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Food, feeding biology and hypothesis on occurrence of empty stomach of the *Plicofollis tenuispinis* (Day, 1877) landed along the Veraval centre of the Saurashtra coast of the India

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Abstract

This study investigation on the food and feeding biology of the Thinspine sea catfish catch landed along the Veraval marine fish landing centre of the Saurashtra coast, along the Maritime of Gujarat, India were carried out during year from March 2016 to February 2017. Reveled with new proposed reasonable hypothesis on Occurrence of Empty stomach and occurrence of various food items indicated that this sp. Highly carnivorous feeding habit in exploited Thin spine sea catfish stock.

Keywords: Thinspine sea catfish, feeding biology, Gastro-somatic index, index of relative, importance, Saurashtra Coast, Mixed planktonic organisms-Mud (MPOM).

Introduction

The Marine catfishes belongs to the Otophysi group one of the Largest fish species order Siluriformes, its diversity rich in species represented around the world by at least 3,407 species in over 37 catfish families and represents about 10.8% of all fish species and 5.5% of known all vertebrate species of the world[1,2]. The Age and Growth Studies along Veraval cost, carried out on this *P. tenuispinis*, reported that this species locally known as Kaggada, this species available throughout the year of study and there is a demand for large size group for edible eggs in domestic market, The Estimated Population growth parameters during the Current studies were, L∞ and K were 665mm and 0.35 and Age at Maturity 2.1 year, respectively[2]. *P. tenuispinis* are highly carnivores and bottom feeder. The gut content of the fish shows very high level of emptiness where 63.5% of total stomachs have been reported to be empty with preferred food as crustaceans, polychaetes, molluscs, fishes and echinoderms[3]. The present study were targeted for investigating the details about different varities of the prey items that are commonly occurring stomach of the Thinspine seacatfish landed at Veraval centre.

Location of the study site: along the Veraval marine fishing centre (20°54'912"N, 70°21'355"E), Saurashtra coast of maritime state of the Gujarat, India.

Design: Multistage stratified random sampling developed by CMFRI.

Materials and methods

The following materials were utilized for the performing the current research studies such as:

Samples of the Thinspine Seacatfish specimens about an approximately 25 numbers were utilized for these investigation, Measuring board with invert scale reader (0.1-60cm), Electronic weighing balance (highest capacity is 5 kg, recording lowest weighing sensitivity is 50g), Insulated box (5kg, capacity), Labels, Specimen bottles, Forceps, Scissors, Formalin (4-10% cons.), Compound microscope.

Methodology: Thin spine seacatfish fishery catch brought by trawlers at Veraval marine fish catch landing harbour of Saurashtra coast of the Gujarat were randomly collected from different areas were utilized for biological investigation. Abdomen of the fishes dissected to get their stomach and gonad, followed by removing of the tissue around the stomach until opened for the prey items collection, identification and recording the number of items in each category, with their weights and number, then volume of each prey items was noticed. During the current investigation following observations were noticed to perform the analysis of the research achievements for concluding. Total length of the fish (mm), Total weight of the fish (g), Sex and maturity stage of gonad, Extent of gut distension (empty, 1/4th, 1/2th, 3/4th or full based on visual observations), Total weight of gut (g), Identification of gut contents (to the best possible taxonomic level), Number and weight of each category of food items.

Different methods of the stomach contents analysis were used.

Index of Relative Importance (IRI): The relative importance of various food items in the stomach was calculated by the index of Relative Importance as followed by Pinkas *et al*[4]. The IRI was computed as given below:

IRI = (%N + %V) x %F

Where, N=number, V=volume and F=frequency of occurrence.

The IRI was used to assess the type of food repeatedly found in the stomach, number of food and volume of each type of food item providing a inference about various types of food items and finally type of feeding habit of species. The intensity of feeding was based on the visual observation, the quantity food items present in their stomach and the volume of food available in stomach measured in measuring cylinder and stomach based on the distention of food items was classified as full, ¾ full, ½ full, ¼ full, trace and empty.

The index of preponderance was calculated here as

$I_j = (V_i + O_i / £ V_i + O_i) \times 100$

Where: P V_i and O_i are the volume and occurrence index of food items showed in percentage where as volume displaced by food items. To examine the occurrence, total number of occurrence of all types of food items were individual percentage wise composition of food. Food i occurred in N times then it is showed as % of food i occurrence expressed as

D_i= occurrence of food in percentage.

