STUDIES ON THE BIOLOGY OF *NEMATOPALAEMON TENUIPES* (HENDERSON) IN BOMBAY COAST

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ABSTRACT

The relationship between total and carapace length of *Nematopalaemon tenuipes*, is calculated as L = -0.82 + 4.595 C, where L and C are total and carapace lengths in mm respectively. Juveniles of less than 33 mm grow at the rate of 6.43 mm per month, whereas the adult female and male grow at the rate of 3.74 and 2.81 mm per month respectively. The fishery is almost entirely composed of 0-year class. Life span of the species appears to be about eighteen months. Existence of sexual segregation has often been noticed. The minimum size at which the female prawn breeds is found to be 50 to 52 mm, when it is about eight months old. Maturation of the ovary and incubation of the eggs to the hatching stage are likely to be accomplished within about a month. About 5 to 6 percent of the total breeding females produce second brood in the same season. The species breeds throughout the year, with the peak season from July to October. A bopyrid parasite infests about one percent of the total population.

INTRODUCTION

One of the most conspicuous features of the "dol" net fishery along the Maharashtra coast is the enormous abundance of the small marine palaemonid, *Nematopalaemon tenuipes*. The only other maritime state where the species supports a commercial fishery is Gujarat (Banerji 1966). It is largely a marine species capable of penetrating estuarine areas, from where it is often commercially exploited, as in the case of the Godavary estuary (Ganapati and Subrahmanyam 1966) and the Sunderbans (Kunju 1956, Rajyalakshmi 1966). The species was formerly known as *Leander tenuipes* (*vide* Holthuis 1950 for synonymy and Kemp 1917 for identification keys of the different species of the genus).

Of the total non-penaeid prawn landings of India which is about a little less than half of the total marine prawn landings, 92.24 percent comes from Maharashtra. The average annual non-penaeid prawn production of the state for the years 1959 to 1968 is 31,509 tonnes of which *N. tenuipes* alone accounts for 5,769 tonnes (Banerji 1969). Kunju (1967) studied the prawn fisheries of Versova, Sassoon Dock and Arnala for the years 1959 to 1963 and estimated

a production of 2055 tonnes for the species constituting 32.56 percent of the total average annual prawn landings at these centres. The period of maximum abundance is from April to May.

In spite of the enormous production very little is known on the biology and life history of the species, particularly from Maharashtra, which is essential for the rational exploitation of the fishery. The only available information on the species is an account of the development of the eggs and early larval stages by rearing them in the laboratory (Pillai 1966) and estimates of its growth and age in the estuaries of West Bengal (Rajyalakshmi 1966).

Material and methods

The dol net catches of Versova, Sasson Dock and Arnala form the basis of this study. The relative positions of the fishing grounds at these centres have been given by Kunju (1968). The dol is a fixed bag net set against the tidal current entrapping all the prawns and fishes irrespective of size. Setna (1949) has described the construction and operation of the gear.

Random samples of the prawn landings were collected once a week at Versova, Sassoon Dock and Arnala from October 1959 to December 1968, from December 1959 to September 1965, and from November 1959 to June 1962 respectively. They were preserved in 5% formaldehyde and studied within a day or two, though, however, a few samples from Sassoon Dock could be examined in the fresh condition. Details of the techniques employed are given under the appropriate sections.

Relation between total length and carapace length

The carapace length is often used to express the size of prawns and therefore the relationship between the total and carapace lengths was determined from measurements of 1,500 prawns. Total length was measured from the tip of rostrum to the tip of telson to the nearest millimeter keeping the prawn stretched dorso-ventrally on a measuring board. Carapace length was measured to the nearest millimeter from the centre of the orbital margin to the posterior mid-dorsal point of the carapace by using a divider and a scale. Carapace lengths were plotted against the corresponding average total lengths. A straight line fitted by the method of least squares gave a good fit (Fig. 1). The relationship was found to be:

$$L = -0.82 + 4.595\ C$$

where L and C are total and carapace lengths in mm, respectively.

Age and Growth

The total length was classified into 3mm groups and the mid-points were plotted against percentage frequencies according to sexes (Figs. 2, 3 and 4),

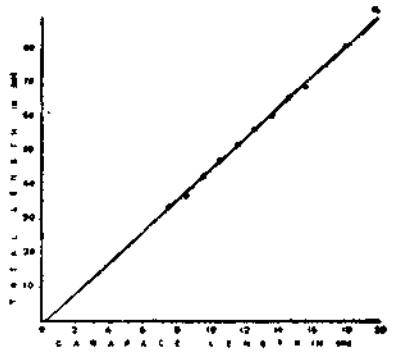

FIG. 1. Relationship between total length and carapace length of *N. tenuipes*.

as the females were found to attain a larger size. As the prawn breeds throughout the year, most of the length frequency curves are polymodal and therefore, extreme care was exercised in tracing the modal progressions, which were ultimately used to estimate growth rate. From a series of carefully selected mode chains from the frequency polygons for the period December 1959 to September

