ON THE FISHERY AND BIOLOGY OF THE CRAB *PORTUNUS SANGUINOLENTUS* (HERBST) ALONG THE SOUTH KANARA COAST

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ABSTRACT

The fishery of the crab *Portunus sanguinolentus* along the South Kanara coast extends generally from December to May. The catches of the species at Mangalore during 1979-80, 1980-81 and 1981-82 are estimated respectively at 102.3 t, 100.2 t and 57.0 t. The catches at Malpe during 1980-81 and 1981-82 are at 65.9 t and 44.1 t, respectively. The carapace-width-body-weight relationship does not differ between sexes. Spawning takes place throughout the season, with peaks in February and April-May. Males are in excess of females, differing though not significantly from the expected 1 : 1 ratio. Fecundity is estimated to be ranging between 0.03 million (in a specimen of 83-mm carapace width) and 0.07 million (in a specimen of 113-mm carapace width), suggesting a positive relationship between size and fecundity. The L_∞ and e^{-k} values are found respectively at 173 mm and 0.7 in males and 163 mm and 0.75 in females.

INTRODUCTION

P. sanguinolentus is one of the commercially important species of crabs caught in moderate quantities all along the Karnataka coast. Brief accounts on the species have been given by Menon (1952) from the Malabar coast and George and Nayak (1961) from the Mangalore area. Chhapgar (1956) and Naidu and Bal (1955) have described the first larval stages and the breeding. The reproductive biology of this crab has been studied by Ryan (1967) and anatomical studies made by George (1961a, 1961b, 1961c and 1963).

With a view to understanding the fishery and resource of this crab, which had been necessitated by the recent increasing of its market demand, investigations were initiated in 1979 at Mangalore. The present paper embodies the result of the investigations along the Mangalore-Malpe coast of the South Karnataka during three fishery years 1979-80 to 81-82.

MATERIAL AND METHODS

Catch statistics were collected visiting Mangalore and Malpe, two important trawl landing centres in South Kanara, 60 km apart. Though this species is also caught from the estuaries in some quantities, the present study was restricted to the coastal trawl fishery, which accounts for the bulk of the catches. Observations were made twice a week at Mangalore and once a week at Malpe. The details of the craft and gear and of the methods employed in collecting data are as given by Ramamurthy (1972a and 1972 b).

For biological studies random samples were collected from trawl landings at Mangalore and Malpe. These were analysed as far as possible in fresh condition for sex, carapace width, length and maturity. The measurement across the tips of the largest spines was considered the carapace width.

The preponderance of berried crabs at different lengths was used in determining the size at maturity. The monthwise distribution of berried crabs together with the relative occurrence of fully matured females was helpful in fixing the sapwning season.

For fecundity studies, berried females only were taken into consideration. After noting the carapace width and weight of each crab, the eggs were carefully removed from the pleopods and weighed. A subsample from these eggs was taken, and the number of eggs counted under a binocular microscope. From this the fecundity of the crab was computed.

FISHERY

Though trawling begins in these regions usually on 1st September, crabs do not appear in the catches until about December, whence they continue to occur till May or early June.

P. sanguinolentus is not generally fished for, but is caught as a bycatch while trawling for prawns. It forms up to 3.4% of the landings during the peak fishing season both at Mangalore and Malpe. At Mangalore its estimated catches during the seasons 1979-80, 1980-81 and 1981-82, were 102.3 t, 10.2 t and 57.0 t, respectively. At Malpe the catches were 65.9 t and 44.1 t, respectively, during 1980-81 and 1981-82.

The cach per trawling hour ranged between 0.2 and 1.7 kg at Mangalore and between 0.2 and 1.6 kg at Malpe.

At Mangalore the landings of this crab were fairly high in January 1980 (44.7 tonnes), May 1981 (22.4 tonnes) and April 1982 (15.4 tonnes), whereas at Malpe, maximum catches were recorded in April 1981 and February 1982 (23.7 t and 18.5 t, respectively).

