



Crustacean bycatch from trawl fishery along north Tamil Nadu coast

S. LAKSHMI PILLAI, SHOBA JOE KIZHAKUDAN*, E. V. RADHAKRISHNAN AND P. THIRUMILU*

Central Marine Fisheries Research Institute, P. B. 1603, Ernakulam North P. O., Kochi – 682 018 Kerala, India

*Research Centre of Central Marine Fisheries Research Institute, 75, Santhome High Road, R. A. Puram Chennai - 600 028, Tamil Nadu, India

e-mail: slaksh mipillai@rediffmail.com

ABSTRACT

Monthly and seasonal diversity of crustacean bycatch landed by trawl at the Chennai Fisheries Harbour from June 2005 to December 2009 is discussed. Seventy to eighty percent of the catch from the trawlers is made up of finfish, both commercial and non-commercial, and other resources like molluscs, crustaceans, and echinoderms. Crustaceans find a prominent place in the low value trawl bycatch that is usually landed in a state of decomposition and fetches only very low price. About 53% of the crustaceans in the bycatch are crabs, followed by stomatopods (23%) and shrimps (18%). A total of 64 crustacean species were recorded which include 37 species of brachyuran crabs, 1 species of anomuran crab, 16 species of shrimps, 2 species of lobsters and 8 species of stomatopods. Univariate and multivariate analysis was done for monthly and seasonal data sets. The Shannon-Weiner diversity index (H) ranged from 3.13 to 5.53 and species evenness (J) 0.92 to 0.99 for monthly data sets. Species richness (d) was highest (10.28) in July 2008. Seasonal diversity indices revealed Shannon-Weiner index to range from 4.76 to 5.59, species richness from 7.18 to 10.71 and Evenness Index (J) from 0.94 to 0.98. Cluster analysis showed that species assemblage co-occur in a parallel manner across months and seasons.

Keywords: Bycatch, Chennai, Cluster analysis, Crustaceans, Diversity index

Introduction

Trawl fishing along the north Tamil Nadu coast is done by trawlers operating from Chennai. The coastal fishing grounds lie in the depth range of 10 to 70 m at a distance of 15 to 80 km from the shoreline, extending between Ongole in south Andhra Pradesh and Nagapattinam to the south of Chennai. Although commercial trawling targets penaeid shrimps, about 70-80% of the catch is made up of finfish, both commercial and non-commercial, and other resources like molluscs and echinoderms. While early accounts of shrimp trawl in Indian waters do not give an estimate of the actual finfish catches or discards, in the last two decades, shrimp trawling has been redefined as trawl fishing, with a major turnabout towards utilisation of finfishes and other marine resources caught in the shrimp trawl.

Over-exploitation of shrimp resources of particular grounds has probably paved the way for a reduction in

the catches of commercially valuable shrimp species. This highly valued resource has been relegated to a mere 7-10% of the total trawl landing at Chennai during 2005-2009. More alarming is the fact that shrimps and other crustaceans find a prominent place in the low-value trawl bycatch that is usually landed in a state of decomposition and fetches only very low price. Another matter of concern is the presence of a high percentage of juveniles of almost all major commercially important crustaceans in the bycatch. Studies on the diversity of bycatch (Bijukumar *et al.*, 2007; Murugesan *et al.*, 2013) from trawl are meager from the Indian coast even though there are quite a number of publications from other countries (Griffiths and Simpson, 1972; Maharaj and Recksiek, 1991; Liggins *et al.*, 1996; Ye *et al.*, 2000; Costa *et al.*, 2008; Paighambari and Moslem, 2012; Kazemi *et al.*, 2013). Griffiths and Simpson (1972) have stated that for most penaeid shrimp fisheries, bycatch is the main component of trawl catches, at 75-95% of the total weight.

Klima (1976) deduced that the shrimp fisheries in the western central Atlantic region discarded approximately 1 million t of finfish annually. The paper attempts to provide information on the monthly and seasonal diversity of crustacean bycatch in trawl landings at the Chennai Fisheries Harbour from June 2005 to December 2009.

