THE FISHERY AND BIOLOGY OF CRABS OF KAKINADA REGION

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ABSTRACT

Kakinada area has a lucrative crab fishery throughout the year with peak landings during March to May and August to November. The morphometric relationships, age and growth, size at maturity, breeding season and sex ratio in *Portunus pelagicus*, *P. sanguinolentus* and *Scylla serrata* are reported. The relation of fecundity to carapace length in *P. sanguinolentus* is discussed. An incidence of infection in *Charybdis cruciata* by a rhizocephalan was noticed. In *P. sanguinolentus* 21% of the eggs were infested by parasitic copepods.

INTRODUCTION

The Kakinada area along the Andhra coast has a lucrative year-round crab fishery. Except for some observations made by Rao et al (1973), no information is available on the fishery and biology of crabs from this region. Hence an attempt was made to study the fishery and biology of the crabs of commercial value of the area during the two years 1979 and 1980.

Weekly samples and catch statistics were collected from the landing centres, namely, Uppada, Kakinada fishing harbour, Matlapalem, Boddu Venkatayapalem and Pedagadimoga, from January 1979 to December 1980. Data on carapace length (from tip of anterior margin of carapace to the anterior margin of first abdominal segment) and width (across the carapace excluding the lateral spines in the case of *P. pelagicus* and *P. sanguinolentus*), total weight and sex and maturity were gathered.

Fecundity studies of *P. sanguinolentus* were done following the method of Rajyalakshmi (1962) and Haynes (1968).

FISHERY

The crab fishery in the Kakinada region was year-round with peak periods from April to May and August to November. The specieswise abundance at various landing centres is given in Table 1. Fishing was carried out both in the backwaters and the sea up to 30 m depth.

TABLE 1. *Centrewise landings of different species of crabs (in tonnes) during* 1979 *and* 80.

	Fishing Harbour			Uppada			Backwaters		
	79	80	Total	79	80	Total	79	80	Total
S. serrata	6.1	22.3	28.4	2.5	5.1	7.6	91.9	41.5	135.7
P. pelagicus	121.2	78.4	199.6	12.8	20.1	32.9	9.8	94.4	104.2
P. sanguinolentus	59.9	161.6	221.5	33.8	38.1	71.9	0.2	0.8	0.9
C. cruciata	1.2	3.5	4.7	0.3	1.6	1.9	—	—	—
Others	8.6	42.1	50.7	—	—	—	—	—	—
Total	196.9	307.8	504.7	49.4	64.9	114.3	93.1	51.7	144.8
No. of units (in hundreds)	535	404	939	435	903	1339	892	536	1427
Fishing effort (in thousands of h)	401	323	724	228	871	1099	959	616	1575
Percentage of crabs	2.12	3.12	2.62	4.38	2.32	2.91	5.83	4.32	5.21

Fishing Methods

From the inshore region, crabs were caught in nylon gillnet, boatseine, shoreseine and *Chinna Alivi* (a type of dragnet); from the offshore region in trawlnets; and from the backwaters in stakenet, drag net and lines. At the low tide crabs were also hand-picked. Fishing exclusively for crabs by lines was carried out in the backwaters during November to March. The line (coir rope) was laid out with dried fish (mostly eels and catfish) as baits, up to about 10 times a day, each time catching 15-20 crabs. Boats, with two men working on each, landed on an average about 150 crabs per trip. The catch details from the line and bait fishery in this region have been given by Rao et al (1973).

Landings

The catch details of crabs during 79 and 80 from the Kakinada region are presented in Tables 1 and 2.

P. pelagicus: In 1979 and 80, a total of 243.38 t were landed, forming 31.83% in the total crab landings of Kakinada region. Bulk of the landings (82.0%) were from the offshore region. About 4.48% were from the backwaters. The size ranged 20 mm-94 mm in carapace length with a mode at 50.5 mm. The landings were abundant from January to June and August to December with peaks in August to November and March to May.

