OBSERVATIONS ON THE FISHERIES OF THREADFIN BREAMS (NEMIPTERIDAE) AND ON THE BIOLOGY OF *NEMIPTERUS JAPONICUS* (BLOCH) FROM KAKINADA

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ABSTRACT

Of the four species of threadfin breams occurring, *N. japonicus* is the most dominant at Kakinada. Peak landings are obtained during first and last quarters. There is significant difference in length-weight relationship of males and females. Peak values of Relative condition factor are associated with accumulation of fat. This species is a fractional spawner releasing the ripe ova in two batches during a protracted spawning season: August-April. The length at first maturity is estimated as 125 mm in females. The estimated fecundity ranges from 23049 to 139160 in fishes of 134-199 mm length; in this length range, there is linear relationship between length and fecundity and between weight and fecundity. Generally males outnumber females and attain larger length. *N. japonicus* attains 185 mm, 255 mm and 285 mm at the completion of the first, second and third years, respectively, at Kakinada. The various growth parameters are estimated as: L_∞ = 314 mm, K = 0.75142 and t_0 = −0.17309 years.

INTRODUCTION

Threadfin breams constitute an important portion of the demersal fish catches at Kakinada: an estimated 394 tonnes were landed by the trawlers during April 1968-December 1970, forming 9.7% of the total trawl catches (Muthu et al 1977). With increase in the fishing effort in recent years, the catches of these fishes increased considerably, though showed decline in 1978 and 1979. The present account deals with the fisheries of threadfin breams and biology of *N. Japonicus*.

MATERIAL AND METHODS

The study is based on data collected during 1976-1979. Estimates of monthly and annual effort and catches were made following Muthu et al (1977). Three types of boats were engaged in fishing in the area, using two-seam bottom trawl nets (see CMFRI 1981 for details). The effort (number of units) was standardised taking *Pomfret* (the total number of units of this boat is maximum in the fleet) as the standard unit, following the procedure of Gulland (1969). The catch rates (C/E) mentioned in this paper refer to catch per unit of standard effort.

Samples for the study were obtained at weekly intervals. Data on length,* weight, sex and stage of maturation were taken from fresh specimens. The length data obtained on each observation day were raised to the day's catch and these data were further raised to get monthly length composition of the catch. For the present study, these data were scaled down to percentages. The length-weight relationship and Relative condition factor were calculated following Le Cren (1951). Ova-diameter measurements were taken from formalin-preserved ovaries: small pieces from the middle of the ovaries were taken and all the ova in the piece were measured with the help of an ocular micrometer at a magnification where each micrometer division was equal to 0.019 mm, following the procedure of Clark (1934). Fecundity was estimated taking stage V ovaries.

FISHERIES

The catches of nemipterids were highest in 1977. In 1978 and 79 the catches were low, when both the effort (Table 1) and the catch rates were also in decline. The period from November to May was the season of abundance with peaks during January, March, May and December (fig. 1).

TABLE 1. *Estimated catches (kg), effort (standard units) and catch rates of Threadfin breams during* 1976-'79. (*Values in parantheses indicate percentage increase or decrease over each previous year*).

Particulars	1976	1977	1978	1979
Effort	33777	58450 (+73.0)	53645 (−8.2)	50125 (−6.6)
Catch	527767	1336945 (+153.3)	393361 (−70.6)	271386 (−31.0)
C/E	15.6	22.9	7.3	5.4

Four species of nemipterids contributed to the fishery. *N. japonicus* was the most dominant species contributing to over 50% (by weight) of nemipterid catches in most months, followed by *N. mesoprion*, *N. tolu* and *N. luteus* (Fig. 2). *N. mesoprion* formed a seasonal fishery, particularly during January-March. During certain years this species dominated over even *N. japonicus*. *N. tolu* occurred almost round the year, but in poor quantities. *N. luteus* was also represented by poor catches, but occurred in considerable quantities during January-March.

Determination of depthwise distribution of different species was not possible on the basis of the present data. According to Narayanappa et al (1968),

* Total length, measured from tip of snout to tip of lower caudal lobe.

Nemipterus spp. were predominent in depths beyond 50 m. The data on experimental trawling, by Satyanarayana et al (1972), also showed that threadfin breams were more abundant in the area beyond 50 m depth.

