RESEARCH ARTICLE

Food and Feeding Habits of Two Major Lizardfishes (Family: Synodontidae) Occurring along North-West Coast of India Between Lat. 18°-23°N

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Received: 11 February 2017/Revised: 07 March 2017/Accepted: 13 April 2017

ABSTRACT- Lizardfishes are commercially important group of species contributing to the fishery in the Indian EEZ. Information on predation, prey-predator relationship and their assessments in respect of *Saurida tumbil* and *Saurida undosquamis* have been derived in this study. A total number of 1630 specimens of *S. tumbil* and 926 of *S. undosquamis* were used for stomach content analysis. The specimens of *S. tumbil* examined in the study ranged between 13.0-53.0 cm (TL) and of *S. undosquamis* 13.0-41.0 cm. Qualitative and quantitative analysis revealed that the species *S. tumbil* prefers food in order of abundance as a teleost fishes (41%), molluscs (9.16%), shrimps (3.64%), crabs (1.41%) and squilla (0.37%) and *S. undosquamis* prefers teleost fishes (49%), molluscs (11%) and shrimps (3%). In *S. tumbil*, the highest feeding intensity observed in July (50%) and in *S. undosquamis*, in October (41%) and the lowest intensity recorded in the month of June for both the species. Monthly Gonado Somatic Index (GSI) shown that the highest feeding was observed in January (10.55%) and July (10.76%) for *S. tumbil* whereas, in case of *S. undosquamis*, the GSI was highest in August (16.58% for males and 17.80% for females). The pieces of sand granules, detritus and benthic organisms in the stomachs of the species indicating the benthic nature at the sea bottom in the search of food. Occurrence of juvenile lizardfishes in gut contents of both the species indicates that the lizardfishes are cannibalistic in nature.

Key-words- Lizardfish, feeding intensity, Gonado Somatic Index (GSI), Cannibalism

INTRODUCTION

Lizardfishes belonging to the family *Synodontidae* and two lizardfishes *Saurida tumbil* and *S. undosquamis* are exploited on commercial basis in Indian waters. Food and feeding habits of fish provide the information on the food chain in a particular ecosystem as well as prey and predator relationship and seasonal variations in the diet composition. This information will give the understanding on the migration patterns, abundance and behaviour of the fish. Most of the fishes are highly adaptable in their feeding habits and utilise most of the richly available food [1].

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Website: www.ijlssr.com

DOI: 10.21276/ijlssr.2017.3.3.12

Quantitative and qualitative analysis of food provides the knowledge on the life history and would be helpful for rational exploitation and management of commercially important species. Though, the studies on food and feeding habits have been attempted earlier by many researchers on many species, as changes in the environment and ecosystem taking place due to pollution and other anthropogenic activities, these studies are required to be attributed. The North-west coast of India covers the coasts of Maharashtra and Gujarat. The state of Maharashtra contributes a maximum of 3.128 Million litres a day (MLD) untreated sewage followed by Gujarat (1,522 MLD). Mumbai city is the largest populated city ranks at number 6 spot in terms of most populated cities in the world situated along the North-west coast of India with the current population of over 22 million people, which the city generate around 2,160 MLD sewage per day [2]. The state of Gujarat is one of the industrial states of India, discharges around 566 MLD of untreated industrial effluent in the sea; contribute 33% of the total discharge in the country

whereas Maharashtra state discharges approximately 80 MLD in the coastal waters these are affecting the food web in the sea which is very serious [3]. It is imperative to study the food and feeding habits of a particular region of the coast so as to derive the strategies for conservation, management and development of these species on sustainable basis.

Research on food and feeding habits of lizardfishes was attempted earlier in other parts of Indian Ocean and other International Oceans [4-8]. In Indian waters along the Bay of Bengal and Arabian Sea these studies were attempted at various coasts [9-19]. Most of the above studies are of qualitative in nature and the research areas of the studies pertain to very limited area. The area chosen for this study is North-west coast of Indian EEZ covering the coast of Gujarat and Maharashtra from the Lat. 18°-23°N/Long. 68°-73°E. The detailed investigations on qualitative and quantitative assessment of food and feeding habits have to be attempted regularly as the changes are taking place in the ecosystem to monitor the resources availability, abundance and distribution so as to understand the existence of the lizardfish fishery. Hence, this study has been undertaken.

MATERIALS AND METHODS

Month-wise data for this study was collected from the exploratory survey vessels of Fishery Survey of India *Viz.* Mastya Mohini and Matsya Nireekashani operating in the northern coast of India and weekly data was collected from the landings centres located in the North-west coast of India (Fig. 1) during the period from 2010 to 2012. Eye estimation on the fullness of stomach, occurrence method (Index of preponderance) was followed [20]. For understanding the food habits and intensity of feeding method was employed [21]. In the occurrence method, emphasis was laid on the occurrence of different food items in the stomach. A total 1630 specimens of *S. tumbil* and 926 specimens of *S. undosquamis* were analysed for quantitative and qualitative analysis.

