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OBSERVATIONS ON SOME ASPECTS OF BIOLOGY OF *ALEPES DJEDABA* (FORSSKAL) FROM COCHIN*

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ABSTRACT

This paper includes observations made on the Food, feeding habits, breeding biology, length-weight relationship and relative condition factor of *Alepes djedaba* for the period 1986-87.

The fish feeds mainly on young fishes (*Stolephorus* spp., *Cynoglossus* spp., *Leiognathus* spp.), crustaceans like decapods (*Acetes* spp., *Lucifer* spp.), ostrocods (*Conchaecia* spp.), amphipods and cladocerans (*Evadne* spp.) followed by nematodes, insect body parts and insect larvae. Higher percentage occurrence of empty stomachs and lower volume of food consumed during breeding season is indicative of reduced feeding activity during that period. Fish within a length range of 150-199 mm and 240-319 mm showed a preference for young fishes, while those in the length range of 200-239 mm relished for ostracods and other crustaceans.

The ova diameter studies indicated presence of batches of ova mature and maturing probably releasing in two batches during June to November. There is no significant difference in the length-weight regression coefficient in the two sexes. Hence, the length-weight relationship for both the sexes together is calculated : Log W = −5.308528 + 3.146849 Log. L. The size at first maturity in females is found to be 180-189 mm. Sex ratio showed predominance of males in most months.

INTRODUCTION

FISHES of the family Carangidae represented by a variety of species enjoy a very wide distribution in the entire shelf area of the Indian Seas. Being caught mainly in trawls, gill nets, purse seines and hook and line, this group forms upto 3.87% of the total marine fish landings of India (Bal and Rao, 1984). High potential of this multispecies resource has been estimated by exploratory fishing from the shelf waters.

Alepes djedaba (Forsskal) forms a major component of the Carangid fishery resources in India contributing upto 18% of the groups catch in the drift gill nets. At Cochin, the species formed 43.1% of the carangids caught in the same gear during 1986-87. Despite its economic importance, no earnest attempt has hitherto been made to study the biology of this species, though allied species like *Megalaspis cordyla* (Sreenivasan, 1974, 1978), *Decapterus dayi* (Sreenivasan, 1981 a, b, 1982) and *Caranx kalla* (Kagwade, 1968 a, b) had been studied for their biological aspects. Information regarding the biology of *A. djedaba* is confined to observations made by Mahadevan (1950). The present work is therefore envisaged to study the various biological aspects of *A. djedaba* from Cochin area.

The author is grateful to Dr. P.S.B.R. James, Director, C.M.F.R.I. and to Shri S. Reuben for the encouragement during the course of this work. Thanks are also due to Shri M. Karthikeyan for the help in Statistical interpretations and to Shri J. Narayanaswami for the help rendered in collecting the data.

MATERIAL AND METHODS

The samples for the study were drawn every week from the gillnet and trawl catches of

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Cochin Fisheries Harbour during July 1986-June 1987. They were measured for their total length and weight in the fresh condition. Their sex, stages of maturity and relative fullness of the stomach were noted.

Gut contents from 238 specimens were analysed qualitatively and quantitatively, the latter by occurrence method (Hartley, 1948 ; Hynes, 1950), where the occurrence of stomachs with each food item was computed as percentage of total number of stomachs examined. The fish examined were grouped into 10 mm length intervals to determine the selectivity of food, if any in different size groups. Monthly average volume of the food in the stomach was also noted using displacement method. Feeding intensity was assessed by noting the state of distention of the stomach and the quantity of food contained in it.

The gonads of 127 males and 117 females (155-315 mm) were examined to study the maturity stage of the species. The stages of maturity of gonads were determined following the method adopted by Sreenivasan (1981) which is in agreement with the scale adopted by International Council for Exploration of Sea (Lovern and Wood, 1937). Percentage occurrence of gonads in various maturity stages was recorded every month. From each maturity stage of the ovary, 500 ova were measured to trace the ova diameter frequencies (Clark, 1934). Females collected during the breeding season were pooled into 10 mm size groups and the percentage of immature, maturing and mature females were noted. The Gonadosomatic Index was determined separately in four size groups *viz.* size-group I (151-200 mm), size group II (201-250 mm), size group III (251-300 mm) and size group IV (301-350 mm) for every month using the formula :

$$\frac{\text{Wt of gonad}}{\text{Wt of body}} \times 100$$

The length-weight relationship was calculated by the method of least squares based on the formula : $\text{Log } W = \text{Log } a + n \text{ Log } L$, where W = weight of the fish in gm, L = Length in mm, a = a constant and n = an exponent. The relative condition factor (Kn) was derived by employing the formula : $Kn = W/\hat{W}$ (LeCren, 1951), where W = observed individual weight and $\hat{W}$ = calculated weight obtained from the length-weight relationship for each fish.

