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FOOD AND FEEDING HABITS OF THE STREAKED SEER, *SCOMBEROMORUS LINEOLATUS* (CUVIER AND VALENCIENNES), IN THE GULF OF MANNAR AND PALK BAY

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ABSTRACT

Adult streaked seer feeds almost exclusively on smaller pelagics of which sardines are the most important, while the juveniles of < 200 mm length feed predominantly on the whitebaits and sometimes on the sciaenids and *Saurida*. The total food spectrum is limited to only about five food items. This species is intermediate between the kingseer and the spotted seer in its predatory habits, but like the latter, does not chase baits fast enough to be caught in trolls. The stock of streaked seer, however is much less than that of either of the other two species in the study areas. Feeding is active around 7 p.m. and between about 5 and 9 a.m. Competition between fish < 800 mm length and fish > 800 mm length was obvious in 1968-69 when there was a shortfall in forage abundance. Food intake and utilisation do not show definite evidence of the prevalence of spawning stress. The *K*-line shows that food intake maintains the streaked seer within the normal biokinetic range as the spotted seer and the kingseer, but the *T*-line suggests low levels of metabolic expenditure per unit time and also conditions of stress.

INTRODUCTION

THE FIRST contribution briefly reporting the food of the juveniles and adults of the streaked seer in the Indian seas is that of Kuthalingam (1959) for the Madras zone. Venkataraman (1960) gave a brief account of the food of juvenile streaked seer from Calicut on the west coast. Srinivasa Rao (1964) made a volumetric analysis of the food of juvenile streaked seer from Waltair on the east coast. The observations by Williams (1964) on the diet of the East African kanadi which he considered to be *S. lineolatus*, actually relate to *S.plurilineatus* Fourmanoir (1966) as shown by van der Elst and Collette (1984). The present account on the feeding biology of the streaked seer is based on limited material sampled from Palk Bay and the Gulf of Mannar during 1967-69.

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MATERIAL AND METHODS

The study is based on the stomach contents of 368 streaked seer including 110 fish from Palk Bay (zone I) and 258 from the northern Gulf of Mannar (zone II) sampled twice or thrice a week from July, 1967 to July, 1969 from the commercial catches landed by drift gillnets and shore seines in the Rameswaram Island and nearby localities. The methods of analysis of the gut contents and the treatment of the data are similar to those adopted in the study of the kingseer (Devaraj, MS-1).

RESULTS

Food composition

The food of streaked seer exclusively comprised of fish. The stomach contents of 368 fish amounted to 1,397 ml comprising 85.21% *Sardinella*, 11.94% *Anchoviella*, 1.01% *Selar* and 0.37% *Leiognathus*, besides 0.60% unidentified fishes ('fishes') and 0.87% digested matter. The total frequencies of occurrence (282) included 47.5% *Sardinella*, 34% *Anchoviella*, 1.7% *Leiognathus* and 0.3% *Selar*, besides 2.8% 'fishes' and 13.4% fully digested matter. Unlike the observations on other two species of seerfish (Devaraj, MS-1 & 2), the occurrence of *Anchoviella* was remarkably frequent in the streaked seer. By the indices of preponderance (IP) *Sardinella* ranked first (68.5) and *Anchoviella* second (30.4). Other items were quite insignificant (Table 1).

Zonal variations

There was no significant difference between Palk Bay and the Gulf of Mannar in the composition of diet.

The food items in 110 fish from Palk Bay in 1967-69 amounted to 336.2 ml in 84 occurrences. Although *Sardinella* formed a larger portion (81.6%) than *Anchoviella* (11.8%) in volume, frequency of the former (42.5%) was almost equal to that of the latter (40.4%), and hence, despite *Sardinella* ranking first by volume, occurrence and IP (57.0%) (Table 2), was lower than the high values attained in the diet of the kingseer and the spotted seer.

The stomach contents of 175 fish from the Gulf of Mannar in 1967-'68 amounted to 852.5 ml, mainly comprising *Sardinella* (87.1%) and *Anchoviella* (11.9%), their occurrences

TABLE 1. *Food composition of streaked seer from Palk Bay (zone I) and the northern Gulf of Mannar (zone II) during 1967-'69*

Food items	Volume (V) (ml)	Volume (V) (%)	Rank	Frequency occurrence (o) Actual	Frequency occurrence (o) (%)	Rank	Index of preponderance (P) %	Index of preponderance (P) Rank
Sardinella	1190.3	85.21	1	134	47.55	1	68.57	1
Anchoviella	166.8	11.94	2	96	34.03	2	30.45	2
Selar	14	1.01	3	1	0.35	6	0.03	5
Leiognathus	5.3	0.37	6	5	1.77	5	0.09	3
'Fishes'	8.5	0.6	5	8	2.83	4	0.02	6
Digested matter	12.1	0.87	4	38	13.47	3	0.04	4