For quantitative analysis, Month-wise, Season-wise, Length group-wise, Sex-wise, Percentage of feeding intensity was derived. Month-wise data differentiated into quarter-wise data to understand the seasonal food preferences. The qualitative analysis was attempted based on dominance, percentage of preference of prey items in the different months, seasons, and size groups. While attempting the above study, sex was determined visually after cutting open the belly. The Gonado Somatic Index (GSI) was calculated by using the formula:

$$GSI = \frac{\text{Weight of stomach}}{\text{Weight of the fish}} \times 100$$

For qualitative observations, the stomach contents were broadly classified into Teleost fishes, Molluscs, Shrimp, Crabs, Squilla, Semi-digested matter and digested matter.

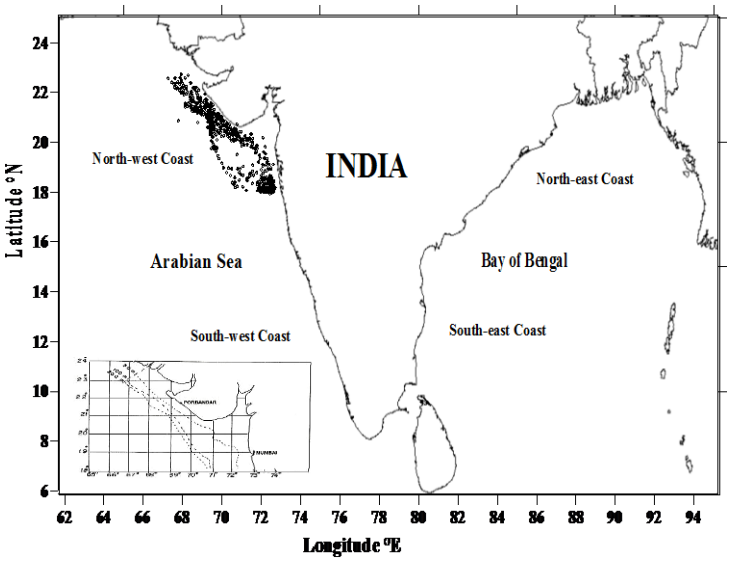

Fig. 1: Sampling stations along the North-west coast of Indian EEZ (Study area)

RESULTS

As per the Index of preponderance method, the main food items observed in *Saurida tumbil* and *S. undosquamis* in order of abundance as Teleost fishes, Molluscs, Crabs and Squilla. Both the species are found carnivorous in nature. Teleosts fishes found to be more in *S. undosquamis* (49%) when compared to *S. tumbil* (41%). Molluscs, Shrimps, Crabs and Squilla are found more or less same in both the species (Fig 2-3). Food preferences in both the species indicate that these species prefers same type of food available in the surrounding ecosystem. Different groups/ species identified in the gut contents of lizardfishes like *Acropoma japonicum, Acanthocepola limbata, Apogon spp., Bregmaceros mcclellandi, Coilia dussumieri, Champsodon* sp., *Decapterus russelli, Grammoplithes suppositus, Harpadon nehereus, Lutjanus vittatus, Leiognathid* sp., *Megalaspis cordyla, Nemipterus japonicus, Nemipterus filamentosus, Platycephalus* sp., *Rastrelliger kanagurta, Saurida tumbil, Saurida undosquamis, Sphyraena obtusata, Trichiurus* sp., *Upeneus moluccensis,* Sciaenids and Carangids. Molluscans are *Loligo duvaucelli* and *Sepia aculeata*. Crustaceans like shrimp were *Acetes indicus, Metapenaeus* sp., *Penaeus monodon* and *Solenocera* sp. Crabs are *Scylla serrata* and Alima larvae, *Squilla* sp. remains of bivalve shells, sand grains, detritus and mud.

About 26 teleost species were identified and reported in the diet of both the species. Among molluscs, squids and cuttlefishes found to be occurring in the diet. Four species shrimps and one species of crabs were observed during the study. Cannibalism has been observed in both the species during juvenile as well as adult stages as the smaller lizardfishes were found in the diet of these species. In the guts of both the species mud, sand grains, detritus found along with the food as these species are bottom dwelling in nature.

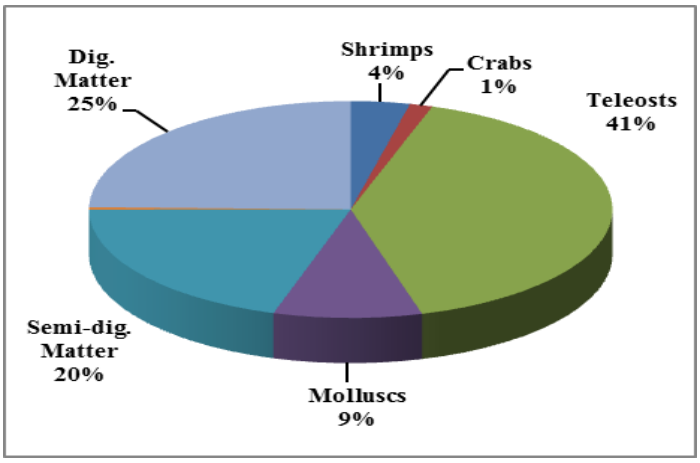

Fig. 2: Percentage occurrence of different food items in the stomach of *S. tumbil*

