STUDIES ON THE FISHERY AND BIOLOGY OF *SOLENOCERA CRASSICORNIS* (H. MILNE EDWARDS) FROM BOMBAY WATERS

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ABSTRACT

The average annual catch of *Solinocera crassicornis* was estimated to be 177 tonnes during 1969-75 at Versova. Bulk of the landings took place during November and March-April. Growth showed considerable disparity between sexes. The average monthly growth rate was found to be 5.20 mm for females and 3.80 mm for males. The life span was estimated as 16-20 months. The average annual total mortality rate was found to be 2.77 for females and 1.99 for males. Segregation of sexes was noticed during February-April when females migrate to deeper waters for spawning. The size at first maturity is 60-65 mm for females. The breeding period is prolonged with two peaks, one in December and another in April. An individual prawn may be spawning three times in its life period. The average number of eggs produced by a female in the size range of 61-102 mm was estimated to be 49,200.

INTRODUCTION

SOLENOCERA CRASSICORNIS (*S. INDICA*) has been recorded from both the coasts of India (Nataraj, 1945 ; Ahmed, 1957 ; Kunju, 1967). However, it contributes to a fishery of considerable significance only along the coasts of Maharashtra with an estimated catch of 606 tonnes during 1959-63 in the Bombay region (Kunju, 1967).

The fishery and some aspects of biology of *S. crassicornis* like, food and feeding, age and growth and breeding and migration have been studied by Kunju (1968) from Bombay region. Mohamed (1967) has briefly dealt with the size distribution, growth and breeding of this prawn from the same grounds. The present work carried out during 1969-75 attempts to add to our knowledge on the fishery and biology of this species at Bombay which is essential for a rational exploitation of the resource.

I am thankful to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, Cochin for his kind encouragement and to Dr. M. J. George and Dr. S. Ramamurthy for going through the manuscript critically and suggesting improvements. Thanks are also due to Dr. M. Devaraj for his suggestions.

MATERIAL AND METHODS

Regular catch statistics were collected once a week from Versova, an important fish landing centre in Greater Bombay, where the species was caught in stake nets locally known as 'Dol' (mesh size varied from 10-12 mm). This gear is operated at depths of 30-40 m at Versova. Detailed descriptions of dol net with its mode of operation has been given by Setna (1939, 1949) and Gokhale (1957). Each boat net combination was taken as one unit. On an average 20% of the units landed were observed for recording the catch based on which the total landings for the day and the month was computed. The catch per unit of effort (CPUE) was also calculated from the above data.

Random samples for biological studies were collected from the landings at Versova on the days of observation.

Maturity stages were determined by the external characters, such as, colouration and size of ovary as well as by microscopic examination of ova.

To study the development of ova and spawning frequency, the diameter of 500 eggs were measured from each female irrespective of their size and development by using an ocular micrometer which gave a value of 0.015 mm to each micrometer division. The ova diameter measurements were grouped into size intervals of 3 micrometer divisions.

To study the fecundity, the ovaries of 20 females in late maturing or mature stage were studied. Each ovary was removed carefully and weighed after recording the total length of the prawn. From each ovary a sub-sample was weighed and the number of eggs counted under a dissection microscope. From these data, the total number of eggs was estimated.

CATCH AND EFFORT

The fishery starts by early October and generally lasts till May or early June. The fishing operations remain suspended during the southwest monsoon period (June-September). The bulk of the annual catch was obtained during November and March-April.

The catch of *S. crassicornis* from 1969-70 to 1974-75 at Versova together with CPUE is presented in Table 1. It is seen that the

TABLE 1. *Catch of* S. crassicornis *in tonnes C.P.U.E. in kg and effort in boat days at Versova*

Year	Catch	CPUE	Effort
1969-70	.. 172.7	35.7	4286
1970-71	.. 198.2	24.5	8074
1971-72	.. 134.0	23.3	5749
1972-73	.. 254.8	40.9	6390
1973-74	.. 228.5	43.2	5280
1974-75	.. 72.4	13.7	5261

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highest catch was during 1972-73 (254.8 tonnes) and the lowest during 1974-75 (72.4 tonnes). The average annual catch was estimated to be 177 tonnes. Kunju (1967) recorded a mean yearly landing of 443 tonnes during 1959-63 at Versova. Thus a decline in the catch by over 60% has been noticed.