Materials and methods

All the crustacean specimens collected by fortnightly sampling from Chennai Fisheries Harbour were identified to species level and their numbers and individual wet weights recorded. Month-wise and season-wise trawl landing data were subjected to univariate analysis for species diversity, species richness and evenness in the crustacean population using PRIMER-6 software. Multivariate analysis was employed to assess whether similarities exist in the distribution and abundance of population during different months and seasons of 2005-09. The Shannon-Weiner index (H) and Pielou's evenness index (J) were used to evaluate relative abundance and evenness of species diversity. Bray-Curtis similarity was performed to assess natural grouping of crustaceans during different months and seasons. In the analysis, fourth root transformation was used to increase the influence of rare species. Identification of the crustaceans, in the laboratory were carried out following Chhapghar (1957), Sakai (1976), Galil (1994, 1997), (Ng *et al.*, 2008) for brachyuran crabs, Holthuis (1980), Perez Farfante and Kinsley (1967) for prawns and Ahyong (2001) for stomatopods.

Results and discussion

Species composition

Sixty four species of crustaceans were recorded during the 50 month study period, of which 53% were brachyuran crabs, represented by a wide range of 21 genera and 37 species (Table 1). The major species of commercially important brachyuran crabs in the landings were *Portunus sanguinolentus*, *Portunus argentatus*, *Portunus gladiator*, *Charybdis lucifera* and *Charybdis hoplites*, represented mostly by juveniles. Fig. 1 illustrates selected crustaceans in the bycatch. The family Portunidae comprised of 13 species. *Calappa* and *Portunus* were the species rich genera represented by 6 and 5 species respectively. Two species belonged to the family Matutinae, 4 to Xanthidae, 5 to Parthenopidae, 1 to Dorippidae and 1 to Corystidae. Stomatopods (23%) were another important group in the bycatch consisting of eight species *viz.*, *Oratosquilla nepa*, *O. woodmasoni*, *O. holochista*, *O. gonyptes*, *O. quinqueidentata*, *Harpisquilla harpax*, *H. annandeli* and *H. raphidae*. Shrimps, forming about 18%, were

represented chiefly by juveniles and decomposed specimens (7 genera and 13 species) of *Metapenaeus* spp., *Metapenaeopsis stridulans*, *Parapenaeopsis* spp., *Trachypenaeus* spp., *Solenocera crassicornis* and *Parapenaeus longipes*. Lobsters, represented by the scyllarid lobsters *Petractus rugosus* and *Thenus unimaculatus* formed about 6%.

Monthly diversity

Maximum number of crustacean species (44) were recorded during July 2008 and minimum (9) during April 2006. Shannon-Weiner diversity index ($H' \log 2$) was highest (5.53) during July 2008 and least (3.13) during April 2006. The range of the index denotes that the crustaceans landed at the Chennai Fisheries Harbour are diverse in nature. Shannon-Weiner Index affects both number of species and evenness of their population, diversity increases as both increase. For individual year from 2006-2009 (Table 2), the index was highest during July and lowest in April. Low H' value during April may be due to low intensity of trawl fishing (trawl ban along Tamil Nadu coast commences from April 15th every year and lasts up to 30th May). During 2007-09, low H' value was recorded in August in 2007 and 2008, and in February in 2009 which may be due to the dominance of one or few species (*P. argentatus* during August 2007, *C. hoplites* in August 2008 and *A. alcocki* and *O. nepa* in February 2009). Diversity is said to be maximum when all species that make up the community are equally abundant. Species richness (d) was 10.28 during July 2008 and lowest (2.4) during April 2006 thus clearly giving the variation in species richness between different months. Maximum Evenness index (J) was in October during 2006-2009 which means that species are evenly distributed during the month. The species richness and evenness during certain months might be due to large scale periodic migration, influenced by slight change in water temperature. Warmer temperature, availability and stability of food result in high level of diversity.

The results of cluster analysis done to find out the nature of groupings of crustaceans during various months are presented in the dendrogram (Fig. 2).

The analysis gave a clear pattern highlighting the similarities in distribution and abundance during the study period. The similarity in species composition and abundance was in the range of 36.18-60.48 with an average similarity percentage of 46.84. Populations of March 2006 and 2007 formed a group with maximum similarity of 89.53% which got linked with March 2008 at a similarity of 76.44%. January 2006 and 2007 formed a group at a similarity of 82.09%. Cluster analysis shows

Table 1. Crustaceans landed in trawl bycatch at Chennai Fisheries Harbour during 2005-09