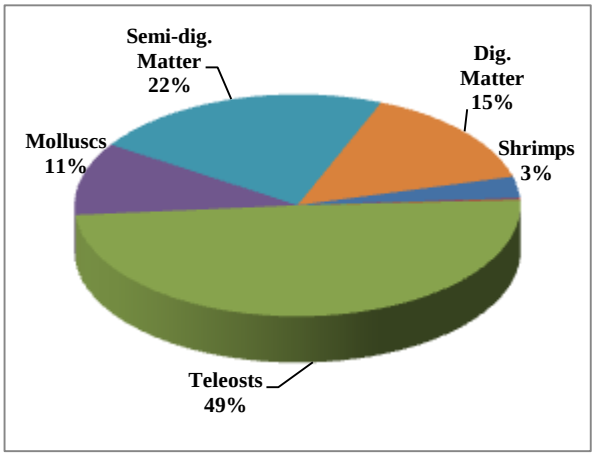

Fig. 3: Percentage occurrence of different food items in the stomach of *S. undosquamis*

Month-wise occurrence of food items revealed that the guts of *S. tumbil* and *S. undosquamis*, the dominant food item were teleost fishes (Fig. 4-5). In *S. tumbil*, the highest feeding intensity was observed in the month of April and lowest in the month of July whereas, in the case of *S. undosquamis*, the highest feeding intensity reported in the month of October and the lowest was in the month of August.

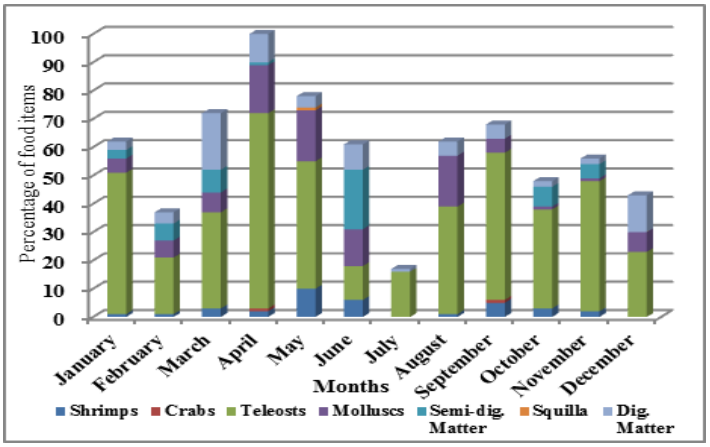

Fig. 4: Month-wise percentage occurrence of different food items in the stomach of *S. tumbil*

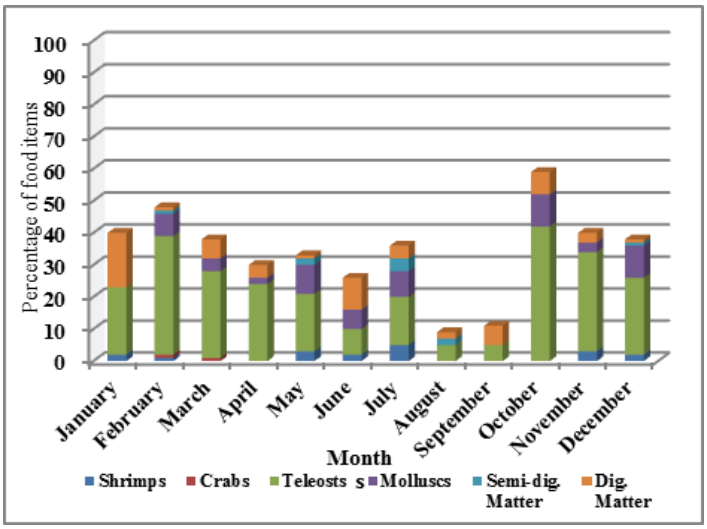

Fig. 5: Month-wise percentage occurrence of different food items in the stomach of *S. undosquamis*

In both the species, percentage of molluscs, shrimps, crabs and miscellaneous food items are not significant. Teleost fishes are the most preferred food identified throughout the year in both the species.

Quarter-wise variation of food items in *S. tumbil* illustrates that the highest feeding intensity was in IVth quarter (Oct-Dec) and teleosts (36%) found to be dominated followed by 34% in IIIrd quarter (July-Sept), 24% in Ist quarter and 21% in IInd quarter (Fig. 6). Molluscs found to be dominated in the IInd quarter. In case of *S. undosquamis*, the highest intensity was in IVth quarter (27%) followed by 26% in Ist quarter. The percentage of food intensity in IInd and IIIrd quarters was 18% in both the species (Fig.7).

