Chia-Lin Lee

Department of Marine Fisheries, Taiwan Fisheries Research Institute, 199 Hou-Ih Rd., Keelung 202, Taiwan.

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A Study on Demersal Fish Community by Bottom Trawler in North Tung-Sha Tao

Abstract

To understand the characteristics of community of demersal fishes in north Tung-Sha Tao, 6 bottom trawl operations were conducted along a transect at depths of 280-361 meters during 17-18 April 1995. A total of 11 major fish species occupying 69.4% of the total collected species were recorded. Three prawn species, *Heterocarpus woodmasoni, Haliporoides sibogae,* and *Plesionika* spp. were found. The species that was found at duplicated stations and with a total linear biomass greater than 20.0 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, the 11 fish species were classified into 2 groups and 6 trawls were grouped into 2 clusters respectively.

Key words: Demersal fish, Species composition, Diversity, Tung-Sha Tao

The South China Sea is one of the biggest marginal seas in the western Pacific Ocean, its depths of the northern slope, structurally as a fault block, change between 200 and 1200 meters with the contour line running on a NE-SW trend and paralleling the coastline[1]. Tung-Sha Tao (20°42'N, 116°43'E) is just on the middle point of the narrow strip continental slope between Pen-Fu banks and Xi-Sha Islands. Commercial fishery activities have been operating in this area at depths of 200-1000 meters since early 1980s.

Marine biological community studies are mostly on benthic and planktonic organisms, rarely on deep-sea fish[2] before the 1960s. Studies on fish community structures have been increasing since the 1970s, but published works are general limited to fishes communities in shallow coastal and offshore waters[3,4]. The characteristics of the biological community were usually defined based on the species diversity index[5]. It has been known that the parameters differ with latitude, age of the community, stability of the community, biological cycle, and other factors.

The surveys of deep-water (broadly defined as fishing grounds at depths under 200 meters in this study) fish community structures have been conducted by Taiwan and China in the northern slope of the South China Sea for many years[2,6,7,8,9]. The goals of this study were to provide additional data on species association and diversity, and station similarity in north Tung-Sha Tao. It is expected that a

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better utilization and management of deep-water fishery resources can be reached.

Materials and Methods

A total of 6 bottom trawls were conducted in the area between 21°00′N and 21°40′N, 116°20′E and 117°00′E during 17-18 April 1995 (Table 1) by R/V Fishery Researcher 1, Taiwan Fisheries Research Institute. Trawlings were conducted along a transect at depths of 280-361 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. Covered net mesh size were 3.63 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.

The Shannon-Wiener index[10] is estimated by

$$H' = -\sum_{i=1}^{S} \left(\frac{n_i}{n} \log \frac{n_i}{n}\right)$$

where n indicates the number of specimens,

n_i: the number of specimens of the ith species.

s: the total number of species at collection station.

In addition to the traditional way of using species abundance as community index, information based on linear biomass were employed. The values of linear biomass (B) for species i was calculated[11]

$$B_i = \left(\frac{\text{Sum of fish species body length}}{\text{Sums of total fishes species body length}}\right) \times 100$$

Following Lyons[12], the author used the Shannon-Wiener 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.

Numerical classification techniques (cluster analysis), were used to compare the dissimilarity distance and to elucidate species groups. Species groups were classified. using the Bray-Curtis dissimilarity values[13] and the Unweighted Pair Group Method Using Arithmetic Averages (UPGMA) method[14]. Log-transformed value of species abundance [log (abundance + 1)] were used for the classification of station and species. Species that occurred in two or more trawls and had a sum value of linear biomass over 20.0 were chosen on the estimation of fish community structure. Rare species were eliminated from the analysis because of their little classificatory information[15].

Cluster analysis was done with a numerical taxonomy and multivariate analysis system (NTSYS-pc) program.

Results and Discussion

I. Species diversity

A total of 46 fish species occupying 94.63% of the total catches was found during the study period. Figure 2 shows the catch per unit effort (CPUE) of fishes at 6 operating stations. The best catches of fishes were at station 3 with the CPUE of 261.4 at average depth of 284.5 m; while station 1 was 233.7; station 5, 181.8; station 6, 110.1; station 2, 104.8; and station 4, 50.4. Prawns were poor at any sampling station. Three species, *Heterocarpus woodmasoni, Haliporoides sibogae,* and *Plesionika* spp. constituting 5.37% by weight were recorded.