Species	TL (mm)	Species	TL (mm)
Penaeidae		Xanthidae	
<i>Metapenaeus dobsoni</i>	38-71	<i>Liagore rubromaculata</i>	32-63
<i>Metapenaeus monoceros</i>	55-110	<i>Demania armadilius</i>	27
<i>Metapenaeopsis stridulans</i>	39-88	<i>Demania baccalipes</i>	38-43
<i>Parapenaeus longipes</i>	38-50	<i>Halimedia ochtodes</i>	42-95
<i>Parapenaeopsis maxillipedo</i>	40-69	Matutidae	
<i>Parapenaeopsis stylifera</i>	60-95	<i>Ashtoret lunaris</i>	28-56
<i>Solenocera crassicornis</i>	28-56	<i>Matuta planipes</i>	
<i>Sycionia lancifera</i>	30-48	Dorippidae	
<i>Trachypenaeus asper</i>	39-66	<i>Dorippe frascone</i>	50-73
<i>Trachypenaeus sedili</i>	48-93	Dromiidae	
<i>Trachypenaeus curvirostris</i>	45-90	<i>Lauridromia dehaani</i>	80-98
Sergestidae		<i>Conchoecetes artificiosus</i>	21-45
<i>Atypopenaeus stenodactylus</i>	50-95	Majidae	
<i>Acetes</i> sp.	18-28	<i>Doclea ovalis</i>	23-48
<i>Exhyppolysmata stylirostris</i>	60-90	<i>Doclea canalifera</i>	43-65
<i>Nematopalaemon tenuipes</i>	28-35	Galenidae	
<i>Alphid</i> sp.	53-130	<i>Galene bispinosa</i>	36-135
Portunidae		Parthenopidae	
<i>Portunus sanguinolentus</i>	24-108	<i>Parthenope longimanus</i>	32-48
<i>Podophthalmus vigil</i>	58-113	<i>Enoplolambrus echinatus</i>	21-38
<i>Portunus argentatus</i>	18-55	<i>Arcania elongata</i>	15-18
<i>Portunus granulata</i>	43-64	<i>Lyphira preplexa</i>	15-16
<i>Portunus gladiator</i>	28-55	<i>Cryptopodia fornicata</i>	30-45
<i>Portunus pelagicus</i>	51-58	Corystidae	
<i>Thalamita integra</i>	31-60	<i>Jonas indica</i>	35-45
<i>Charybdis natator</i>	43-98	Hermit crab	
<i>Charybdis lucifera</i>	35-93	<i>Clibanarius</i> sp.	20-22
<i>Charybdis cruciata</i>	45-55	Lobsters	
<i>Charybdis smithii</i>	22-60	<i>Thenus unimaculatus</i>	65-120
<i>Charybdis truncata</i>	46-78	<i>Petractus rugosus</i>	30-55
<i>Charybdis hoplites</i>	20-48	Stomatopods	
Calappidae		<i>Oratosquilla nepa</i>	48-115
<i>Calappa bilineata</i>	40-83	<i>Oratosquilla woodmasoni</i>	32-110
<i>Calappa calappa</i>	53-73	<i>Oratosquilla holochista</i>	36-123
<i>Calappa lophos</i>	58-109	<i>Oratosquilla gonyptes</i>	62-105
<i>Calappa clypeata</i>	55-62	<i>Oratosquilla quinquindata</i>	95-135
<i>Calappa capelloni</i>	72-78	<i>Harpisquilla harpax</i>	53-198
<i>Calappa exanthematos</i>	50-55	<i>Harpisquilla annandeli</i>	42-118
		<i>Harpisquilla raphidae</i>	110-150

