

## Growth and mortality parameters of the three spot crab, *Portunus sanguinolentus* (Herbst, 1783) from Gulf of Mannar, South East Coast of India

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The stock characteristics of growth and mortality parameters of *portunus sanguinolentus* were studied from Gulf of Mannar. The carapace width of male and female *P. sanguinolentus* was ranged from 3.9 cm to 19.10 cm, carapace length 1.9 cm to 10.3 cm and the weight ranged from 15 to 328 g. The growth parameters of *P. sanguinolentus* (Male-  $L_{\infty} = 19.31$  cm,  $K = 1.08$  yr<sup>-1</sup>,  $t_0 = -0.165$ ; Female -  $L_{\infty} = 20.49$  cm,  $K = 1.43$  yr<sup>-1</sup>,  $t_0 = -0.121$ ). The mortality parameters like natural mortality (M), fishing mortality, total instantaneous mortality (Z) and exploitation ratio (E) of *P. sanguinolentus* (Male-  $M = 2.00$ ;  $F = 1.97$ ;  $Z = 3.97$  &  $E = 0.4962$ ; Female -  $M = 2.3$ ;  $F = 2.39$ ;  $Z = 4.69$  and  $E = 0.5095$ ) were observed. The results showed that *P. sanguinolentus* population is marginally over exploited at Gulf of Mannar.

[**Keywords:** Portunid crab; *Portunus sanguinolentus*; Bottom set gill net; Growth parameters; Mortality parameters.]

### Introduction

Gulf of Mannar situated in the southeastern coast of India extending from Rameswaram in the north to Tuticorin in the south along with its marine environment has been declared as India's first Marine Biosphere Reserve. However, this area is now facing severe threat due to destruction of sensitive ecosystems like corals and seagrass through indiscriminate and intensive trawling, coral mining, dynamite fishing etc, commercialized fishing of specific fauna such as sea fans, chanks, sea cucumber, sea horses, and endangered species like dugongs and turtles. These activities have depleted the resources and reduced the biological wealth of this region. In Gulf of Mannar region, 210 species were observed<sup>1,2,3,4</sup>. The dominant genera were *Dromia*, *Cryptodromia*, *Ranina*, *Dorippe*, *Calappa*, *Scylla*, *Portunus*, *Charybdis*, *Thalamita*, *Demania*, *Leptodius*, *Atergatis*, *Phymodius* and *Doclea*. Portunid crabs are one of the good fishery resources of South East Asian seas, out of which, swimming crabs, i.e., three spot crab (*P. sanguinolentus*) and blue swimming or flower crab (*P. pelagicus*) are of high commercial value along with mud crabs<sup>5-16</sup>. The diversity of crustaceans were abundant in five major habitats i.e., inter-tidal, mangroves, coral reefs, littoral and deep sea. *P. pelagicus* is typically found near shore marine

and estuarine waters throughout the Indo-West Pacific<sup>17</sup>, where it is present in large numbers and contributes towards recreational and commercial fisheries<sup>16-21</sup>. However, the blue swimming crabs (*P. sanguinolentus* and *P. pelagicus*) are abundant throughout the year in Gulf of Mannar.

The estimation of natural mortality rates is one of the most difficult and most critical elements of many fishery stock assessments. The natural mortality rate is a key determinant of the potential productivity of a stock and thus the amount of exploitation a stock can sustain. The main objectives of this study were to determine the population size structure and population parameters of *P. sanguinolentus*. Many factors in the marine environment act to reduce the chances of survival of individuals in a population. These include adverse conditions, lack of food, competition and predation. Therefore, knowledge of the growth parameters, total mortality rate, and its components of fishing and natural mortality, is essential for an adequate understanding of the population dynamics of an exploited population.

