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FOOD AND FEEDING HABITS OF THE SPOTTED SEER, *SCOMBEROMORUS GUTTATUS* (BLOCH AND SCHNEIDER), IN THE GULF OF MANNAR AND PALK BAY

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ABSTRACT

The spotted seer, essentially a surface feeder, feeds on a limited number of about five species, of which the sardines are the most important and the whitebaits the next. The ration per active feeding (*R*) in 1968-69 declined by 50% of the 1967-68 level, owing to shortage of food. The shift from whitebaits which constitute the exclusive diet of the young, to sardines which form the major food of the adult, takes place at about 315 mm, about 1/4 the asymptotic length. The fish is far less aggressive than the kingseer or the streaked seer as evident from its inability to compete ably in times of food shortage, the much larger size at which it shifts to feeding on larger forage species and the orientation of 68.4% of the forage fish in its stomach in its reverse axis. The spotted seer is numerically more abundant, but gravimetrically less abundant than the kingseer, and therefore, its poor catch by weight must be seen more as a function of its small size than as a function of competence or competitiveness.

There are two active feedings a day, one between 7 and 10 p.m. and the other between 6 and 10 a.m. Food intake did not slacken in maturing or ripe fish and was generally high from September to March. Young fish less than 300 mm length, distributed in nearshore areas were found much better fed than the adults in grounds beyond the 20 meter depth line. Young spotted seer (say, 1 to 3 year old) consume more food per unit body weight than old fish (say, 4 year old), but the former require much less food to produce a unit weight growth than the latter. The *T*-line suggests that the ration available and consumed by the spotted seer is sufficient enough to sustain the normal growth of the fish, and that the process of normal food consumption and growth goes on in spite of severe interspecific competition. The *K*-lines reveal that the general level of gross growth efficiency is within the normal range of 0.25 to 0.75. The Paloheimo-Dickie weight growth model is not valid for the spotted seer, owing to the slope of the *T*-line being significantly different from the value describing the relation between metabolism and body weight under normal non-stress conditions.

INTRODUCTION

STUDIES concerning the food of the spotted seer of the seas around India are limited to those by Venkataraman (1960) for the juveniles from Calicut, Kumaran (1964), of the postlarvae and juveniles from Vizhinjam and Srinivasa Rao (1964) of the juveniles and adults from Waltair. The results of a systematic study on the food and feeding habits of the spotted seer *scomberomorus guttatus* from the northern Gulf of Mannar and Palk Bay along the southeast coast of India, undertaken during 1967-'69, are dealt with in this account.

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MATERIAL AND METHODS

710 spotted seer comprising 65 from Palk Bay (zone I) and 645 from the northern Gulf of Mannar (zone II) sampled from the commerical drift gillnet fishery in the Rameswaram Island twice or thrice a week between July, 1967 and July, 1969, formed the basic material for the study. The method of

examination of the stomach contents and the treatment of the data for the determination of food composition, qualitative and quantitative variations of food according to zones and seasons, according to the size and maturity of the fish, variation in average ration and ration per unit body weight, aggressiveness in feeding, and food intake and utilisation are the same as followed in a similar study of the king seer (Devaraj, MS).

RESULTS

Food composition

The food of the spotted seer was represented by fishes belonging to three families, one cephalopod and one penaeid (Table 1).

(i) Analysis by volume

710 spotted seer from both zones I (Palk Bay) and zone II (northern Gulf of Mannar) were found to have consumed 1,651.1 ml food comprising 99.6% fish (teleosts), 0.3% *Loligo* and 0.01% prawn. *Sardinella* contributed the greatest volume (86.8%) of all food elements. *Anchoviella* was second in importance (6.3%). Carangids formed a meagre 0.3%. Unidentified fishes ('fishes') accounted for 2.1%. Fish scales formed 0.6% and digested matter, 3.6% (Table 1).

(ii) Analysis by frequency of occurrence

99.6% of the total frequencies (487) were contributed by fish to which were also added the frequencies of digested matter on the presumption that they were of fish origin. Squids and prawns contributed 0.2% each. *Sardinella* alone accounted for nearly half (49.3%) with an index of preponderance 60 and *Anchoviella* 11.3% with an *IP* 35.3. 29.4% of the stomachs contained only digested matter. Other items occurred less frequently; carangids with an IP of 0.0002 and fishes with an IP of 0.34. Prawns and *Loligo* recorded a meagre 0.0001% and 0.0002% respectively by *IP* (Table 1)

Zonal variations

The food dispensation is similar in both the zones. The volume of 282 ml food taken from 65 stomachs sampled from zone I was composed exclusively of fish (*Sardinella* 236 ml, *Anchoviella* 37.5 ml and 'fishes' 7.8 ml) including 2.5 ml digested matter assumed to be of fish origin. By volume (*V*), occurrence (*O*), and *IP*, *Sardinella*, *Anchoviella* and 'fishes' ranked in descending order.

Besides the organisms noted above, negligible quantities of carangids, squids and

TABLE 1. *Food composition by volume (V), frequency occurrence (O) and index of preponderance (IP) for a total of 710 spotted seer sampled from Palk Bay (zone I) and the northern Gulf of Mannar (zone II) during 1967-'69*

	Volume			Frequency occurrence			Index of preponderance	
Food items	ml	%	rank	Actual	%	rank	%	rank
Sardinella	1432.1	86.8	1	240	49.3	1	60	1
Anchoviella	102.7	6.3	2	55	11.3	3	35.3	2
Carangids	5	0.3	6	1	0.2	6	0.002	6
'Fishes'	35	2.1	4	34	7	4	0.34	4
Fish scales	10.5	0.6	5	12	2.4	5	0.22	5
Prawns	0.2	0.01	8	1	0.2	6	0.001	7
Loligo	5	0.3	6	1	0.2	6	0.002	6
Digested matter	60.6	3.67	3	143	29.4	2	4.18	3
Total	1651.1	100		487	100		100	

prawns also formed the diet in zone II. In the first year (August, 1967 to July, 1968), the food consisted of 99.8% fish and 0.2% prawns. *Sardinella* formed 91.3% by *V*, 60.7% by *O* and 98.3 by *IP* (Table 3). The other six items food in all months in 1967-'68 with *IP* varying from 75 to 100 except in July and September (*IP* = 20 to 29) during which *Anchoviella* dominated the diet (*IP* = 52 to 61). During the other months, *Anchoviella* was very low

TABLE 2. *Index of preponderance (IP) of organisms in the diet according to months for zone I (Palk Bay) during 1967-68*

Months	Aug. (1967)	Sep.	Oct.	Dec.	Jan. (1968)	Jun.	Jul.	Aug.	Sep.	Oct.	Total	Rank
No. of fish examined	5	5	15	5	6	4	8	10	6	1	65	
Sardinella	89.6	93.8	98	100	99	0	0	53.3	52.2	0	92.2	1
Anchoviella	10.4	6.2	2	0	0	100	37.2	30.1	43.5	0	7.2	2
'Fishes'	0	0	0	0	1	0	0	15.4	0	0	0.4	3
Digested matter	0	0	0	0	0	0	62.8	1.2	4.3	100	0.2	4
Total	100	100	100	100	100	100	100	100	100	100	100	

had the levels of *IP* ranging from a mere 0.002 (prawns) to 0.912 (digested matter) (Table 3a).