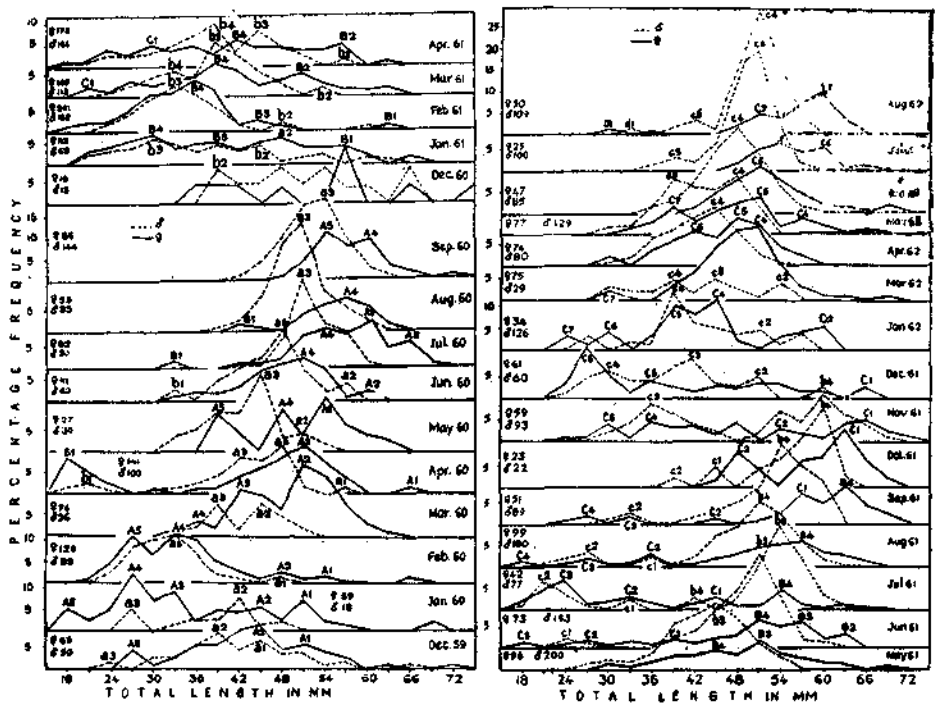

FIG. 2. Length-frequency distribution of *N. tenuipes* at Sassoon Dock during December 59-August 62.

1965 of Sassoon Dock (Fig. 2 & 3) and for the period January 1960 to December 1968 of Versova (Fig. 4), the rate of growth was estimated. Samples which were insufficient in numbers were excluded from the length-frequency analysis.

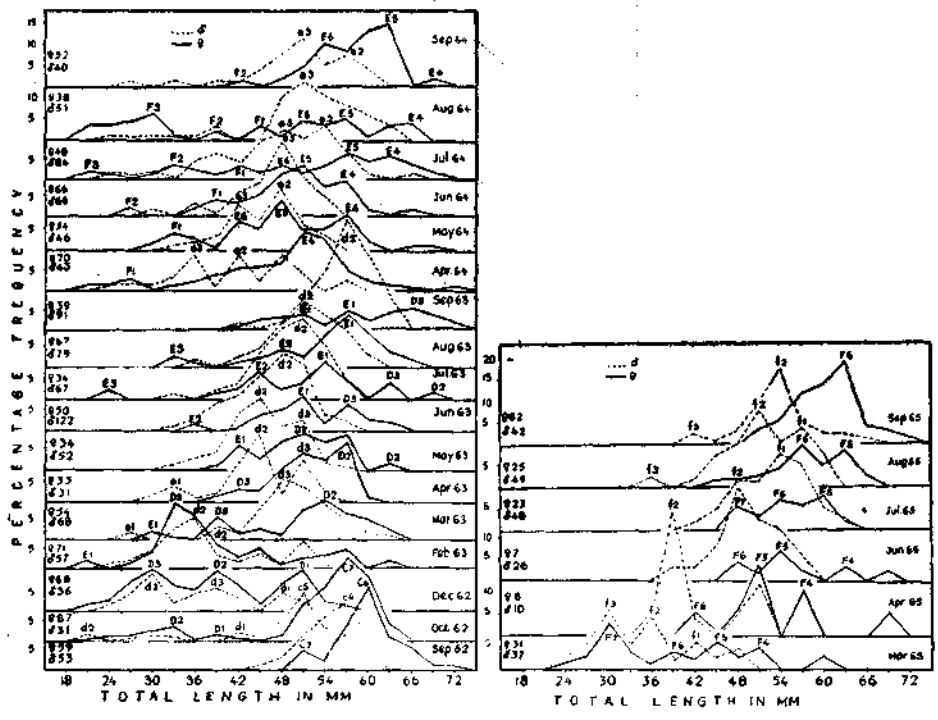

FIG. 3. Length-frequency distribution of *N. tenuipes* at Sassoon Dock during September 62-September 65.

Length frequency distribution at Sassoon Dock

The various broods among both the sexes have been assigned to different year classes commencing from 1959 and designated according to the alphabetical and numerical order. Thus, for example, the five female broods of A1 to A5 and the three male broods of a1 to a3 of Sassoon Dock represent the year classes of 1959 (Fig. 2). Similarly, the seven female broods of I 1 to I 7 and the four male broods of i 1 to i 4 of Versova belong to the year classes of 1967 (Fig. 4).

A total of 32 mode chains commencing from A1 and ending with F7 among females and 21 mode chains from a1 to f3 among females are taken into account to estimate the growth rate. A few of the more important broods are represented by A4, C6 and F1 among females, and a2, b4, c2 and d2 among males (Fig. 2 & 3).