TABLE 2. *IP of organisms during different months for zone I (1967-'69)*

Months	Aug. 1967	Sep.	Oct.	Dec.	May 1968	June	July	Aug.	Oct.	May 1969	Total	Rank
No. of fish examined	10	28	15	2	29	12	3	5	3	3	110	
Food items,												
Sardinella	78.1	99.6	80.3	31.2	2.3	85.6	0	0	96.7	96	57	1
Anchoviella	21.9	0.1	19.7	12.5	97.7	0	57.1	0	3.3	0	21	2
Selar	0	0	0	43.8	0	0	0	0	0	0	4.4	4
'Fishes'	0	0.3	0	12.5	0	0	0	0	0	0	1.3	5
Digested matter	0	0	0	0	0	14.4	42.9	100	0	4	16.1	
Total	100	100	100	100	100	100	100	100	100	100	100	

being 56% and 32.2% respectively. By IP, *Sardinella* ranked first (72.4%), *Anchoviella* second (25%), 'fishes' fourth (0.09%) and *Leiognathus* fifth (0.01%). 8.6% of stomachs contained only digested matter (Table 3a). In 1968-'69 the stomach contents of 83 fish amounted to 208.3 ml, frequencies of occurrence being 61. *Sardinella* and *Anchoviella* formed the major food items while *Leiognathus* was insignificant as an item of food. 27.8% of fish showed only digested matter (Table 3b).

Seasonal variations

In Palk Bay *Sardinella* was dominant in the diet in all months except in December, 1967 and May, 1968, but absent in July and August 1968 and *Anchoviella* was much less significant when sardines were abundant (September, 1967 and October, 1968), but increased in August and October, 1967 when *Sardinella* declined slightly and became very prominent in May and July, 1968 at the sudden decline or abundance of *Sardinella*. The only instance that *Anchoviella* did not compensate for the shortfall of *Sardinella* in the diet was in December, 1968, when *Selar* accounted for 44% of IP. *Selar* did not form the food in any other month (Table 2).

In the Gulf of Mannar *Sardinella* was comparatively less in the diet in May, June and August of 1967-68, but abundant in all other months. *Sardinella* constituted the only food item in September, November and February. *Anchoviella* was observed in October and from April to August, especially in the diet of the juveniles. The low level of *Sardinella* in May, June and August was compensated by *Anchoviella*. *Leiognathus* occurred only in October. In 1968-69 *Sardinella* contributed quite significantly to the diet for seven months but

TABLE 3a. *IP of organisms according to months for zone II (1967-'68)*

Months	Sep.	Oct.	Nov.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Total	Rank
No. of fish examined	4	21	23	3	7	36	60	4	3	14	175	
Food items												
1. *Sardinella*	100.0	93.7	100.0	100.0	93.3	99.7	8.4	33.3	83.3	6.2	72.4	1
2. *Anchoviella*	0.0	6.2	0.0	0.0	0.0	0.1	88.8	44.5	16.7	93.6	25.0	2
3. *Leiognathus*	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5
4. 'Fishes'	0.0	0.0	0.0	0.0	0.7	0.2	0.0	0.0	0.0	0.0	0.1	4
5. Digested matter	0.0	0.0	0.0	0.0	0.0	0.0	2.8	22.2	0.0	0.2	2.5	3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

TABLE 3b. *IP of organisms according to months for zone II (1968-'69)*

Months	Sep.	Oct.	Nov.	Dec.	Jan.	Mar.	Apr.	May	Total	Rank
No. of fish examined	1	11	6	6	8	18	14	19	83	
Food items										
1. *Sardinella*	0.0	52.3	93.9	50.0	100.0	92.7	92.7	21.5	62.9	1
2. *Anchoviella*	100.0	31.2	0.0	0.0	0.0	0.0	6.8	61.0	24.9	2
3. *Leiognathus*	0.0	0.0	0.0	0.0	0.0	0.0	0.2	17.5	2.2	4
4. Digested matter	0.0	16.5	6.1	50.0	0.0	7.3	0.3	0.0	10.0	3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	

was absent in September and comparatively less in the other months; in October, December, April and May. *Anchoviella* was dominant during September and October when *Sardinella* was absent or less abundant. It was absent from November to March. but appeared, especially juveniles, again in April-May. *Leiognathus* formed part of the diet of the juveniles in April-May alone (Table 4). The period of low abundance of sardines in the diet in the first year was generally different from that in the second year.

Food variations according to size of fish

Anchoviella was the only item of food of young fish upto 120 mm length and continued to dominate the diet of fish upto 280 mm length in which *Sardinella* either played a very minor role or was absent. In the 281-320 mm group there was a sharp decline in *Anchoviella* but a steep rise in *Sardinella.* In all larger length groups, *Sardinella* dominated the diet, while *Anchoviella* was much less except in the 441-480 mm, 481-520 mm and 561-600 mm groups. *Selar* was taken by only one fish in the 681-720 mm length group and *Leiognathus* by fish of 161-200 mm and 681-720 mm groups (Table 4).

