International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

ISSN 2347-2677
www.faunajournal.com
IJFBS 2020; 7(1): 118-123
Received: 24-11-2019
Accepted: 28-12-2019

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Diversity of by catch at Visakhapatnam fishing Harbour

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Abstract
The noncommercial fishes called by catch forms a significant quantity of the total marine fish landings particularly in the landing area of Visakhapatnam fishing harbor. Among the inedible fishes bulk catches of juvenile fishes, low value fishes and unacceptable for human consumption were also included, and these were commonly referred to as by catch. Visakhapatnam is one of the main harbors with deep-sea trawler base on the east coast of India, field survey was conducted in Visakhapatnam fishing harbor between October 2014 to September 2016. Totally 21 dominant species of shellfish and fin fishes from by catch were identified. 9 species of shell fish and 12 species of fin fish were found from by catch. Hence the present study was focused to investigate the diversity of by catch along the fishing harbor, Visakhapatnam.

Keywords: Visakhapatnam fishing harbor, by catch, shell fish, fin fish, biodiversity

Introduction
In Andhra Pradesh more than 50% of the marine fisheries production of India is accounted by trawl fisheries. Among this, Andhra Pradesh is contributed for 9% of Indian trawl landing of which a share of 51% is by Visakhapatnam fishing harbor. Visakhapatnam is one of the main harbors for the mechanized boats, were adequate shelter, shore facilities exist and is the only deep-sea trawler base on the east coast of India. The present survey was carried out from October 2014 to September 2016, aimed to collect data to investigate the diversity of by catch at fishing harbor. The present authors have also studied and reported on microbiological, organic and inorganic components of 3 species of by catch collected from Visakhapatnam fishing harbor (Sasikala *et al.*, 2019 a,b &c.) [19-20-21].

By catch/low valued fish is still the most commonly used feed in marine culture in Asia. Use of this fish is controversial with regard to the sustainability of the farming practices and related issues on environmental degradation. The main problem in aquaculture is the provision for supplementary feed for fulfillment of nutritional requirement. For solving this problem by catch plays very important role. Sizeable amount of low value fish is landed across the landing centers on account of the targeted fishing (Sarah *et al.*, 2007) [18]. Low value fishes include juveniles, by catch are discards. It is estimated that around 30% of the mechanized landings constitute low value. In 2003, nearly 2.7 lakh tons of low value fish were landed which constituted 10-20% of trawl catch in India.

According to FAO report in (1994) [7], it is estimated that 27 million tons or approximately 27% of the global catch are discard annually. The term by catch varies from country to country and can change both seasonally and with location wise. According to FAO (2010) [8] the global trend has been towards a proper and better utilization of non- commercial fishes. By catch were widely used in coastal areas either directly or indirectly for human consumption and unhygenically dried and used as poultry feed (Chattopadhay *et al.*, 2004) [3]. By catch that are freshly prepared and carefully managed can be a very good and low cost, source of food for culturing aquatic animals. Sadly, this is not in practical due to its unknown nutritional components (Kevin and Rimmer, 2005) [13]. The nutritional values of the discarded fishes are very important to initiate proper use of these by catch in a desirable way (Rukhsana *et al.*, 2005) [17]. Thus, the nutritional value of by catch is very important.

Low value fish or by catch is broadly used terms that relates fish species, by virtue of their small size or low consumer reference and have little or no commercial value (Dayton et.al., 1996) [5]. Large quantities of small sized fish were regarded as by catch due to a lack of ways for valuable utilization throughout the world (Anupam *et al.*, 2010) [1]. If those fish could be

exploited as raw materials for the production of fermented fish paste, the fish would become economically valuable. As a trail, fish *miso*, a promising fermented fish meat paste product from those by catch, were well investigated for its taste components and nutritional status (Giri *et al*., 2008) [11]. However, for any new flavor active products it's very important to analyze the acceptability in all regards including flavor. According to FAO 2007 [9], the global trend has been towards a proper and better utilization of non-commercial fishes. By catch were widely used in coastal areas either directly or indirectly for human consumption and unhygenically dried and used as poultry feed (Chattopadhay and Madhusudana, 2008) [3]. By catch/low value fish that are freshly prepared and carefully managed can be a very good and inexpensive, source of food for culturing aquatic animals. Sadly, this is not in practice due to its unknown nutritional components (Moghaddam *et al*., 2007) [14].

