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Pallavi K. Pakhmode,
Dept. of Fisheries Biology, College of Fisheries, Ratnagiri, Maharashtra, India.
Tel: +91-9405260740
E-mail: pallavi.pakhmode@gmail.com

Swapnaja A. Mohite*,
Dept. of Aquaculture, College of Fisheries, Ratnagiri, Maharashtra, India.
Tel: +91-9545030642
E-mail: sa_mohite@yahoo.co.in

Correspondence:
Swapnaja A. Mohite*,
Dept. of Aquaculture, College of Fisheries, Ratnagiri, Maharashtra, India.
Tel: +91-9545030642
E-mail: sa_mohite@yahoo.co.in

Feeding biology of ribbonfish, *Lepturacanthus savala* (Cuvier, 1929) off Ratnagiri coast, Maharashtra

Pallavi K. Pakhmode and Swapnaja A. Mohite *

ABSTRACT
Lepturacanthus savala is a highly carnivore fish, feeding mainly on fish, crustaceans and cephalopods etc. Fishes were observed to form important food item and were mainly recorded in *L. Savala* of the size group 30-40 cm to 60-70 cm. Cannibalism had also been recorded by the presence of juvenile ribbonfishes in the guts of bigger *L. Savala.* Index of fullness showed a peak in September (280.98) but it was low during April (83.24) and November (122.93) suggesting probable cessation of feeding during spawning season. The period of low digested matter and empty guts coincided with the two spawning peaks, suggesting that the fish preferred not to feed during the spawning months.

Keywords: *Lepturacanthus savala,* feeding habit, Index of fullness, Gut analysis.

1. Introduction
India exports 64% of ribbonfish landed annually in frozen form to China, Japan and other Southeast Asian countries. Local people consume fresh as well as dry ribbon fishes but dried fishes have a good demand in local as well as in foreign market. The non- fatty and ribbon like body makes the fish suitable for rapid sun drying. The under-sized fish brought ashore goes with the trash and are utilized in fishmeal production. Incidentally they are also utilized as bait in long – lining and trolling for capturing bigger fish like seer, tuna, eels, cat fish and *Sciaenids* [1]. *L. Savala* is one of the important ribbonfish species that is landed in good quantity along the coast of Ratnagiri, Maharashtra, India. In the present paper an attempt has been made to study the food and feeding habit of *L. savala* of Ratnagiri region through qualitative and quantitative analysis of the gut.

All the four species of ribbon-fishes are reported to be highly carnivorous and predominantly piscivorous. They are voracious feeders, feeding both during day and night. The most important items of food included a variety of small fishes (mostly of the anchovy type, e.g. (*Anchoviella)*, prawns and shrimps (e.g. *Acetes*) [2-3]. A comparison of the stomach contents of *L. savala* with fishes and other organisms landed in the nets along with it revealed that this species also exercised a certain amount of selectivity for certain varieties of fishes like *Stolephorus, Sardinella, Dussumieria,* prawns of the genera, *Penaeus* and *Metapenaeus* and shrimps represented by *Acetes.* It was reported that *L. savala* fed at night [4].

2. Material and Methods
A total of 680 specimens of *L. savala* were collected from the Mirkarwada fish landing centre and from the main fish market at Ratnagiri, at weekly intervals from February 2012 to February 2013. Fishes were measured fresh and examined for gonadal condition and gut contents. Both qualitative and quantitative analysis was carried out to study the food and feeding of *L. Savala* as per the procedure [5-6]. The identification of different organisms was done upto the generic level and whenever possible upto the species level, depending on the state of digestion. The quantitative analysis was carried out by using by using gravimetric method [7 – 8].

The stomach contents were emptied into a petridish. The weight of individual food item was taken and later converted into percentage. From the weight obtained for individual fish, monthly averages and percentages of each food item were worked out.

To estimate the degree of satiation (index of fullness) was applied by using the following formula [9]:

$$\text{Index of fullness} = \frac{W \times 10^4}{W}$$

Where, w = weight of the gut content

W = weight of the fish

3. Results

3.1. Food composition:

The details of qualitative and quantitative analyses of stomach contents of during different months are presented in Table 1 and Fig 1. The gut content analysis indicated that fishes, crustaceans and cephalopods formed the main food of the species. Digested, semi digested matter and empty stomach also occurred in considerable quantity. The average proportions of the gut contents for the whole period of study were: Fishes; 27.68%, Cephalopods; 5.11%, Crustaceans; 13.76%, semi digested matter; 13.55%; Digested matter; 17.98% and empty stomach 21.90%.