Biological Studies

Size Distribution

To eliminate the bias involved in sampling and to project only the prominent modes, which was nevertheless difficult owing to their considerable overlapping, three-point moving averages were calculated and percentages were plotted (Fig. 1). From this, it can be seen that in males the broods 'a' (53 mm) in March 1980 and 'b' (48 mm) in May 1981 progressed to 118 mm and 98 mm in April 1981 and April 1982, respectively, and in females the modes 'A' (53 mm) in March 1980 and 'B' (48 mm) in May 1981 progressed to 108 mm in April 1981 and April 1982, respectively, suggesting that the average monthly growth was more or less uniform in the sexes.

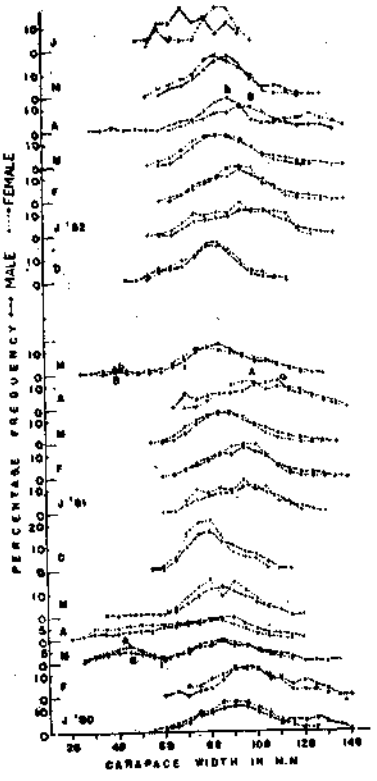

FIG. 1. Length-frequency distribution in *P. sanguinolentus* in the trawl catches at Mangalore during 1980-82.

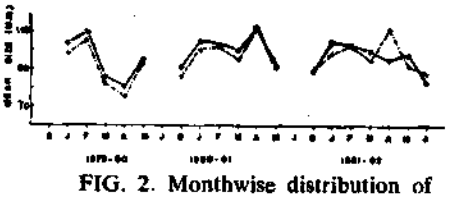

FIG. 2. Monthwise distribution of mean sizes of *P. sanguinolentus* during 1979-80, 1980-81 and 1981 82 at Mangalore.

Mean Size

Mean monthly size values are plotted against the respective months in Fig. 2, which shows two peaks in each season, one in January or February and

the other in April or May. Increase in mean lengths could be either due to moulting and subsequent growth or due to entry of larger crabs in the fishing ground. However, the former is more likely since there had been no indication of a mass migration of adult population to the fishing ground, particularly in the middle of the season. The sudden fall in the mean size after February 1980 may be attributed to incursion of large numbers of smaller crabs into the fishery, which had been observed in March-April 1980 (Fig. 1). Size in relation to total catch has indicated that large-scale recruitment, together with consequent increase in catches, had resulted in the reduction of mean sizes in May 1981 and April 1982. However, a similar relationship was not observed during 1979-80 season.

Carapace Width-Body Weight Relationship

For width-weight relation, 169 males and 104 females were examined. The carapace-width-body-weight relationship was derived separately for each sex by employing the formula: $W = aL^n$, where, 'W' is the weight in g, 'L' is the carapace width in mm and 'a' and 'n' are constants. The relationships can be expressed by the equations (Fig. 3):

$$\text{Males: } \log W = -4.4640 + 3.0874 \log L,\ r = 0.9773$$
$$\text{Females: } \log W = -4.0955 + 2.8947 \log L,\ r = 0.9862$$

where, log W and log L are the log values of weight and width, respectively.

The identicality of these regression lines was tested for significance. It was seen that the difference between the observed and tabulated F values was negligible (Table 1).

TABLE 1. *Anova table for testing the identicality of regression lines in the carapace width-weight relationship among males and females of* P. sanguinolentus.

