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Demersal Fish Assemblages by Bottom Trawler off Western Tung-Sha Tao: A Case Study

Abstract

The main purpose of this study was to understand the characteristics of demersal fish assemblages in the area near west Tung-Sha Tao, South China Sea, with six bottom trawl operations along a transect at depths of 400-450 meters during 18-19 April 1995. A total of 8 major fish species and 5 prawn species occupying 74.9% and 9.7% of the total collected species were recorded respectively. The species found at duplicated stations of which the total linear biomass were greater than 20.0 for fish and 5.0 for prawn were selected for the cluster analysis. The relationship between the values of Shannon-Wiener's index and the sampling stations had no significant difference ($p>0.05$). Using the unweighted pair group method arithmetic average (UPGMA) and the Bray-Curtis dissimilarity values, 6 trawl operation stations were grouped into 1 cluster and 8 fish species and 5 prawn species were classified into 2 groups respectively. Based on the catch percentages and cluster analysis, the study area may be considered as one of the major habitats of hairtail *Trichiurus lepturus*.

Key Words: Demersal fish, Assemblages, Diversity, West Tung-Sha Tao

The Tung-Sha Tao (20° 42′ N , 116° 43′ E), located between Pen-Fu Banks and Xi-Sha Islands, is just on the middle point of the narrow strip continental slope of the South China Sea. Its commercial fishery activities have been operated in the waters at depths of 200-1000 meters near the island since early 1980s.

Before the 1960s, marine biological community studies are mostly on benthic and planktonic organisms but deep-sea fish(1). Studies on fish community have been increased since the 1970s, but previous published works were generally limited in shallow coastal and offshore waters(2,3). Numerical abundance is often used as abundance measure in the study of fish communities(4). The characteristics of the biological community are usually defined based on the species diversity indices(5), and it has been known that the parameters differ with latitude, age of the community, stability of the community, biological cycle, and other factors.

Fish community structures studies have been conducted for many years by Taiwan and China, in the continental slope of the East and South China Sea(1,6-10), but little information is available on the demersal fishes assemblages at depth under 200 meters near west Tung-Sha Tao. Therefore, the aim of this study was to provide adequately quantitative data on species groups, diversity, and station similarity in the waters near western Tung-Sha Tao. It is expected that a better utilization and management of continental slope fishery resources

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can be reached in the near future.

Materials and Methods

With the help of scientific equipments SCANMAR System 400 depth and distance sensors, a total of 6 bottom trawls were conducted in the area between 20° 20′ N and 20° 40′ N, 115° 30′ E and 115° 50′ E during 18-19 April 1995 (Table 1) by R/V Fishery Researcher 1, Taiwan Fisheries Research Institute. Trawlings were conducted along a transect at depth of 400-450 m for 1.0 hour each, excluding shooting and hauling time. The bottom trawl net used in this study consisted of a four-panel with a stretched-mesh size of 6.0 cm in the cod end attached to a covered net with a mesh size of 3.6 cm. The mesh sizes on the wings and body were 20.0 cm and 10.0 cm respectively. The towing speed was 2 knots. Shooting directions for each station are shown in Fig. 1.

