J.mar.biol. Ass. India, 1998, 40 (1 & 2) : 69 – 90

FOOD AND FEEDING HABITS OF THE KINGSEER, *SCOMBEROMORUS COMMERSON* (LACEPEDE), IN THE SEAS AROUND THE INDIAN PENINSULA

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ABSTRACT

The kingseer prey on surface schooling species like the sardines and the whitebaits. Year-to-year changes in the abundance and recruitment of lesser sardine stocks reflect well in the abundance and size of the prey in the gut. The fish change over from whitebaits to sardines at a size which is about 1/13th its asymptotic length (2081 mm). A linear relation exists between the size of fish caught and the size of bait used for a given hook size of troll. The high incidence of anteroposterior orientation of prey (67.8%) in the gut, small number of gill rakers, strong dentition, larger prey size, and a more fusiform and robust body indicate the kingseer to be a very aggressive predator. Intraspecific competition is apparent from a drastic reduction in the ration level at the peak of kingseer abundance. Ration per unit body weight is much higher in the younger fish. Maturing and ripe fish increase their food intake considerably. Conversion factor and gross growth efficiency indicate considerable energy loss on account of the fast swimming and aggressive habits. The slope of the T-line, q=0.9106, shows that the fish live on optimum levels of diet in a normal nonstress state. The maximum level of growth efficiency at low feeding levels $K = e^{-a} = 0.23$, is outside the range of values, 0.25 to 0.75, obtained in feeding experiments. The von Bertalanffy model describes the weight growth of kingseer much better than the growth models built on food utilisation parameters.

INTRODUCTION

OUR PRESENT knowledge of the food of the kingseer in the Indian seas is limited to a few observations. Venkataraman (1960) examined the stomach of juvenile kingseer (138-207 mm in total length) from Calicut. Kumaran (1964) dealt with the percentage occurrence of the food items of 283 postlarval and juvenile kingseer in the three arbitrary fork length groups: 17-30 mm, 31-60 mm and 61-225 mm from Vizhinjam. Srinivasa Rao (1964) studied the food of 177 young kingseer measuring upto 200 mm in standard length from the Waltair coast. Deshpande and Sivan (1969) listed the food of 41 troll-caught seer from Cochin. Dhawan *et.al.* (1972) reported briefly on the food of the kingseer, 460-1252 mm range in length, from Goa. Very limited observations are available from the Indo-pacific regions where this species is quite abundant. Kingseer caught from the East African waters were examined by Williams (1964) for their food. The food of kingseer from Queensland was reported by Whitley (1964). However, information on food and feeding habits of the adults are too fragmentary to be of real value in elucidating the feeding habits and the dynamics of food intake and utilization. The present account complements our knowledge on the feeding biology of the kingseer.

I am indebted to Dr. S. Jones, Dr. R.V. Nair, Dr. E.G. Silas and Dr. P.S.B.R. James of the Central Marine Fisheries Research Institute, Cochin and to Dr. S.N. Dwivedi of the Central Institute of Fisheries Education, Bombay for their invaluable guidance and encouragement. I owe my sincere thanks to Mr. M. Stephen, fleet owner, for his co-operation in the collection of samples for the study.

MATERIAL AND METHODS

The study was based on the stomach contents of 1,649 kingseer sampled during the period July, 1967 to July, 1969 from Palk Bay (Zone I; N=732 and the northern (Zone II; N=653) and southern (Zone III; N=18) Gulf of Mannar and the southwest coast from Cape Comorin to Colachel (Zone IV; N=246). Most of the fish from zones I and II were collected from the drift gillnet catches, and the rest, from the shore seines. In zones III and IV, samples were taken from the drift gillnet, shore seine, and troll line catches. The stomach contents were identified to the level of genera or species and fishes in advanced stage of digestion, were treated together as 'fishes'. The number (N), occurrence (O), and volume (V) of each food item found in each stomach were then recorded. The relative values of the different organisms in the diet of the kingseer were evaluated by the index of preponderance, IP (Natarajan and Jhingran, 1962),

$$IP = \frac{VO \times 100}{\Sigma VO} \quad ......(1)$$

The average volume of food (*R*) taken by the fish was estimated by,

$$R = \frac{V}{N} \quad ......(2)$$

Where *V* is the total volume of food consumed by *N* number of fish in the samples. Since digestive enzymes do not seem to have affected the gut contents significantly between capture and examination (a duration of 6 to 12 hours), the value *R* may be taken to represent the quantity of food consumed during an active feeding period, and hence, termed "ration" following Winberg (1956) and Hastings and Dickie (1972). The ration per 1,000 g body weight of the predator (*R*1) was estimated by using the expression,

$$R1 = \frac{R}{W} \times 1000 \quad ......(3)$$

Where *W* is the mean weight of the predator in the sample. Units for intensity of feeding may be expressed in terms of daily, monthly and yearly ration (Ivlev, 1955). If it be assumed that at each active feeding in a day, the ration is the same, frequency of active feeding per day (x) leads to the estimation of the annual ration ($R \Delta t$) from the average ration per active feeding period (R),

$$R \Delta t = R.x.365 \quad ......(4)$$

After ascertaining the density (weight/volume) of the stomach contents from a few samples, *R* in grams wet weight was derived by multiplying *R* in *ml* by density. The relation between annual ration in grams wet weight ($R \Delta t$) and grams wet body weight (*W*) is expressed by,

$$R \Delta t = aw^b \quad ......(5)$$

or, in the logarithmic form, by,

$$\log R \Delta t = \log a + b \log W \quad ......(6)$$

Indices of food utilization for growth were derived from the two simple ratios given by Hastings and Dickie (1972),

$$C = \frac{R \Delta t}{\Delta W} \quad ......(7)$$

$$K = \frac{\Delta W}{R \Delta t} \quad ......(8)$$

Where *C*=conversion factor, *K* = gross growth efficiency, $R \Delta t$ = ration per unit time Δt, and ΔW = growth increment during the same unit time. Total metabolic expenditure (*T*) was derived by using Winberg's (1956;1961) expression,

$$T = R \Delta t - \Delta W / \Delta t \quad ......(9)$$

The regression of *T* on body weight, *W*, referred to as

TABLE 1. ***Volume, frequency occurrence and index of preponderance (IP) of organisms in the diet of 1,554 fish sampled from zones I to IV during 1967-'69 (data exclude troll-caught fish of zones III and IV)***