The aim of this study was to investigate and estimate the seasonal von Bertalanffy growth parameters and mortality parameters of *P. sanguinolentus* by using length frequency distribution data for both sexes. Therefore, the present

study was conducted to assess the stock of *P. sanguinolentus* along this coast and to judge the possible implication of uncertainty involved in decision making so that precautionary approach can be suggested for sustainable exploitation of the resource.

**Materials and Methods**

The present study was carried out for a period of 12 months from June 2015 to June 2016 at Gulf of Mannar (Fig.1). South East coast of India. Gulf of Mannar covers approximately an area of 10,500 sq.km along 8° 35' N - 9° 25' N latitude and 78°08'E-79°30'E longitude. The portunid crabs were sampled from four landing centers at Gulf of Mannar coast. The sample stations are Theraspuram, Vellapatti, Vethalai, Periyapattinam from these stations fournightly samples of *P. sanguinolentus* were collected and each crab was measured and recorded for its carapace width by using Vernier calipers with an accuracy of 0.5 mm, body weight and its sex. The fishing ground is generally characterized by muddy or loamy bottom and it is locally called as “Kappal pariyan”. The gill net is mainly used for crab fishing and it is locally called as “nandu vallai”. The crabs were collected up to a distance 8 to 15 nautical mile from the sea shore and the maximum is 18 nautical mile, the depth of operation ranges from 10-15 m in the Gulf of Mannar region.

**Growth and mortality parameters**

Length frequency data were recorded two times in a month for *P. sanguinolentus*, Twelve month data (June 2015 to June 2016) were collected for the growth and mortality study, total length and weight of each specimen were measured and recorded. Length frequency data (carapace width) were grouped into 5 mm class interval. The length frequency data were subjected to model progression technique by splitting

the modes using Bhattacharya’s analysis followed by linking of means. Growth curve was derived using analysis of growth increment data by Appeldoorns method. The  $L_{\infty}$  was estimated by Powell-Wetherall method. We used an empirical equation by Pauly (1979) to estimate the  $t_0$  value of VBGF:

$$\log_{10} - t_0 = - 0.3922 - 0.2752 * \log_{10} L_{\infty} - 1.038 \log_{10} K$$

Finally, generalized Von Bertalanffy’s model for growth was derived for this species sex-wise.

$$L_t = L_{\infty} \{1 - \exp^{-k(t-t_0)}\}$$

The total instantaneous mortality rate (Z) was estimated by length converted catch curve method using FISAT. The natural mortality (M) was estimated by Pauly’s (1980) equation considering the mean annual habitat temperature (taken as 29°C in this study)  $L_{\infty}$  and K which were taken from the VBGR.

Pauly’s empirical equation (1980):

$$\text{Log (M)} = 0.0066 - 0.279 \log (CW_{\infty}) + 0.6543 \log (K) + 0.4634 \log (T)$$

The co-efficient of fishing mortality (F) was calculated using the relationship

$$Z = F + M$$

The exploitation rate (E) was computed from the formula:

$$E = F/Z$$

**Results and Discussion**

*Size composition*

In the present study, 1985 *P. sanguinolentus* were observed, out of these 1026 males and 959 females were observed from the four different landing centers of Gulf of Mannar coast. The carapace width of male and female of *P. sanguinolentus* ranged from 3.9 cm to 19.10 cm (Fig. 2), carapace length 1.9 cm to 10.3

