maturity in crabs. Fisher [55] who investigated the effect of temperature and salinity on size at sexual maturity of female blue crab C. *sapidus* from nine Texas bay systems stated that size at maturity can vary along the Texas coast, as temperature and salinity vary from bay to bay.He also mentioned that seasonal and annual variation in temperature and salinity in the bay could also affect size at onset of maturity.

Egg bearing females occurs throughout the year with proportion of females bearing egg masses being peak during three different months August, January and March along Parangipettai coast [56], whereas November to March in South west coast [57], whereas December to May and July to August in Calicut coast [59]. Peaks of higher breeding intensity may be associated with variation in temperature, salinity, food availability, rainfall and photoperiod [59]. In brachyuran crabs inhabiting tropical waters usually breed throughout the year whereas those found in temperate waters breeds only in certain months. It is generally suggested that near the tropics reproduction occurs year round because environmental conditions are generally favorable for gonad development [60,61]. However both continuous and seasonal reproductive patterns are found in subtropical and tropical regions [62].

Fecundity is defined as the number of eggs produced by an individual female [63]. Fecundity is calculated as the number of eggs carried externally by the female [6]. In general the fecundity of decapod crustaceans is evaluated as the number of eggs or weight of eggs produced by a female in a single egg batch (Batch fecundity) and is positively correlated with body size (or) weight of females [45,64-66]. Fecundity is significantly related to the female crab's carapace width [44]. The larger females have potential to produce more eggs than smaller females [67]. Fecundity is a species specific character, not only regarding the number of eggs extruded in a single batch but also the frequency of brood production during the life cycle of crustaceans [68].

In general the fecundity of the similar species was varied between different locations. Ryan [1] reported that the fecundity in *P. sanguinolentus* was ranged between 9.6 lakhs to 22.5 lakhs. Sukumara [41] has reported that feacundity was ranged between 2, 68,400 to 6, 68,300 eggs from Mangalore [52] has been reported that the eggs ranged between 1, 58,608 - 7, 12,526 eggs from Karwar [46] reported that the fecundity from Karachi was between 2, 25,649 to 5, 24,456 eggs.

In general, Portunids lay around 1 to 6 million eggs per spawning. In the present investigation the fecundity of *C. feriata* was found to be ranging from 2, 83,963 to 9, and 67,293. Whereas, previous reports on the fecundity of the portunid species were reported to be more or less similar [50] reported 1, 51,780 to 3, 07,500 eggs (1.5 to 3.07 lakhs) and later [56] reported a total of 15,314 to 1, 48,800 eggs (0.15 to 1.48 lakhs). Contrastingly higher fecundity levels were observed by [33] – 2, 88,162 to 9, 20,510 eggs (2.88 to 9.20 lakhs). But the allied species *P. pelagicus* was reported to be having 52,025 to 20,22,500 eggs [69], 3,18,720 to 5,21,450 eggs in southwest coast [57] and 0.1 to 2.3 million eggs were reported by Srinivasagam [70]. The fecundity in *S. tranquebarica* and *S. serrata* was comparatively higher [57,69-73]. Several factors such as salinity, temperature, photoperiod, abundance of food in the environment and intrinsic state of the animal have been attributed to both interspecific and intraspecific variability of fecundity. There has been considerable variation in the results obtained by various workers who studied fecundity of portunids from different regions [74,75]. In several crustaceans there is a linear relationship between the number of eggs per brood and the size of the female. This has also been observed for the freshwater prawn *Macrobrachium lamarrei* [77], the freshwater crayfish *Astacus leptodactylus* [78], the crayfish *Procambarus* (*Austrocambarus*) ilamasi [78] and the velvet swimming crab *Necora puber* [69,79] showed a similar direct relationship between size and fecundity in S. *serrata* up to a size of 140 mm carapace width. Giles Churchill [80] reported a significant correlation between crab size and fecundity, with larger crabs having higher fecundities. In *P. trituberculatus* [81], emphasized that oocyte number increased with increasing female's body size and predicted estimates ranged between 0.8 and 4.5 million for carapace width of 130–240 mm.

The fecundity was varried in relation to latitudinal range, habitat structure and food availability [62]. Food availability is the most important factor as feeding factor in paramount for yolk formation [62]. Fecundity determines the reproductive potential of a species and the stock size of its population [82]. Information on fecundity is curcial for the management of crab fisheries [82]. A clear knowledge of the fecundity plays a significant role to evaluate the commercial potentialities of crab stock and also be used to assess the abundance and reproductive potential of the spawning stock.The discrepancy may be affected by environmental factors, including predation, parasitization and temperature, which may affect the balance between the optimal number and the size of eggs and also by the loss of eggs during incubation period and/or during handling as the crabs were obtained from commercial landings.

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