STUDIES ON THE FISHERY AND BIOLOGY OF *PARAPENAEOPSIS HARDWICKII* (MIERS) FROM BOMBAY AREA

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ABSTRACT

The catch and catch par unit effort of *Parapenaeapsis hardwickii* during the seisons from 1967-68 to 1974-75 varied widely during different seasons. The average monthly growth recorded by female in the fishery was 7.6 mm at Sassoon Docks and 5.4 mm at Versova. The fishery was supported by 0-year and one-year classes. Female always predominated, the ratio being 4.9 and 2.0 female for unit male at Versova and Sassoon Docks, respectively. The males were represented by smaller size groups ranging between 43 and 68 mm in the fishery. The majority of females were found to be mature at 73 mm iia length. The species appears[1] to bread all through the fishing season' with peaks during October and April-May at Versova and during November-December at Sassoon Docks. The average number of eggs produced by females ramgiinig in size hetweeni 63 mm and 121 mm was 65450'.

INTRODUCTION

The penaeid prawn, *Parapenaeopsis hardwickii* forms a fishery of commercial magnitude along the coast of Maharashtra (Kunju 1960) and to a lesser extent in the Andhra coast (Aleock 1906). A few observations on the food, growth, sex ratio, recruitment and fishery of the species from Malayasian waters were made by Hall (1962). A brief study on size and spawning season was made by Mohamed (1967) from Bombay waters, while Kunju (1967) gave an account of its fishery from the same region. InvestigationiS on the various aspects of the biology of the species were initiated at Bombay in 1967 and carried out through 1975 and the results are presented here.

MATERIAL AND METHODS

Regular weekly observations were made at Versova and Sassoon Docks. two landing centres in Bombay, to collect oatch statistics and sample for biological study. Along with other species, *P. hardwickii* is caught in stake nets, locally known as 'dol', operating at 30-40 m depth at Versova, and in dol and trawl nets operating at 10* 15m and 30-40m depth, respectively, at Sassoon Docks. On an average, 20% of the units were observed for estimation of daily total catch. Samples were analysed in the laboratory for determination of sex, weight, and maturity conditions. To study the development of ova, diameter of

500 eggs were measured from each female irrespective of their size and development, by an ocular micrometer which gave a value of 0.016 mm to each micro-division (m.d.) The ova-diameter measurements were grouped into size intervals of 3 m.d. The fecundity studies were based on the ovaries of 12 females in late maturing and mature stages. Each ovary was dissected out carefully and weighed after recording the total length. From each ovary a subsample was taken, weighed and the number of eggs counted under a dissection microscope and the fecundity estimated.

FISHERY

The fishery of *P. hardwickii* commences usually in late September or early October. It formed 3.9 and 0.6% of the catch of Versova and Sassoon Docks, respectively. The heavy catches during November and December decrease thereafter (Table 1). The heaviest catch was recorded during 1973-74 (96.59 t) and lowest during 1971-72 (30-38 t) at Versova. At Sassoon Docks, the catches

TABLE 1. *Catch of P.* hardwickii *in tonnes and catch per unit effort in kg (in parenthesis) at Versova and Sassoon Docks.*