Observations

Food and feeding habits

Qualitative and quantitative analyses of food items : It could be seen from Table 1 that the species fed mainly on fish juveniles (*Cynoglossus* spp., *Stolephorus* spp., *Leiognathus* spp.) from January to June. Crustaceans which formed the major food during July to November were represented by ostracods (*Conchoecia* spp.) decapods (*Acetes* spp.), *Lucifer* spp., amphipods (*Hyperia* spp.), cladocerans (*Evadna* sp.) and Stomatopods (Alima larvae). Insect (Order Diptera) food was mostly in a semi-digested condition. Algae represented by *Oscillatoria* sp. and *Lyngbya* sp. were rare. Digested matter also formed a good percentage in a number of stomachs analysed.

Food preference in relation to different size groups : A. djedaba within the size—ranges of 150-199 mm and 240-319 mm showed a preference for young fishes (Table 1). This food item occurred in almost all the guts analysed in the younger size groups upto 169 mm while in the advanced size-groups (290-299 mm), they occurred in about 83% of the stomachs examined. On the other hand, those in the size range of 200-239 mm, were found relishing more on crustacean diet, where the occurrence of stomachs with ostracods was upto 47% and those with amphipods formed 37% of the stomachs analysed. Insects, though

TABLE 1. *Percentage occurrence of stomachs with different food items in different size groups of* A. djedaba

Size-group mm	No. examined with food	Food items											
		Fish	Decapods	Ostracods	Amphipods	Other Crustaceans	Alima larvae	Cladocerans	Nematodes	Insect body parts	Algae	Detritus	Digested matter
150-159	1	100											
160-169	2	100	—	50.00	—	50	—	—	—	—	—	—	100.00
170-179	6	50	16.67	16.67	—	—	—	—	16.67	—	—	—	50.00
180-189	8	50	12.50	—	—	12.50	—	—	12.50	—	—	—	62.00
190-199	10	50	—	20.00	20.00	10.00	—	—	—	—	—	—	30.00
200-209	22	9.09	31.82	45.45	9.09	9.09	9.09	—	4.55	—	—	—	45.46
210-219	32	12.50	15.63	46.88	6.25	18.75	9.38	—	3.13	—	—	—	71.89
220-229	26	30.77	3.85	30.77	11.54	34.62	—	—	—	—	—	—	38.46
230-239	19	15.79	—	10.55	36.34	21.05	—	—	—	—	—	—	52.63
240-249	5	60.00	—	20.00	—	—	—	—	—	—	—	—	60.00
250-259	14	78.57	28.57	14.29	14.29	—	—	—	—	—	—	—	35.71
260-269	13	61.54	—	—	—	15.38	—	—	7.69	—	7.69	—	53.85
270-279	16	68.75	12.50	—	—	12.50	—	—	18.75	6.25	—	—	31.26
280-289	19	73.68	21.05	10.52	—	10.52	—	5.26	—	—	—	—	15.79
290-299	6	83.33	—	—	—	16.67	—	—	—	—	—	—	16.67
300-309	4	50.00	—	—	—	50.00	—	—	—	25.0	—	50.0	50.00
310-319	2	100.00	—	—	—	—	—	—	—	—	—	—	50.00

TABLE 2. *Monthly fluctuations in the intensity of food of* A. djedaba *during July* 1986-*June* 1987

Months	No. of Stomachs examined	No. of stomachs with food	% condition of stomachs						
			Empty	trace	1/4Full	1/2Full	3/4Full	Full	Gorged
July 1986	31	27	12.9	22.55	25.78	6.44	12.89	19.33	—
August	25	18	28.0	44.0	8.0	8.0	4.0	4.0	4.0
September	40	33	17.5	22.5	17.5	25.0	7.5	2.50	7.5
October	30	23	23.33	16.67	26.67	26.67	—	6.67	—
November	13	12	7.69	23.07	46.14	15.38	—	—	7.69
December			No data						
January 1987	12	12	—	—	16.66	50.00	8.33	25.00	—
February	13	13	—	23.08	7.69	23.08	—	46.14	—
March	18	18	—	—	5.56	16.67	5.56	55.60	16.67
April	25	25	—	28.0	4.0	20.00	—	48.0	—
May	15	12	20.0	—	26.67	19.98	—	33.33	—
June	16	12	25.0	—	43.75	12.50	12.50	6.25	—

rarely encountered were noticed in the diet of the advanced size groups alone.