Food items	Volume			Frequency occurrence			Index of preponderance	
	(ml)	(%)	Rank	Actual	(%)	Rank	(%)	Rank
Sardinella	7456.9	67.24	1	706	50	1	97.41204	1
Anchoviella	276.8	2.5	6	203	14.39	3	1.04236	2
Hilsa	553.	5	4	30	2.13	5	0.30858	4
Amblygaster	141.4	1.28	9	4	0.28	15	0.01038	12
Ilisha	144.5	1.3	8	6	0.42	13	0.01582	10
Dussumieria	72.5	0.65	14	6	0.42	13	0.00791	15
Thrissocles	3	0.03	25	2	0.14	17	0.00012	25
Chirocentrus	278.8	2.51	5	10	0.71	11	0.05164	8
Mugil	67	0.6	15	1	0.07	18	0.00012	18
Caranx	103.5	0.93	11	20	1.42	7	0.03826	9
Selar	92.5	0.83	12	5	0.35	14	0.00842	14
Megalaspis	17	0.15	19	3	0.21	16	0.00091	20
Chorinemus	4.5	0.04	24	1	0.07	18	0.00008	26
Other carangids	724	6.53	2	16	1.13	9	0.2138	6
Upeneus	75	0.68	13	1	0.07	18	0.00138	17
Sphyraena	16	0.14	20	1	0.07	18	0.00028	
Tachysurus	23.5	0.21	17	1	0.07	18	0.00043	21
Perches	7	0.06	23	1	0.07	18	0.00012	25
Leiognathus	38.1	0.34	16	17	1.2	8	0.01182	11
Gerres	12.5	0.11	22	1	0.07	18	0.00022	24
Tetradon	2.2	0.02	26	1	0.07	18	0.00004	28
Rhynchorhamphus	3	0.03	25	1	0.07	18	0.00006	27
Therapon	13.5	0.12	21	1	0.07	18	0.00024	23
Rastrelliger	564	5.09	3	6	0.42	13	0.06194	7
Fishes	191	1.72	7	66	4.68	4	0.23323	5
Fish scales	19.1	0.17	18	21	1.49	6	0.00734	16
Fish bones	3	0.03	25	1	0.07	18	0.00004	28
Isopods	3.7	0.04	24	12	0.85	10	0.00099	19
Loligo	66.3	0.6	15	8	0.57	12	0.00991	13
Digested matter	116.7	1.05	10	260	18.42	2	0.56039	3
Total	11090.5	100		1412	100		99.9988	

T-line by Hastings and Dickie (1972) was fitted as

$$T=PW^q \;.......\; (10)$$

or, in the logarithmic form

$$\log T=\log P + q \log W \;......\; (11)$$

Hastings and Dickie's (1972) *K*-line expressing the relation of logarithm of the gross growth efficiency as linear on the amount of ration was fitted as

$$\log K = \log\frac{(\Delta W)}{(R\,\Delta t)} = -a - b\,R\Delta t \;......(12)$$

Eq. (12) may be rewritten as,

$$\log \frac{\{\Delta W\}}{\{R\Delta t\}} = \log K = -a - b\,R$$

Weight growth *(W)* for age in years, *t*, was estimated by the expression,

$$W = \{(1-q)\,c\,(t-t_0) + W_0\,1-q\}\;1/(1-q) \;......(13)$$

developed by Paloheimo and Dickie (1965) for fish which stay on a fixed *T*-line with constant *P* (Eq. 11) and $b = 0$ or close to zero (Eq. 12), and comparison made with the results of the von Bertalanffy model (Devaraj, 1981). In Eq. (13), $C = Pe^{-a}/(1-e^{-a})$ and W_0=weight at the arbitrary origin of the growth curve.

The possible periodicity of feeding was inferred from the degree of fullness of stomachs of fish caught in the drift gillnets, troll lines, and shore seines operated at various times of the day. The degree of aggression shown in predation was ascertained from the orientation of the prey organisms in the stomach of the predator.

RESULTS

Food composition

Food organisms taken by the kingseer included fishes belonging to 14 families, 1 cephalopod and 1 isopod (Table 1). The stomach contents of 1,554 kingseer from all the four zones amounted to 11,090.5 ml comprising 99.36% fish (teleosts) including 1.05% of digested matter, identified to be of fish origin, 0.60% cephalopods, and 0.04% isopods. Because of the involvement of bait, the troll-caught kingseer from zones III and IV were excluded from the evaluation of food composition. *Sardinella*, mainly *S.albella* and *S.gibbosa*, contributed the greatest volume (67.24%) of all food sources. The next few ranks were held by other (=unidentified) carangids (6.53%), *Rastrelliger kanagurta* (5.09%), *Hilsa kanagurta* (5.0%), *Chirocentrus dorab* (2.51%) and *Stolephorus* (2.5%) in decreasing order. Each of the other items contributed to much less than 2% of the total volume of food consumed (Table 1).

The total frequencies of occurrence (1,412) included 98.58% fish, 0.85% isopods, and 0.57% cephalopods. Species of *Sardinella* were predominant (50%). Next in importance were *Stolephorus* spp. (14.39%) and *Hilsa kanagurta* (2.13%). Only digested matter was observed in 18.24% of kingseer while unidentified fishes (hereafter referred to as 'fishes') were observed in 4.68% of fish studied. All other items contributed much less than 2% each; 11 items (*Mugil, Chorinemus, Upeneus, Sphyraena, Tachysurus,* Perches, *Gerres, Tetrodon, Rhynchorhamphus, Therapon* and bone remains occurred only once each (Table 1).

Among fish that accounted for 99.9% by IP, *Sardinella* was the most dominant food item (97.4%). All other items including *Stolephorus* (1%) which ranked second to *Sardinella* were quite insignificant (Table 1).

Among the tweny food items observed in 1967-'68 and nine items in 1968-'69 in Zone I *Sardinella* was the most preferred item (77.4% in 1967-'68 and 47.9% in 1968-'69 in volume and 63% and 55.3% in frequency in the respective years). Looking at the frequency of occurrence, *Anchoviella* (9.4 in the former year and 14.9% in the latter year) ranked second in the food contents. IP of *sardinella* was 91.9 in 1967-'68 and 76.1 in 1968-'69. Table 2a and 2b give the details on food items and respective IPs.

Food items in Zone II (northern Gulf of Mannar) were more or less similar to those observed in zone I. Here again *Sardinella* was the main item accounting for 55.3% and 86.9% in volume and 48.2% and 47.1% in frequencies in the respective years. *Anchoviella* occurred in 14.% and 23.1% of the frequencies observed and ranked second to *Sardinella. Sardinella* registered an IP of 80.4 in 1967-'68 and 85.67 in 1968-'69. Table 3a, 3b give the details of IP of food items in zone II.

A combined analysis for the zones III and IV (central Gulf of Mannar and southwest coast of India) is presented (Tables 4a, 4b) for two reasons (i) The zones are contiguous and also identical in relation to kingseer fishery and its feeding behaviour and (ii) data for zone III are too small to warrant separate treatment.

The food amounting to 286 ml of 169 adult kingseer sampled from drift gillnets consisted chiefly of *Sardinella* (34%), *Upeneus* (26.5%) and *Anchoviella* (17.9%) by volume. *Anchoviella* occurred in 17.4% cases and Sardinella in 9.8% giving an IP of 21.8 for *Sardinella* and 17.2 for *Anchoviella.* Other items were insignificant as shown by low IP values

TABLE 2a. *Monthly average index of preponderance (IP) of food organisms in the diet of fish sampled in different seasons from Zone I (Palk Bay) during 1967-68.*