The female mode A4 at 27 mm in January 1960 has been found shifting to 60 mm in September of the same year, the growth increment being 33 mm in

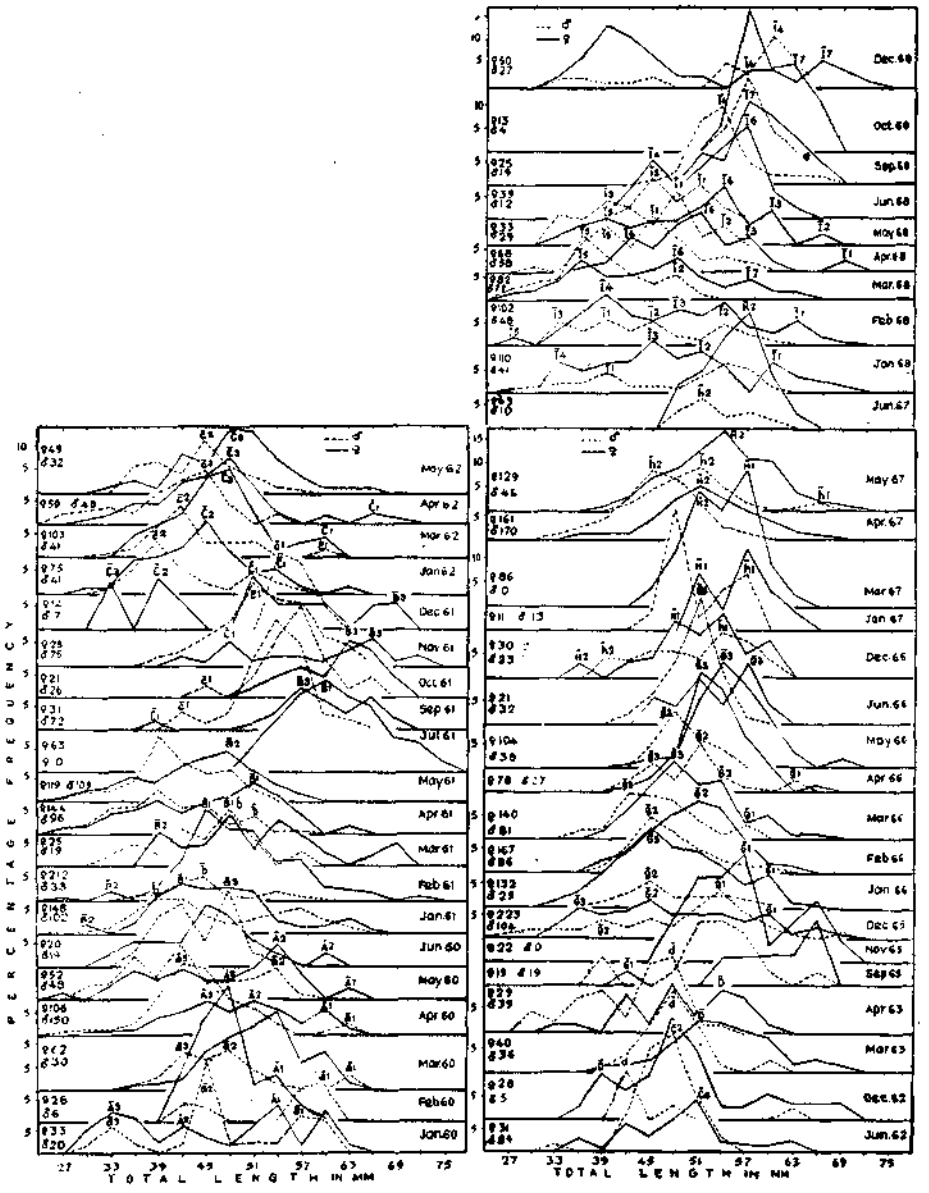

FIG. 4. Length-frequency distribution of *N. tenuipes* at Versova.

eight months, of which the first month alone shows an increment of 6 mm. The mode C6 at 27 mm in December 1961 is seen shifting to 60 mm in September of the following year, showing a length increment of 33 mm in 9 months. The mode F1 at 27 mm in April 1964 attains 45 mm in August, of which the first month shows a faster growth than the subsequent months.

The male mode a2 at 39 mm in December 1959 is found shifting to 57 mm in June 1960, showing a growth increment of 18 mm in six months, while the mode b4 at 33 mm in March 1961 is found to attain 60 mm in December of the same year, thus showing a growth of 27 mm in nine months. The mode c2 at 21 mm of July 1961 shifts to 33 mm in September and thence to 54 mm in March of the following year, showing fast growth in the early stage. Similarly, the mode d2 at 21 mm of October 1962 in seen shifting fast to 30 mm in December, and thence at a slow rate to 57 mm in September of the following year.

Juvenile prawns of 18 to 33 mm were found at Sassoon Dock in greater numbers than at Versova, probabily due to their preference to shallow waters, the fishing grounds at Sassoon Dock being in shallower areas than those at Versova (Kunju 1968).

Juvenile prawns are represented in the mode chains A3, to A5, B1, C1 to C4, C7, E1, E3 and F1 to F3 among females, and in a3, b1, c1, c2, d2 and e1 among males. Size increments from 18 to 30 or 33 mm in these chains are estimated separately and it was found that the growth rates of female and male are 6.47 and 6.33 mm per month respectively, the average for both the sexes being 6.43 mm per month, which is much greater than those of the older prawns.

Though slight variations have been observed in the growth rates of older prawns belonging to various broods of different year classes, the average rates of growth of the female and male prawns are 3.92 and 3.00 mm per month, respectively.

Length-frequency distribution at Versova

The dol net prawn fishery of Versova is suspended during the south-west monsoon months of June to Setpember (Kunju 1967) and the modal progressions therefore, are traced mostly between the months of October and May.