In the second year (August, 1968 to May, 1969), 332.8 ml food from 240 stomachs consisted mainly of fish items and only 5 ml of squid remains. *Sardinella* was the most dominant item of food by *IP* = 80.2, but *O* for *Sardinella* declined to 31% as majority of stomachs contained only digested matter (Table 3b).

Seasonal variations

In 1967-'68, in Palk Bay (zone I), *Sardinella* formed a major item of food from August through January with *IP* (90 to 100), during which *Anchoviella* was much less significant *IP* = 0 to 10. In June and July, *Sardinella* was absent in the diet, but *Anchoviella* dominated with *IP* ranging from 37 to 100. In the two succeeding months, August and September, *Sardinella* attained a marginal increase over that of *Anchoviella* (Table 2).

In northern Gulf of Mannar (zone II), *Sardinella* was the most significant item of in the food with an *IP* = 4 in August and absent during October to January and April. Carangids and prawns were present only in July and September (Table 3a).

In 1968-'69, *Sardinella* was absent in the diet in January, ranked low in December and May and high in all other months (*IP* = 81 to 92). In those months in which *Sardinella* was either absent or the least in the diet, either digested matter alone was present as in December and in January the *Anchoviella* dominated the diet as in May (Table 3b).

Food variations according to size

710 Spotted seer in the length range between 31 mm and 720 mm, sampled during the period 1967-'69 from zones I and II were divided into 20 length groups at 30 mm intervals. Fish in the range 61 mm to 300 mm were found to have fed exclusively on *Anchoviella* which dominated in the succeeding group, but progressively reduced in the succeeding length ranges and was absent in fish beyond 601 mm. *Sardinella* first appeared in the diet of fish in the 301-330 mm group

TABLE 3a. *IP of organisms in the diet according to months for zone II (northern Gulf of Mannar) during 1967-'68.*

Months	Aug.	Sep.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Total	Rank
No. of fish examined	22	32	18	55	26	34	51	59	40	38	30	405	
Sardinella	96.19	20.14	100	99.94	99.68	99.87	99.42	95.95	87.01	75.31	28.63	98.306	1
Anchoviella	3.81	60.87	0	0	0	0.07	0.02	0	0.05	2.88	52.15	0.438	3
Carangids	0	0	0	0	0	0	0	0	0	0	5.11	0.004	5
'Fishes'	0	18.88	0	0.06	0.28	0.02	0.4	0.18	0.23	0.55	3.07	0.337	4
Fish scales	0	0	0	0	0	0	0	0	0.68	0	0	0.004	5
Prawns	0	0.11	0	0	0	0	0	0	0	0	0	0.002	6
Digested matter	0	0	0	0	0.04	0.04	0.16	3.87	12.03	21.26	11.04	0.912	2
Total	100	100	100	100	100	100	100	100	100	100	100	100	

TABLE 3b. *IP of organisms in the diet according to months for zone II during 1968-69.*

Months	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Mar.	April	May	Total	Rank
No. of fish examined	45	18	32	13	24	9	22	51	26	240	
Sardinella	80.78	82.3	85.32	92.29	3.54	0	92.46	82.59	7.85	80.29	1
Anchoviella	7.27	17.49	0.69	0	0	0	0	0.34	50.26	2.69	3
'Fishes'	0.33	0	1.35	0	0	0	0	0.71	0	0.02	6
Fish scales	0	0	0	1.63	12.42	7.69	0.45	0	0	0.44	4
Loligo	0.84	0	0	0	0	0	0	0	0	0.03	5
Digested matter	10.78	0.11	12.64	6.08	84.04	92.31	7.09	16.36	41.89	16.53	2
Total	100	100	100	100	100	100	100	100	100	100	

TABLE 4. *IP of organisms in the diet according to length groups for zones I and II during 1967-69.*

Length groups (mm)	61-90	91-120	121-150	151-180	181-210	271-300	301-330	331-360	361-390	391-420
No. of fish examined	4	6	9	5	5	5	15	31	34	62
Food items										
Sardinella	0	0	0	0	0	0	11.56	83.01	78.8	86.95
Anchoviella	100	100	100	100	100	100	57.81	12.09	19.32	9.67
'Fishes'	0	0	0	0	0	0	0	0	0.54	0.01
Fish scales	0	0	0	0	0	0	2.89	0.29	0	0
Digested matter	0	0	0	0	0	0	27.74	4.61	1.34	3.36
Total	100	100	100	100	100	100	100	100	100	100

Length groups (mm)	421-450	451-480	481-510	511-540	541-570	571-600	601-630	631-660	661-690	691-720
No. of fish examined	93	104	100	95	59	36	33	8	6	1
Food items										
Sardinella	97.41	98.07	76.48	95.97	91.91	93.05	91.66	98.92	97	100
Anchoviella	0.49	0.02	1.69	0.01	2.5	0.62	0	0	0	0
'Fishes'	0.18	0.14	1.77	0.41	2.16	0.87	0.59	0.17	0	0
Fish scales	0	0	0	1.23	0	0	0	0	0	0
Digested matter	1.92	1.72	20.08	2.38	3.43	5.46	7.75	0.91	3	0
Total	100	100	100	100	100	100	100	100	100	100

TABLE 5. *Total volume of food, average ration (R) and ration per unit body weight of 1000 g (R1) in ml according to months for zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-68 and 1968-69.*

1967-68 Months	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Combined
Mean weight of fish (g)	478.2	527.7	587.5	588.2	567.7	592.5	684.2	696.4	640	640	1027.7	437.7	727.1
No. of fish examined	27	37	33	55	5	32	34	51	59	40	42	38	453
Total volume	19	73.9	145.8	221.9	33.5	100.4	161.7	187.3	177.3	89.8	24.5	33	1268.1
R	0.7	1.9	4.4	4	6.7	3.1	4.7	3.6	3	2.2	0.5	0.8	2.7
R1	1.4	3.6	7.4	6.8	11.8	5.2	6.8	5.1	4.6	2.1	1.1	1.1	4.4

1968-69 Months	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Mar.	Apr.	May.	Combined
Mean weight of fish (g)	675.6	523.3	818.1	1151.5	750	714.2	1187.5	812.5	800	
No. of fish examined	55	24	33	13	24	9	22	51	26	257
Total volume	131.5	50.3	27.3	50.5	14.4	2.5	40.8	61	4.7	383
R	2.3	2	0.8	3.8	0.6	0.2	1.8	1.1	0.1	1.4
R1	3.4	3.8	0.9	3.3	0.8	0.2	1.5	1.3	0.05	2

and formed the major diet of all groups above 331 mm Prawns, squids, and carangids were found to have been fed upon by fish in the length groups of 391-420 mm, 451-480 mm and 481-510 mm respectively, in very negligible quantities (Table 4).