Months	JUL-SEP	OCT-DEC	JAN-MAR	APR-JUN	Total	Rank
No. of fish examined	170	163	8	177	518	
Food items						
Sardinella	81.65	97.98	89.02	98.08	91.924	1
Anchoviella	0.22	0.74	0.00	0.17	0.311	5
Hilsa	3.78	0.09	0.00	0.45	1.177	4
Amblygaster	0.00	0.08	0.00	0.00	0.021	13
Chirocentrus	0.01	0.00	0.00	0.01	0.006	15
Mugil	0.00	0.10	0.00	0.00	0.026	12
Caranx	0.07	0.07	0.00	0.29	0.117	8
Selar	0.00	0.14	9.24	0.00	1.717	3
Megalaspis	0.00	0.00	0.00	0.01	0.003	16
Other carangids	0.00	0.00	0.00	0.61	0.167	7
Perches	0.01	0.00	0.00	0.00	0.002	17
Leiognathus	0.11	0.00	0.00	0.00	0.030	11
Gerres	0.00	0.02	0.00	0.00	0.006	15
Rhynchorhamphus	0.00	0.00	0.00	0.01	0.002	17
Therapon	0.04	0.00	0.00	0.00	0.011	14
Rastrelliger	0.00	0.00	0.00	0.23	0.062	9
'Fishes'	14.04	0.76	0.46	0.00	4.119	2
Fish scales	0.05	0.00	1.29	0.00	0.247	6
Isopods	0.03	0.01	0.00	0.00	0.011	14
Digested matter	0.00	0.00	0.00	0.14	0.041	10
Total	100.00	100.00	100.00	100.00	100	

TABLE 2b. *Monthly average index of preponderance (IP) of food organisms in the diet of fish sampled in different seasons from Zone I (Palk Bay) during 1968-69.*

Months	JUL-SEP	OCT-DEC	JAN-MAR	APR-MAY	Total	Rank
	137	79	16	12	244	
Food items						
Sardinella	89.24	85.03	79.19	3.75	76.104	1
Anchoviella	3.20	3.58	0.00	62.50	9.205	2
Hilsa	0.00	0.00	1.37	0.00	0.303	9
Chirocentrus	2.52	0.00	0.00	0.00	0.842	8
Carangids	3.82	6.47	0.00	—	3.441	5
Leiognathus	0.07	0.00	0.00	33.75	3.771	3
Rastrelliger	0.39	1.80	2.68	—	1.322	6
Fish scales	0.00	0.00	16.67	—	3.702	4
Digested matter	0.76	3.11	0.11	—	1.310	7
Total	100.00	100.00	100.00	100.00	100	

(Table 4a). 765 ml of food from 95 kingseer from troll lines consisted of 2.9% prawns and 0.7% cuttlefishes, besides 96.4% of fish. With an IP of 30-88, *Chirocentrus* was predominant among forage items followed by *Sardinella.* Indices for other forage items were quite insignificant (Table 4b). In both cases, a higher percentage in frequency led to high IP rates for digested matter; 59.2 for drift gill nets and 40.8 for troll lines.

The relation between the size (TL mm) of kingseer (x) using 70-90 mm hooks and the volume of baits in ml (y) in their stomachs was found to be linear, and fitted by the following equation

$$y = -155.3 + 0.1792x \quad ......(14)$$

$$(r=0.53)$$

This implies that for a given hook size (in the present case 70-90 mm), kingseer of a certain size range around the desired size could be caught by adjusting the bait size.

Seasonal variations

Tables 2a & 2b gives the IP for food items in a span of three months each during 1967-'69. In zone I *Sardinella* remained the most important item in all the season except April to June 1968-69. However, a decreasing trend in the IP values could be seen from October-December '67 onwards indicating some others gaining prominence, *e.g.* carangids, *Anchoviella* and *Rastrelliger* in October-December '68 and fish scales, *Rastrelliger* in June-March '69 and *Anchoviella* and *Leiognathus* in April-June '69. In all other season *Sardinella* was the mainstay of the food.

In zone II obviously *Sardinella* remained prominent in the food items throughout though conspicuous decrease could be observed during May-July period (Tables 3a, 3b). Carangids were prominent in May-July '68 with an IP of 30.7 and *Anchoviella* ranked second with an IP of 38.7, very close to 49.1 of *Sardinella.* Except fish scales in May-July 1969, no other item seems to have gained prominence in the food contents.

Variations according to age

IP values computed for different size groups are presented in Table 5. A comparison of IP of sardine and *anchoviella* indicates that *Anchoviella* was the sole forage item

TABLE 3a. *IP of organisms in the diet of fish sampled in different months from Zones I and II (northern Gulf of Mannar) during 1967-68.*

Months	AUG-OCT	NOV-JAN	FEB-APR	MAY-JUL	Total	Rank
No. of fish examined	130	82	100	104	416	
Food items						
Sardinella	83.55	98.62	86.75	52.99	80.484	1
Anchoviella	0.57	0.00	0.10	5.35	1.503	5
Hilsa	4.48	0.21	8.13	1.61	3.607	3
Amblygaster	0.00	0.00	0.84	0.00	0.210	13
Ilisha	2.88	0.00	0.00	0.00	0.719	8
Dussumieria	2.04	0.00	0.00	0.00	0.511	10
Thrissocles	0.00	0.00	0.00	0.04	0.010	19
Chirocentrus	1.14	0.00	0.00	5.49	1.659	4
Caranx	1.78	0.07	0.13	0.00	0.496	11
Megalaspis	0.17	0.00	0.00	0.00	0.043	15
Chorinemus	0.05	0.00	0.00	0.00	0.013	18
Other carangids	0.00	0.08	0.00	30.75	7.708	2
Tachysurus	0.08	0.00	0.00	0.00	0.019	17
Leiognathus	0.81	0.17	0.00	0.00	0.247	12
Tetradon	0.08	0.00	0.00	0.00	0.019	17
Rastrelliger	0.00	0.00	0.00	2.58	0.644	9
'Fishes'	2.04	0.80	0.54	0.00	0.845	7
Fish scales	0.07	0.02	0.00	0.00	0.020	16
Isopods	0.01	0.00	0.00	0.00	0.003	20
Loligo	0.25	0.00	0.00	0.00	0.062	14
Digested matter	0.00	0.00	3.51	1.20	1.178	6
Total	100.00	100.00	100.00	100.00	100.00	

TABLE 3b. *IP of organisms in the diet of fish sampled in different months from Zones I and II (northern Gulf of Mannar) during 1968-69.*

Months	AUG-OCT	NOV-JAN	FEB-APR	MAY-JUL	Total	Rank
No. of fish examined	68	72	55	42	237	
Food items						
Sardinella	96.13	97.19	88.02	49.19	85.672	1
Anchoviella	0.15	0.00	9.37	38.76	9.645	2
Amblygaster	0.55	0.00	0.00	0.00	0.149	7
Carangids	1.11	0.00	0.00	0.00	0.302	6
Leiognathus	0.00	0.00	0.43	0.03	0.124	8
Fish scales	0.04	0.05	0.00	4.90	0.913	4
Loligo	0.56	1.71	0.00	0.00	0.619	5
Digested matter	1.46	1.05	2.17	7.14	2.576	3
TOTAL	100.00	100.00	100.00	100.00	100.00	

IP for small size groups

Items/size group (mm)	51-100	101-150	151-200	201-250
Anchoviella	99.80	85.97	32.85	18.52
Sardinella	—	13.95	65.68	96.49

observed in the lowest length group 51-100 mm. The sudden decrease of IP values for *Anchoviella* and a matching increase in that of *Sardinella* in the size group 151-200 mm indicate a plausible shift in the food preference at a length of about 160 mm. Further increasing trend in the IP values of *Sardinella* and decreasing trend in that of *Anchoviella* corroborate this observation. No other item of food exhibited any clear trend indicating lack of preference or otherwise. Dominance of *Sardinella* in food item is persistently seen in all age groups (Table 5).