A total of 32 mode chains commencing from A1 and ending with I7 among females and 16 mode chains from a1 to I4 among males are utilised to estimate the growth rate. A few of the more important broods are represented by A2, C1, G3 and 14 among females, and a2, ci, g3 and i1 among males (fig. 4).

The male mode a2 at 45 mm of January 1960 shifts to 54 mm in May, thereby registering a growth of 9 mm in 4 months, while the mode c1 at 42 mm of September 1961 moves to 60 mm in March 1962, the growth increment being 18 mm in 6 months. The mode g3 at 42 mm of March 1966 attains 51 mm in June, increasing in length by 9 mm in 3 months, while the mode I1 at 39 mm of January 1968 moves to 51 mm June, the growth increament being 12 mm in 5 months.

As noticed at Sassoon Dock, slight variations are observed in growth of the prawns of various broods and year classes at Versova also. The average rates of growth of the female and male prawns are estimated as 3.42 and 2.51 mm per month respectively.

Age

The growth estimates enumerated above are considered fairly reliable, since a large number of distinct modes traceable over a fairly long period was taken into account to derive the growth trend. The estimated growth rates are found to be slightly more at Sassoon Dock than at Versova. Striking out an average from the trends at both the centres the female and male appear to grow at the rate of 3.74 and 2.81 mm per month, respectively.

The first larva of the species is about 2 mm in length (Pillai 1966) and it may not be incorrect to assume that it may grow to about 17 mm within a month. From the overall growth trends discussed above, the female and male prawn respectively attains a length of 65 and 57 mm at end of the first year The fishery is almost entirely composed of these prawns, larger size groups being scarce. The female grows exceptionally to lengths of 88 to 90 mm, which may be attained probably when it is about an year and six months old. These results reyealed that the species grows at a much faster rate than what was indicated by Rajyalakshmi (1966), according to whom lengths of 26, 40.2 to 49.5 and 64.5 mm are attained by the prawn at the end of the first, second and third years respectively. Moreover, she did not observe any differential growth in the sexes.

Sex ratio

Sex was determined by the presence or absence of appendix masculina in the second pleopod, those having it being males. This secondary sexual character starts appearing as a bud in the angle formed by the appendix interna and the border of the endopodite of the second pleopod when the prawn is about 17 mm in length. Those below this size were considered as indeterminates and they were seldom present in the dol net catches. The bud ultimately develops into the appendix masculina by the time the prawn grows to about 23 mm in length.

The monthly sex proportions among the various size groups are more or less discernible from Figs. 2 and 3. Certain interesting features were observed in the sex ratio of the populations. In some months the catches from all the fishing units were entirely composed of one sex, as was noticed in the landings of March 1967 at Versova (Fig. 4). On some days either all the fishing units or some of them were found to catch exclusively or almost exclusively one or the other sex (Table 1), which indicates that there is a certain amount of sexual segregation in the species. The effect of this phenomenon on the breeding habits of the prawn is stated in a later section.

TABLE 1. *Selected catch samples of* N. tenuipes *from three fishing centres showing pronounced display in the sex ratio.*

Fishing centre	*Date of sampling*	*Total No. in sample*	*Male*	*Female*
Arnala	28-1-1960	34	32	2
	17-3-1960	89	7	82
	16-6-1960	50	3	47
	15-2-1961	54	8	46
	7-3-1961	78	6	72
	3-5-1961	37	2	35
	9-8-1961	65	3	62
	6-3-1962	101	5	96
Versova	23-10-1959	28	25	3
	17-2-1961	97	6	91
	27-9-1961	63	0	63
	8-3-1963	16	0	16
	24-4-1964	13	1	12
	27-4-1966	30	2	28
	8-3-1967	22	0	22
	23-3-1967	14	0	14
	29-3-1967	50	0	50
	18-5-1967	25	1	24
	6-1-1968	12	0	12
Sassoon Dock	27-6-1961	86	78	8
	10-8-1962	45	40	5
	12-6-1963	52	43	9
	17-9-1963	55	49	6

In the year-wise sex composition of the fishery at Sassoon Dock from 1960 to 1965 (Fig. 5) the males were found to dominate in all the years except in 1960, when the sex ratio was almost equal. But an interesting feature was the dominance of females among the juveniles of 17 to about 30 mm groups and among older prawns of over 54 mm in length, the size groups in between having been always dominated by males in all the years (Fig. 5). The overall average male-female ratio of the fishery at Sasoon Dock was 6:5. Sex composition of the Versova fishery from 1960 to 1968 was entirely of a different pattern, as seen from Fig. 6, where, in most of the years males were dominant among the smaller size groups and females among the larger groups. The average male-female ratio of the fishery at Versova was 2:3 (Fig. 6).

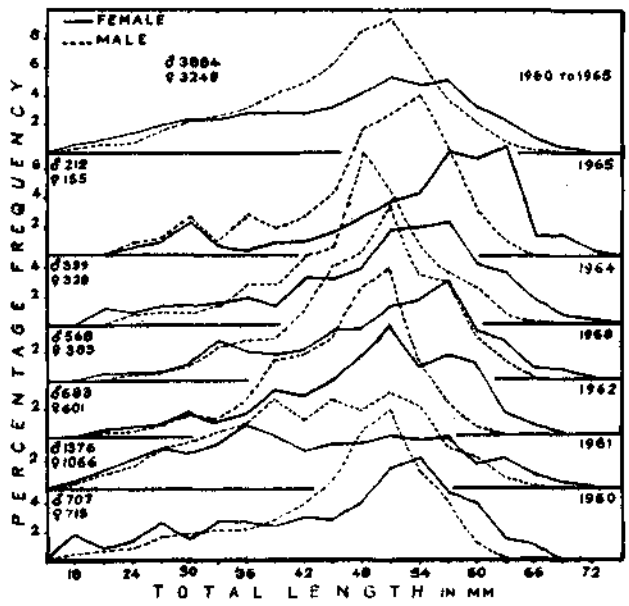

FIG. 5. Yearwise sex distribution (in percentage) among the various size groups of *N. tenuipes* at Sassoon Dock during 1960-65.