	VERSOVA						SASSOON DOCKS		
	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75	1969-70	1970-71	1971-72
Sep	0.14 (0.2)	——	0.06 (0.3)	0.17 (1.0)	——	——	2.39 (1.1)	0.59 (0.2)	——
Oct	0.90 (1.2)	0.32 (0.2)	0.26 (0.2)	5.74 (7.7)	0.12 (0.2)	0.18 (0.3)	1.40 (0,7)	0.45 (0,2)	——
Nov	60.36 (59.2)	3.12 (2.1)	3.12 (3.8)	26.71 (40.0)	16.39 (24.2)	0.55 (0.7)	1.03 (0,6)	1.74 (1.0)	0.47 (0.2)
Dec	*	16.72 (16.4)	11.96 (15.9)	26.10 (36.2)	23.33 (30,8)	5.92 (8.8)	*	*	0.06
Jan	1.73 (1.8)	4.88 (5.8)	*	3.26 (3.9)	13.52 (17.8)	6.25 (10.4)	1.01 (0.7)	1.01 (0.5)	
Feb	*	2.65 (3.3)	4.62 (6.6)	6.76 (11.6)	7,84 (1.3)	,12.34 (27.0)	*	1.66 (1.3)	0.22 (0.1)
Mar	1.80 (2.3)	10.51 (12.0)	*	15.38 (26.2)	18.53 (24.2)	3.29 (4.9)	0.30 (0.2)	1.36 (0.7)	*
Apr	7.96 (13.9)	3.53 (3.4)	8.20 (7.3)	1.95 (2.0)	16.86 (14.5)	2.48 (3.2)	0.22 (0.1)	0.88 (0.4)	1.44 (0.7)
May	6.01 (8.7)	0.33 (0.4)	2.05 (1.9)	2.10 (2-0)	*	2.38 (2.9)	0.57 (0.3)	0.75 (0.4)	0.72 (0'.4)
Jun	0.06 (1.0)	0.26 (2.1)	0.1 (0.7)	0.5 (0.5)	——	——	2.20 (0.1)	0.26 (0.2)	0.28 (0.1)
Jul	t	t	t	t	t	t	0.09 (0.1)	0.05	*
Aug	t	t	t	t	t	t	0.53 (0.3)	0.27 (0.1)	*
Total	78.96 (16.4)	42.32 (5.2)	30.38 (5.3)	68.22 (10.7)	96.56 (18.3)	33.39 (6.3)	7.59 (0.5)	8.92 (0.4)	3.19 (0.2)
Effort in boat days	4826	8074	5749	6390	5280	5261	17950	21839	17501

no obesrvation

no fishing

ranged from 3.19 t to 8.92 t during 1969-70 to 1971-72. The catches indicated an overall decrease by over 75 % of the mean yearly landings recorded by Kunju (1967) during 1959-63.

At Versova, the catch per unit effort was at the highest at 18.3 kg per boat-day during 1973-74 and the lowest 5.2 kg per boat-3ay during 1970-71. In respect of Sassoon Docks, the catch per unit effort varied from 0.2 to 0.5 kg per boat-day.

AGE AND GROWTH

The length-frequency polygons for male ;and female from September 1967 to December 1972 at Sassoon Docks and from January **1969 to December 1975** at Versova are presented in Fig. 1 and 2, respectively. A few modes which showed

