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Diet and feeding habits of *Saurida tumbil* (Bloch, 1795) from northern Kerala, south-west coast of India

P. P. MANOJKUMAR* AND P. P. PAVITHRAN
Calicut Research Centre of ICAR-Central Marine Fisheries Research Institute, Kozhikode - 673 005, Kerala, India
Tuticorin Research Centre of ICAR-Central Marine Fisheries Research Institute, Thoothukudi - 682 001 Tamil Nadu, India
e-mail: manojppin@yahoo.com

ABSTRACT

Composition of the diet of greater lizardfish *Saurida tumbil* (Bloch, 1795), caught from northern Kerala, south-west coast of India was studied and described. The stomachs of 1981 specimens were collected between January, 2012 and June, 2014. Analysis of stomach contents based on index of relative importance (IRI) revealed that this species is exclusively piscivorous. Contrary to other benthic predators of the study area, it mainly feeds on pelagic and demersal fishes (IRI = 63.2), molluscs (IRI = 17.86), crustaceans (IRI = 18.33) and other miscellaneous items (IRI = 2.54). The diet of *S. tumbil* were found to be related to the seasonal availability of resources, occurrence of juveniles of certain species and on the migration of fishes from nearby places to the study area. Significant changes in prey items were observed between predator length groups, but a positive, significant relationship was recorded between prey size and predator size ($p<0.05$). Statistical analysis indicated a uniform representation of different diets in the stomach. Maximum similarity in diet between different food items was found in April and November.

Keywords: Diet, Feeding habits, Index of relative importance, Lizard fish, *Saurida tumbil*

Introduction

Lizardfishes (family: Synodontidae) occupy an important place as a demersal fishery resource worldwide. The group includes 70 species under four genera. Lizardfishes in India are represented by 3 genera, namely *Saurida, Synodus* and *Trachinocephalus* comprising about 20 species. Among them, the genus *Saurida* is commercially important and is represented by about 10 species. Of these, two species namely, *Saurida tumbil* (Bloch, 1795) and *Saurida undosquamis* (Richardson, 1848) are commercially important having high flesh content and good flavour. Kerala contributed about 1446 t of lizardfishes annually forming 7.72% of the all India lizardfish catch during the 10 year period of 2005-2014. Studies on lizardfishes reported earlier in Indian waters include that of Kuthalingam (1959), Rao (1983; 1984), Nair *et al*. (1992), Sivakami *et al*., (2003), Rao (1981), Dighe (1977) and Manojkumar and Sivakami (2005). The present paper details the dietary composition and feeding habits of *S. tumbil* from Malabar coast of Kerala.

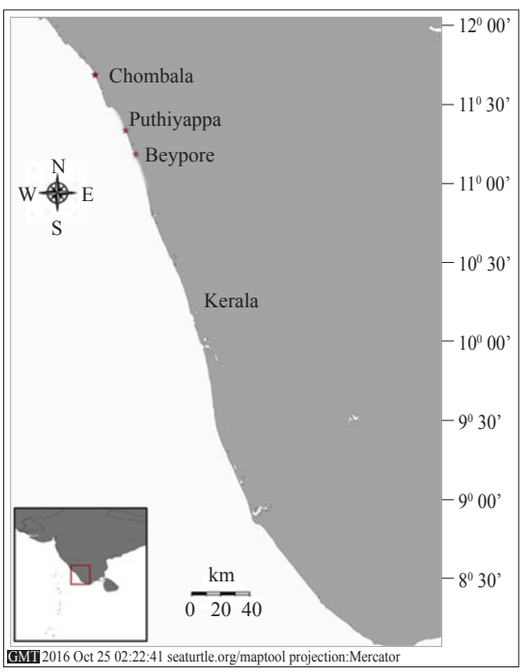

Fig.1. Map showing study area

Materials and methods

Samples of *S. tumbil* collected randomly at weekly intervals during 2012 - 2014 from the fish landings at Puthiappa, Beypore and Chombala (Fig.1) were used for the study. A total of 1981 specimens in the length range of 102-510 mm was analysed. Data on total length and maturity stage of the fish were recorded and the stomach

contents were analysed using the index of relative importance (IRI) (Pinkas *et al.,* 1971). Intensity of feeding was determined based on the degree of distension of the stomach due to feeding and the amount of food items available in the stomach. The stomachs were accordingly classified as gorged, full, ¾, ½, ¼ full, trace and empty. Data thus collected during the study period were pooled and classified as poorly fed (empty and trace), moderately fed ($^1/_4$ and ½ full) and heavily fed (¾ full, full and gorged). Since no difference in the food and feeding habits of both the sexes was noticed, data of both sexes were combined. The cumulative monthwise dominance plot and cluster analyses were done using PRIMER 6 software.