Materials and Methods

The fishing harbor at Visakhapatnam port trust is one of the biggest in the coast of Andhra Pradesh. The harbor was setup in 1976 spreading across 24 hectors of land. 17.6868 latitude and 83.2185 longitudes can be mapped to address of Visakhapatnam, Andhra Pradesh, India. The by catch were collected from the landing area of Visakhapatnam fishing harbor during the study period. Fish samples were collected from fishing harbor during the early hours of the day between 7.00 and 8.00 AM. By catch of different size ranging from 2.0 - 35cm were collected after the landing. Usually the anglers go for the commercially beneficial catch. Nearly one week of time is required for catching them. In spite of being idle for one week, the anglers cast the net and collect the by catch when they return. In this catch, they separate the important and commercially valuable fish send to market and commercially unimportant fish, very small sized fish which belong to valuable species and some wounded were heaped by heap. The heaps keep with salt 2 to 4 days. The fishermen transport the by catch and get it dry in the sunshine, the pouters and aquaculture farmers bought the fish and they make them into powder. The powder gives as a feeding to the poultry hens and the powder scatter into the growing fish tanks. We receive as nutrients through the fish eaten powder.

Correspondingly, their fish samples were collected from the fishing harbor connected to Bay of Bengal. A simultaneous investigation for these fish was carryout by collecting the samples once a month. A drag net consisting of 5 pieces (5.0 x 2.7 in each) with a stretched mesh varying from 0.9-2.5 cm was operated in the estuary between 6.30 and 8.30 hrs. The net was cast in a semicircular pattern from a fiber boat and then dragged at either ends towards the shore.

At Visakhapatnam fishing harbor, both mechanized and non-mechanized boats are being used regularly for fishing. Mechanized boats are called sona boats and non-mechanized boats are called fiber boats which are locally known as 'Teppalu'. Each Sona boat measures 14m. Long, 4m.wide and (3+10) m. height, with the ground floor of the boat as storage block. In each sona boat, a crew of 10 fishermen will go for fishing along with 10 fishing nets, 10 tons of ice, diesel and other requirements. After crossing more than 30 km. on the sea, leave the nets at a depth of 50-150 m., as the shrimps inhabit deep sea. The mouth of the gear which will be used for shrimp fishery was 40m. Wide. After dropping, the nets will be dragged for 3 hours.

Then they lift the nets to collect the catch. The catch will be sorted on board and stored in the ice storage block. After repeating the process for 10-15 days, they return to the harbour and the catch will be landed. The unacceptable, low valued fish and commercially unimportant fish were separated from the catch. The non-mechanized boats will go for fishing in the early hours of the day and return to the shore in the evening of the same day. Each fiber boat measures 10m.long, 2m.wide and 3m. Height. The gear used for fish catch was cast nets and trawl nets. The non-mechanized boats cross only 15m. on the sea, drop and drag the nets from a maximum depth of 30m., lift the catch and return the shore. After landing, the sorting out the trash will be separated and put in the heaps.

Data on total by catch was collected and computed by eye estimation, enquiry from the boat crew and traders. Shell fish and Fin fish samples were collected from landings at fishing harbor, once a month throughout the study period by identifying each species. Monthly pooled data was used to derive yearly estimates. The finfish and shell fish species were noted. Immediately after collection, specimens were brought to the laboratory, washed with fresh running tap water and wiped. After taking categorized in shellfish and fin fishery, species wise identification was done by F.A.O. manuals.

