FOOD AND FEEDING HABITS OF THE HORSE-MACKEREL, *CARANX KALLA* (CUV. & VAL.)

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INTRODUCTION

The importance of the knowledge of food and feeding habits of a fish in understanding its fishery biology has been very well established. Often it helps in finding out the seasonal variations in the distribution of a fish species. Sometimes the rate of feeding has a bearing on the spawning of the fish. The nature of the food composition of a fish will also throw light on the possible habitats it frequents. Chidambaram and Venkataraman (1946), Chacko and Mathew (1955) and Kagwade (1965) have given short accounts of the food of *Caranx kalla*. The food and feeding habits of the different species of the horse-mackerel have been described briefly in the works of Datar (1954), Kuthalingam (1955, '59) and Tandon (1960). But for these, there is no other published account on the food and feeding habits of *C. kalla* which forms an important component of the fish catches both on the east and west coasts of India. Hence, an attempt has been made here to study this aspect in detail.

MATERIAL AND METHODS

The material was collected from the landings of boat seines and gill nets operating in the inshore waters off Calicut. During the period of investigation, from January 1958 to December 1959, 556 fish were examined. Of these, 196 were juveniles and 360 adults. Usually two or three samples, each of about 10 fish, were examined every month.

C. kalla when brought to the laboratory were cleaned and their total lengths were noted. The fish were cut open ventrally and after recording the sex and maturity stages the stomachs were removed and preserved in 5% formalin for further analysis. The first sexual maturity had been observed at 121 mm total length when they were considered as adults. All fish below that size were regarded as juveniles.

In adults, the entire food in the stomach was assessed by visual estimation in terms of arbitrary units representing the quantity of food consumed in relation to the bulk of the total food required to fill up the entire space in the stomach. Accordingly, the stomachs were described as full, three-quarter full, half-full and

quarter-full. The stomach without food was recorded as empty. In the case of juveniles, it was difficult to assess the degree of fullness of stomach. Hence their stomachs were sorted out into the ones with food and others without food. Occasionally distended stomachs were also encountered and these were recorded as such.

Hynes (1950) has suggested that of the recognised three methods of food analysis, the occurrence method alone would be sufficient to give a reliable picture of the seasonal and other features, in the food preferences of a fish. The occurrence method is adopted in the present study.

Empty Stomachs

During the two-year period of observation, 21% of the total stomachs examined were empty. The presence of empty stomachs in juveniles was comparatively less than in adults. There were, in juveniles, only 3% of empty stomachs in 1958 and 9% in 1959. The empty stomachs in adults formed 29% in both the years.

Juveniles—There were no juveniles in the samples of July, November and December 1958. In 1958, the maximum of 12% of the empty stomachs was noticed in January and the minimum of 5% in February. In the rest of the months, namely March, April and August, no empty stomachs were noticed. In the year 1959, the juveniles were absent during the period April to July. The maximum of 26% of the empty stomachs and the minimum of 7% were noticed in August and October respectively. The months December and March registered 25% and 20% of empty stomachs respectively. No empty stomachs were met with in January, February, September and November.

Adults—During 1958, the percentage of empty stomachs in adults ranged between 8 in August and 57 in November. In December, a fairly high percentage of 40 empty stomachs was recorded and this was followed by 26%, 20% and 14% in April, January and July in that order. In 1959, the percentage ranged between 7 in August and 76 in October. The months of November and December registered a good percentage of empty stomachs with 50 and 47 respectively. Likewise, as high as 30 and 33 per cent of empty stomachs were encountered in March and June respectively.

It is seen from the above that the appearance of empty stomachs was rather erratic in juveniles but showed certain seasonal trends in the adults. In the latter the monthly percentages of empty stomachs were high, the range being 40-76 during the period October to December, moderate between 18 and 33 from January to June and low from 0 to 14 during July to September.