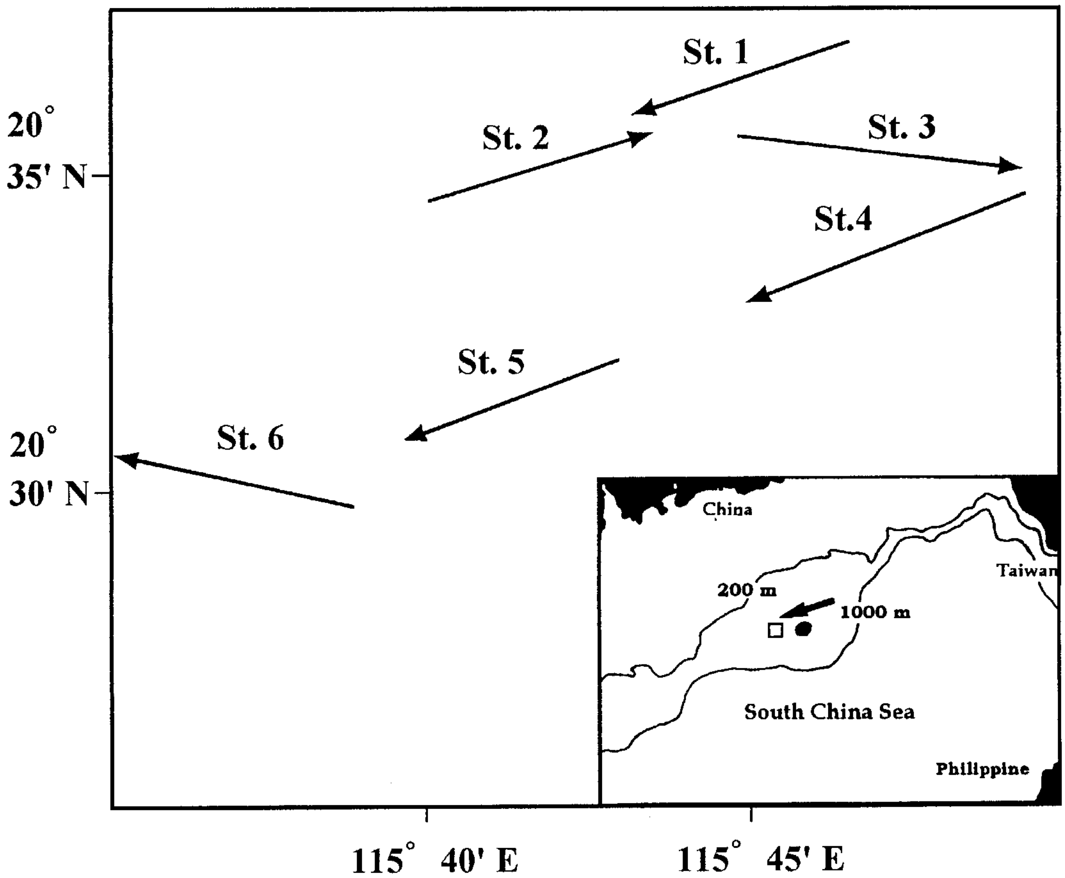

Fig. 1. Map shows the positions and directions of bottom trawl operating in this study, 18-19 April 1995.

In addition to the traditional way of using species abundance as community index, information based on linear biomass was also be employed in this study. Bianchi[11] indicated that it is more natural to use biomass values to evaluate the fish community study. Wilhm also suggested use of biomass in Shannon-Wiener's index H′ shortly after Pielou[12,13]. Following Lyons[14], the author calculated the values of linear biomass for each species[15] and used the Shannon-Wiener's diversity index, weighted by the linear biomass for measuring the diversity of the target area. Analysis of variance (ANOVA) was used to test the differences of species diversity index values among the sampling stations.