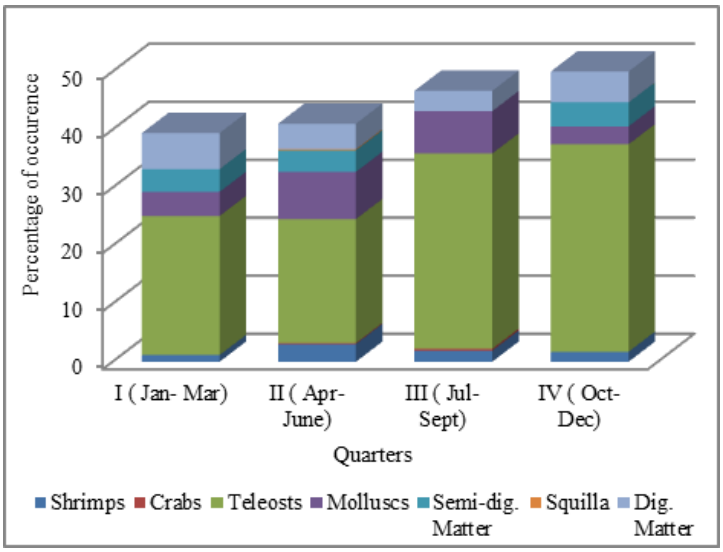

Fig. 6: Quarter-wise percentage occurrence of different food items in the stomach of *S. tumbil*

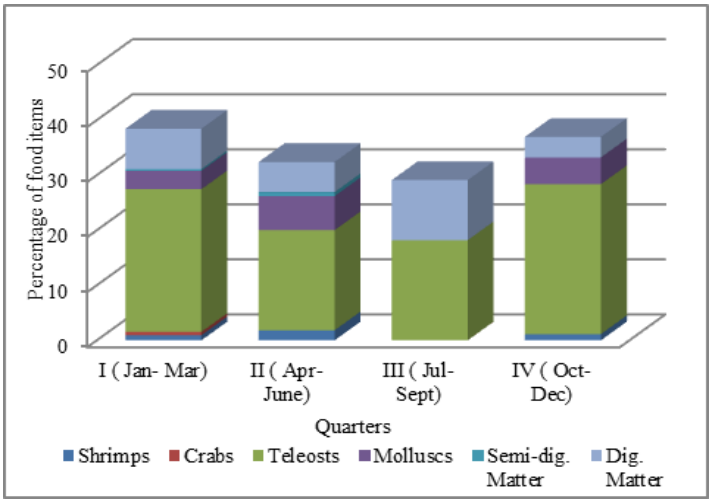

Fig. 7: Quarter-wise percentage occurrence of different food items in the stomach of *S. undosquamis*

Feeding intensity in relation to size of the fish emphasised that, teleost fishes and molluscs were mostly preferred by *S. tumbil* and are reported in all length groups. This species commences intake of fin-fishes when they are at minimum length of 13.0 cm (TL) and there is gradual increase in the percentage consumption of food items with increasing length. The diet of specimens above 21.0 cm total length revealed that they feed exclusively on fishes, molluscs and shrimp. The maximum feeding intensity was observed in 51-53 cm length group and minimum was in 19-21 cm length group. Molluscs were preferred by the fishes in between the 17-47 cm length group (Fig. 8).

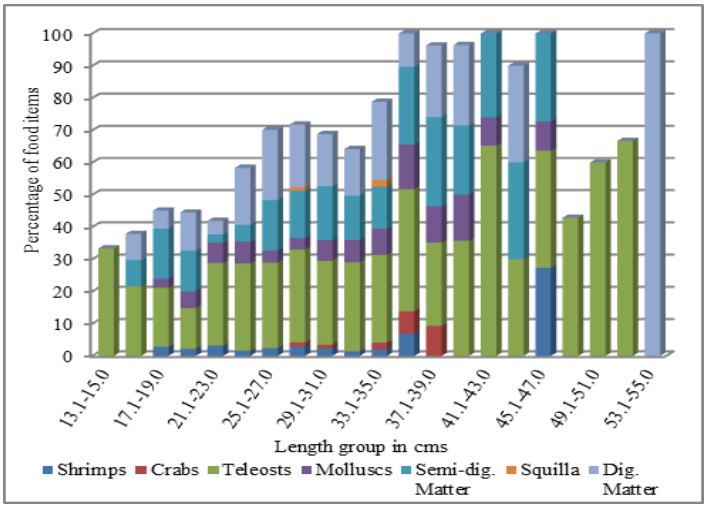

Fig. 8: Length group-wise percentage occurrence of different food items in the stomach of *S. tumbil*

Unlike *S. tumbil*, *S. undosquamis* also preferred teleosts fishes and molluscs as food in all length groups. Molluscs were observed in 15-35 cm length group and shrimps were regularly found in 17-29 cm length group. Crabs were exclusively observed in the fishes at the length group of 23-25 cm (Fig. 9).

