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DISTRIBUTION PATTERN OF THREADFIN BREAMS ALONG NORTH TAMIL NADU AND SOUTH ANDHRA COASTS

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ABSTRACT

Catch rate and biomass of threadfin breams were estimated for north Tamil Nadu - south Andhra coast based on exploratory trawling conducted by M. V. *Matsyajeevan* and R. V. *Cadalmin III*. In the entire region explored by M. V. *Matsyajeevan*, the catch rate was 2.2 kg/hr and the biomass was 0.001 t/km². In the region explored by R. V. *Cadalmin III*, the catch rate was 0.7 kg/hr and the biomass was 0.002 t/km². Threadfin breams occurred upto a depth of 220 m and the highest catch rate of 71.7 kg/hr was obtained in 101-110 m depth.

Of the 5 species that constituted the threadfin bream catch, *Nemipterus japonicus* formed 55.1%. Biological studies revealed a positive correlation between depth and length of *N. japonicus*. About 78% of *N. japonicus* in 6-10 m depth was immature and the percentage of immature individuals decreased with increasing depth. With increasing depth, the percentage of female with ripe ovary increased. *N. japonicus* in shallow waters were observed to feed mostly on prawn and those in deeper waters mostly on fish and crab.

INTRODUCTION

Since threadfin breams form an important demersal fishery resource along the Indian coast, biology and population dynamics of this group have been studied by many fishery biologists in recent years based on commercial trawling operations, most of which are restricted to shallow waters. There are only a very few studies on the biology and resource characteristics of threadfin breams inhabiting areas beyond 40 m depth (Kuthalingam, 1966; Narayanappa *et al.*, 1968; Satyanarayana *et al.*, 1972; Krishnamoorthi, 1973; Vinci, 1982; Vivekanandan and Krishnamoorthi, 1985). As it is a prerequisite to quantify the threadfin bream resource in deeper areas so as to examine the possibility of employing fishing effort in areas beyond 40 m depth, the exploratory data collected by M. V. *Matsyajeevan* and R. V. *Cadalmin* III in north Tamil Nadu - south Andhra Pradesh coasts were analysed. The salient features of the analysis on resource characteristics of threadfin breams and biology of *Nemipterus japonicus* are presented here.

MATERIALS AND METHODS

Every voyage of the trawler M. V. *Matsyajeevan* (overall length: 33.6 m) belonging to the Fishery Survey of India, Madras base, lasted for 10 days or more during the 3 year period viz., 1983, 1984 and 1985. The trawler conducted survey in the region between 10°10'N (off Point Calimere) and 16°40'N (off Kakinada) (Fig. 1). The trawler R. V. *Cadalmin* III (overall length: 13.3 m) belonging to the Research Centre of CMFRI, Madras, undertook daily voyages during the years 1981 - '85 (except during 1983) in two regions viz., 12°40'N (off Mahabalipuram) and 13°10' (off Ennore). The data of M. V. *Matsyajeevan* that were provided to the Research Centre of CMFRI, Madras and the data collected from R. V. *Cadalmin* III were processed separately.