Condition of feed : With a view to ascertaining the degree of feeding, stomachs examined in the course of the study were grouped into empty, trace, 1/4 full, 1/2 full, 3/4 full, full and gorged and the percentages obtained are given in Table 2. Empty stomachs were found occurring from May to November. Fish with stomachs in full condition were predominant during January to May.

Volume of feed : Monthly average displacement volume of the feed alongwith the percentage of empty stomachs is depicted in Fig. 1. It could be seen that volume of food ranges from 0.258 ml to 1.45 ml during June to November increasing thereafter to 4.79 ml from January to May.

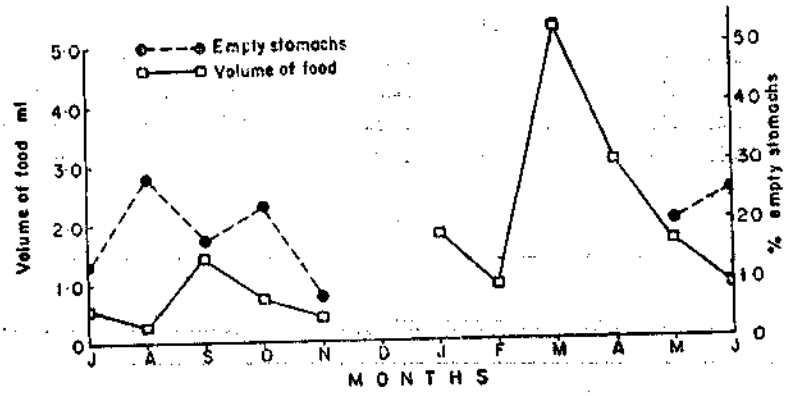

Fig. 1. Monthly percentage of empty stomachs with volume of food in *Alepes djedaba*.

Breeding biology

Maturity stages — Stage I immature : Ovary thin, pinkish ova transparent with the diameter ranging upto 90μ; testis thin, cylindrical and tapering anteriorly.

Stage II Maturing/recovering spent : Ovary opaque, slightly enlarged, with one group of ova having yolk deposition started. Ova diameter ranging upto 210 μ; testis slightly enlarged, occupying 1/3 of the body cavity; ovaries in the spent recovering stage were pale reddish and had only immature stock of ova with the diameter ranging upto 180μ; testis in this stage were not observed.

Stage III Maturing : Ovary enlarged and light yellowish, ova visible to the naked eye, with two groups of yolked ova differentiated, ova diameter ranging upto 390 μ; testis thick, pale whitish occupying 1/2 of the space of the body cavity.

Stage IV Mature : Ovaries much enlarged and yellowish with ova diameter upto 450 μ; testis whitish distended occupying 3/4 of the body cavity.

Stage V Ripe : Ovary bright yellowish, almost filling the entire body cavity, eggs measuring upto 480μ; testis whitish, enlarged occupying the entire body cavity.

Stage VI Spawning : Ovary deep yellowish with eggs extending on slight pressure, diameter of ripe ova ranging upto 750 μ. Single large oil globule ranges in diameter from 120 to 210 μ; testis identical with that of stage V.

Stage VII Spent : Ovary blood shot, flaccid and was in partialy spent (VII a) and fully spent (VII b) condition. In stage VII a, the

ovary had a mature batch of ova with a diameter range upto 540 μ and with a few residual eggs of diameter upto 690 μ. In stage VII b, only a few residual eggs measuring upto 480 μ diameter were present in addition to the maturing and the immature stock; testis shrunken and withered, dull whitish occupying about 1/2 of the space of the body cavity.