TABLE 2. *Gearwise landings in toones of the different species of crabs.*

	Nylon gillnet	Cinna-alivi	Boat seine	Shore seine	Trawl net	Drag net	Stake net	All pooled
P. pelagicus	19.2	0.9	11.8	0.9	199.6	9.5	1.4	243.4
P. sanguinolentus	52.2	1.4	16.9	1.4	221.4	0.7	0.2	294.2
S. serrata	6.1	—	1.5	—	28.4	111.5	22.2	169.7
C. cruciata	1.6	—	0.3	—	4.7	—	—	6.6
Others	—	—	—	—	50.7	—	—	50.7
Total	79.1	2.3	30.5	2.4	504.8	121.7	23.8	764.4
Units (in hundreds)	1040	76	216	7	939	1183	244	3704
Effort (in thousands of h)	393	35	121	4	724	1427	148	3398
Percentage in the total catch	3.55	0.62	3.25	0.65	2.62	5.75	3.51	2.94

P. sanguinolentus: A total of 294.22 t were caught in 79 and 80 forming 38.48% of the total crab landings. Of this, 99.70% were from the sea and only 0.30% were from the backwaters. The size ranged from 15 mm to 78 mm carapace length, with a mode at 47.5 mm. The peak landings were during August to November.

Scylla serrata: This species accounted for 169.66 t contributing to 22.19% of the total crab landings. Backwaters accounted for the major portion (78.80%) and the rest by the sea. The size ranged from 15 mm to 129 mm with a mode at 48.5 mm. Peak landings were in February to June and September to October.

Charybdis cruciata: Landing only 6.6 t, this species was of minor importance, forming 0.86% of the total crab landings.

Others: A total catch of 50.73 t of smaller-size crabs, consistiing of *Thalamita, Charybdis, Portunus, Phylira* and juveniles of Portunid crabs, were landed. These being unsuitable for consumption in fresh, were dried with other trashfish and small-sized prawns.

MORPHOMETRIC RELATIONSHIPS

Carapace Length-Width Relationship

The relationship between carapace length and carapace width was determined by the method of least squares. The carapace length when plotted against

carapace width yielded a straight line. The regression equations of the type Y = a + bx derived for males and females of *P. pelagicus, P. sanguinolentus* and *S. serrata* are presented in Table 3.

TABLE 3. *Relationship between carapace length* (X) *on carapace width* (Y).

	Sex	N	CL range mm	a	b	r^2
P. sanguinolentus	M	140	18-78	8.8443	1.65416	0.9428
	F	170	22-76	19.7	1.421	0.9235
P. pelagicus	M	450	22-93	11.3934	1.5369	0.8641
	F	198	27-85	4.9881	1.6399	0.9262
S. serrata	M	219	19-126	2.9723	1.3269	0.9543
	F	263	17-124	5.5193	1.2911	0.8342

Carapace Width-Weight Relationship

The relationship between the carapace width and total weight has been determined after logarithamic transformation by the equation:

$$W = a\,bL;$$

Where 'W' = log weight in grams; a = constant, b = exponent of carapace width and L = log width in mm across the carapace between the tips of the two lateral spines. In the case of *P. sanguinolenthus* L = log carapace length in mm.

P. pelagicus

Males: W = 3.17767 + 2.71898L

(C.W. ranges from 45-154 mm, No. of observations. 170)

Females: W = 3.60964 + 2.8385 L

(C.W. ranges from 49-154 mm, No. of observations 170)

Analysis of covariance showed that both the slopes and elevations did not differ significantly. Hence the data of sexes were combined and the resultant equation is written as

$$W = -3.38846 + 2.72509\ L$$

The correlation coefficient for the regression was found to be 0.95146 (d.f. 338, r 5% = 0.111, r 1% = 0.1556) which is significant. The '*t*' test

was applied and the value of '*t*' was 3.43726 (d.f. 338, *t* 1% = 2.58, *t* 5% = 1.96). Hence the regression coefficient is to be regarded as significantly different from 3.

P. sanguinolentus

Males: W = − 2.2382 + 2.3846 L
(No. of observations = 114)
Females: W = − 2.43311 + 2.54039 L
(No. of observations = 218)

Here too analysis of covariance showed that both the slopes and elevation did not differ significantly, and hence the data of sexes were combined. The resultant regression equation is W = − 2.3867 + 2.4757 L

The correlation coefficient for the regression was found to be 0.88035 (df 332; r 5% = 0.117 r 1% = 0.148) which is significant. The '*t*' test was applied to see whether the regression coefficient (b) differs from 3. The value of *t* was 7.14049 (df 332, *t* 1% = 2.58; *t* 5% = 1.96) hence the regression coefficient is to be regarded as significantly different from 3 even at 1% level.