Table 1. Deep-water bottom trawl fishing grounds survey dates, locations, depths and operating time, 17-18 April, 1995.

St. no.	*Dates*	*Positions*		*Depths (m)*		*Running time*	*Catches (kg)*
		Lat.	*Long.*	*Shot*	*Retrieved*		
1	17Apr.1995	21° 19.9′N	116° 48.6′E	361	354	01h-00m	342.5
2	17Apr.1995	21° 31.0′N	116° 58.6′E	326	326	01h-00m	116.0
3	18Apr.1995	21° 37.6′N	116° 51.6′E	289	280	01h-00m	326.5
4	18Apr.1995	21° 12.6′N	116° 34.0′E	337	335	01h-00m	52.0
5	18Apr.1995	21° 09.6′N	116° 30.2′E	330	327	01h-00m	220.0
6	18Apr.1995	21° 05.5′N	116° 26.3′E	328	320	01h-00m	135.5

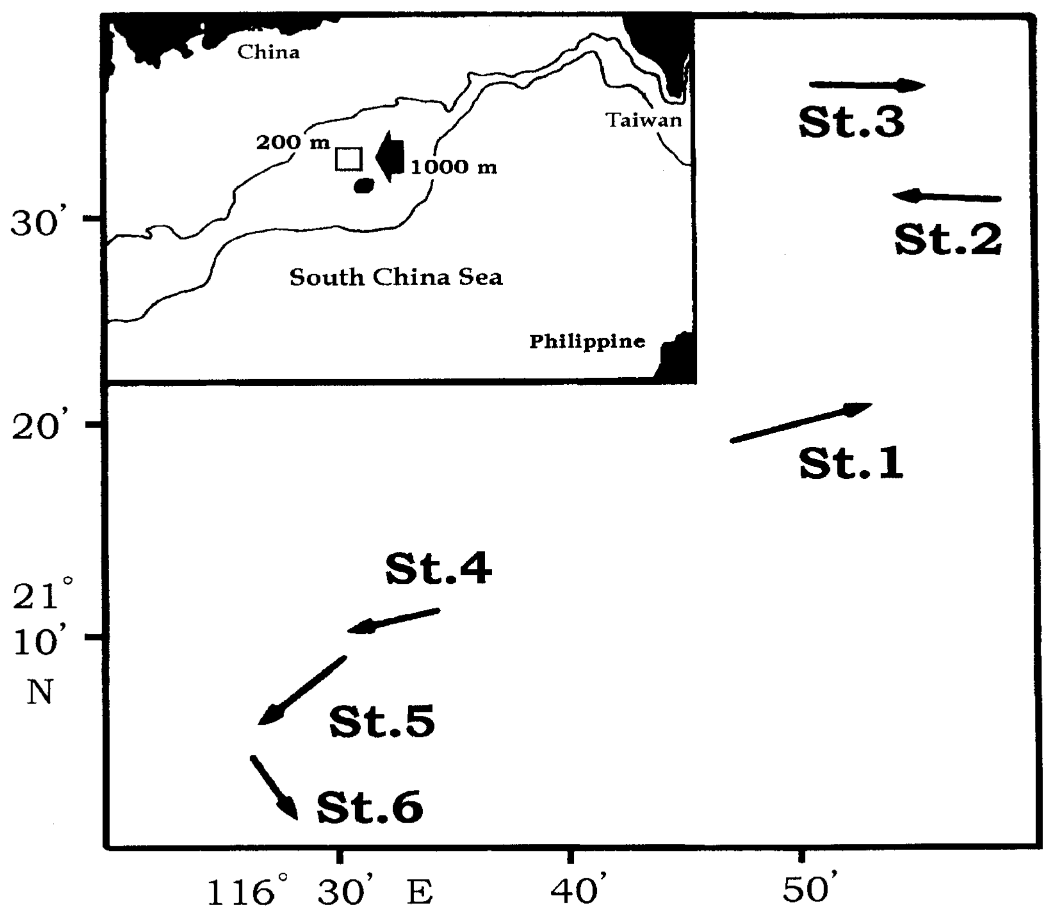

Fig. 1. Surveyed area, showing bottom trawl operating locations and their directions in north Tung-Sha Tao, 17-18 April 1995.