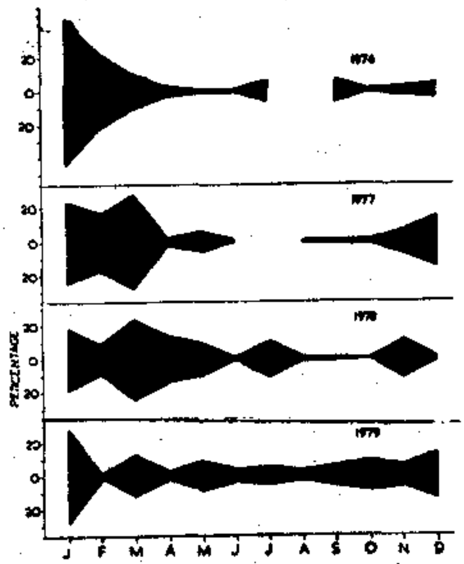

FIG. 1. Seasonal abundance of Threadfin breams during 1976-1979.

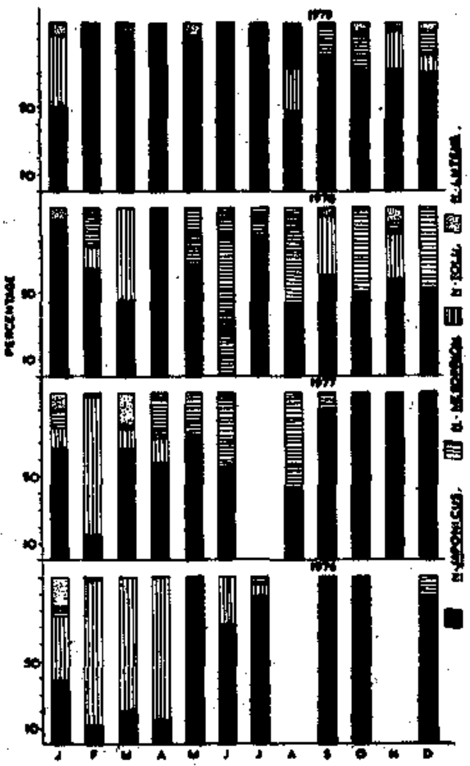

FIG. 2. Monthly percentage composition (by weight) of nemipterid species during 1976-1979.

Silas (1969) showed that, in the depth zone 75-100 m along the west coast, *N. japonicus* predominated in exploratory and experimental fishing operations, often forming 75% of the trawl catch. Zupanovic and Mohiuddin (1975) also reported similar abundance of this species in the 50-125 m depth zone along the northeastern Arabian sea.

BIOLOGY OF *Nemipterus japonicus*

Length-weight relationship

The study was based on 279 females ranging from 69 mm and 5 g to 218 mm and 139 g and 168 males ranging from 71 mm and 6 g to 251 mm and 184 g, collected during April 1976-March 1977. The relationship was calculated separately for the sexes and the equations obtained are:

Males: $\log W = -3.65045 + 2.43025 \log L$
Females: $\log W = -4.78737 + 2.95688 \log L$

The significance of difference between the Regression coefficients of sexes was tested by Analysis of covariance following Snedecor and Cochran (1967) (Table 2). The difference is significant at 5% level.

TABLE 2. *Comparison of Regression lines of length-weight relationship of males and females of* N. japonicus *from Kakinada.*

	Df	Σx^2	Σxy	Σy^2	Regression coefficient	Deviation from Regression Df	SS	MS
Within								
Males	167	2.77689	6.74856	20.03178	2.43025	166	3.63104	
Females	278	2.82427	8.35101	25.15722	2.95688	277	0.46435	
						443	4.09538	0.00924
Pooled	445	5.60116	15.09957	45.18900	2.69579	444	4.48368	
		Difference between slopes				1	0.38830	0.38830

Comparison of slopes: $F = 42.02$; Df = 1,443; Significant at 5% level.

Differences in length-weight relationship between sexes in nemipterid fishes are known; Eggleston (1970) recorded the difference in *N. virgatus* and Krishnamoorthi (1973) in the case of *N. japonicus* off Visakhapatnam. Vinci and Nair (1975) and Hoda (1981), however, did not find difference in the length-weight relationship of males and females of *N. japonicus* from Cochin on the west coast of India and from Pakistan coast, respectively.

Relative condition factor

The Relative condition factor (Kn) values of females were less than unity in January, April and June and more than unity in other months. In males, the values were more than unity in all the months. It was also observed that the Kn values of males were more than those of females in most months. Fat accumulation started in June, became heavy in August-October, and traces of it were present in November-December. During January-May there was no fat. The high Kn values in July-October (fig. 3) were thus due to fat accumulation.

For comparing the Kn values of different lengths, data of March-May 1977 only were considered, to eliminate any possible influence of different factors (e.g., maturation, fat accumulation, etc.) on Kn values. The Kn values of males up to 155 mm were less than those of females, but from 165 mm onward these values were more (fig. 4). In females, there was a peak at 75 mm, followed by a gradual fall till a minimum at 125 mm, increasing again to a peak at 145 mm; there was another fall at 165 mm and another peak at 195 mm.