Variation in average ration (R)

In zones I-II, R (= ration per one active feeding period) declined from 4.1 ml in 1967-'68 to 2.8 ml in 1968-'69. During the former period, R ranged from 0.8 ml in May and July to 17.4 ml in February. It remained at less than 5.3 ml during April to September,

TABLE 4. *IP of organisms according to length groups for Zone I and Zone II combined for 1967-'69*

Length group	No. of fish examined	*Sardinella*	*Anchoviella*	*Selar*	*Leiognathus*	Fishes	Digested matter	Total
41-80	6	0.0	100.0	0.0	0.0	0.0	0.0	100.0
81-120	14	0.0	100.0	0.0	0.0	0.0	0.0	100.0
121-160	34	0.2	99.5	0.0	0.0	0.0	0.3	100.0
161-200	34	0.0	96.6	0.0	0.6	0.0	2.8	100.0
201-240	22	8.8	86.5	0.0	0.0	0.0	4.7	100.0
241-280	6	6.4	92.7	0.0	0.0	0.0	0.9	100.0
281-320	2	60.0	40.0	0.0	0.0	0.0	0.0	100.0
321-360	1	100.0	0.0	0.0	0.0	0.0	0.0	100.0
401-440	8	98.8	0.6	0.0	0.0	0.0	0.6	100.0
441-480	14	74.7	24.1	0.0	0.0	0.0	1.2	100.0
481-520	26	64.0	34.4	0.0	0.0	0.2	0.8	100.0
521-560	31	97.3	2.6	0.0	0.0	0.1	0.0	100.0
561-600	21	88.7	11.1	0.0	0.0	0.2	0.0	100.0
601-640	21	93.2	5.9	0.9	0.0	0.0	0.0	100.0
641-680	45	99.5	0.1	0.0	0.0	0.0	0.4	100.0
681-720	16	97.7	0.6	0.0	1.4	0.3	0.0	100.0
721-760	11	99.9	0.0	0.0	0.0	0.0	0.1	100.0
761-800	10	97.6	1.1	0.0	0.0	0.0	1.3	100.0
801-840	7	95.1	0.0	0.0	0.0	0.0	4.9	100.0
841-880	20	98.7	0.0	0.0	0.0	0.0	1.3	100.0
881-920	6	95.7	4.1	0.0	0.0	0.0	0.4	100.0
921-960	5	100.0	0.0	0.0	0.0	0.0	0.0	100.0
961-1000	4	100.0	0.0	0.0	0.0	0.0	0.0	100.0
Total	368	68.6	30.5	0.0	0.1	0.0	0.0	100.0

but over 8.0 ml during October to March. During the second year, *R* ranged from 1.1 ml in May to 7.8 ml in January, and there were no definite periods of high and low rations (Table 5).

Ration did not increase very steadily with increase in fish size, especially in the second year. In 1967-'68, *R* for fish less than 520 mm in length was less than 4.5 ml and more than 4.5 ml for fish > 521 mm in length except the 801-840 mm group (3.66 ml). Both the years, the 921-960 mm group received the maximum ration, 20 ml in the first year and 46 ml in the second year (Table 6).

TABLE 5. *Volume of food, average ration, and ration per 1000 g body weight for Zones I and II during 1967-'69*

1967-68 Months	Mean weight of fish	No. of fish examined	Total	Average ration (R)	Body weight (R1)
Aug.	515.1	10	50.5	3.1	6.0
Sep.	805.9	32	163.0	5.3	6.5
Oct.	1482.7	36	297.6	8.5	5.7
Nov.	2000.0	23	305.5	13.2	6.6
Dec.	1009.4	2	32.0	8.0	7.9
Feb.	1528.0	3	34.8	17.4	11.3
Mar.	1500.0	7	48.3	12.1	8.0
Apr.	1285.7	36	67.7	4.8	3.7
May	150.0	89	42.5	0.8	5.3
Jun.	931.0	16	42.3	4.2	4.5
Jul.	1333.3	6	4.6	0.8	0.6
1968-69 Months					
Aug.	758.1	19	62.0	4.1	5.4
Sep.	1000.8	1	3.0	3.0	3.0
Oct.	1586.2	14	59.8	5.9	3.7
Nov.	3500.0	6	16.5	4.1	1.1
Dec.	2500.0	6	10.0	2.1	0.8
Jan.	3011.4	8	39.5	7.8	2.5
Mar.	2285.7	18	20.5	1.8	0.7

Effect of maturation of feeding

The values of *R* for the males increased from the immature (1st year = 6.0 ml; 2nd year = 3.5 ml) to the intermediate (1st year = 12.7 ml, 2nd year = 5.7 ml), declined in the maturing (1st year = 5.9 ml; 2nd year 1.5 ml), and shot up to a very high level in the ripe stage (1st year = 18.8 ml; 2nd year = 28.0 ml). The spent males consumed very little (2nd year = 1.2 ml). Among the females, *R* attained maximum values in the maturing stage (1st year = 19.5 ml; 2nd year = 8.7 ml). Values of *R* for ripe fish were comparatively smaller (1st year = 5.8 ml; 2nd year = 1.8 ml). The rise in the value of *R* to 6.8 ml at the spent stage seems to indicate resumption of normal feeding after spawning (Table 7).