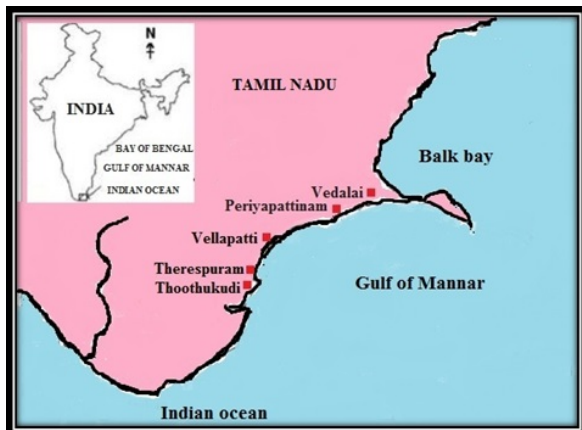


Fig.1 — Sampling stations at Gulf of Mannar

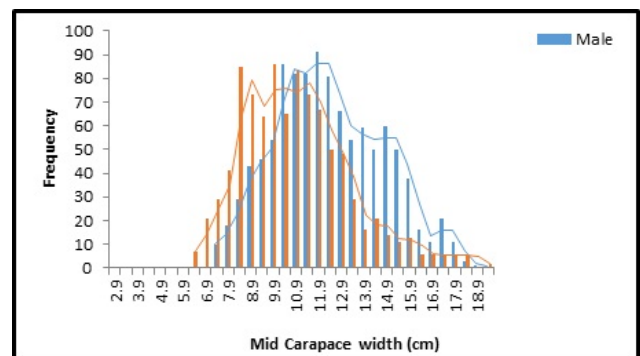


Fig. 2 — Carapace width distribution for male and female *P. sanguinolentus* from Gulf of Mannar

cm (Fig.3) and the weight ranged from 15 to 328 g (Fig.4). The size range of male and female of *P. sanguinolentus* ranged from 12.41 to 11.25 cm and 10.3 to 8.8 cm was observed from Karnataka<sup>17</sup>. In the same place the size range of male and female of *P. sanguinolentus* ranged from 5.6 to 16.0 cm and 6.1 to 17.0 cm was observed<sup>4</sup>. In the same species, the male and female size ranged from 3.6 to 15.5 cm and 2.6 to 17.5 cm was observed from Calicut<sup>15</sup> and in Chennai the male and female of *P. sanguinolentus* was reported 4.1 to 165 cm and 41 to 155 cm, respectively<sup>13</sup>.

*Growth parameters*

The K value (curvature parameter indicator of how fast the animal reaches  $L_{\infty}$ ) which indirectly influence the physiological condition of animal showed marked difference between the species. Growth curve was derived for male, female and pooled data of *P. sanguinolentus* (Fig. 5, 6 and 7). The estimated asymptotic length ( $L_{\infty}$ ) of males and females of *P. sanguinolentus* were found to be 19.31 cm and 20.49 cm and growth co-efficient (K) was 1.08 and

1.43. The M/K value for male and female was 1.99 and 1.74 and the  $t_0$  for both sexes of *P. sanguinolentus* was -0.1 (Fig. 8 and 9).

In India, the age and growth in two marine portunid crabs, *P. pelagicus* and *P. sanguinolentus* along the south west coast of India and reported in

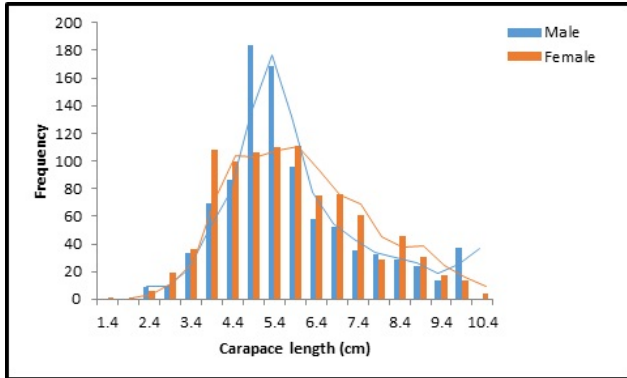


Fig. 3 — Carapace length distribution for male and female *P. sanguinolentus* from Gulf of Mannar

