STUDY ON THE FISHERY AND BIOLOGY OF THE MANTIS SHRIMP *ORATOSQUILLA NEPA* (LATREILLE) OF SOUTH KANARA COAST DURING 1979-83

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ABSTRACT

The catches of *Oratosquilla nepa* along the South Kanara coast were maximum during 1981-82, amounting to 2543.3 t at a catch rate of 16.5 kg|h at Mangalore and to 1868.8 t at 16.7 kg|h at Malpe. The catch was high during January-April. A mean growth of 7-8 mm|month was indicated. The species appear to grow to it length of about 108 mm by the end of first year and to live for 15-16 months. In the development of the ovary, five maturity stages, ie., immature, early maturing, late maturing, mature and spent|spent-recovering, have been recognised. The size at maturity at 50% level is estimated at 95 mm. The spawning season is found to be extending from December to October with peaks during March-June and September-October. Females generally outnumbered males. Chi-square test showed significant variation from 1:1 ratio in the distribution of sexes. The fecundity is estimated at 6,78,200 in a female measuring 108 mm body length. The growth parameters, 1 a, and $_c$.k were estimated at 143 mm and 0.2877 respectively. The mean.monthly Z values were 0.9767 for males and 0.923d for females.

INTRODUCTION

Stomatopods, being non-edible, were a neglected group until recently though they had been forming a major portion of the trawl catches. They, however, received certain amount of significance in recent years since they started forming good raw material for the production of fish meal, poultry feed and manure, fetching fairly good price. The group is represented along this coast by a single species, i.e., *Oratosquilla nepa.* Other than a few accounts on distribution (Kemp 1913), distribution of larvae (AMkunchi 1950, 1962, Shambhogue 1975), post-larval growth (Alikunhi 1965) and resource (Shanbhoue 1973), nothing is known on the fishery and biology of this species. The only available information on the biology is from the works of Kubo et al (1959) on an allied from, *SquUla oratorio* De Hann, from Tokyo Bay. The present paper gives an account on the fishery and some aspects of biology of *O. nepa,* based on the studies conducted at Mangalore during 1979-83.

MATERIAL AND METHODS

Observations were made twice a week at Mangalore and once a week at Malpe, two important fish landing centres in South Kanara, during 1979-83. On each day, around 10% of the trawl units were observed at random to record the catch in weighl, from which the catch for the day was computed. The catch and effort data for different days of observation were pooled and raised to make the monthly estimate.

Random samples, collected from the landing centre, were analysed for total length, weight, sex ratio and maturity conditions, using, as far as possible, fresh materials. The measurements of the body length were taken from tip of rostrum to tip of sub-median teeth of teison. Body weight was measured by a tripple beam balance with a scale readable to 0.02 g. Sex could be differentiated by the presence of a pair of tube-like process in the inner base of the last thoracic leg in males, which is absent in females. Sex recognition was possible even in smaller specimens.

Methods adopted in the determination of growth rate, size at maturity, spawning season, growth parameters, etc. are given in the appropriate sections.

FISHERY

Though trawling, after the monsoon break, used to resume in September, stomatopods used to appear in the catches only from the second half of November or early December, the fishery extending up to the end of May or early June. Though forming only a by catch, they have contributed during peak seasons almost 55% of the trawl landings.

Landings at Mangalore (Bunder): The maximum, the minimum and the average annual catches of stomatopod for the seasons from 1979-80 to 1982-83 were 2543.3 t(1981-82), 1576.3 t (1979-80) and 1946.8 t, respectively (Table 1). The estimated annual catch rate fluctuated from 6.5 kg|h (1982-83) to 16.5 kg|h (1981-82). The catches were generally high during January-April and low during the rest of the season. The landings were the highest in January 1980, February 1981, April 1982 and March 1983.