Results

Results showed that *S. tumbil* feeds on 36 food items which are classified into four general categories namely, fishes, molluscs, crustaceans and miscellaneous items (Table 1).

Food items

Fishes: Analysis of the annual stomach contents of *S. tumbil* during the years 2012-14 revealed that the diet was essentially similar during this period. Species of fish identified in the stomachs were: *Nemipterus japonicus*, *Nemipterus randalli*, *Decapterus russelli*, *Cynoglossuss macrostomus*, *Stolephorus* spp., *Bregmaceros mcclellandi*, horse mackerel, *Epinephelus diacanthus*, other flat fishes, *Lactarius lactarius*, *Rastrelliger kanagurta, S. tumbil*, *S. undosquamis*, fish larvae, *Sardinella longiceps*, silver bellies (*Leiognathus bindus* and *Secutor insidiator*), other sardines, flatheads (*Platycephalus* spp.), sciaenids (*Johnieops* spp.), goatfishes (*Upeneus* spp.), eel (*Gymnothorax* spp.) and *Apogon* spp. The average annual composition of all fishes for the period had an IRI value of 63.20. Fishes formed the dominant dietary element of *S. tumbil* which was observed throughout the year. The IRI values for fishes were highest during August (94.41) and lowest in December (35.26). *N. japonicus* was the dominant food item found in the stomach of *S. tumbil* with IRI value ranging from 2.29 (February) to 74.67 (August) (with mean IRI of 21.73). *R. kanagurta* formed the second dominant food item with an IRI value of 9.04 and monthly IRI value ranged between 0.44 (April) and 47.6 (November). The third dominant fish food item was *D. russelli* with IRI value of 0.42 (March) - 24.33 (October). Horsemackerel was another dominant food item and its IRI values were between 1.39 (March) and 43.31 (April). *Stolephorus* spp. were represented by *Stolephorus devisi* and *S. commersonii* and the IRI values ranged between 0.11 (February) and 47.05 (June). Other fishes found in the stomach were *N. randalli* (IRI =2.47), flatheads (IRI = 1.98), eels (IRI = 1.73), *C. macrostomus* (IRI = 0.92), *S. tumbil* (IRI = 0.71), silverbellies (IRI = 0.40), *B. mcclellandii* (IRI = 0.24), sciaenids (IRI = 0.31), goatfishes (IRI = 0.25), fish larvae (IRI = 0.21), other sardines (IRI = 0.04), *L. lactarius* (IRI = 0.03), other flatfishes (IRI = 0.01), *E. diacanthus* (IRI = 0.01) and *Apogon* spp. (IRI = 0.02). Juvenile fishes contributed to the diet for a greater part of the year. They were maximum in November (IRI = 75.21) and minimum in April (IRI = 24.79).

Crustaceans: The second most important prey category was crustaceans (IRI = 18.33). *Acetes* spp. (IRI = 9.11), *Fenneropenaeus indicus* (IRI = 9.02), mysids *(*IRI = 0.18), *Metapenaeus stridulans* (IRI = 0.01), *Parapeneaopsis stylifera* (IRI = 0.01) and crabs (IRI = 0.01) being the most important crustacean diet items. *Acetes* spp., was the chief crustacean component found in the stomach with a peak occurrence during December (IRI = 20.98) and minimum in March (IRI = 7.16). *F. indicus* was present during nine months with peak occurrence in April (IRI = 19.57) and minimum in November (IRI = 0.33). Mysids were represented by *Mesopodopsis orientalis, M. zeylanica, Rhopalophthalmus indicus* and *Kochimysis pillaii* with peak occurrence in June. *Thalamitta* spp., a small sized crab was present in the food with peak occurrence during May and August. Negligible quantities of *M. stridulans* were observed with average IRI of 0.11.