BREEDING

Various aspects of the breeding habits of *N. tenuipes* were studied and these are described below.

Classification of the breeding stages

Ripeness of the ovary was determined mostly by external features, i.e., the extent to which the ovary fills the space beneath the carapace, a feature which could readily be seen through the transparent carapace. Certain characters of the ovum discernible under the micriscope were also taken into consideration to determine the stages. The various stages are as follows:

OR 1 Ovary fills less than one-fourth of the carapace; ovum with yolk granules; nucleus is clearly visible under microscope.

OR 2 Ovary fills about one-third of the carapace; ovum as in OR 1.

OR 3 Ovary fills about half of the carapace; ovum filled with yolk granules; nucleus only faintly visible.

OR 4 Ovary fills about three-fourths of the carapace and juts into the first abdominal somite; nucleus of the ovum not visible.

OR 5 Ovary fills almost the entire carapace and a large part of the first abdominal segment and juts into the second abdominal segment as well; ovum is turgid with yolk granules; size of the ovum is much larger than earlier stages; ready for spawning.

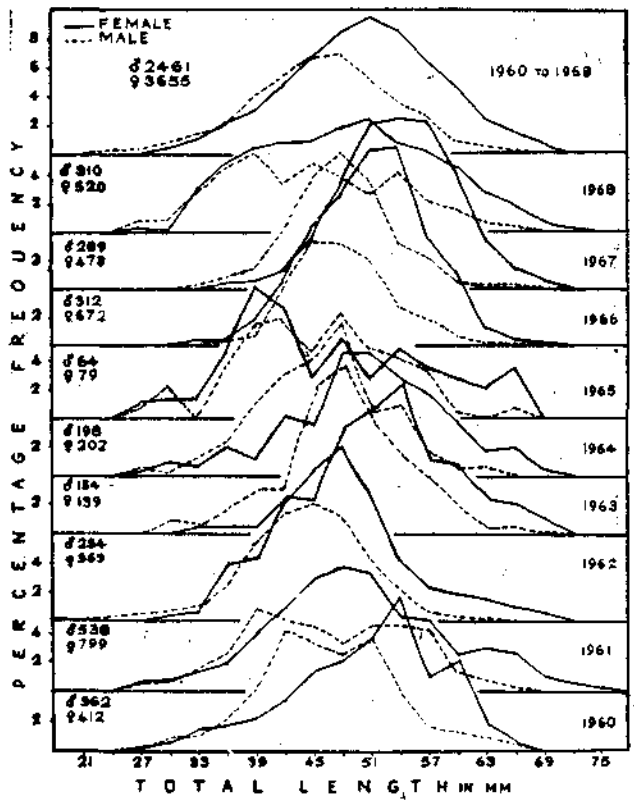

FIG. 6. Yearwise sex distribution (in percentage) among the various size groups of *N. tenuipes* at Versova during 1960-68.

Colour of the ovary of OR 1 to 3 stages is yellow in the fresh condition as well as after a day's preservation in formaldehyde, whereas the OR 4 and OR 5 ovaries are orange red in colour.

As the smallest breeding female encountered during the study has been 38 mm (Table 2), all the prawns above this size showing no signs of ripening ovaries and devoid of external eggs are counted as "neuter" (Forster 1951).

Rajyalakshmi (1961 b) classified the maturation stages of the small palaemonid prawn *Macrobrachium mirabile* (= *Palaemon mirabilis*) into six categories almost on similar grounds.

When the prawn is ready to spawn, it developes a "breeding dress" (Hoglund, 1943), the most outstanding feature of which is the emergence of a set of non-plumose ovigerous setae on pleopods 1 to 4 at the time of the pre-spawning moult. At the time of spawning, the eggs are attached to these setae by a "cement" secreted by the cement glands concentrated on the pleopods.

TABLE 2. *Distribution of various breeding stages among the different size groups of females of* N. tenuipes *during the years* 1959 *to* 1963 *at Versova and Sassoon Dock*