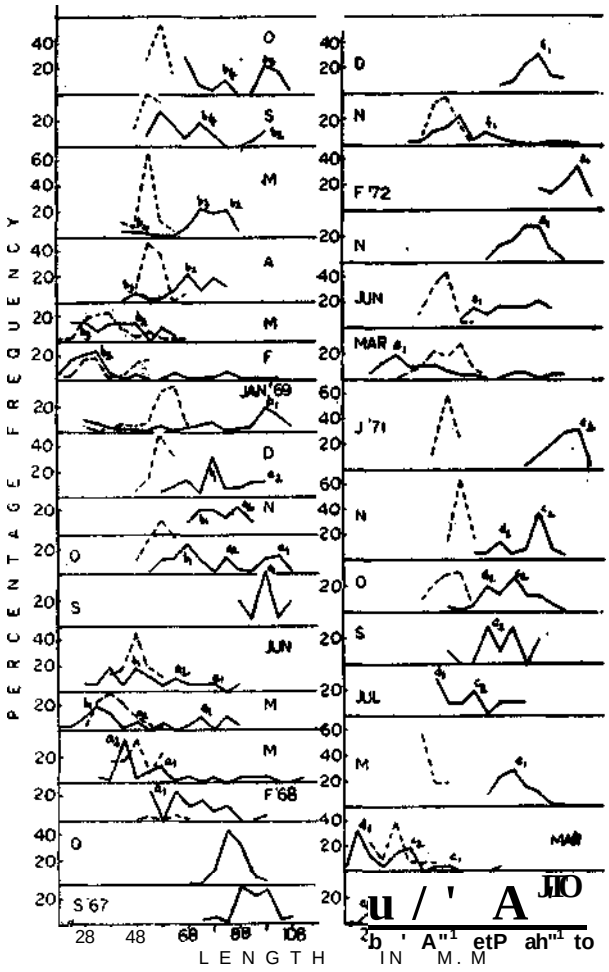

FIG. 1. Length-frequency distribution of *P. hardwicldi* during different months ait Sassoon Docks. Male (. . . . .), Female (———)

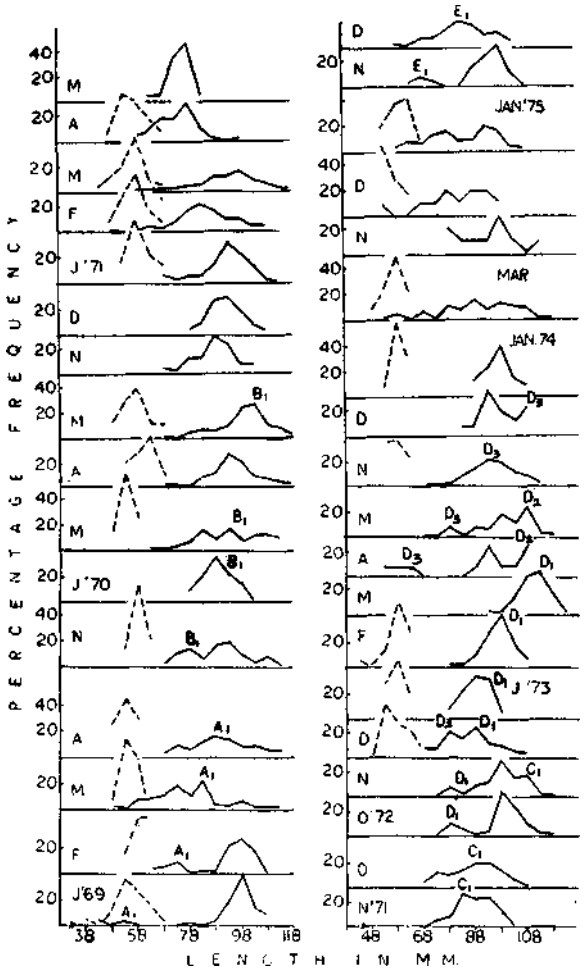

FIG. 2. Length-frequency distribution of *P. hardwickii* during different months at Versova. Male (. . . . .), Female (———).

clear shift were traced to study the growth pattern and the results are presented in Table 2. It could be seen from Table 2 that the average monthly growth recorded by female is 7.6 mm at Sassoon Docks and 5.4 mm at Versova. (See figures 1 and 2 also). The possible reason for the reduced growth rate recorded at Versova may be attributed to the fact that the growth studies were made mostly on large prawns and it is known that larger prawns show lesser growth rate than the smaller ones. Hence, the data from both the centres were treated together and it js seen that an average growth of 6.8 mm per month has been obtained.

Since males were not sufficiently represented in the samples collected for study, no inference could be made from the available data. However, it seems that males grow very slow whereas females register faster rate of growth.

TABLE 2. *Progression of modes and rate of growth in the female of* P. hardwickii *at Sassoon Docks and Versova*