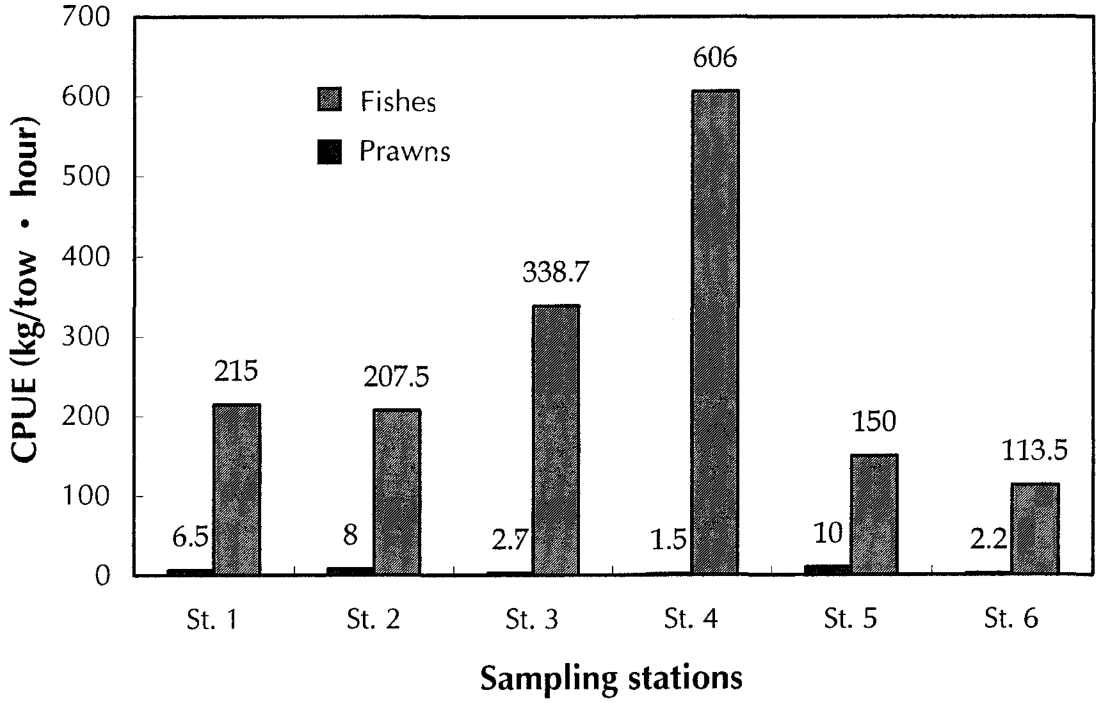

Fig. 2. The catch per unit effort (CPUE) of fishes and prawns in 6 operation stations.

Table 1. Deep-sea bottom trawl fishing grounds survey dates, location, depths and operating time, 18-19 April, 1995.

St. no.	*Dates*	*Positions*		*Depth (m)*		*Running time*	*Catches (Kg)*
		Lat.	*Long.*	*Shot*	*Retrieved*		
1	18 Apr. 1995	20°37.1′ N	115°46.9′ E	414.0	408.0	01h-00m	113.5
2	19 Apr. 1995	20°34.7′ N	115°40.2′ E	404.0	418.0	01h-00m	150.0
3	19 Apr. 1995	20°35.5′ N	115°44.8′ E	418.0	441.0	01h-00m	606.0
4	19 Apr. 1995	20°34.5′ N	115°49.0′ E	447.0	444.0	01h-00m	338.7
5	19 Apr. 1995	20°32.2′ N	115°43.0′ E	441.0	432.0	01h-00m	207.5
6	19 Apr. 1995	20°29.7′ N	115°38.7′ E	442.0	414.0	01h-00m	215.0

Cluster analysis was used to compare the similarity distance between trawl collections and to elucidate species assemblages. Using the Bray-Curtis dissimilarity values(16) and the unweighted pair group method arithmetic averages (UPGMA)(17), species groups were classified. To reduce the effects of the extreme values generally presented in trawl collections, a log-transformed value of species abundance [log (abundance + 1)] was used for the classification of station and species. Additionally, only species that occurred in at least two trawls collections and had a sum value of linear biomass over 20.0 for fish and 5.0 for prawn were chosen on the estimation of fish community structure. Rare species were eliminated from the analysis because of their little information on the basic patterns of community structure. Cluster analysis was done with a numerical taxonomy and multivariate analysis system (NTSYS-pc) program.

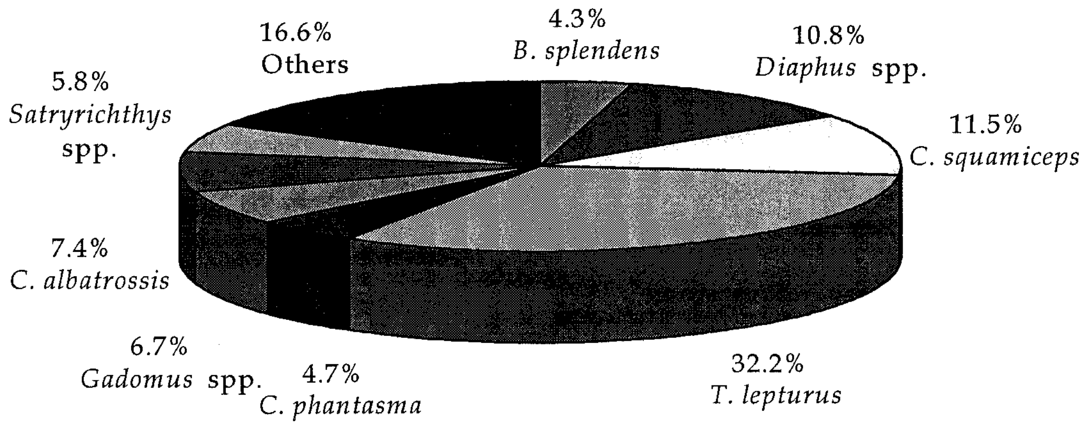

Fig. 3. Percentages of the major fish species collected by bottom trawl in west Tung-Sha Tao.

Table 2. The linear biomass of 8 major species of fish collected from 6 bottom trawl operating stations.