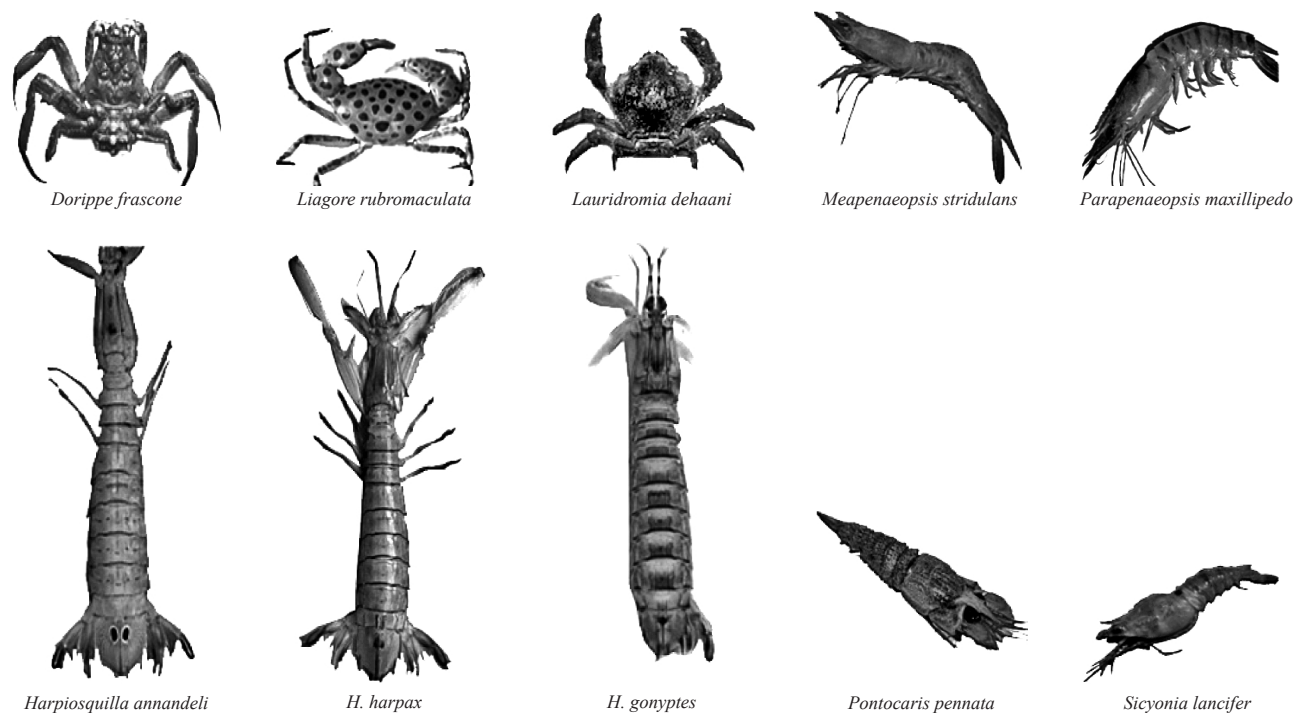


Fig. 1. Crustaceans landed in trawl bycatch at Chennai Fisheries Harbour

Table 2. Monthly diversity indices of crustaceans landed at Chennai Fisheries Harbour during 2005-09

Month	2005-06			2006-07			2007-08			2008-09			2009		
	J'	H'(log2)	d	J'	H'(log2)	d	J'	H'(log2)	d	J'	H'(log2)d	J'	H'(log2) d		
July	0.963	4.421	5.62	0.967	5.373	7.48	0.975	5.222	7.05	0.986	5.536	10.28	0.98	5.382	8.51
Aug	0.914	3.932	4.11	0.964	4.522	4.90	0.965	4.846	5.48	0.993	4.751	5.76	0.98	5.024	8.04
Sept	0.963	4.127	4.65	0.953	4.617	4.94	0.956	4.879	5.63	0.981	5.118	8.37	0.979	5.009	7.40
Oct	0.978	4.06	4.35	0.973	4.771	6.92	0.971	5.229	5.26	0.99	5.162	8.58	0.982	5.02	7.79
Nov	0.955	4.2	4.92	0.943	4.759	6.15	0.948	5.276	7.34	0.993	5.155	8.38	0.98	5.183	8.71
Dec	0.965	4.812	6.78	0.937	4.93	5.25	0.956	4.967	6.45	0.993	5.347	9.41	0.981	5.038	6.95
Jan	0.962	5.334	8.40	0.963	5.376	8.88	0.948	5.347	8.69	0.972	5.092	7.33			
Feb	0.969	5.277	7.70	0.967	5.116	6.99	0.979	5.251	8.42	0.95	4.858	6.94			
Mar	0.973	4.964	7.00	0.974	5.091	7.22	0.985	5.162	8.60	0.973	5.249	8.51			
April	0.959	3.137	2.40	0.974	4.783	6.10	0.992	4.691	6.39	0.977	5.022	8.00			
June	0.973	4.871	7.41	0.97	5.038	6.27	0.992	5.102	7.80	0.982	5.023	8.02			

the presence of groups of species in a parallel manner across months. Among crabs, abundance of *P. gladiator*, *P. argentatus* and *C. natator* was noticed. *Metapenaeopsis stridulans* and *P. longipes* were abundant among shrimps and *O. nepa* among stomatopods. The study revealed that the crustaceans landed at Chennai Fisheries Harbour are diverse (3.13-5.53) and species assemblages occur in a parallel manner across months. Great diversity in bycatch species composition is a common phenomenon in trawl fisheries (Saila, 1983; Ye *et al.*, 2000).