Feeding Intensity

In the year 1958, 97% of the juveniles had food in their stomachs while in 1959, 91% had. During the year 1958, 34% of adults had half-full stomachs. The

percentages of quarter-full and three-quarter full stomachs were more or less the same (23 and 22%). Only 16% of the fish had full stomachs while 5% had their stomachs distended. In 1959, the percentage of quarter-full stomachs had increased and that of half-full and three-quarter full stomachs had reduced. The percentage of full stomachs remained more or less the same. A slight increase in the percentage of distended stomachs was noticed during 1959. On the whole, it can be said that in both the years, quarter-full and half-full stomachs together contributed more than 50% to the total number of fish with food in the stomachs. The percentage of full stomachs was much less when compared with those partially full.

To ascertain if there is a seasonal variation in the feeding activity, the data were analysed month by month for the adults. The percentages of quarter-full and half-full stomachs were more than three-quarter full and others almost throughout the year (Table 1). The percentage of full stomachs was high during the months of April, May and July and it was very low during October-December. The presence of empty stomachs in high percentage also indicated low feeding rate in the latter period.

TABLE 1. *Percentages of stomachs in different degrees of fullness in adult* C. Kalla *during* 1958 *and* 1959.

Month	1958					1959				
	¼ full	½ full	¾ full	full	dist-ended	¼full	½full	¾full	full	dist-ended
January	37	25	25	13	0	44	23	11	11	11
February	0	50	50	0	0	25	0	25	25	25
March		No adults				72	14	0	14	0
April	18	9	27	37	9	23	18	41	12	6
May		No	data			15	21	28	36	0
June		No	data			83	9	8	0	0
July	13	33	17	27	10	25	9	17	30	19
August	4	35	44	13	4	15	36	43	6	0
September		No	data			44	23	11	11	11
October		No	data			100	0	0	0	0
November	33	53	7	7	0	0	83	0	0	17
December	60	33	7	0	0	55	33	12	0	0

FOOD COMPONENTS

The food in the V-shaped stomach of *C. kalla* was found to concentrate in the cardiac portion while only a white pulp was noticed in the pyloric portion. The food was seen to consist of diatoms, dinoflagellates, polychaetes, crustaceans,

molluscs, fishes, crustacean eggs and fish eggs. Other organisms like sipunculids and *Sagitta* spp. were also occasionally found in the stomachs. Presence of fish scales and sand particles was also noticed.

Fig. 1 shows the relative importance of the main categories of food items in the stomachs examined during 1958 and 1959. It can be seen that crustaceans formed the most important food item of *C. kalla,* occurring in more than 60% of the stomachs in both the years. The crustacean food comprised cladocerans, copepods, amphipods, stomatopods, decapods and their larval forms. Next to crustaceans came molluscs. They occurred in 10% of the stomachs in 1958 and 7% in 1959. The molluscan food consisted of lamellibranch and gastropod post-larvae and pteropods. Polychaetes occurred in 5 and 2 per cent of the stomachs while fish were observed in 4 and 2 per cent in 1958 and 1959 respectively. The latter category consisted of post-larval forms and smaller fishes in semi-digested