Species	***Linear biomass***					
	St. 1	***St. 2***	***St. 3***	***St. 4***	***St. 5***	***St. 6***
Diaphus spp.	18.65	16.10	1.39	5.84	3.28	13.07
Cubiceps squamiceps	0.00	3.66	1.10	9.12	18.55	29.57
Trichiurus lepturus	38.93	10.45	83.71	37.86	3.01	0.00
Beryx splendens	0.00	0.65	0.55	5.91	15.77	0.28
Gadomus spp.	8.97	6.13	2.20	3.08	2.41	13.34
Chlorophthalmus albatrossis	2.83	7.33	0.49	5.45	18.07	5.60
Satryrichthys spp.	5.87	15.66	0.76	7.11	0.00	1.97
Chimaera phantasma	14.70	0.76	1.35	1.02	4.59	3.00

Results and Discussion

I. Species diversity

Figure 2 shows the catch per unit effort (CPUE) of fishes and prawns at 6 operating stations. The best catch of fishes was at station 3 with the CPUE of 606.0 at average depth of 429.5 m; while station 1, 113.5, was the worst of the catch in six trawl operation stations. Prawns catches were poor at every sampling station, The best catch was at station 2 with the CPUE of 10.0 at average depth of 411 m. Five major prawn species, *Heterocarpus woodmasoni, Haliporoides sibogae, Plesionika* spp., *Penaeopsis eduardoi,* and *Heterocarpus sibogae* constituting 9.8% of total catches were recorded.

Eight fish and five prawn species and their linear biomass were recorded as major components (Table 2, 3), and their weight constituted 75.0% and 9.7% of the total specimens collected respectively. For major fish component, *Trichiurus lepturus* occupying 32.2% of the total fish specimens was the most dominant species, *C. squamiceps,* the second. *B. splendens* consisting of 4.3% of total fish catch was the minimum in the eight dominant fish species (Fig. 3). For major prawn component, *Plesionika* spp. occupying 25.6% of the total prawn specimens was the most dominant species, *H. sibogae,* the second. *H. woodmasoni* consisting of 8.0% was the minimum in the five dominant prawn species (Fig. 4).

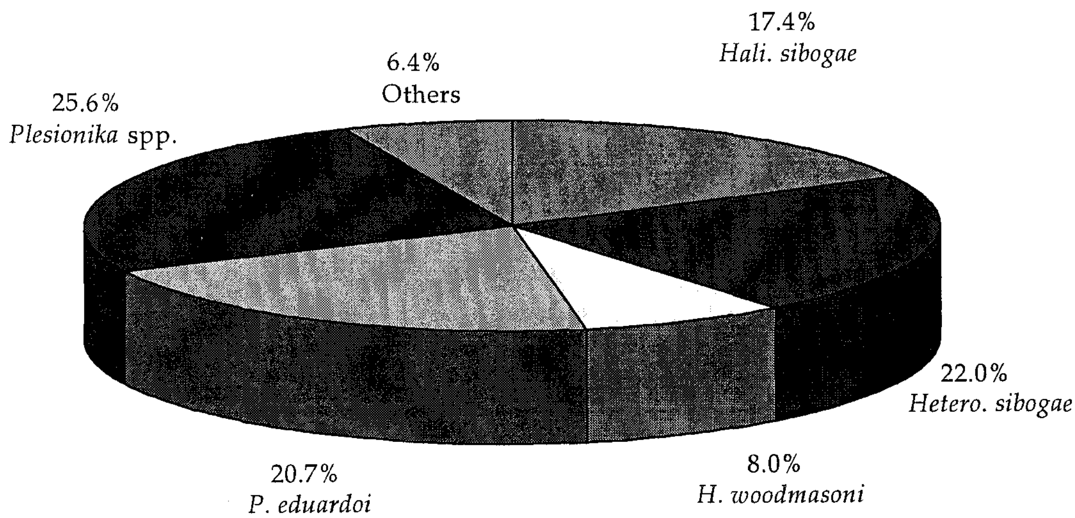

Fig. 4. Percentages of the major prawn species collected by bottom trawl in west Tung-Sha Tao.