Variations in average ration and ration per unit body weight

In 1967-'68, the spotted seer consumed an average ration (*R*) of 2.7 ml food per one active feeding period (vide infra). *R* ranged from 0.5 ml in June to 6.7 ml in December . *R* was less than 2.2 ml from May to September, and higher than 3.0 ml from October to April (Table 5). The ration taken by fish of different length groups steadily increased from 0.2 ml in the 121-150 mm group to 6.0 ml in the 661-690 mm group, with only minor fluctuations between this range. The fish in the largest length group, 691-720 mm, had a ration of 50 ml food (Table 6).

In 1968-'69, the average ration dropped to 1.4 ml. The ration ranged from 0.1 ml in May to 3.8 ml in November. In spotted seer less than 300 mm in length, the ration ranged from 0.05 ml to 1.0 ml. In fish ranging from 301 mm to 630 mm length, ration never exceeded 2.1 ml except in the 331-360 mm group (4.3 ml). In the largest length groups, 631-660 mm and 661-690 mm, it attained the maximum values of 8.8 ml and 4.3 ml respectively (Table 6).

In 1967-'68, ration per unit body weight of 1000 g (R_1) was found to be 4.4 ml. R_1 ranged from 1.1 ml in June and July to 11.8 in December. R_1 recorded 10.3 to 13.8 ml in fish ranging from 121 mm to 210 mm length. It declined to 7.1 ml in the 271-300 mm group. In the length groups of 301-690 mm, R_1 varied from 2 ml to 5.5 ml except for the 361-390 mm group in which it recorded the lowest of

TABLE 6. *Total volume of food, average ration per unit body weight of 1000 g (R_1) in ml according to length groups for Zone I and Zone II during 1967-68 and 1968-69*

1967-'68						1968-'69			
Length group (mm)	Mean weight of fish in g	No. of fish examined	Total volume	Average ration :(R)	Body weight	No. of fish	volume	R	R_1
31-60	1.2	0	0.0	0.0	0.0	1	0.0	0.0	0.0
61-90	2.9	0	0.0	0.0	0.0	4	0.5	0.1	34.5
91-120	7.2	0	0.0	0.0	0.0	6	1.2	0.2	27.8
121-150	19.4	2	0.4	0.2	10.3	7	0.5	0.1	3.6
151-180	29.4	2	0.8	0.4	13.6	3	2.0	0.6	20.4
181-210	36.0	1	0.5	0.5	13.8	4	0.2	0.1	1.4
271-300	140.0	4	4.0	1.0	7.1	1	1.0	1.0	7.1
301-330	199.4	11	4.4	0.4	2.0	2	4.3	2.1	11.0
331-360	247.6	30	20.8	0.7	2.8	1	4.3	4.3	17.3
361-390	321.7	25	24.9	1.0	3.1	9	10.2	1.1	3.4
391-420	389.5	45	96.7	2.1	5.3	17	16.8	0.9	2.3
421-450	476.3	58	136.6	2.3	4.8	35	66.5	1.8	3.7
451-480	594.0	76	240.3	3.3	5.5	28	17.3	0.6	1.0
481-510	633.2	69	239.9	3.4	5.3	31	51.6	1.6	2.5
511-540	864.3	65	250.8	3.8	4.3	30	48.8	1.6	1.7
541-570	992.9	33	83.3	2.5	2.5	26	30.3	1.1	1.1
571-600	1258.0	11	28.2	2.7	2.1	25	48.6	1.9	1.5
601-630	1433.5	13	56.4	4.3	2.9	20	35.4	1.7	1.1
631-660	1586.2	5	18.1	3.6	2.2	3	26.5	8.8	5.5
661-690	1822.5	2	12.0	6.0	3.2	4	17.3	4.3	2.4
691-720	2070.0	1	50.0	50.0	24.1	0	0.0	0.0	0.0
Combined	13125.2	453	1268.1	2.7	4.4	257	383.3	1.4	2.0

TABLE 7. *Average ration (R) and ration per unit body weight of 1000g (R_1) in ml according to length groups and maturity stages for zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-68.*

Length groups (mm)		271-300	301-330	331-360	361-390	391-420	421-450	451-480	481-510	511-540	541-570	571-600	601-630	631-660	661-690	691-720	Combined
A. Male																	
Immature	R	2	1	1.6	1.6	1.8	4	0	0	0	0	0	0	0	0	0	2
	R_1	14.3	5	6.5	5	4.7	8.4	0	0	0	0	0	0	0	0	0	7.3
Intermediate	R	0	8.5	0.3	1.2	2.8	3	2.6	1.1	3.4	2.5	0	0.5	0	0	0	1.8
	R_1	0	2.6	1.3	3.7	7.2	6.3	4.4	1.7	3.9	2.5	0	0.4	0	0	0	3.4
Maturing	R	0	0	0	0.5	1.1	3.2	3.3	2.7	1.8	0.5	3.3	0	0.8	0	0	1.9
	R_1	0	0	0	1.6	2.8	6.6	5.5	4.3	2.1	0.5	2.6	0	0.5	0	0	2.9
Ripe	R	0	0	0	0	0	2.5	0.7	11.9	0.7	0	0.3	0	0	0	0	3.2
	R_1	0	0	0	0	0	7.7	1.2	18.8	0.8	0	0.2	0	0	0	0	5.7
Spent	R	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0.2
	R_1	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0.2
B. Female																	
Immature	R	0	0.2	0.8	0.6	2.4	0.8	4	0	0	0	0	0	0	0	0	0.9
	R_1	0	0.2	3.2	2	6.3	1.7	6.7	0	0	0	0	0	0	0	0	3.5
Intermediate	R	0	0	1.8	0	1.8	3.8	4.6	3.3	4	0.4	1.7	2	0.8	11	50	6.1
	R_1	0	0	7.3	0	4.6	8	7.7	5.2	4.6	0.4	1.3	1.4	0.5	6	24.2	5.1
Maturing	R	0	0	0	0	0	8	0	3.7	7	4.1	8.2	1.9	16	0	0	7
	R_1	0	0	0	0	0	16.8	0	5.8	8.1	4.1	6.5	1.3	10	0	0	7.5
Ripe	R	0	0	0	0	2.5	0	0.4	3.6	6.7	2.3	0.9	8.3	0.3	1	0	2.9
	R_1	0	0	0	0	6.4	0	0.7	5.7	7.7	2.3	0.7	5.8	0.2	0.6	0	3.3
Spent	R	0	0	0	0	0	0	0	0	5	0.3	0.3	0	0	0	0	1.9
	R_1	0	0	0	0	0	0	0	0	5.8	0.5	0.4	0	0	0	0	2.2

TABLE 8. *Average ration (R) and ration per body weight of 1000 g (R1) in ml according to length groups and maturity stages for zones I (Palk Bay) and II (northern Gulf of Mannar) during 1968-'69*