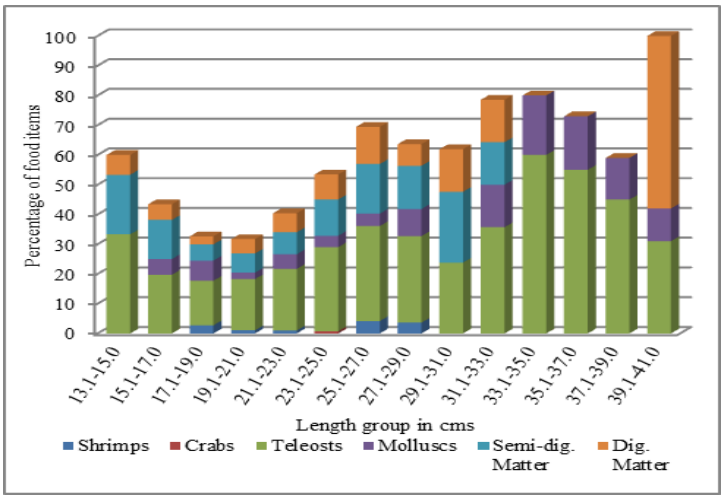

Fig. 9: Length group-wise percentage occurrence of different food items in the stomach of *S. undosquamis*

The Gonado Somatic Index (GSI) values (Table 1-2) obtained in each month for *S. tumbil* and *S. undosquamis* revealed that the index was found to be maximum in January (10.55%) and July (10.76%) whereas, the female species shown the maximum index in July (9.55%) and October (8.82%). In case of *S. undosquamis*, the maximum values of GSI in males were obtained in August (16.58%) and February (13.04%) and in females, it was in August (17.80%) and March (14.69%). The peak GSI value obtained in July for *S. tumbil* and August for *S. undosquamis* (Fig. 10-11). This indicates maximum feeding during these months.

Table 1: Gonado-somatic index (GSI) values of *S. tumbil*

Months	Males (M)	Females (F)
January	10.55	5.87
February	6.53	0.91
March	3.40	5.02
April	4.32	2.90
May	4.86	4.08
June	8.51	5.89
July	10.76	9.55
August	5.86	4.14
September	6.25	5.79
October	4.52	8.82
November	4.01	6.18
December	7.98	7.98

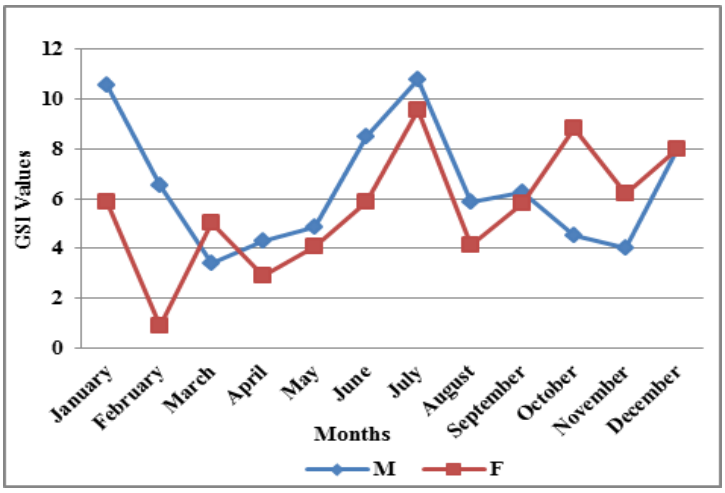

Fig. 10: Gonado-somatic index (GSI) of *S. tumbil*

Table 2: Gonado-somatic index (GSI) values of *S. undosquamis*

Months	Males (M)	Females (F)
January	1.85	9.06
February	13.04	7.94
March	10.21	14.69
April	11.78	10.25
May	9.12	5.62
June	1.62	0.78
July	9.10	9.29
August	16.58	17.80
September	1.47	3.78
October	6.71	8.44
November	5.19	6.18
December	9.30	11.53

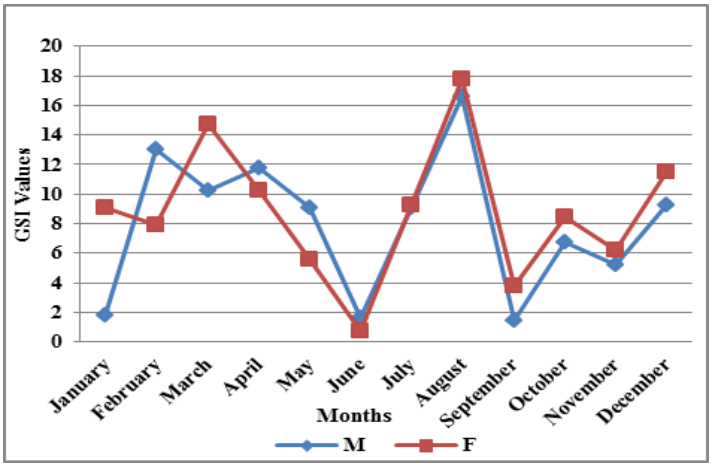

Fig. 11: Gonado-somatic index (GSI) of *S. undosquamis*

Month-wise feeding condition indicated that July month has shown the peak and moderate to actively fed condition in *S. tumbil* (Fig. 12-13). In case of *S. undosquamis* October month shown the peak from moderate to actively fed condition. Maximum empty stomachs obtained in July which indicates the poor feeding condition.