Deviation due to	d.f.	S.S.	M.S.	F		
				Observed	5% F	1% F
Sex	2	0.0406	0.0203	3.05*	3.03	4.69
Error	269	1.7888	0.00665			
Total	271	1.8294				

* Significant at 5% level

d.f. - degrees of freedom; S.S. - Sum of Squares; M.S. - Mean Square

Breeding

Maturity stages: As in other crustaceans, in *P. sanguiuolentus* four maturity stages, viz, immature, early maturing, late maturing and mature, could be fixed based on the development of ovary. The preponderance of these different stages varied from month to month and season to season. Hence the data for the entire period were pooled and monthwise percentages were found out (Fig. 4). It is seen that fully matured crabs were present throughout the fishing season, in larger proportions in February and April-May.

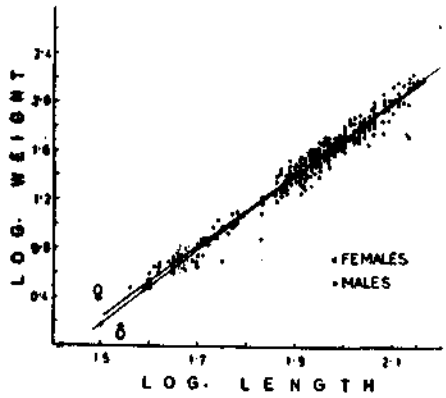

FIG. 3. Regression of weight on carapace width in *P. sanguinolentus* at Mangalore.

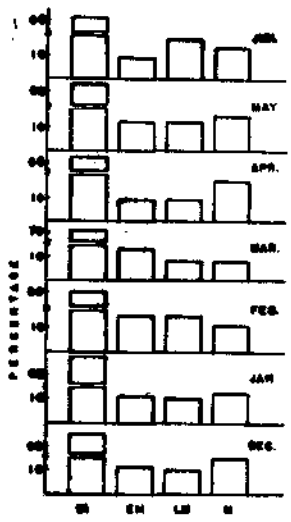

FIG. 4. Monthwise distribution of maturity stages in females of *P. sanguinolentus* (pooled) at Mangalore (IM - immature; EM - early maturing; LM - late maturing; M - mature).

Berried females: The perçentage distribution of berried crabs for three seasons at Mangalore and one season at Malpe is given in Fig. 5. It can be seen that berried crabs were available throughout the fishing season in all the years of study, with peaks in February 1982 (30.9%) at Mangalore, and in May 1981 (43.1%) at Malpe.

These indicate that the crabs were spawning all through the season with peak activity in February and April-May. Menon (1952) had found that *P. sanguinolentus* was breeding in February-April along the Malabar coast. According to Chhapgar (1956), it had been breeding throughout the year at Bombay. Rao et al (1968) had reported that the breeding was during February-April.

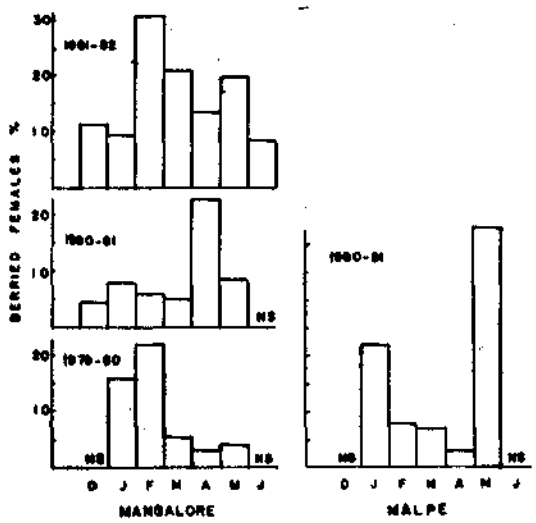

FIG. 5. Monthwise distribution of berried females of *P. sanguinolentus* during different seasons at Mangalore and Malpe (NS - no sample).