Size at maturity: The size-wise percentage of mature females is depicted in Fig. 2. It

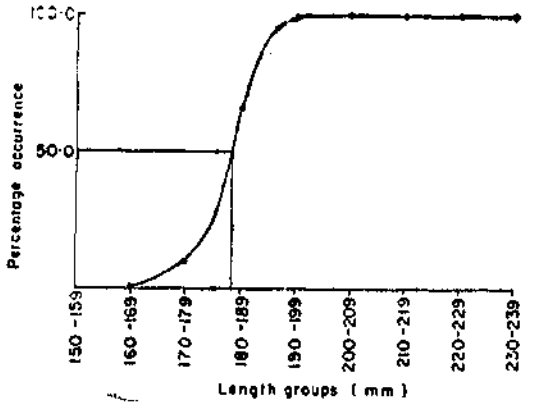

Fig. 2. Length at first maturity in *A. djedaba*.

may be seen that until 199 mm length, mature individuals showed progressive increase in their occurrence. From 200 mm and above, all were in the mature condition. Since 66.6% of the specimens examined in 180-189 mm group were in the mature gonadal condition and since the smallest mature female measured 183 mm, it may be inferred that *A. djedaba* matures at a length of 180-189 mm.

Development of ova: The ova diameter frequency polygons in ovaries of successive maturity stages are given in Fig. 3. In stage I, there is only one batch of ova, with the mode at 60 μ. In stage II, a gradual growth of ova is evident with the mode shifting to 90 μ. The largest ovum measured 210 μ. As development progresses in stage III, this mode at 90 μ gets shifted to 300 μ, while formation of two other batches of ova is discernible with modes at 120 μ and 180 μ. In stage IV, the maturing batch of ova further moves forming a mode at 360 μ. Here only one secondary batch of ova with a mode at 150 μ is obvious which probably would have shifted from the mode at 120 μ in stage III. Evidently, the other secondary mode at 180 μ in stage III would have got merged with the developing batch of eggs in stage IV. In stage V; the mode of the largest group of eggs has shifted to 390 μ, with the secondary batch forming a well defined mode at 240 μ. In stage VI, the ripe ova form a mode at 630 μ and have become transparent and highly enlarged in size. The secondary batch of ova in this stage gets further shifted to a mode at 390 μ. In stage VII a, the ripe batch of ova is replaced by a few residual eggs, while the secondary batch of ova develop further to form a mode at 450 μ, with two tertiary modes formed at 240 μ and 330 μ. In stage VII b, only one tertiary batch of eggs is discernible, with the other batch probably getting released along with the secondary batch of eggs as in stage IV.

It may be noted that there are two batches of maturing ova with adjacent modes at 390 μ and 240 μ in stage V. These two groups of ova are found shifted to successive modes at 630 μ and 390 μ respectively in stage VI. Since these two batches together form not less than half of the total percentage of the intraovarian eggs (Prabhu, 1956; Karekar and Bal, 1960) and also because of the occurrence of only a small mode in stage VII b, of the ovary, it may clearly be concluded that the two batches of eggs are released one after another during the same spawning season.

Spawning season: The frequency distribution of gonads in various maturity stages of the females and males in different months is presented in Fig. 4. In females, gonads in stages I to III were available during January to May. They were in stages III to V in June,