In general, *R*1 decreased with increase in fish size (Table 7), and since immature fish are comparatively smaller than fish of other maturity catagories, *R*1 could not be a criterion in evaluating the effects of progress of maturity on food intake. However, *R*1 for the ripe male was notably high in both the years (11 ml) in the first year and (6.8 ml) in the second year (Table 8).

Condition of feed and feeding periodicity

In 1967-'68, more than 25% of the fish were in well fed condition from September to

TABLE 6. *Total volume of food, average ration (R) and ration per 1,000 g body weight (R1) in ml according to length groups from Zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-68 and 1968-69*

	A. 1967-68.					B. 1968-69			
Length groups (mm)	Mean weight of fish (g)	No. of fish examined	Total	R	R1	No. of fish examined	Total	R	R1
41-80	2.2	4	0.3	0.07	31.8	2	0.0	0.00	0.0
81-120	5.6	7	2.1	0.30	53.5	7	0.5	0.07	12.5
121-160	13.0	27	10.7	0.39	30.0	7	2.0	0.25	19.2
161-200	28.8	28	7.6	0.27	9.3	6	1.5	0.26	9.0
201-240	52.7	22	5.7	0.25	4.7	0	0.0	0.00	0.0
241-280	75.0	6	5.1	0.85	11.3	0	0.0	0.00	0.0
281-320	120.0	2	5.0	2.50	20.8	0	0.0	0.00	0.0
321-360	180.0	1	4.5	4.50	25.0	0	0.0	0.00	0.0
361-400	266.0	4	0.5	0.12	0.4	0	0.0	0.00	0.0
401-440	382.8	8	13.9	1.73	4.5	0	0.0	0.00	0.0
441-480	483.9	13	32.5	2.50	5.1	1	0.3	0.30	0.6
481-520	628.4	13	55.9	4.30	6.8	13	53.6	4.10	6.5
521-560	809.8	25	143.7	5.74	7.0	6	8.3	1.38	1.7
561-600	992.7	16	134.8	8.42	8.4	5	40.0	8.00	8.6
601-640	1222.8	17	127.5	7.50	6.1	4	23.7	5.92	4.8
641-680	1437.3	30	174.1	5.80	4.0	15	12.7	0.84	0.5
681-720	1710.8	8	84.4	10.55	6.1	8	15.2	1.90	1.1
721-760	2018.6	4	44.4	11.10	0.5	7	22.5	3.21	1.5
761-800	2393.8	3	23.2	7.73	3.2	7	14.5	2.08	0.8
801-840	2537.6	6	20.0	3.66	1.4	1	0.5	0.50	0.1
841-880	4016.7	7	84.0	12.00	2.9	13	36.0	2.76	0.6
881-920	4055.5	2	16.0	8.00	1.9	4	28.5	7.12	1.7
921-960	4127.5	4	79.0	19.75	4.7	1	46.0	46.00	11.1
961-1000	4353.3	3	14.2	4.73	1.0	1	2.0	2.00	0.5
Combined		260	1089.1	4.10	4.7	108	307.8	2.80	1.8

TABLE 7. *Volume of R, R1 according to stages of maturity for Zones I and II during 1967-'68*