The community structure and the occurrence of deep-water demersal fishes are greatly influenced by the depth layer and bottom topography[18,19]. Etter and Grassle[20] indicated that the characteristics of sedimentation plays an important role in determining the number of species within a community. Lee et al.[21] also showed that the distribution of demersal species seemed to have a close relationship with the types of sea bottom, and the CPUE of deep-water prawns under the muddy bottom was two times of the sandy's. The sea bottom sampled and analyzed in study region were found to be muddy. Considering the relationship between types of sea bottom and the abundance of collected species by CPUE, I found that the average values of CPUE of fish and prawn were 271.8 and 5.2 respectively. Lee[10] described that the sea bottom in north Tung-Sha Tao were found to be muddy and sandy. The average values of CPUE of fish and prawn, without considering the effect of depth layer factor to the catches, were 157.0 and 3.4 lower than those caught in west Tung-Sha Tao.

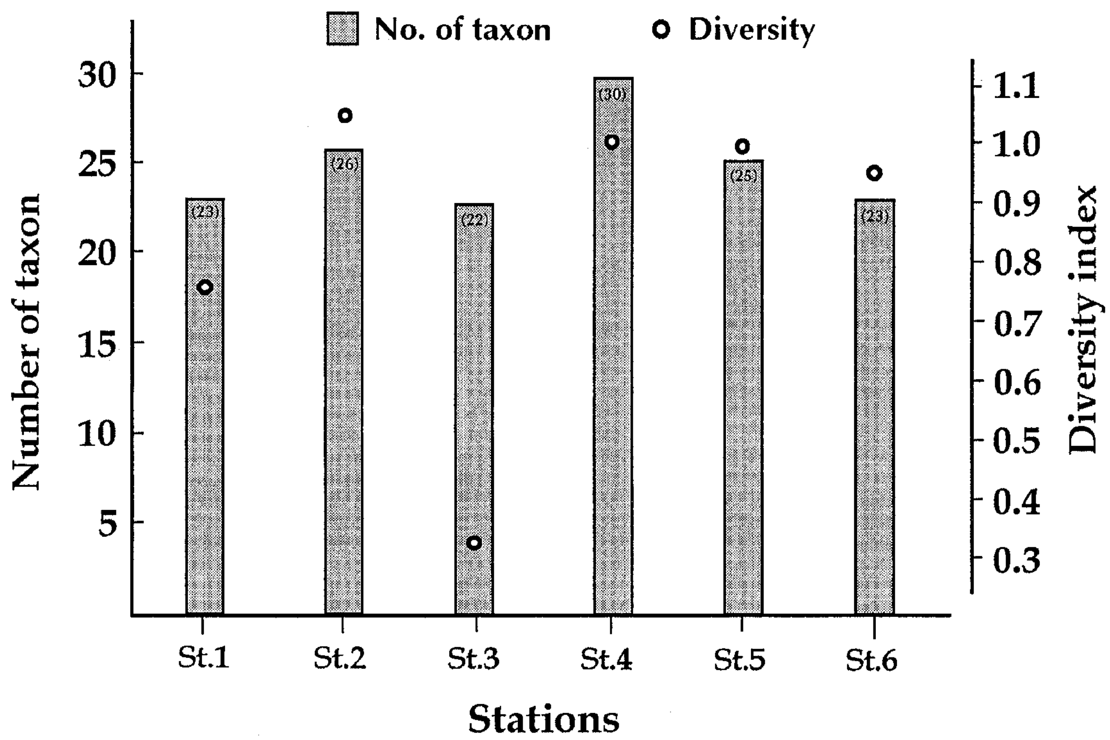

Fig. 5. Diagram shows the value of Shannon-Wiener's index and number of taxon in 6 operations, 18-19 April 1995.

Table 3. The linear biomass of 5 major prawn species collected from 6 bottom trawl operating stations.

Species	*Linear biomass*					
	St. 1	*St. 2*	*St. 3*	*St. 4*	*St. 5*	*St. 6*
Haliporoides sibogae	2.02	1.69	0.69	0.57	3.11	2.77
Heterocarpus woodmasoni	0.00	0.48	0.00	0.12	0.45	3.95
Plesionika spp.	1.47	6.83	0.23	0.66	3.57	3.20
Heterocarpus sibogae	0.30	4.05	0.15	0.83	4.43	3.96
Penaeopsis eduardoi	0.00	2.44	0.21	0.91	4.93	4.42