Length groups (mm)	Immature		Intermediate		Maturing		Ripe		Spent	
	R	R_1	R	R_1	R	R_1	R	R_1	R	R_1
A. Male										
301-330	4	20.1	0	0	0	0	0	0	0	0
331-360	0	0	2	8.1	0	0	0	0	0	0
361-390	2.5	7.8	1.8	5.6	0	0	0	0	0	0
391-420	1	2.6	1.5	3.9	0	0	0	0	0	0
421-450	0.3	0.6	2.2	4.6	3	0.6	2.5	5.2	0	0
451-480	0	0	1.5	2.5	0	0	2.1	3.5	0.3	0.5
481-510	0	0	4.7	7.4	0	0	0.8	1.3	0.3	0.4
511-540	0	0	1.3	1.5	0	0	2.8	3.2	6.5	7.5
541-570	0	0	2.5	2.5	0	0	0.9	0.9	0.3	0.3
571-600	0	0	0	0	0	0	0.5	0.4	0	0
601-630	0	0	0	0	0	0	0	0	10.2	7.1
631-660	0	0	0	0	0	0	0	0	0	0
661-690	0	0	0	0	0	0	0	0	0	0
Combined	1.7	6.2	2.2	4.5	1.5	3.1	1.6	2.4	2.9	2.6
B. Female										
271-300	1	7.1	0	0	0	0	0	0	0	0
301-330	0.3	1.5	0	0	0	0	0	0	0	0
331-360	0	0	0	0	0	0	0	0	0	0
361-390	0.2	0.5	0	0	0	0	0	0	0	0
391-420	0.1	0.3	0	0	0	0	0	0	0	0
421-450	3	6.3	0	0	0	0	0	0	0	0
451-480	1.7	2.9	0.3	0.5	0	0	0	0	2.5	4.2
481-510	0.5	0.8	0.7	1.1	0.2	0.3	0	0	2.2	3.5
511-540	0	0	0.8	1	0.5	0.6	1.1	1.3	2.4	2.7
541-570	0	0	0.4	0.4	0.8	0.8	0.9	0.9	2.1	2.1
571-600	0	0	1.6	1.3	1.5	1.2	0.8	0.6	3.7	2.1
601-630	0	0	0.7	0.5	0.3	0.2	0.4	0.3	0.6	0.5
631-660	0	0	0	0	0.5	0.3	13	8.2	6	3.5
661-690	0	0	0.2	0.1	0	0	7	3.8	3	1.7
combined	1	2.8	0.6	0.6	0.6	0.6	3.9	2.5	2.8	2.7

0.3 ml. The exceptionally high value of R_1 (24.1 ml) in the largest length group, 691-720 mm, is due to the high of R recorded for the only fish in this group (Table 6).

In 1968-'69, R_1 declined to 2 ml. It remained at a low level in all months (< 1.5 ml) except in August (3.4 ml), September (3.8 ml) and November (3.3 ml) (Table 6). R_1 recorded maximum values (27.8 to 34.5 ml) in the smaller length groups in the range of 61-120 mm. It ranged from 11.0 to 20.4 ml in the 151-180 mm, 301-330 mm and 331-360 mm groups, but less than 3 ml in most of the length groups beyond 361 mm (Table 6).

Effect of maturation on feeding

In 1967-'68, among the males of different maturity stages, the values for R and R_1 attained the maximum 3.2 ml and 5.7 ml in ripe males. Spent males consumed very poor ration (0.2 ml). In the immature, intermediate and maturing males, R did not vary much (1.8 to 2.0 ml), but R_1 steadily decreased from 7.3 ml in immature to 2.9 ml in the maturing male, apparently because of size effect (Table 7). In the following year (1968-'69), the values of R for the males did not vary significantly from one maturity stage to the other (Table 8).

The values for R_1 steadily increased from immature to maturing females, but declined in the ripe and spent females in the first year of the study. The length groups to which the intermediate, maturing and ripe females belonged were nearly the same, and hence, the drop in the ration in the ripe females (R = 2.9 ml; R_1 = 3.3. ml) from the high levels in the intermediate (R = 6.1 ml; R_1 = 5.1 ml) and maturing females (R = 7.0 ml; R_1 = 7.5 ml) might indicate slackening in food intake (Table 8). On the other hand, the ripe females in the following year (1968-'69) consumed more food (R = 3.9 ml; R_1 = 2.5 ml) than the intermediate and maturing females (R and R_1 = 0.6 ml each) (Table 8).

With increase in fish length, R exhibited generally an increasing trend, and R_1 a decreasing trend in both sexes (Tables 8 and 9). (Since the results of the observation in the first year are not repeated the following year, no definite conclusions could be arrived at regarding the effect of gonad maturation on feeding). However, the overall results of both years' observations seem to indicate that the maturing and ripe females might be feeding as normally as the immature and intermediate fish.

Condition of food and feeding periodicity

In 1967-'68, all the samples were taken from the catches by drift gillnets operated from about 6.30 p.m. to 4 a.m. (first haul at 10 p.m. and second haul at 4 a.m.). 41.7% of the fish examined were well or partly fed and the rest poorly fed or starving (Table 9). The stomachs of fish in the samples from the second haul were mostly empty, but the analysis of the first haul material, which formed the bulk of the samples, showed the duration between 7 p.m. and the time of first haul at about 10 p.m. to be one of the active feeding periods of the spotted seer.

In the second year (1968-'69), all fish below 150 mm in length were taken from shore seines operated from about 5 a.m. to 10 a.m. and fish above 150 mm in length from the drift gillnets operated between about 6.30 p.m. and 4 a.m. The very low ration received by the fish in the second year of observation was also confirmed by the degree of fullness of the stomachs. During this year, 62.7% of the fish examined were poorly fed and 17.1% starving. Well fed and partly fed fish accounted for only 20.2% of the total (Table 9). In the pooled shore seine samples, 50 to 75% of fish (61-120 mm in length) were found well fed indicating that the spotted seer fed actively for some period in the forenoon also.

TABLE 9. *Feeding intensity according to months for zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-'69.*

Months 1967-'68		Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April.	May.	Jun.	Jul.	Combined
Well fed	No.	2	4	8	12	1	6	12	8	11	5	2	1	72
	%	7.4	10.8	24.3	21.9	20	18.7	35.3	15.6	18.7	12.5	4.8	2.6	15.8
Partly fed	No.	6	12	12	16	3	15	10	15	9	10	5	4	117
	%	22.3	32.8	36.4	29	60	46.9	29.5	29.5	15.2	25	11.9	10.5	25.9
Poorly fed	No.	2	10	7	13	0	4	5	10	29	17	16	16	128
	%	7.4	27.1	21.2	21.9	0	12.5	14.7	19.6	49.2	42.5	38.1	42.1	28.2
Starving	No.	17	11	6	15	1	7	7	18	10.8	19	17	136	
	%	62.9	29.7	18.1	27.2	20	21.9	20.5	35.3	16.98	20	45.2	44.8	30.1
Total		27	37	33	55	5	32	34	51	59	40	42	38	453
1968-'69														
Well fed	No.	7	3	0	2	0	0	0	1	1	0	0	0	14
	%	12.7	12.5	0	15.1	0	0	0	4.5	1.9	0	0	0	5.4
Partly fed	No.	8	5	5	3	2	0	0	4	11	0	0	0	38
	%	14.5	20.8	15.1	23.1	8.3	0	0	18.2	21.6	0	0	0	14.8
Poorly fed	No	26	3	23	7	22	9	0	12	34	25	0	0	161
	%	47.3	12.5	69.8	53.9	91.7	100	0	54.6	66.7	96.2	0	0	62.7
Starving	No.	14	13	5	1	0	0	0	5	5	1	0	0	44
	%	25.5	54.2	15.1	7.7	0	0	0	22.7	9.8	3.8	0	0	17.1
Total		55	24	33	13	24	9	0	22	51	26	0	0	257