Molluscs: Molluscs represented by squids *viz*., *Uroteuthis (Photololigo) duvaucelii*, *U.(P.) edulis* and *U.(P.) singhalensis*; cuttlefishes (juveniles of *Sepia pharaonis* and *Sepiella inermis*) and octopus (*Amphioctopus membranaceus* and *A. aegina*) were present in the diet almost throughout the year and the average IRI for this item was 7.86. The highest IRI value was observed in February (38.1) and minimum in June (2.47). The IRI values for squids, cuttlefishes and octopus were 19.23, 0.09 and 0.18 respectively.

Miscellaneous items: Miscellaneous food items observed occasionally in the stomach were medusa, detritus, jellyfish, salpa and rope bits and the average IRI value of this group was 2.54. The highest IRI value was observed in May (8.13) and lowest in January (0.03). As their volumes were low, they were considered as secondary inclusions in the diet. The IRI values of jellyfish, salpa, medusae and nereis worms were 0.03, 0.02, 2.47 and 0.02 respectively.

Seasonal variations in feeding

Fishes occupied an important place throughout the year and their peak occurrence was observed during monsoon period (IRI = 68.97), followed by post-monsoon months (IRI = 62.53) and pre-monsoon period (IRI = 58.13) (Fig. 2). Among fishes, threadfin breams represented by *N. japonicus* and *N. randalli*

Table 1. Index of relative importance (IRI) of different food items in *Saurida tumbil* along northern Kerala during 2002-14

Prey items	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Fishes													
Eels	8.83	-	3.95	2.1	-	-	-	-	2.61	-	0.09	0.19	1.73
Apogon spp.	-	-	0.21	-	-		-	-	-	-	-	-	0.02
C. macrostomus	1	3.56	1.49	1.46	0.46	-	-	-	0.33	2.07	0.23	-	0.92
D. russelli	13.52	4.4	0.42	0.92	2.92	3.63	-	14.95	3.07	24.33	5.37	19.59	8.83
Horsemackerel	-	25.14	1.39	43.31	7.2	-	-	-	2.39	6.06	0	4.69	7.65
E. diacanthus	-	-	-	-	-	-	-	0.10	-	-	-	-	0.01
Other flat fishes	-	-	-	-	-	-	-	0.10	-	-	-	-	0.01
L. lactarius	-	0.14	-	-	-	-	-	-	0.15	-	-	-	0.03
R. kanagurta	13.05	4.08	10.6	0.44	1.06	-	-	-	6.31	3.19	47.6	1.46	9.04
Saurida tumbil	-	0	0.95	0	5.68	-	-	0.22	1.71	-	-	-	0.71
Stolephorus spp.	-	0.11	12.34	0	3.15	47.05	-	4.21	12.45	-	0.22	-	6.62
S. undosquamis	-	-	-	-	-	-	-	0.17	0.07	-	-	-	0.02
N. randalli	-	-	-	-	-	-	-	0	8.43	3.27	12.59	0.85	2.47
Fish larvae	-	2.19	0	0.12	-	-	-	-	-	-	-	0.18	0.21
N. japonicus	40.72	2.29	28.96	13.64	26.06	22.46	-	74.67	8.47	19.42	4.13	3.71	21.71
S. longiceps	-	-	-	0.02	0	-	-	-	-	-	-	-	0.01
Silverbellies	-	-	-	0.56	2.66	-	-	-	-	-	-	1.15	0.40
B. mcclellandi	-	-	-	-	0.56	2.26	-	-	-	-	-	-	0.24
Other sardines	-	-	0.51	-	-	-	-	-	-	-	-	-	0.04
Flatheads	-	2.55	0.18	6.8	4.79	-	-	-	-	1.93	3.92	1.71	1.98
Sciaenids	-	-	-	-	-	-	-	-	-	-	1.05	1.74	0.31
Goatfish	-	-	-	-	3.03	-	-	-	-	-	-	-	0.25
Fishes total	77.13	44.46	61	69.37	57.58	75.4	-	94.41	45.8	60.26	75.21	35.26	63.20
Crustaceans													
Acetes spp.	-	-	7.16	-	7.34	-	-	-	17.07	15.66	16.59	20.98	9.11
Crabs	-	-	-	-	2.51	-	-	0.05	-	-	-	-	0.01
M. stridulans	-	-	-	-	-	-	-	-	-	-	-	0.11	0.01
P. stylifera	-	-	-	-	-	-	-	-	-	-	-	0.07	0.01
F. indicus	-	16.39	3.2	19.57	8	10.16	-	-	19.17	5.27	0.33	7.04	9.02
Mysids	-	-	-	-	-	5.04	-	-	-	-	-	-	0.18
Crustaceans total	-	16.39	10.36	19.57	17.84	10.16	-	0.05	36.24	20.94	16.93	28.2	18.34
Molluscs													
Cuttlefishes	-	-	-	0.61	-	-	-	-	-	-	-	0.23	0.09
Squids	22.83	38.1	25.74	3.51	16.45	2.47	-	5.24	17.34	18.59	4.59	35.79	19.23
Octopus	-	-	-	1.68	-	-	-	-	-	-	-	-	0.18
Molluscs total	22.83	38.1	25.74	5.81	16.45	2.47	-	5.24	17.35	18.59	4.59	36.01	17.86
Miscellaneous items													
Medusa	0.03	0.94	2.89	4.92	8.13	6.93	-	0.3	0.41	0.15	3.27	0.43	2.47
Salpa	-	-	-	0.29	-	-	-	-	-	-	-	-	0.02
Jelly fish	-	-	-	-	-	-	-	-	0.19	0.06	-	0.04	0.03
Neeris	-	0.11	-	0.04	-	-	-	-	-	-	-	0.07	0.02
Detritus	-	-	-	-	-	-	-	-	0.01	-	-	0	0.00
Others total	0.03	1.05	2.89	5.25	8.13	6.93	-	0.3	0.61	0.21	3.27	0.54	2.54