Scylla serrata

Males: W = −3.185900 = 2.71832 L
(C.W. ranges from 27-168 mm; No. of observations 120)
Females: W = −3.00429 + 2.65819 L
(C.W. ranges from 2937-164 mm; No. of observations 120)

Analysis of covariance showed significant difference in the elevation (Snedecor and Cohran 1961) (Table 4) at 1%. Hence the sexes were treated separately and the regression lines shown in Fig 1. The correlation coefficient for the regression were found to be 0.9446 for males and 0.9419 for females. (df 120, r 5% = 0.2502, r1% = 0.2748) which is significant.

The '*t*' test was applied for males and females to see whether the regression coeefficient (b) differs from 3. The values of *t* were 2.37375, and 4.9808 respectively (df 120 t 1% = 2.47, *t* 5% = 1.98). Hence the regression coefficient was regarded as significantly different from 3 at 5% level.

AGE AND GROWTH

As there were no differences in the size composition of crabs between the years, the data for 79 and 80 were pooled.

P. pelagicus (Fig. 2A)

Females: Mode 'A' at 46.5 mm in January has shifted to 61.5 mm in March with an increment of 15 mm|2 months. Mode 'B' at 41.5 mm in April can be

TABLE 4. *Analysis of covariance to test the significance of differences between regression lines of sexes in the carapace width-weight relationship of* S. serrata.

Sources of variation	df	Deviation from regression S.S.	M.S.
Due to regression within sexes	236	3.29209	0.0139495
Diifference between regression coefficients	1	0.0183658	0.0183658
Residuals due to regression pooled within	237	3.3104558	0.0139681
Difference between adjusted mean	1	0.3826333	
Total	238	3.6930891	

Comparison of slopes F = 1.32, df. 1.236. N.S.

Comparison of elevation F = 27.39 d.f. 1.237. H.S. at 1%

NS: Not Significant

HS: Highly significant

traced to 81.5 mm in November with an increment of 40 mm|7 months which gives an average growth rate of 5.71 mm|month. Mode 'C' at 31.5 mm in January shifted to 51.5 mm in March with an increment of 20mm|2 months indicating a growth rate of 10 mm|month. For different modes the average growth rate works out to 6.8 mm|month.

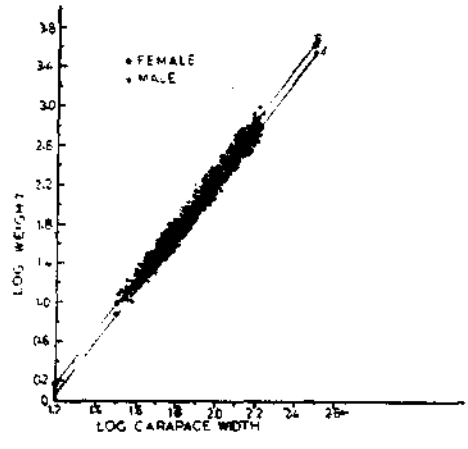

FIG. 1. Relation between Log Carapace width and log total weight of males and females in *S. serrata*.

It is reasonable to assume that Mode 'B' at 81.5 mm in November represents the crabs spawned in September|October in previous year. This suugests that they attain 81.5 mm when they are one year old.

Males: Mode 'a' at 61.5 mm in January has shifted to 76.5 mm in March with a growth rate of 7.5 mm|month. Mode 'b' at 46.5 mm in May can be traced to 76.5 mm in November with an increment of 30 mm|6 months, giving a growth rate of 5 mm|month. Mode 'c' at 51.5 mm in March can be traced up to 71.5 mm in June, with a growth increment of 20 mm in 3 months, giving a growth rate of 6.7 mm|month. From the modal progression the average growth rate of males is 6.4 mm|month. It is probable that Mode 'b' at 76.5 mm in November represents the crabs spawned in September|October in previous year. This suggests that they attain 76.5 mm when they are one year old. The age of the crabs in the commercial catches is comprised of '0' and 1 year old crabs. Most of the crabs are therefore vulnerable to fishing before they are one year old.