TABLE 10. *Feeding intensity according to length groups for zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-'69.*

Length groups (mm)		31-60	61-90	91-120	121-150	151-180	181-210	271-300	301-330	331-360	361-390	391-420	421-450	451-480	481-510	511-540	541-570	571-600	601-630	631-660	661-690	691-720	Combined
1967-'68																							
Well fed	No.	0	0	0	2	0	0	0	0	1	1	8	12	15	10	18	4	2	1	1	0	0	75
	%	0	0	0	100	0	0	0	0	3.3	4	17.8	20.6	19.8	14.4	27.7	12.1	18.2	7.6	20	0	0	16.5
Partly fed	No.	0	0	0	0	2	1	2	3	5	8	10	14	22	21	16	7	3	4	0	1	0	11.9
	%	0	0	0	0	100	100	50	27.2	16.7	32	22.2	24.2	28.9	30.5	24.6	21.2	27.2	30.8	0	50	0	26.3
Poorly fed	No.	0	0	0	0	0	0	0	4	5	8	12	14	13	21	18	13	4	5	3	0	0	120
	%	0	0	0	0	0	0	0	36.4	16.7	32	26.7	24	17.1	30.5	27.7	39.4	36.4	38.5	60	0	0	26.5
Starving	No.	0	0	0	0	0	0	2	4	19	8	15	18	26	17	13	9	2	3	1	1	1	139
	%	0	0	0	0	0	0	50	36.4	63.3	32	33.3	31	34.2	24.6	20	27.3	18.2	23.1	20	50	100	30.7
Total		0	0	0	2	2	1	4	11	30	25	45	58	76	69	65	33	11	13	5	2	1	453
1968-69																							
Well fed	No.	0	3	3	0	0	0	0	1	0	2	1	2	5	2	2	0	1	1	1	2	0	26
	%	0	75	50	0	0	0	0	50	0	22.3	5.9	5.7	17.9	6.5	6.6	0	4	5	33.3	50	0	10.1
Partly fed	No.	0	0	0	2	0	2	1	0	1	1	2	9	1	1	3	8	6	2	1	1	0	41
	%	0	0	0	28.6	0	50	100	0	100	11.1	11.7	25.7	3.5	3.2	10	30.8	24	10	33.3	25	0	15.9
Poorly fed	No.	0	0	0	1	1	0	0	1	0	3	7	17	15	26	20	16	16	13	1	0	0	137
	%	0	0	0	14.2	33.3	0	0	50	0	33.03	41.2	48.5	53.6	83.8	66.7	61.6	64	65	33.3	0	0	53.4
Starving	No.	1	1	3	4	2	2	0	0	0	3	7	7	2	5	2	2	4	0	1	0	53	
	%	100	25	50	57	66.7	50	0	0	0	33.3	41.02	20	25	6.5	16.7	7.6	8	20	0	25	0	20.6
Total		1	4	6	7	3	4	1	2	1	9	17	35	28	31	30	26	25	20	3	4	0	257

In 1967-'68, both well fed and partly fed fish together ranged from 44 to 80% during September to March, but declined to 13 to 38% in April to August during which a majority of fish (62 to 87%) were either poorly fed or starving (Table 9). In 1968-'69, no well fed fish were met with during October, December, January and May. The well fed and partly fed fish together formed more than 25% only in August (27.2%), September (33.3%) and November (38.2%), and less than 25% in other months. The incidence of poorly fed fish was remarkably high in all months (47.3 to 100%) but September (12.5%), and there were large number of starving fish (54.2%) (Table 9). The period of maximum incidence of well fed and partly fed fish was nearly the same in both the years.

Most fish of less than 300 mm length, which normally were distributed along the nearshore waters, were found to be well fed or partly fed both the years. However, in 1967-'68, in all the length groups between 361 mm and 690 mm which were normally taken from areas beyond the 20 meter depth line the incidence of these two categories together ranged from 33.3% to 52.3% (Table 10). In 1968-'69, both well fed and partly fed fish formed less than 33.3% in all the length groups from 361 mm to 630 mm and 66.7% and 75.0% respectively in the two largest groups, 631-660 mm and 691-720 mm (Table 10). Based on these observations, it is inferred that the juveniles find good pastures in the nearshore areas, while the adults meet with competition from other predators in the area beyond the 20 meter depth line. However, among the adult spotted seer, the larger fish do not seem to compete with the smaller fish, especially during years of forage abundance as in 1967-'68, but may do so in lean years as in 1968-'69.

TABLE 11. *Percentage orientation of forage in the stomach of fish from zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-'69.*

A. Monthwise

Months	Aug.	Sep.	Oct.	Nov.	Jan.	Feb.	Mar.	Apr.	May	June	July	Combined
Head anteriorly oriented	33.3	47.4	33.3	34	100	100	29.2	17.6	40.9	90	40	36.1 (78 actual)
Head posteriorly oriented	66.7	52.6	66.7	66	0	0	70	82.4	59.1	10	60	63.9 (138 actual)

B. Sizewise

Length groups (mm)	121-150	151-180	271-300	331-360	361-390	391-420	421-450	451-480	481-510	511-540	541-570	571-600	601-630	631-660	661-690	691-720	Combined
Head anteriorly oriented	100	100	100	33.3	25	37	22.7	37.5	36.7	35.1	28.6	45.5	20	66.7	50	0.36.1 (78 actual)
Head posteriorly oriented	0	0	0	66.7	75	63	77.3	62.5	63.3	64.9	71.4	54.5	80	33.3	50	10063.9 (138 actual)

Aggressiveness in feeding

That the spotted seer is a passive predator is suggested by the orientation of prey in their stomachs: 36.1% of the prey were found oriented anteroposteriorly characterising aggressive seizure and 63.9% of prey in the reverse, denoting passive capture (Table 11). percentage of reverse orientation which dominated in all the months ranged from 52.6% in September to 82.4% in April. However, in fish up to 300 mm in length which were found to have fed exclusively on anchovies, all the prey were anteroposteriorly oriented denoting aggressive predation. Beyond 300 mm and up to 630 mm passive predation dominated. Aggressive predation increased (66.7%) in only one group, i.e., 631-660 mm, but in the next group, 661-690 mm, both types of predation were in equal proportions while all fish in the largest group, 691-720 mm, exhibited passive predation (Table 11). Sardines formed the major food organisms of the spotted seer of length beyond 300 mm. The observations indicate that the adult spotted seer, however large they be, are not able to exert as much aggression on sardines as their juveniles are on anchovies.