recorded IRI values of 21.73 and 2.47 respectively. IRI of *N. japonicus* was high during monsoon period (31.25), followed by pre-monsoon (17.74) and post-monsoon months (16.19). In the case of *N. randalli*, highest IRI was recorded during post-monsoon months (4.48), followed by monsoon months (2.93), but in pre-monsoon months *N. randalli* was absent in the stomach of *S. tumbil*. *D. russelli* was negligible in the stomach during pre-monsoon months (IRI = 2.87), which gradually increased to 11.49 during monsoon season and further to 12.85 during post-monsoon months (IRI = 12.83). Presence of horsemackerel was more during pre-monsoon months (IRI = 19.26), which further declined to 2.1 in monsoon and further to 1.56 during post-monsoon months. Occurrence of *R. kanagurta* in the diet was more during post-monsoon months with an IRI value of 20.7 and

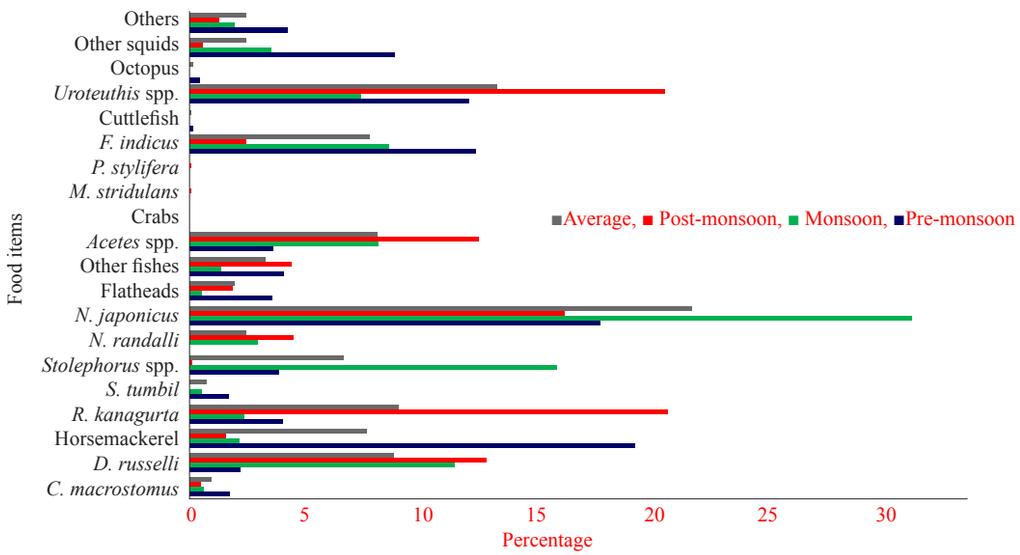

Fig. 2. Seasonwise IRI of different food items in *S. tumbil*

during pre-monsoon and monsoon months the IRI values were negligible. *Stolephorus* spp. was highest in the guts during monsoon period with an IRI value of 15.87 and during pre-monsoon period the IRI was 3.90 and it was negligible during post-monsoon (IRI = 0.07). Presence of other fishes in the diet was more during post-monsoon (IRI = 4.41) and pre-monsoon period (4.03). In general IRI value of fishes in *S. tumbil* was higher during monsoon and post-monsoon months.