Initial mode (mm)	Month	Final mode (mm)	Month	Increment in growth (mm)	duration (month)	Average growth/ month (mm)
Sassoon Docks						
53	a1 Feb 68	103	**Oct** 68	50	8	6.3
43	a2 Mar 68	98	Dec 68	55	9	6.1
33	b1 May 68	98	•*Im* 69	65	8	8.1
33	b2 Feb 69	98	Sep 69	65	7	9.2
28	b3 Mar 69	98	Oct 69	70	7	10.0
48	b4 May 69	83:	Oat 69	35	s	7.0
43	c1 Jan 70	83	May 70	40	4	10.0
28	c2 Jan 70	108	Jan 71	80	12	7.5
23	d1 •Mar 70	78	Nov 70	55	8	6.9
38	e1: 'Mar 71	108	'Feb 72	70	l'l	6.3
73	f1 % Nov 72	93	Dec 72	20	1	20.0
				605	80	7.6
Versova						
53	A1 Jan 69	**88**	Apr 69	35	3	11.6
78	M Nov 69	**103**	May 70	25	6	4.1
83	C1 Nov 71	**108**	Nov 72	25	**12**	2.0
78	D1 **Oct** 72	**113**	Mar 73	35	5	7.0
78	**D2 Dec** 72	**108**	May 73	30	5	6.0
5«	**D3** Apr 73	**108**	**Dec** 73	50	8	**6,2**
68	E1 Nov 75	**83**	Deo 75	*5	1	**15.0**
				215	40	5,4

LENGTH-WEIGHT RELATIONSHIP

The carapace lengths-weight relationship was determined in female, by using the formula W = aL ; where, W ** the weight of the prawn in mg; L = the carapace length of the prawn in mm and a and n are constants. The observed mean-weights were plotted against their respective carapace lengths and a regression line was fitted.

$$\log W = -0.1192 + 2.8617 \log L$$

While studying the biology of some penaeids from Malayaisian waters, Hall (1962) suggested the following relationship between weight and carapace length.

$$W = 0.5808\ C^{2.824}$$

This can be rewritten in the following logarithmic form:

$$\text{Log } W = -0.236 + 2.824 \log C$$

In order to find out the significant difference if any, between these two ohservaitions, they were statistically tested. Applying the t-test, it was seen that the difference between the regression coefficients (since b values are generally tested to find out the significant difference if any, between two variables in biological studies, the same has been considered here) of the present observation (2.8617) and that of the Hall's formula (2.8240) was not significant at 5% level ($t = 0.612$, d.f. = 14, $t_{5\%} = 2.145$). Therefore, it could be mentioned that the present finding confirms the observations of Hall (1962).

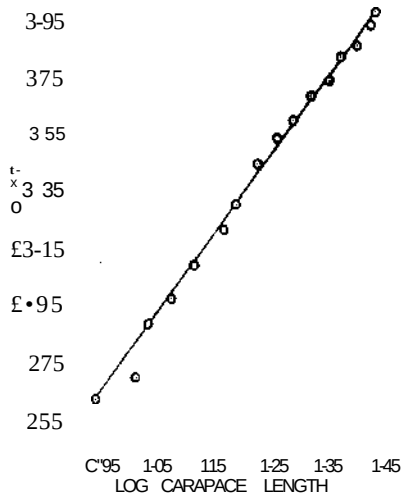

FIG. 3. Relationship between weight and carapace length in *P, hardwickii.*

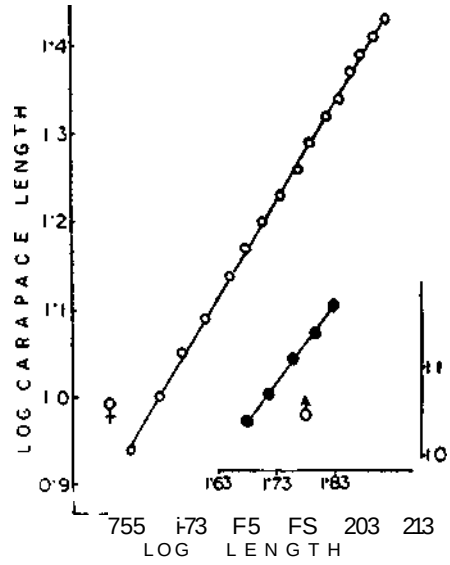

FIG. 4. Relationship between total Oeingth and carapace length *n P. hardwickii.*

CARAPACE LENGTH-TOTAL LENGTH RELATIONSHIP

The relationship between carapace length and toal length was estimated by the least square method and was based on 454 females and 74 males. The values have been expressed logarithmically (Fig. 4) and expressed by the formula,

Male : $C = -0.4341 + 0.8733 \log L$

Female : $C = -0.8853 + 1.1203 \log L$,

where, C = carapace length and L = total length of prawn.