The CPUE values over the years revealed that the highest value of 43.2 kg occurred during 1973-74, whereas, 1974-75 witnessed the lowest value of 13.7 kg. To find out the trend of the fishery, the catch and CPUE were plotted against effort and smoothed lines were drawn visually through the points (Fig. 1). It is seen that there was no substantial increase
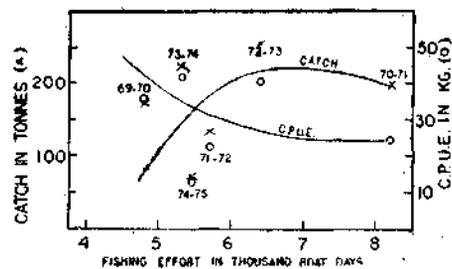

Fig. 1. Catch and CPUE of *S. crassicornis* plotted against fishing effort at Versova during 1969-70 to 1974-75.

in the catch eventhough the effort was maximum during 1970-71 (8074 boat days). It could be seen from the figure that the sustainable yield is 200-250 tonnes and the effort needed for the same is about 6400 boat days in a fishing season, *i.e.*, about 32 boats per day calculated on the basis of 200 fishing days in a fishing season.

AGE AND GROWTH

The size frequency distribution of females and males during the different months is depicted in Fig. 2 and 3. The multimodal distribution pattern of the size frequency is due to the prolonged spawning behaviour of the species. Though the spawning is prolonged,

it is seen that most of the principal modes described in Table 2 are the product of spawning during November-December and April-May.
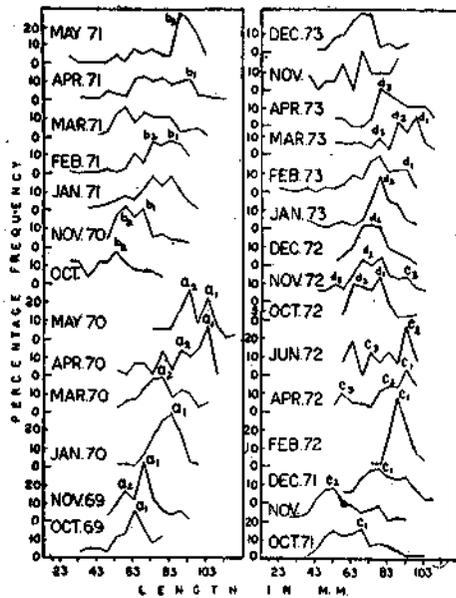

Fig. 2. Length frequency distribution of *S. crassicornis* (female) at Versova during October 1969-December 1973.

It could be seen that for females, the brood 'a²' (58 mm) of November 1969, a product of the same year's spawning and 'c⁸' (58 mm) of April 1972, a product of the previous year's spawning, attained a length of 93 mm in May 1970 and November 1972 respectively when one year old.

For males, the brood 'A²' (33 mm) of October 1969 and 'B¹' (38 mm) of October 1970, products of the same year's spawning attained a length of 63 mm in May 1970 and April 1971 respectively when one year old.

It could, therefore, be inferred that female and male attained a length of 93 and 63 mm respectively when one year old. According to Mohamed (1967) female of this species measured 90 mm in length at the end of first year.

Females showed faster rate of growth (9-10 mm/month) until matured at 60-65 mm; thereafter, the growth rate was 5.6 mm per month upto one year (93 mm) and 3-4 mm per month subsequently. The growth of males beyond 48 mm in length was found to be remarkably low (2.5 mm/month). The mean monthly growth rate was found to be respectively 5.20 and 3.80 mm among females and males. The life span was estimated to be 16-20 months.
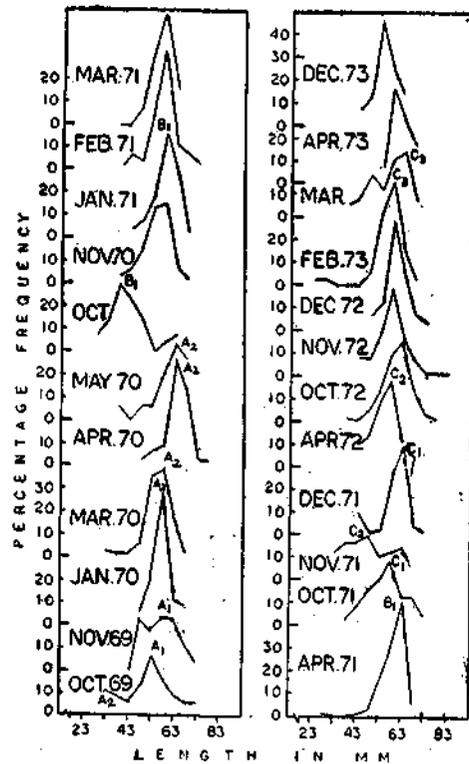

Fig. 3. Length frequency distribution of *S. crassicornis* (male) at Versova during October 1969-December 1973.