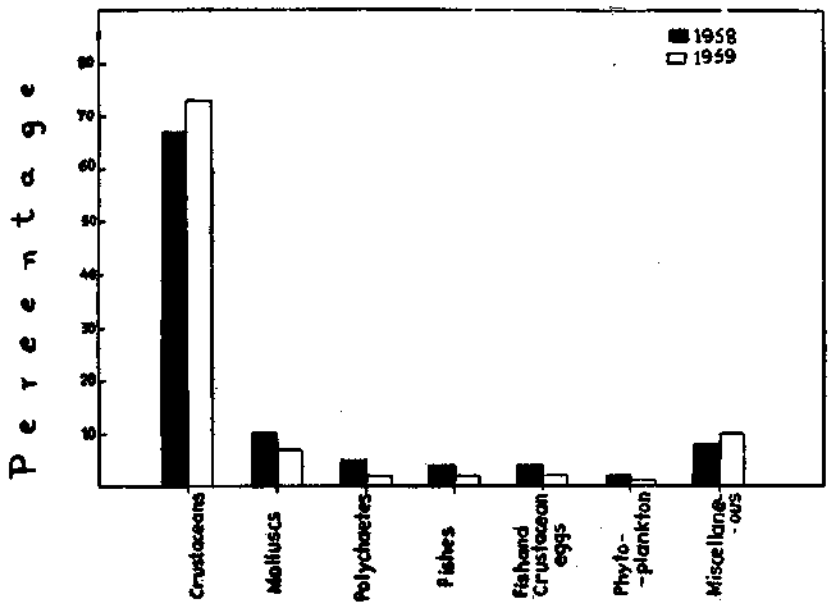

FIG. 1. Percentage frequency of main categories of food items in *Caranx kalla* during 1958 and 1959.

condition. Diatoms, dinoflagellates and crustacean and fish eggs occurred in very small percentages of the stomachs in both the years of observation. Other organisms like sipunculids and *Sagitta* spp. which were of rare occurrence, together occurred in 8 and 10 per cent of stomachs during 1958 and 1959 respectively.

In order to know whether there was any difference in food preferences in the juveniles and adults, the data were further analysed. Fig. 2 shows the importance of main food categories in juveniles and adults separately. Crustaceans formed the main item of food, both in juvenile and adult *C. kalla*. It was observed that 72% of the juveniles and 73% of the adults had this food constituent in their stomachs. Molluscs and polychaetes occurred in a slightly higher percentage in juveniles than in adults. Fishes were not noticed in the stomachs of juveniles while diatoms and dinoflagellates were entirely absent in adults. Crustacean and fish eggs were more important in adults than in juveniles. The percentage of food items of relatively rare occurrence, like sipunculids and *Sagitta* spp., was more in adults than in juveniles.

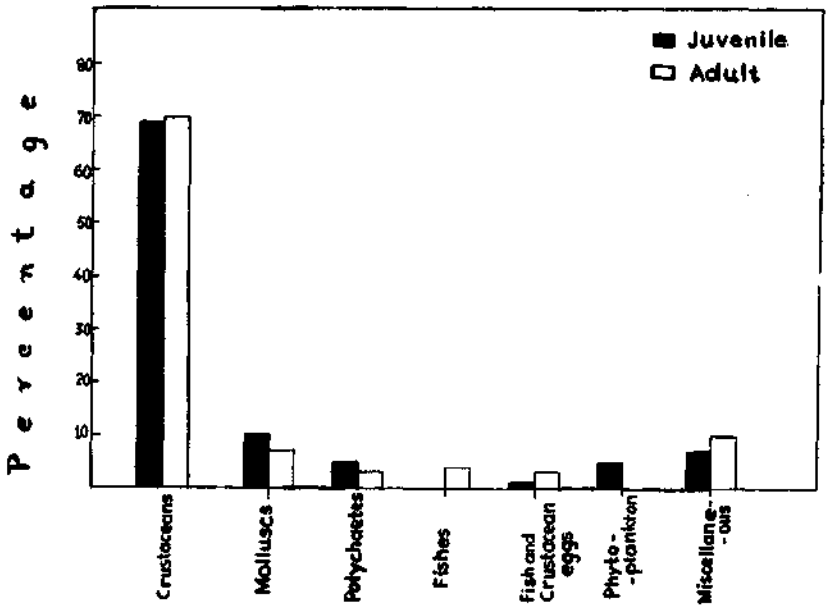

FIG. 2. Percentage frequency of main categories of food items in the juvenile and adult *C. kalla*.

The food items were grouped under broad categories, namely, diatoms, dinoflagellates, cladocerans, copepods, decapods, molluscs, chaetognaths, fishes and other miscellaneous food which included items of rare occurrence like polychaetes, amphipods, stomatopods and crustacean and fish eggs. Tables 2 and 3 show the monthly percentage occurrence of different items of food for juveniles and adults.