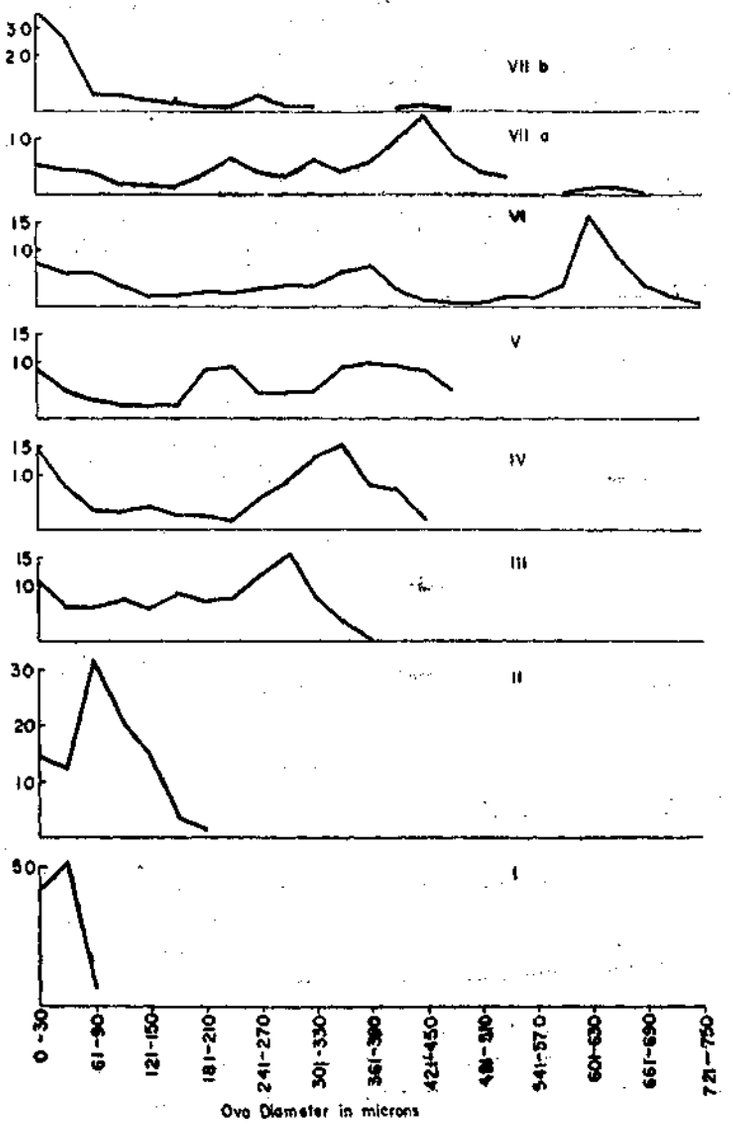

Fig. 3. Ova diameter frequency distribution in ovaries of different maturity stages in *A. djedaba*.

when upto 50% of the samples examined were in stage IV and 24% in stage V. Mature females were also encountered in February, when they formed 50% of the samples. Gonads in stages I and V to VII were obtained in July. They were in spent and recovering stages during August to November, the former stage constituting upto 70% in September.

In males, testis was in stages I to III during January to April and in stages II to IV during May-June period. Males with gonads in stages V to VII were encountered during July to November with some of them in the immature stages also during this period.

Since the occurrence of gonads in spent stage

is during July to November with a peak in September and since the incidence of spawners is from July to October with the peak in August, it may be concluded that this species in this area has a prolonged breeding season extending from July to November releasing two batches of eggs during the spawning period.

0.133 in January. In size-group II, higher values upto 5.22 were obtained during July to October, decreasing thereafter to a minimum of 0.31 in March. The index was high in size group III also during July-October with a maximum of 8.68 in August. Size group IV was not well represented in both the sexes.