Year-round spawning of this species had also been reported by Ryan (1967) from Hawaii. George and Nayak (1961) had noticed breeding females in all months along Mangalore coast, with peaks during March-April.

The relationship between the berried condition and carapace width revealed that, though at any size beyond 78 mm (Table 2) carapace width the crab could be a spawner, the majority of the spawners are in size groups between 98 and 118 mm. The smallest and the largest berried crabs recorded during the course of this study were 78 mm and 143 mm, respectively. The smallest berried female observed by Menon (1952), too, had measured 78 mm in carapace width.

Sex Ratio

Sexwise distribution of crabs during different months at Mangalore showed males to be more than females all through the period of study, except in April 1981 and March and April 1982 (Table 3). At Malpe too males were found to be more, in all the months except May 1981. In order to ascertain whether the distribution of sexes during different months was significantly different from the expected 1 : 1 ratio, the values were statistically tested by employing the chi-square formula, and the results are presented in Table 4. It can be seen that the chi-square values are significant for 1980-81, whereas the values are not significant for 1979-80 and 1981-82. Therefore the distribution of sexes during various seasons is considered to be not significantly different from the expected 1 : 1 ratio.

TABLE 2. *Distribution of berried females* of* P. sanguinolentus *in relation to carapace width during different seasons at Mangalore.*

Size group mid-point (mm)	1979-80		1980-81		1981-82	
	Total females	% of berry	Total females	% of berry	Total females	% of berry
78					34	2.9
83	91	5.5	127	1.6	71	4.2
88	107	2.8	117	4.3	84	6.0
93	113	7.1	117	4.3	96	13.5
98	137	8.0	130	7.7	74	20.3
103	86	15.1	123	12.2	51	19.6
108	69	13.0	106	13.2	62	21.0
113	53	18.9	71	15.5	39	23.0
118	34	32.4	52	15.4	50	30.0
123	16	37.5	40	32.5	29	34.4
128	17	41.1	25	24.0	26	26.9
133	9	—	15	13.3	17	10.4
138	3	33.3	6	33.3	8	12.5
143			7	28.6	4	50.0
Total	735	11.4	934	10.1	645	17.4

* Females measuring less than 78 mm carapace width not included

The frequency distribution of sexes in the different carapace widths shows that males were more than females in all the size groups. George and Nayak (1961) too had reported a similar preponderance of females from this region.

Fecundity

Altogether 17 berried crabs were studied for fecundity. The smallest crab, measuring 87 mm in carapace width, was carrying an estimated 0.3 lakh eggs (Table 5). The maximum fecundity recorded was 0.7 lakh, in a crab measuring 113 mm. Between 87 mm and 113 mm the fecundity appeared to show a direct relationship with size. However, beyond 113 mm this fecundity-size relationship seems to cease. Ryan (1967) had reported that the fecundity ranged between 9.6 lakhs and 22.5 lakhs in the few specimens he had studied,

TABLE 3. *Monthwise sex ratio of* P. sanguinolentus *during different seasons at Mangalore and Malpe.*

	MANGALORE						MALPE	
	1979-80		1980-81		1981-82		1980-81	
	Total crabs	Proportion of males	Total crabs	Proportion of males	Total crabs	Proportion of males	Total crabs	Proportion of males
Dec.	—	—	166	0.4759	235	0.5489	—	—
Jan.	354	0.5734	279	0.6093	565	0.5451	121	0.5207
Feb.	260	0.5538	370	0.5081	156	0.5641	181	0.5414
Mar.	421	0.5701	443	0.5576	169	0.4556	118	0.5000
Apr.	776	0.5740	261	0.4713	205	0.4683	71	0.5493
May	568	0.5334	755	0.5218	252	0.5675	69	0.3623
Jun.	—	—	—	—	49	0.5306	—	—
Total	2379	0.5615	2274	0.5281	1631	0.5314	560	0.5071

TABLE 4. *Test of homogeneity (chi-square) for the proportion of males of* P. sanguinolentus *in the monthly samples during* 1979-80 *to* 1981-82 *at Mangalore and* 1980-81 *at Malpe.*