Diatoms and dinoflagellates

Diatoms and dinoflagellates occurred in the stomachs of juveniles only. In the order of dominance, it can be said that this food came next to crustacean and

molluscan food of juveniles. This food occurred in a maximum of 33% of stomachs in March 1959 (Table 4). The common genera representing Bacillariophyceae were *Coscinodiscus, Rhizosolenia, Chaetoceros, Biddulphia, Thallassiothrix* and *Nitzschia* while those under Dinophyceae were *Peridinium* and *Ceratium.*

Copepods

Copepods formed the most important item of food of both the juveniles and adults and they occurred in the stomachs throughout the year. This food constituent was dominant between September and April. It was observed that during these months a majority of stomachs had only copepods in them and in such cases the stomach contents appeared reddish due to the colour of the pigments of copepods. In juveniles (Table 2) the highest percentage of stomachs containing this food

TABLE 2. *Percentage occurrence of different food items in the juveniles of* C. Kalla *in* 1958 *and* 1959.

Food items	Year	Jan	Feb	Mar	Apr	Aug	Sep	Oct	Nov	Dec
Diatoms and Dinoflagellates	1958	20	16	3	—	20	—	—	—	—
	1959	13	33	—	—	—	—	—	—	—
Copepods	1958	67	58	43	75	60	—	—	—	—
	1959	78	33	27	—	45	78	38	85	83
Cladocerans	1958	—	—	—	—	10	—	—	—	—
	1959	—	—	—	—	9	28	—	23	33
Lucifer	1958	47	10	23	37	10	—	—	—	—
	1959	—	33	64	—	9	93	—	—	—
Prawns	1958	—	5	—	—	—	—	—	—	—
	1959	—	33	—	—	—	—	—	—	—
Decapod larvae	1958	—	—	—	—	30	—	—	—	—
	1959	—	16	—	—	—	—	—	—	—
Other crustacean larvae	1958	—	15	10	—	—	—	—	—	—
	1959	22	16	—	—	—	—	—	—	—
Crustacean remains	1958	—	7	25	—	10	—	—	—	—
	1959	—	—	9	—	9	—	8	—	—
Polychaete larvae	1958	—	—	—	—	50	—	—	—	—
	1959	—	—	—	—	—	—	77	—	—
Lamellibranch post-larvae	1958	27	20	3	37	10	—	—	—	—
	1959	9	16	8	—	9	—	31	—	67
Pteropods	1958	—	—	7	—	—	—	—	—	—
	1959	—	—	—	—	—	—	—	—	—
Invertebrate eggs	1958	—	5	—	—	—	—	—	—	—
	1959	—	—	9	—	—	—	—	—	17
Fish eggs	1958	—	—	—	—	10	—	—	—	—
	1959	—	—	—	—	—	—	—	—	—
Fish scales	1958	7	10	7	—	10	—	—	—	—
	1959	9	16	9	—	—	—	—	—	17
Sand particles	1958	—	—	—	—	10	—	—	—	—
	1959	4	33	—	—	—	—	—	—	—

item was 85 in November 1959 and the lowest was 27 in March 1959. In 1958 during the months when this item was observed in the adults (Table 3), over 50%

TABLE 3. *Percentage occurrence of different food items in the adults of* C. Kalla *in* 1958 *and* 1959.