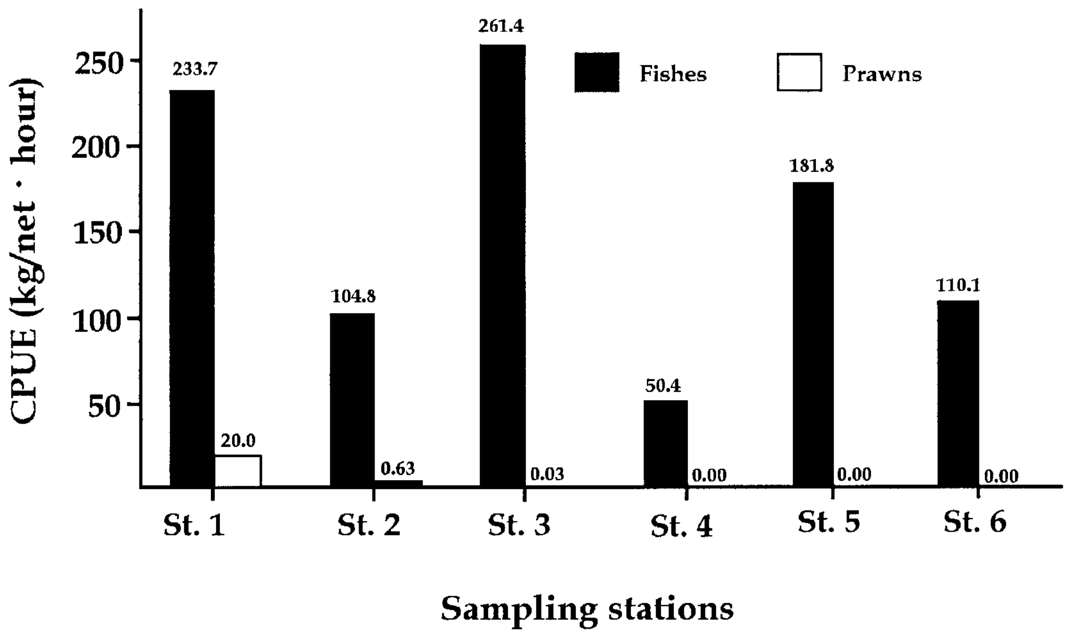

Fig. 2. The catch per unit effort (CPUE) of fish and prawn in 6 operation stations.

Table 2. The linear biomass of 11 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.	0.79	6.72	0.75	14.20	0.19	6.08
Cubiceps squamiceps	16.52	3.72	11.90	2.52	3.54	2.00
Ophisurus macrorhynchus	12.32	0.00	0.00	0.00	7.40	29.00
Pricanthus macracanthus	3.84	4.47	1.26	1.57	5.72	13.60
Diretmus argenteus	0.27	0.00	4.74	12.40	0.89	8.30
Chlorophthalmus albatrossis	4.06	0.77	9.26	3.36	7.06	5.82
Satryrichthys spp.	7.83	23.87	2.12	11.80	5.72	0.68
Rouleina spp.	4.78	0.00	17.60	0.00	0.00	0.00
Synagrops japonicus	0.33	0.00	1.32	6.16	24.50	2.40
Galeus spp.	0.00	0.00	30.25	4.88	1.74	0.00
Argentina spp.	0.00	0.00	0.00	13.20	8.22	0.00

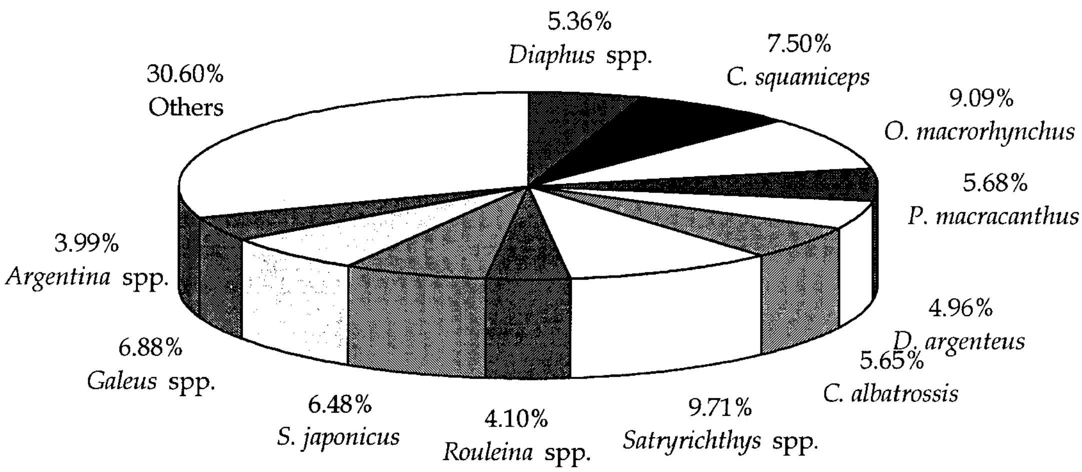

Fig. 3. Percentages of the major fish species collected by bottom trawler in north Tung-Sha Tao.