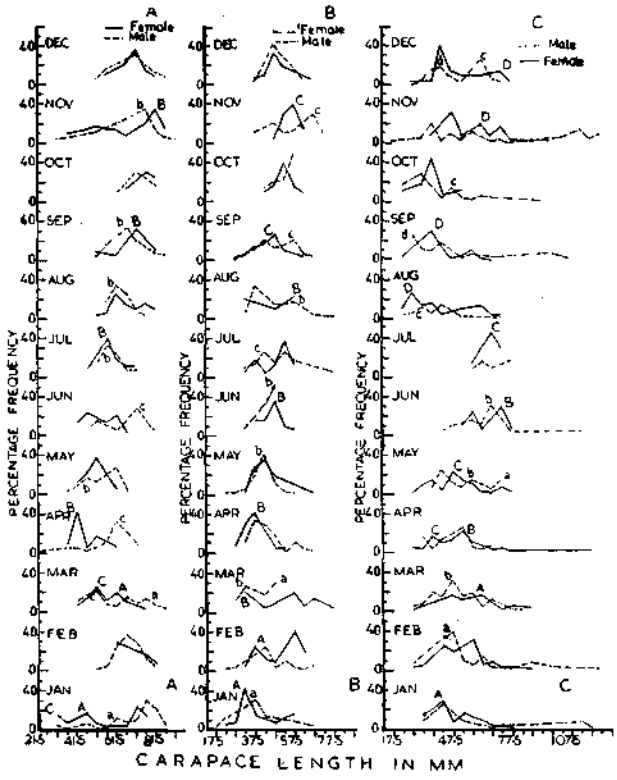

FIG. 2. Percentage carapace-length frequency of (A) *P. pelagicus*, (B) *P. sanguinolentus* and (C) *S. serrata*.

P. sanguinolentus (Fig. 2B)

Females: Mode 'A' at 32.5 mm in January has shifted to 37.5 mm in February with a growth rate of 5 mm|month. Mode 'B' at 32.5 mm in March has shifted to 57.5 mm in August with an increment of 25 mm in 5 months. Mode 'C' at 47.5 mm in September has shifted to 57.5 mm in November with 10 mm growth in two months. (The average growth of females works out to 5 mm| month in carapace length).

Males: Mode 'a' at 37.5 mm in January has shifted to 47.5 mm in March with an increment of 10 mm in two months. Mode 'b' at 32.5 mm in March has shifted to 57.5 mm in August with an increment of 25 mm in 5 months. Mode 'c' at 42.5 mm in July can be traced up to 62.5 mm in November with an increment of 20 mm in 4 months.

Thus the growth rate of males and females appears to be the same, with an average of 5 mm|month carapace length. The occurrence of small-sized crabs in January, February and May may correspond to the broods of October-November and February spawning, respectively. From the growth rate, crabs with 60-67 mm in carapace length are one year old and those above this size belong to 1 year.

Scylla serrata (Fig. 2C)

Females: Mode 'A' at 42.5 mm in January has shifted to 62.5 mm in March with an increment of 20 mm in two months. Mode 'B' at 52.5 mm in April has shifted to 72.5 mm in June, with an increment of 20 mm in two months. Mode 'C' at 37.5 mm in April has shifted to 67.5 mm in July, 30 mm growth in 3 months. Mode 'D' at 32.5 mm in August has shifted to 72.5 mm in December with 40 mm increase in 4 months. Thus in females the average growth rate is 10 mm|month.

Males: Mode 'a' at 47.5 mm in February has shifted to 72.5 mm in May with an increment of 25 mm in 3 months. Mode 'b' at 47.5 mm in March has shifted to 67.5 mm in June with an increment of 20 mm in 3 months with a growth rate of 6.6 mm|month. Mode 'c' at 32.5 mm in August has shifted to 62.5 mm in December with an increase of 30 mm in 4 months with an average growth of 7.5 mm. Mode 'd' at 27.5 mm in September has shifted to 42.5 mm in December. The growth rate of males varies from 5.0 mm to 8.3 mm|month. In general, females grow faster, with an average growth rate of 10 mm|month, than males, which grow 7 mm|month.

