Preliminary Analysis of the Demersal Fish Assemblages in the Bangladesh waters of the Bay of Bengal

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Abstract

This paper presents the results of analyses of the demersal fish assemblages in Bangladesh waters of the Bay of Bengal. Catch data from three trawl survey cruises from January to February 1985 covering 135 stations were utilized for community structure analysis using TWINSPAN and DCA techniques. Both techniques separated the deepwater stations (> 90 m) from the shallow areas (< 90 m). The shallow regions had the most species and the dominant ones included *Nemipterus japonicus, Lepturacanthus savala, Pennahia* spp.*, Pentaprion longimanus, Upeneus* spp.*, Arius* spp.*, Pomadasys maculatus, Thryssa brevirostris, Leiognathus bindus, Rastrelliger kanagurta, Leiognathus* spp. and *Upeneus sulphureus.* Dominant species in deeper regions were *Priacanthus hamrur, Priacanthus* spp.*, Johinus* spp.*, Saurida elongata* and *Nemipterus* spp.

Introduction

The fishery sector in Bangladesh plays a vital role in meeting the protein demand, employment opportunity and foreign exchange earnings of the country. Bangladesh declared its 200 nautical mile (nm) Exclusive Economic Zone (EEZ) in 1974, and as a result an area of more than 166 000 km^2 is now under the economic jurisdiction of the country for exploration, exploitation, conservation and management of its fisheries resources.

The continental shelf (between 0 to 200 m depth) of Bangladesh is relatively wide, covering about 66 400 km^2, of which 24 000 km^2 is less than 10 m depth (Chowdhury et al. 1979; Rashid 1983; Shahidullah 1986; White and Khan 1985). The average depth of the Bay of Bengal within Bangladesh territorial limits is about 10 m (Mahmood 1977). There are four major fishing grounds in the bay (i.e. South Patches, South of South Patches, Middling and Swatch of No Ground). The "South Patches" and "Southwest of South Patches" cover the most extensive area (i.e. 6 200 km^2) of the major fishing grounds (Shahidullah 1983).

Limited information about the intensity of fishing pressure and the status of exploitation of the coastal resources of Bangladesh is available (Chowdhury et al. 1979; Hussain et al. 1972; Khan et al. 1989; Khan et al. 1983; Mustafa 1994; Mustafa 1999; Mustafa and Khan 1993; Mustafa et al. 1987; Mustafa et al. 1996; Rashid 1983). However, several resource surveys have been carried out in Bangladesh waters and these reported that the fisheries resources were still abundant (Hussain et al. 1972; Khan et al. 1989; Khan et al. 1983; Lamboeuf 1987; Mustafa and Khan 1993; Mustafa et al. 1987;

Mustafa et al. 1996; Rashid 1983; White and Khan 1985).

A multi-species, multi-gear fishery exploits the traditional fishing grounds in Bangladesh waters. Among the capture fisheries activities trawl fishing is the most effective and profitable gear, with two types of trawl gear operating. These are the pair boom trawl for shrimp (in this paper referred to as "shrimp trawler") and stern trawl for fish (referred to as "fish trawler"). At present there are 41 shrimp trawlers and 15 fish trawlers operating in the trawlable grounds off Bangladesh. Research surveys (Lamboeuf 1987; Mustafa and Khan 1993; Mustafa et al. 1987) provide an indication of the catch composition of the shrimp and fish trawls, with 58 fish and shrimp taxa recorded (Table 1). A number of species dominated the fish trawl catch. As expected, catch composition from shrimp trawls consisted mainly of shrimp species.

The present study looked at the distribution pattern of demersal species assemblages based on the research trawl surveys. Specifically the study aimed to describe; (1) the composition of the species assemblages; (2) the delineation of assemblage boundaries or potential fishing zones; and (3) the relationship of the assemblages to environmental parameters.

Material and Methods

Trawl Surveys

The Bangladesh Marine Fisheries Survey Management and Development Project conducted an exploratory demersal fishing survey in the offshore waters of the Bay of Bengal between September 1984 and December 1986 (Table 2, see also Khan et al. this vol.). The survey area extended from the 10 m depth contour in the north and east to the 200 m depth contour in the south. A line drawn at 45°(from the southern tip of St. Martin Island was considered to approximate the Bangladesh/Burmese marine border in the southeast. The area in the west portion of the survey area extended to the Bangladesh/Indian marine border, but in practice no trawling was conducted west of the eastern edge of the "Swatch of No Ground" (Fig 1.).