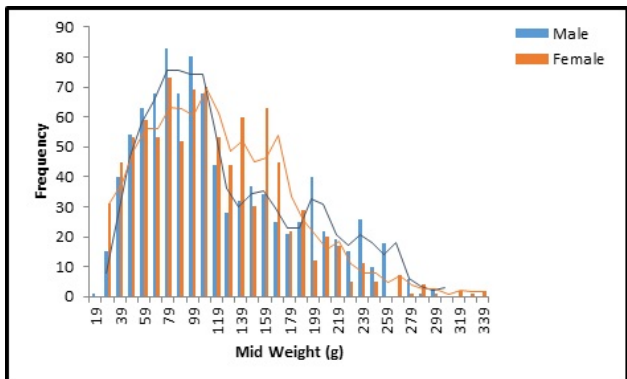


Fig. 4 — Weight distribution for male and female *P. sanguinolentus* from Gulf of Mannar

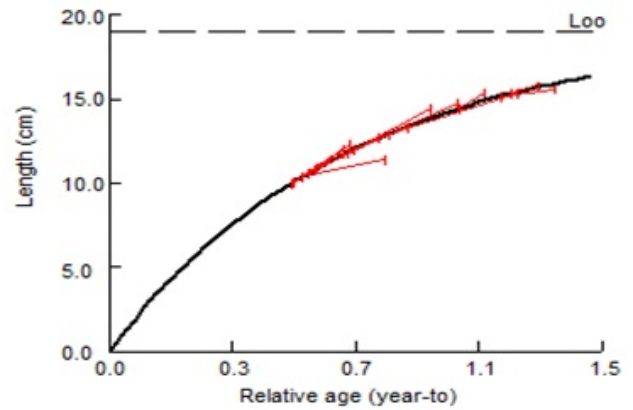


Fig. 5 — Growth curve of male *P. sanguinolentus*

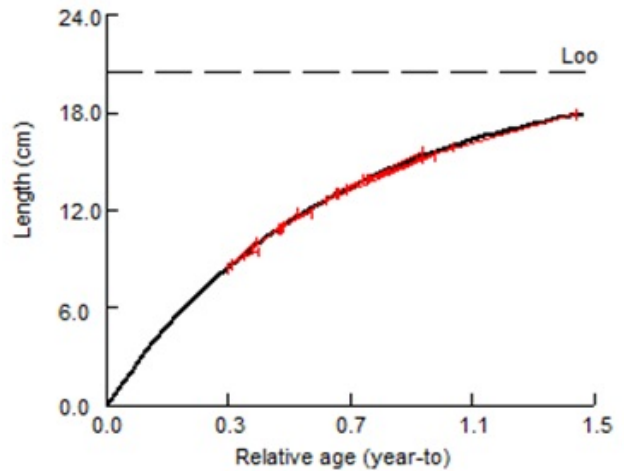


Fig. 6 — Growth curve of female *P. sanguinolentus*

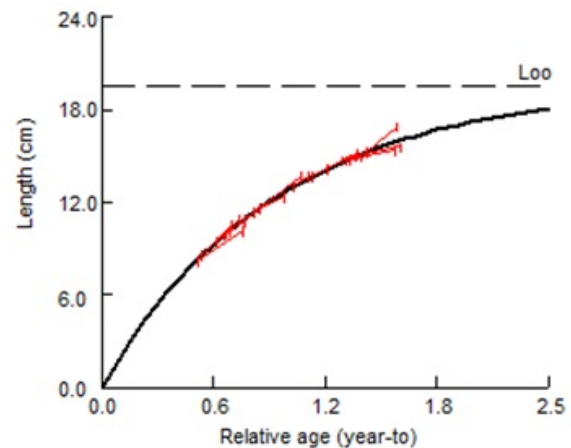


Fig. 7 — Growth curve of sex pooled data of *P. sanguinolentus*

*P. sanguinolentus*, the mean monthly growth rate were 10.3 and 8.8 cm and attained a carapace width of 12.41cm and 11.25 cm by males and females, respectively and in *P. pelagicus*, the average growth were 14.52 and 13.25 cm by males and females respectively at the end of year. The maximum growth rate of *P. pelagicus* at age of 12 months for males and 9 months for females<sup>17</sup>(Fig. 10). This agrees with findings of many authors<sup>3, 6, 8, 9, 11, 16, 19, 20</sup>. Age