Results and discussion

The major sources for these species samples for the investigation of details about its feeding biology was collected by following the multiple random sampling from the commercial trawler and gill netter landed at Veraval center from the Jaleshwar to Fishing harbour, In Gir Somanath district. A total of 310 specimens collected were used for these feeding biological details investigation of *P. tenuispinis.* These species stomach condition and its food items indicating highly carnivorous feeding nature during current study observation.

Table-1: Monthly feeding intensity of *P. tenuispinis* at Veraval during 2016 -17.

Month	Gorged stomach	Full stomach	3/4Full stomach	1/2Full Stomach	1/4Full Stomach	Trace Stomach	Empty Stomach	Total Stomach
March	0.0	3.3	0.0	0.0	13.3	26.7	56.7	30
April	0.0	6.7	6.7	0.0	23.3	33.3	30.0	30
May	0.0	0.0	3.2	12.9	35.5	3.2	45.2	31
June	0.0	25.0	0.0	18.8	6.3	0.0	50.0	16
August	0.0	0.0	0.0	0.0	11.8	61.8	26.5	34
September	3.8	50.0	3.8	7.7	11.5	11.5	11.5	26
October	16.1	3.2	3.2	3.2	6.5	45.2	22.6	31
November	4.8	4.8	4.8	0.0	19.0	9.5	57.1	21
December	19.4	0.0	0.0	9.7	3.2	29.0	38.7	31
January	0.0	10.0	50.0	3.3	23.3	3.3	10.0	30
February	0.0	0.0	10.0	16.7	3.3	33.3	36.7	30
Mean % year	4.2	8.1	7.7	6.1	14.5	25.5	33.9	310

Note: % = percentage, % Stomach distension.

Stomach contents of the Thinspine Seacatfish *P. tenuispinis*: A total of 39 different types food items were visually noticed, items were identified at their possible at species level few with representative taxon level.

Prey species of *P. tenuispinis:* The prey species of the *P. tenuispinis* constitute of finfishes group *Apogon sp*, *Bregmoceros sp*, *Coilia Dussumeiri*, *Decapterus sp*, *Epinephalus sp*, *Leiognathus sp*, *Nemipterus sp*, *Upeneus sp*, *Polynemus sp*, *Priacanthus sp*, *Sardinella sp*, *Scianids sp*, *Stoliphorus sp*, Bombayduck, Clupeids, other small carangids and other Teleost remain.Category crustaceans includes *Acetus sp*, Amphipods, Crab, *Nematoplaemon sp*, non penaeid shrimp, Squilla/*Oratonepha sp*. Penaeid shrimp, Phyllosoma (lobster larvae), *Solenocera sp* and Crusrtacean remaining. Annelidsas Polychaets and Molluscan species included Gastropod, Bivalves, *Loligo sp*, Cuttlefish, Squid and Cephalopod remaining. Echinodermsinclude Brittle star and Ophuiroids/ Ehinoderms. Catfish eggs, digested organic matter (Animal parts DOM), Mixed planktonic organisms-Mud (MPOM).

Month wise food composition of various gut contents (food prey items) majorly belongs to the crustaceans, fishes, Molluscans, Echinoderms, Annelids and miscellaneous were commonly observed during study.

Frequency of occurrence of the different food items in *P. tenuispinis:* Throughout the year of the study totally 310 specimens *P. tenuispinis* stomachs were dissected and recorded various food items was analyzed using methods for gut contents by both index of relative importance and index of preponderance. The present study results as given Table.2 Stomach content analysis by Index of Relative Importance (IRI) method and Table-3 Comparative analysis of stomach contents using IRI and IP, shows that highest rate of food items preference of *P. tenuispinis* along the Saurashtra coast were on the Crustaceans group which was about 78.3 % of the IRI of all the types food items taxon wise categories. Among the crustaceans, *Acetus* sp was singles highest preferred food item of the *P. tenuispinis.* Teleost fishes are second most important food item category with 10.2% followed by miscellaneous, Molluscans, Echinoderms and Annelids, 9.6%, 1%, 0.5% and 0.5% of IRI respectively.