Statistical analysis

Student t Test (paired, two tailed) was performed on the mean distribution data of fish availability in Visakhapatnam harbor obtained significant differences between the two years 2014-'15 and 2015-'16 with R^2=0.358 at P<0.05 and R^2=0.708 at P<0.05 respectively.

Results

At Visakhapatnam fishing harbor, considerable amount of by catch in the harbor landings is observed during the entire study period resulting in a need to improve its utilization. The fishing trawlers bring in large quantities of by catch, besides the principal fishery groups, i.e., crustaceans, stomatopods, cephalopods, gastropods, juveniles of commercially important fishes, damaged fishes and low valued species were recorded in the trawl net by-catch landings at fishing harbor. The by catch after landing is subjected to auction and is dried for some hours by mixing with minimum quantity of salt, which will be used for aqua feed. However, there is conflicting data on the volume of by catch landed at the study area. From the present survey, it may be given that the inshore fishery in Visakhapatnam is heavily over-fished but the total fish catch, as well as the proportion of biomass of by catch in the total catch, continue to rise. Prior to the present survey also, at the same survey area, the by catch landing showed a steady increase from 2% to 21% due to enhanced demand for low value fish for the production of fish meal and fertilizer.

Total population

Dominant by catch from the fishing harbor were grouped into two categories, namely shellfish and fin fish. A total of 9 species of shellfish 12 species of fin fish collected from landing centre. Shell fish species were *Squilla mantis* (Linnaeus 1758), *Portunus haanii* (Weber 1795), *Portunus pelagicus* (Linnaeus 1758), *Charybdis cruciata* (Linnaeus 1758), *Drupa rubusidaeus* (Roding 1798), *Harpa conoidalis* (Lamark 1822), *Ficus gracilis* (Showerby. G.B.I 1825), *Loligo duvauceli* (Orbigny 1848) and *Sepia inermis* (Van Hasselt 1835) found at landing centre.

And 12 species of finfish were *Anguilla bengalensis* (Gray 1831), *Stolephorus indicus* (Van Hasselt 1823), *Halieutaea indica* (Valenciennes 1837), *Fistularia commersonii* (Ruppel 1838), *Fistularia villosa* (Klunzinger 1871), *Priacanthus hamrur* (Forsskal 1775), *Secutor insidiator* (Bloch, 1787), *Leiognathus equulus* (Forsskal 1775), *Leiognathus bindus* (Valenciennes 1835) *Upeneus vittatus* (Forsskal 1775), *Upeneus sulphureus* (G.Cuvier 1829), and *Trichiurus lepturus* (Linnaeus 1758) found at fishing harbour landing centre.

During the breeding season, the bycatch was not observed in the months of May and June. Fishing harbour remains closed. Hence, the data were not collected in these months. The two years of the study period, monthly wise distribution of shell fish Species was identified. The species *Squilla mantis* (Linnaeus, 1758) is not available in the months of March, September and November. *Portunus haanii* (Weber, 1795) is not available in the months of February, March, April and October. *Portunus pelagicus* (Linnaeus, 1758) is not available in the months of January and February. *Charybdis cruciata* (Linnaeus, 1758) is not available in the months of April, October and November. *Drupa rubusidaeus* (Roding, 1798) is not available in the months of February, March, April, June, October and November. *Harpa conoidalis* (Lamark, 1822) is not available in the months of January and October. *Ficus gracilis* (Showerby. G.B.I, 1825) is not available in the months of February, March, August and October. *Loligo duvauceli* (Orbigny, 1848) is not available in the month of December only. *Sepia inermis* (Van Hasselt, 1835) is not available in the month of September.

In fin fishes, *Anguilla bengalensis* (Gray, 1831) is not available in the month of November only. *Stolephorus indicus* (Van Hasselt, 1823) is not available in the months of February, April Months except May and June. *Fistularia commersonii* (Ruppel, 1838) is not available in the months of April and October.