Eleven fish species and their linear biomass were recorded as major component (Table 2), and their weight constituted 69.4% of the total fish collected (Fig. 3). *Satryrichthys* spp. occupying 9.71% of the total specimens was the most dominant species, *O. macrorhynchus* the second. *Argentina* spp. consisting of 3.99% of total catches was the minimum in the 11 dominant species. The community structure and the occurrence of deep-water demersal fishes were greatly influenced by the depth layer and bottom topography [16,17]. Etter and Grassle[18] indicated that the characteristics of sedimentation has an important role in determining the number of species within a community. Lee and Lee[19] 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 almost two times of the sandy ones. The sea bottom sampled and analyzed in study region were found to be muddy (in station 1, 2, and 3) and sandy (in station 4, 5, and 6). Considering the relationship between types of sea bottom and the collection species, we found that only 3 prawn species, *Haliporoides sibogae, Plesionika* spp., and *Heterocarpus woodmasoni*, existed in sandy bottom, i.e., species *Heterocarpus woodmasoni* only recorded in station 1, *Plesionika* spp. in station 2 and 3, *Haliporoides sibogae* in station 1 and 2. For fish species, *Argentina* spp. existed in sandy bottom, species *Rouleina* spp. in muddy bottom.

Figure 4 shows that the diversity index value ranged between 0.995 and 1.060, and the value from sandy bottom is just a little bigger than that from muddy one. The term diversity is commonly used as a synonym for species richness. However, the number of species present in the community may differ with factors such as latitude, age of the community, its stability, and biological cycle[20,21]. Therefore, we may conclude that the diversity index values of different operation stations may be attributed to the types of sea bottom and the characteristics of sedimentation in the surveyed areas.

Analysis of variance on Shannon-Wiener's indices (H′) (weighted by the respective value of linear biomass) against surveyed stations with depths layer of 280-361 meters, I found that the regression coefficient was not significant ($p>0.05$) (Table 3). In addition to perennial darkness, most of the deep-sea is cold and season variations in temperature are very small[22]. Comparing with the linear biomass of 11 major species of fish (Table 2) and the number of the taxon of the sampling stations (Fig. 4), it was with the general belief that the categories of animals in this study region are more stable than those in any other pelagic or shallower water layer regions.

II. Cluster analysis

Eleven major fish species were classified into 2 groups (Fig. 5). Group 1 consisted of 2 species: *Rouleina* spp. and *Galeus* spp.. Group 2 consisted of 2 subgroups 2A and 2B. Subgroup 2A consisted of 5 species: *Diaphus* spp., *Diretmus argenteus, Argentina* spp., *Satryrichthys* spp., and *Synagrops japonicus.* Subgroup 2B consisted of 4 species: *Cubiceps squamiceps, Chlorophthamus albatrossis, Ophisurus macrorhynchus,* and *Pricanthus macracanthus.* Group 1 and 2 comprised 15.82% and 84.18% of the major specimens respectively. Based on the collected data, species of subgroup 2A and subgroup 2B exist at about the same depth layer of 280.0-361.0 m within 900 square miles. Since most of the species composition that exist in the depth layer overlapped, I suggest to combine the two subgroups into one group.

The analysis on station similarity based on 11 major species, two major groups were classified (Fig. 6). Group 1 contained stations 1, 6, 4, 5 and 2, which occured at depths of 326.0-361.0 m. Group 2 was formed by station 3 at depth of 280.0-289.0 m. By comparison of the station groups analysis, the dissimilarity of the station 3 was quite different from those of others, a transition layer of community might exist between station 2 and 3 (about 290.0-310.0 m depth layer). From the Shannon-Wiener index value H′ of 6 sampling stations, we found that they were close or equal to 1.0, it means that the number of taxon within 6 operation stations was collected at almost the same depths of 280.0-361.0 m. The result mentioned above also indicate that the community structure of the surveyed region was relatively stable.