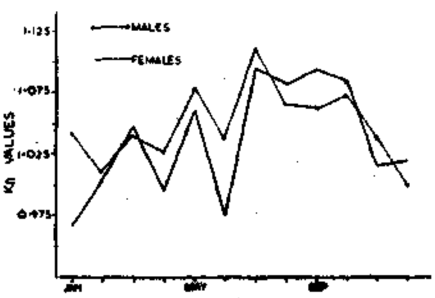

FIG. 3. Relative condition factor in *N. japonicus* in different months.

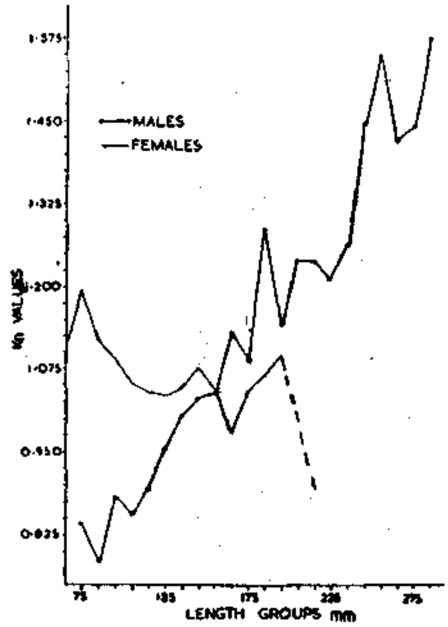

FIG. 4. Relative condition factor in *N. japonicus* in different length groups.

Maturation and spawning

Only females (1001 nos.) ranging from 65 to 215 mm in total length, collected during January 1977-December 1979, were considered for this study.

1. Stages of maturation: The following seven stages of maturation were recognised (arbitrarily) for females of *N. japonicus*,

Stage I (Immature): Ovary thin, narrow, cylindrical, occupying less than ¼ of body cavity length; pale translucent.

Stage II (maturing virgins): Ovary thin, narrow, cylindrical, occupying about ¼ of body cavity length, pale, translucent. Ova translucent, irregularly shaped, with slight yolk (spent-recovering adults were not encountered).

Stage III (maturing): Ovary occupies about ½ the length of the body cavity, narrow, cylindrical and pale yellow. Blood capillaries not distinct, ova not clearly visible to naked eye; larger ova are opaque and smaller ones are translucent.

Stage IV (mature): Similar to that in stage III but with numerous blood capillaries. Majority of the ova are opaque and are visible to naked eye.

Stage V (gravid): Ovary occupies about ¾ the length of the body cavity, whitish, with numerous blood capillaries, ovarian wall thin; ova spherical, opaque with narrow translucent outer border.

Stage VI (ripe): Ovary occupies from ¾ to entire length of the body cavity, cream-coloured. Ripe ova, which are translucent and with a distinct oil globule, are already released into the lumen of the ovary; along with these ova are several mature (opaque) and maturing (translucent) ova. (In several instances, the ovary extended to about half the length of body cavity, with a few ripe and a majority of opaque ova. Obviously the majority of ripe ova were released. Such ovaries were also included under stage VI.)

Stage VII: Completely spawned ovary was never encountered.

2. *Length at first maturity*: Only females in stages III-VI were taken as mature for this purpose. The data of August-April (spawning period) alone were considered. Fishes of 100 mm and above showed mature gonads and there was an increase in the number of mature fishes with increase in length. About 50% of the fish were mature at a length of 125 mm (fig. 5). Hence this length was taken as the length at first maturity at Kakinada. According to Krishnamoorthi (1973), the length at first maturity of females of *N. japonicus* off Waltair was 165 mm.

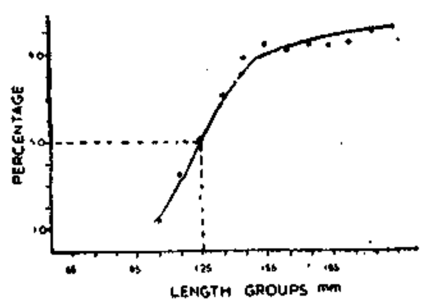

FIG. 5. Percentage-frequency distribution of mature females of *N. japonicus* in different length groups.