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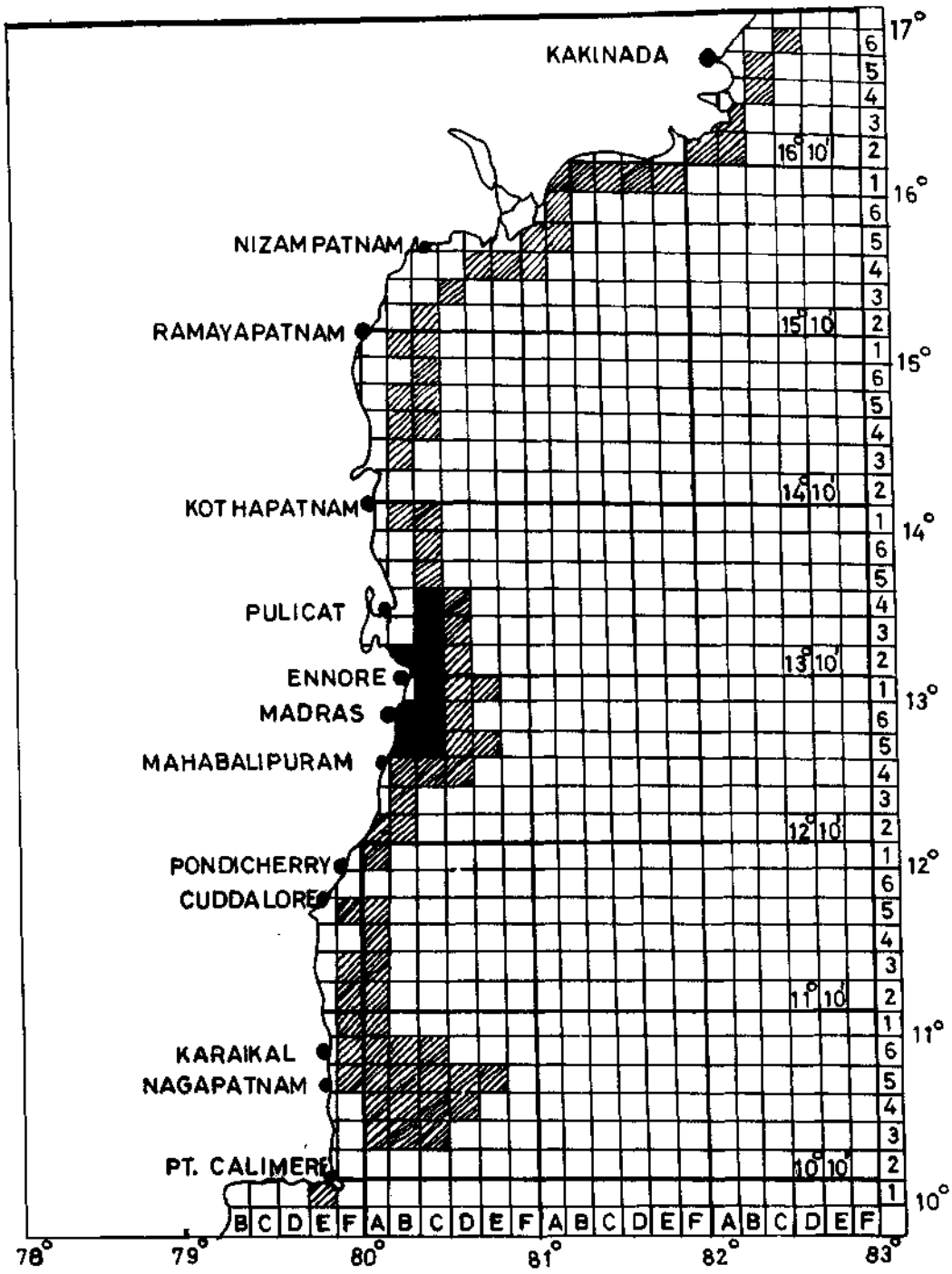

Fig. 1. Map of north Tamil Nadu - south Andhra coast. Areas surveyed by M.V. *Matsyajeevan* (▨) and R.V. *Cadalmin* III (■) are shaded.

To estimate the threadfin bream biomass, "swept area" method (Pauly, 1983; Sparre, 1988) was followed:

$$\text{Biomass} = \frac{Ac \times C/f}{As \times X_1}$$

Where, Ac = Area considered = Area of each 10' square (326.6 km^2) x No. of squares fished;

C/f = Catch per unit area;

X_1 = proportion of the fish in the path of the gear that are retained by the net (considered here as 0.5 as suggested by Pauly, 1983); and

As = Area swept

The As was computed from the expression

$$As = t \times v \times h \times X_2$$

where, t = time spent in trawling;

V = speed of the trawler when fishing;

h = length of the trawl net's head rope; and

X_2 = fraction expressing the width of the area swept by the net divided by the length of the head rope.

In the present investigation, the trawling speed of both the vessels was 3 knots/hr. The head rope length of the trawl nets operated by M. V. *Matsyajeevan* and R. V. *Cadalmin III* were 25 and 15 m, respectively. The X_2 was considered as 0.5 for both the nets, which is suggested to be best compromise (Pauly, 1979).

The number of 10' squares fished in each latitude zone and the Ac by the two trawlers are presented in Table 1. For determining "all year" biomass, the catch in each zone during the study period was pooled and the C/f was calculated; the biomass was subsequently calculated for the areas fished in each latitude zone. Each square that is repeated over the years was considered as a single square while calculating the "all year" biomass. For calculating the "all latitude" biomass, the catch in each year in the entire study area was pooled and the C/f and subsequently the biomass were calculated.

Species composition of threadfin breams was determined by collecting samples from R. V. *Cadalmin* III. For analysing length frequency, sex ratio, maturity stages and feeding habits of *N. japonicus*, samples were collected from R. V. *Cadalmin III*.

Results and Discussion

Catch rate and biomass

During the 3 year period (1983 - 1985), M. V. *Matsyajeevan* spent 2,042.56 trawling hours in 14 latitude zones. The catch rate of threadfin breams was maximum (38.6 kg/hr) in 12°10'N (off Marakkanam) followed by 11°40'N (off Porto Novo; 21.4 kg/hr) (Table 2). The average catch rate in all the 14 zones explored was 2.2 kg/hr. The biomass estimations were 0.003, 0.002 and 0.001 t/km^2 for the years 1983, 1984 and 1985, respectively and the 3 year average was 0.001 t/km^2 (Table 3). The biomass was maximum (1.346 t/km^2) in 11°40' followed by 12°10'. But the effort expended in these two zones was very much limited (Table 2) to arrive at any conclusion. In the zones where the effort was appreciable (more than 100 hr), the biomass ranged between, 0.001 and 0.006 t/km^2. As the vessel spent meagre trawling time in 13°40'N (9.76 hr) and 16°40'N (12.50 hr), there was no catch of threadfin breams, resulting in nil biomass in these two zones.