Variations in a average ration and ration per unit body weight

The average ration of the kingseer in Palk Bay and northern Gulf of Mannar at any active feeding time was found to range between 3.3 ml and 12.1 ml with the mean of 8.2 ml during 1967-'68 and between 1.2 ml and 13.4 ml with the mean of 7 ml during 1968-69 (Table 6). It may be observed that ration was almost steady about 9.2 ml during five months-August to December in former year and steady about 6.3 ml during five months July to November of latter year. It ranged between 0.3 ml in 51-100 mm size to 73 ml in the 1301-1305 mm size group during 1967-'68 and between 0.2 ml in 51-100 mm group and 66 ml in 1001-1050 mm group in 1968-'69 (Table 7). Though the trend observed during 1967-'68 was not identical with that observed in 1968-'69, combining the two sets of observations, it is inferred that a positive regression exists for ration on size groups.

The average ration per 1000 grams of body weight (*R*1) over time was observed to follow a random behaviour in both the years (Tables 6, 8,9). *R*1 in relation to fish size conspicuously showed a decreasing trend in contrast to the apparent increasing trend in *R*. Reference to table 10 would reveal that the decreasing trend was more marked in lower size groups, relatively high values occurring when juveniles dominate.

Data were available from zones III and IV only for a short period: from September through November, 1968 and April 1969. Out of the 9 fish 7 in September and out of 25, 15 in April, were juveniles while in all other months fish over a meter in length dominated the samples.

Effect of maturation on feeding

The Table 10 gives the average ration (R) and the ration per unit body weight (*R*1) of kingseer fishes of size groups of 50 mm ranges for males and females separately. It could be observed that intermediate and maturing fish consume more food than immature fish. The order of variation in R among the three groups does not differ much between males and females; (CV = 74.5 for males and 72.0 for females). But the order of variation in R1 among the three groups is a little higher in respect of males (CV=44.1 for males; 35.6 for females). Further R1 is, in general, found to be greater in intermediate stage than in mature and immature stages in both sexes indicating thereby maximum food intake just before the onset of maturity.

Condition of feed and feeding periodicity

The drift gillnets are operated ordinarilly from 6.30 p.m. to 4 a.m., and the shore seines from 5 a.m. to 10 a.m. The material from these two gear were treated separtely to find out periodicity in the feeding activity. Stomachs which were found gorged, full or 3/4 with food were designated as 'well fed', 1/2 or 1/4 filled as 'partly fed', with traces of food as 'poorly fed', and empty as 'starving'.

TABLE 4a. *Percentage volume (V), percentage occurrence (O), and IP of organisms in the diet of drift gillnet-caught fish from zone III (central Gulf of Mannar, Tuticorin) and zone IV (southwest coast of India, Cape Comorin-Colachel).*

Months	September 1968			September 1968			October 1968			April 1969			Combined			
No. of fish examined	7			5			130			27			169			
Food items	%vol.	%freq	IP	%vol.	%freq	IP	%vol.	%freq	IP	%vol.	%freq	IP	%vol.	%freq	IP	Rank
Sardinella	4.3	14.3	0.7	0	0	0	40.4	10.6	24.9	10.5	4.8	0.8	34	9.8	21.83	2
Anchoviella	95.7	85.7	99.3	0	0	0	2.2	0.9	0.1	84.7	66.7	96.8	17.9	14.7	17.24	3
Carangids	0	0	0	0	0	0	1.3	0.9	20	0	0	0	1	0.7	0.05	7
Upeneus	0	0	0	0	0	0	32.4	0.9	1.7	0	0	0	26.2	0.7	1.2	4
Sphyraena	0	0	0	0	0	0	6.9	0.9	0.3	0	0	0	5.6	0.7	0.26	5
Fish scales	0	0	0	0	0	0	1.7	2.7	0.3	0	0	0	1.4	2.1	0.19	6
Fish bones	0	0	0	90.9	50.9	90.9	0	0	0	0	0	0	1	0.7	0.06	8
Digested matter	0	0	0	9.1	50	9.1	10.1	84.2	72.7	4.9	28.6	2.4	12.8	70.6	59.2	1
Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

actual 23 ml 7 3.3 ml 2 231.4 ml 113 28.7 ml 21 286.4 ml 143

TABLE 4b. *Percentage volume (V), percentage occurrence (O), and IP of organisms in the diet of troll line-caught fish from zone III (Tuticorin) and IV (Cape Comorin-Colachel).*

Zone	Tuticorin			Cape Comorin-Colachal									Combined			
Months	November 1968			October 1968			November 1968			April 1969						
No. of fish examined	3			61			26			5			95			
Food items	%vol.	%freq	IP	%vol.	%freq	IP	%vol.	%freq	IP	%vol.	%freq	IP	%vol.	%freq	IP	Rank
Sardinella	54.8	33.3	55.1	21	16	21.5	1.7	1.7	0.6	0	0	0	16.5	13.9	12.56	3
Anchoviella	0	0	0	4.2	5.4	1.4	0	0	0	0	0	0	1.1	3.8	0.23	6
Amblygaster	8.3	33.3	8.4	0	0	0	0	0	0	0	0	0	1.5	1.3	0.11	8
Chirocentrus	0	0	0	56.1	17.8	64	22	28.6	29.1	24.2	33.3	17.6	27.6	20.3	30.88	2
Carangids	0	0	0	8.3	3.6	1.9	67.7	21.4	67.2	0	0	0	26.7	6.3	9.27	4
Lactarius	0	0	0	4.2	1.8	0.5	0	0	0	0	0	0	1.1	1.3	0.08	9
balistes	36.9	33.3	36.5	0	0	0	0	0	0	75.6	50	82.4	20.6	5.1	5.79	5
Fish scales	0	0	0	0.3	3.6	0.1	0.3	7.1	0.1	0	0	0	0.2	3.8	0.04	11
Penaeus	0	0	0	0	0	0	8	7.1	2.7	0	0	0	2.9	1.3	0.21	7
Loligo	0	0	0	2.7	1.8	0.3	0	0	0	0	0	0	0.7	1.3	0.05	10
Digested matter	0	0	0	3.2	50	10.3	0.3	28.6	0.3	0.2	16.7	20.1	1	41.8	40.77	1
Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	

actual 325 ml3 481.1 ml 56 636.6 ml 14 322.5 ml 6 1765.2 ml 79

TABLE 5. *IP of organisms in the diet of fish of different length groups from zones I (Palk Bay) and II (Northern Gulf of Mannar) during 1967-69.*