Food items	Year	J	F	M	A	M	J	J	A	S	O	N	D
Copepods	1958	50	50	—	82	—	—	50	78	—	—	86	100
	1959	44	—	14	53	28	58	70	93	55	83	50	78
Cladocerans	1958	—	—	—	—	—	—	—	13	—	—	40	33
	1959	—	—	—	—	—	—	9	86	11	33	17	22
Lucifer	1958	12	50	—	73	—	—	43	22	—	—	—	13
	1959	—	25	—	65	50	100	46	100	89	17	17	—
Acetes	1958	—	—	—	—	—	—	17	22	—	—	—	—
	1959	—	—	—	—	—	—	21	7	—	—	—	—
Prawns	1958	25	50	—	18	—	—	7	—	—	—	—	7
	1959	22	25	14	12	7	—	2	—	—	—	—	—
Decapod larvae	1958	—	—	—	—	—	—	—	22	—	—	20	27
	1959	—	25	—	—	7	—	21	—	11	—	17	11
Amphipods	1958	—	—	—	—	—	—	—	—	—	—	—	—
	1959	—	—	—	—	78	—	2	—	—	—	—	—
Squilla	1958	—	—	—	—	—	—	—	—	—	—	—	—
	1959	—	—	14	—	—	—	—	—	—	—	—	—
Other crustacean larvae	1958	—	50	—	—	—	—	—	—	—	—	33	—
	1959	—	25	—	18	—	—	2	—	—	—	—	—
Crustacean remains	1958	—	50	—	45	—	—	17	22	—	—	—	23
	1959	—	—	30	41	—	25	9	—	—	—	—	11
Polychaete larvae	1958	—	—	—	—	—	—	30	17	—	—	13	—
	1959	—	—	—	—	—	—	—	—	—	—	—	—
Annelids	1958	—	—	—	—	—	—	—	—	—	—	—	—
	1959	11	—	—	—	—	—	—	—	11	—	—	—
Sipunculids	1958	—	—	—	—	—	—	—	—	—	—	—	—
	1959	11	—	—	—	—	—	—	—	—	—	—	—
Lamellibranch post-larvae	1958	12	50	—	54	—	—	10	17	—	—	27	7
	1959	11	25	14	29	—	—	9	—	11	—	33	44
Gastropod post-larvae	1958	—	—	—	—	—	—	—	—	—	—	—	13
	1959	—	—	—	—	—	—	—	—	—	—	17	11
Pteropods	1958	—	—	—	—	—	—	—	—	—	—	7	27
	1959	—	—	—	—	—	—	14	—	—	—	—	—
Sagitta	1958	—	—	—	—	—	—	—	35	—	—	13	7
	1959	—	—	—	—	—	—	32	14	—	—	—	—
Fish	1958	25	—	—	—	—	—	7	—	—	—	—	20
	1959	—	50	—	—	—	—	2	—	—	—	—	—
Fish remains	1958	—	—	—	—	—	—	7	13	—	—	20	13
	1959	—	—	30	—	21	—	—	—	—	—	—	—
Invertebrate eggs	1958	—	—	—	—	—	—	—	—	—	—	20	27
	1959	—	—	14	—	14	—	—	—	—	—	—	—
Fish eggs	1958	—	—	—	—	—	—	10	9	—	—	13	—
	1959	—	—	14	18	—	—	—	—	—	—	—	—
Fish scales	1958	12	—	—	—	—	—	—	—	—	—	—	7
	1959	—	—	—	12	21	—	12	14	—	—	—	—
Sand particles	1958	—	—	—	—	—	—	3	5	—	—	—	—
	1959	—	—	—	—	21	—	—	—	—	—	—	—

of the stomachs had copepods in them, the maximum being in December when all the fish examined had this item. In 1959 the copepods occurred in the adults in all the months excepting Februaiy; their percentages were constantly high, between 50 and 93 from June to December.

Copepod food was mainly composed of three groups, namely, calanoids, harpacticoids and cyclopoids. Fig. 3 shows the monthly average percentage of