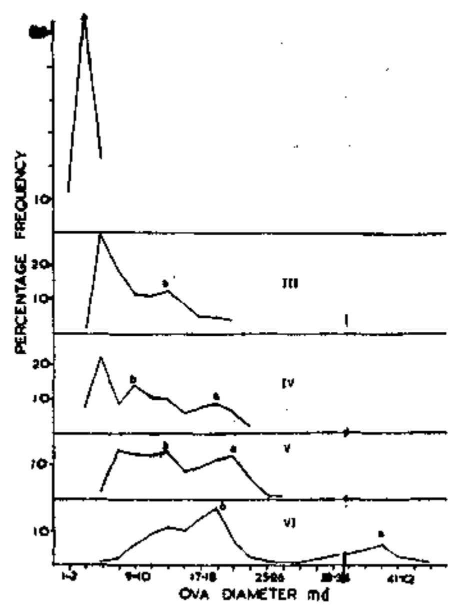

FIG. 6. Ova-diameter frequency distribution in ovaries of different stages of maturation in *N. Japonicus*.

3. *Spawning habits*: The ova were distributed around a modal value of 0.08 mm in stage II (fig. 6). In stage III, a batch of ova was released from the parent stock and formed a mode around 0.27 mm (mode 'a'). This mode progressed to 0.76 mm in stage VI. In stage IV, another batch of ova was released from the parent stock and it formed a mode around 0.19 mm (mode 'b'). This mode could be traced to 0.38 mm in stage VI. Two batches of ova were, thus, released from parent stock and underwent the process of maturation. While the ova at mode 'a' in stage VI were ripe and to be released, the ova at mode 'b' in stage VI were opaque and were yet to become ripe (figs. 6-7). Also the mode 'a' in stage V and mode 'b' in stage VI were more or less at the same diameter, indicating that the ova at mode 'b' in stage VI probably took the same

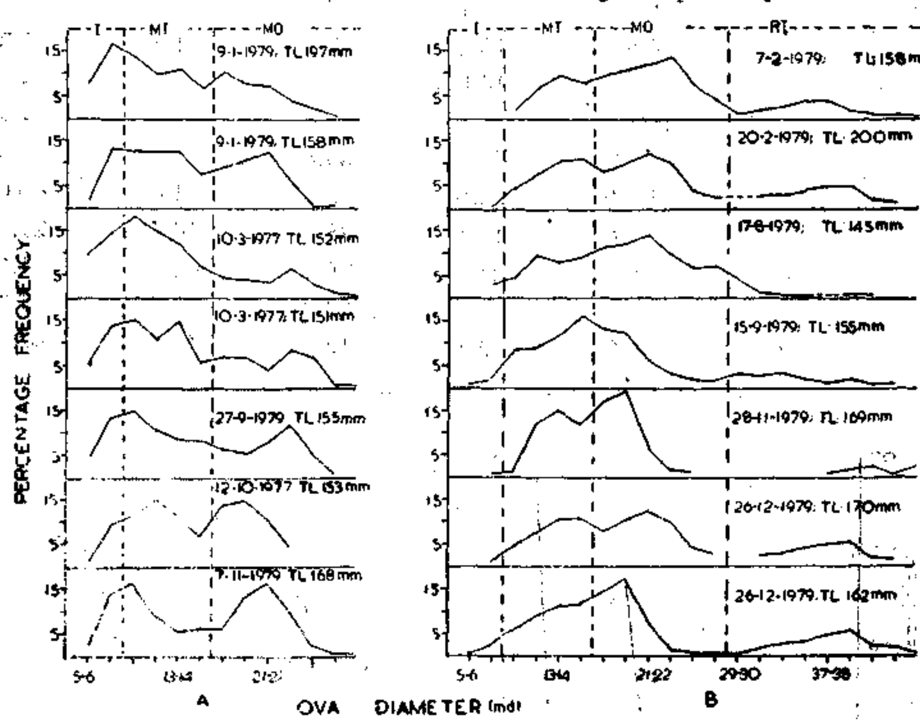

FIG. 7. Ova-diameter frequency distribution in (A) stage V and (B) stage VI ovaries collected during different months. Diameter ranges of Immature ova (I); Maturing translucent ova (MT); Mature opaque ova (MO), Ripe translucent ova with an oil globule (RT).

time to become ripe and spawned as the ova at mode 'a' in stage V. Thus, it appears that *N. japonicus* is a fractional spawner, releasing its ripe eggs in two batches during the spawning season. Eggleston (1973) and Dan (1980) have obtained similar results. The process of maturation also suggests that once the fish reaches stage VI and release the batch of ripe ova, it may revert to stage V and again undergo ripening and reach stage VI. This is possible, because

TABLE 4. *Maturing translucent ova and mature opaque ova in ovaries of stages VI and V in* N. japonicus *(percentages).*