Fishes (27.684%) were recorded in good amount in all the months. The highest quantity was during August (32.9%), followed by February (32%), April and May (31.7%), October (28%), November (27%), December (26.7%), March (25.13%), and lowest in January and February (22%).

Cephalopods (5.11%) were also recorded in all the months. Cephalopods were highest during February (12.1%) followed by August (7%), April (5.27%), January (5.6%), May (5%), March (4.28%), September (4.16), November (3.7%), October (3.4%) and February (2.9%) while during December (2.8%) they were recorded in low quantity.

Crustaceans (13.765%) were the second important item among the gut content. Crustaceans were observed in highest quantity during October (18.42%) followed by September (18.6 %), May (17.7%), August (17.2%), November (17%), April (15.9%), February 12 (15.2%), February 13(11%), December (8.9%), March (7.6%) and lowest during January (3.9%). It was absent during March, October, November and February months.

Table 1: Percentage composition of food items in the stomach of *L. savala* from February 2012 to February 2013.

Food items	Feb	Mar	Apr	May	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Annual Average(%)
Fishes	22	25.13	31.7	31.7	32.9	25.4	28	27	26.7	22	32	27.684
Crustaceans	15.2	7.6	15.9	17.7	17.2	18.6	18.42	17	8.9	3.9	11	13.765
Cephalopods	12.1	4.28	5.27	5	7	4.16	3.4	3.7	2.8	5.6	2.9	5.11
Semi digested matter	6.75	14.11	8.33	5	20	23.7	9	6.7	20	27.9	7.6	13.553
Digested matter	38.95	20.6	8.8	11.8	12.9	17.14	7.8	11	13.7	22.6	32.5	17.98
Empty gut	5	28.28	30	28.8	10	11	33.38	34.6	27.9	18	14	21.905

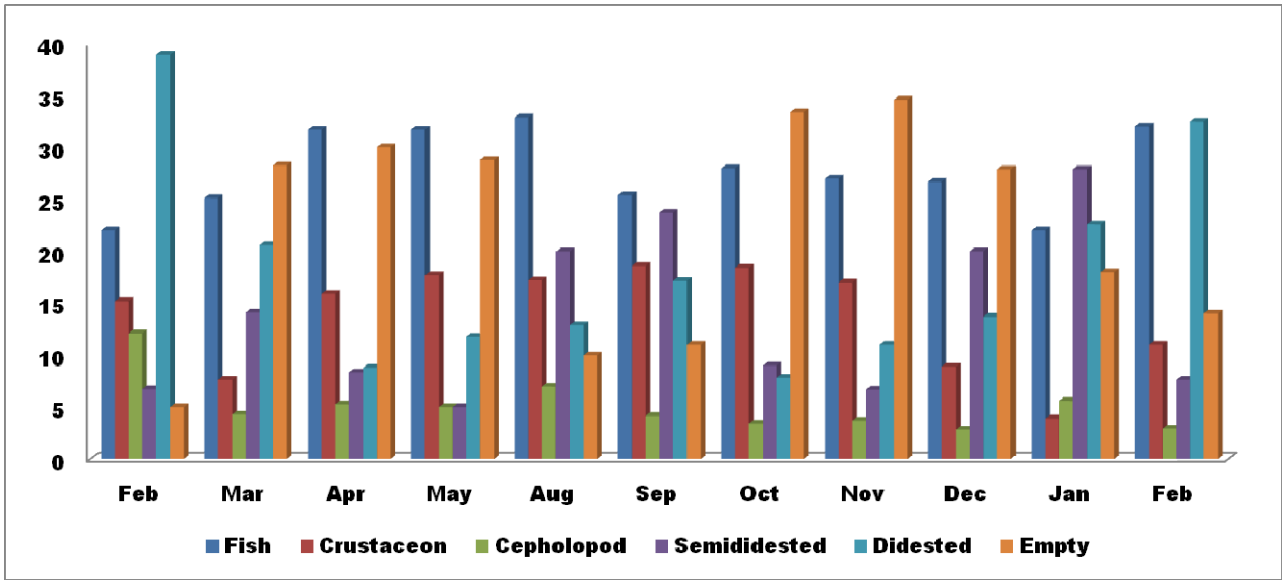


Fig 1: Percentage composition of food items of *L. savala* during different months from February 2012 to February 2013

Semi-digested matter (13.553%) was recorded in all the months with peak abundance in January (27.9%) followed by September (23.7%), August and December (20%), March (14.11%), October (9%), April (8.33%), February 13 (7.6 %), February 12 (6.75%) and November (6.7%). The lowest quantity was noticed during May (5%).