Landings at Malpe Fisheries Harbour: The estimated stomatopod landings fluctuated between 1016.7 t (1982-83) and 1868.8 t (1981-82) with an overall annual average of 1334.7 t (Table 2). The catch rate was the lowest during 1982-83 (6.2 kg|h) and the highest during 1981-82 (16.7 kg|h). The best catches were recorded in January 1981, March 1982 and February 1983.

AGE AND GROWTH

Length-frequency polygons for males and females of *O. nepa* at Mangalore and Malpe are presented in Figs. 1, 2 and 3. The unimodal pattern of

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TABLE 1. *Catch of* O. nepa *(in tonnes), effort (in fishing hours)* and *catch rate (kg\hr) by shrimp trawlers at Mangalore in various months during different seasons.*

Month	1979-80 Effort	1979-80 Catch	1979-80 Catch rate	1980-81 Effort	1980-81 Catch	1980-81 Catch rate	1981-82 Effort	1981-82 Catch	1981-82 Catch rate	1982-83 Effort	1982-83 Catch	1982-83 Catch rate
Sep.	4748	—	—	6305	—	—	923	—	—	8936	—	—
Oct.	2790	—	—	234	—	—	341	—	—	2550	—	—
Nov.	2538	—	—	534	9.5	**17.8**	15648	147.3	**9.4**	19320	8.3	0.4
Dec.	21024	213.3	**10.1**	18333	383.8	**20.9**	19272	326.1	**16.9**	38261	266.0	7.0
Jan.	26559	448.1	16.9	20615	441.2	**21.4**	20873	326.2	17.4	44370	310.7	7.0
Feb.	29646	336.5	11.4	20671	500.2	**24.2**	25004	273.2	10.9	30976	425.1	13.7
Mar.	27711	322.2	11.4	14504	163.5	**11.3**	26009	627.3	24.0	44938	504.6	**11.2**
Apr.	20278	218.6	10.8	19585	220.3	**11.2**	24240	758.2	31.3	46060	158.6	3.4
May	13248	37.6	**2.8**	18751	168.7	**9.0**	20774	80.8	**3.9**	35477	102.5	2.9
Jun.	5	—	—	—	—	—	684	4.2	6.1	4625	4.6	1.0
Total	148547	1576.3	10.6	26549	1887.2	**15.8**	34196	2543.3	**16.5**	275513	1780.0	6.5

TABLE 2. *Monthwfse catch of* O. *nepa (in tonnes), effort (fishing hours) and catch rate (kg\h) by shrimp trawlers at Malpe.*

Month	1980-81 Effort	1980-81 Catch	1980-81 Catch rate	1981-82 Effort	1981-82 Catch	1981-82 Catch rate	1982-83 Effort	1982-83 Catch	1982-83 Catch rate
Sep.	—	—	—	923	—	—	9738	—	—
Oct.	—	—	—	1418	—	—	5380	—	—
Nov.	—	—	—	12825	313.3	24.4	16125	1.1	—
Dec.	—	—	—	13598	475.4	35.0	21375	105.1	4.9
Jan.	10989	265.6	24.2	9460	118.0	12.5	14313	210.8	14.7
Feb.	13230	221.5	16.7	16163	249.7	15-4	1*6205	202.2	18.0
Mar.	14976	150.8	10.0	21278	505.4	23.8	15401	129.1	8.4
Apr.	25650	242.4	9.5	15870	189.9	12.0	31050	184.8	6.0
May	23374	238.2	10.2	16890	15.0	0.9	30342	85.4	2.8
Jun.	—	—	—	3150	2.1	0.7	5250	8.2	1.6
Total	88219	1118.5	12.7	111575	1868.8	16.7	165179	1016.7	6.2

length-frequency distribution together with the clear-cut shifting of modes through successive months made the growth studies easy. The initial modes and the month of their appearance, the final modes to which they could be traced, month of their occurrence, growth increments, duration and monthly avtrage growth are given in Table 3.