From the above growth rate it is assumed that the age of crabs in the commercial catches is below 2 years. Most of the crabs are caught before they complete one year.

Size and Maturity

Attempts were made to determine the size at maturity only of females.

P. pelagicus: The smallest crab observed bearing eggs was 56 mm in carapace length and the largest was 86 mm in carapace length. Fig. 3 shows the percentage of ovigerous crabs at different size groups. The maximum number is seen in the size range between 67-77 mm in carapace length. In addition to the direct observation on the ovigerous females, the 3rd stage females with widened 6th abdominal segment and the relative growth of the first walking legs show abrupt changes at a carapace length of about 44 mm which may be attributed to the onset of first maturity.

P. sanguinolentus: The smallest crab observed bearing eggs was 36 mm in carapace length and the largest was 72 mm in carapace length. The percentage of ovigerous crabs at different size groups is shown in Fig. 3. The maximum number was seen in the size range of 50-65 mm in carapace length. The females attain maturity at a size of 26 mm in carapace length.

Scylla serrata: Fig. 3 shows the percentage of Ovigerous females at various size groups. The smallest crab bearing eggs was 57 mm and the largest was 118 mm in carapace length. The females attain first maturity at the size of 39 mm in carapace length.

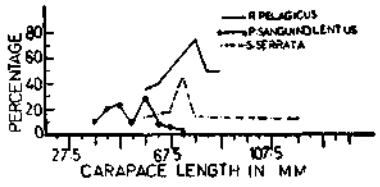

FIG. 3. Percentage of ovigerous crabs at different size groups.

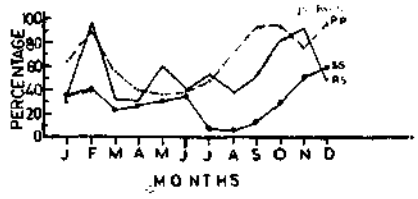

FIG. 4. Spawning season of *P. Pelagicus*, *P. sanguinolentus* and *S. serrata*.

Breeding Season

Since the incidence of ovigerous females gives a clear indication of the breeding activity the observations were limited to females. Depending on the percentage occurrence of mature females the breeding season for the commercially important crabs is given (Fig. 4).

P. pelagicus: Berried females are found throughout the year, abundant from September-March, with peaks in September-December and February, suggesting that spawning takes place in these months.

P. sanguinolentus: Berried females are found throughout the year with abundance from October-November and February-May with the peak in February.

Scylla serrata: Berried females are found during November-April with the peak in December and February.

Sexual Dimorphism

In the case of *P. sanguinolentus* and *Scylla serrata* sexual dimorphism with reference to size and colour was not observed. The female crabs of *Scylla serrata* were found to be heavier than the male crabs.

In the case of *P. pelagicus* males and females exhibit sexual dimorphism. The males are brilliantly coloured, with the walking and swimming legs bright blue. The females are dull and light green in colour. The males grows to a larger size with the chelate legs bigger than the females.

Sex Ratio

Sex ratio of the crabs from the commercial catches for the years 79 and 80 are presented in Table 6. Size distribution of males and females of *P. pelagicus, P. sanguinolentus* and *S. serrata* are shown in Fig. 5 A-C.

In a chi-square test to determine if the samples were from a population having a 1 : 1 sex ratio, the X^2 value of 1.2212 obtained for *Scylla serrata* is non-significant at 1% level. For *P. pelagicus* the value is 187.839 and is highly

Table 5. *Sexwise number of crabs.*

Species	Year	Males	Females	Total	X^2	Remarks
P. pelagicus	79	382	298	680	10.376	H.S.
	80	524	111	635	134.3062	N.S.
Total		906	409	1315	187.839	H.S.
P. sanguinolentus	79	318	304	622	0.3151	N.S.
	80	231	207	439	1.3150	N.S.
Total		553	501	1060	1.9962	N.S.
S. serrata	79	312	317	629	0.0397	N.S.
	80	235	257	492	0.9837	N.S.
Total		547	574	1121	1.2212	N.S.