Among crustaceans, highest IRI was recorded during monsoon (16.04) and pre-monsoon period (16.85), which declined to 15.04 during post-monsoon months. Occurrence of *Acetes* spp. in the diet was high in post-monsoon period (IRI =12.52). *F. indicus* dominated with IRI value of 12.42, its presence gradually declined in monsoon months (IRI = 8.65) and further during the post-monsoon period (IRI = 2.46). Presence of molluscs in the diet was more during pre-monsoon and post-monsoon months.

Dominance plot was constructed on the data sets to find out the diet components at different months and the curve for December which lies on the lower side, extends further and rises slowly due to the uniform composition of different diets. The curve for August shows higher dominance of fishes in the stomach of *S. tumbil* (Fig. 3).

Cluster analysis revealed grouping of dietary components over the months in *S. tumbil*. Cluster analysis did not reveal any definite pattern over the months due to its voracious feeding nature. The highest similarity of 98.95% was found between April and November followed by 93.15% in February and November (Fig. 4).

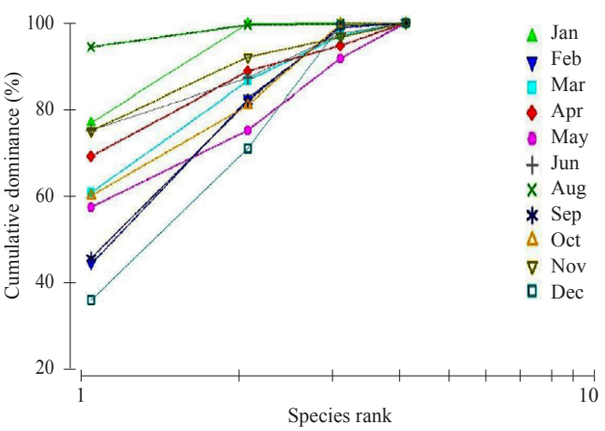

Fig. 3. Plot of monthwise cumulative dominance for *S. tumbil* from northern Kerala

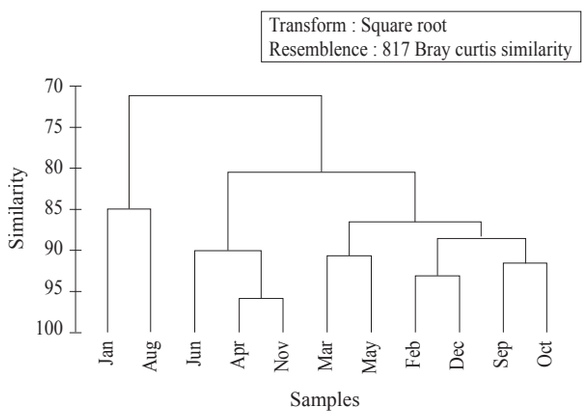

Fig. 4. Dendrogram based on cluster analysis of monthwise diet assemblege of *S. tumbil* from northem Kerala

Food in relation to size

Analysis of the food items in relation to size of the fish species studied indicated that fishes were preferred by all length groups and the IRI of fishes of most of the length groups were higher (Fig. 5). Crustaceans were the second dominant food preferred by the fish, particularly they were the most preferred food item by the juveniles. There was gradual preference for fish items as the size of fish increased. Between 290-359 mm length group, preference for fishes as well as crustaceans were almost equal. Juveniles of *Stolephorus* spp. were the only item that dominated the food of young fish up to 149 mm. Other teleost fishes started to appear in the diet of *S. tumbil* from 150 mm size and above. Juveniles of *B. mcclellandi* as well as threadfin breams appeared in the gut from 140 mm onwards.