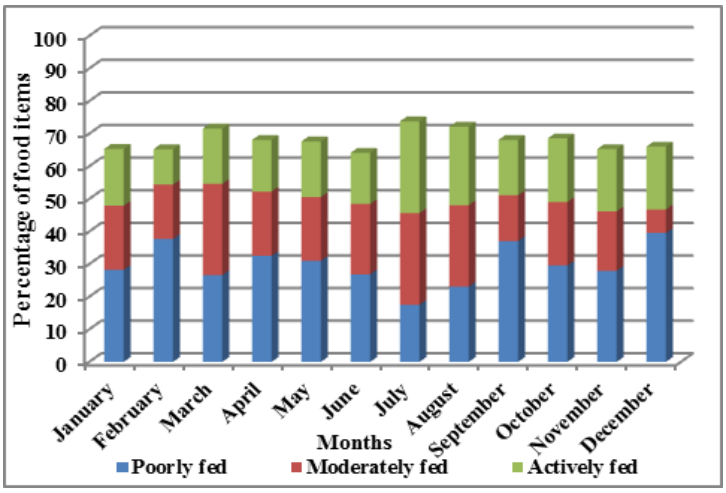

Fig. 12: Month-wise feeding intensity in *S. tumbil*

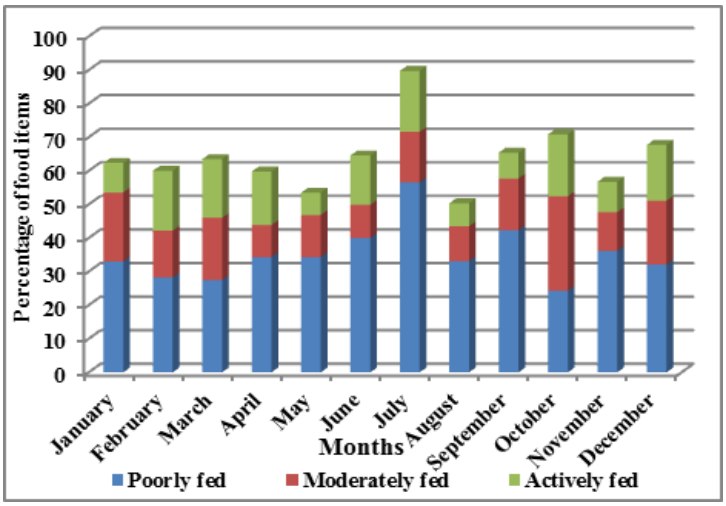

Fig. 13: Month-wise feeding intensity in *S. undosquamis*

Season-wise feeding condition observed that, in *S. tumbil* actively fed condition reported in the monsoon season followed by post and pre-monsoon seasons. *S. undosquamis* was reported to be poorly fed condition during the monsoon season (Fig. 14-15).