Food items	51-100	101-150	151-200	201-250	251-300	301-350	351-400	401-450	451-500	501-550	551-600	601-650	651-700	701-750
Sardinella	0	13.95	65.58	80.68	96.49	98.75	92.85	90.23	98.63	98.63	96.36	94.69	98.87	93.77
Anchoviella	99.8	85.97	32.85	18.52	3.45	1.24	0.4	1.37	0.78	0.96	0.73	1.08	0.08	0
Hilsa	0	0	0	0	0	0	0	0.02	0.01	0	0	0.1	0.06	5.01
Amblygaster	0	0	0	0	0	0	0	0	0	0.07	0.17	0.13	0	0
Ilisha	0	0	0	0	0	0	0	0	0	0	0.001	0.42	0.62	0.03
Dussumieria	0	0	0	0	0	0	0.16	0	0	0.01	0.08	0.1	0	0
Thrissocles	0	0	0.04	0.07	0	0	0	0	0	0	0	0	0	0
Chirocentrus	0	0	0	0.23	0	0	0	0	0	0.03	0.12	0.01	0	0
Caranx	0	0	0	0	0	0	0	0	0.02	0.04	1.38	0.37	0.01	0
Selar	0	0	0	0	0	0	0	0	0	0	1.01	0	0.26	0.13
Chorinemus	0	0	0	0	0	0	0.11	0	0	0	0	0	0	0
Other carangids	0	0	0	0	0	0	0	0	0.08	0	0	0	0.02	0.01
Leiognathus	0	0	0.66	0.02	0	0	0.35	0	0	0.02	0.09	0.1	0	0
Rastrelliger	0	0	0	0	0	0	0	0	0	0	0	0	0	0.39
'Fishes'	0	0	0	0	0	0	0.3	7.76	0.22	0.13	0.34	2.64	0.004	0.29
Fish Scales	0	0	0.02	0	0.06	0	0.01	0	0	0.001	0.001	0.01	0	0.003
Isopods	0	0	0	0	0	0	0.07	0	0.01	0.001	0	0	0	0.01
Digested matter	0.2	0.08	0.76	0.48	0	0.01	0.3	0.58	0.26	0.07	0.71	0.11	0.08	0.36
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

TABLE 5. contnd..

	751-800	801-850	851-900	901-950	951-1000	1001-1050	1051-1100	1101-1150	1151-1200	1201-1250	1301-1350	Total	Rank
No,. of fish examined	67	41	33	37	33	17	13	20	10	5	2	1385	
Food items													
Sardinella	93.69	94.88	97.88	97.56	97.81	72.31	44.19	95.26	64.49	82.2	54.42	80.784	1
Anchoviella	0	0	0	0.002	0	0	0	0	0	0	0	9.899	2
Hilsa	3.62	3.77	0	0	0	0	55.1	0	0	0	0	2.707	4
Amblygaster	0	0	0	0	0	1.69	0	0	0	0	0	0.0.82	11
Ilisha	0	0	0	0	0	0	0	0	0	0	0	0.042	14
Dussumieria	0	0	0	0	0.08	0	0	0	0	0	0	0.017	17
Chirocentrus	0	0.35	0	1.45	0	2.44	0.02	0	0	0	0	0.186	9
Mugil	0	0	0	0	0	0	0	0	0	0	45.58	1.823	5
Caranx	0	0	0	0	0.04	0	0.28	0	0	0	0	0.085	10
Selar	0	0	0	0	0.25	0	0	0	0	0	0	0.026	16
Megalaspis	0	0.02	0	0	0	0	0	0	0.82	0	0	0.033	15
Chorinemus	0	0	0	0	0	0	0	0	0	0	0	0.004	19
Other carangids	0.67	0.55	0.14	0.94	0	22.45	0	0	34.14	17.56	0	3.063	3
Leiognathus	0	0	0.04	0	0	0	0	0	0.45	0	0	0.069	12
Rastrelliger	0.82	0	1.78	0	1.16	1.11	0	3.56	0	0	0	0.352	7
'Fishes'	0.005	0.01	0	0.02	0	0	0	0	0	0	0	0.468	6
Fish Scales	0.08	0	0.02	0	0.01	0	0.07	0	0	0	0	0.01	18
Loligo	00.8	0.16	0	0	0.02	0	0	1.11	0	0	0	0.058	13
Digested matter	1.01	0.26	0.14	0.03	0.36	0	0.34	0.07	0.01	0.24	0	0.273	8
Total	100	100	100	100	100	100	100	100	100	100	100	100	

The drift gill nets are operated during night hours; paying out after 6.30 p.m. and two hauls taken at 10 p.m. and 4 a.m. Catches from first haul are subjected to pitcuring and from the second landed in fresh condition. About 95% of the specimens from second haul revealed empty stomachs while a little over 50% from first haul were well fed or partly fed which lead to the inference that the fish feeds actively between 7 p.m. and 10 p.m. Specimens from troll lines operated primarily between 10 a.m. and 2 p.m. had large quantities of baits indicating that seer fish take to baits vigorously during this period. Evidence was there (Deshpande and Siva, 1969) that there was a progressive increase in the catch from 8.30 a.m. and the peak attaining between 10 a.m. and 11 a.m. in the forenoon indicating feeding

TABLE 6. *Volume of food in ml (total, average for 1,000 gram body weight in the samples for successive months from Zones I (Palk Bay) and II (northern Gulf of Mannar during) 1967-68 and 1968-69*

		Mean weight of fish in samples	No. of fish examined	Total	Average	For 1000g body weight
1967	July	967.7	25	83.4	3.3	3.4
	Aug	884.6	103	966.2	9.4	10.6
	Sept	935.5	100	768	7.7	8.2
	Oct	1075.9	180	1532.2	8.5	7.9
	Nov	1573.7	44	443.8	10.1	6.4
	Dec	1324.3	75	806.2	10.7	8.1
1968	Jan	2318.1	24	137.8	5.7	2.5
	Feb	2000	15	144.3	9.6	4.8
	Mar	2312.5	27	328.3	12.2	5.3
	Apr	666.6	61	234.4	3.8	5.8
	May	414.8	154	830.3	5.4	13
	Jun	1283	96	1154.4	12	9.4
1968	July	502.8	58	432.1	7.5	14.8
	Aug	454.5	75	398.1	5.3	11.7
	Sept	1155.5	50	311.3	6.2	5.4
	Oct	928.5	68	477	7	7.6
	Nov	803	30	170	5.7	7.1
	Dec	3500	53	712.5	13.4	3.8
1969	Jan	2458.3	24	307	12.8	5.2
	Feb	1138.2	29	373	12.9	11.3
	Mar	327.8	12	33.7	2.8	8.6
	Apr	182.4	28	94.1	3.4	18.4
	May	44.3	47	56.4	1.2	27.1
	Jun	–	–	–	–	–
	July	3500	7	9.6	1.4	0.4
67-68	combined	946865.3	904	7429.3	8.2	7.8
68-69	combined	521382.8	481	3374.8	7	6.5

activity around that time. Combining the observation on species from shore seines, it would appear that feeding activity is good in the forenoon, may be between 8.30 and 11.30 a.m. and a second peak between 7.00 p.m. and 10 p.m.

Aggressiveness in feeding

The items of prey that are oriented in the stomach in reverse axis of the predator may be regarded to have been passively preyed upon and those oriented in same axis (anteroposterior) of the predator may be considered to have been actively chased and fed upon. Based on this criterion 67.8% of the prey oriented in anteroposterior axis indicate an aggressive nature of feeding (Tables 11a, 11b). An interesting observation has been that 100% agressiveness was noticed in the 1051-1100 mm, 1201-1250 mm and 1301-1350 mm groups.

Food intake and utilization at successive years of age

The weights (W) attained by the kingseer at successive years of age (Devaraj, 1981), and average annual rations (R Δ t) consumed at successive ages in years (Eq. 4; R in ml x density 1.25 = *R* in g; frequency of active feeding per day = 2) are given in Table 12 from which the relation between *W* and R Δ t is fitted by using Eq. (6),

$$\ln R \Delta t = 2.2806 + 0.8859 \ln W \;...... (15)$$

(r = 0.98).