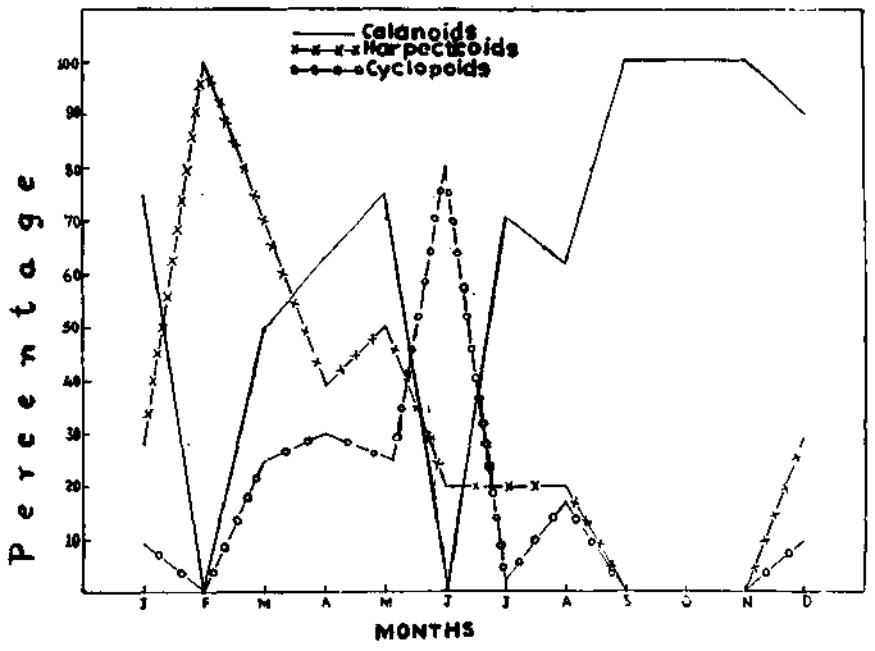

FIG. 3. Monthly average percentage distribution of copepod groups in *C. kalla*.

the three groups to the total copepod food. It can be seen that calanoids were dominant and formed more than 50% of the total copepod food. In September, October and November, only this group was occurring in the stomach contents. Harpacticoids came next to the calanoids in the order of abundance contributing 40% to the copepod food. It can be seen that during February, when the calanoids were absent, these made up the entire copepod food. From February to May they occurred in good percentage, but from May onwards their percentage came down and were entirely absent in the stomachs examined in September, October and November. These made their appearance again in December, when they formed 30% of the copepod food. Cyclopoids came last in the order of abundance. It can be seen that these were not encountered in the food during February, September, October and November. In June alone, these formed a dominant group contributing to 85% of the copepod food. The calanoids were

represented by the genera *Acartia*, *Paracalanus* and *Labidocera* and harpacticoids by *Euterpina*, *Macrosetella* and *Microsetella* and the cyclopoids by the genus *Oithona*.

Amphipods

Amphipods were rare in the food. In juveniles this food was never encountered. In adults (Table 3), however, it was found only in two months, May and July, 1959, when its percentage occurrence was 78 and 2 respectively. It was observed that in May the majority of stomachs was having only tube-dwelling amphipods in them. Free-living amphipods belonging to the family Hyperiidae were noticed only in July 1959.

Cladocerans

Cladocerans formed an important food item during July-December period. The period of occurrence of this food in both juveniles and adults was more or less the same. From Tables 2 and 3 it can be seen that in juveniles during 1958, it was noticed only in August when it occurred in 10% of the stomachs, while in 1959, it was encountered in August, September, November and December.

Decapods

Along with copepods, decapods formed one of the important food items of this fish during the period February to July. In other months also this food was found in appreciable quantity. Tables 2 and 3 show that prawns were common in the stomachs of adults while in juveniles they were noticed only in February of both the years when they occurred 5 and 33 per cent respectively. In adults they were common during the period December to May. *Acetes* spp. were noticed in the stomachs of adults only. In both the years they were encountered in July and August when they occurred in 17% and 22% in 1958 and 21% and 7% in 1959 respectively. *Lucifer* spp. were the commonest among decapods and occurred in both the juveniles and adults. Decapod larvae were not common in juveniles. The common decapod larvae found in the stomachs were zoea and the mysis stages of macrurans.

Annelids

Polychaete larvae occurred very rarely in the stomachs of *C. kalla*. The common polychaete larvae observed in the stomachs belonged to the family Spionidae. Adult annelids, frequently in broken condition, occurred only in adults in January and September 1959.