Table 1: Monthly distribution of shellfish at Visakhapatnam fishing harbour during Oct 2014 to Sep '15

S.NO	Name of the species	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1.	*Squilla mantis* (Linnaeus,1758)	1	0	2	4	1	1	1	not available	not available	3	2	0
2.	*Portunus haanii* (Weber,1795)	0	1	1	1	0	0	0	"	"	2	3	5
3.	*Portunus Pelagius* (Linnaeus,1758)	2	1	1	0	0	2	1	"	"	1	3	4
4.	*Charybdis cruciate* (Linnaeus,1758)	0	0	1	2	2	1	0	"	"	1	1	1
5.	*Drupa rubusidaeus* (Roding, 1798)	1	0	1	1	0	0	0	"	"	1	2	1
6.	*Harpa conoidals* (Lamark, 1822)	0	1	0	0	1	1	0	"	"	2	1	0
7.	*Ficus gracilis* (Showerby. G.B.I, 1825)	0	1	1	0	0	0	0	"	"	1	0	1
8.	*Loligo duvauceli* (Orbigny, 1848)	2	1	0	2	2	1	1	"	"	1	0	1
9.	*Sepia inermis* (Van Hasselt, 1835)	0	2	1	1	0	1	1	"	"	1	0	0

Fistularia villosa (Klunzinger, 1871) is not available in the months of February and November. *Priacanthus hamrur* (Forsskal, 1775) is not available in the months of January, April, September and October. *Secutor insidiator* (Bloch, 1787) is available in all the months except May and June. *Leiognathus equulus* (Forsskal, 1775) is available in all the months except May and June. *Leiognathus bindus* (Valenciennes, 1835) is not available in the month of February only. *Upeneus vittatus* (Forsskal, 1775) is available in all the months except May and June. *Upeneus sulphureus* (G.Cuvier, 1829) is not available in the months of April only. *Trichiurus leptutus* (Linnaeus, 1758) is not available in the months of March.

Monthly availability of shell fish in bycatch heaps is depicted in table 1 and 3 and fin fish is depicted in table 2 and 4. In the above study shellfish was dominated by fin fish. The annual mean months of the occurrence of bycatch are furnished with Fig 1 & 2.

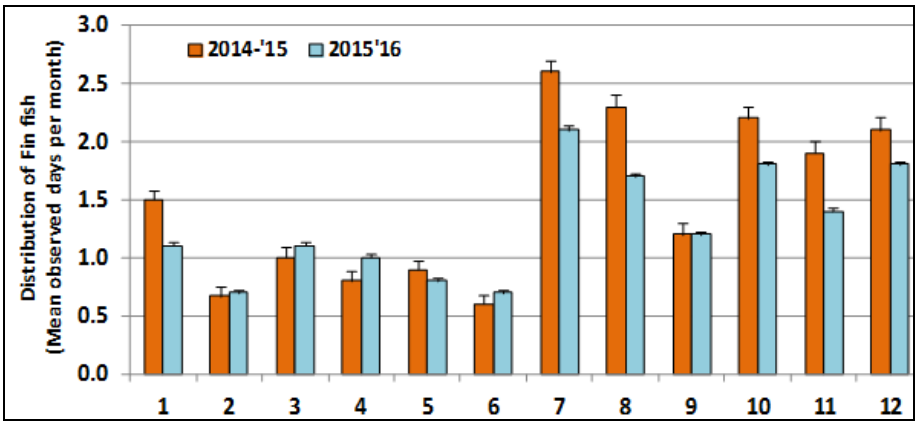

Fig 1: distribution of fin fish (Mean observed days per month)