Centre	Season	d.f.	Chi-square value	Significant at 5%
MANGALORE	1979-80	4	3.0209	NS
	1980-81	5	15.1187	S
	1981-82	6	10.4491	NS
MALPE	1980-81	4	7.3019	NS

d.f. - degrees of freedom; S - Significant; NS - Not Significant

without going into the relationship between fecundity and size. To ascertain whether there was any relation between fecundity and size of crab, a regression equation was obtained by the least square method, which is:

$$\log F = -0.8909 + 0.7486 \log W,$$

where F is the fecundity in lakhs and W is the width of carapace in mm. The observed values were plotted against mean widths and a regression line was fitted to the data (Fig. 6), which together with r value (0.9416) suggests that there was good agreement between the two factors.

TABLE 5. *The carapace width (mm) and weight (g) of crab, weight of egg mass, sub-sample weight (g), colour of egg mass and the estimated number of eggs in* P. sanguinolentus *at Mangalore.*

	Carapace width	Weight of crab	Weight of eggmass	Weight sub-sample	Colour of egg-mass	Estimated number of eggs
1	89	52.32	6.20	0.59	Brown	2,86,000
2	113	79.00	7.00	0.50	Drity yellow	3,18,550
3	91	44.49	7.68	0.55	Yellow	4,30,100
4	98	55.32	7.46	0.62	Dirty yellow	4,27,700
5	92	55.77	7.76	0.58	Yellow	3,47,300
6	100	49.52	6.99	0.54	Brown	3,87,300
7	87	37.29	5.36	0.58	Brown	2,68,400
8	94	42.08	7.35	0.54	Yellow	3,82,200
9	107	70.67	14.33	1.10	Dirty yellow	5,69,400
10	113	89.90	20.10	1.30	Dirty yellow	6,68,300
11	115	65.50	8.60	1.00	Dirty yellow	3,12,600
12	125	120.23	9.43	1.00	Yellow	3,18,400
13	120	91.27	12.11	0.86	Dirty yellow	5,20,900
14	105	68.32	11.70	1.63	Dirty yellow	4,25,600
15	101	53.68	8.79	0.52	Dirty yellow	6,19,300
16	88	45.00	4.75	0.73	Yellow	3,80,100
17	104	72.03	11.23	0.65	Dirty yellow	5,42,800

Soft-Shelled Crabs

The freshly moulted crabs have soft shells and are with very little flesh and therefore are of no commercial value. These soft-shelled crabs are nevertheless taken in varying proportions in trawls and are awasted. To determine the extent of damage if caused to the stock by taking these crabs thus indiscriminately, and also to know if there was any relative intensity of moulting in different months, these soft-shelled crabs too were observed, sexewise, during the

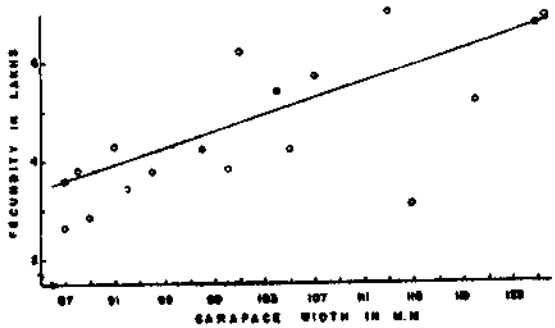

FIG. 6. Fecundity-size relationship in *P. sanguinolentus* at Mangalore.

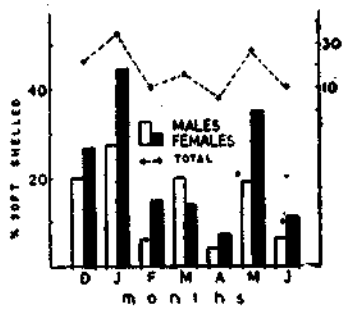

FIG. 7. Monthwise distribution of soft-shelled crabs in *P. sanguinolentus* during 1982-83 at Mangalore.