Food intake and utilisation

From the knowledge of a density of 1.25 for the stomach contents, 2 active feedings per day and the average ration per active feeding, the annual rations in grams wet weight for 1,2,3 and 4 year old spotted seer (Devaraj, 1981) were estimated by using the method followed in Devaraj (MS). The relation betwen grams wet weight of fish (*W*) and grams wet weight of annual ration (*R*Δ*t*) at age 1,2,3 and 4 years (Table 12) is found to be,

$$\ln R\Delta t = 0.6495 + 1.0722 \ln W \text{ ...... (1)}$$

Since the annual ration for the 4 year old fish has been found to be extremely high owing to one fish in the sample, the above relation has been restricted to 1 to 3 year old fish only (Eq. 2),

$$\ln R\Delta t = 2.8902 + 0.6800 \ln W \text{ ..... (2)}$$

For the same reason as above, data from 4 year old fish have been excluded in fitting T-line and K-line. The lines fitted for 1 to 3 year old fish are,

$$\ln T = 2.5637 + 0.6773 \ln W \text{ ..... (3)}$$

$$\ln K = -1.2531 + 0.000007223\, R\Delta t \text{ .... (4)}$$

Weight growth model developed by Palmoheimo and Dickie (1965) for species whose *K*-line has a slope close to zero,

$$W = \{(1\text{-}q)\ c\ (t\text{-}t_o) + W_o\ 1\text{-}q\}^{1/1\text{-}q} \text{ ... (5)}$$

Where q is the slope (0.6773) of the *T*-line; $c = pe^{-a}/(1\text{-}e^{-1})$ where p is the antilog of a-axis intercept of the T-line and -a is the y-axis intercept of the *K*-line; and, W_o is the weight at 1 = 10.3 cm (derived from the von Bertalanffy equation: l_t = 127.8 $(1\text{-}e^{-0.18007(t-0.4654)})$ ($\underline{t}$ = 0 year) which has been converted into W_0 by using the length-weight relation $W = 0.01011\ \underline{L}^{2.8605}$ where W = weight in g and L = total length in cm (Devaraj, 1981). Substituting the values of q = 0.6773, W_0 = 7.98g, c = 5.1910 and t_0 = -0.4654 year in Eq. (7), W for t = 1 year is found to be 99 g which is rather different from the observed value of 162 g and the von Bertalanffy estimate of 161 g.

Following Paloheimo and Dickie's (1965) view that their growth model holds only for a particular food type, the length of 31.5 cm at which the spotted seer begin to shift to their adult diet of sardines was considered as the 1_0 and the growth estimates made according to Eq. (5). Growth estimates thus obtained are consistently higher than those from von Bertalanffy growth function. This holds good for comparison with estimates obtained by summation of weight increments (Σ Δ W) derived from the difference between the annual ration increments (RΔt) and total metabolic rate

(*T*) even though the difference is of the order of 22% for ages 5 to 8 years but much higher during lower and higher ages. Thus the Paloheimo and Dickie (1965) weight growth model does not seem to be valid for spotted seer. Growth estimates by the summation of weight increments ($\Sigma \Delta W$), derived from the differences between the annual ration increment ($R\Delta t$) and total metobolic rate (*T*), are found to agree with the empirical or von Bertalanffy estimates up to the fourth year of life, but significantly higher at subsequent ages (Table 13).

DISCUSSION

The spotted seer feed on a very limited range of about 5 food items, many of which are species low in the food chain, unlike the kingseer which feed on a large spectrum of items. In spite of this striking dissimilarity, the lesser sardines (*Sardinella albella* and *S. gibbosa*) were found to be the most favourite food of both the species, with whitebaits (anchovies), the most important among the supplementary diets, being in the much greater favour with the spotted seer than with the king seer. Between Palk Bay (zone I) and the northern Gulf of Mannar (zone II), the spotted seer diet included more of whitebaits in the former, apparently due to greater abundance, although they are not known to be of any commercial fishery importance in zone I. In contrast, the spotted seer, both juveniles and adults, along the Waltair coast (Lawson's Bay) are reported to feed primarily on whitebaits and secondarily on sardines (Srinivasa Rao, 1964), obviously due to the predominance of whitebaits in this area. Whitebaits are known to undertake diurnal vertical migration, but whether the spotted seer follow them to the sea bottom during daytime is not known. Despite substantial stocks of silverbellies and rainbow sardines in the bottom and midwaters of zone I, the total absence of these items in the diet may suggest the spotted seer to be a surface feeder as the king seer, although its demersal existence for a part of the day is known from its occurrence in the daytime bottom trawl catches along the northwest coast of India. Therefore, bottom feeding of spotted seer cannot be totally ruled out.

The contribution of sardines to the spotted seer diet in zone II declined marginally in 1968-69 from the previous year's level, apparently owing to the shortage of young sardines and predominance of older ones which the spotted seer could not more effectively prey upon unlike the king seer. In spite of a significant decline in the abundance of spotted seer in both zones I and II (Table 14), the decline in the spotted seer ration per active feeding in zones I-II in 1968-69 by about 50% of the 1967-68 level denotes acute scarcity of forage leading to an aggravation of the already severe competition from the king seer and other predators. That the decline in the king seer ration in 1968-69 was only 15% of the 1967-68 level is proof enough that the spotted seer is a far less competent species. Unlike the king seer which shifts to feeding on larger items like the sardines at a size about 1/13 of its asymptotic size, such a change over occurs at a much larger size (about 1/4 its L_∞) in the spotted seer, because of its far less aggressive nature which is also evident from most of its prey being oriented in its reverse axis (indicating passive predation as the prey comes face the predator). The presence of a relatively large number of gill rakers (8-12) on the outermost gill arch and a relatively less fusiform and much deeper body further support the view that this species is much less predatory than the kingseer (Nilson, 1958). The relatively poor spotted seer catches, forming about 33% (second rank), 18% (third rank) and 19% (third rank) of the average annual seerfish catches from the

TABLE 12. *Empirical lengths in mm(L), weights in g(W), ration per one active feeding period in ml(R), R per 1000g body weight in ml(R_1), annual R, i.e., R Δ t in g, annual R_1 i.e., R Δt/1000 g W in g, conversion factor (C), growth efficiency (K) and annual total metabolic rate in g (T = RΔt - ΔWt) according to age in years (t). Increments are given between brackets. N = numbers of fish studied for the estimation of food intake and utilisation parameters.*

t	*L*	*W*(Δ*Wt*)	*R*	R_1	*R*Δ*t*	*R*Δ*t*/1000 g *W*	*C*	*K*	*T*	*N*
1.	297(297)	167(167)	0.6(0.6)	11.4(11.4)	548	3281	3.3	0.3	381	268
2.	453(156)	551(384)	1.7(1.1)	5.3(-6.1)	1551	2815	4	0.25	1167	358
3.	594(141)	1188(637)	2.2(0.5)	2.6(-2.7)	2008	1690	3.2	0.32	1371	83
4.	705(111)	1998(810)	12.4(10.2)	6.4(3.8)	11315	5663	14	0.07	10505	1

