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Note

A preliminary study on richness, diversity and evenness of decapod crustaceans off Mumbai

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Abstract

Richness, diversity and evenness of decapod crustaceans off Mumbai coast based on sampling during October 2002 to January 2003 are reported. The richness estimated by Margelaf and Menhinick indices gave contrasting values of 0.86 and 0.23, respectively, with the same sample size. Simpson and Shannon diversity indices were 0.49 and 1.07, respectively. The evenness was studied using five different indices and the results were analysed for the sensitivities of the indices with the number of species in the sample. Hill diversity numbers of different orders were in units of effective number of species in the sample. The Ranked Species Abundance curve showed the clear dominance of some species over others.

Decapods constitute the most important group of crustaceans that are exploited commercially on a large scale throughout the country. At present, as many as 150 species of this group form part of the commercial catches. The excessive fishing pressure and use of destructive fishing gears are major threats to the biodiversity of crustaceans. For aquatic ecosystems, indices of diversity are basically an approach to biological quality through the structure of the community. Most studies on benthic communities have focused on the infauna and little work has been done on the benthic crustaceans. As a member of epifauna, crustaceans have much higher mobility than members of infauna. When the environment changes, the community structure responds with the disappearance or recruitment of organisms at the species level. In the present work, the decapod crustacean community of a particular site off Mumbai was studied to find out the richness, diversity and evenness of this group, and the changes in the diversity status on the temporal scale at the same location.

Materials and methods

Data were collected fortnightly for a period of four months from October 2002 to January 2003 from southwest of Mahim off Mumbai coast, using research vessel M.F.V. *Narmada,* of Central Institute of Fisheries Education, by bottom trawl net of cod end mesh size 25 mm. The trawling time was around one hour with a speed of 3 knots. The depth of the selected area varied between 18 and 20 m and a stretch of 2.9 km has been covered in each sampling. The latitude and longitude of the initial and final points of trawling were 19°05'16" N and 72°41'26" E' to 19°05'06" N and 72°39'51E. The decapod crustaceans were separated and counted species-wise from the total catch.

To study the biological status in terms of decapods, 11 different indices (Magurran, 1988) were used. Richness and diversity were measured using Margalef (1958), Menhinick (1964), Simpson (1949) and Shannon-Wiener (Shannon-Weaver, 1949) indices. Evenness was calculated using five different indices E1, E2, E3, E4 and E5 given by Pielou (1975), Sheldon (1969), Heip (1974), Hill (1973) and Alatalo (1981), respectively. Hill's diversity numbers of different orders were also calculated. Ranked Species Abundance Curve (May, 1975) was drawn to evaluate the relative abundance of the species. Statistical analysis was done using Pearson Correlation Matrix to find out the relationship among different diversity indices and Students' t-test was applied to find out the significant values at $p<0.01$.

Results and discussion

A total 29,839 individuals belonging to 12 species coming under four major groups of decapods were recorded throughout the sampling period (Table 1). Nonpenaeid shrimp, *Acetes indicus,* was recorded in the highest number (20075). Seven species of penaeid shrimps were recorded, among which *Parapenaeopsis stylifera* dominated followed by *Metapenaeus brevicornis* and *Solenocera crassicornis*. This indicated a rich-fishing ground for this species. A total of 9 individuals belonging to one species of lobster, *Panilurus polyphagus,* were recorded. Among crabs *Thalamita crenata* was recorded in the highest number (5925), while others like *Charybdis feriatus* and *Portunus pelagicus* occurred in low numbers.

Table 1. *Species inventory and Ranked Species Abundance (RSA) of decapod crustaceans for different sampling*

Species	Dates of sampling									RSA
	2002					2003				
	1st Oct*	16th Oct	30th Oct	13th Nov	2nd Dec	24th Dec	7th Jan	24th Jan	Total	Abundance (%)
A. indicus	-	-	10950	7300	1825	-	-	-	20075	92.3
T. crenata	-	-	4800	320	325	170	150	160	5925	4.6
P. stylifera	-	235	840	152	560	132	120	42	2081	1.6
M. brevicornis	-		600	123	125	86	85	60	1079	0.8
S. crassicornis	-		-	25	25	40	200	25	315	0.24
P. sculptilis	-	20	-	-	52	35	59	30	196	0.15
M. dobsoni	-	45	34	-	-	-	-	-	79	0.06
M. monoceros	-	12	30	7	-	-	2	-	51	0.03
M. affinis	-	5	-	15	-	-	-	5	25	0.02
P. polyphagus	-	-	-	1	3	1	2	2	9	0.007
C. feriatus	-	-	-	-	-	3	-	-	3	0.002
P. pelagicus	-	-	-	-	-	1	-	-	1	0.0007
Total	-	317	17254	7943	2915	468	618	324	29839	

* No decapod catch

Richness, diversity, evenness and Hill diversity numbers are shown in Table 2. The richness increased with sample size (Ludwig and Reynolds, 1988). Margalef index (R1) ranged from 0.43 to 1.14, and Menhinick index (R2) from 0.01 to 0.38. Both the indices showed almost the same pattern of variation. The R1 gave higher values than R2 for the same sample size. The low value obtained for R2 was because of the functional relationship existing between sample size (S) and the number of species (n) in the community, which varied in an unknown manner (Peet, 1974; Ludwig and Reynolds, 1988).