R. V. *Cadalmin III* spent 378.62 trawling hours in 2 latitude zones during 1981, 1982, 1984 and 1985. The catch rate during the 4 years ranged between 0.6 and 0.9 kg/hr and averaged to 0.7 kg/hr (Table 4). The catch rate was 0.8 and 0.7 kg/hr in 12°40'N and

TABLE 1. *Latitude zones and areas explored by M. V.* Matsyajeevan (1983 - '85) *and R. V.* Cadalmin III (1981 - '85)

	M. V. *Matsyajeevan*		R. V. *Cadalmin III*	
Latitude zone (°N)	No. of squares	Area considered (km^2)	No. of squares	Area considered (km^2)
10°10'	8	2,612.8	n. s.	n. s.
10°40'	10	3,266.0	n. s.	n. s.
11°10'	7	2,286.2	n. s.	n. s.
11°40'	3	979.8	n. s.	n. s.
12°10'	7	2,286.2	n. s.	n. s.
12°40'	6	1,959.6	4	1,306.4
13°10'	10	3,266.0	4	1,306.4
13°40'	2	653.2	n. s.	n. s.
14°10'	3	979.8	n. s.	n. s.
14°40'	5	1,633.0	n. s.	n. s.
15°10'	6	1,959.6	n. s.	n. s.
15°40'	4	1306.4	n. s.	n. s.
16°10'	9	2,939.4	n. s.	n. s.
16°40'	2	653.2	n. s.	n. s.
All latitudes	82	26,781.2	8	2,612.8

n. s. = not surveyed.

13°10'N, respectively. The biomass estimations were 0.006 and 0.004 t/km^2 in 12°40'N and 13°10'N, respectively (Table 5). These biomass estimations are comparable with those obtained in the present study based on M. V. *Matsyajeevan* data for the latitude zones 12°40'N and 13°10'N (Table 3).

To understand the depthwise distribution of threadfin breams, the catch rate obtained in different depth zones upto 220 m in M. V. *Matsyajeevan* and upto 60 m in R. V. *Cadalmin III* are presented in Table 6. Eventhough M. V. *Matsyajeevan* operated trawl net upto a depth of 540 m, the effort expended beyond 300 m was meagre. The threadfin breams were recorded upto 220 m depth. The maximum catch rate (71.1 kg/hr) was obtained in 101 - 110 m depth, in which a total of 1,269 kg was obtained by expending 17.86 hr. In 211 - 220 m, which was the maximum depth recorded for the occurrence of threadfin breams in the present study, 471 kg was realised from 45.32 trawling hours. By grouping the depthwise operation into 3 equal categories, it was calculated that the vessel expended 69, 12 and 19% of the total fishing effort in 11 - 80 m, 81 - 150 m and 151 - 220 m depth categories, respectively; the corresponding threadfin bream catches in these 3 depth categories were 31, 46 and 23% of the total threadfin bream catch. Though there is no uniform pattern in the catch rate in relation to depth, fairly higher catch rate beyond 80 m depth indicates good concentration of threadfin bream resources beyond the areas of commerical operations, which is restricted upto a depth of about 40 m. R. V.

TABLE 2. *M. V. Matsyajeevan : Annual effort (hr) and catch rate (kg/hr) of threadfin breams in each latitude zone*

Latitude zone (°N)	1983			1984			1985			All years		
	No. of squares	Effort	Catch rate	No. of squares	Effort	Catch rate	No. of squares	Effort	Catch rate	No. of squares	Effort	Catch rate
10°10'	5	16.42	0.0	6	90.89	0.4	7	229.90	1.6	8	337.21	1.2
10°40'	4	19.49	0.0	7	259.79	3.9	8	506.21	1.2	10	785.49	2.1
11°10'	7	11.50	2.2	5	120.90	0.3	5	192.73	1.0	7	325.13	0.8
11°40'	2	4.49	21.2	1	1.16	0.0	1	1.58	38.0	3	7.23	21.4
12°10'	6	13.82	10.9	2	24.52	54.2	0	n. s.	n. s.	7	38.34	38.6
12°40'	5	21.25	0.0	5	89.58	2.6	3	24.08	0.0	6	134.91	1.7
13°10'	10	162.23	1.9	7	90.21	0.0	2	16.65	0.0	10	269.09	1.2
13°40'	2	7.10	0.0	2	2.6	0.0	n. s.	n. s.	n. s.	2	9.76	0.0
14°10'	4	15.25	1.7	2	2.00	0.0	n. s.	n. s.	n. s.	3	17.25	1.5
14°40'	3	9.83	0.0	3	5.50	1.8	n. s.	n. s.	n. s.	5	15.33	0.7
15°10'	6	20.77	0.0	4	7.83	3.2	n. s.	n. s.	n. s.	6	28.60	0.9
15°40'	3	10.33	0.0	3	7.83	1.3	n. s.	n. s.	n. s.	4	18.16	0.6
16°10'	n. s.	n. s.	n. s.	9	43.56	0.3	n. s.	n. s.	n. s.	9	43.56	0.3
16°40'	n. s.	n. s.	n. s.	2	12.50	0.0	n. s.	n. s.	n. s.	2	12.50	0.0
All lat.	57	312.48	2.0	58	738.93	3.6	26	971.15	1.3	82	2042.56	2.2

n. s. = not surveyed.