From this it may be seen that the monthly average growths of males and females were 8 mm and 7.8 mm, respectively, at Mangalore, and 7 mm for both sexes at Malpe. Although there is slight difference in growth rates between these centres, it appears that the growth is almost identical in both sexes as observed by Kubo et al (1959) in *S. oratorio.*

To ascertain the time of brood origin, the number of broods per year class, the periodicity of brood release, the growth of brood since its origin through successive months; and the approximate longevity of life, the scatter-diagram technique of the modal progression analysis (Devaraj 1982a) was attempted (Fig. 4). The mean lengths at age are estimated based on the lengths at age in months as read along the vertical lines. Mean lengths at age in months for males and females at Mangalore and Malpe based on the scatter diagram are presented in Fig. 5. A comparison of mean lengths at age data for males and females at Mangalore as well as at Malpe revealed that the values agree very closely.

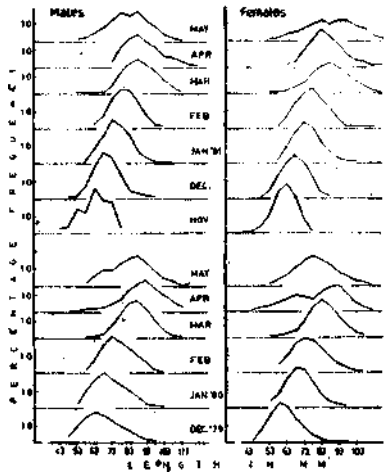

FIG. 1. Length-frequency distribution of males and females of *O. nepa* in various months during 1979-80 and 1980-81 at Mangalore.

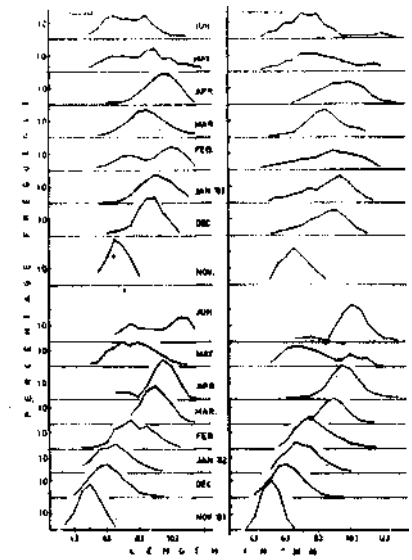

FIG. 2. Length-frequency . distribution of males and females of *O. nepa* in various months during 1981-82 and 1982-83 at Mangalore.

Since peak spawning is recorded during March-June (with maximum intensity in June), those recruits entering the fishery in large numbers in the beginning of the season, i.e., during November-December, are taken to have been born in June, and, hence, to be 5-6 months old. It this be so, the growth of the species is 108 mm by the end of first year (Fig. 5). Those thus-recruited to the fishery during November-December, however, do not appear to be surviving till the second fishing season, as the fishery at the beginning of each season is exclusively supported by smaller ones, measuring less than 98 mm in body length. It is, therefore, only reasonable to believe that the life span of *O. nepa* is 15-16 months. Kubo et al (1959) reported that *S. oratorio* lives for about 3 years in the Tokyo Bay.

Alil:unhi (1965) observed that in the laboratory conditions *O. nepa* grows to 27.5 to 30.0 mm in 15-30 days, 41 to 53 mm in **34-61** days and 93 to 96 mm in 129-176 days. This faster rate of growth is perhaps due to better environmental and food conditions that may have been provided in the aquarium.