Digested matter (17.98%) was recorded in all the months with peak in February 2012 (38.95%). Higher values were noticed during January 2013 (22.6%) and February 2013 (32.5%). The lowest quantity was found during October (7.8%).

Specimens with empty stomach (21.905%) were recorded in in varying percentages all the months. But higher occurrence was recorded from March (28.28%) to May (28.8%), and during October (33.38%) to December (27.9%). The lowest was observed February (5%).

3.2. Food in relation to size:

The details of percentage composition of various food items in the stomach contents of *L. savala* in various size groups are given in the Table 2 and Fig. 2 a and b.

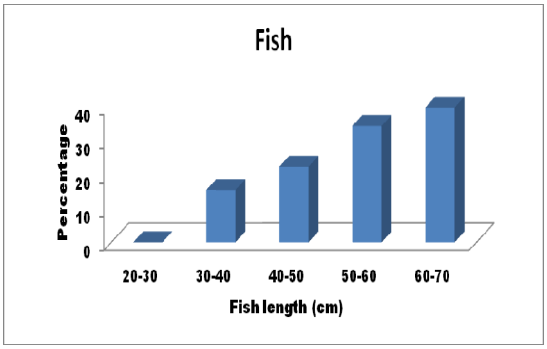
It can be seen from the table that crustaceans were recorded in the size groups of 20-30 cm to 60-70 cm showing dominance in this size groups. Their percentage was highest (24.72%) in the size group 60-70 cm and lowest in the size group 20-30 cm.

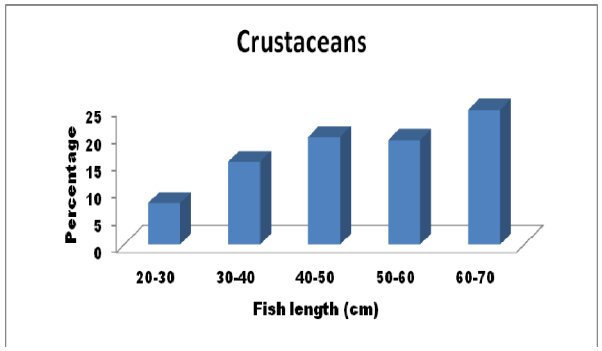
Fishes were observed to form important food items; they were recorded from the size group 30-40 cm to 60-70 cm. The size group 60-70 cm recorded highest percentage (39.72%) of fish, while the lowest (15.37%) was recorded in 30-40 cm.

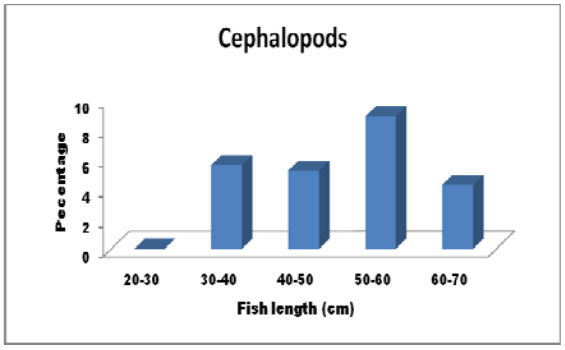
Cephalopods were found to occur in size groups 30-40 cm to 60-70 cm. The highest percentage (8.89%) was observed in the size group 50-60 cm and lowest (4.30%) in the size group 60-70 cm.

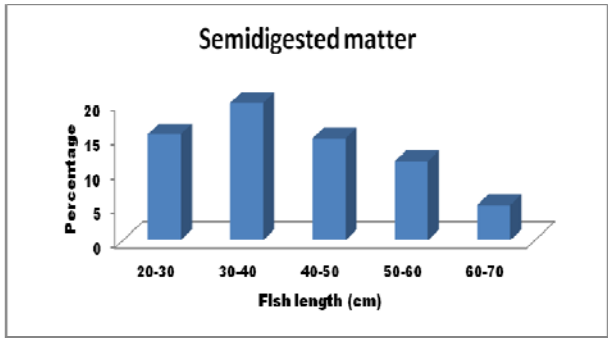
Table 2: Percentage composition of food items in the stomachs of *L. savala* in various size groups from February 2012 to February 2013.