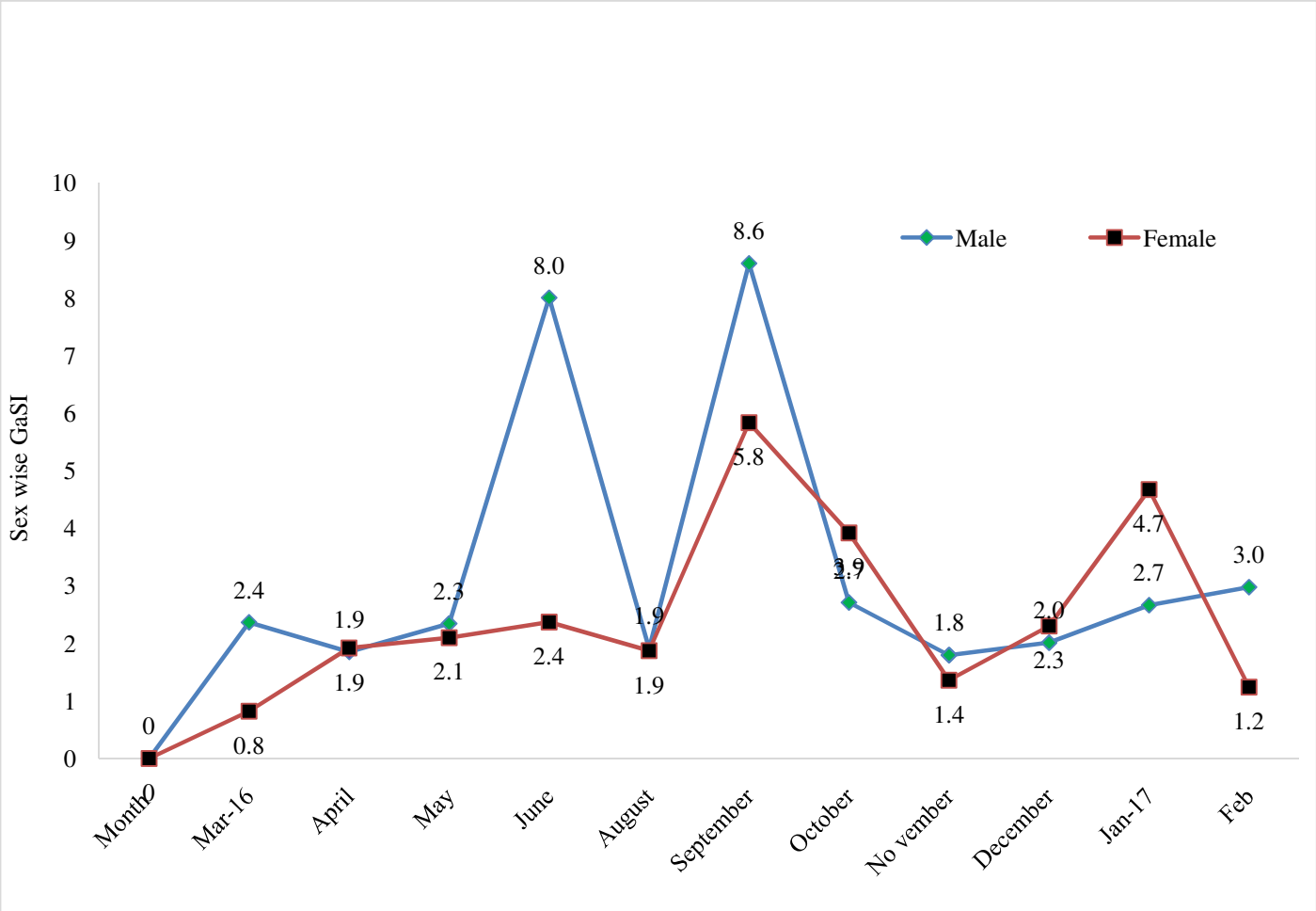

Figure-1: Month wise and Sex wise Gastro-Somatic Index (GaSI).

Table-2: Stomach content analysis by Index of Relative Importance (IRI) method.