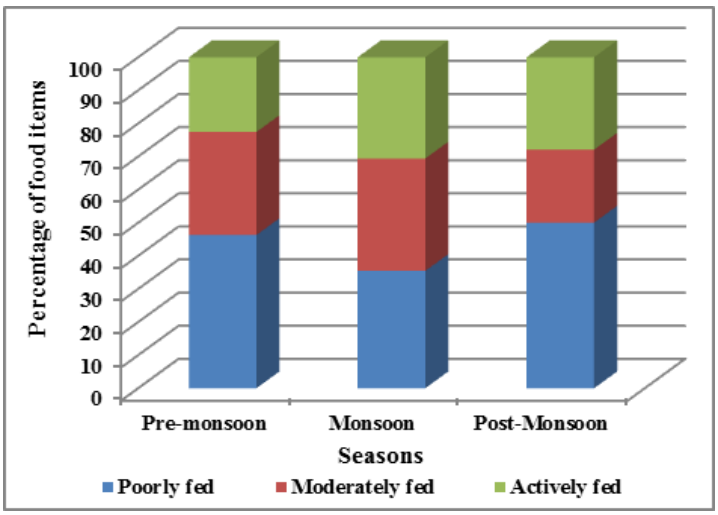

Fig. 14: Season-wise feeding intensity in *S. tumbil*

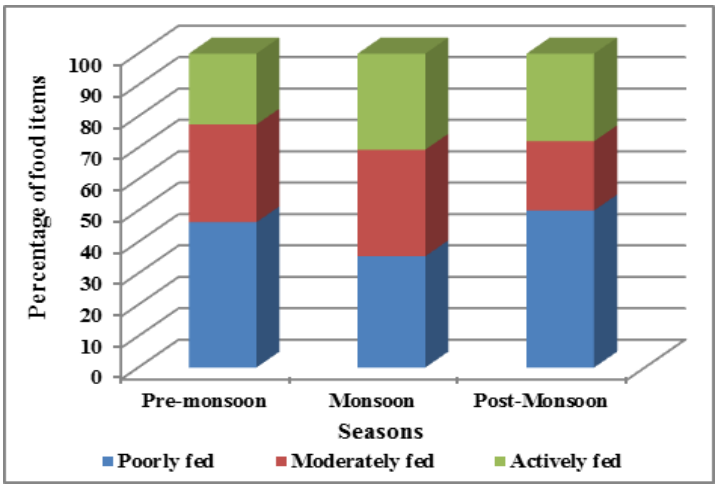

Fig. 15: Season-wise feeding intensity in *S. undosquamis*

The feeding condition was found to be increased from moderate to actively fed condition in the length range of 35-55cm in *S. tumbil* which indicates that when the length of fish increases, the feeding capabilities also increase. In case of *S. undosquamis*, moderate to actively feeding condition was observed from 33-41cm length groups otherwise it has shown the insignificant feeding condition (Fig. 16-17).

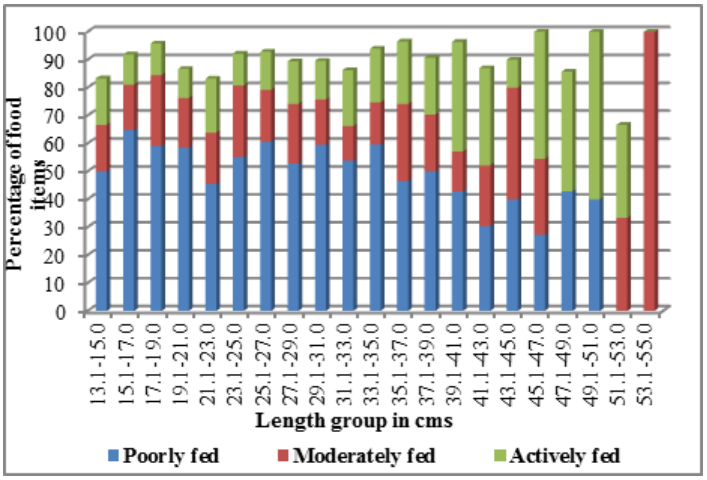

Fig. 16: Length-wise feeding intensity in *S. tumbil*

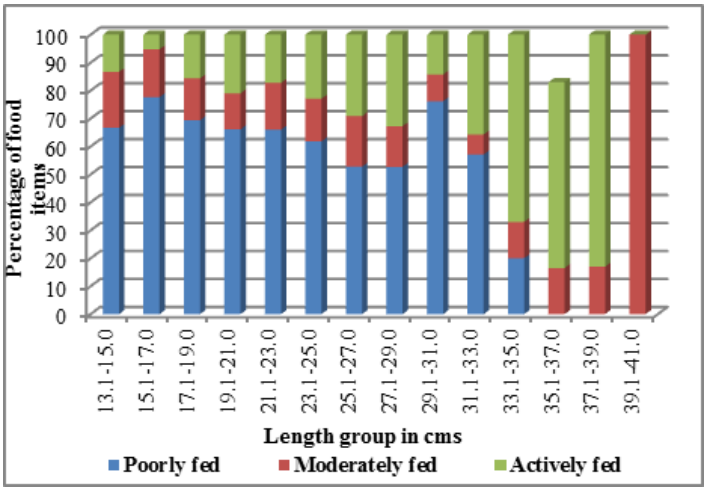

Fig. 17: Length-wise feeding intensity in *S. undosquamis*

Feeding condition as per the maturity stage of the fish has shown actively fed condition in both the species when the stage was immature. As the fish attains towards the maturity in both the species, the actively fed condition decreases (Fig. 18-19). This may be due to occupancy of matured gonad and the food might have been digested faster. Empty stomachs observed in the matured fishes.

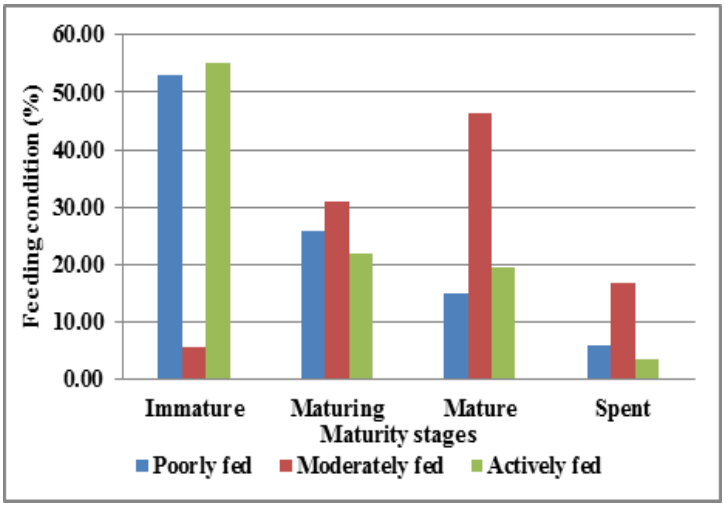

Fig. 18: Feeding condition of *S. tumbil* in relation to different stages of maturity