The present observations are not in conformity with the findings of Kunju (1968) and Mohamed (1967). Kunju (1968) opined that males and females of this prawn registered a faster rate of growth per month (6.49 and 6.96 mm respectively) and the life span of the respective sexes was 9-10 and 14-15 months. According to Mohamed (1967) the growth rate

TABLE 2. *Distribution of different modes and their progression in* S. crassicornis *at Versova*

Initial mode (mm)	Month	Final mode (mm)	Month	Growth increment (mm)	Duration in months	Average growth per month (mm)
Female						
63 a1	Oct. 69	103	May 70	40	7	5.7
58 a2	Nov. 69	93	May 70	35	6	5.8
68 b1	Nov. 70	93	Apr. 71	25	5	5.0
53 b2	Oct. 70	88	May 71	35	7	5.0
68 c1	Oct. 71	93	Apr. 72	25	6	4.2
53 c2	Nov. 71	93	June 72	40	7	5.7
58 c3	Apr. 72	93	Nov. 72	35	7	5.0
78 d1	Oct. 72	98	Mar. 73	20	5	4.0
63 d2	Oct. 72	88	Mar. 73	25	5	5.0
53 d3	Nov. 72	78	Mar. 73	25	4	6.2
				305	59	5.2
Male						
53 A1	Oct. 69	58	Nov. 70	5	1	5.0
33 A2	Oct. 69	63	Apr. 70	30	6	5.0
38 B1	Oct. 70	63	Apr. 71	25	6	4.2
58 C1	Oct. 71	63	Dec. 71	5	2	2.2
48 C2	Nov. 71	58	Apr. 72	10	5	2.0
58 C3	Feb. 73	63	Mar. 73	5	1	5.0
				80	21	3.8

TABLE 3. *Age composition of* S. crassicornis *in the commercial catches at Versova for the period* 1969-70 *to* 1974-75. (Figures denote C.P.U.E. in numbers)

Size range (mm)	Estimated age in months	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75
Female							
Upto 60 mm	1- 6	5572	9056	3211	7611	38882	2512
61-95 mm	7-12	24515	30091	18672	91976	36191	7475
96-116 mm	13-20	3026	1474	2277	7007	3201	92
Male							
Upto 45 mm	1- 6	1002	1256	908	4386	240	122
46-65 mm	7-12	17560	44687	7298	50987	11662	6607
66-80 mm	13-20	6857	1237	482	10443	3496	1000

in this species was uniform in both the sexes (4-5 mm per month). The disparity in growth rates observed in the present studies and that of Kunju (1968) may probably be due to the fact that the studies made by Kunju were largely on smaller size groups (33-58 mm in males and 38-83 mm in females) which grow at a faster rate, whereas, the present observations included comparatively larger sizes 38-63 mm and 58-103 mm respectively for males and females which grow at slower rate.

The age composition of *S. crassicornis* at Versova is presented in Table 3 based on the age-size relation. It is seen that the bulk of the population was contributed by the age groups ranging between 7-12 months. Prawns less than 6 months old were negligible.

LENGTH-WEIGHT RELATIONSHIP

The length (weight data) was grouped into 5 mm class intervals and the length weight relationship was derived separately for each sex using the formula, $W = aL^n$, where, ' W
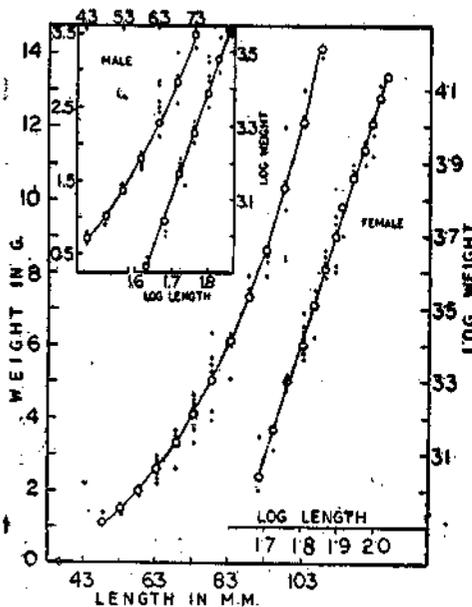

Fig. 4. Length-weight relationship of *S. crassicornis*.