Breeding stage		*Size groups in mm*													
		38-40	41-43	44-46	47-49	50-52	53-55	56-68	59-61	62-64	65-67	68-70	71-73	74-76	77-79
OR 1	Versova	—	5	14	10	15	7	9	3	2	3	—	—	—	—
	Dock	—	—	1	13	17	15	22	12	4	1	1	—	—	—
OR 2	Versova	—	5	10	14	11	9	4	3	1	1	—	—	—	—
	Dock	—	1	2	11	16	24	16	8	3	3	1	—	—	—
OR 3	Versova	—	2	13	12	10	9	5	4	1	1	—	—	—	—
	Dock	—	1	4	14	28	16	17	8	5	2	—	—	—	—
OR 4	Versova	—	—	8	8	11	9	4	—	2	—	—	—	—	—
	Dock	—	—	4	5	17	11	12	2	1	—	2	—	—	1
OR 5	Versova	1	—	2	—	3	3	2	1	1	—	—	—	—	—
	Dock	—	1	—	2	3	5	4	3	2	4	1	—	—	—
EB 1	Versova	1	—	5	6	13	7	9	6	10	5	3	2	—	—
	Dock	—	—	—	10	28	33	33	29	22	11	1	1	—	—
EB 2	Versova	—	—	3	6	9	10	11	8	4	3	1	1	—	—
	Dock	—	—	—	6	10	17	21	24	17	2	1	—	—	—
EB 3	Versova	—	1	2	4	16	17	11	6	9	5	3	—	—	—
	Dock	—	—	2	2	12	19	23	20	8	9	4	—	—	—
EB 4	Versova	—	1	3	3	5	5	6	4	6	2	1	—	—	—
	Dock	—	—	2	—	2	8	4	5	7	1	1	—	—	—
EB 5	Versova	—	—	4	12	10	10	6	4	5	7	2	—	1	—
	Dock	—	1	—	2	2	5	10	2	4	3	2	2	1	—
C	Versova	—	2	21	44	58	55	38	42	23	15	8	4	1	—
	Dock	—	—	1	7	14	35	53	47	28	20	5	4	—	1
Total No. of breeding prawns		2	20	10	191	310	329	320	241	165	98	37	14	3	2
Total No. of prawns in the size group															
	Versova	97	158	216	253	249	210	144	113	71	48	18	7	2	—
	Dock	184	167	202	233	331	293	288	201	117	62	19	7	1	2
	Total	281	325	418	486	580	503	432	314	188	110	37	14	3	2
Percentage of Breeding females		0.71	6.15	24.16	39.30	53.45	65.41	74.87	76.75	87.75	89.03	100	100	100	100

Ovigerous setae first appear only when the female moults into the egg-carrying condition, being absent in the succeeding "neuter" inter-moult or inter-moults when they are represented by a similar series of spinous discs (Gurney 1923).

The famle with external eggs has been divided into the following five categories, according to the stage of development of the eggs as seen from their size and colour. The eggs are oval in shape and their size increases along the length axis from 25 to 39 micrometer divisions (1 m.d. = 0.0172 mm), and the colour changes from yellow to brown as incubation progresses to hatching.

EB 1 25 m.d.; yellow in colour

EB 1 32 m.d.; yellowish orange in colour

EB 3 35 m.d.; orange in colour

EB 4 38 m.d.; light brown in colour; eye of the embryonic larvae faintly visible

EB 5 39 m.d.; brown in colour; eyes of the embryonic larvae clearly visible; ready for hatching

These stages more or less correspond to those described by Pillai (1966) from the eggs reared in the laboratory.

After hatching the young the ovigerous setae are found to have remnants of the "cement" and egg shells still sticking on to them for a while till the next moult. This stage is designed as C.

In a few instances the maturating ovary (OR) is found along with incubating eggs (EB) or ovigerous setae (C) in the same prawn. These are designed as EBOR or COR

Size at first maturity

Distribution of various breeding stages among different size groups from 38-40 mm onwards at Versova and Sassoon Deck during 1959-1963 is shown in Table 2. Various stages of OR, EB and C were found common among the 41-43 mm size group, though exceptional instances of OR 5 and EB 1 were encountered among the 38-40 mm size group. Since the 50-52 mm size group, which is about eight months old, shows the presence of over 50 percent of prawns in mature condition, it may probably represent the minimum size at which the species breeds (Table 2).

Maturation of the ovary and period of egg-carriage

Prawns that have just hatched one brood but with fully ripe ovaries (i.e., COR5) have been frequently met with, as also sometimes prawns with fully ripe ovaries having incubating eggs ready for hatching (i.e., OR 5 EB 5). Prawns in the COR 5 stage are examples where, after liberating one brood, they are ready for the next spawning. In these prawns, the ovary and the incubating eggs have been developing simultaneously probably at the same rate,

so that when the external eggs are hatched and shed, the ova are ready for another spawning. An almost similar situation is possible among prawns in the OR 5 EB 5 stages also. These instances point to the possibility that the duration of the maturation of the ovary and the period of egg-carriage may be the same.

Pillai (1966) found that the incubation period of the eggs of *N. tenuipes* is about 14 days. Therefore the entire process of maturation of the ovary, incubation of the eggs and hatching may perhaps be accomplished within a period of about one month. In a closely allied species, *Leptocarpus fluminicola* (= *Leander fluminicola*) the period of incubation was found to be 15 days (Rajyalakshmi 1961a).

Double or multiple broods

It was rather difficult to estimate the number of double or multiple laying females. Evidence of such prawns is provided by the presence of cemented or ovigerous stage simultaneously occurring along with ripe or ripening ovary in the same individual. From among 5,067 breeding females of over 38 mm in length only 284 or 5.6 percent showed these stages (EBOR and COR) (Table 3). It is possible that certain percentage of prawns either with naturating ovary (i.e., OR) or berried (i.e., EB) may also be potential double layers. In an exhaustive analysis of the problem relating to *Palaemon squilla,* Hoglund (1943) stated that "much more than what is apparent are potential double layers and that females recently hatched occurred mostly with unripe ovaries, whereas those with ripening or ripe ovaries were only very few," indicating that multiple broods in the same season are only rare. C and EB females with ripening ovaries of OR 1 to OR 4 stages have also been frequently met with during the present study indicative of multiple broods within the season. In these prawns the "breeding dress" and ovigerous setae are probably retained throughout the season till all the successive broods are hatched out.