The Shannon–Wiener diversity index (H') showed high variability ranging from 0.25 to 1.95 (Table 2) and Simpson diversity index (λ) ranged from 0.22 to 0.89. The H' and λ showed an opposite trend of variation. The H' increased with increasing evenness while 'λ' increased with decreasing diversity (Ludwig and Reynolds, 1988).

The evenness index E1 ranged from 0.14 to 0.94, E2 from 0.18 to 0.88 and E3 from 0.06 to 0.86 and showing a similar pattern of variation. E4 ranged from 0.55 to 0.98 and E5 from 0.38 to 0.97. An evenness index should be independent of the number of species in the sample., E1, E2 and E3 are highly sensitive to the number of species in the sample and are strongly affected by species richness (Peet, 1974). The addition of one rare species to a sample that contains only a few individuals greatly changes the value of E1, E2 and E3. In contrast, E4, which is the Hill ratio and E5, the modified Hill ratio, are relatively unaffected by species richness. E5 approaches zero as a single species becomes more and more dominant in the community, while E4 approaches one. Thus, E5 gives a more clear picture of evenness as compared to E4 and therefore is preferred (Peet, 1974). Hill's diversity number N0 is the number of all species in the sample regardless of their abundances which was found varying from 6 to 8. N1 ($e^{H'}$) which is the measure of the number of the abundant species in the sample that ranged from 1.29 to 7.03. This indicated an increase in the dominance of few species in the sample (Table 1). N2 ($1/\lambda$) is the measure of the number of the very abundant species in the sample and ranged from 1.12 to 4.46. Hill diversity numbers showed much variability and gave more information than H'.

Diversity and evenness were found to be highly correlated and vary in accordance with each other (Table 3). H' showed a high correlation ($r = 0.99$) with the evenness indices (Ismael and Dorgham, 2003). Ranked Species Abundance (RSA) showed the dominance of non-penaeid shrimp. The penaeid shrimp showed high abundance (Table 1). The crabs and lobsters were recorded in very low numbers

The species richness and heterogeneity diversity measure have most commonly been used to asses the impacts of disturbances on the marine environment. In this context, much importance has been given to values of the Shannon-Wiener index (Gray, 2000). In Norway, the index has been incorporated into environmental legislation (Molvar, 1997). In the present investigation, the

Table 2. *Species richness, diversity and evenness indices for decapod crustaceans*

	Date of sampling	No. of species	No. of individuals	Richness indices		Diversity indices		Hill's diversity number			Evenness indices				
				R1	R2	λ	H'	N0	N1	N2	E1	E2	E3	E4	E5
	1st Oct	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2002	16th Oct	6	317	0.86	0.32	0.50	1.06	6	2.87	2.00	0.59	0.48	0.38	0.69	0.53
	30th Oct	6	17254	0.43	0.01	0.89	0.25	6	1.29	1.12	0.14	0.21	0.06	0.87	0.43
	13th Nov	8	7943	0.78	0.09	0.85	0.38	8	1.47	1.18	0.19	0.18	0.06	0.80	0.38
	2nd Dec	7	2915	0.75	0.13	0.44	1.11	7	3.03	2.25	0.57	0.43	0.33	0.74	0.61
	24th Dec	8	468	1.14	0.37	0.26	1.95	8	7.03	3.89	0.94	0.88	0.86	0.55	0.48
2003	7th Jan	8	618	1.08	0.32	0.22	1.60	8	4.93	4.46	0.77	0.62	0.56	0.90	0.88
	24th Jan	7	324	1.03	0.38	0.31	1.20	7	3.32	3.25	0.62	0.47	0.39	0.98	0.97

Table 3. *Pearson Correlation Coefficients between different indices*

	R1	R2	λ	H'	E1	E2	E3	E4	E5	N1	N2
R1	1										
R2	0.87	1									
λ	0.32	-0.33	1								
H'	0.88	0.88	-0.33	1							
E1	0.89	0.90	-0.31	0.99*	1						
E2	0.87	0.86	-0.23	0.98*	0.97*	1					
E3	0.81	0.85	-0.37	0.97*	0.97*	0.98*	1				
E4	0.68	0.40	0.55	0.37	0.39	0.36	0.22	1			
E5	0.80	0.73	-0.002	0.67	0.68	0.59	0.52	0.83	1		
N1	0.85	0.82	-0.27	0.97*	0.95*	0.99	0.99	0.32	0.56	1	
N2	0.89	0.86	-0.27	0.95	0.93	0.91	0.89	0.53	0.80	0.91	1

average value of H' was 1.07, showing a poor diversity of decapod crustaceans. The appearance and disappearance of species during different samplings might be due to the frequent mobility of species in and out of the area in response to environmental changes and disturbances created by trawling, and probably pollution. This observation was also supported by Chou *et al.* (1999).

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