Stage VI		Stage V	
Maturing-translucent ova	Mature-opaque ova	Maturing-translucent ova	Mature-opaque ova
46.8	53.2	55.8	44.2
30.3	69.7	54.6	45.4
45.3	54.7	69.9	30.1
48.5	51.5	58.5	41.5
39.2	60.8	53.2	46.8
34.1	65.9	50.4	49.6
41.5	58.5	42.5	57.5
Pooled			
40.8	59.2	54.6	45.4

Where F = total fecundity in thousand eggs, L = length in mm, and W = weight in grams. The Correlation coefficient (r) for both the equations are 0.83 and 0.92 respectively. According to Dan (1980) the average fecundity ranged from 13.9 to 58.4 thousand eggs in *N. japonicus*, with the range of 138 to 205 mm, from Waltair. The estimated fecundity for the first batch spawning in the present study agrees well with the fecundity estimates of Dan (1980)..

Sex ratio

Females outnumbered males in January, March and May-June 1977 and in January, March-July, September and November 1978 (Table 6). In 1979,

TABLE 5. *Estimated average batch fecundities and total fecundity in different length groups (cm) of* N. japonicus.

Average length (mm)	Average Wt. (g)	N	I Batch Average	II Batch Average	Average total fecundity
134*	32	1	10372*	12677*	23049*
146	44	5	25149	30738	55887
153	47	9	23064	28189	51253
163	59	5	30514	37294	67808
174	63	3	30152	36851	67003
183	79	5	35904	43883	79787
195	105	2	56064	68522	124586

* Actual values.

males outnumbered females in all months except August-December. The annual sex ratios, however, showed predominence of males in 1977 and 1979, whereas in 1978 the ratio was 1 : 1. A test of variance for homogeneity (Snedecor and Cochran 1967) of the sex ratio over a period of one year was applied for the data of the three years separately.

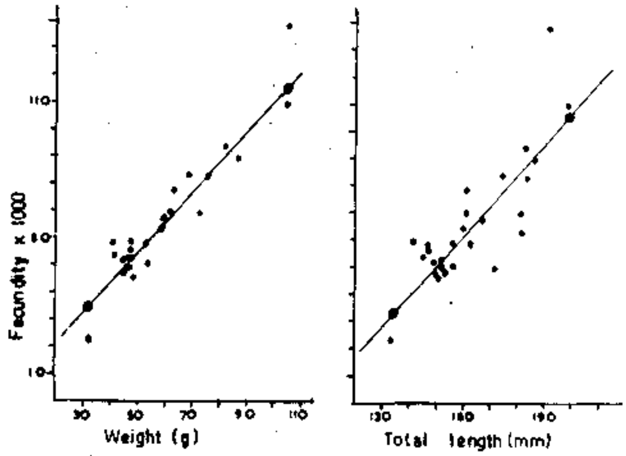

FIG. 9. Relation between fish weight and fecundity and between fish length and fecundity in *N. japonicus*.

At 5% probability level the X^2 values for 1977 and 1978 showed that the observed differences in the monthly sex ratios were statistically significant, whereas they were not significant for 1979. In this connection, it may be noted that data were not available for all 12 months in 1977 and 78.

The data on the sex ratio in relation to length (Table 7) showed that in most length groups males outnumbered females and females were not represented in groups beyond 215 mm. Also the mean length of males in the catches was always greater than that of females. The present observation therefore supports that of Krishnamoorthi (1979) off Waltair that females were generally smaller in siize than males and males grew quicker and to a larger size.

Age and growth

A total of 6654 specimens, ranging from 35 to 285 mm, were measured for age and growth during the years 1977-1979 (figs 10-12). Mode 'f' at 65 mm in January 1977 could be traced to 85 mm in February 77, with a growth rate of 20 mm per month (fig. 10). Mode 'a' at 75 mm in April 1977 could be traced continuously to the mode at 275 mm in May 1978; the mode at 75 mm in April 1977 showed a progression up to 115 mm in June (2 months) at a growth rate of 20 mm per month; the mode at 115 mm in June 1977

Table 6. N. japonicus: *Proportion of females and sex ratio in monthly samples during* 1977-1979.