Size group In cm (TL)	No. of fish examined	Fish	Crustaceans	Cephalopods	Semi digested	Digested	Empty
20-30	13	0	7.6	0	15.38	7.79	69.23
30-40	132	15.37	15.19	5.6	19.92	18.92	25
40-50	248	22.25	19.74	5.24	14.78	15.07	22.92
50-60	244	34.26	19.19	8.89	11.49	14.7	11.47
60-70	43	39.72	24.72	4.3	5.11	14.53	11.62
Total	**680**						









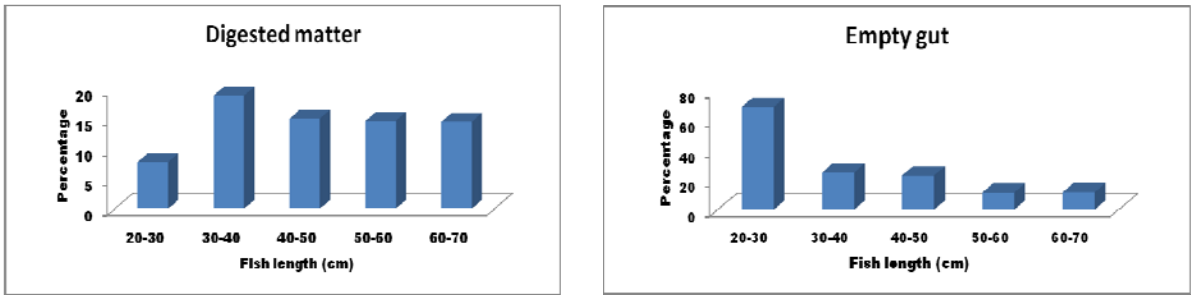


Fig 2: Percentage composition of food items of *L. savala* in relation to size

Digested matter is found in all the size groups of 20-30 cm to 60-70 cm. highest percentages (18.92%) of digested matter were recorded in 30-40 cm size group and the lowest (7.79%) in 20-30 cm size group. Semi digested matter was recorded in variable percentages in different size groups from 20-30 cm to 60-70 cm size group. The maximum percentage (19.92%) was recorded in the size group 30-40 cm. The minimum percentage was found in the size group 60-70 cm (5.11%). Empty stomach was observed in different proportions in size groups 20-30 cm to 60-70 cm. The highest percentage (69.23%) was recorded in the size group 20-30 cm and the lowest (11.47%) in 50-60 cm size group.

3.3. Qualitative analysis of gut content:

The major items of food were identified upto the genus level. The collected data is given in Table 3. Fish formed the major item of the diet of *L. savala*. This species exercised a certain amount of selectivity for certain varieties of fishes like *Leiognathus* spp., *Stolephorus* spp., *Sardinella* spp., *Dussumieria* spp., *Trissocles* spp., *Nemipterus* spp. as well as *Hemirhamphus* spp., *Sphyraena* spp. and *R. kanagurta*. Cannibalism was also observed especially in the larger size groups of these fishes. Fish larvae or juveniles of some fishes were also observed in almost all the size groups. Crustaceans were represented by *Lucifer*, zoea, megalopa, mysids, *Penaeus* spp., *Metapenaeus* spp., *squilla* spp. and *Acetes* spp. etc. The diet of ribbonfishes also included cephalopods such as *Loligo* spp., *Sepia* spp. and *Octopus* spp. of smaller sizes.

Gut content analysis of the different size groups showed a gradual change in diet with smaller *L. savala* (11 to 20 cm size group) preferring smaller fishes while larger groups (21 to 55 cm size group) showed preference for fishes, cephalopods and crustaceans. Instance of' cannibalism had also been recorded where their own kind were devoured. Fish below 25 cm were observed to feed on smaller fishes and crustaceans but as they grow, they began to consume a greater variety of big fishes and prawns. Ribbon-fishes showed a highly carnivorous and predominantly piscivorous feeding habit.