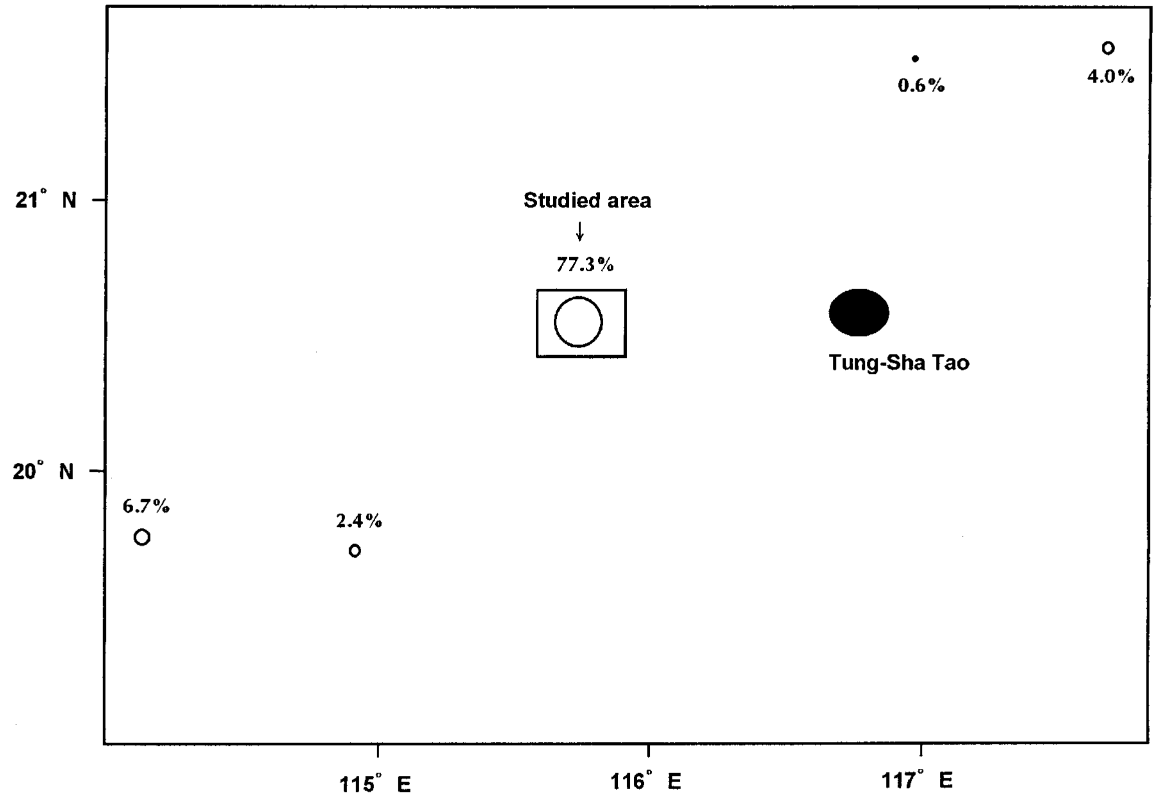

Fig. 6. Diagram shows the value of Shannon-Wiener's index and number of taxon in 6 operations, 18-19 April 1995.

Table 4. Analysis of variance on Shannon-Wiener's indices of the stations with depths layer of 410-450 meters.

	SS	*DF*	*MS*	*F-ratio*
Treatment	0.001736	1.000000	0.001736	0.020200
Error	0.342246	4.000000	0.085561	
Total	0.343982	5.000000		

p(0.893)>0.05

With analysis of variance on Shannon-Wiener's indices (H') (weighted by the respective value of linear biomass) against surveyed stations in depth layer of 400-450 meters, I found that the regression coefficient was not significant (*p*>0.05)(Table 4). The diversity index value ranged between 0.33 and 1.02 (Fig. 5). The hairtail *Trichiurus lepturus* occupied 83.7% and 38.9% of the total catches at station 3 and 1 with the diversity index value of 0.33 and 0.76 respectively. Based on the catch percentage of hairtail in the northern slope of the South China Sea, I found that the fish composition did not change much and catch percentage of hairtail in the study area occupied 77.3%, comparing with the other operation stations during 28 April 1994 - 22 April 1995 (Fig. 6). Therefore, the study area may be considered as the major habitat of hairtail. The term "diversity" is commonly used as a synonym for species richness. However, the number of species presents in the community may differ with factors such as latitude, age of the community, its stability, and biological cycle[22,23]. I, therefore, may conclude that the lower diversity index values may be attributed to the occurrence of dominant species such as hairtail in this study.