LENGTH-WEIGHT RELATIONSHIP

The length-weight relationship was derived saparately for each sex, using the formula W = aL'', where 'W is the weight in g and 'a' and V are con-

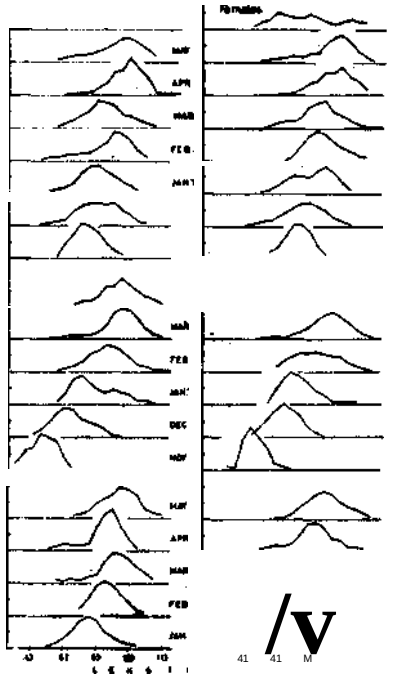

FIG. 3. Length frequency distribution of males and females of *O. nepa in* various months during 1980-81, 1981-82 and 1982-83 at Malpe.

stants, which were estimated by the usual method of least squares. The relationship among males and females are given by the following equations.

Males : log Y - -4.7954 + 2.9302 log X
Females : log Y = -4.6556 + 2.8471 log X

Since the regression equations for males and females were not found to be different when tested for significance a common equation was worked out:

log Y == -4.6628 + 2 8542 log x

MATURATION AND SPAWNING

Maturity Stages

As in other crustaceans, the following five maturity stages could be observed in the ovary of *O. nepa:*

Immature: In this stage, the ovary is very thin and transparent. The ova are tiny with large nuclei and clear cytoplasm, showing no sign of development. The diameter of ova ranges between 3 and 6 mocrodivisions.

TABLE 3. *The initial modes, the final modes, their month of occurrence, growth increments, duration and monthly average growth in males and females of* O. nepa *at Mangalore and Malpe.*

Initial mode (mm)	Month of occurrence	Final mode (mm)	Month of occurrence	Growth increments (mm)	Duration in months	Monthly average growth (mm)
			MANGALORE			
Males						
63	Dec. 79	93	Apr. 80	30	4	7.5
63	Nov. 80	88	Mar. 81	25	4	6.3
53	Nov. 81	108	June 82	55	7	8.0
73	May 82	78	June 82	5	1	5.0
68	Nov. 82	103	Feb.83	35	3	11.7
78	Feb.83	98	Apr. 83	20	2	10.7
Average				170	21	8.0
Females						
58	Dec. 79	93	Apr.80	35	4	8.0
68	Apr. 80	78	May 80	10	1	10.0
63	Nov. 80	88	May 81	25	4	6.2
53	Nov. 81	103	June 82	50	7	7.1
68	Nov. 82	103	Apr. 83	35	5	7.0
Average				155	21	7.8
			MALPE			
Males						
78	Jan. 81	93	Mar. 81	15	2	7.5
93	Apr. 81	98	May 81	5	1	5.0
48	Nov. 81	98	Apr. 82	50	5	10.0
73	Nov. 82	108	June 83	35	7	5.0
Average				105	15	7.0
Females						
78	Jan. 81	93	Mar. 81	15	2	7.5
88	Apr. 81	93	May 81	5	1	5.0
48	Nov. 81	103	Apr. 82	55	5	11.0
78	Nov. 82	108	June 83	30	7	4.3
Average				105	15	7.0