Seasonal diversity

A year was divided into four seasons namely summer (S) (April, May, June), south-west monsoon (SWM) (July, August, September), north-east monsoon (NEM) (October, November, December) and post-monsoon (PM) months (January, February, March). The univariate analysis revealed the Shannon-Weiner index to range from 4.76 in summer 2006 to 5.59 during south-west monsoon of 2008. Similarly d ranged from

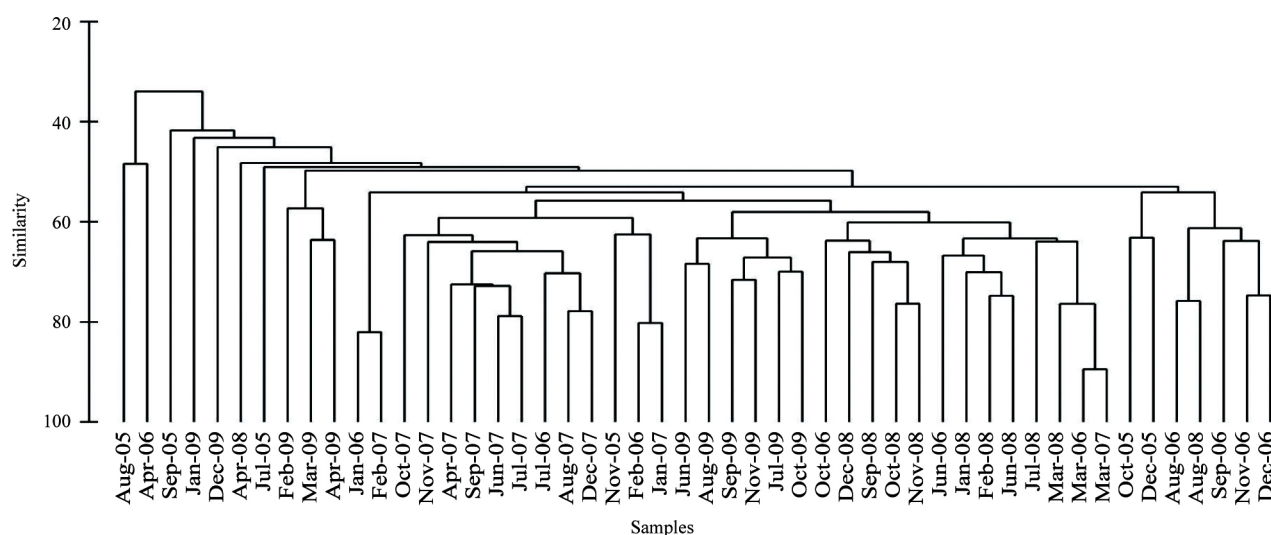


Fig. 2. Monthly Bray-Curtis similarity of crustaceans landed at Chennai Fisheries Harbour during 2005-09

7.18 during north-east monsoon of 2005 to 10.71 during south-west (SWM) of 2008 and J ranged from 0.94 during north-east monsoon of 2007 to 0.98 during Summer (S) 2008. When individual seasons were taken on a yearly basis, post-monsoon (PM) months showed maximum diversity (Table 3). Bijukumar *et al.* (2007) observed higher numerical abundance of brachyuran crabs during post-monsoon and higher species richness and diversity during monsoon seasons in Kerala. On an average, the maximum number of species (107 species) was recorded during the post-monsoon months of different years under study, but overall, the maximum number of species (117 species) was observed during the south-west monsoon of 2008.

The dendrogram (Fig. 3) from Bray-Curtis analysis showed a similarity of 99.34% between the post-monsoon months of 2005 and 2007 which was linked with the post-monsoon months of 2008 at a similarity of 90.35%. A similarity range of 81.7 to 82.3% was observed between the south-west monsoon and north-east monsoon of different years (2006-2009).