Molluscs

Molluscs were represented by bivalve and gastropod post-larvae and pteropods. The molluscan food of *C. kalla* formed an important part during the period October to April. Bivalve larvae occurred more frequently than

gastropod larvae in both juveniles and adults. Gastropod larvae did not occur in juveniles. In adults, they were found only in December 1958 and November and December 1959.

Pteropods were of rare occurrence. In the stomachs of juveniles (Table 2) these were noticed only in March 1958 and in adults (Table 3) these occurred in November and December, 1958 and July 1959.

Fish larvae

The post-larval forms of fishes, generally of clupeids, were noticed in the stomachs of adults only. In most of the cases these were found to occur in broken bits which rendered the specific identification difficult. Of all the food items, the fish food was of the least importance.

The contribution of other food items to the diet of *C. kalla* can be seen from Tables 2 and 3.

General Considerations

From the foregoing account it is clear that *C. kalla* is a plankton feeder and that its diet is made up largely of pelagic copepods, cladocerans and decapod and molluscan post-larval forms. In adults this food is supplemented by fish larvae, polychaete larvae, *Sagitta* spp., invertebrate eggs and fish eggs. The diatoms and dinoflagellates form a very small portion of the food of juveniles.

Chacko and Mathew (1955) state that *Caranx* (*Selar*) *kalla* has an avidity for planktonic organisms such as diatoms, flagellates, copepods, larval bivalves and fish eggs. Young prawns have been noted by them in some cases. Fish scales recorded from the stomachs are believed to have been gulped accidentally. The present study indicates a relatively more intensive feeding on zooplanktonic organisms. The feeding habit of this species of horse-mackerel is not very different from other species studied by Chacko (1949), Datar (1954), Kuthalingam (1955, '59) and Tandon (1960).

It is seen that fishes with quarter-full and half-full stomachs together constituted more than 50% of the fish examined almost throughout the year. The occurrence of empty stomachs was also very frequent. The percentage of fish with full stomachs was low. It was also found that the stomach contents in most cases were in partially digested condition. All the specimens examined were from the commercial landings in the mornings. These facts suggest the possibility of the fish feeding during the night and the process of digestion being much advanced by the time they were obtained in the commercial catches. Examination of the stomach contents of fish caught at different times of the day would

have given more precise information on the feeding time of the fish, but owing to the limitations of the availability of samples at other times, further observations could not be made.

The feeding intensity was moderate during January to June, high from July to September and low from October to December. There appears to be some relationship between low feeding intensity and the peak of breeding period in *C. kalla.*

Maturity studies have shown two possible spawning periods, one in December-January and the other in May-June (Kagwade, 1967). The low rate of feeding during October-December may probably be associated with the major breeding activity of the fish in December-January. Again the moderate feeding rate between January and June may be associated with the second and minor breeding period in May-June. The major breeding period during December-January closely follows the period of north-east monsoon striking along south-west coast. Gopinath (1946) records a number of post-larval fishes along the Trivandrum coast during November to April or May suggesting the influence of north-east monsoon on the breeding of fishes.

SUMMARY

The food of juvenile and adult *Caranx kalla* from the boat seine and gill net catches from the inshore waters off Calicut was studied.

C. kalla was noticed to be a plankton feeder, feeding mainly on the pelagic crustacean and molluscan post-larval forms. In addition to these, the juvenile food consisted of diatoms and dinoflagellates, which were absent in the adults. The crustacean items, fish eggs and polychaetes were more in the food of the adults than in juveniles. Fish larvae were found in the food of adults only. Sipunculids and *Sagitta* spp. appeared rarely in the adults. Fish scales and sand were also met with in small quantities among the stomach contents of this fish.

The low rate of feeding observed in October-December appears to be associated with the major peak breeding period during December-January and the moderate feeding during January-June with the minor peak breeding period during May-June.

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