A. Male	Immature		Intermediate		Maturing		Ripe	
Length group	R	R1	R	R1	R	R1	R	R1
321-360	3.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0
361-400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
401-440	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0
441-480	2.3	4.8	0.0	0.0	0.0	0.0	0.0	0.0
481-520	2.4	3.8	0.0	0.0	0.0	0.0	0.0	0.0
521-560	4.4	5.5	9.2	11.3	0.0	0.0	0.0	0.0
561-600	8.6	8.7	5.5	5.5	0.0	0.0	0.0	0.0
601-640	12.0	9.8	3.0	2.5	0.0	0.0	0.0	0.0
641-680	15.0	10.4	5.8	4.0	2.7	1.9	0.0	0.0
681-720	0.0	0.0	5.0	2.9	3.8	2.2	18.8	11.0
721-760	0.0	0.0	37.0	18.3	0.0	0.0	0.0	0.0
761-800	0.0	0.0	23.0	9.6	0.0	0.0	0.0	0.0
801-840	0.0	0.0	13.0	5.1	0.0	0.0	0.0	0.0
841-880	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
881-920	0.0	0.0	0.0	0.0	3.0	0.7	0.0	0.0
921-960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
961-1000	0.0	0.0	0.0	0.0	14.0	3.2	0.0	0.0
Combined	6.0	6.3	12.7	7.4	5.9	2.0	18.8	11.0
B. Female								
321-360	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
361-400	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
401-440	3.4	8.9	0.0	0.0	0.0	0.0	0.0	0.0
441-480	0.8	1.7	4.5	9.3	0.0	0.0	0.0	0.0
481-520	1.9	3.0	8.1	12.9	0.0	0.0	0.0	0.0
521-560	2.3	2.9	3.6	4.5	0.0	0.0	0.0	0.0
561-600	0.0	0.0	8.1	8.2	0.0	0.0	0.0	0.0
601-640	15.0	12.3	7.8	6.4	0.0	0.0	0.0	0.0
641-680	17.5	12.2	0.0	0.0	0.0	0.0	0.0	0.0
681-720	7.0	4.1	5.2	3.0	0.0	0.0	6.5	3.8
721-760	0.0	0.0	0.3	0.1	0.0	0.0	5.0	2.5
761-800	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0
801-840	0.0	0.0	1.1	0.2	0.0	0.0	0.0	0.0
841-880	0.0	0.0	9.0	2.2	24.0	6.0	0.0	0.0
881-920	0.0	0.0	13.0	3.2	0.0	0.0	0.0	0.0
921-960	0.0	0.0	21.3	5.2	15.0	3.6	0.0	0.0
961-1000	0.0	0.0	0.3	0.1	0.0	0.0	0.0	0.0
Combined	6.8	6.4	6.4	4.3	19.5	4.8	5.8	3.2

TABLE 8. *Average ration (R), and ration per 1000 g body weight (R1) in ml according to maturity stages in Zones I and II during 1968-'69*

A. Male Length group	Immature		Intermediate		maturing		Ripe		Spent	
	R	R1	R	R1	R	R1	R	R1	R	R1
441-480	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
481-520	4.7	6.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
521-560	0.0	0.0	5.0	6.2	0.0	0.0	0.0	0.0	0.0	0.0
561-600	2.0	2.0	5.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0
601-640	6.8	5.5	1.5	1.2	0.0	0.0	0.0	0.0	0.0	0.0
641-680	0.5	0.3	8.0	5.6	0.9	0.7	0.0	0.0	0.0	0.0
681-720	0.0	0.0	0.6	0.4	0.8	0.4	0.0	0.0	1.0	0.6
721-760	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0
761-800	0.0	0.0	0.0	0.0	0.3	0.1	0.0	0.0	2.0	0.8
801-840	0.0	0.0	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0
841-880	0.0	0.0	8.0	2.0	0.0	0.0	10.0	2.2	0.5	0.1
881-920	0.0	0.0	0.0	0.0	5.0	1.2	0.0	0.0	0.0	0.0
921-960	0.0	0.0	0.0	0.0	0.0	0.0	46.0	11.1	0.0	0.0
961-1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Combined	3.5	3.6	5.7	2.9	1.5	0.5	28.0	6.8	1.2	0.5
B. Female										
441-480	0.3	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
481-520	3.8	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
521-560	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
561-600	3.0	3.0	14.5	14.6	0.0	0.0	0.0	0.0	0.0	0.0
601-640	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
641-680	2.5	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
681-720	0.0	0.0	7.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0
721-760	0.0	0.0	10.7	5.3	0.3	0.1	0.0	0.0	0.0	0.0
761-800	0.0	0.0	0.0	0.0	2.9	1.2	0.0	0.0	0.0	0.0
801-840	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
841-880	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.4	6.8	1.7
881-920	0.0	0.0	0.1	0.1	23.0	5.7	0.0	0.0	0.0	0.0
921-960	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
961-1000	0.0	0.0	0.0	0.0	2.0	0.5	0.0	0.0	0.0	0.0
Combined	2.4	2.8	8.2	6.0	8.7	1.9	1.8	0.4	6.8	1.7

April (26.1 to 66.7%), but less than 25% from May to August. Well fed and partly fed fish together formed well over 60% in most of the months. In 1968-'69, well fed fish alone formed 36 to 43% during October, January and April falling within the period of best feeding in the previous year, but remained at 16 to 22% in other months. Well fed and partly fed categories together accounted for over 60% except in November, December and May (Table 9). In this year more than 25% fish were in well fed condition in only three groups below 800 mm, but were well fed in all the three groups above 800 mm. This difference may be attributed to competition between larger (> 800 mm) and smaller (< 800 mm) fish perhaps owing to the decline in the abundance of forage in 1968-'69.

Streaked seer less than 320 mm in length were normally caught in shore seines operated during the period 5 a.m. to 10 a.m. In 1967-'68, nearly 50% of fish in the shore seine samples were found well fed or partly fed, the rest being poorly fed and a few starving fish. In 1968-'69, out of 22 fish less than 320 mm in length caught in shore seines, only one was found partly fed and others poorly fed. Among fish larger than 320 mm in length taken largely from the first haul of the drift nets operated from 6.30 p.m. to 10.00 p.m., well fed and partly fed fish accounted for over 65% in most of the length groups. None of the few fish examined from the second haul (fishing time 10 p.m. to 4 a.m.) were found to be well fed or partly fed. These observations suggest that the streaked seer may feed actively around 7 p.m. and also during 5 a.m. to 9 a.m.