TABLE 13. *Estimated annual ration increment (RΔt, Eq. 2), total metabolic rate (T ; Eq. 5), weight increment (ΔW) and weight (W) at age in years, t (vB = weight estimate by the von Bertalanffy growth equation (Devaraj, 1981); Σ ΔW = weight estimated by the summation of ΔW; PD = weight estimate by the Paloheimo-Dickie growth equation, Eq. 7; bR = reference point where b is the slope of the K - line of Eq. 6).*

t	*R* (g)	$T_{(g)}$	Δ*W* (g)	vB	*W(g)* Σ Δ*W*	*PD* (for l_o=10.3 cm)	PD (for l_o=31.5cm)	bR
1.	568	406	162	161	162	130	337	0.0002
2.	1351	957	394	572	556	177	424	0.0004
3.	2244	1581	663	1201	1219	234	524	0.0007
4.	3132	2203	929	1957	2148	302	640	0.001
5.	3962	2777	1185	2759	3333	383	772	0.0012
6.	4707	3294	1413	3550	4746	477	920	0.0015
7.	5357	3744	1613	4289	6359	585	1088	0.0017
8.	5913	4130	1783	4957	8142	710	1275	0.0018
9.	6384	4455	1929	5545	10071	851	1482	0.002
10.	6779	4729	2050	6053	12121	1010	1711	0.0021
11.	7106	4953	2153	6485	14274	1188	1963	0.0022
12.	7377	5141	2236	6850	16510	1386	2239	0.0023
13.	7600	5294	2306	7155	18816	1606	2541	0.0024
14.	7782	5421	2361	7488	21177	1847	2868	0.0024
15.	7930	5524	2406	7616	23583	2112	3223	0.0025

Indian seas (1960-81), the Indian Ocean (1965-77) and the Pacific Ocean (1965-77) respectively, is attributable, *inter alia*, to the inability of this species to compete effectively for the available food.

However, the fact that in zone II, the spotted seer was numerically more abundant than the kingseer in both 1967-68 (2.4 times) and 1968-69 (1.2 times) would mean the former to be a more successful species than the latter, from the numerical angle. Therefore, its low abundance in terms of weight in this zone (1967-68: 0.75 times the kingseer; 1968-69): 0.7 times the kingseer; should be seen more as a function of its size, i.e., its growth characteristics (L_∞ = 1278 mm; W_∞ = 8,540 g; Devaraj, 1981) relative to the much larger kingseer (L_∞ = 2081 mm; W_∞ = 39,027 g), than as a function of competence or competitiveness. One could add credence to this argument from the fact that the seerfish fishery in the neighbouring Palk Bay (zone I) comprised almost exclusively the spotted seer until about 1955 but progressively got replaced by the kingseer (Table 14) not because of less competence, but because of the change in the salinity regime after the construction of the Vaigai Dam across the Vaigai river draining into Palk Bay.

Although the spotted seer is far less predatory than the kingseer and the streaked seer, on no occasion were planktonic items noticed in its diet. Moreover, Srinivasa Rao's (1964) observations from Waltair show that juvenile spotted seer feed predominantly on teleosts and negligible quantities of crustaceans while the adults feed on teleosts and macrocrustaceans. The insignificant occurrence of diatoms in the gut of 20-190 mm (total length) spotted seer from Vizhinjam together with the major items like fishes crustaceans and molluscs would appear to have resulted from their release from the gut of planktivorous forage fish already ingested and being digested by the spotted seer.

The fact that food intake by maturing and ripe fish did not decrease is not necessarily

TABLE 14. *Age composition of spotted seer expressed in number of fish per 1000 units of 76 mm mesh type drift gillnet effort (boat days) for Palk Bay (zone I) and the northern Gulf on Mannar (zone II) during 1967-68 and 1968-69 together with a comparison of the total number and weight of spotted seer per 1000 units against the total number and weight of kingseer and streaked seer each per 1000 units (percentages between brackets).*

Age group	Palk Bay 1967-68	Palk Bay 1968-69	Northern Gulf of Mannar 1967-68	Northern Gulf of Mannar 1968-69
0	6 (0.4)	1 (0.32)	3 (0.02)	0
1	909 (60.52)	167 (53.25)	7459 (52.44)	1695 (20.72)
2	542 (36.09)	126 (40.91)	6150 (43.24)	5400 (66.03)
3	44 (2.93)	17 (5.52)	597 (4.2)	1073 (13.12)
4	1 (0.07)	0	15 (0.11)	11 (0.13)
Total No. of spotted seer	1502	308	14224	8179
Total weight of spotted seer (kg)	503	116	5374	4555
Total No. of kingseer	8402	7246	5948	6916
Total weight of kingseer (kg)	3603	2852	7192	6562
Total No. of streaked seer	734	458	1677	1660
Total weight of streaked seer (kg)	447	362	2433	2579

indicative of a lack of spawning stress as conditions of stress could indeed aggravate food intake to compensate the energy lost in stress. However, the marked fall in *R* increment between 2 and 3 years of age seems to suggest some kind of a depression following first maturation at an age of about 1.7 year, but that there has been a quick recovery is evident from a marked increase in the *R* increment as well as R_1 between 3 and 4 years of age. The steady decrease in *R* with age except at the 4th year denotes that young fish consume more food per unit body weight owing to much faster growth and much greater physical (e.g., swimming) activity. Evidently, comparatively younger fish, say, 1 to 3 year old fish, require much less amount of food (in absolute terms) to produce a unit growth (C = 3.2 to 4; K = 0.25 to 0.32; T = 381 to 1371 g) while the 4 year old fish require large amounts of food to produce a unit growth (C = 14; K = 0.07; T = 10,505 g). However, in view of the very limited sample of 4 year old fish (N = 1; Table 13), no definite conclusion is possible, although at older ages close to the asymptotic age, growth efficiency is bount to be at its minimum.