	N	Females	Proportion of females	M:F ratio	χ^2 test
1977					
Jan	63	39	0.619	1.0:1.6	
Feb	23	13	0.565	1.0:1.3	
Mar	131	83	0.634	1.0:1.7	
Apr	99	39	0.394	1.0:0.7	
May	72	40	0.556	1.0:1.3	$\chi=59.524$
Jun	19	10	0.526	1.0:1.1	Df=9
Jul			— No data —		Significant
Aug	42	10	0.238	1.0:0.3	
Sep	92	27	0.293	1.0:0.4	
Oct	110	38	0.345	1.0:0.5	
Nov	85	26	0.306	1.0:0.4	
Dec			— No data —		
Pooled	736	325	0.442	1.0:0.8	
1978					
Jan	49	43	0.673	1.0:2.1	
Feb	43	19	0.442	1.0:0.8	
Mar	42	31	0.738	1.0:2.8	
Apr	144	55	0.382	1.0:0.6	
May	15	5	0.333	1.0:0.5	
Jun			— No data —		
Jul	84	46	0.548	1.0:1.2	
Aug	9	2	0.222	1.0:0.3	
Sep	25	14	0.560	1.0:1.3	Significant
Oct			— No data —		
Nov	131	72	0.550	1.0:1.2	
Dec	43	16	0.372	1.0:0.6	
Pooled	585	293	0.501	1.0:1.0	
1979					
Jan	93	39	0.419	1.0:0.7	
Feb	100	47	0.470	1.0:0.9	
Mar	120	56	0.467	1.0:0.9	
Apr	50	16	0.320	1.0:0.5	
May	47	20	0.426	1.0:0.7	
Jun	20	8	0.400	1.0:0.7	
Jul	24	11	0.458	1.0:0.8	
Aug	48	27	0.563	1.0:1.3	
Sep	83	38	0.458	1.0:0.8	
Oct	90	36	0.400	1.0:0.7	
Nov	53	14	0.264	1.0:0.4	
Dec	134	71	0.530	1.0:1.1	
Pooled	862	383	0.444	1.0:0.8	

TABLE 7. N. japonicus: *Sex ratio in relation to length.*

Length groups (mm)	1977 M	1977 F	1978 M	1978 F	1979 M	1979 F	pooled 1977-79 M	pooled 1977-79 F
65	—	1	—	—	—	—	—	1
75	2	2	1	3	—	—	3	5
85	9	7	9	7	4	5	22	19
95	14	15	16	15	11	12	41	42
105	18	29	21	25	34	31	73	85
115	32	39	34	41	48	40	114	120
125	23	37	39	37	44	51	106	125
135	27	58	24	48	40	37	91	143
145	57	52	25	35	43	50	125	137
155	42	34	32	47	33	59	107	140
165	55	22	13	23	33	51	101	96
175	47	8	18	4	31	26	96	38
185	20	11	16	2	35	12	71	25
195	22	6	14	5	22	7	58	18
205	23	1	16	—	27	1	66	2
215	6	3	8	1	22	1	36	5
225	2	—	3	—	34	—	39	—
235	6	—	1	—	9	—	16	—
245	1	—	2	—	5	—	8	—
255	2	—	—	—	1	—	3	—
265	1	—	—	—	3	—	4	—
275	1	—	—	—	—	—	1	—
285	1	—	—	—	—	—	1	—
N	411	325	292	293	479	383	1182	1001
mean length (mm)	155.34	135.74	145.75	133.46	160.05	141.40	154.88	137.24
Sex ratio	1.26 : 1.00		1:00 : 1.00		1.25 : 1.00		1.18 : 1.00	

could be traced to 145 mm in August 1977 (2 months), with an average growth rate of 15 mm per month. The mode at 145 mm in August 1977 could be traced to 165 mm in October (2 months), with a growth rate of 10 mm per month. From 165 mm in October 1977 the growth was not traceable but this could be connected to the mode at 205 mm in March 1978 (fig. 11) (5 months) with an average growth rate of 8 mm per month. The mode at 205 mm in March 1978 was traced to 215 mm in May (2 months), with an average growth rate of 5 mm per month; this mode was not further traceable but the mode 'b' at 205 mm in November 1978 could be traced to 235 mm in May 1979 (in 6 months) (figs. 11 & 12), with an average growth rate of 5 mm per month. Similarly, the mode 'e' at 215 mm in January 1977 (fig. 10) could be traced to 235 mm in May (4 months), with an average growth rate of 5 mm per month. The progression of this mode was not traceable further. The mode 'c' at 245 mm in October 1979 was traceable to 255 mm in December 1979