Mode of seizure of prey

61.5% of the prey (mostly sardines) were found oriented in the anteroposterior axis of

TABLE 9. *Condition of feed of fish sampled in different months from Zones I (Palk Bay)and II (northern Gulf of Mannar) during 1967-'68 and 1968-'69*

Months (1967-'68)		Aug.	Sep.	Oct.	Nov.	Dec.	Feb.	Mar.	Apr.	May	June	July	Combined
Well fed	No.	2	13	11	6	1	2	2	11	20	2	1	71
	%	20	40.6	30.6	26.1	50	66.7	28.5	30.6	22.4	12.5	16.7	27.4
Partly fed	No.	5	8	12	12	0	1	2	16	22	6	3	87
	%	50	25	33.4	52.2	0	33.3	28.5	44.5	24.7	37.5	50	33.4
Poorly fed	No.	2	5	7	4	0	0	1	2	22	6	1	50
	%	20	15.7	19.4	17.3	0	0	14.5	5.5	24.7	37.5	16.7	19.2
Starving	No.	1	6	6	1	1	0	2	7	25	2	1	52
	%	10	18.7	16.6	4.4	50	0	28.5	19.4	28.2	12.5	16.7	20
Total	No.	10	32	36	23	2	3	7	36	89	16	6	260

Months (1968-'69)		Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Mar.	Apr.	May	Combined
Well fed	No.	3	0	5	0	1	3	4	6	0	22
	%	15.8	0	35.7	0	16.5	37.5	22.3	42.8	0	20.4
Partly fed	No.	10	1	5	2	0	3	8	6	11	46
	%	52.6	100	35.7	33.3	0	37.5	44.5	42.8	50	42.6
Poorly fed	No.	3	0	3	4	5	2	3	1	11	32
	%	15.8	0	21.4	66.7	83.5	25	16.6	7.2	50	29.6
Starving	No.	3	0	1	0	0	0	3	1	0	8
	%	15.8	0	7.2	0	0	0	16.6	7.2	0	7.4
Total	No.	19	1	14	6	6	8	18	14	22	108

the predator (indicating active chasing and seizure of the prey from behind) and 38.5% in the reverse axis of the predator. Thus, in the nature of predation, the streaked seer resemble greatly the kingseer. 100% reverse orientation of prey organisms was noticed in March and June, 87.5% in January and 75% in December, while anteroposterior orientation dominated in all other months. Out of the 17 length groups studied, 100% reverse orientation was observed in fish belonging to the 41-80 mm, 681-720 mm and 721-760 mm groups. Reverse orientation dominated in the 81-120 mm (60%), 601-640 mm (62.4%), 761-800 mm (75) and 881-920 mm (75%) groups also. In all other length groups, there was a predominance of anteroposterior orientation which attained 100% level in the 310-360 mm, 441-480 mm and 921-960 mm groups.

Food intake and utilisation

Since the male and female streaked seer differ from each other in their growth characteristics (Devaraj, 1981), food intake and utilisation are dealt with separately for the sexes. Annual ration according to age in years was estimated in wet weight from the average ration in ml per active feeding (*R*), the frequency of active feeding per day (two) and the density of the gut contents (1.25) as in the case of the kingseer (Table 10). The regression of wet weight of annual ration in grams (<u>$R\Delta t$</u>) on wet weight of fish in grams (*W*) according to age in years (Table 13) is fitted to be,

for males : $\log R\Delta t = 1.0396 + 0.8339 \log W$ .....(1)

for females : $\log R\Delta t = 2.5566 + 0.3558 \log W$ ....(2)

The <u>T</u>-line (Table 13) is fitted by,

for males : $\log T = 0.8398 + 0.8665 \log W$ = ...(3)

for females : $\log T = 2.6712 + 0.2859 \log W$ = ...(4)

and the <u>K</u>-line (Table 13).

for males : $\ln K = 1.2725 - 0.00005588\, R$....(5)

for females : $\ln K = -1.4791 - 0.00001762\, R$ .....(6)

Since the y-axis intercept in Eq. (4) for the females is an extremely unrealistic value, estimation of *R* by averaging the individual observations according to age groups (Table 10), as followed in the case of the kingseer and the spotted seer, is perhaps less realistic. $R\Delta t$ has been estimated through a regression of daily ration on mean weight ignoring difference in the growth rates between sexes as

$\log R = 1.2233 + 0.6030 \log n$ (Table 11)

$R\Delta t$ for different ages and related parameters are in table T and K lines have been consequently reestimated by using $R\Delta t$ estimated as above. Thus,

$\ln R\Delta t = 4.0279 + 0.5023 \ln w$ ....(8)