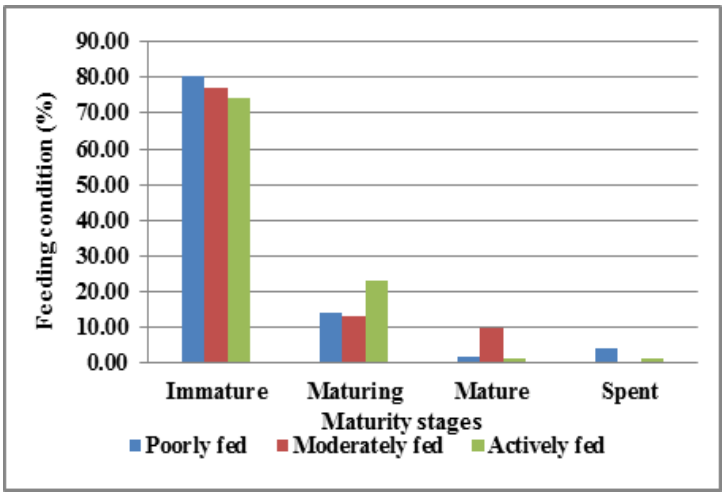

Fig. 19: Feeding condition of *S. undosquamis* in relation to different stages of maturity

DISCUSSION

In this present study, the dominance of Teleost fishes (45%) in both the species followed by Molluscs (10%), Shrimps (4%) and Crabs (1%) indicates that these species are carnivorous in nature. Predominant feeding of fishes belonging to the groups *Viz.* Carangids, Sciaenids, Upenids, Nemipterids, Leiognathids, Barracudas, Lizardfishes, Bregmaceros, Groupers besides *Acetes sp*., *Metapenaeus* sp., among the shrimps and cuttlefishes and squids among molluscs reported in the study. These observations are similar to the works of Euzen, Baksh and Fofandi [17, 22-23]. Dominance of fishes as the most preferred food in both the species, the similar study was represented by Okada and

Kyushin [4] from East China and the Yellow Seas, Tung [5] from East China Sea, Tiews [7] from Philippine waters, Singh *et al.* [10], Rao [11] from north western part of Bay of Bengal and Metar *et al.* [4] off Mumbai waters. Presence of juvenile lizardfishes in the stomachs of both the species in the present study shows that these species are cannibalistic in nature. This study is in agreement to the works of Raje *et al.* [15] and Metar *et al.* [16]. Highest percentage of empty stomachs (54%) was observed during maturity condition of both fish species in the present study. It was also observed that as the fish attains maturity stage, feeding either reduced or declined. The empty stomach nature may be the reason that the maximum portion of gut occupied by the gonad and the pressure might have been exerted by the gonad. This condition is very well supported by made observations of Thomas [24]. He observed that the feeding in mature fishes was declines during the breeding season as the ovaries are enlarged and densely packed with ova, spreading out and occupying the abdominal cavity, exerting a lot pressure on the stomach. As stated by Thresher [25] that the uncertainty remains about population structure for most marine species due to complex dispersal patterns. The impact of pollution due to discharge of untreated sewage disposal and industrial effluents along the North western Indian EEZ is also contributing to the dispersal patterns of the fishes. Therefore, these studies would give better understanding about distribution of the lizardfish population based on the availability of food, which in turn helps to harvest these resources on sustainable basis.

CONCLUSIONS

The lizardfishes were carnivorous in nature and major share (45%) of prey in the species under study was contributed by Teleost fishes. About 26 teleost fishes were identified as prey in the food composition including juvenile specimens of lizardfishes. This indicates that these species are cannibalistic feeders, feeds on their own species. Highest feeding intensity was observed in the month of April in case of *S. tumbil* and October for *S. undosquamis*. In the IVth quarter (Oct-Dec) the feeding intensity was observed to be more when compared to other 3 quarters for both the species. The peak GSI values obtained in July for *S. tumbil* and in August for *S. undosquamis* indicating maximum feeding during these months. It was observed that, as the length increases in size, the feeding intensity also increases. During monsoon season, *S. tumbil* reported to be actively fed and *S. undosquamis* observed to be poorly fed. In both the species, it was observed that actively fed condition in immature samples are more than mature samples which indicates that as the fish attains maturity, the feeding intensity decreases.

ACKNOWLEDGMENT

The authors are grateful to all the scientists, vessel officers and crew who contributed their might in collecting the data. We thank the authorities of DAHD & F, MOA and FSI for their incessant support in accomplishing the work.

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How to cite this article:

Mali KS, Vinod KM, Farejiya MK, Bhargava AK: Food and Feeding Habits of Two Major Lizardfishes (Family: Synodontidae) occurring along North-West Coast of India Between Lat. 18°-23°N. Int. J. Life Sci. Scienti. Res., 2017; 3(3): 1039-1046. DOI:10.21276/ijlssr.2017.3.3.12

Source of Financial Support: Nil, **Conflict of interest:** Nil