From the weight increments (Wt), *C* (Eq. 7), *K* (eg. 8) and *T* (Eq. 9) at successive years of age (Table 12), the following relations were fitted,

$$\ln T = 1.9067 + 0.9106 \ln w \; (r=.97) \;...... (16)$$

$$\ln K = 1.4538 - 0.000026 R \Delta t \; (r=-0.92) \;..... (17)$$

Since the value of b = 0.000026 in Eq. 17 is close to zero, weight growth in kingseer was estimated by Eq. (13). c in Eq. (13) has been estimated to be 2.0524 for P = 6.7305 (Eq. 16) and $-a$ - 1.4538 (Eq. 17). W_o has been estimated by converting l_o = 6.15 cm (derived for t = 0 year) into weight using the length-weight relation: $W = 0.009614 L^{2.8577}$ where W = weight in g and L = total length in cm (Devaraj, 1981). Substituting the values of q = 0.9106, W_o = 1.7269 g. C = 2.0524 and t_o = -0.15955 year in Eq. (13), W for t = 1 year has been found to be 13.6 g as against the empirical value of 265 g (Table 12).

DISCUSSION

In all the study zones the IP for the major food items, sardines or whitebaits or both, generally matched their abundance in the ecosystem. The fact, however, that whitebaits occupied only a second position in the diet in spite of their greater abundance in zones III and IV owes to their diurnal vertical migratory habits, and hence, their being inaccessible to pelagic predators during day time. That there generally exists a relation between the pattern of distribution and abundance of the major prey and predator populations is apparent from the peak in the troll line fishery for the kingseer in the central of Gulf of Mannar (zone III) in September when the whitebaits migrating from the southwest coast of India pile up in zone III with a stock size of 0.21 to 0.51 million tons (UNDP/FAO, 1974). By October, as the whitebaits begin their return migration, the kingseer fishery immediately dwindles in zone

TABLE 7. *Volume of food in ml (total), average and for 1000 g body weight taken by fish of different length groups from zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-68 and 1968-69.*

	Length groups (mm)	51-100	101-150	151-200	201-250	251-300	301-350	351-400	401-450	451-500	501-550	551-600	601-650	651-700
	Mean weight of fish in samples in g (W)	3.2	13.3	30.3	64.9	126	209.8	319.8	433.2	568.9	747.7	955.3	1234.2	1493.5
A. 1967-68	No. of fish examined (N)	4	34	65	37	14	20	46	85	91	105	92	71	38
	Total	1.1	16.8	59.3	46.8	24.8	47.4	166	311.6	500.7	727.8	614	639	407.4
	Average	0.3	0.4	0.9	1.2	1.7	2.3	3.6	3.6	5.5	6.9	6.6	9	10.7
	For 1000 g body weight	93.8	30	29.7	18.4	13.4	10.9	11.2	8.3	9.6	9.2	6.9	7.2	7.1
B. 1968-69	No. of fish examined (N)	15	34	42	24	15	7	11	23	49	25	30	31	34
	Total	3.6	29.1	56.8	46.5	35	20.5	38.7	112.9	266.6	61.3	53	198.1	172.9
	Average	0.2	0.8	1.3	1.9	2.3	2.9	3.5	4.4	5.4	2.4	1.7	6.6	5
	For 1000 g body weight	52.6	60.1	42.9	29.2	18.2	13.8	10.9	10.1	9.4	3.2	1.7	5.3	3.3

	Length groups (mm)	701-750	751-800	801-850	851-900	901-950	951-1000	1001-1050	1051-1100	1101-1150	1151-1200	1201-1250	1301-1350	Combined
	Mean weight of fish in samples in g (W)	1838.3	2208.1	2609.8	3182.3	3909.8	4370.9	5307.5	6276	7085.1	8675.5	10850	14700	1187741.2
A. 1967-68	No. of fish examined (N)	37	44	26	18	28	17	11	2	10	5	2	2	904
	Total	468.2	366.4	629	394	663	623.9	206	44.1	60.2	146.3	118.5	147	7429.3
	Average	12.6	8.3	24.1	21.8	23.6	36.7	18.7	22	6	29.2	59.2	73	8.2
	For 1000 g body weight	6.8	3.7	9.2	6.8	6	8.3	3.5	3.5	0.8	3.3	5.4	4.9	6.2
B. 1968-69	No. of fish examined (N)	34	28	23	15	9	16	6	11	10	5	3	0	481
	Total	295.2	240	65.4	56.5	220.1	137.6	396	364.1	270	160.4	74.5	0	3374.8
	Average	10.4	10.4	4.4	5.7	24.4	8.6	66	33.1	27	32.1	24.8	0	7
	for 1000 g body weight	5.6	4.7	1.6	1.7	6.2	1.9	1.2	5.2	3.8	3.7	2.2	0	

III, but increases enormously along the southwest coast. The low incidence of the rainbow sardine, *Dussumieria acuta*, suggests that the kingseer is essentially a surface feeder.

Kingseer apparently switches over from a smaller forage like whitebaits to a large one like sardines at a size of about 160 mm, about 1/13th of its L_∞ 2081 mm (Devaraj, 1981).

Although there was a marked reduction in the number of forage items from over 20 in 1967-68 to less than 10 in 1968-'69 in zone I and II alike, the average ration taken by the kingseer reduced in the latter year only by a marginal 15% from that in the former year while during the same period R decreased by 32% and 50% respectively in the case of streaked seer and the spotted seer and this is a further evidence that the kingseer is a highly competent and successful species. The occurrence of relatively low ration as the one observed in Kanyakumari coast (zone IV) in October is perhaps suggestive of intraspecific (intraspecies) competition.

The high incidence of starving kingseer (70.6%) in the night catches by drift gillnets from zones III and IV during September-December 1968 and April 1969 was possibly due to scarcity of forage. Comparing the incidence of starving in kingseer, it appeared the higher the incidence of starving in the nights, the greater, was the success of daytime trolling in view of the ready response expected of starving fish to baits. The absence of food including baits in 41.8% of the individuals caught during might suggest regurgitation while being trolled as noticed by Williams (1964) in 65.5% of kingseer caught in trolls from East African waters. It should, however, be noted that the kingseer off the Goa coast readily caught in trolls had artificial lures in stomachs in spite of their stomachs being gorged with natural food in fresh or slightly digested state. (Dhawan, *et al.*, 1972) and hence, the hypothesis that starvation is vital to successful trolling appears untenable. The fact that 51% of the kingseer caught off Cochin in trolls using jigs and double hooks were found to have fed on sardines, whitebaits, mackerels and cuttlefish while 49% had empty stomachs (Deshpande and Sivan, 1969) owing to regurgitation while being trolled, also suggests that starvation does not play any great role in determining the success of trolling. The lure of the type used by Dhawan, *et al.* (1972) certainly seems to prevent regurgitation. Evidently, the jigs used by Deshpande and Sivan (1969) could not serve this purpose.