II. Cluster analysis

Eight major fish species were classified into 2 groups (Fig. 7). Group 1 consisted of 2 subgroups 1A and 1B. Subgroup 1A consisted of 4 species: *Diaphus* spp., *Gadomus* spp., *Satryrichthys* spp., and *Chimaera phantasma*. Subgroup 1B consisted of 3 species: *Cubiceps squamiceps, Beryx splendens,* and *Chlorophthamus albatrossis*. Group 2 only contained one species: hairtail *Trichiurus lepturus*. Based on the collected data, species of subgroup 1A and subgroup 1B exist at about the same depth layer of 400-450 m within 225 square miles.

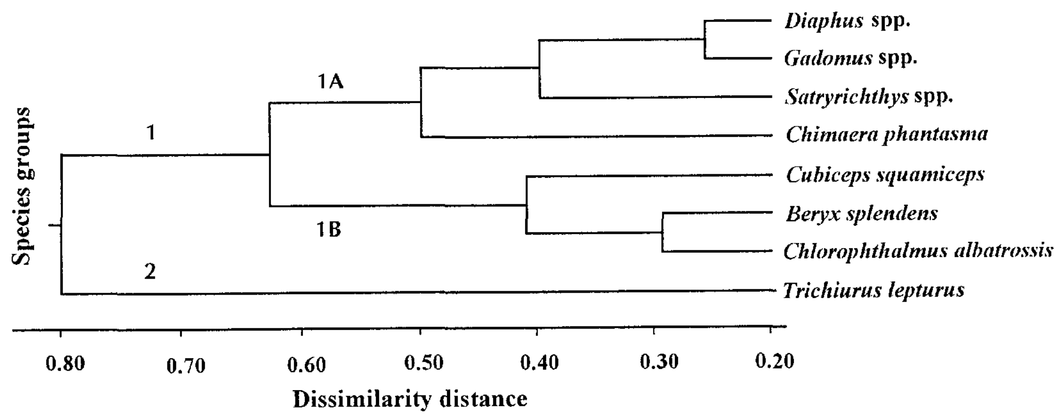

Fig. 7. Dendrogram of UPGMA cluster analysis, including the classification of 2 fish species groups from 6 sampling stations using a log-transformed value of fish species abundance.

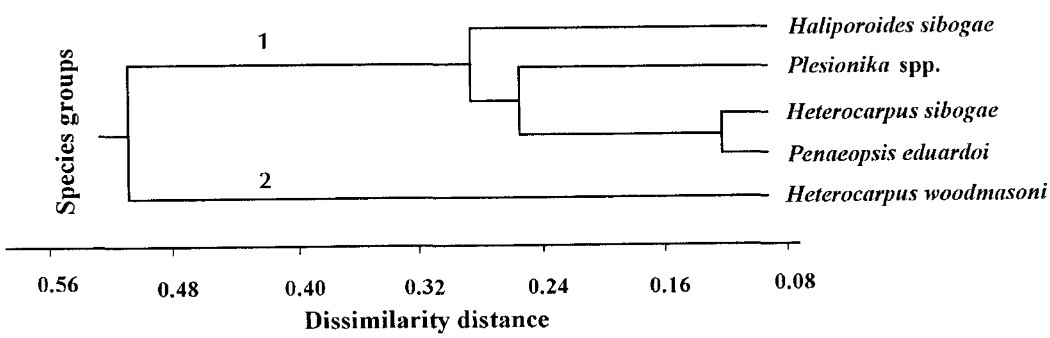

Fig. 8. Dendrogram of UPGMA cluster analysis, including the classification of 2 prawn species groups from 6 sampling stations using a log-transformed value of prawn species abundance.

Since most of the fishes composition existed in the overlapped depth layer, I suggest to combine these two subgroups into one group. Group 1 and 2 comprised 61.4% and 38.6% of the major specimens respectively. Five major prawn species were classified into 2 groups (Fig. 8). Group 1 consisted of 4 species: *Haliporoides sibogae, Plesionika* spp., *Heterocarpus sibogae,* and *Penaeopsis eduardoi*. Group 2 contained only one species: *Heterocarpus woodmasoni*. Group 1 and 2 comprised 91.5% and 8.5% of the major specimens respectively.