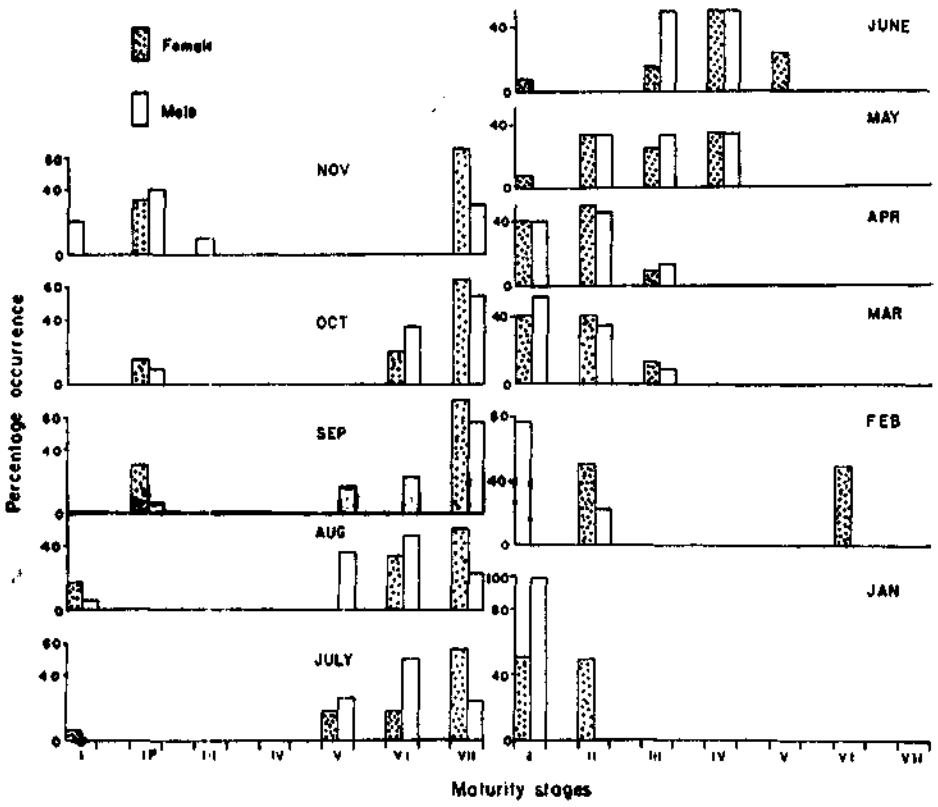

Fig. 4. Monthly percentage occurrence of gonads of different maturity stages in *A. djedaba*.

Gonado-somatic Index : In females, the GSI in size group I was 1.72 in July and 0.26 in March. In size group II, the values reached upto 3.70 in July and 2.04 in November, but declining thereafter to 0.312 in April. In size group III, the values were high during July to October and also in February (Fig. 5).

In males, the GSI in size-group I ranged upto 3.75 in August with the lowest value of

Sex ratio : Males outnumbered females during all the months except during October, January, May and June.

Length-weight relationship

The length-weight relationship was studied based on 127 males ranging in length from 160-308 mm and in weight from 38-335 gm and 106 females within a length range of 155-315 mm and weight range of 39-320 gm. The

equation arrived at for males and females are :

Males : Log W = −5.190187+3.095861 Log L
(r = 0.948406)

Females : Log W = −5.400013+3.186501 Log L
(r = 0.970127).

The data subjected to analysis of covariance (Snedocor, 1961) showed that there is no significant difference in the 'n' values (calculated

It is obvious from Fig. 7 that the kn values follow almost a similar trend in both the sexes where higher values are discernible during July to November and again from March to June, with lower values encountered during February and April.

It is seen that in females, the value declined from size-group 150-159 mm to 160-169 mm thereafter increasing gradually reaching a peak

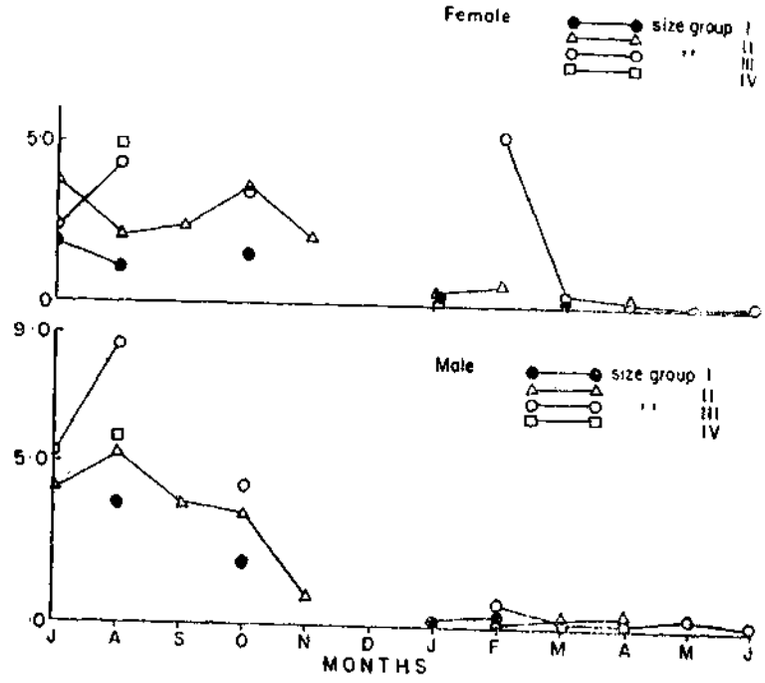

Fig. 5. Monthly Gonado-Somatic Index in different size groups of *A. djedaba* (Size group I = 151-200 mm, II = 201-250 mm, III = 251-300 mm, IV = 301-350 mm)

F ratio = 0.5657215 on 1,229) (Table 3 and 4). Therefore a common equation was fitted for both the sexes together as :

Log W = −5.308528 + 3.146849 Log L
(r = 0.960654)

Relative condition factor (*kn*) : The kn factor calculated for individual fish was added up and the average for each month and each length-group of 10 mm interval was obtained for males and females.

at 180-189 mm, which may be corroborated with attainment of maturity in this size - group (Fig. 8). Another peak in the kn value is discernible in size-group 270-279 mm when the species may be maturing for a second time during its life span. In males, however, no such correlation was noticed.