MATURATION AND SPAWNING

Maturity Stages

In the female of *P. hardwickii* five maturity stages were recognised (Fig. 5) and these stages are characterised by certain distinguishing features as given in Table 3.

TABLE 3. *The different stages of maturity in the female of* P. hardwickii *with their distinguishing features at Bombay.*

Stage of maturity	Ova diameter	Colour	Nature
Immature (Fig. 5, stage A)	less than 5 miorodivisions (below 0.08 mm)	transparent	The ovary is very thin; the ova are spherical and small with clear cytoplasm and conspicuous nuclei.
Early maturing (Fig. 5, stage B)	between 5 and 11 microdivisions (0.08 mm-0.176 mm)	yellowish	The ovary shows slight increase in size, not visible through exoskelc-tom. Yolk granules appear in the cytoplasm, and nucleus not visible.
Late maturing (Fig. 5, stage C)	between 8 amd 23 miicnodivisioms (O.I128-0.36* mm)	orange	The ovainy has further enlarged, visible through exoskeleton. The ova are opaque due to the accumu-lation! of yolk and nuclei are r.ot visible.
M&twe (Fig. 5, stage D)	between 11 amd 32 mdcrod'i visions (0.176-0.512 mm)	deep orange	The ovary occupies the entire: cara-psce cavity, visible through exo-skeleton. The peripheral region of ova is rather transparent.
Spent recoveriag (Fig. 5, stage E)	below 11 microdivisions (below 0.176 mm)	dirty yellow or white	The ovaries ar© greatly reduced in size and flaccid.

Spawning Season

In order to determine the spawning^ season and also to find out the major size groups supporting the spawning populations 3906 females were studied Mature females were available in all months (Table 4). The preponderance of prawn in late maturing, mature and spent stages were so high that all these togeiflier formed about 63 to 85% of the catch at Vensova. The spawning season appears to be prolonged with peaks during October and April-May at Versova and during November-December at Sassoon Docks. Mohamed (1967) observed that the spawning season is protracted in this prawn from October to February with peaks in December and January in Bombay waters.

Spawning Population

The size distribution of late maturing and mature females (month-wise pooled) are presented in Table 5. Though spawners are available above the size

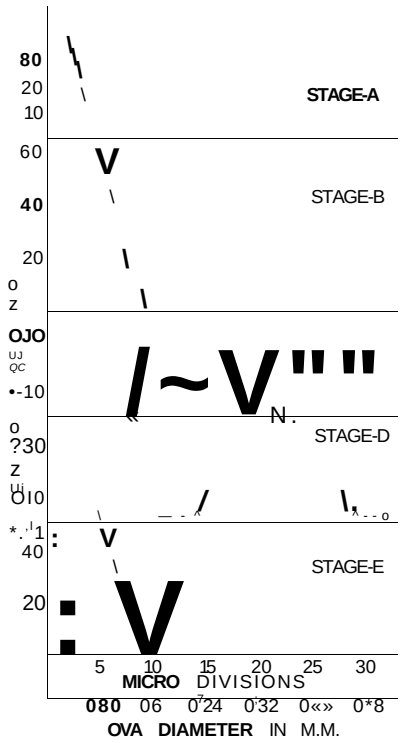

FIG. 5. Ova-diiiaineter polygons in •different stages of maturity in *P. hardwickii.*