Table 3: Qualitative analysis of food items of *L. savala* from February 2012 to February 2013

Month	No. of fish examined	Size range (cm)	Items of food		
			Fish	Crustaceans	Cephalopods
February	20	30- 48	*Leiognathus* sp., *Sardinella* sp., *Nemipterus* sp., *R. kanagurta*, Fish larvae	*Lucifer*, *Penaeus* sp., *squilla sp.*	*Loligo* sp.
March	60	20.5 -55.5	*Stolephorus* sp., *Trissocles* sp., *Leiognathus* sp., *Hemirhamphus* sp., *Sardinella* sp., *Sphyraena* sp., *Nemipterus* sp., *R. kanagurta, L. savala*, Fish larvae	*Acetes*, zoea, megalopa, mysids, *squilla sp.*	*Loligo* sp., *Octopus, Sepia.*
April	60	24-53.2	*Stolephorus sp., Sardinella* sp., *Nemipterus* sp., *R. kanagurta, Dussumieria* sp., *L. savala* fish larvae	*Acetes*, zoea, megalopa, *Lucifer*, *squilla sp.*	*Loligo* sp.
May	80	13-56	*Stolephorus* sp., *Hemirhamphus* sp., *Sardinella* sp., *Nemipterus* sp., *Dussumieria* sp., *R. kanagurta, L. savala*	*Lucifer*, mysids, *squilla sp.*	*Sepia sp.*
August	40	11.6-35.3	*Stolephorus* sp., *Trissocles* sp., *Leiognathus* sp., *Sardinella* sp., *Nemipterus* sp., *R. kanagurta*	*Lucifer*, mysids, *squilla sp.*	*Loligo* sp.
September	80	11-35.3	*Trissocles* sp., *Teradon sp.*, fish larvae, *Leiognathus* sp., *Sardinella* sp., *Nemipterus* sp., *R. kanagurta*	*Lucifer*, zoea, megalopa, mysids, *squilla sp.*	*Loligo sp., Octopus, Sepia.*
October	100	18.3-49.3	*Trissocles* sp., *Leiognathus* sp, *Hemirhamphus* sp., *Sardinella* sp., *Nemipterus* sp., fish larvae,	*Acetes, Lucifer*, zoea, megalopa, mysids, *squilla sp.*	*Loligo* sp.
November	60	31-51	*Trissocles* sp., *Teradon sp.*,fish larvae, juveniles of fish *Leiognathus* sp., *L. savala*	*Acetes, Lucifer, squilla sp.*, Mysids.	*Sepia sp.*
December	60	34-55	*Trissocles* sp., *Leiognathus* sp, *Hemirhamphus* sp., *Sardinella* sp., *Nemipterus* sp., *L. savala*, juveniles of fish.	*Acetes, Lucifer, Mysids.*	*Loligo* sp.
January	40	12.5-48	*Leiognathus* sp, *Sardinella sp.*,	*Acetes, Metapenaeus spp.*	*Loligo* sp.
February	80	14.2-46.5	*Gazza* sp., *Nemipterus* sp., *Sardinella* sp.	*Acetes, Penaeus sp.*,	*Octopus, Loligo* sp.

The most important items of food included a variety of fishes followed by the crustaceans.

3.4. Index of fullness:

Monthly index of fullness was calculated as the ratio of the food weight to the body weight. Higher values were recorded during February 2012 (192.56), September (280.98), January (206.85) and February 2013 (218.53). Lower values were recorded from March to May with the lowest value of 83.24 in April. Lower values were also recorded from October to December with lowest value of 122.93 in November. During these periods of low indices, fishes with empty stomach were also recorded. Fishes with bursting stomach were reported in February, September and January. The observed data is represented in Table 4 and Fig. 3.

Table 4: Monthly index of fullness in *L. savala*

Month	Index of Fullness
February	192.56
March	138.27
April	83.24
May	121.31
August	163.82
September	280.98
October	151.18
November	122.93
December	152.9
January	206.85
February	218.53

4. Discussion

4.1. Food composition:

The qualitative analysis of food of *L. savala* indicated that this species feeds mainly on fishes, cephalopods and crustaceans. Semidigested and digested matter was reported in the gut showing the state of digestion. *L. savala* with empty stomach were also observed during study. The present study therefore showed that *L. savala* was a carnivorous fish preferring fish as its main item of diet. The percentage occurrence of fishes as food item was recorded in different proportions in all the months, highest in August (32.9%) and lowest in January and February 2012 (22%).