The *T*-line fitted for 1 to 3 year spotted seer seems more realistic than that fitted for 1 to 4 year fish as the only 4 year old fish in the sample gave rather unrealistic values of $R\Delta t$ and T (Table 13). Since the slope, q (which defines the rate of change of metabolism with body weight), of the *T*-line for 1 to 3 year old fish (0.6773) and for 1 to 4 year old fish (1.1534) are significantly different from the value of 0.8 describing the relation betwen metabolism and body weight in most fish species under normal non-stress conditions in nature (Winberg, 1956; 1961), the spotted seer do not appear to live in a normal non-stress state. The y-axis intercept (which defines the level of metabolic expenditure per unit time), p = 0.8555 (log p = -0.0678), of the *T*-line for 1 to 4 year old fish in zones I-II, denotes low metabolic level, and hence, a ration only marginally higher than the maintenance ration, perhaps owing to competition from much abler predators including the kingseer. The maximum size attained by the spotted seer in differnt areas bears a distinct relation to its abundance in relation to the kingseer. For example, in zones I-II where the kingseer is the most dominant (88.38% by weight in 1964-76) among the seerfish, the spotted seer is much less abundant (8.14% by weight in 1964-76) and generally of smaller size (maximum recorded size is 723 mm) unlike along the northwest coast of India where it attains 800-900 mm length because of the generally poor abundance of the kingseer (1981 spotted seer catch by weight in total seerfish catch; 75% in the Bombay region; 72.6% in the Gujarat coast; 39% in the Maharashtra coast). In contrast, the *T*-line for 1 to 3 year old fish in zones I-II denotes a rather high metabolic level of 13.00 (log p = 1.1134) and high food intake, and therefore, the competition theory does not look plausible, in spite of reduced levels of *R* in 1968-69 when there was an obvious food shortage. What therefore emerges from this analysis is that the average ration available and taken by the spotted seer at least of 1 to 3 year age during 1967-69 was sufficient enough to sustain their growth that may be considered characteristic of the spotted seer stock in zones I-II, and that the process of food consumption and growth considered normal for zones I-II goes on in spite of severe interspecific competition in times of food scarcity. The *K*-lines also show that the general level of gross growth efficiency ($K = e^{-a} = e^{-0.4603}$ = 0.63 of Eq.4 for 1 to 4 year old fish; $K = e^{-0.5405}$ = 0.58 of Eq. 6 for 1 to 3 year old fish), which does not change from one species or food type to another, falls between the range of 0.25 and 0.75 observed in feeding experiments, although the value of e^{-a} in nature is reportedly less than this level (Paloheimo and Dickie, 1965). Estimates of weight growth by the Paloheimo and Dickie (1965) model are far less than either the empirical or von Bertalanffy values in relation to younger age upto 7 years, apparently because of the slope of the *T*-line being significantly different from the value describing the relation between metabolism and body weight under normal nonstress conditions in nature. However, the higher values in the later years indicate recovery to normal growth condition.

References

DESHPANDE, S. D. AND T. M. SIVAN. 1969. On the troll line investigations off Cochin during five fishing seasons. *Fish. Tech.*, **6** (1) : 26-35.

DEVARAJ, M., 1981. Age and growth of three species of seerfishes (*Scomberomorus commerson, S. guttatus* and *S. lineolatus*) in India. *Indian J. Fish.*, **28** : 104-127.

DHAWAN, R. M., P. V. S. NAMBOOTHIRI AND V. G. GOPINATHAN. 1972. Results of trolling line operations in Goa waters during 1965-68. *Ibid.* **16** : 181-187 (for 1969).

HASTINGS, W. H. AND L. M. DICKIE. 1972. Feed formulation and evaluation. In : Fish Nutrition. Academic Press, New York and London : 327-374.

IVLEV, V. S. 1955. Experimental ecology of the feeding of fishes. Translated from the Russian by Douglas Scott. New Haven, Yale University Press, 1961 : 1-302.

KUMARAN, M. 1964. Observations on the food of juveniles of *Scomberomorus commerson* (Lacepede) and *S. guttatus* (Bloch & Schneider) from Vizhinjam, west coast of India. Mar. Biol. Ass. India, *Proc. Symp. Scombroid Fishes*. Part-II : 586-590.

LEWIS, A. D., B. R. SMITH AND R. E. KEARNEY. 1974. Studies on tunas and baitfish in Papua New Guinea waters-II, Res. Bull. DASfP. Moresby (10) : 1-112.

MOORE, H. B. 1972. Aspects of stress in the tropical marine environment. *Adv. Mar. Biol.* **10** : 217-269.

NATARAJAN, A. V. AND A. G. JHINGRAN. 1962. Index of preponderance a method of grading the food elements in the stomach analysis of fishes. *Indian J. Fish.*, **8** : 54-59 (for 1961).

NILSON, N. R. 1958. On the food competition between two species of *Coreqonus* in a North Swedish lake. *Inst. Freshw. Res. Drottingholm, Rept.*, (39).

PALOHEIMO, J. E. AND L. M. DICKIE. 1965. Food and growth of fishes. 1. A growth curve derived from experimental data. *J. Fish. Res. Bd. Canada,* **22** : 521-542.

SILAS, E. G., 1967. Tuna fishery of the Tinnevelly coast, Gulf of Mannar. Mar. Biol. Ass. India, *Proc. Symp. Scombroid Fishes*, Part II : 1083-1117.

SLOBODKIN, L. B. 1961. Preliminary ideas for a productive theory of ecology. *Amer. Nat.*, **95** (882) : 145-153.

SRINIVASA RAO, K. 1964. Observations on the food and feeding habits of *Scomberomorus guttatus* (Bloch and Schneider) and juveniles of *S. lineolatus* (Cuvier and Valenciennes) and *S. commerson* (Lacepede) from the Waltair coast. Mar. Biol. Ass. India, *Proc. Symp. Scombroid Fishes,* Part II : 591-598.

SUBRAMONIA PILLAI, N., R. S. MANOHARDOSS AND SULOCHANAN, P., 1972. Standardisation of specifications for different trolling lures. *Fish. Tech.*, **9** (1) : 68-75.

UNDP/FAO. 1974. Survey results 1972/73. Pelagic Fishery Project (IND 69/593), *Progress Report*, (6) : 1-141.

VENKATARAMAN, G. 1960. Studies on the food and feeding relationship of the inshore fishes off Calicut on the Malabar coast. *Indian J. Fish.*, **7** : 275-306.

——— AND M. BADRUDEEN. 1974. On the diurnal variation in the catches of silverbellies in Palk Bay. *Ibid.*, 21 (1) : 254-265.

WHITELY, G. P. 1964. Scombroid fishes of Australia and New Zealand. Mar. Biol. Ass. India, *Proc. Symp. Scombroid Fishes*, Part-I : 221-253.

WILLIAMS, F. 1964. The scombroid fishes of East Africa. Mar. Biol. Ass. India, *Ibid.*, Part I : 107-164.

WINBERG, G. G. 1956. Rate of metabolism and food requirements of fishes. Nauchney, Trudy Belorusskogo Gosudarstvennogo Universiteta, Minsk. : 1-253 (Translated from Russian by *Fish. Res. Bd. Canada, Transl. Ser.*, (194), 1960).

WINBERG, G. G. 1961. New information on metabolic rate in fishes. *Vopt. ikhtiol.*, 1 : 157-165 (Translated from Russian by *Fish. Res. Bd. Canada, Transl. Ser.*, 362).

WOODHEAD, P. M. J. 1966. The behaviour of fish in relation to light in the sea. *Oceanogr. Mar. Biol. Ann. Rev.*, 4 : 337-404.