is the weight of the prawn in mg., ' L ' is the length in mm ' a ' and ' n ' are constants. The observed mean weights were plotted against their respective lengths and a regression line was fitted to the data (Fig. 4, 5). The relationship among females and males is given below.
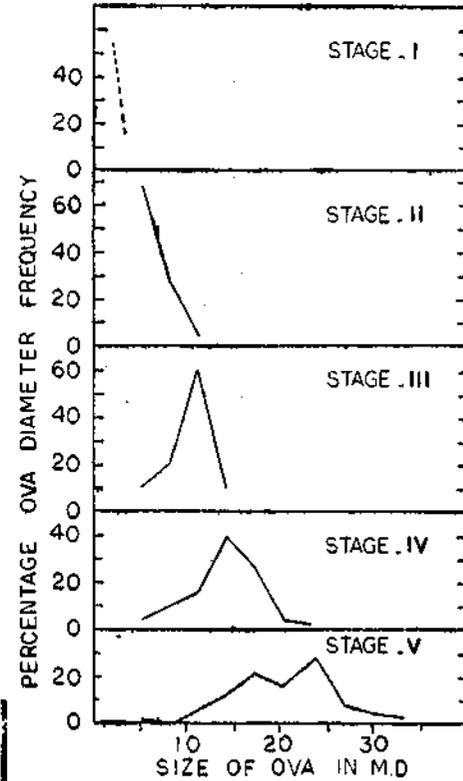

Fig. 5. Ova diameter frequency polygons in ovaries of different stages of maturity of *S. crassicornis*.

Female :   Log W =
$$\overline{2}.2099 + 3.1263 \log L$$

Male :   log W =
$$\overline{1}.7760 + 2.8630 \log L$$

ESTIMATES OF MORTALITY RATE

The data pertaining to the age composition is further analysed for estimating the instantaneous mortality rate. Since prawns below

six months are not fully representative, the instantaneous mortality rate, 'Z' could be calculated between 7-12 months and 13 months and above by using the formula.

$$Z = \log_e \frac{n^1}{n^2}$$

Where, n^1 = number of prawns per unit of effort between 7-12 months in a season ; and n^2 = number of prawns per unit of effort from 13 months and above in the same season. The number of prawns exploited in a season (October-May) was estimated based on the same method the author has used for similar studies in *Nematopalaemon tenuipes*. The estimated values vary from year to year and the average value is found to be 2.77 and 1.99 for females and males respectively (Table 4).

TABLE 4. *Estimates of mortality rate in* S. crassicornis

Year	Male	Female
1969-70	0.94	2.09
1970-71	3.59	3.02
1971-72	2.72	2.11
1972-73	1.58	2.57
1973-74	1.20	2.42
1974-75	1.89	4.40
Average	1.99	2.77

SEX RATIO

Kunju (1968) observed that females always dominated the population. However from the present studies it is seen that females outnumbered males throughout the year except during February-April in all the years of observations (Table 5). Males were in higher proportions in March and April 1970, February to May 1971 and February 1973.

MATURATION AND BREEDING

The various maturity stages, *viz.*, ' immature ', ' early maturing ', ' late maturing ', ' mature ' and ' spent ' adopted in the present study are according to those described by Kunju (1968).

The ova diameter polygons showing the distribution of ova during the different stages of maturity are depicted in Fig. 6. It could be seen that only one batch of eggs in stages III to V is getting differentiated from the immature egg stock to reach maturity and is subsequently shed by a single spawning act.
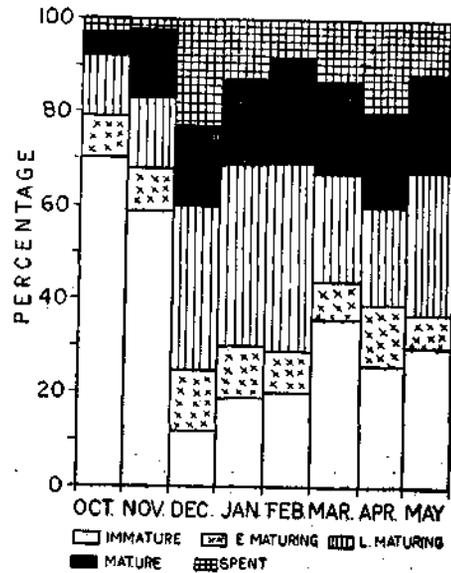

Fig. 6. Monthly percentages (pooled) of *S. crassicornis* in different stages of maturity at Versova.