Discussion

Qasim (1973) stated that the spawning of fishes largely occurs during the monsoon and

TABLE 3. *Analysis of covariance of male and female* A. djedaba

groups of specimens	d.f. (n—1)	Σy^2	Σx^2	Σxy	$b=\frac{\Sigma xy}{\Sigma x^2}$	Reg. SS $b\Sigma xy$	Deviation from SS $\Sigma y^2 - b\Sigma xy$	d—f (n—2)
Males ..	126	4.4814577	0.4205766	1.302047	3.095861	4.030956	0.4505017	125
Females ..	105	5.8354403	0.5408827	1.723523	3.186501	5.492008	0.343423	104
				Individual regression Total			0.7939247	229
Pooled (within)	231	10.3168980	0.961460	3.025570	3.146849	9.521012	0.7958860	230

TABLE 4. *Test of significance of equality of regression coefficients*

Source of variation	d—f	SS	M.S.	Cal. F.	Inference
Average Regression ..	230	0.7958860	0.0034603		
Individual regression ..	229	0.7939247	0.0034669	0.5657215	Not significant at 5% level of significance
Deviation ..	1	0.0019613	0.0019613		

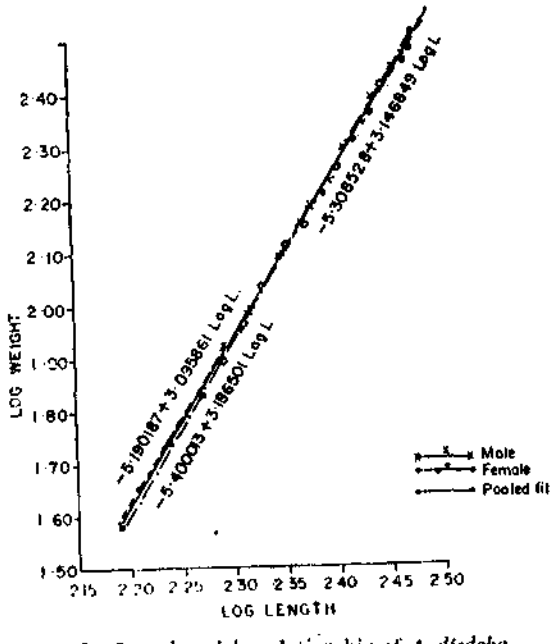

Fig. 6. Length-weight relationship of *A. djedaba*.

postmonsoon months along the west coast According to David Raj and Ramamirtham (1981) the peak in zooplankton biomass occurring during the peak monsoon months can attract fish and subsequent spawning can be enhanced. A close scrutiny of the food habits of *A. djedaba* in the present case shows that it feeds mainly on zooplankton with preference to crustaceans like ostracods which forms upto 42% of the diet during September. In their observations on the abundance of zooplankton along the southwest coast of India, Menon and George (1977) have recorded that ostracods were mainly distributed in the Cochin-Ratnagiri shelf are a and were observed to be common during June-October period with occasional swarming. Further, though fish juveniles formed one of the preferred food items of *A. djedaba*, they were found relished as second priority item only, during July to November, in spite

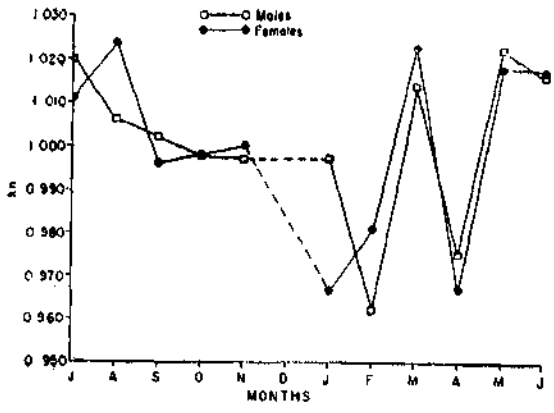

Fig. 7. Monthly Kn values in *A. djedaba*.

of their fair abundance during the period (Menon and George, 1977), thereby showing a significant correlation between the occurrence of ostracod swarms and the fishery of *A. djedaba*. Similar relationship between the abundance of *Acetes indicus* and the related fishery has been discussed in an allied carangid species like *Megalaspis cordyla* in the Kovalam Bay, Madras (Thangavelu *et al.*, 1987).