The station groups from 8 fishes species with log-transformed values of abundance were classified into 2 groups (Fig. 9). Group 1 contained stations 1, 4, 2, and 3, which occurred at depth of 404-447 m, group 2 contained stations 5 and 6, which appeared at depth of 414-442 m. These 2 station groups derived from fish abundance that existed in the overlapped depth layer. The station groups from 5 prawns species with log-transformed values of abundance were also classified into 2 groups (Fig. 10); Group 1 contained stations 1, 3, and 4, which occurred at depth of 408-447 m and group 2 contained stations 2, 5, and 6, which at depth of 404-442 m. These two station groups from prawn abundance also existed at the same depth stratum in the surveyed area. I, therefore, suggest to define these two groups as one major group.

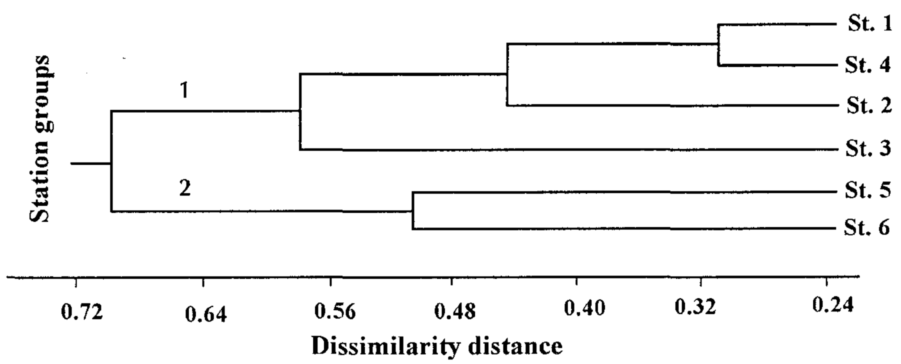

Fig. 9. Dendrogram of UPGMA cluster analysis, including the classification of 2 station groups from 6 sampling stations using a log-transformed value of fish species abundance.

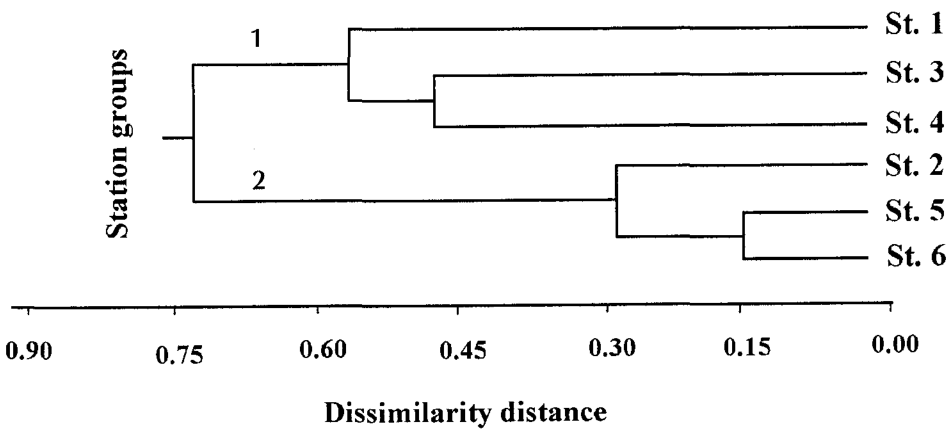

Fig. 10. Dendrogram of UPGMA cluster analysis, including the classification of 2 station groups from 6 sampling stations using a log-transformed value of prawn species abundance.

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東沙島西部底棲性魚類群社組成之個案研究

摘要

本研究之主要目的旨在探討東沙島西部小範圍之陸坡漁場魚種群社組成。1995 年 4 月 18 至 19 日調查期間，於 20° 20′ N - 20° 40′ N，115° 30′ E - 115° 50′ E，水深 400 至 450 公尺之海域，實施 6 網次底拖網漁撈試驗。魚類及蝦類之線性生物量分別大於 20.0 及大於 5.0 且於兩測站以上同時出現者，魚類計有 8 種，佔魚類總漁獲量的 83.5%；蝦類 3 種，佔蝦類總漁獲量的 94.7%。各測站之夏農・魏能 (Shannon-Wiener) 歧異度指數與各測站間之差異不顯著。群社分析結果顯示，主要魚種與蝦類組成均可區分爲 2 組群社。依魚種別之對數線性生物量可將所調查測站群社區分爲 1 組；依蝦種別分析所獲得之測站群社組數亦同。

關鍵詞： 底棲魚類，群社，歧異度，東沙島西部

李嘉林 (1995) 東沙島西部底棲性魚類群社組成之個案研究.
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