N.S. Not significant at 5%

H.S. Highly significant at 5%

significant at 1% level indicating that the samples were drawn from a population in which there is a preponderance of males over females. Amongst the small sized crabs (30-60 mm in cl) apparently there is dominence of females but the X^2 value is 1.89 which is not significant. Preponderance of males over females may be due to schooling according to sex. There is no such segregation by sex among juveniles. For *P. sanguinolentus* the X^2 value is 1.9962 and is not significant at 1% indicating that there exists 1 : 1 ratio in the population.

FECUNDITY

The fecundity of *P. sanguinolentus* has been worked out. Carapace length of ovigerous crabs was measured to the nearest 0.1 mm. A total of 58 ovigerous crabs representing all the size groups and covering carapace length range of 36-72 mm were studied. The number of eggs in each egg mass was determined in the lab by the methods used by Rajyalakshmi (1962) and Haynes (1968).

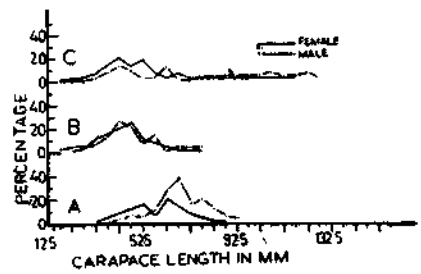

FIG. 5. Size distribution of males and females of (A) *P. pelagicus*, (B) *P. sanguinolentus* and (C) *S. serrata*.

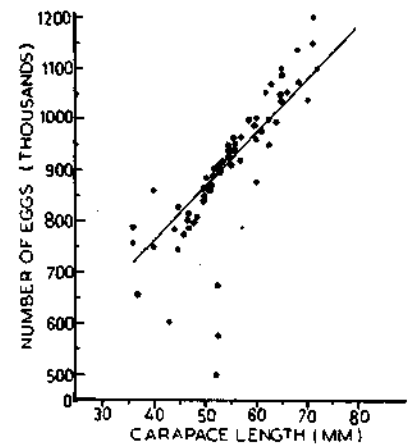

FIG. 6. Relationship between carapace length and number of eggs in *P. sanguinolentus*.

In general, fecundity increased as carapace length increased. There was a wide range in the number of eggs carried by crabs of any given carapace length and the range increased with the carapace length (Fig. 6). The greatest range was in crabs of 50-70 mm size. Females in this size group had 420,000 to 1,150,000 eggs. To describe the relation of fecundity to carapace length, linear regression of fecundity (Y) on carapace length (X) was fitted by least squares as

$$Y = 343.0784 + 10.5389\ X$$

Where Y = number of eggs in thousands.

The correlation coefficient for the regression was found to be 0.7863. (df 58, r 5% = 0.2546 r 1% = 0.3308). The cause of the wide range in fecundity is unknown but it is possible that an exceptionally low number of eggs is the result of successive egg laying in the tropical crabs, even without mating. In the early peak period of breeding season usually the eggs borne by the crabs were more, and the number decreased as the season advanced.

The diameter of fresh eggs from each crab was measured (with an ocular micrometer) to determine if the size of the egg increased with the size of the crab. The mean egg diameters varied among the crabs, but could not be related to carapace length. The mean diameter of 870 eggs (15 from each crab) measured 0.39102 mm. The diameter of the eggs in the initial stage of development (orange in colour) varied from 0.2999 mm to 0.3833 mm. The diameter of the eggs in the advanced stage of development (grey in colour) ranged from 0.41666 mm to 0.4833 mm.

Parasitization

P. pelagicus, P. sanguinolentus and *S. serrata* collected from Kakinada region were free from rhizocephalan infections. But epizoans such as barnacles, colonial ciliates and hydrozoans were present on carapace, and the gills were choked with *Lepas* spp. *C. cruciata* was found to be infected by an unidentified rhizocephalan. The incidence of infection was 28%. Tampi (1952) and Ameer Hamsa (1978) have reported the incidence of infection of *P. pelagicus*, respectively from Mandapam and Palk bay and Gulf of Mannar, to be as high as 20-29%.