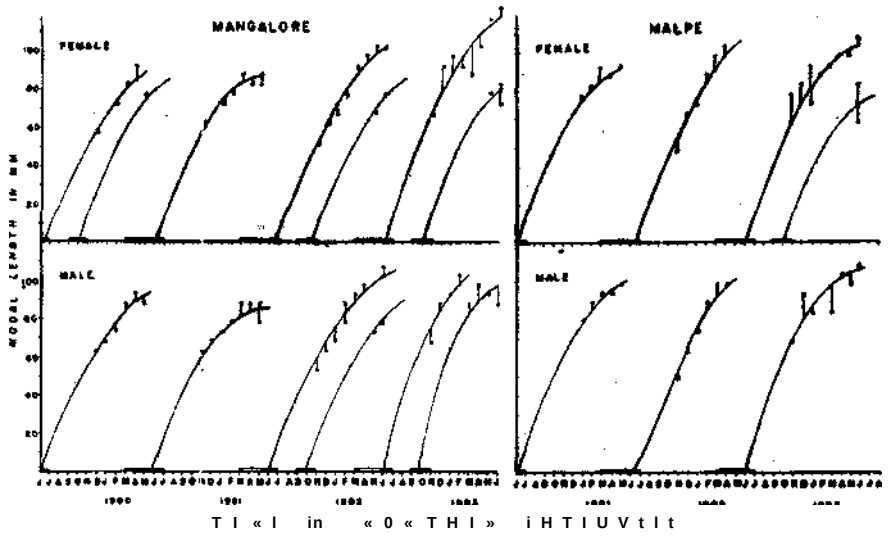

FIG. 4. Scatter diagram of modal length/month for males and females of *O. nepa.*

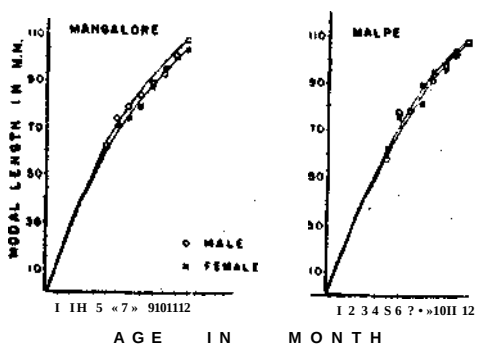

FIG. 5. Mean lengths at age in months based on **the** scatter diagrams for *O. nepa* from Mangalore and Malpe areas.

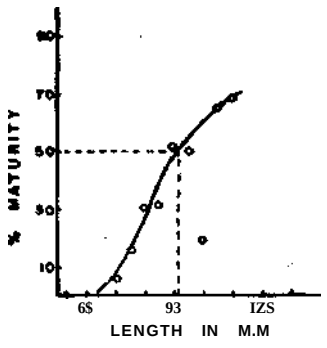

FIG. 6. Size at maturity in *O. nepa* at Mangalore.

Early maturing: The ovary is slightly enlarged and pale-yellow in colour. The ova show signs of development; yolk granules sparse, and nuclei visible. The diameter of ova ranges between 5 and 17 miorodivisions.

Late maturing: The ovary is lemon yellow in colour, enlarged, extending from the carapace to the last abdominal segment. The ova are enlarged, and nuclei not visible owing to the accumulation of yolk. The diameter of ova ranges between 10 and 30 microdivisions.

Mature: The ovary is deep orange or reddish brown in colour, very much enlarged, extending dorsally from the posterior region of carapace right up to telson. The ova are spherical, round or ovodial in shape, and are brittle due to the accumulation of yolk granules. These ova are fully ripe and ready to be shed. The diameter of ova ranges between 15 and 40 microdivisions.

Spent\spent—recovering: The ovary is flaccid and dirty yellow or white in colour. A few mature eggs together with a number of broken ones are to be noticed.

Size at Maturity

To determine the size at maturity, 1288 females were examined during 1980 and 1981. Since the females less than 60 mm body length did not show any sign of maturity, they were excluded from this study. Maturing (late) and mature females were combined size-wise and grouped into 5mm-class intervals and percentages taken. From this it was seen that fairly good number of females were mature at 83 mm and around 50% of females were mature at 95 mm (Fig. 6). The smallest female with fully matured ovary measured 68 mm.

Spawning Season

Kubo et al (1959) had used an indirect method (ovary-weight analysis) to determine the spawning season of *S. oratorio.* However, in the present study, gross examination of ovary (colour, size etc.,), together with microscopic examination of ova (to record the development of ova), is employed to determine the spawning season. It was observed, by this method, that fully mature squilla were present throughout the season except in November. Since there was differential variation among seasons in the incidence of maturity stages, the data for the entire period was pooled monthwise and percentages were plotted (Fig. 7), which has suggested peak spawning during March-June with maximum intensity in June.