Names of the Prey groups IRI	V%	N%	%F	IRI	IRI%
Apogon sp	3.09711	0.69825	2.90323	11.02	0.58
Bregmoceros sp	7.92651	1.84539	6.77419	66.20	3.46
Coilia dussumeiri	5.93176	0.99751	4.19355	29.06	1.52
Decapterus sp	2.99213	0.399	1.6129	5.47	0.29
Epinephalus sp	2.93963	0.399	1.6129	5.38	0.28
Leiognathus sp	4.40945	0.99751	2.58065	13.95	0.73
Nemipterus sp	4.35696	0.44888	2.90323	13.95	0.73
Upeneus sp	4.09449	0.5985	3.22581	15.14	0.79
Polynemus sp	2.93963	0.29925	1.29032	4.18	0.22
Priacanthus sp	1.94226	0.29925	1.6129	3.62	0.19
Sardinella sp	1.73228	0.1995	1.29032	2.49	0.13
Scianids sp	5.19685	0.99751	2.58065	15.99	0.83
Stoliphorus sp	2.20472	0.44888	1.29032	3.42	0.18
Other Teleost remain	0.36745	0.14963	0.96774	0.50	0.03
Acetus sp	7.71654	74.015	17.4194	1423.71	74.31
Amphipods	1.41732	0.69825	0.32258	0.68	0.04
Crab	4.56693	1.74564	3.87097	24.44	1.28
Nematoplaemon sp	0.20997	0.14963	0.96774	0.35	0.02
non penoid shrimp	0.99738	1.44638	3.54839	8.67	0.45
Squilla /*Oratonepha sp*	3.72703	1.44638	5.16129	26.70	1.39
penoid shrimp	1.88976	0.5985	4.51613	11.24	0.59
Phyllosoma lobster (larvae)	1.25984	0.44888	1.6129	2.76	0.14
Solenocera sp	0.26247	0.24938	0.96774	0.50	0.03
Crusrtacean remain	0.36745	0.14963	0.96774	0.50	0.03
Polychaets	1.41732	1.24688	3.54839	9.45	0.49
Gastropod	3.46457	0.84788	2.58065	11.13	0.58
Bivalves	0.68241	0.24938	1.29032	1.20	0.06
Loligo sp	0.57743	0.09975	0.32258	0.22	0.01

Names of the Prey groups IRI	V%	N%	%F	IRI	IRI%
Cuttle fish	0.57743	0.1995	0.64516	0.50	0.03
Squid	1.5748	0.399	1.29032	2.55	0.13
Cephalopod remain	1.78478	0.34913	1.6129	3.44	0.18
Brittle star	1.04987	0.399	1.6129	2.34	0.12
Ophuiroids/Ehinoderms	2.15223	0.64838	2.58065	7.23	0.38
Catfish eggs	0.52493	0.69825	1.6129	1.97	0.10
Digested organic matter (Animal parts DOM)	4.54068	2.94264	19.0323	142.42	7.43
Mixed planktonic organisms-Mud (MPOM)	4.80315	1.04738	6.77419	39.63	2.07
Bombayduck	0.7874	0.14963	0.96774	0.91	0.05
Clupeids	2.04724	0.34913	0.64516	1.55	0.08
Other small carangids	1.46982	0.64838	0.64516	1.37	0.07
				1915.81	100.00

Note: IRI= index of the relative importance of the food items; V% = percentage of volume of the each food item; N% = percentage of number of each food item; F% = percentage of frequency of the occurrence of the each food item.

Table-3: Comparative analysis of stomach contents using IRI and IP.

Major Prey groups	IRI	% IRI	Rank	Vi*Oi	% IP	Rank
Annelids	9.5	0.5	6	5.0	37.0	6
Crustaceans	1499.6	78.3	1	186.7	35.0	1
Echinoderms	9.6	0.5	5	7.2	3.0	5
Miscellaneous	184.0	9.6	3	119.8	1.4	3
Molluscans	19.0	1.0	4	15.3	1.0	4
Teleost fishes	194.2	10.2	2	175.5	22.6	2

Note: IRI= Index of relative importance, IP= index of preponderance, Vi= % of volume of ith food items, Oi= % of occurrence of ith food items.

The studies of Manikandarajan, *et al*[5] on south east coast on *Arius maculates* noticed that major to miner preferred food in sequence as miscellaneous, Crustacean, Fish, *Polychaetes*, Sand grains, Digested matter, Zooplankton and Phytoplankton. Present studies recorded that preferred food items for the *P. tenuispinis* was highest Crustaceans, followed by Teleost fishes with 10.2% followed by miscellaneous, Molluscan, Echinoderms and Annelids, 9.6%, 1%, 0.5% and 0.5% of IRI respectively. Present investigated work on *P. tenuispinis* at Veraval noticed that higher peak in gastro-somatic index (GaSI) of both males and females at Veraval were during the month of September with 8.6 and 5.8 respectively. These increasing in the GaSI during the post spawning period due to recovered feeding nature from prolonged starvation during spawning season, reproductive stress and availability of prey items at *P. Tenuispinis* feeding habitats. The minimum peak in GaSI was recorded during the Spawning season in females was 0.81 in March while in Males during the pre-spawning season during month of November were 1.79 respectively.

Figure-2: Prey items of *P. tenuispinis* at Veraval landing centre during investigation (2016-17).