$\ln T = 3.3442 + 0.4958 \ln w$......(9)

$\ln K = -0.6468 - 0.00000649\, R\, \Delta t$...(10)

The equation (8) and (10) seem to be relatively realistic. Y intercept in the equation of T-line and consequently p value ($=e^{3.3442} = 28.3$) seems to be quite unrealistic eventhough the slope of the line (=0.4958) seems to be well below 0.8, characterising non-stress normal conditions of growth. The weight growth for age in years estimated by the cumulative weight increment ($\Sigma \Delta W$)

method is significantly different from the von Bertalanffy estimate (Table 13). However, the margin of difference of such estimates for ages 2 to 5 is around 22% only. In fact, the observed mean weights of streaked seer of size greater than 841 mm (i.e., 3 + and 4 year old) are much higher (>4000 g; Table 11) which compare well with estimates arrived at by both the methods for the 4 year old fish Table (13). Hence it may be surmised that the method of estimating weight by cumulating the annual increments is not at much variance with VB method at least for fish in exploited phase.

TABLE 10. *Empirical lengths in mm (L), weights in g (W), ration per one active feeding period in ml(R) annual R in g, conversion factor (C), gross growth efficiency (K), and annual total metabolic rating (T) according to age in years (t) and sex increments in brackets. M = male; F = female.*

	L		W (dWt		R		R dt		C		K		T	
t	M	F	M	F	M	F	M	F	M	F	M	F	M	F
1	414	440	356	419	1.56	3.40	1506	3103	4.2	7.4	0.24	0.14	1150	2682
			(356)	(416)	(1.56)	(3.40)								
2	621	648	1192	1422	5.17	6.25	4718	5703	5.6	5.7	0.18	0.18	3882	4700
			(836)	(1003)	(3.61)	(2.85)								
3	786	820	2435	2876	7.39	4.21	6743	3842	5.4	2.6	0.18	0.38	5500	2388
			(1243)	(1454)	(2.22)	(-2.04)								
4	918	964	3965	4667	5.71	10.57	5210	9645	3.4	5.4	0.29	0.19	3680	7854
			(1530)	(1791)	(-1.68)	(6.36)								
5	1024	1084	5493	6663	30	0	27375	0	17.9	0	0.06	0	25847	0
			(1528)	(1996)	(24.29)									

DISCUSSION

The streaked seer exhibits considerable similarity in their food spectrum with the spotted seer as both feed on a limited range of about five food items, but the mainstay of the food of the streaked seer is the lesser sardines, *Sardinella albella* and *S.gibbosa*, as in the case of the kingseer and the spotted seer. Interzonal differences (i.e., between zones I and II) in the contribution of sardines and whitebaits to the streaked seer diet were quite negligible unlike in the case of the spotted seer. The presence of only meagre amounts of silverbellies (*Leiognathus*), which are an important demersal stock in zones I and II, in the diet of the streaked seer suggests surface feeding, but the fact that the juveniles up to a size of 120 mm feed exclusively and those up to a size of about 280 mm feed predominantly on the diurnally vertically migrating whitebaits suggest that bottom feeding, if at all, is restricted to the juveniles. The presence of such demersal species as the sciaenids and *Saurida* in significant quantities besides the whitebaits in the diet of the juvenile streaked seer (upto 150 mm SL = 180 mm TL) from the Waltair coast (Srinivasa Rao, 1964) confirms that the juveniles feed at the bottom also. Streaked seer juveniles are known to feed only on the smaller nekton, mainly of teleosts (Venkataraman, 1960; Srinivasa Rao, 1964), and the report that they feed predominantly on copepods and diatoms off the Madras coast is disputable since the identity of the juveniles described as the streaked seer (Kuthalingam, 1959) is of questionable validity (Jones, 1961).

Considering the size (120 mm) at which a shift in food from exclusively whitebaits to the larger sardines, the size (281 mm) at which

TABLE 11. *Daily ration in g (R), in Zones I and II during 1967-69, according to weight in g (W), length groups and age groups (sexes combined) (L and W are lengths in mm and weights in g at age in t)*

Age group	Length group (mm)	Mean weight of fish (g)	No. of fish in samples	Mean daily ration per fish (g)
0 to 1 year (L1 = 365 mm W1 = 388 g)	41-80	2.2	4	0.10
	81-120	5.6	14	0.24
	121-160	13.0	34	0.46
	161-200	28.8	34	0.34
	201-240	52.7	22	0.33
	241-280	75.0	6	1.06
	281-320	120.0	2	3.13
	321-360	180.0	1	5.63
	361-400	266.0	4	0.16
1+ to 2 year (L2 = 700 mm W2 = 1307 g)	401-440	382.8	8	2.18
	441-480	483.9	14	2.93
	481-520	628.4	26	5.26
	521-560	809.8	31	6.13
	561-600	992.7	21	10.40
	601-640	1222.8	21	9.00
	641-680	1437.3	45	5.19
	681-720	1710.8	16	7.79
2+3 year (L3 = 8 60 mm W3 = 2656 g)	721-760	2018.6	11	7.60
	761-800	2393.8	10	4.71
	801-840	2537.6	7	3.66
	841-880	4016.7	20	7.50
3 + to 4 year (L4 = 977 mm W4 = 4316 g)	881-920	4055.8	6	9.28
	921-960	4127.5	5	31.25