In the food of *L. Savala*, "fishes" formed its major diet followed by *Acetes*, and prawn *(Penaeus* and *Metapenaeus)* [2]. *Squilla, lucifer,octopus, Sepia*, zoaea larvae, were preyed upon

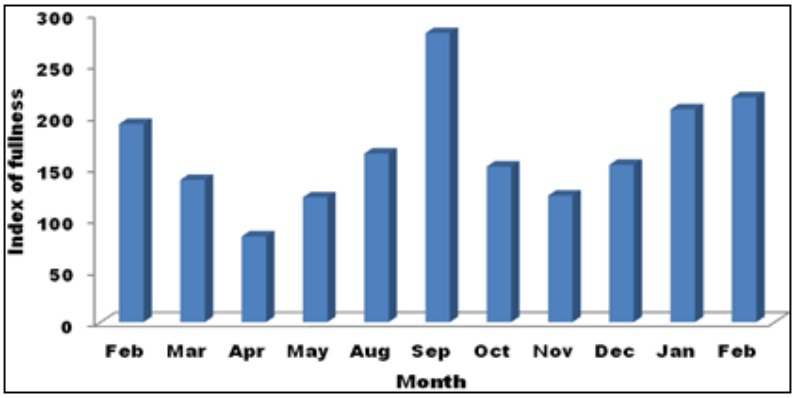


Fig 3: Monthly index of fullness in *L. savala*

Whenever available. Of the fishes special mention may be made of *Stolephorus* spp., *Sardinella* spp., *Dussmieria* spp. and *Caranx* spp. A certain amount of selectivity for certain varieties of fishes like *Stolephorus, Sardinella, Dussumieria*, prawns of the genera, *Penaeus* and *Metapenaeus* and shrimps represented by *Acetes.* It was observed that the food items such as mackerel, oil sardine and prawns occurred in the stomach of larger fish and *Stolephorus*, *Thrissocles* and shrimp *(Acetes)* occurred in the smaller ones [10].

It was seen that all the four species of ribbon-fishes are highly carnivorous and predominantly piscivorous[4]. The most important items of food included a variety of small fishes, prawns and shrimps. The teeth and other oral structures of ribbon-fishes are suitable to hold the prey, bite and devour the same easily. Fish below 25 cm usually feed on smaller fishes and crustaceans but as they grow, they begin to add to their diet a greater variety of big fishes and prawns.

4.2. Food in relation to size:

The analysis of food with respect to size revealed variation in quantity of food consumed and also food preferences based on size groups. Fishes were observed to form important food items; they were recorded from the size group 30-40 cm to 60-70 cm. The size group 60-70 cm recorded highest percentage

(39.72%) of fish, while the lowest (15.37%) was recorded in 30-40 cm. Crustaceans were recorded in the size groups of 20-30 cm to 60-70 cm showing dominance in this size groups. Their percentage was highest (24.72%) in the size group 60-70 cm and lowest in the size group 20-30 cm. Cephalopods were found to occur in size groups 30-40 cm to 60-70 cm. The highest percentage (8.89%) was observed in the size group 50-60 cm and lowest (4.30%) in the size group 60-70 cm. Semi digested matter was recorded in different size groups from 20-30 cm to 60-70 cm size group. The maximum percentage of 19.92% was recorded in the size group 30-40 cm. The minimum percentage was found in the size group 60-70 cm (5.11%). Digested matter is found in all the size groups of 20-30 cm to 60-70 cm. highest percentages (18.92%) of Digested matter were recorded in 30-40 cm size group and the lowest (7.79%) in 20-30 cm size group. Empty stomach was observed in different proportions in size groups 20-30 cm to 60-70 cm. The highest percentage (69.23%) was recorded in the size group 20-30 cm and the lowest (11.47%) in 50-60 cm size group. Cannibalism had also been recorded where guts of bigger *L. savala* were seen with juvenile ribbonfishes consumed. Fish below 25 cm were observed to feed on smaller fishes and crustaceans but as they grow, they began to consume a greater variety of big fishes and prawns. Ribbonfish below 25 cm usually feed on smaller fishes and crustaceans but as they grow, they begin to add to their diet a greater variety of big fishes and prawns [4]. During a study, more than 1000 specimens in the size range of 30-1140 mm during 1997-98 to 2000-2001 for biological studies [11]. He reported that the species was carnivorous predator feeding on crustaceans, fish and cephalopods. Large percentage (67.2) fishes were encountered with empty stomach**.**