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Table 3. Analysis of variance on Shannon-Wiener's indices of the stations with depths layer of 280-361 meters.

	SS	*DF*	*MS*	*F-ratio*
Treatment	0.000041	1	0.000041	0.019400
Error	0.008427	4	0.002106	
Total	0.008468	5		

p (0.895) >0.05.

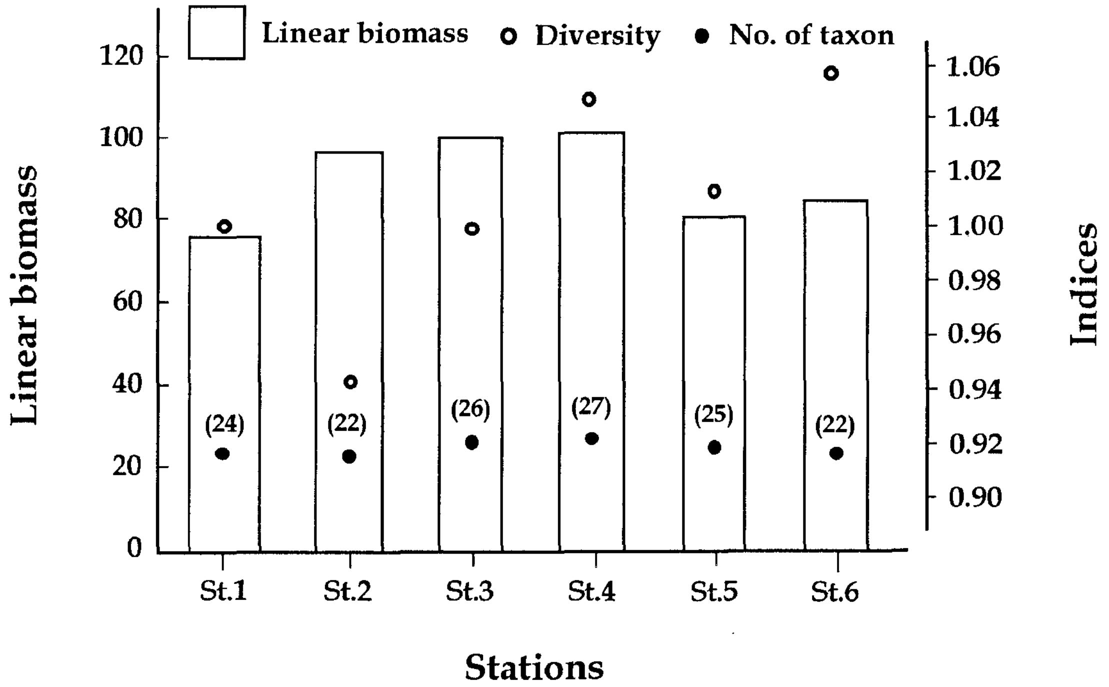

Fig. 4. Diagram shows the value of linear biomass, Shannon-Wiener's index, and number of taxon in 6 operation stations.