Cadalmin III too recorded the maximum catch rate (2.3 kg/hr) in 51 - 60 m depth (which is the maximum depth in which the vessel conducted trawling). It appears that ventures in the offshore areas beyond the conventional fishing grounds would be rewarding.

Species composition

Samples collected from R. V. *Cadalmin III* during the years 1981, 1982, 1984 and 1985 revealed that *N. japonicus* formed 55.1% of threadfin bream catch followed by *N. mesoprion* (15.4%), *N. tolu* (14.7%), *N. luteus* (7.6%) and *N. delagoae* (7.2%). Data collected from private trawlers during the years 1980 - 1984 also showed that *N. japonicus* forms more than 50% of the threadfin bream landings in Madras coast (Vivekanandan and James, 1986). The depthwise monthly species composition and catch rate were analysed. As there was no remarkable depthwise difference either in species composition or catch rate, the data were pooled and illustrated in Figures 2 and 3. The composition of *N. japonicus* increased from 44.4% in 6 - 10 m depth to 68.9% in 51 - 60 m depth (Fig. 2). Similarly, the composition of *N. mesoprion* increased from 0.6% in 6 - 10 m depth to 35.2% in 41 - 50 m depth and decreased to 20.0% in 51 - 60 m depth. The composition of the other 3 species decreased with increasing depth.

The catch rate of *N. japonicus*, *N. mesoprion* and *N. delagoae* fluctuated with increasing depth and was the highest in 51 - 60 m depth (Fig. 3). The correlation between depth and catch rate had high r values for two species, viz., *N. mesoprion* and *N. luteus*; whereas depth (x = m) and catch rate (y = g/hr) of *N. mesoprion* were positively correlated (y = - 78.4 + 9.47 x; r = 0.974), the two variables were negatively correlated (y = 133.1 - 2.75 x; r = 0.832) for *N. luteus*. There was no catch of *N. luteus* beyond 40 m depth.

TABLE 3. *Biomass (tonnes) of threadfin breams for the years 1983-1985 based on data collected from M. V. Matsyajeevan*

Latitude zone (°N)	Biomass (tonnes)				
	1983	1984	1985	All years	t/km²
10°10'	0.0	4.4	7.2	4.2	0.002
10°40'	0.0	15.5	2.9	3.9	0.001
11°10'	197.9	1.6	4.1	2.6	0.001
11°40'	1,379.1	0.0	3,919.2	1,318.6	1.346
12°10'	709.8	662.1	n. s.	1,057.3	0.462
12°40'	0.0	21.5	0.0	11.4	0.006
13°10'	12.4	0.0	0.0	6.5	0.002
13°40'	0.0	0.0	n. s.	0.0	0.000
14°10'	66.5	0.0	n. s.	39.2	0.040
14°40'	0.0	151.3	n. s.	32.0	0.020
15°10'	0.0	241.7	n. s.	27.4	0.014
15°40'	0.0	72.4	n. s.	18.1	0.014
16°10'	n. s.	10.7	n. s.	10.7	0.004
16°40'	n. s.	0.0	n. s.	0.0	0.000
All lat.	53.3	40.6	5.1	13.4	-
Biomass per km²	0.003	0.002	0.001	-	0.001

n. s = not surveyed.

Biological studies on *N. japoncius*

Length frequency

Samples of *N. japonicus* were collected from R. V. *Cadalimin III* for biological studies during the year 1981, 1982, 1984 and 1985. Depthwise analysis was done by pooling data collected during the 4 years. For length frequency study, a total of 1,543 specimens ranging from 55 to 295 mm in total length were measured. With increasing depth, length range and modal length increased. The length range increased from 55 - 175 mm in 6 - 10 m depth to 115 - 295 mm in 41 - 50 m depth (Fig. 4). The modal lengths were 115, 135, 155, 155, 205 and 225 mm in 6 - 10 m, 11 - 20 m, 21 - 30 m, 31 - 40 m, 41 - 50 m and 51 - 60 m depths, respectively. There was a positive correlation between depth and average length too upto the explored 60 m depth (Fig. 5). The pattern beyond 60 m depth is not known and study in deeper area is wanting eventhough the threadfin breams occur upto 220 m. Working on depthwise distribution of different length groups of *N. japonicus* off Mangalore, Kuthalingam (1966) reported concentration of smaller length groups (50 to 200 mm) between 10 and 30 m depth and abundance of larger groups (130 to 240 mm) between 31 and 50 m. Sainsbury and Whitelaw (1984) and Pauly and Martosubroto (1980) also observed positive correlation between depth and length of *N. peronii* and *N. marginatus*, respectively.