1982-83 season. It can be seen from Fig. 7 that these crabs were being caught throughout the year. The peaks seen in January and May suggest that moulting had been intensive in these two months. It is also seen that the proportion of of soft-shelled females was more than that of males in all the months except March.

Migration

Menon (1952), finding *P. sanguinolentus* almost completely absent from the coastal grounds after the start of the monsoon rains, had reported that the species possibly perform an annual migration, moving into the offshore waters during the S.W. monsoon. George and Nayak (1961) had inferred that juveniles might go into deeper waters and might return to inshore grounds when they become mature. Larger crabs were fewer in the present collections, particularly of March-May, when smaller crabs (28 to 68 mm carapace width) were recorded in large numbers. Though trawling had begun in September along this coast, the crab did not appear in the catches till December as has been reported by Menon (1952). As this author had suggested, it is possible that the crabs move out to deeper waters during the latter half of the season, perhaps after mating. The occurrence of soft-shelled crabs in larger proportions during this period seems to confirm this view. Besides, the sudden reappearance of large-sized crabs in the fishery in December also add to the conclusion that the crabs make regular offshore-inshore movements.

Estimation of L_∞ and e^{-k}

The growth parameters, L_∞ and e^{-k} (monthly values), were estimated to be 173 mm and 0.75 for males and 163 mm and 0.75 for females. Three modes with equal increase in the time interval, occurring in the monthly modal

distribution (Alagaraj 1984), were selected as l_1, l_2 and l_3. In males, 93, 113 and 128 mm, and in females, 83, 103 and 118 mm were identified for this purpose.

Estimation of Instantaneous Total Mortality Coefficient, Z

Since the age at lengths could not be determined, it was not possible to regroup the annual size-distribution into age-composition data for estimating Z. However, Z has been estimated from the descending limb of the annual size distribution (Alagaraja 1984), which is subjected to heavy fishing mortality. For this, the estimated numbers during different fishing seasons for males and females were smoothened by three-point moving averages. The monthly estimates of Z and standard error SZ, are presented in Table 6. The Z estimates for all seasons combined were 0.78 for males and 0.79 for females.

TABLE 6. *Estimates of* $\bar{Z}$ *and* $S\bar{Z}$ *for males and females of* P. sanguinolentus *for different seasons at Mangalore.*

Season	MALES		FEMALES	
	$\bar{Z}$	$S\bar{Z}$	$\bar{Z}$	$S\bar{Z}$
1979-80	0.6258	0.1186	0.6544	0.1433
1980-81	1.0146	0.1514	0.9135	0.1312
1981-82	0.8355	0.4054	0.5830	0.2133
1982-83	0.6713	0.1296	1.0388	0.3516
Combined estimate for all seasons	0.7812	0.0709	0.7861	0.0809

$\bar{Z}$ = mean Z; $S\bar{Z}$ standard error of $\bar{Z}$

Since *P. sanguinolentus* carry several batches of eggs successively, moulting and growth are likely to be delayed in females and therefore the growth studies based on modal progression may have their own limitations; mark-recovery experiments being perhaps the only method that might throw some light on the growth trends in this crab.

Since there are no restrictions in our country to prevent the berried and soft-shelled crabs from being caught, as it is in force in British waters (Edwards 1979), these crabs are taken in trawls indiscriminately, throughout the fishing

season, even though the fishery is not primarily aimed at them. The proportion of berried females, above 78 mm carapce width, was 11.4%, 10.1% and 17.4% during 1979-80, 1980-81 and 1981-82, respectively, forming 30-40% of females in certain months. In 1982-83 the soft-shelled crabs formed around 18.0%. Since the flesh content in these soft-shelled crabs is negligible, they are not utilised but are discarded. This type of indiscrimate fishing, which might affect the future fishery adversely, call for urgent management measures for the conservation of this resource.

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