The Hypothesis on occurrence of Empty stomachs in mouth cavity brooding marine catfishes were proposed by the author, Bhukya Bhaskar, After careful investigations as,

Hypothesis on the occurrence of the empty stomachs and poor feeding behavior of the oral cavity breeder marine catfish species: i. Due to the breeding season commence of fully matured ovary that occupy complete abdominal cavity of the females result in there is adequate place for the storing consumed food items. ii. Matured females oppose to feeding during the mature oocytes development to prevent damage from the consumed food items from undigested prey items. iii. Oral cavity brooding behavior of matured male individuals temporarily stop their feeding for the safety of fertilized eggs until the juveniles of *P. tenuispinis* actively released from the oral cavity of matured males to prevent ova breaking during the physically breakdown process of food particles in between the jaws. iv. engulfing action of the jaws create harmful and injurious movable hardbones directly and indirectly cause serious damages the developed oocytes and fertilized embryos in order to prevent their immediate broking action these *P. tenuispinis* might follow the poor feeding habits during most probably in breeding season. v. The occurrence of immature individuals of *P. tenuispinis* was may be due to there is no preferable or inadequate prey availability of *P. tenuispinis* at its feeding grounds. vi. Empty stomach may due to carnivorous consumed food items by *P. tenuispinis* was digested within less time duration. vii. Empty stomachs may be due to the omitting of recently consumed food items during the process of catching by the gears, entangling, handing of gears on the vessel deck. viii. Due to polluted feeding grounds and habitat modified due to associated ecosystem changes which inducing *P. tenuispinis* resulted in its poor feeding conditions. ix. Poor feeding behavior of *P. tenuispinis* may be caused due to pathogens and other reasons may be due to unknown negative impacts caused by multiple factors.

Discussion: Feeding intensity: These species monthly feeding intensity was noticed that maximum during the post spawning during particularly increasing in the feeding rate was from August to January, while poor feeding in which the occurrence of the Empty stomach was higher during the spawning season February to June and post spawning period with overall about 33.9% throughout the year. Raje *et al*[4]. noticed that the occurrence of empty stomach was very high (70%) *Tachysurus jella* from Mumbai waters while Raje[3], studied on some aspects

of biology of *Arius tenuispinis* at Veraval recorded very high of empty stomachs where 63.5% of total stomachs were found to be empty with preferred food as crustaceans, polychaetes, molluscs, fishes and echinoderms.

Frequency of occurrence of the different food items in *P. tenuispinis:* Throughout the year of the study totally 310 specimens *P. tenuispinis* stomachs were dissected and recorded various food items was analyzed using methods for gut contents by both index of relative importance and index of preponderance. The present study results shows that highest rate of food items preference of *P. tenuispinis* along the Saurashtra coast were on the Crustaceans group which was about 78.3 % of the IRI of all types of prey food items and their taxonomic categories. Among the crustaceans, *Acetus* sp was singles highest preferred food item of the *P. tenuispinis.*Teleost fishes are second most important food item category with 10.2% followed by miscellaneous, Molluscan, Echinoderms and Annelids, 9.6%, 1%, 0.5% and 0.5% of IRI respectively.

Some aspects of biology of *Tachysurus thalassinus* (Ruppell) and *P. tenuispinis* (Day) off Visakhapatnam was carried by Sastry[6]. revealed that index of preponderance Natarajan and Jhingran[7] of food items of *A. thalassinus*: Crabs-31.57, Teleosts-20.63, Squilla-7.3, Prawns-7.13, Crustacean remains-4.9, Molluscs-0.70, *Polychaetes*-0.06, Enchinoderms-0.004 and Miscellaneous items 27.7. Whereas for *P. tenuispinis*: *Polychaetes*-69.86, Prawns-3.4, Teleosts-1.45, *Lucifers*-1.04, *Squilla*-0.67, Echinoderms-0.54, Molluscs-0.48, Crustacean remains-0.10 and Miscellaneous items 22.46. The present study work at Veraval observed that index of preponderance for food items of *P. tenuispinis*: Crustaceans-37, Teleost fishes- 35%, miscellaneous items- 22.6, Molluscan 3%, Echinoderms 1.4 and Annelids–1 respectively. The most preferred food items for these species during the current study were is *Acetus sp*.