To study the sex ratio of *N. japonicus*, a total of 888 specimens were analysed during

TABLE 4. *R. V. Cadalmin III: Annual effort (hr) and catch rate (kg/hr) of threadfin breams in each area*

Latitude zone (°N)	Area	1981		1982		1984		1985		All years	
		Effort	Catch rate	Effort	Catch rate	Effort	Catch rate	Effort	Catch rate	Effort	Catch rate
12°40'		55.22	0.9	53.11	0.7	31.88	0.5	16.24	1.0	156.45	0.8
	12.80/B5	10.91	0.0	1.50	0.7	13.48	1.1	n. s	n. s	25.89	0.6
	12.80/C5	n. s	n. s	6.58	2.7	2.25	0.7	n. s	n. s	8.83	2.1
	12.80/B6	34.31	1.2	30.30	0.3	8.91	0.4	14.24	1.0	87.76	0.7
	12.80/C6	10.00	1.1	14.73	0.1	7.24	0.0	2.00	1.5	33.97	0.7
13°10'		51.23	0.4	77.39	1.1	25.47	0.6	68.08	0.5	222.17	0.7
	13.80/C1	19.32	0.8	37.91	0.03	3.91	1.6	45.50	3.0	106.64	0.4
	13.80/C2	21.50	0.1	29.07	2.5	21.56	0.4	22.58	0.8	94.71	1.1
	13.80/C3	10.41	0.0	7.41	1.0	n. s	n. s	n. s	n. s	17.82	0.4
	13.80/C4	n. s	n. s	3.00	0.0	n. s	n. s	n. s	n. s	3.00	0.0
All lat./All area		106.45	0.7	130.50	0.9	57.35	0.6	84.32	0.6	378.62	0.7

n. s = not surveyed.

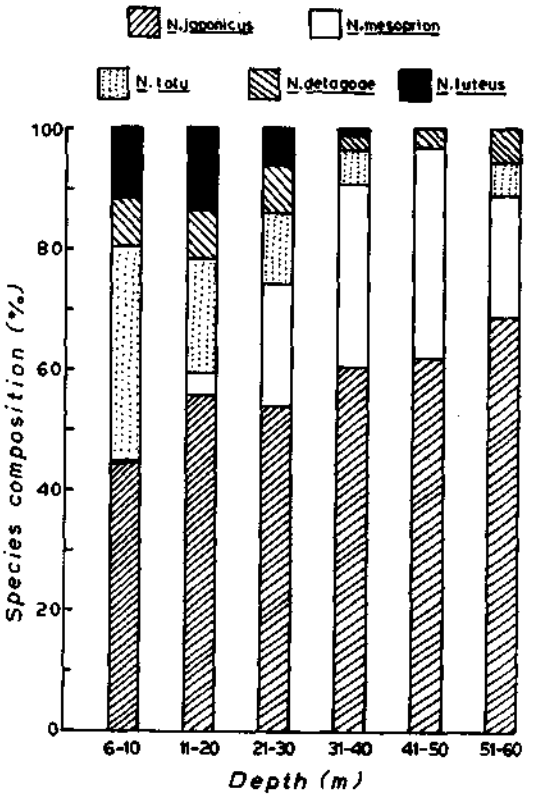

Fig. 2. Species composition of threadfin breams in different depths.

the 4 year period. As the abundance of smaller length groups of *N. japonicus* was more in shallow waters, the percentage of immature individuals decreased with increasing depth. The immature individuals, which constituted 78.0% of the catch in 6 - 10 m depth, decreased sharply to 8.6% in 31 - 40 m depth (Fig. 6a); immature individuals were not recorded beyond 40 m. Vivekanandan and James (1986) reported that *N. Japonicus* matures when it attains 135 mm total length. As the mean length of the fish inhabiting 6 - 10 m depth was only 100 mm, it is not surprising that 78% of the fishes in 6 - 10 m were immature.

TABLE 5. *Biomass (tonnes) of threadfin breams based on data collected from R. V.* Cadalmin III

Latitude zone (°N)	Area	1981	1982	1984	1985	All years t	All years t/km²
12°40'		20.3	22.4	28.0	52.7	8.3	0.006
	12.80/B5	0.0	181.8	33.6	n. s.	9.7	0.030
	12.80/C5	n.s.	173.9	121.2	n. s.	104.0	0.318
	12.80/B6	13.9	4.3	5.1	28.2	3.4	0.010
	12.80/C6	42.9	18.7	0.0	306.2	8.3	0.025
13°10'		8.4	24.1	19.6	6.0	4.9	0.004
	13.80/C1	17.6	0.3	160.9	2.9	1.4	0.004
	13.80/C2	1.7	35.7	8.2	15.3	4.8	0.015
	13.80/C3	0.0	54.4	n. s.	n. s.	9.4	0.029
	13.80/C4	n.s.	0.0	n. s.	n. s.	0.0	0.000
All lat. / All area		7.4	35.4	24.5	11.7	6.2	
Biomass per km²		0.004	0.014	0.013	0.009	-	0.002

n-s = not surveyed.