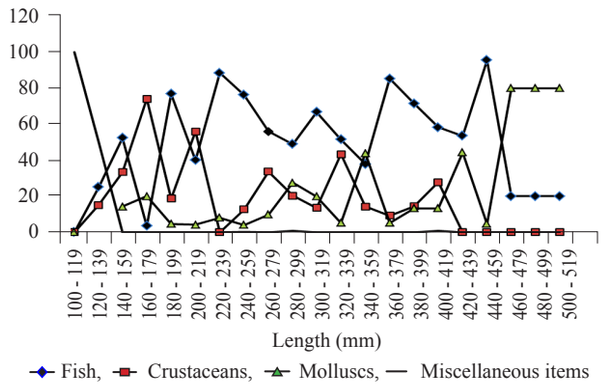

Fig. 5. Lengthwise food composition of *Saurida tumbil*

Presence of crustaceans like penaeid shrimps, mysids, crabs, *Acetes* spp. and stomatopods were observed in the diet upto 359 mm size. Mysids were present only in juvenile and subadult fishes. Young ones of squids, cuttlefishes and octopus were occasionally present in the diet contents of fish below 150 mm. Juveniles of squids were present in the stomach from 140 mm onwards and their presence continued upto 509 mm. Cuttlefishes formed prominent food items when the fishes were above 230 mm. Miscellaneous items were present in the fishes of all size groups in small quantities.

Feeding intensity

Poorly fed fishes were observed during all the months and on an average it formed 56.39% (Fig. 6.) Highest percentage of fishes with empty stomachs indicates that the intensity of feeding in different months has no regular periodicity. Fishes with heavily fed stomachs were observed more during January, October, November and December months which indicates that the feeding intensity was high during these months.

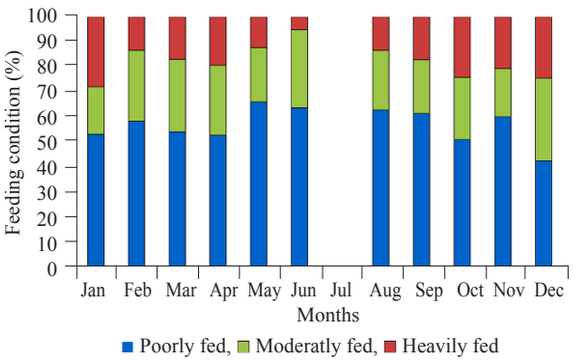

Fig. 6. Monthly feeding condition of *S. tumbil*

Feeding condition in relation to different maturity stages indicated that intensity of feeding was higher in immature (89.47%), maturing (55.25%) and spent fishes (30.81%) (Fig. 7). Moderately fed stomach fluctuated between 9.78% in immature fishes to 24.17% in maturing fishes. Poorly fed fishes were more in mature fishes (60.39%) and least in immature fishes (0.75%).

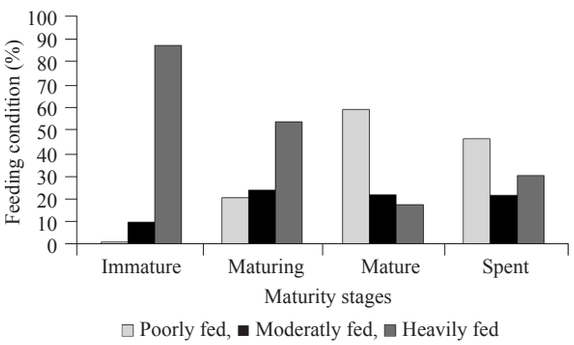

Fig. 7. Feeding condition of *S. tumbil* in relation to different stages of maturity

Discussion

Results of the present study shows that *S. tumbil* feeds mainly on fishes, crustaceans and cephalopods. Food of *S. tumbil* comprised of fishes, molluscs and crustaceans in the East China Sea (Yamada *et al.,* 1966). Tiews *et al.* (1972) reported that fishes are the favourite food of *S. tumbil* in the Philippine waters. The main food of *S. tumbil* along the Oman coast was fishes, cephalopods and crustaceans (Budnichenko, 1974). While *S. tumbil* from the Bombay coast fed mainly on fishes, molluscs were next important and crustaceans the third (Dighe, 1977). The diet of *S. tumbil,* from Bay of Bengal comprised of fishes and the rest were *Loligo* sp. and crustaceans (Rao, 1981). The present observations have shown that threadfin breams, *R. kanagurta*, *D. russelli*, *Stolephorus* spp. and *U.(P.) duvaucelii* as the most preferred food item of *S. tumbil.* This is evident from their dominance in the food in