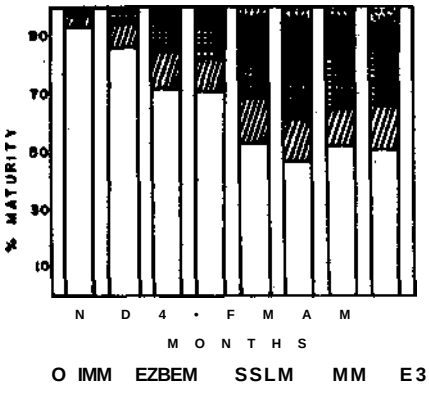

FIG. 7 Percentage distribution of different stages of maturity in females of *O. nepa* during different months at Mangalore. (IMM - immature; EM - early Maturing; LM - late maturing; M - mature and SP - spent/spent recovering).

Recruitment

The fishery was exclusively supported by smaller size groups every November, indicating bulk recruitment into the fishery around this period. These new recruits can reasonably be the product of the peak spawning during March-June *(op. cit.)*. A further recruitment of smaller size groups (63-88 mm) in considerable magnitudes in May 82 and May 83 suggests that the spawning activity also has a secondary peak during September-October. However, this could not be substantiated owing to the break in fisheries during monsoon period.

Sex Ratio

Monthwise proportion in percentages of males and females of *O. nepa* during 1979-80, 1980-81, 1981-82 and 1982-83 at Mangalore is given in Table 4. It is seen that generally females were in excess of males. Overall sex ratio indicated that females formed 62.2% of the population at this centre. Chi-square test showed that the apparent variation from the 1:1 ratio in the distribution of sexes is significant in all seasons (Table 5).

The sex distribution in relation to length indicated that females outnumbered males in all sizes below 85 mm and above 110 mm, whereas males were more in the intervening sizes (Table 6).

Fecundity

A late-maturing female measuring 108 mm in length had 6,78,200 ova in its ovary.

ESTIMATION OF L=> AND e-k

The growth parameters i«. and e-k can be estimated from three observations of length £it age (Alagaraja 1984). For this, three modes with equal interval of time from the monthly length-frequency distribution were selected as 11, 12 and 13. By this method, a series of pairs of 1<= and e-k values were obtained by taking different groups of these modes. The suitable pair of 1 =° and ek estimates selected in the present study were 143 mm and 0.2877, and the modes chosen as 11,-12 and 13 for arriving at these values were 63 mm, 83 mm and 98 mm respectively.

ESTIMATES OF Z

Since the life span of this species is only 15-16 months and brood remains in the fishery only for a season, age composition data were not useful in estimating Z. However, the instantaneous total mortality coefficient, Z, could be estimated from the discending limb of the annual size distribution (Alagaraja

TABLE 4. ***Monthwise sex ratio of*** **O. nepa** ***at Mangalore.***

	1979-80			1980-81			1981-82			1982-83		
	Total	**Males** /o	**Females** /o	Total	Males /o	**Females** /o	Total	**Males 0/ /o**	**Females o/ /o**	Total	**Males o/ /o**	**Females o/ /o**
Oct.	—	—	—	—	—	—						
Sep.							—		—	—	—_	"^
Nov.	—	—		256	34.0	**66.0**	198	41.4	**58.6**	137	48.2	**51.8**
Dec.	191	31.9	68.1	411	37.0	**63.0**	382	38.4	**61.6**	297	46.5	**53.5**
Jan.	400	37.2	61.8	325	49.5	**50.5**	416	42.3	57.7	282	48.9	**51J1**
Feb.	387	**41.8**	**58.2**	344	39.5	**50.5**	242	47.9	**52.1**	302	**51.3**	**48.7**
Mar.	504	46.0	54.0	381	**48.0**	**52.0**	295	40.0	60.0	245	45.3	**54.7**
Apr.	494	40.3	59.7	290	44.5	**55.5**	170	35.9	**64.1**	359	36.5	**63.5**
May	411	49.6	**50.4**	400	41.5	**58.5**	184	39.1	**60.9**	229	43.7	**56.3**
June							49	18.4	**S1.6**	154	38.3	**61.7**
Total	2387	42.0	**58.0**	2407	42.2	**57.8**	1936	40.3	**59.7**	2005	44.8	**55.2**