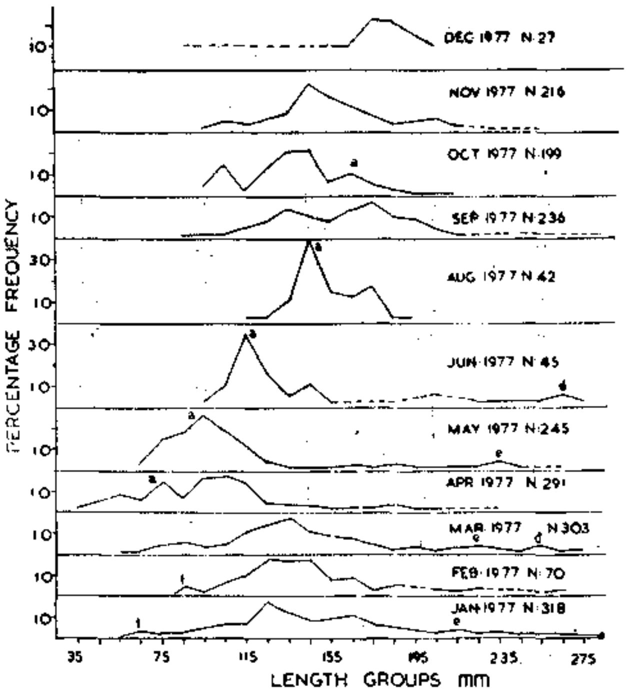

FIG. 10. Monthly length-frequency distribution of *N. japonicus* in 1977.

(2 months), with a monthly growth rate of 5 mm. Since the growth rate from 215 mm to 235 mm and from 245 mm to 255 mm was the same (5 mm| month), the same growth rate could be taken from 235 to 245 mm. The mode 'd' at 255 mm in March 1977 could be traced to 265 mm in June '77 (3 months), with an average growth rate of 3.3 mm per month.

Since the growth rates from 65 mm to 85 mm and from 75 mm to 115 mm were estimated at 20 mm per month, a still higher growth rate can be expected for fish up to 65 mm (the smallest modal length in the present study period was 65 mm, *vide* figs. 10-12) and an age of 3 months (at a growth rate of 21.7 mm per month) could be reasonably allotted to fish of 65 mm. On the basis of the estimated growth rates for different lengths, the lengths attained at different ages (months) are shown in figure 13A. The points on the graph are the modal lengths obtained from the data (figs. 10-12) and the curve indicates the authors interpretation of modal progression.

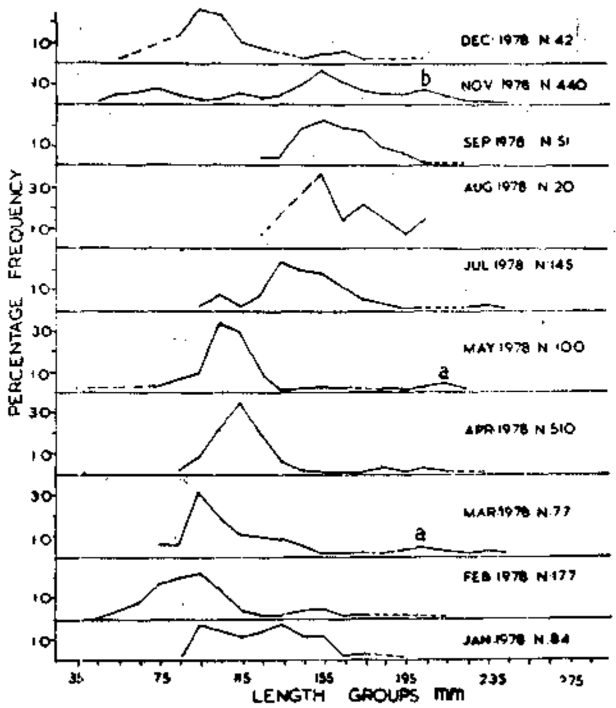

FIG. 11. Monthly length-frequency distribution of *N. japonicus* in 1978.

The von Bertalanffy equation for growth in length is of the form:

$$L_t = L\alpha\,(1-e^{-K\,(t-t_o)})$$

The Ford-Walford plot (Beverton and Holt 1957; Ford 1933; Walford 1946) on the basis of lengths attained at intervals of 6 months is shown in figure 14. It was observed that the points were well represented by a straight line. The asymptotic length ($L\alpha$) obtained in this study is 314 mm. The values of K and t_0 were estimated on annual basis from the relation:

$$\log_e(L\alpha - l_t) = (\log_e L\alpha + K\,t_o) - K_t$$

and the values obtained are K = 0.7514 and t_o = −0.1731 year (fig. 15). The von Bertalanffy growth equation for *N. japonicus* from Kakinada can be written as:

$$L_t = 314\ (1-e^{-0.7514\ (t+0.1731)})$$

The lengths at different ages, calculated from the above growth equation (figure 13b), show that *N. japonicus* attains 185, 225 and 285 mm at the completion of first, second and third years respectively. Since the maximum length obtained in this study was 285 mm, the fishable life span is 3 years.