Fin fish

1. *Anguilla bengalensis;* 2. *Stolephorus indicus;* 3. *Halieutaea indica;* 4. *Fistularia commersonii;* 5. *Fistularia villosa;* 6. *Priacanthus hamrur;* 7. *Secutor insidiator;* 8. *Leiognathus equulus;* 9. *Leiognathus bindus;* 10. *Upeneus vittatus; 11. Upeneus sulphureus; 12. Trichiurus lepturus*

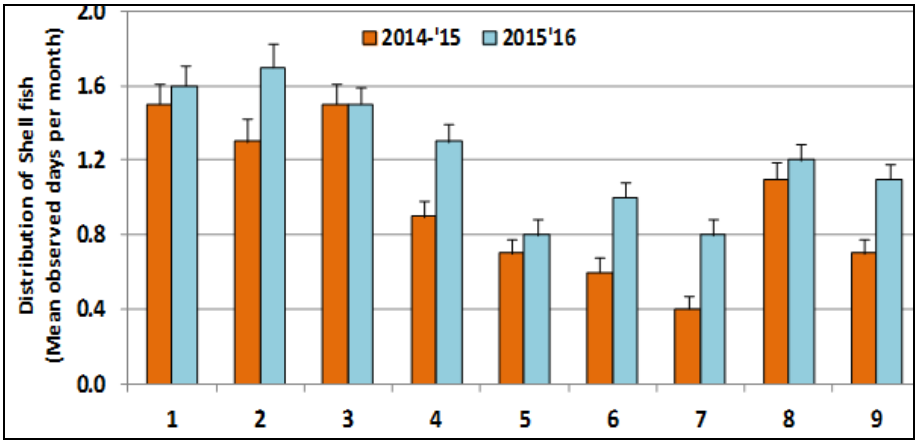

Fig 2: Distribution of fin fish (Mean observed days per month)

Shell fish:

1. *Squilla mantis;* 2 *Portunus haanii;* 3. *Portunus Pelagicus;* 4. *Charybdis cruciata;*
5. *Drupa rubusidaeus;* 6. *Harpa conoidalis;* 7. *Ficus gracilis;* 8. *Loligo duvauceli;* 9. *Sepia inermis*

Table 2: Monthly distribution of fin fish at Visakhapatnam fishing harbor during Oct 2014 to Sep'15

S. No	Name of the species	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1.	*Anguilla bengalensis* (Gray, 1831)	1	0	2	4	1	1	1	not available	not available	3	2	0
2.	*Stolephorus indicus* (Van Hasselt, 1823)	0	1	2	1	0	0	-	"	"	1	1	0
3.	*Halieutaea indica* (Valenciennes, 1837)	0	1	1	0	2	2	1	"	"	1	0	2
4.	*Fistularia commersonii* (Ruppel, 1838)	0	0	1	1	2	1	0	"	"	1	1	1
5.	*Fistularia villosa* (Klunzinger, 1871)	1	0	1	1	0	2	0	"	"	1	2	1
6.	*Priacanthus hamrur* (Forsskal, 1775)	0	1	0	0	1	1	0	"	"	2	1	0
7.	*Secutorins idiator* (Bloch, 1787)	2	1	4	2	2	4	3	"	"	3	2	3
8.	*Leiognathus equulus* (Forsskal, 1775)	2	3	0	2	2	3	4	"	"	4	1	2
9.	*Leiognathus bindus* (Valenciennes,1835)	1	2	1	3	0	1	2	"	"	1	0	1
10.	*Upeneus vittatus* (Forsskal, 1775)	2	1	3	3	0	2	2	"	"	4	2	3
11.	*Upeneus sulphureus* (G.Cuvier, 1829)	1	2	2	1	2	3	0	"	"	4	2	2
12.	*Trichiurus lepturus* (Linnaeus,1758)	3	2	3	1	1	0	2	"	"	1	4	4

Table 3: Monthly distribution of shell fish at Visakhapatnam fishing harbour during Oct 2015to Sep '16