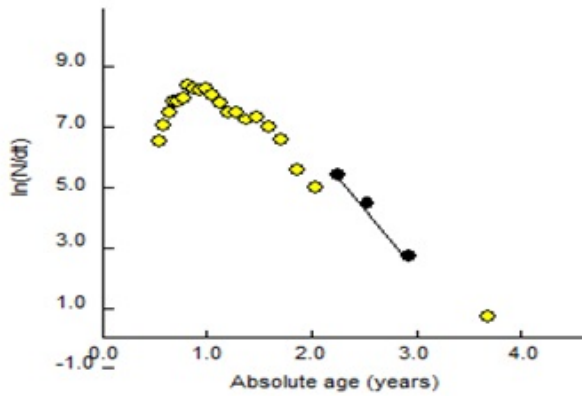


Fig. 8 — Length-converted catch curve-male

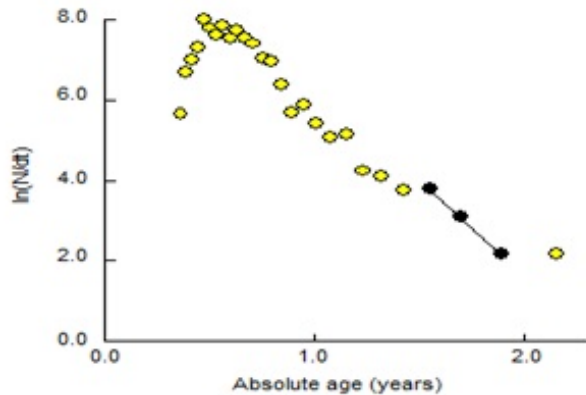


Fig. 9 — Length-converted catch curve-female

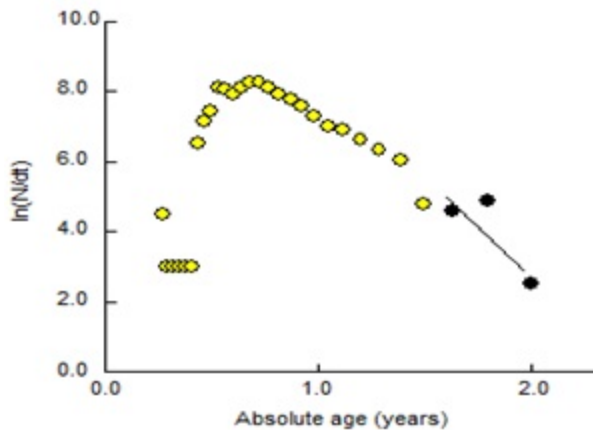


Fig.10 — Length-converted catch curve-pooled data

composition of *P. pelagicus* was determined using Bhattacharya's method<sup>14</sup> and the results showed that the maximum life span of *P. pelagicus* was about 15 months. The generalized VBGF of males and females of *P. pelagicus*, *P. sanguinolentus* and *C. natator* are given below. The length attained by female *P. sanguinolentus* from Calicut in the first year was reported to be 13.1 cm and male 13.6 cm<sup>15</sup> which was relatively lower than that obtained in the present study, whereas another author obtained for females 11.2 cm in the first year and 15.5 cm in the second year, but for males the values were 12.4 cm in the first and 16.8 cm in the second year<sup>18</sup>. Asymptotic length was 16.18 cm for males and 16.86 for females by the Powell-Wetherall plot. On comparing these studies, the present study indicates higher K value for *P. sanguinolentus*<sup>13</sup>. The estimated M/K value was high in *P. sanguinolentus* indicating the animals are in higher stress (Table 1).