all months. The next favoured diet seemed to be shrimps, *Acetes* spp., crabs and mysids. However, Kuthalingam (1959) recorded shrimps as the major food item of *S. tumbil* along with teleostean larvae as well as adults, small quantity of copepods, cirripede larvae, decapod larvae and *Sagitta* spp. from Madras waters. In the present study, it was seen that *N. japonicus*, *R. kanagurta*, *D. russelli*, horsemackerel and *Stolephorus* spp., formed the dominant diet of *S. tumbil* and their dominance continued even after the fish has grown to large size. From this it is clear that the above fishes are the preferred diet of *S. tumbil* as observed from different regions (Rao, 1964, Yamada *et al.,* 1966, Tiews *et al.,* 1972 and Dighe, 1977). According to Yamada *et al.* (1966), juveniles of *S. tumbil* fed mainly on shrimps and juvenile jackmackerel. As the fish grows, they feed on anchovy and cuttlefish and the larger fish feed on small jackmackerel, hairtail and cardinal fish. Budnichenko (1974) also observed variation in the diet composition among different size groups of *S. tumbil.* He observed that the food of small individuals consisted predominantly of Bregmacerotidae, Callionymidae, Champsodontidae, Trichiuridae, *Squilla* sp. and *Loligo* sp. and that the larger fishes feed on *Loligo* spp., Clupeidae, Carangidae, Sparidae and Nemipteridae. Dighe (1977) reported that while *S. tumbil* in all stages of growth feed on fishes, crustaceans were consumed more by smaller fish and molluscs by those in advanced stages of growth. Rao (1981) reported that the food of *S. tumbil* of less than 160 mm were composed of small fish mainly *Stolephorus* spp., *Leiognathus* spp. and *Sardinella* spp. Large fishes fed more on large size fishes like *Trichiurus* spp., *Leiognathus* spp., *Upeneus* spp., *R. kanagurta* and carangids. The volume of crustaceans and cephalopods in the diet was more in the 16-30 cm size group than in the 31-45 cm size group. In the 160-300 mm size group, fish item increased appreciably and cephalopod diet was steady, whereas the shrimp intake reduced to low levels. The percentage of intake of cephalopod was high in fish up to 300 mm and low in *S. tumbil* >300 mm. In the present observation, the proportion of fish diet was high in fishes up to 259 mm and with growth, fish diet decreased while cephalopod diet increased. *Bregmaceros* sp. constituted the principal diet up to 110-119 mm and above this length, *Stolephorus* spp. increased. Low feeding activity during the spawning season was observed in *S. tumbil* from Bombay waters (Dighe, 1977) and from the north-western part of Bay of Bengal (Rao, 1981). In contrast, high feeding intensity was recorded in both sexes of *S. tumbil* during the spawning period (Yamada *et al.,* 1966; Qiyong and Ganlin, 1986). However, Tiews *et al.* (1972) could not find any seasonal variation in feeding intensity. The present study has shown that feeding intensity was relatively higher in immature and spent fishes.

Although items like shrimps, carangids, soles and sciaenids were recorded in good proportion in trawl catches along with *Saurida* spp., they were poorly represented in the stomachs of *Saurida* spp. Rao (1981) observed *Leiognathus bindus* as the major food of *S. tumbil* on the east coast, but in the west coast, *S. tumbil* does not prefer *Leiognathus* spp., though they are available in the environment in good quantity. The cannibalistic nature of *Saurida* spp. as reported by Tews *et al.* (1972); Yamada *et al.* (1966); Qiyong and Ganlin (1986); Wu (1984) and Rao (1981), was also observed in the present study. But the presence of pelagic fishes in the stomach of *S. tumbil* led Budnichenko (1974) to conclude that *S. tumbil* is capable of pursuing their prey actively for more distance and even making short vertical migrations. However, Hayashi (1983) remarked that lizardfish resorts to change of feeding behaviour between sit and wait feeding on benthic prey and mobile searching behaviour for pelagic prey based on the prey resource in the environment. The present observation of *Saurida tumbil*, feeding mainly on pelagic prey in the area shows that they indulge in more mobile searching behaviour than of sit and wait mode for benthic prey.

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