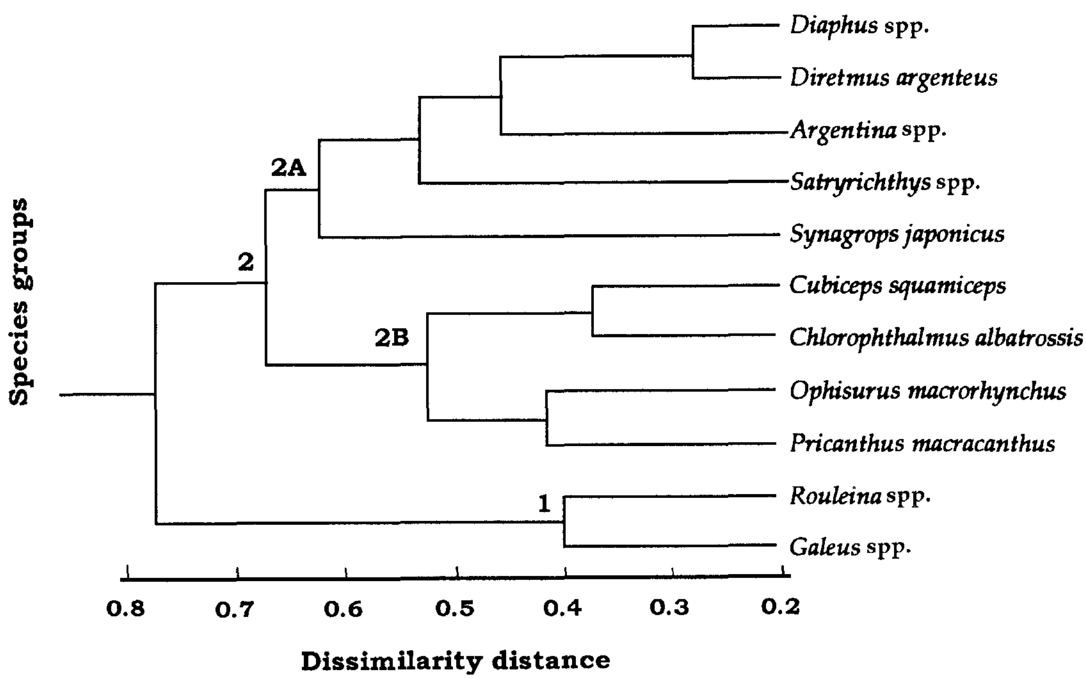

Fig. 5. Dendrogram of UPGMA cluster analysis, indicating the classification of 2 fish species groups from 6 sampling stations using a log-transformed value of fish species abundance.

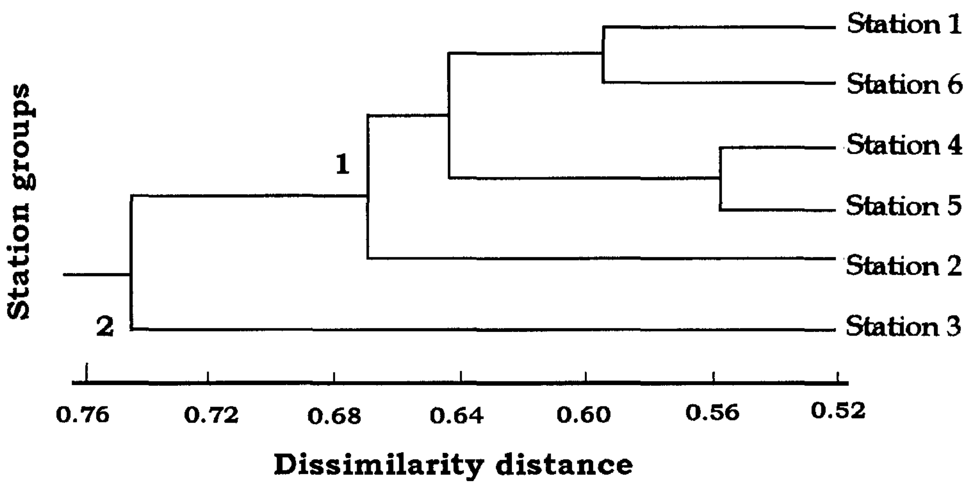

Fig. 6. Dendrogram of UPGMA cluster analysis, indicating the classification of 2 station groups (assemblages) from 6 sampling stations using a log-transformed value of fish species abundance.

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李嘉林
臺灣省水產試驗所 海洋漁業系
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以底拖網對東沙島北部底魚群社進行之一項研究

摘 要

爲瞭解東沙島北部小區域陸坡漁場之魚種組成及社群結構，1995 年 4 月 17 至 18 日間，於 21°00′N - 21°40′N，116°20′E - 117°00′E，水深 280 至 361 公尺海域，實施 6 網次底拖網漁撈試驗，漁獲種類 46 種。其中，魚類之線性生物量 (Linear biomass) 大於 20.0，且於兩測站或兩測站以上同時出現者，計有主要魚種 11 種，約佔總漁獲量的 69.4%。捕獲的 3 種蝦類約佔總漁獲量的 5.37%。調查結果：(1)各測站之夏農・魏能 (Shannon-Wiener) 歧異度指數與各測站無顯著的差異。(2)以社群分析調查各測站結果，主要魚種組成大致可區分爲 2 個群社。依魚種別之對數線性生物量亦可將所調查測站區分爲 2 個群社。

關鍵字：底棲魚類，魚種組成，歧異度，東沙島

李嘉林 (1995) 以底拖網對東沙島北部底魚群社進行之一項研究.
水產研究, **3**(1): 1-10.