S. No	Name of the species	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1.	*Squilla mantis* (Linnaeus,1758)	1	1	3	3	2	0	1	not available	not available	2	3	0
2.	*Portunushaanii* (Weber,1795)	0	2	1	1	1	0	1	"	"	3	3	5
3.	*Portunus Pelagius* (Linnaeus,1758)	2	1	2	0	1	2	1	"	"	1	2	3
4.	*Charybdis cruciate* (Linnaeus,1758)	1	0	1	2	2	1	0	"	"	2	1	3
5.	*Drupa rubusidaeus* (Roding, 1798)	0	0	2	1	0	1	0	"	"	1	2	1
6.	*Harpa conoidals* (Lamark, 1822)	0	1	2	0	1	1	1	"	"	2	1	1
7.	*Ficus gracilis* (Showerby. G.B.I, 1825)	0	1	1	2	0	0	1	"	"	1	0	2
8.	*Loligo duvauceli* (Orbigny, 1848)	2	1	1	2	2	1	0	"	"	1	0	2
9.	*Sepia inermis* (Van Hasselt, 1835)	1	2	2	1	1	1	1	"	"	1	1	0

Table 4: Monthly distribution of fin fish at Visakhapatnam fishing Harbour during Oct 2015to Sep'16

S. No	Name of the species	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1.	*Anguilla bengalensis* (Gray, 1831)	1	0	2	2	0	1	1	not available	not available	1	1	2
2.	*Stolephorus indicus* (Van Hasselt, 1823)	0	2	1	0	0	1	0	"	"	2	0	1
3.	*Halieutaea indica* (Valenciennes, 1837)	2	1	1	1	0	0	1	"	"	1	3	1
4.	*Fistularia commersonii* (Ruppel, 1838)	0	2	1	2	2	1	0	"	"	1	0	1
5.	*Fistularia villosa* (Klunzinger, 1871)	1	0	1	1	0	0	1	"	"	1	2	1
6.	*Priacanthus hamrur* (Forsskal,1775)	0	1	1	0	2	1	0	"	"	1	1	0
7.	*Secutor insidiator* (Bloch, 1787)	2	2	4	1	2	1	1	"	"	3	3	2
8.	*Leiognathus equulus* (Forsskal, 1775)	0	2	3	2	2	1	0	"	"	3	0	2
9.	*Leiognathus bindus* (Valenciennes,1835)	0	2	1	2	0	3	1	"	"	1	2	0
10.	*Upeneus vittatus* (Forsskal, 1775)	2	3	3	2	1	1	0	"	"	1	3	2
11.	*Upeneus sulphureus* (G.Cuvier, 1829)	1	2	3	3	0	1	0	"	"	1	1	2
12.	*Trichiurus lepturus* (Linnaeus,1758)	2	2	3	2	1	0	0	"	"	2	3	3

The student t-test, which has been observed to know the mean distribution of trash fish availability in the study area exhibited significant differences between the two years of the study i.e., 2014-15 and 2015-16. The R^2 value for the year 2014-15 is 0.358 as a P value less than 0.05 and the R^2 value of 2015-16 is 0.708 as a P value less than 0.05. Hence, the

mean availability of trash fish in the Visakhapatnam fishing harbour is significantly different between the two years of study.

Discussion

Biodiversity study of the by catch exhibited high values during the months of September and December in the study period i.e., 2014-15 and 2015-16. There is some diversity among shellfish and fin fish with respect to their availability and this can be attributed to the variations in seasons, as they have recorded higher values in post monsoon period (September and December) compared with other seasons(April and May). Similar observations were noticed in Molluscans biodiversity by reference of Sini and Jansi, (2016) [22]. And finfish diversity observations noticed at Visakhapatnam by Sujatha, (1995) [24].