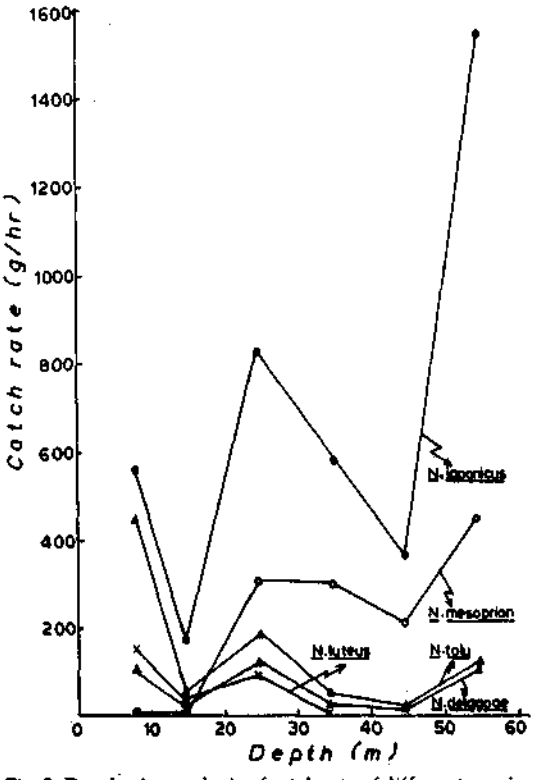

Fig. 3. Depthwise analysis of catch rate of different species of threadfin breams.

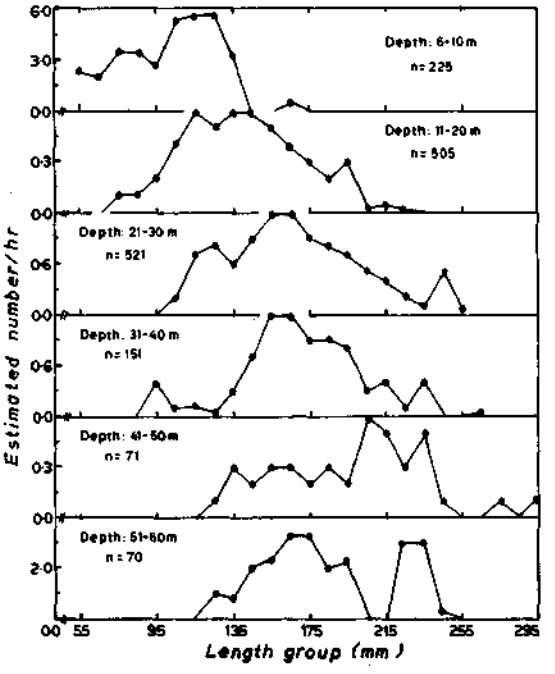

Fig. 4. Length-frequency of *N. japonicus* in different depths.

The percentage of male and female fluctuated in different depth groups (Fig. 6a). However, analysis of female (n = 326) gonadal condition revealed depthwise change in

TABLE 6. *Depthwise annual catch rate (kg/hr of threadfin breams in M.V. Matsyajeevan(1983-1985) and R. V. Cadalmin III (1981 - 1985)*

Depth (m)	M. V *Matsyajeevan*	R.V. *Cadalmin III*
6-10	n.s.	1.3
11-20	0.0	0.3
21-30	0.0	1.5
31-40	2.2	1.0
41-50	1.0	0.6
51-60	0.9	2.3
61-70	4.2	n.s
71-80	0.2	n.s
81-90	0.0	n.s
91-100	1.0	n.s
101-110	71.1	n.s
111-120	0.6	n.s
121-130	0.0	n.s
131-140	15.3	n.s
141-150	1.7	n.s
151-160	4.6	n.s
161-170	1.1	n.s
171-180	1.3	n.s
181-190	7.6	n.s
191-200	0.0	n.s
201-210	0.0	n.s
211-220	10.4	n.s

n.s. = not surveyed.

the proportion of ovaries that constituted maturing (stage II), mature (stages III & IV) and ripe (stage V & VI eggs). Whereas the proportion of maturing eggs decreased with increasing depth, the proportion of ripe eggs increased with increasing depth (Fig. 6b). At 51 - 60 m depth, 33% of the females had ripe eggs. From this observation and that of Kuthalingam (1966), it appears that *N. japonicus* moves to deeper area as it becomes sexually mature and spawns beyond 40 m. However, the smallest fish observed in the present investigation (55 mm)

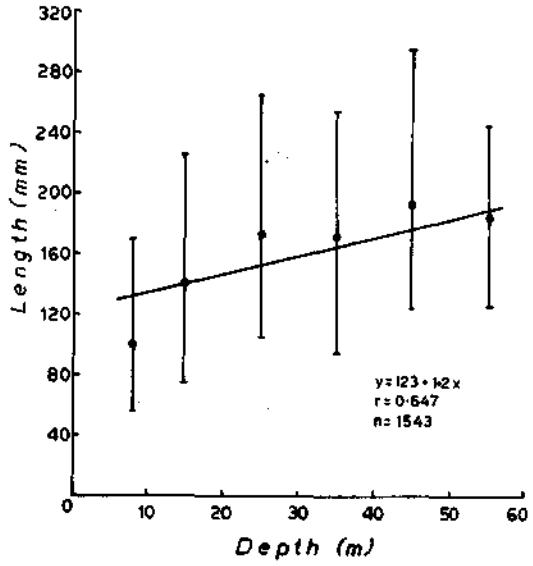

Fig. 5. Correlation between depth and average length of *N. japonicus;* vertical lines indicate the range of values.