Gastro-somatic index (GaSI): Present investigated work on *P. tenuispinis* at Veraval noticed that higher peak in gastro-somatic index (GaSI) of both males and females at Veraval were during the month of September with 8.6 and 5.8 respectively. These increasing in the GaSI during the post spawning period due to recovered feeding nature from prolonged starvation during spawning season, reproductive stress and availability of prey items at *P. Tenuispinis* feeding habitats. The minimum peak in GaSI was recorded during the Spawning season in females was 0.81 in March while in Males during the pre-spawning season during month of November were 1.79 respectively.

More recently a new genus and species of marine catfishes (Siluriformes; Ariidae), *Qarmoutus hitanensis*, described from the base of the upper Eocene Birket Qarun Formation[8]. Osteogeneiosus militaris (Linn.,1758) off Mumbai waters, was reported as carnivorous and predacious. Index of preponderance values pointed that, this marine catfish feeds predominantly on crustaceans (shrimps, crabs), molluscs (bivalves, squids) and young fishes (Coilia spp., ribbon fish). Among the prey groups of food items, crustaceans major preferred food group available in stomach contents comparison to molluscs and fishes[9]. The index of relative importance of different prey food items preference by Tachysurus teniiispinis during month wise shows that feeding is selective. Preference of various prey item quantity contribution indicated that majority of the prey food items belongs crustaceans group in stomach of the *T. teniiispinis,* which includes taxonomic groups as crabs, prawns, Squilla sp and crustaceans remains; second most predominant prey item were is polychaetes and remaining in the next in sequence of most preference to least as molluscs, teleosts, ophiuroids and the rest miscellaneous food items. Their studies reveled that *T. tenuispinis* is, a carnivorous bottom feeder. Out of above group items due to a single polychaetes prey group are majorly dominated with single food prey type, occurred in highest frequency due to which they were considered is as most preferred prey item, Mojumder and Dan[10].

The similar type of studies on feeding habits of the *Tachysurus thalassinus*, were carried out, noticed and reported that majority of the prey taxonomic group consists of crabs, prawns, Squilla spp., and crustacean remains, while second major prey group is belongs to the teleost and remaining prey group consists of molluscs. Concluded that there is a correlation between the observed prey items in the stomach and the presence of food items in the feeding habitat is noticed[11]. A case study of the disappearance of *Arius tenuispinis* in the vicinity of Visakhapatnam due to mechanized fishing consequence in hardening of the substratum to the extent of making it uninhabitable to the polychaetes and polychaete feeding fish. The shoaling and strictly demersal marine catfish, *Arius tenuispinis*, a prolific polychaete feeder on the fishing grounds off Visakhapatnam, as Srinivasa rao and Lakshmi[12]. The studies along the coast of south-eastern Brazil, on the food and reproduction of cave catfish. *T. itacarambiensis,* revealed that the major preys groups were autochthonous insects and earthworms. It is a chemically oriented predator of bottom and surface animals, using foraging tactics also used by other cave catfishes, such as the *Pimelodids pimelodella kronei* and *Imparfinis* sp.[13]. Reproduction and feeding habits of the marine catfish, *Netumabarba* (Siluriformes, Ariidae), in the estuary of the Patos Lagoon along Brazil waters[14]. Biology of the important species in marine catfish resources of India. Exploitation and prospects studies carried out by Menon and Muthiah[15]. Some aspects of biology of *Tachysurus thalassinus* (Ruppel!) and *T. tenuispinis* (Day) off Visakhapatnam[16].

Conclusion

Present study at Veraval were reveling that these Thinspine sea catfish were highly carnivorous with predominantly animal matter were most preferred variety of the diet. major possible suggested reasons for the occurrence of empty stomachs, frequency of occurrence of the different food items in *P. tenuispinis*, Gastro-somatic index (GaSI), The Index of Relative Importance determined for the Stomach contents of *P.*

tenuispinis revealed that 78.3% for crustaceans components among which *Acetus* spp. was most predominant food item. Followed by fish components (10.2%), Miscellaneous (9.6%), Molluscans group (1%), Annelids (0.5%) and Echinoderms (0.5%) respectively. were also important dietary components. These study observations revealed that *P. tenuispinis* were known to highly carnivorous feeding behavior.

Gastro-somatic index studies were highest peak showed during the post spawning season and specifically poor feeding behavior were recorded during the peak breeding also during the starting from oocyte maturing stage, present study were noticed also pointed few expected reasons for the occurrence of the empty stomach in Thinspine seacatfish with associated its natural feeding grounds and spawning sites during their immature and maturing life stage for both the sex. It necessary to be carry the monitoring studies in closer to its feeding grounds and breeding grounds and their specificity for prey items in order to give the brief generalization of the feeding specifically during various developmental stages of the life.

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