A total 9 species of shellfish and 5 species of fin fish were collected from landing center. Among them, 4 species of crustaceans, 2 species of cephalopods, 3 species of gastropods were observed. And fin fishes, 1 species of anguilliformes, 1 species of clupeifomes, 1 species of lohiformes, 2 species of syngnathiformes and 7 species of perciformes were observed. The details of their taxonomic position represented in appendix (I & II). To carry out the study mentioned standard methods were followed. It is observed from the study that fin fishes dominates the shellfishes with respect to the availability in all most all the months during the study period. Hence, the availability of fin fish is higher than shell fishes in the study area i.e., Vishakhapatnam fishing harbor.

The entire study, *Leiognathida*e family and *Mullidae* family species were most dominant in all the by catch species in 24 months of total study period. Some recent studies have assumed that no discards exist for trawl fisheries in India presumably due to burgeoning by catch demand in poultry and aquaculture feed sectors in the last two decades. Jayaram and Shetty (2004) [12] based on a study in 2003 estimated by catch to constitute 10-20% of total catches (2, 71,000 t) landed by trawlers operating along Indian coast. By catch, is poor compared to the valuable catch of shrimp and table fish (Chandrapal, 2005) [2].

Sujatha (1995) [24] identified 228 species from the discards in Visakhapatnam which constituted about 11% of the trawl catch. Luther and Sastry (1993) found that bulk of the landings in different maritime states in different fishery comprised of juveniles. Sivasubramanyam (1990) [23] observes 50% of the by catch sample studied was immature fish in trawlers from Bay of Bengal. Pillai and Mataraians (1977) [16] also observed that 40% of the catch from Indian seas was juveniles. Gibinkumar *et al.*, (2012) [10] found 281 species in the trawl catch, off southwest coast of India.

At Visakhapatnam, finfish was the most dominant group among by catch accounting for 78.9 per cent in multi day trawlers (MDT). Crabs, cephalopods, shrimps and other crustaceans, molluscans other than cephalopods were found in lesser quantities. The by catch consisted of 27 families of finfish's represented by 53 species. The by catch of single day trawlers (SDT) consisted of 20 families of finfish represented by 35 species (Zachria *et al.*, 2008) [25]. Dineshbabu *et al.*, (2013) [6] reported that the single day trawlers generally operate in waters up to 30 m depth and the entire catch is brought to shore, which is separated as commercial catch and the rest as low valued by catch (LVB) termed as trash.

Present survey coincides with a previous study, where in fishes have dominated among the by catch. Crustaceans find a prominent place in the low value trawl by catch at the Chennai fisheries harbor that was usually landed in a state of decomposition and had fetch very low price of 54,207 tons of annual by-catch of south west coast India, 281 species; 237 species of marine fauna with juveniles of commercially important fishes from different landing centers along the coast of India, were identified.

Fish waste can also be used for the production of various value added products such as proteins, oil, amino acids, minerals, enzymes, bioactive peptides, collagen and gelatin. Likewise, the solid shrimp waste, namely, the head and shell which accounts approximately 40-50% of whole shrimp weight contain protein (35-40%), chitin (10-15%), minerals (10-15%) and carotenoids. 205 tons of shells, 10 tons of gastropod operculum, could be produced annually in India and the production potential of chitin is estimated at 3,560 and 1,354 tons from shrimp and crab shells wastes respectively. The extraction of various bio-molecules from the seafood processing waste using organic and inorganic acids, polar and non-polar solvents, fermentation with the aid of bacteria, using different enzymes was practiced by some researchers.

Conclusion

Diversity study of the by catch exhibited more number during the months of September and December in the study period i.e., 2014-'15 and 2015-'16. Hence it can be concluded that there is some diversity among shellfish and fin fish with respect to their availability and this can be attributed to the variations in seasons, as they have recorded higher values in post monsoon period (September and December) compared with other seasons (April and May). It is observed from the study that fin fishes dominate the shell fishes with respect to the availability in all most all the months during the study period. Hence, it can be concluded that the availability of fin fish is higher than shellfish in the study area i.e., Vishakhapatnam fishing harbor.

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