$$L(t) = 19.31 \{1 - \exp^{-1.08(t+0.1)}\}$$

$$L(t) = 20.49 \{1 - \exp^{-1.43(t+0.1)}\}$$

*Mortality parameters*

In the marine environment, many factors act to reduce the chances of survival of individuals in a population. These include adverse conditions, lack of food, competition, pollution and predation<sup>7</sup>. In the present study, the total instantaneous mortality parameters (Z) calculated for males and females of *P. sanguinolentus* were 3.97 and 4.69 and natural mortality (M) was 2.0 and 2.3, respectively. The fishing mortality co-efficient (F) calculated for males and females of *P. sanguinolentus* were 1.97 and 2.39. The estimated exploitation ratio of males and females *P. sanguinolentus* were 0.4962 and 0.5095. A high Z values for males and females of *P. sanguinolentus* was observed 5.96 and 6.84 in Karnataka coast<sup>4</sup>. The instantaneous total mortality (Z) was estimated at 4.3 and 3.2 for females and males, respectively and the natural mortality (M) was 1.2 for females and 1.1 for males. The fishing mortality (F) was 3.0 and 2.1 for females and males, respectively. The exploitation rate (E=F/Z) is higher

Table 1 — Growth parameters of males and females of *P. sanguinolentus* of Gulf of Mannar coast

Sex	L∞ (cm)	K	M/K	t <sub>0</sub>
Male	19.31	1.08	1.99	-0.165
Female	20.49	1.43	1.74	-0.121
Pooled data	19.50	1.02	2.35	-0.134

Table 2 — Mortality parameters of males and females of *P. sanguinolentus* of Gulf of Mannar coast

Sex	Natural mortality (M)	Fishing mortality (F)	Total instantaneous Mortality(Z)	Exploitation Ratio (E=F/Z)
Male	2.00	1.97	3.97	0.4962
Female	2.3	2.39	4.69	0.5095
Pooled data	2.4	3.57	5.97	0.5979

than 0.5 for both females (0.70) and males (0.67) observed from Chennai coast<sup>13</sup>. The M was found to be higher in males of *P. sanguinolentus* compared to females whereas, the Z and F were found to be lower in males compared to female. The F (2.8 yr-1) observed in the present study, was higher than M (1.84 yr-1) as a result of which E cur (0.61) was found to be higher than the optimum exploitation rate (0.5) reported. In *P. sanguinolentus*, the mean values of total mortality coefficient (Z), natural mortality coefficient (M), fishing mortality coefficient (F) were  $4.2 \pm 0.51$ , 1.6 & 2.6 for males and  $3.9 \pm 0.42$ , 1.5 and 2.4 for females respectively. In *P. pelagicus* the average values of Z, M & F were  $5.6 \pm 0.71$ , 1.7 and 3.9 for males and  $4.9 \pm 0.69$ , 1.6 and 3.2, respectively for females. The total mortality rates for *P. sanguinolentus* in the waters off northern Taiwan (males:  $Z=3.16/\text{year}$ ; females:  $Z=3.37/\text{year}$ ) was relatively lower than those obtained for *P. sanguinolentus* in the Indian Ocean<sup>11</sup> (Table 2).

### Conclusion

From this present study, the growth parameters of males of *P. sanguinolentus* indicate the shorter longevity and fast growth rate than females at Gulf of Mannar coast. The mortality parameters from this study indicate the highest fishing pressure was observed in *P. sanguinolentus*. The crab resources *P. sanguinolentus* were marginally over exploited at Gulf of Mannar coast. The growth overfishing encountered by this crab fishery resources stressed and the need for control the fishing effort to achieve the optimal exploitation. Since more berried crabs are exploited, as a conservation measure, fisherman may be educated to release the berried crabs to the sea while they are alive. Marketing of berried crabs should also be regulated. The nursery grounds and breeding grounds of these species especially the sea grass and seaweed habitats have to be protected. Hence, the present effort could be continued without any increase to get a sustained yield.

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