4.3. Qualitative analysis of gut content:

Crustaceans (13.765%) were the second important food item among the gut content. The post larvae of *E. muticus* feed mainly on anchovy larvae, calanoid copepods and larvae of penaeid prawns[1]. The juveniles fed on larvae and juveniles of clupeids and carangids, post-larvae and juveniles of penaeid prawns, *Acetus, Lucifer* and crabs. The diet of adult of *L. savala* consisted mainly of fish (*Stolephorus*, *Sardinella*, *Dussumieria* and *Carnax*), prawns (*Penaeus* and *Metapenaeus*), *Acetes*, *Squilla*, *Lucifer*, *Octopus*, *Sepia* and zoaea larvae. It was reported that as *L. savala* had comparatively powerful caniniform teeth and long jaws, these species preferred larger prey. It was reported that the *Acetes* spp. was preferred by *L. savala* throughout the year and highest percentage was reported in January (51.96 %) [12], the basic food consisted of crustaceans, fishes and cephalopods [11]. Among prawns sergestid, *Acetes* spp. was most frequently encountered followed by *Nematopalaemon tenuipes* and *Exhippolysmata ensirostris.* The penaeid prawns found in the guts were *Solenocera crassicornis, Parapeneopsis stylifera, and Metapenaeopsis stridulans.* Stomatopods were also observed. The fish component consisted of *Myctophum* sp. *H. nehereus, Megalaspis cordyla, Polynemus heptadactylus, Upeneus* spp., *Apogon* spp., *Fistularia* spp., *Stolephorous* spp., *Decapterus* spp., young ones of *Congresox talabonoides, Arius* spp *and* flat fishes. Its own young ones have been observed frequently in the gut indicating that the species resorted to cannibalism. Among cephalopods mainly *Loligo* spp. was also recorded. The most important food item with highest occurrence was *Acetes* spp. And it formed the main item of food in all predatory and carnivorous fishes, such as *L. Savala* [13].

Semi digested matter was in variable proportion in all the months. It mainly consisted of fish scales, appendages of crustaceans and cephalopod remains in an advanced stage of digestion. Since it was difficult to put it under the category fish or prawn due to its advanced state of digestion, the actual quantity of fish, crustaceans and cephalopod would have been more than that recorded.

Digested matter (17.98%) was recorded in all the months with peak in February (38.95%). The lowest quantity was found during October (7.8%). Empty guts were reported in highest percentage in November (34.6%) followed by October (33.38%), April (30%), March (28.28%), May (28.8%), December (27.9%), January (18%), February 13 (14%), September (11%) and August (10%).

4.4. Index of fullness:

Index of fullness recorded during all the months with peak in September (280.98) and low during April (83.24) and November (122.93) because of probable cessation of feeding during spawning season. The examination of stomachs of *L. savala* revealed that they were in varying degrees of fullness indicating that the species feeds at night also [2]. Three ripe fish had their stomachs empty indicating a probable cessation of feeding during spawning season. In the ripe fish the gonads occupy almost the entire body cavity and it was observed that the empty stomach was even displaced to a side. Because of the enlarged gonads and lack of space in the body cavity, fish probably abstained from feeding at this time. In these specimens the abdomen was quite distended even with an empty stomach. Consequently it was concluded that the fish might feed voraciously after spawning. Unusual heavy landings of ribbonfishes were reported close to the shore of Visakhapatnam during April in spent condition [14] and the stomach contents of *L. savala* of shore-seine sample were studied. The analysis showed that 18% of the guts were full, 45% were 3/4th full, 23% half full and 14% 4th full. Empty gut were not encountered in the fish landed by shore-seine, whereas in the boat-seine samples 50% guts were empty and in trawl samples 90%, guts were empty. The spent condition of the gonads, the intensity of feeding and the nature of stomach contents showed that the fish had hit the shore in search of food after spawning. The similarity of the stomach contents and the miscellaneous catch of the shore-seine vindicated this view.

Fishes landed by gillnets were mainly (48-67%) in well fed condition with full guts; whereas that by trawls were in poorly fed condition (59-76%) [3]. This may probably be due to vomiting of the prey during their struggle to escape from the trawl. Some fishes were found to ingest preys as high as 9.4% of their body weight.

Based on the above data and earlier works it can be stated that fishes forms the primary food item of *L. savala* of Ratnagiri region followed by crustaceans and cephalopods. From the food consumed, it was evident that *L. savala* fed on pelagic organisms. The period of low digested matter and empty guts

coincided with the two spawning peaks, suggesting that the fish preferred not to feed during the spawning months. This also could be attributed to the developing gonads that occupied the entire body cavity as the gametogenesis progressed, leaving a very limited space for the gut.

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