Species richness and diversity are indicative of the stability of a community. The present study provides

baseline information on the diversity and abundance of crustacean species based on monthly and seasonal trawl landings at the Chennai Fisheries Harbour, which can act as an important reference data set for further studies related to fisheries management, ecological impact assessments of bottom trawling, conservation and pollution in the region. Present study also has importance for the interpretation of anthropogenic or natural disturbance events. Bycatch is a conundrum in global marine fisheries. Bottom trawling can cause significant impact on marine trophic chains (Alverson *et al.*, 1994). In some fisheries, most of the species caught with the shrimps are discarded due to lack of market but in many others the biomass captured is utilised for human consumption or animal feed (Clucas, 1997). The crustacean bycatch landed at Chennai Fisheries Harbour finds market as manure and poultry feed. A first step towards understanding and solving the bycatch problem is to identify and quantify bycatch (Alverson *et al.*, 1994; Ye *et al.*, 2000); similar studies can assist in understanding the lesser known impacts of trawling and also maintaining biodiversity. The ramifications of plundering the seas with fine mesh nets should be evaluated to safeguard diversity and health of the ecosystem and allow marine life an opportunity to grow and reproduce.

Table 3. Seasonal diversity indices of crustaceans landed at Chennai Fisheries Harbour during 2005-09

	SWM	NEM	PM	S	SWM	NEM	PM	S	SWM	NEM	PM	S	SWM	NEM	PM	S	SWM	NEM
	05	05	05	06	06	06	07	07	07	07	08	08	08	08	09	09	09	09
S	34	33	49	32	38	40	49	33	39	39	49	40	52	47	50	43	47	46
N	87	86	105	68	90	88	105	72	90	88	112	85	117	112	106	86	108	107
d	7.38	7.18	10.3	7.35	8.21	8.7	10.3	7.47	8.44	8.49	10.16	8.78	10.7	9.75	10.5	9.43	9.82	9.62
J'	0.957	0.95	0.965	0.952	0.952	0.94	0.964	0.9679	0.949	0.9446	0.981	0.985	0.9809	0.983	0.963	0.979	0.976	0.976
H' (\log_2)	4.86	4.79	5.41	4.76	4.99	5.00	5.41	4.88	5.01	4.99	5.50	5.24	5.59	5.45	5.43	5.31	5.42	5.39

S-Summer, SWM – South-west monsoon, NEM – North-east monsoon, PM – Post-monsoon

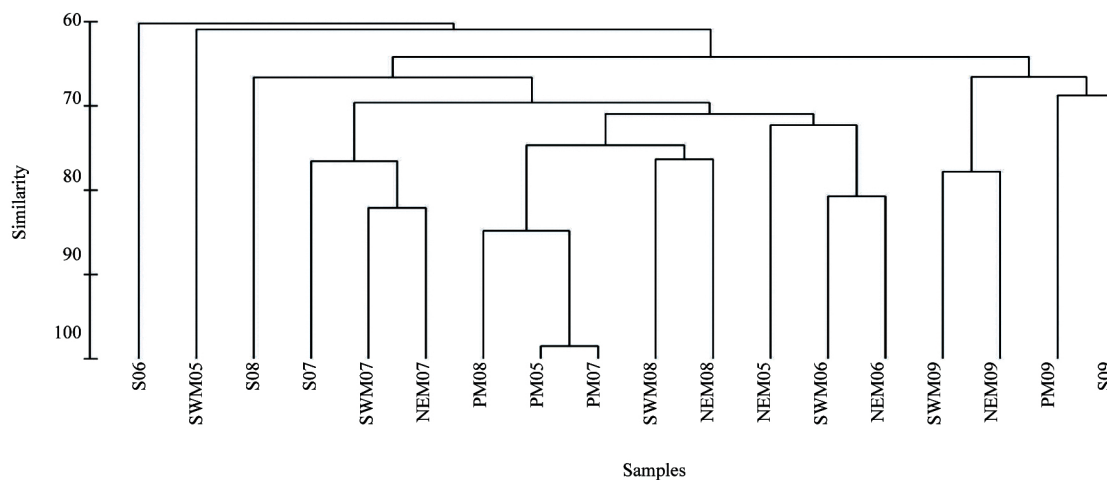


Fig. 3. Seasonal Bray-Curtis similarity of crustaceans landed at Chennai Fisheries Harbour during 2005-09.

Acknowledgements

The authors thank the Director, CMFRI for encouragement and permission to present the paper in the 9th Indian Fisheries Forum held at Chennai in December, 2011.