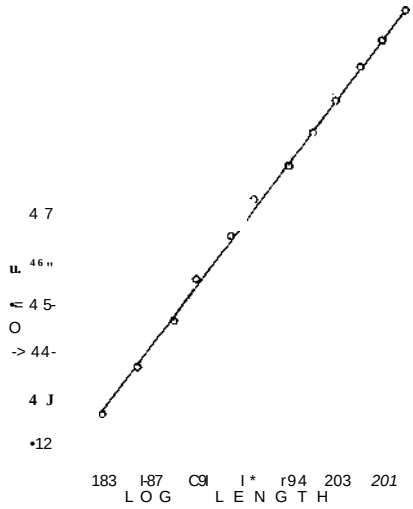

FIG. 6. The relation between size of prawn fecundity in *P. hardwickii.*

of 63 mm in length at Versova and 68 mm in length at Sassoon Docks, the bulk of the spawning population was in the size range of 78-108 mm and 78-113 mm respectively at these centres, probably 0-year and one-year olds.

TABLE. 4. *Percentage composition of various maturity stages of* P. hardwickii *(pooled data) during different months at Sassoon Docks and Versova.*

Maturity stages	Jan	F«b	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sassoon Docks												
IM	42.9	72.3	92.8	64.0	53.0	86.7	63.8		40.3	54.6	30.4	28.9
EM	7.9	3.6	0.8	8.0	9.0	4.3	4.5	33.3	12.7	10.2	7.6	6.7
LM	20.9	6.3	2.4	23.0	20.0	9.0	4.5		24.6	18.4	8.7	22.2
M	17.3	12.4	2.4	5.0	10.6		22.7	66.7	21.6	15.8	40.4	20.0
Sp	11.0	5.0	1.6	——	7.4		4.5		0.8	1.0	12.9	22.2
Versova												
IM	27.3	16.3	23.2	14.2	12.9					8.9	11.4	9.6
EM	9.1	5.3	5.0	5.6	1.5					6.7	16.7	14.9
LM	19.2	18.5	15.5	32.5	31.8					8.9	18.3	17.9
M	32.9	50.4	45.0	38.6	34.1					44.4	17.3	31.1
Sp	11.5	9.5	11.3	9.1	19.7					31.1	36.3	26.5

IiM =:immature, -..EM.— early maturing, LM = late maturing, M = mature, Sp = spent recovering

TABLE 5. *Sizewise distribution of late maturing and mature females of* P. hardwickii *during different months (month-wise pooled) at Sassoon Docks and Versova*

Size group	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sassoon Docks (1967-73 data)												
(nun)												
63												
68					3					1	J	
73	2	—	—	2	5	1	1	—	1	2	2	—
78	1	—	—	3	11	1	—	—	3	8	13	J-
83	4	2	1	3	lib	3	2	1	4	4	20	1
88	20	—	—		9	4	1	4	14	3	30	2
93	29	6	—	—	1	7	2	7	13	5	36	3
98	30	3	1					12	17	9	15	2
103	24	8	1	—	—	—	—	3	~3	"6	7	—
108	'19	11	—	—	—	—	—	1	6	1	5	—
113	3	1	—	—	—	—	—	—	—	—	—	—
118												
Versova (1969-75 data)												
63	—	—	—		l ' l	—	—	—				
68	—	3	2	6	3	—	—	—	—	—	—	5
73	2	8	2	14	6	—	—	—	—	—	—	7
78	7	33	13	13	11	—	—	—	—	—	.-_	28
83	29	46	11	15	6	—	—	—	—	—	17	44
88	48	47	25	16	3	—	—	—	—	—	23	62
93	45	40	31	25	8	—	—	—	—	1	30	49
98	26	45	36	17	15	—	—	—	—	12	28	41
103	7	17	26	10	1«	—	—	—	—	"i	14	16
108	3	5	34	7	* 9	—	—	—	—	1	14	4
113	—	l	i [5]	7	6	—	—	" —	—	—	—	1
1-1*	—	—	21	2	1	—	—	—	—	1	1	—

A closer look at the data pertaining to late maturing and mature females (Table 5) would show that 0- year olds were main spawners during November-December and April-July, while one-year olds during rest of the period at Sassoon Docks. Similarly, 0-year olds were the principal spawners during November-February and April, whereas, the bulk of the spawners belong to one-year old prawns during March, May and October at Versova.