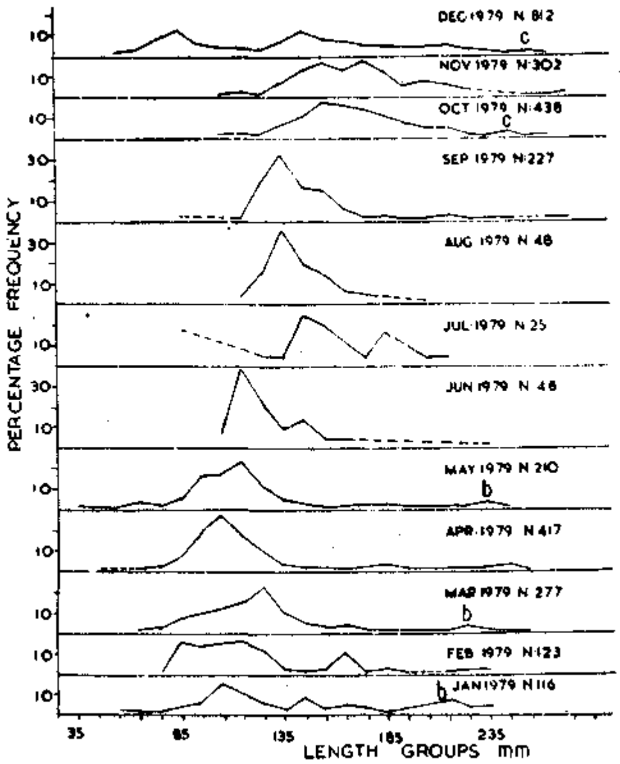

FIG 12. Monthly length-frequency distribution of *N. japonicus* in 1979.

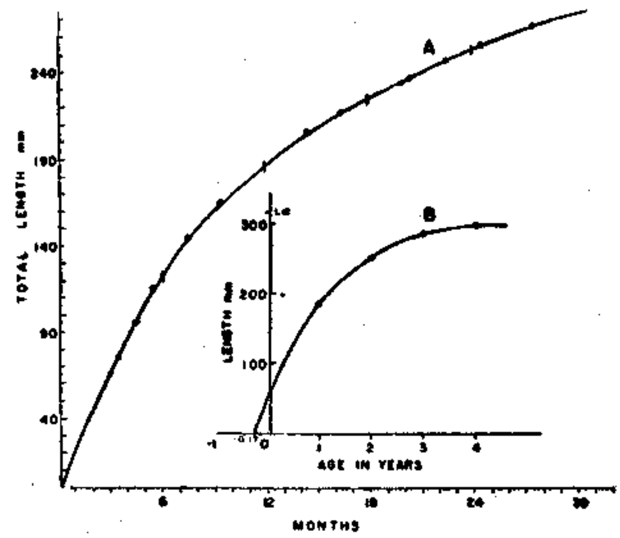

FIG. 13. A. Growth in length of *N. japonicus* on the basis of modal progression; B. Von-Bertalanffy growth curve.

According to Krishnamoorthi (1973) *N. japonicus* attains 150, 210 and 240 mm at the completion of first, second and third years, respectively, in the sea off Visakhapatnam. Ben Tuvia (1968) presented the length data of *N. japonicus* obtained during November-December 1957 from the Ethiopian coast and assumed that the modes obtained at 13 and 17 mm ac belonging to '0'

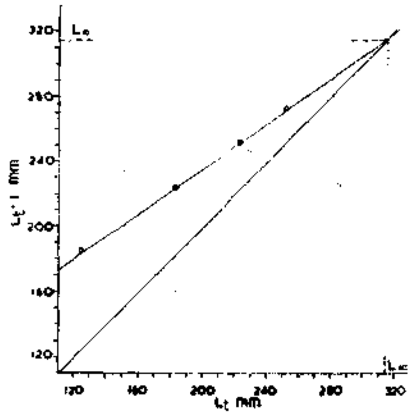

FIG. 14. Ford-Walford plot of growth of *N. japonicus*.

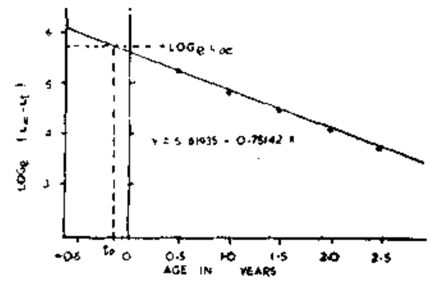

FIG. 15. Plot of $\log_e L_\alpha - L_t$ against 't' to determine 'to' graphically.

and 'I' age group respectively. Eggleston (1973) and Fischer and Whitehead (1974) observed differential growth rate in sexes of *N. japonicus*. In the present study it was observed that males attain longer length than females (*vide* section on sex ratio), but it was not possible to determine the age and growth of sexes separately by length-frequency method, in the absence of external sexual dimorphism in this species.

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