Since the monthly preponderance of different maturity stages varied from season to season, the data for the entire period (1969-70 to 1974-75) was pooled together monthwise. It could be seen that the spawning is very prolonged. Though spawners were available throughout the fishing season, as indicated by the occurrence of maximum number of spent prawns, the peak spawning seems to be in December and in April (Fig. 7).

Kunju (1968) suggested two spawnings during the entire life period. However, the present studies indicated that the prawn may possibly be spawning three times in its life time. To find out the number of spawnings by individual prawn as well as the major size groups spawning

TABLE 5. *Sex ratio of S. crassicornis during different months for the period 1969-75 at Versova*

Month	1969-70 Total prawns	1969-70 % of male	1970-71 Total prawns	1970-71 % of male	1971-72 Total prawns	1971-72 % of male	1972-73 Total prawns	1972-73 % of male	1973-74 Total prawns	1973-74 % of male	1974-75 Total prawns	1974-75 % of male
Sept.	+		+		12	66.7	+		+		+	
Oct.	76	50.0	63	42.9	194	26.8	115	42.6	+		+	
Nov.	88	29.8	185	40.0	231	30.3	190	35.8	31	29.0	49	14.3
Dec.	*		5	20.0	135	14.8	216	33.3	68	27.9	8	37.5
Jan.	161	24.2	261	44.8	*		82	23.2	64	14.1	15	46.6
Feb.	*		369	54.5	52	9.6	122	54.0	18	—	—	
Mar.	235	57.0	460	60.0	*		61	45.9	113	23.9	50	62.0
April	78	62.8	228	59.7	61	37.7	47	40.4	—		12	25.0
May	65	23.1	39	35.9	12	16.7	—		*		—	
June	+		+		20	25.0	—		—		+	

* No fishing   + No sampling   — No specimen

during peak seasons, mature and spent prawns were studied in relation to the size groups during the different months particularly during peak seasons (Table 6). It may be inferred that the prawns spawning in December for the first time when they are only 7-8 months old (68-70 mm) may be spawning for the second time during April-May when they are just one year old (93 mm). It is likely that these prawns may spawn atleast once more during the remaining period of life since prawns above 93 mm in length were met with in good numbers in mature and spent conditions.

It was observed that the spawning population was mainly constituted by 8 to 14 month old prawns (70-100 mm).

RELATIVE CONDITION FACTOR

The relative condition factor, ' Kn ', for different lengths was calculated for males and females separately by employing the formula, W/Ŵ and is presented in Fig. 7 (W = observed weight ; Ŵ = calculated weight). It is seen that the factor, Kn, fluctuated in a rhythmic pattern.
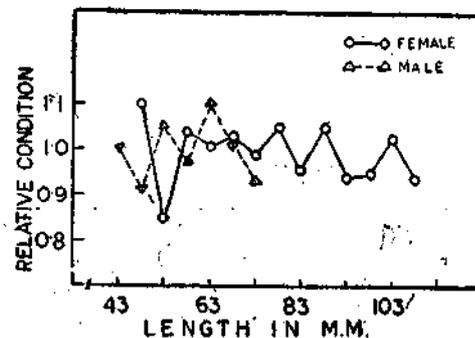

Fig. 7. Mean 'Kn' values at different length in S. crassicornis.

SIZE AT MATURITY

To determine the size at maturity, 2,333 females were studied during 1969-70 to 1973-74. Prawns in late maturing, mature and spent conditions were considered in the present study. The size at first maturity is found to 60-65 mm

TABLE 6. *Mature and spent prawns of* S. crassicornis *during peak spawning seasons (pooled for all years) at Versova* (The figures denote number of prawns)

size group (mm)	March	April	May	November	December
56-60	1				
61-65	5	1		2	11
66-70	6	1		3	31
71-75	17	4		8	26
76-80	16	12	1	9	33
81-85	8	9	—	16	15
86-90	17	12	4	8	11
91-95	24	13	6	8	11
96-100	25	10	2	1	6
101-105	8	11	1	4	—
106-110	5	1	—	—	2
	132	74	14	59	136

(Table 6). Kunju (1968) opined that this prawn may spawn for the first time when it measured 81-85 mm in length.

FECUNDITY

The average number of eggs produced by females in the length range of 61-102 mm was 49,200, the smallest female having 28,230 and the largest having 101,380 eggs.

MIGRATION

Two types of migration have been observed during the present study, one in connection with breeding and another in relation to salinity as reported by Kunju (1968).

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