the sardines begin to be the major food item, the size (321 mm) at which the whitebaits are absent or quite insignificant in the diet, the ratios of these lengths to the length infinity (male = 1447 mm; female = 1683 mm), the average ration per active feeding (4.1 ml in 1967-68; 2.8 ml in 1968-69), and the degree of decline in ration in 1968-69 from the previous year's (by 68%) owing to a decline in forage abundance, it is evident that the streaked seer are intermediate between the kingseer and the spotted seer in their predatory habit. However, the fact that the streaked seer, as the spotted seer, are seldom caught in trolls unlike the kingseer, suggests that they do not very actively chase the prey, and hence, are as passive as the spotted seer. But, the much greater incidence (61.5%) of anteroposterior orientation of forage in their stomachs (an index of active chasing of the prey) as in the case of the kingseer (67.8%) indicates that the streaked seer do chase and ingest their prey; nevertheless, their chasing speed seems too low to reach the baits on a trolling gear; although their body is as fusiform, if not as robust, as that of the fast swimming kingseer. Growth depends on the volume of food consumed which in turn is linked to the number of gill rakers, the best growth obtaining in fish possessing small number of gill rakers (Nilson, 1958), however, the streaked seer which possess the same number of gill rakers (8 to 12) as the spotted seer, consume more food and attain much larger size than the spotted seer, but less than the food consumed and size attained by the kingseer with less number of gill rakers (2 to 5). In *Acanthocybium solandri* which is far more aggressive and which attains much larger size than even the kingseer, and caught mainly in trolls, the gill rakers are completely lost, thus confirming the trend within the Scomberomorini towards a complete loss of gill rakers together with an increase in size and aggressive habits. Although the streaked seer occupy an intermediate status in terms of their predatory habits as also their growth characteristics (Devaraj, 1981) between the kingseer and the spotted seer, the stock of this fish in zones I and II has been much less than that of the spotted seer or the kingseer as evident from the 1967-68 and 1968-69 catches.

The marked fall in the annual ration increment (based on *R*) of the females between

2 and 3 years of age followed by a marked recovery between 3 and 4 years of age and its decline in the males between 3 and 4 years of age followed by a marked increase between 4 and 5 years of age (Table 10) suggest initial spawning stress at and immediately following the age at first maturity (2 to 3 years) followed by recovery from the stress. But the annual ration increment estimated based on the regression of individual *R* values on the respective *W* values (Eqs. 7 and 8; Tables 12 and 13) show a progressive increase with age, implying thereby, the absence of any spawning stress.

TABLE 12. *Annual increment in ration (R dt), C, K, T; and, mean weight (W) according to age in years. Rt has been estimated directly from Eq. (7) by substituting W t for W*

Age in years (t)	Weight in g (W)	Daily ration in g (R)	Annual ration (Rt)	Δt	WΔt in g	RΔt in g	C	K	T	W in g
1	388	2.5326	924	0-1	388	924	2.38	0.42	640	388/2=1=194.
2	1307	5.2618	1921	1-2	919	1554	1.69	0.59	5226	388+1307/2=848
3	2656	8.0641	2943	2-3	1349	1958	1.45	0.69	12598	307+2656 /2=1982
4	4316	10.8022	3943	3-4	1660	2218	1.34	0.75	19871	656+4316/2=3486

Values of RΔt given between brackets are the increments of Rt between adjacent years while the C,K and T values given between brackets are values estimated from incremental RΔt.

TABLE 13. *Estimated annual ration increment (R dt), total metabolic rate (T), weight increment (dW) and weights in g (W) at age in years. t (vB=mean weight sexes combined from the von Bertalenffy growth equation and weight estimates by summation of dW, vB values of W have been used for the estimation of R dt and T here)*

t	R t (Eq. 8)	T (Eq. 9)	W (R t-T)	B (g)	W (g)
1	2337	1664	673	388	673
2	8517	7180	1337	1307	2010
3	18122	16858	1264	2656	3274
4	30388	30241	97	4316	3371
5	43752	45667	-1915	6078	0

As in the case of the spotted seer and the kingseer, K-lines (Eq. 10) agree closely with those fitted by Paloheimo and Dickie (1965) for experimental data indicating that the food intake maintained the fish within the normal biokinetic ranges, defined as the metabolism between the maintenance and active levels. But the T-line differ drastically from those fitted for experimental data (Winberg, 1956, 1961). The level of metabolic expenditure given by $e^{3.3446}$ is unrealistically high while slope of T line indicates a non-stress condition of food utilization and growth.

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