An evaluation of the food preference of *A. djedaba* in relation to different size-groups shows that those belonging to size group 150-199 mm and 240-319 mm were preferring fish juveniles, while those in the size-groups of 200-239 mm were found relishing ostracods and other crustaceans. One of the possible explanations for this kind of food selectivity is that feeding habits may change as the fish grows and this as suggested by Hartley (1948) can be a major method by which fish avoids direct competitive clashes for food. Further, since the size groups preferring plankton are in the mature condition, it may be inferred that the zooplankton with rich oil content (Subrahmanyan and Gupta, 1963) serves as a source of lipid required for ovarian maturation. This view is substantiated by the statement of Venkataraman and Chari (1953) that zooplankton along the west coast is richer in oil content than that of east coast.

The feeding intensity of the species also denotes certain noteworthy features. A comparison of the average volume of food with

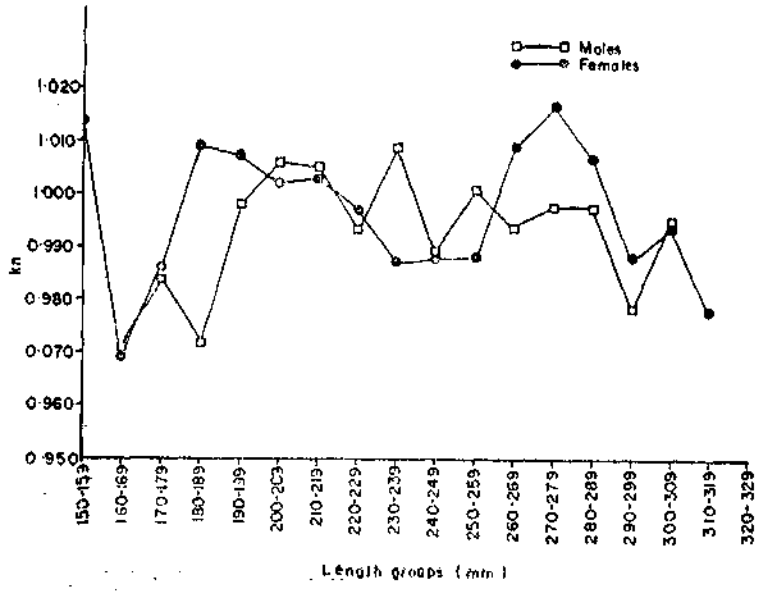

Fig. 8. Kn values in different size groups in *A. djedaba*.

the stomachs in various degrees of fullness showed reduced feeding activity in the species during breeding season as is evidenced by the lower volume of feed coupled with higher percentage of empty stomachs. On the other hand, the higher percentage of empty stomachs in the actively fed condition during the period from January to May is suggestive of the species to have actively fed during the post-spawning season.

The Gonado-Somatic Index in males is found to be higher than that in females during the breeding season. Generally among fishes, females invest more energy in gonadal development. Nevertheless, in pelagic spawners, the eggs being smaller in size, the males have to produce enormous quantities of sperms in order to assure fertilisation. Therefore gonadal investment between sexes is most nearly equal in fishes that are pelagic spawners (Moyle, 1982). This can be attributed to be a possible reason for the increased GSI observed in males of *A. djedaba*—a pelagic schooling species. Another probable explanation may be the differentiation in maturation in different size groups. In specimens of size group II and III (200 mm to 300 mm), which have already spawned once, the recovery may be faster adding more gonad weight than those which attain maturity for the first time as is also observed by Pantalu (1961) and Chakraborty and Singh (1963). However, the lesser GSI observed in females in the present study especially during the breeding season may also be due to the higher percentage (50-79%) of partially spent ovaries examined.

Alterations in the general conditions of fish can be due to changes in gonad cycle and even the state of fullness of the alimentary canal may influence (Weatherly, 1972). This statement holds good in the present case also since the kn factorindicates a closer correlation with the spawning cycle and to a lesser extent with the feeding activity. While the higher kn values obtained during July and August may be attributed to the increased gonad weight associated with maturation, similar values observed during March, May and June with lesser GSI values may be due to the increased feeding activity and this can be substantiated by the higher percentage of stomachs (72%) in the actively fed condition during this period.

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