The eggs of *P. sanguinolentus* were infected by parasitic copepods. The infection was 21%. Infected eggs were in an atrophied state with arrested development, and those eggs with advanced-stage embryo did not hatch. Gnanamuthu (1954) had reported *P. sanguinolentus* eggs with parasitic copepod *Choniosphaera indica*, causing considerable atrophy of the eggs.

Commercial Utilization

Crabs are well accepted in all parts of the coastal Andhra Pradesh and has a great demand in fresh condition. The crabs are regularly sent to neighbouring places through corporations and middlemen. The small-sized crabs along with trash fish and small sized prawns are sundried for use in the preparation of poultry feed.

Discussion

In the Kakinada region, the period of abundance is from February-June and August-December with peaks in April-May and August November, but, between the species, the abundance and peak landings showed considerable

variation. The occurrence of *P. pelagicus* and *P. sanguinolentus* in the backwaters of Kakinada during March-June and August-November with the peak in March-April are in concurrence with the observations made by Rao and Kathirvel (1971) from Cochin backwaters and those of Rajinder et al (1976) on *P. pelagicus* from Zuary estuary (December-April with peak in February). The breeding season of *P. pelagicus* has been varyingly reported as September-March (Prasad and Tampi 1953), August-March (Pillai and Nair 1969) and January-March (Ameer Hamsa 1978). Present observations are to some extent in agreement with those of Ameer Hamsa (1981). Breeding season of *P. sanguinolentus* in the Kakinada region is from October-November and February-May, with the peak in February. Menon (1952) reported the breeding season of this species from Malabar coast to be from December-March with the peak in April-May and February-April. From the south-west coast of India, Pillai and Nair (1968) reported the breeding season of *P. sanguinolentus* from November to March with the peak in February. Present observations on the breeding season of *Scylla serrata* are in agreement with those of Pillai and Nair (1968).

Prasad and Tampi (1953) had observed a growth rate of 10.66 mm|month in carapace width of *P. pelagicus*. Present observation showed that the average growth rate of females was 6.6 mm CL. (17.95 mm C.W.)|month and in males 6.4 mm in CL (21.22 mm C.W.). Growth was therefore faster both in male and female crabs of this region.

Menon (1952) had noticed a growth rate of 19.8 mm|month in the carapace width of *P. sanguinolentus*. Present observations showed that the growth rate of males and females was 5 mm|month in carapace length. i.e. 14.60 mm. in males and 27.97 mm C.W. in females|month.

Prasad and Tampi (1953) had reported the siize at maturity of *P. pelagicus* females as 108 mm in carapace width, smallest crab bearing eggs was 106 mm and largest 163 mm in carapace width. According to Pillai and Balakrishna Nair (1976) the minimum size carrying eggs was 95 mm in carapace width and maximum is 164 mm. Present observations showed that females attain maturity at a size of 44 mm in carapace length (77 mm C.W.) and the minimum size of the crab bearing eggs was 56 mm (96 mm C.W.) and the maximum size of the ovigerous female 86 mm in CL (146 mm C.W.). Menon (1952) had reported the smallest ovigerous female of *P. sanguinolentus* to be 78 mm in carapace width; and maturity of males and females at about 80-90 mm in carapace width. Pillai and Nair (1976) reported the minimum size of ovigerous female to be 128 mm in carapace width. From the present observations the females attained maturity at the size of 26 mm in CL (57 mm C.W.), smallest ovigerous female recorded was 36 mm in CL (122 mm in CW). The diameter of the eggs was 0.391 mm and the number of eggs ranged

from 400 to 1300 (in thousands). Krishna Pillai and Nair (1976) reported the diameter of the eggs as 328 μ (0.328 mm); number of eggs ranging from 151780 to 307500.

There was also difference in the minimum and maximum sizes of the mature females of *Scylla serrata* reported by Pillai and Balakrishna Nair (1976). From the present observations it was clear that the crabs of Kakinada region attained maturity at a smaller size, and the maximum size of the mature females was less when compared with the maximum size of the mature females reported from elsewhere, but the fecundity was more.

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