and from private trawlers (40 mm; Vivekandandan, personal observation) were recorded in very shallow waters (below 10 m). Perhaps the juveniles below 50 mm length, which are not fully recruited to the fishery, move from deeper waters where they are spawned, to the shallower area for feeding.

Feeding

Examination of stomach of 888 specimens ranging in length from 85 to 275 mm revealed that 46.1% of the fishes had empty stomach (Table 7). The remaining 479 fishes were used for interpretation of feeding habit of *N. japonicus* as follows: The number of individuals containing different food items in each depth group was totalled and the percentage of representation of each food item was calculated and plotted in Figure 7. In the entire sample analysed, crustaceans were represented in 70.4% of the fishes. Among the crustaceans, prawns, squilla and crabs were represented in 45.0, 17.0 and 5.5% of the specimens, respectively. Cephalopods (9.2%0,

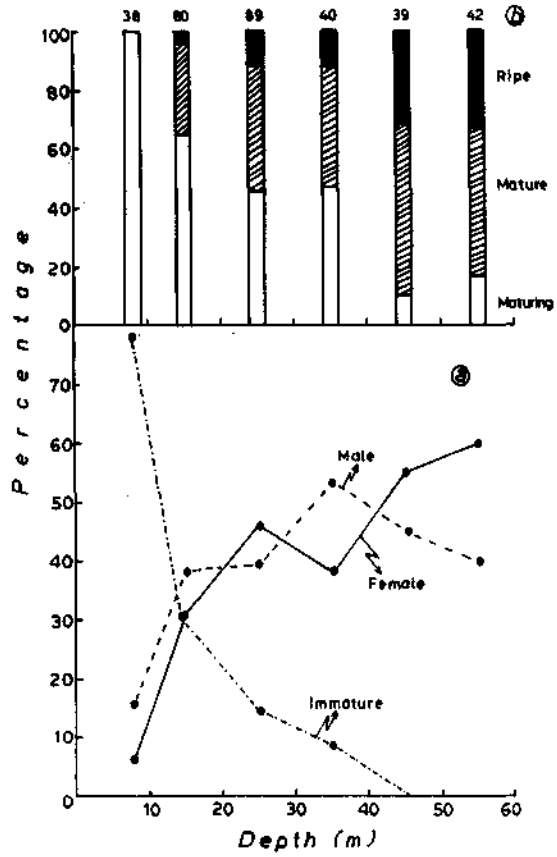

Fig. 6. Depth - wise analysis of sex ratio (a) (n=888) and gonadal maturity stages (b) (n=328) of female *N. japonicus*.The number above each bar indicates samples in each depth.

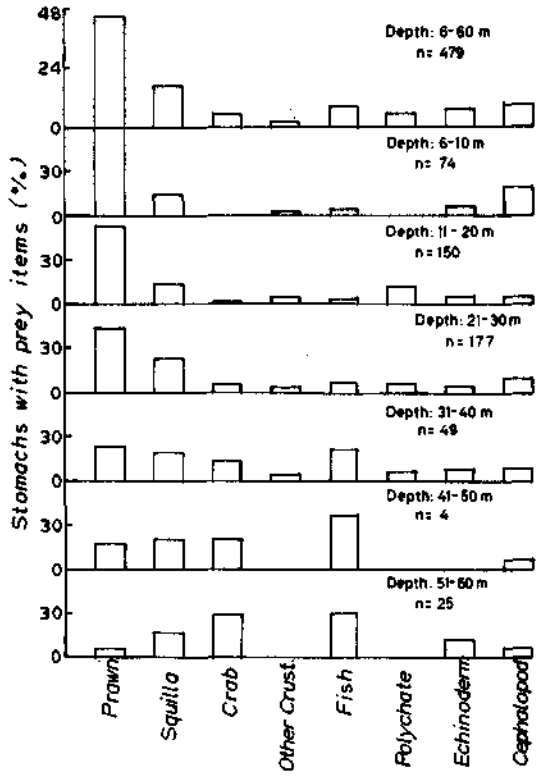

Fig. 7. Percentage of *N. japonicus* observed to contain various categories of prey items in different depths.