Although a linear relation has been found to exist between the size of the kingseer caught in trolls and the size of bait used for a given hook size in zones III and IV (70-90 mm

TABLE 8. *Volume of food in ml (total, average and for 1000 g body weight) taken by fish sampled in diffeent months from zones III (Tuticorin) and IV (Cape comorin-Colachel).*

Months	Sep 1968	Oct 1968	Nov 1968	Apr 1969	Total
No. of fish examined	9	177	18	25	229
Total	26.3	730.7	965.8	350.2	2073
Average	2.9	4.2	53.7	14	9.1
For 1000 g body weight	31.7	1.3	5.1	9.4	1.9

TABLE 9. *Volume of food in ml (total, average and for 1,000 g body weight) taken by fish of different length groups from zones III (Tuticorin) and IV (Cape Comorin-colachel)*

Length groups (mm)	151-200	201-250	251-300	501-550	551-600	601-650	651-700	701-750	751-800	801-850	851-900	901-950	951-1000
Mean weight of fish in g (W)	37	65.2	111.1	800	790	1285	1450	2025	2500	2833.3	3380.3	4036.3	4684.3
No. of fish examined (N)	4	12	7	1	3	4	4	2	4	5	22	38	32
Total	7.8	28.7	10.1	0.5	12.6	10.1	15	0.8	69.1	17.4	28	52.2	19.9
Average	2	2.4	1.4	0.5	4.2	2.5	3.7	0.4	17.3	3.5	1.3	1.4	0.6
For 1000 g body weight	54	36.8	12.7	0.6	5.3	2	2.6	0.2	6.9	1.2	0.4	0.3	0.1

Length groups (mm)	1001-1050	1051-1100	1101-1150	1151-1200	1201-1250	1251-1300	1301-13500	1351-1400	1401-1450	1451-1500	Combined
Mean weight of fish in g (W)	5287.5	5937.5	6320	9282.9	9224.5	1666.6	12040	12333.3	16850	18800	1097788.3 {=Σ (NW)}
No. of fish examined (N)	26	20	15	12	5	3	6	2	1	1	229
Total	93.5	123.5	234.4	446.4	149.3	52.3	404.5	94.5	0.3	202	2072.9
Average	3.6	6.2	15.6	37.2	29.9	17.4	67.4	49.3	0.3	202	9.1 (=2072.9/229)
For 1000 g body weight	0.7	1	2.5	4	3.2	5.6	5.6	3.8	0.01	10.8	1.9 (=(2072.9×100)1097788.3)

hooks), the age structure of troll-caught fish seems to depend more on the age structure of the population in a given season and locality than on the size of bait or hook. For example, in zones III and IV where 70-90 mm hooks with fish as bait were used, the age of fish caught ranged from 3 to 6 years with 3 and 4 years olds forming the bulk, whereas off Goa 90 mm hooks with 100 mm long artificial lure caught 2 to 4 year old fish of which 2 year olds were predominant (Dhawan, *et al.* 1972). In Cochin where 50-70 mm hooks with jigs were used, the average weight of kingseer was much less in the 1960-61 season (1.48 kg) than in 1961-62 (4.80 kg) indicating that older fish dominated in the latter season (Deshpande and Sivan, 1969).

The kingseer seems to be an aggressive predator. This is evident from the high incidence (67.8%) of anterosposterior orientation of the prey items in the gut.

Feeding is intense between 8.30 and 11.30 a.m. and between 7 and 10 p.m., and therefore, trolling, which is usually carried out during daytime, is more productive between 8.30 and 11.30 a.m. Since feeding is usually by vision, it is not known whether artificial lures with an iridescent surface would be able to attract the predators in the night from a distance at the optimum trolling speed of 4 to 6 knots to take advantage of their active feeding between 7 and 10 p.m. Diurnal cycles of locomotory activity in fish are frequently associated with feeding. The kingseer and the sardines which constitute the mainstay of their diet exhibit more or less similar diurnal cycles of activity. Therefore, if the sardines are inactive or less active by night, say between 7 and 10 p.m.,

TABLE 10. *Average ration (R) and ration per 1,000 g body weight (R1) in ml consumed by fish of different length groups (mm) under I (immature), II (intermediate) and III (maturing) stages from zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-68 and 1968-69.*

Length groups mm		301-350	351-400	401-450	451-500	501-550	551-600	601-650
1967-68								
Male I	R	0.4	4.4	5.5	5.6	4.5	9	2.8
	R1	1.9	13.8	12.6	9.9	6	9.5	2.3
II	R	0	0	4.5	4.7	12.1	9.7	6.5
	R1	0	0	10.4	7.3	16.2	10.1	5.2
III	R	0	0	0	4.5	5.3	7.8	12.1
	R1	0	0	0	7.8	7.1	8.2	9.8
Female I	R	0	4.7	4.6	5.2	6.2	6.1	9.2
	R1	0	14.5	10.5	9.2	9	6.4	7.5
II	R	0	0	0	10.5	10.1	9.2	9.8
	R1	0	0	0	18.5	13.4	9.7	7.9
III	R	0	0	0	0	7	0	0
	R1	0	0	0	0	9.4	0	0
1968-69								
Male I	R	0	3.3	2.2	6.7	2.5	1.4	4.8
	R1	0	10.4	5.1	11.8	3.3	1.4	3.9
II	R	0	0	0	0	1	0.3	3.3
	R1	0	0	0	0	1.3	0.3	2.7
III	R	0	0	0	0	0	1.3	0
	R1	0	0	0	0	0	1.4	0
Female I	R	0	3.5	4.4	3.7	2.5	3.1	3.1
	R1	0	11	10	6.5	3.3	3.2	2.5
II	R	0	0	0	0	0	0	52
	R1	0	0	0	0	0	0	42.1
III	R	0	0	0	0	0	0	0
	R1	0	0	0	0	0	0	0

TABLE 10 *Continued.....*

Length groups mm		651-700	701-750	751-800	801-850	851-900	901-950	951-1000	1001-1050
1967-68									
Male I	R	2.5	0	0.5	0	0	0	0	0
	R1	1.7	0	0.2	0	0	0	0	0
II	R	13.2	9.5	3.9	21.3	16	32.4	0	0
	R1	8.8	5.2	1.8	8.2	5	8.3	0	0
III	R	9.1	10.3	5.7	16.9	20.5	11.3	14.9	10.9
	R1	6.1	5.6	2.6	6.5	6.4	2.9	3.4	2.1
Female I	R	10.9	9.5	0	0	0	0	0	0
	R1	7.3	5.2	0	0	0	0	0	0
II	R	15.4	11.8	13.3	22.4	25.1	15.6	18.8	0
	R1	10.2	6.4	6	8.6	7.9	4	4.3	0
III	R	13	0	8	7.1	14.3	39	73.3	32.8
	R1	8.7	0	3.6	2.7	4.5	10	16.8	6.2
1968-69									
Male I	R	3.5	0	6	0.3	0	0	0	0
	R1	2.3	0	2.7	0.1	0	0	0	0
II	R	7	4.8	7.2	7.6	0	10.4	1.5	10
	R1	4.7	2.6	3.3	2.9	0	2.7	0.3	1.9
III	R	1.7	5.4	2.7	0.2	6.1	0	7	15.2
	R1	1.1	2.9	1.2	0.1	1.9	0	1.6	2.9
Female I	R	7.2	14	1	0	0	0	0	0
	R1	4.8	7.6	0.5	0	0	0	0	0
II	R	10.6	15.9	20.7	12.1	0.8	18	7.7	2.7
	R1	7.1	8.6	9.4	4.6	0.2	4.6	1.8	39
III	R	0	1.5	2.9	0	3.8	53.2	23.5	10.8
	R1	0	0.8	1.3	0	1.2	13.6	5.4	2