Spawning Migration

The migratory habit of the prawn to slightly deeper waters, but within the fishing grounds, for spawning, has been evidenced by the occurrence of fairly large number of mature and spent prawns in the catches of do! nets usually operate at 30-40 rn depth off Versova, whereas, immature and maturing specimens dominated the catches of dol nets operated from Sasson Docks in lesser depths.

Minimum Size at Maturity

The percentage of occurrence in various stages of maturity were grouped in 5mm-size intervals. Prawns in late maturing, mature and spent-recovering stages were treated as mature for calculating the size at maturity. Though the smallest female with fully matured ovary measured 63 mm in length, majority of them were found to be mature at 73 mm and above (Table 5).

SEX RATIO

Considerable disparity in the distribution of the sexes was observed at both centres. By and large, there was preponderance of females over males. An interesting feature was that during certain months males were practically not observed in the catches and the trawl catches were solely composed of females. It is possible that males escaped through the large mesh (50-60 mm knot to knot) of trawl net because of their small size.

TABLE 6. *Month-wise sex ratio of* P. hardwickii *during different years at Sassoon Docks and Versova {The figures denote number of females per unit male).*

	1967-68	1968-69	.1969-70	1970-71	1971-72
Sassoon Docks					
Sep	36.7		0.9	5.0	
Oct	13.7	0.9	2,1	2.2	
Nov	t	3.0	—	3.7	116.0
Dec	1.5	0.7	—	—	
Jao	—	1.6	1.6	8.5	
Feb	2.5	2.2	—	2.7	23.0
Ma>r	0.6	1.1	2.0	0.7	0.8
Apr	—	2.2	3.3	—	—
May	1.4	2.0	13.0	—	—
Jun	1.5	0.7	—	1.7	—
Jul	—	—	2.5	9.0	•—
Aug	—	t	—	*	—
Annual	2.4	1.5	2.2	2.2	2.7

Versova	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74
Sept	—	—	—	—	—	
Oct	—	t	—	—	12.3	—
Nov	—	4.7	4.0	*	13.5	6.2
Dec	—	—	20.8	6.7	4.6	8.5
J:n	2.0	10.5	2.7	—	6.1	2.9
Feb	3.6	—	3.8	—	4.5	—
Mar	1.4	5.3	3.1	—	35.0	4.9
Apr	3.7	7.8	4.2	—	1.5	—
May	3.0	11.5	17.0	—	*	—
Annual	2.3	7.4	3.9	10.4	6.9	5.1

t Poor sample * all female

The number of female for unit male at Versova was 2.3, 7.4, 3.9, 10.4, 6.9 and 5.1 during 1968-69, 1969-70, 1970-71, 1971-72, 1972-73 and 1973-74, respectively (Table 6). At Sassoon Docks, these values were 2.4, 1.5, 2.2, 2.2, and 2.7, respectively during 1967-68, 1968-69, 1969-70, 1970-71 and 1971-72. The overall ratio of female was 4.9 and 2.0 for unit male at Versova and Sassoon Docks respectively.

FECUNDITY

The fecundity estimate in sizes ranging between 63 mm and 121 nm varied from 17,250 to 1,21,570 eggs with an average of 63,690 eggs. The relationship between he size of the prawn and fecundity was calculated and is logarithmically expressed by the equation,

$$F = -0.7104 + 3.3424 \log L$$

Where, F = fecundity and L = total length of prawn. The relationship between the size of the prawn and fecundity is found to be linear (Fig. 6).

ACKNOWLEDGEMENTS

The authors wish to express their gratitude to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, Cochin, for encouragements and to Dr. M. J. George for critical reading of the manuscript and suggesting improvements. They are also thankful to Shri M. H. Dhulkhed for valuable suggestions and to Dr. K. Alagaraja for his help in toe statistical analysis.

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