Unsuccessful spawning

Prawns with plain ovigerous setae without encrustations of cement and egg shells should normally have the ovary in advanced stages of development, either in OR 4 or OR 5 stage. However, it was observed in some prawns that these plain ovigerous setae occur alone without the ripe or ripening ovary. This condition is sometimes encountered with a few eggs sticking on these setae. Under the microscope these eggs were neither found attached to the ovigerous setae by cement strands, nor did they show any sign of development. A sample of catch collected from Versova on 21-7-1961 from a single fishing unit consisting entirely of females was observed to have several prawns in the condition described above. Probably these are instances of unfertilised eggs failing to get attached to the ovigerous setae due to non-exudation of the cement. Hoglund (1943) observed that some of these eggs in *Palaemon squilla* are eaten up by the mother prawn.

Breeding season

The occurrence of various breeding stages in different months is shown in Table 3, from which it is evident that the prawn breeds throughout the year, since almost all the breeding stages occur all the year round at all the three centres of observation. However, the total number of prawns in various breeding conditions is relatively much greater during the period July to October than in the other months, at all the centres (Fig. 7). A secondary peak period of breeding is found in March-April. The number of prawns in EB, C and COR stages is found to increase from July onwards so as to attain a maximum in October, indicating the peak period of spawning and hatching. The number of double or multiple broods is relatively large during the period August to October (Fig 7).

TABLE 3. *Number of female* N. tenuipes *in various breeding stages among total number above* 38 *mm in length, in different months at the three centres of observation*

Centre of observation	*Breeding stage*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*	*Oct.*	*Nov.*	*Dec.*
Sassoon Dock	OR 1	—	2	8	15	3	12	15	7	8	8	—	—
	OR 2	3	1	8	11	11	9	12	12	5	3	1	—
	OR 3	2	1	24	12	3	21	14	9	5	2	3	—
	OR 4	4	1	3	10	3	8	7	8	5	2	4	1
	OR 5	2	—	2	3	—	5	2	5	4	—	3	—
	EB 1	2	2	8	11	17	15	19	31	33	28	—	2
	EB 2	2	2	3	6	4	10	16	28	12	10	1	5
	EB 3	4	4	18	8	1	6	17	15	19	8	1	3
	EB 4	1	1	1	1	—	3	3	12	6	1	—	1
	EB 5	1	—	2	9	—	—	4	4	7	2	3	2
	C	3	—	7	12	7	1	16	10	34	15	3	6
	COR	1	—	1	2	3	—	2	28	47	21	6	3
	EBOR	—	—	—	—	—	—	4	—	1	1	—	—
Total No. above 38 mm		101	121	266	296	217	205	167	238	228	115	41	74
Versova	OR 1	3	14	12	9	12	—	5	—	2	—	—	3
	OR 2	2	20	8	12	5	1	5	—	2	—	—	—
	OR 3	6	22	11	4	4	1	6	—	2	—	1	—
	OR 4	3	11	10	6	6	—	2	—	1	1	—	1
	OR 5	2	1	1	3	2	—	4	—	—	—	—	—
	EB 1	6	—	8	14	8	—	8	—	13	9	1	—
	EB 2	6	—	8	11	3	—	6	—	17	3	1	—
	EB 3	6	3	4	15	8	—	2	—	25	8	1	—
	EB 4	2	—	4	7	1	1	1	—	11	6	1	2
	EB 5	1	—	6	30	—	—	4	—	13	3	—	2
	C	26	53	40	51	18	—	9	—	29	4	3	3
	COR	4	10	13	10	2	—	1	—	11	9	1	—
	EBOR	—	—	1	1	—	—	—	—	4	1	—	—
Total No. above 38 mm		225	235	222	296	231	46	63	—	169	47	20	37

TABLE 3. (*Continued*)

Arnala	OR 1	—	26	12	2	—	4	—	8	3	—	—	—
	OR 2	—	16	7	6	2	4	1	6	2	—	—	—
	OR 3	—	15	7	4	1	3	2	3	5	2	—	—
	OR 4	—	6	1	1	2	—	5	2	2	1	—	—
	OR 5	—	2	1	—	2	—	1	—	2	2	—	—
	EB 1	—	10	5	4	1	1	1	6	9	2	—	1
	EB 2	—	6	12	3	—	2	2	8	13	—	—	—
	EB 3	2	5	9	4	—	1	4	11	18	3	1	3
	EB 4	1	1	3	1	4	—	2	2	3	1	1	—
	EB 5	1	—	—	—	5	—	—	—	1	1	2	—
	C	3	—	59	19	54	5	1	8	9	3	2	1
	COR	2	—	26	22	6	1	—	19	8	5	2	—
	EBOR	—	—	1	—	—	—	—	—	—	2	2	—
Total No. above 38 mm		20	232	368	135	187	160	23	130	93	23	17	19

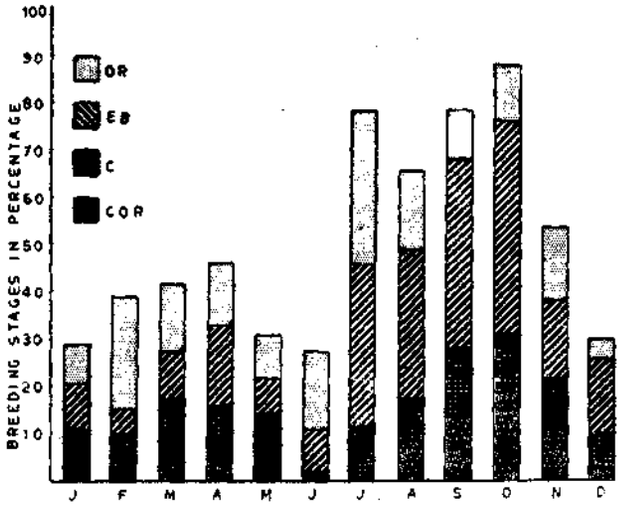

FIG. 7. Occurrence of various breeding stages *N. tenuipes* (in percentage of total breeding females) from all the three centres of observation in different months.