TABLE 5. *Test of homogeneity (chi square) for the proportions of males in different months at Mangalore.*

	Degrees of freedom	Chi square value	Significance at *5%*
1979-80	5	33.5824	S
1980-81	6	25.3538	S
1981-82	7	17.8565	**S**
1982-83	7	20.8322	**S**

S - Significant

TABLE 6. *Sex ratio of* O. nepa *(in percentage) at various length groups at Mangalore.*

Size group mid-point (in mm0	1979-80		1980-81		1981-82		1982-83	
	male	female	male	female	male	female	male	female
43			33.3	66.7	58.8	41.2	—	100.0
48	36.8	60.2	20.0	80.0	47.4	52.6	33.3	66.7
53	18.6	81.4	21.6	78.4	30.7	69.3	11.8	88.2
58	29.3	70.7	30.1	69.9	45.3	54.7	33.3	66.7
63	30.8	69.2	33.0	67.0	36.9	63.1	47.3	52.7
68	35.3	64.7	42.0	58.0	42.8	57.2	47.3	52.7
73	35.0	65.0	39.7	60.3	46.0	54.0	48.2	51.8
78	38.7	61.3	43.8	56.2	39.1	60.9	34.6	65.4
83	45.0	55.0	48.7	51.3	44.3	55.7	46.2	53.8
88	51.3	48.7	42.9	57.1	41.0	59.0	57.8	42.2
93	51.8	48.2	51.3	48.7	43.4	56.6	48.5	51.5
98	54.8	45.2	48.4	51.6	41.6	58.4	44.4	56.0
103	48.7	51.3	43.4	56.6	34.4	65.6	48. 9	51.1
108	65.6	34.4	42.6	57.4	24.5	75.5	47.2	52.8
113	75.0	25.0	36.7	63.3	28.6	71.4	36.5	63.5
118	50.0	50.0	33.3	66.7	20.0	80.0	33.3	66.7
123	—	—	50.0	50.0	—	100.0	—	—
128	—	—	100.0	—	—	100.0	10.0	90.0
133	—	—	—	—	—	100.0	—	—

TABLE 7. *Estimates of* Z *and* SZ *for males and females of* O. nepa *at Mangalore*

	Males		Females	
	Z	SZ	Z	Z
1978-79	0.9136	0.2518	1.0326	0.2900
1979-80	1.0304	0.2658	1.3201	0.2458
1980-81	1.1190	0.1329	1.0907	0.1171
1981-82	1.2076	0.3811	0.8661	0.1445
1982-83	0.6362	0.1130	0.7354	0.1322
seasons	0.9767	0.0878	0.9231	0.0603

1984) which is subjected to heavy fishing mortality. For this, the estimated numbers of males and females during different fishing seasons were smoothened by three point moving averages. The monthly estimates of Z and the standard error of Z, SZ, are given in Table 7. The mean values of Z for males and females were 0.9231 and 0.9767 respectively.

UTILIZATION

The South Kanara coast contributes more than 50% of the estimated landings of stomatopods in India. These, along with other trash fish, are now a good raw material for the production of nshmeal, poultry feed and manure, for which a number of fish meal plants have come up in this area in recent years. While the entire landings at Mangalore are being consumed by these plants, part of the landings at Malpe is being dried and sold as manure.

ACKNOWLEDGEMENTS

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