fish (8.4%), polychaetes (6.2%) and echinoderms (5.7%) were the other representative food items. There was difference in the feeding habit of *N. japonicus* inhabiting different depths. Prawns, which were represented in 60.0% of the individuals in 6 - 10 m depth; were represented in only 5.9% of the specimens in 51 - 60 m depth : correspondingly, representation of cephalopod also decreased from 17.5 to 5.9%. On the other hand, crabs, which were not represented in the stomach of individuals from 6 - 10 m, were represented in 29.4% of the specimens in 51 - 60 m; correspondingly, fish representation also increased from 0.9 to 29.4%. Kuthalingam (1966) also recorded high percentage of prawns (40 - 50%) *Metapenaeus dobsoni* and *Parapenaeopsis stylifera* in the stomach of *N. japonicus* in shallow waters (10 - 30 m) off Vizhinjam and high percentage of fish remains (35 - 65%) in specimens from deeper waters (30 - 50 m). One of the following two reasons may influence *N. japonicus* inhabiting shallow waters to feed mostly on prawns and those in deeper waters to feed mostly on crabs and fishes : i) As abundance of prawn

TABLE 7. N. japonicus : *Number of specimens in different stomach conditions; figures in parentheses are percentage in each depth group*

Stomach condition	Depth (m)						
	6-10	11-20	21-30	31-40	41-50	51-60	Total
Empty	54 (42.5)	110 (42.3)	78 (30.6)	56 (53.3)	66 (93.0)	45 (64.3)	409 (46.1)
1/2 full	31 (24.4)	78 (30.0)	75 (29.4)	29 (27.6)	4 (5.6)	14 (20.0)	231 (26.0)
Full	30 (23.6)	59 (22.7)	97 (38.0)	20 (19.1)	0 (0.0)	11 (15.7)	217 (24.4)
Gorged	12 (9.4)	13 (5.0)	5 (2.0)	0 (0.0)	1 (1.4)	0 (0.0)	31 (3.5)
Total	127	260	255	105	71	70	888

is less in waters more than 30 m depth (Anon., 1981), *N. japonicus* inhabiting more than 30 m depth has only limited opportunity of encountering prawns. ii) Larger *N. japonicus* inhabits deeper waters and it is possible that the fish changes the feeding habit from prawn to crab/fish as it grows.

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REFERENCES

ANON. 1981. Industrial fisheries off Madras coast based on exploratory surveys during 1973 - 1980. *Mar. Fish. Infor. Serv., T & E Ser.*, 32 : 7 - 36.

KRISHNAMOORTHI, B. 1973. An assessment of *Nemipterus* fishery of Andhra - Orissa coasts based on exploratory fishing. *Proc. Symp. Living resources of the seas around India, Spl. Publ. CMFRI* : 495 - 516.

KUTHALINGAM, M. D. K. 1966. Notes on some aspects of the fishery and biology of *Nemipterus japonicus* (Bloch) with special reference to feeding behaviour. *Indian J. Fish.*, 12 : 500 - 506.

NARAYANAPPA, G., D. A. N. RAJU AND A. V. V. SATYANARAYANA 1968. Certain observations on the otter trawl operations carried out in the inshore and deeper waters off Kakinada. *Prog. Indo-Pacific Coun.*, 13 : 450 - 455.

PAULY, D. 1979. Theory and management of tropical multispecies stocks; a review, with emphasis on the southeast Asian demersal fisheries. *ICLARM Stud. Rev.*, 1 : 35 pp.

PAULY, D. 1983. Some simple methods for the assessment of tropical fish stocks. *FAO Fish. Tech. Pap.*, 234 : 52 p.

PAULY, D AND P. MARTOSUBROTO 1980. The population dynamics of *Nemipterus marginatus* (Cuv. & Val.) off Western Kalimantau, South China Sea. *J. Fish Biol.*, 17 : 263 - 273.

SAINSBURY, K. J. AND A. W. WHITELAW 1984. Biology of peron's threadfin bream *Nemipterus peronii* (Valenciennes) from the northwest shelf of

Australia. *Aust. J. mar. freshwat. Res.*, 35 : 167 - 185.

SATYANARAYANA, A. V. V., G. NARAYANAPPA AND D. A. N. RAJU 1972. On the comparative fishing experiments with a four-seam and a two-seam trawl on the east coast. *Fish Technol.*, 9 : 169 - 179.

SPARRE, P. 1988. Introduction to tropical fish stock assessment. FAO/DANIDA Project training in Fish Stock Assessment. GCP/INT/392/DEN. *Denmark Funds - in - Trust, Rome, FAO*, 655 pp.

VINCI, G. K. 1982. Threadfin bream (*Nemipterus*) resources along the Kerala coast with notes on biology of *Nemipterus japonicus*. *Indian J. Fish.*, 29 : 37 - 49.

VIVEKANANDAN, E. AND D. B. JAMES 1986. Population dynamics of *Nemipterus japonicus* (Bloch) in the trawling grounds off Madras. *Indian J. Fish.*, 33 : 145 - 154.

VIVEKANANDAN, E. AND B. KRISHNAMOORTHI 1985. Estimated resources of demersal fisheries off north Tamil Nadu - south Andhra coast based on exploratory surveys. *Proc. Symp. Harvest and Post-harvest technology of fish, Soc. Fish. Tech.*, 69 - 76.