References

- Alverson, D. L., Freeberg, M. H., Pope, J. G. and Murawski, S. A. 1994. A global assessment of fisheries bycatch and discards. *FAO Fish. Tech. Pap.*, 339 : 233 pp.
- Ahyong, S. T. 2001. Revision of the Australian stomatopod crustacea. *Records of the Australian Museum: Supplement*, 26: 1-326.
- Bijukumar, A., Sushil Kumar, M., Raffi, S. M. and Ajmal Khan 2007. Diversity of brachyuran crabs associated with trawl bycatch in Kerala coast, India. *Indian J. Fish.*, 54(3): 283-290.
- Chapghar, B. F. 1957. On the marine crabs (Decapoda:Brachyura) of Bombay State. *J. Bom. Nat. Hist. Soc.*, 54: 503-549.
- Clucas, I. 1997. A study of the options for utilization of bycatch and discards from marine capture fisheries. *FAO Fish. Cir.*, 928: 59 pp.
- Costa, M. E., Erzini, K. and Borges, T. C. 2008. Bycatch of crustacean and fish bottom trawl fisheries from southern Portugal (Algarve). *Sci. Mar.*, 72(4): 801-814.
- Galil, B. S. and Clark, P. F. 1994. A revision of the genus *Matuta* Weber, 1795 (Crustacea: Brachyura: Calappidae). *Zoologische Verhandelingen, Leiden*, 294: 1-55, fig. 1-7, pl. 1-14.
- Galil, B. S. 1997. Crustacea Decapoda: A revision of the Indo Pacific species of genus *Calappa* Weber, 1795 (Calappidae). In: Crosnier, A. (Ed.), *Resultats des Campagnes MUSORSTOM, Volume 18. Memoires du Museum National d'Histoire naturelle, Paris*, 176: 271-335.
- Griffiths, R. C. and Simpson, J. C. 1972. An evaluation of the present levels of exploitation of the fishery resources of Venezuela. *Ser. Recursos. Explot. Pesq.*, 2(5): 29-52.
- Holthuis, L. B. 1980. FAO species catalogue. Vol. I. *Shrimps and prawns of the world. FAO Fish. Synop.*, I (125).
- Kazemi, S. H., Paighambari, S. Y. and Naderi, R. A. 2013. Species composition of trawl shrimp by-catch in the fishing grounds of Northern Persian Gulf (Hormuzgan Province). *World. J. Fish. Mar. Sci.*, 5(5): 505-510.
- Klima 1976. A review of the fishery resources in the Western Atlantic. *WECAF. Stud.*, 3: 77.
- Maharaj, V. and Recksiek, C. 1991. The bycatch from the artisanal shrimp trawl fishery, Gulf of Paria, Trinidad. *Mar. Fish. Rev.*, 53(2): 9-15.
- Liggins, G. W., Kennelly, S. J. and Broadhurst, M. K. 1996. Observer based survey of bycatch from prawn trawling in Botany Bay and Port Jackson, New South Wales. *Mar. Freshw. Res.*, 47(7): 877-888.
- Murugesan, P., Silambarasan, A., Purusothaman, S., Muthuvelu, S. and Anantharaman, T. 2013. Diversity of invertebrate trawl bycatch off Cuddalore, Parangipettai and Pazhayar, south-east coast of India. *Indian J. Fish.*, 60(1): 41-49.
- Ng, P. K.L., Guinot, D. and Davie, P. J. F. 2008. Systema Brachyurorum. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bull. Zool. Suppl. Ser.*, 17: 1-313.

- Paighambari, S. Y. and Moslem, D. 2012. The bycatch composition of shrimp trawl fisheries in Bushehr coastal waters, the northern Persian Gulf. *J. Per. Gulf.*, 3(7): 27-36.
- Perez Farfante, I. and Kensley, B. 1997. Penaeoid and sergestoid shrimps and prawns of the world. Keys and diagnosis for the families and genera. *Memoires Museum National D'Histoire Naturelle*, p. 1-223.
- Saila, S. B. 1983. Importance and assessment of discards in commercial fisheries. *FAO Fish. Cir.*, 765: 62 pp.
- Sakai, T. 1976. *Crabs of Japan and the adjacent seas*. Kodansha Ltd., Tokyo. Japan, 773 pp.
- Ye, Y., Alsaffar, A. H. and Mohammed, H. M. A. 2000. Bycatch and discards of Kuwait shrimp fishery. *Fish. Res.*, 45(1): 9-19.

Date of Receipt : 08-05-2013

Date of Acceptance : 26-11-2013