PARASTISATION

A bopyrid parasite was found infesting the branchial chamber of about one percent of the prawns examined from all the three centres (Table 4). The parasite was usually noticed on one side of the prawn, but rarely both the sides were found infested simultaneously. Similar instances of bopyrid parasitism have been recorded earlier among both penaeid and palaemonid prawns (Kunju 1956,

TABLE 4. *Incidence of bopyrid parasitism in* N. tenuipes *during various years at the three observations centres*

	Versova		*Sassoon Dock*		*Arnala*	
	No. of infested prawns	*No. of prawns examined*	*No. of infested prawns*	*No. of prawns examined*	*No. of infested prawns*	*No. of prawns examined*
1960	4	774	13	1422	8	994
1961	19	1337	21	2441	13	948
1962	7	593	9	1284	3	440
1963	1	293	8	951	—	—
1964	6	400	10	667	—	—
1965	1	143	—	——	—	—
1968	5	830	—	——	—	—
Total	43	4370	61	6765	24	2382

Menon 1953, Chopra, 1923). Gonads of the infested prawns never develop, nor the infested females of palaemonids carry eggs. However, in an exceptional instance of a female *N. tenuipes*, 49 mm in length collected from Sassoon Dock on July 27, 1960 it was found carrying early developing eggs. Probably the parasite might have got lodged in the branchial chamber after spawning has taken place.

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REFERENCES

BANERJI, S. K. 1969. Crustacean production in India. *Prawn Fisheries of India, CMFRI Bull.* 14: 259-272.

CHOPRA, B. N. 1923. Bopyrid isopods on Indian Decapod Macrura. *Rec. Ind. Mus.* 5: 411-550.

FORSTER, G. R. 1951. The biology of the common prawn, *Leander serratus* Pennant. *J. mar. biol. Ass. U.K.* 30: 333-360

GANAPATI, P. N. AND M. SUBRAHMANYAM. 1966. The prawn fishery in Godavary estuary, *J. Zool Soc. India*, 16 (1 & 2): 11-20.

GURNEY, G. R. 1923. Some notes on *Leander longirostris* M. Edw. and other British prawns. *Proc. Zool. Soc., London*, 1: 97-123.

HOGLUND, H. 1043. On the biology and larval development of *Leander squilla* (L) *forma typica* de Man, *Svenska hydrogr. biol. Kommn. Skr.*, N. S. *biol.*, BA6): pp. 44

HOLTHUIS, L. B. 1950. The palaemonidae collected by the Siboga and Snellius Expeditions with remarks on other species. 1. Sub-family Palaemoninae. The Decapoda of the Siboga Expedition. Part X. *Siboga Exped., Mon.*, 39 a9 : pp. 268.

HOLTHUIS, L. B. 1980. FAO Species catalogue Vol. I, Shrimps and prawn of the world *FAO Fish. Synopsis* (125) vol. 1: pp. 261.

KEMP, S. 1917. Notes on Crustacea Decapoda in the Indian Museum IX *Leander styliferus* Milne Edwards and related forms. *Rec. Ind. Mus* 13: 203-218.

KUNJU, M. M. 1956. Preliminary studies on the biology of the Palaemonid prawn *Leander styliferus* Milne Edwards. *Proc. Indo-Pacific Fish. Counc.*, 6(3): 404-416 (1954).

KUNJU, M. M. 1967. Observations on the prawn fishery of Maharashtra coast. *Proc. Symp. Crustacea, Mar. Biol. Ass. India. Part IV*: 1328-1397.

KUNJU, M. M. 1968. Some aspects of the biology of *Solenocera indica* Nataraj. *F.A.O. Fish. Rep.*, 57(2): 461-486

MENON, M. K. 1053. Notes on the bionomics and fishery of the prawn *Parapenaeopsis stylifera* (M.Edw) on the Malabar coast. *J. Zool. Soc. India*, 5(1): 153-162.

PILLAI, S. V. 1966. Early development and larval stages of *Palaemon tenuipes* Henderson, *J. mar. biol. Ass. India*, 8(2): 329-338.

RAJYALAKSHMI, T. 1961a. Larval development of *Palaemon lamarrei* H. M. Edw and *Leander fluminicola* Kemp, *J. Zool. Soc. India*, 13(2): 220-237.

RAJYALAKSHMI, T. 1961b. Studies on maturation and breeding in some estuarine palaemonid prawns, *Proc. Nart. Inst. Sci. India*. 27 B(4): 179-188.

RAJYALAKSHMI, T. 1966. On the age and growth of some estuarine prawns, *Proc. Indo-Pacif. Fish. Counc.*, 11(II): 52-83 (1964).

SETNA, S. B. 1949. Bombay fishermen's ingenuity, *J. Bombay Nat. Hist. Soc.*, 48(3): 444-449.