TABLE 10 *Continued.....*

Length groups mm		1051-1100	1101-1150	1151-1200	1201-1250	1301-1350	Combined
1967-68							
Male I	R	0	0	0	0	0	3.9
	R1	0	0	0	0	0	6.4
II	R	0	0	0	1	0	11.2
	R1	0	0	0	0.1	0	7.2
III	R	4.6	11.8	20	117.5	147	25.3
	R1	0.7	1.7	2.3	10.9	10	5.5
Female I	R	0	0	0	0	0	7.1
	R1	0	0	0	0	0	8.7
II	R	0	0	0	0	0	14.7
	R1	0	0	0	0	0	8.8
III	R	0	0	125	0	0	35.5
	R1	0	0	14.4	0	0	8.5
1968-69							
Male I	R	0	0	0	0	0	3.4
	R1	0	0	0	0	0	4.7
II	R	40.2	35.4	0	0	0	10.7
	R1	6.4	5	0	0	0	10.7
III	R	12.5	22	0.5	37.8	0	9.4
	R1	2	3.1	0.1	3.5	0	1.8
Female I	R	0	0	0	0	0	4.7
	R1	0	0	0	0	0	5.5
II	R	19.2	24.3	67	0	0	37.9
	R1	3.1	3.4	7.7	0	0	11
III	R	7	1	71.3	0	0	17.6
	R1	1.2	0.1	8.2	0	0	3.4

TABLE 11a. *Percentage orientation of forage fish in the stomach of fish from zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-1969.*

A. Monthwise

Months	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Combined
'Head anterior'	83.3	81.8	80	51.7	64.3	71.9	50	46.2	55.6	55.6	64.4	75	67.8 (251 actual)
'Head posterior'	16.7	18.2	20	48.3	35.7	28.1	50	53.8	44.4	44.4	35.6	25	32.2 (119 actual)

TABLE 11b. *Percentage orientation of forage fish in the stomach of fish from zones I (Palk Bay) and II (northern Gulf of Mannar) during 1967-1969*

B. Size groupwise

Length groups (mm)	301-350	351-400	401-450	451-500	501-550	551-600	601-650	651-700	701-750	751-800
'Head anterior'	66.9	90.9	63.2	68.6	50	60	40	63.2	33.3	50
'Head posterior'	33.3	9.1	36.8	31.4	50	40	60	36.8	66.7	50

B. Size groupwise

Length groups (mm)	801-850	851-900	901-950	951-1000	1001-1050	1051-1100	1101-1150	1151-1200	1201-1250	130-1350	Combined
'Head anterior'	88.2	57.6	87.5	60	53.8	100	79.3	69.6	100	100	67.8 (251 actual)
'Head posterior'	11.8	42.4	12.5	40	46.2	0	20.7	30.4	0	0	32.2 (119 actual)

the kingseer feeding on them would also have so reduced their swimming activity that they may not be inclined to chasing actively after the lure on a fast moving trolling gear.

The steady increase in *R* and *R* increment between successive years of age with increasing age of the kingseer is commensurate with the increase in the length and weight increments between successive years of age, excepting a slight decline observed in weight increment between 4 and 5 years of age which may be due to random causes. The steady decrease in the ration per unit body weight (R_1) with increasing age, excepting a slight increase at the age of 5 years, suggests much greater food needs per unit body weight at younger ages in accordance witl. the relatively greater physical and physiological activities of young fish. The fact that maturing and ripe fish increased their food intake indicates that, unlike popular belief, conditions of stress due to maturity and spawning can, in fact, enhance food consumption rather than retard it. In the tropics which is a region of higher stress, although under conditions of stress, gonad production is generally given preferencee over somatic growth, growth after maturity may be large (Moore, 1972), but the marginal decline in weight increment noticed in the kingseer between 4 and 5 years of age following first maturity and spawning at 2-3 years of age is rather puzzling. Conversion factor (*C*) and gross growth efficiency (*K*) values which ranged from 4.11 to 15.96 and 0.06 to 0.24 respectively reveal that generally large amounts of food are utilised by the kingseer to produce a unit

TABLE 12 *Empirical lengths in mm(L), weights in g (W), ration per one active feeding period in ml (R), R per 1000 g body weight in ml (R1), Annual R, i.e. R Δ t in g, annual i.e., R Δ t /1000 g W in g, conversion factor (C), gross growth efficiency (K) and R1 annual total metabolic rate in G (T = RΔ t - Δ Wt) according to age in years (t). Increments are given between brackets. N = Nunber of fish studied for the estimation of food intake and utilisation parameters.*

tt	L	W(Wt)	R	R1	R Δ t	R Δ t/1000 g W	C	K	T	N
1	358(358)	265(265)	1.8(1.8)	27.9(27.9)	1643	6200	6.2	0.16	1378	968
2	661(303)	1530(1265)	5.7(3.9)	6.8(-21.1)	5201	3399	4.1	0.24	3936	278
3	932(271)	4083(2553)	13.9(8.2)	5.2(-1.6)	12319	3017	4.8	0.21	9766	100
4	1149(217)	7423(3340)	27.3(13.4)	3.5(-1.7)	24911	3356	7.5	0.13	21571	35
5	1304(115)	10650(3227)	54.7(27.4)	4.3(0.8)	49914	4687	15.5	0.06	46687	2
Combined		10650			93988		8.8	0.11	83341	

growth, owing to considerable energy loss on account of its fast swimming and aggressive habits. Since generally one half or more of food energy is required to support metabolic processes, *C* is rarely less than 2 and *K* rarely greater than 0.5 (Hastings and Dickie, 1972).

Since under normal nonstress living conditions in nature *q* (the slope of the *T*-line) of about 0.8 describes the relation between metabolism and body weight in most fish species (Winberg, 1956; 1961), $q = 0.9106$ (Eq. 16) for the kingseer shows that the fish live on optimum levels of diet in a normal nonstress state.

The value of $e^{-a} = e^{-1.4538} = 0.23$ of the *K*- line (Eq. 17) for the kingseer in their natural state is outside the range of values (0.25 to 0.75) arrived at in the feeding experiments by Paloheimo and Dickie (1965). These are practical limits in feeding experiments and in nature the range may very well be less than this (Slobodkin, 1961). This would explain the low value (0.23) obtained in the present study. In the kingseer, the Paloheimo-Dickie model shows that the weight increments keep increasing even after *bR* attains a value of one since *b* which is close to zero (when $b = 0$, growth efficiency does not change) pushes the reference point, where fish attain their maximum growth, to infinity. However, weight growth estimates by different methods suggest the von Bertalanffy model to be very realistic and superior to the models built on food utilisation parameters. That the von Bertalanffy-estimated weight asymptote (39 kg) is genuine is evident from the fact that the largest kingseer weighing 33 kg caught in October 1975 from Palk Bay was so senile and inactive that it formed a stable substratum for the settlement of 40 specimens of *Balanus* and rich growth of filamentous algae on the sides of its body, head and fins.

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