Different sampling methodologies were applied by the different surveys in the waters within the Bangladesh EEZ. These included blocked designed surveys, line, random and stratified random surveys. The present study only utilized data obtained from surveys using stratified random sampling, where the position of the sampling stations was randomly selected within depth strata. Five depth strata were applied, 10 - 20 m, 20 - 50 m, 50 - 80 m, 80 - 100 m and 100 - 200 m. However, only four depth strata were sampled for most of the surveys, as the 100 - 200 m depth zone was composed of strips of deeper zones that were difficult to trawl. A total of 626 trawl stations were surveyed using the random stratified sampling technique (Table 3). The depth zone between 80 and 100 m had the highest number of stations occupied while the depth zone > 100 m comprised few sampling stations. Table 4 shows the distribution of trawl stations across sampling seasons and years.

The survey vessel (R.V. Anusandhani) is a 32.4 m multipurpose research vessel, principally designed for stern trawling, constructed in Japan in 1979 and used for resource surveys since 1983. The trawl net used was an Engel high-opening fish trawl with a cod-end mesh size of 32 mm. The distance between the wings was estimated to be 2.5m as measured by the net-sounder and the footrope was equipped with a 30 cm diameter rubber float. The technical specifications of the vessel and trawl gear are described in (Lamboeuf 1987).

All hauls were 30 minute duration, time started when the net reached the bottom and ended as soon as hauling commenced as determined by the net-sounder. If trawl fishing was disrupted within 15 minutes of dragging, the haul was considered invalid and the results were discarded. The procedures used in the surveys followed (Pauly 1983). The catch was sorted to species level whenever possible, and then taxa weighed to the nearest 0.25 kg. When a catch exceeded 500 kg, it was divided into two equal portions and one was sorted and the final results then doubled.

Table 1. Percentage catch composition of shrimp and fish trawls using R.V. Anusandhani (Mustafa 1999).

Taxa		Shrimp trawl	Fish trawl
Croakers, Jewfishes	Sciaenidae	16.36	11.58
Threadfin bream	Nemipteridae	14.07	10.16
Trash fish		12.62	6.27
Catfish	Aridae	8.00	12.21
Lizardfish	Synodontidae	5.75	4.37
Jacks, Scads	Carangidae	5.61	4.76
Goatfish	Mullidae	4.41	4.84
Shrimps		3.69	1.82
Rays		3.11	3.64
Bombay duck	Harpadon nehereus	2.67	1.47
Grunter	Terapontidae	2.16	2.44
Cuttlefish, squids	Cephalopodae	2.08	1.54
Scalts		1.92	0.00
Silver biddis	Gerreidae	1.88	1.71
Ponyfish	Leiognathidae	1.87	3.58
Sardines, Shads	Clupeidae	1.79	3.43
Crustaceans		1.25	0.42
Tongue sole	Cynoglossidae	1.09	0.19
Bullseyes	Priacanthidae	1.04	2.31
Sharks		1.01	0.84
Tripoid fishes	Triacanthidae	0.90	0.98
Hairtails	Trichiuridae	0.88	4.42
Indian halibuts	Psettodidae	0.69	0.15
Shark and Rays		0.60	0.32
Drift fishes	Centrolophidae	0.60	0.81
Pike conger	Muraenesocidae	0.54	0.21
Mackerels/Tuna	Scombridae	0.40	5.99
Barracuda	Sphyrnidae	0.35	0.82
Pomfrets	Bramidae	0.31	1.95
Pufferfish	Tetraodontidae	0.30	0.25
Threadfins	Polynemidae	0.25	0.29
Sicklefish	Drepaenidae	0.23	0.21
Snappers	Lutjanidae	0.22	1.20
False trevallies	Lactariidae	0.20	0.68
Cardinal fish	Apogonidae	0.19	0.28
Lefteye flounders	Bothidae	0.13	0.08
Groupers	Serranidae	0.13	0.15
Cornet fish	Aulostomidae	0.11	0.14
Anchovies	Engraulidae	0.11	1.67
Spade fish	Ephippidae	0.10	0.10
Tenpounders	Elopidae	0.09	0.26
Mixed fish		0.08	0.18
Seabreams	Sparidae	0.06	0.14
Therapons	Teraponidae	0.05	0.29
Cobias	Rachycentridae	0.05	0.05
Sillaginidae		0.02	0.02
Wolf-herring	Chirocentridae	0.01	0.22
Tiggerfish	Diadontidae	0.01	0.02
Moonfish	Monodactylidae	0.00	0.40
Sharksuckers	Echeneidae	0.00	0.01
Scorpionfish	Scorpaenidae	0.00	0.05
Grey mullets	Mugilidae	0.00	0.01
Flying fish	Exocoetidae	0.00	0.04
Flatheads	Platycephalidae	0.00	0.01

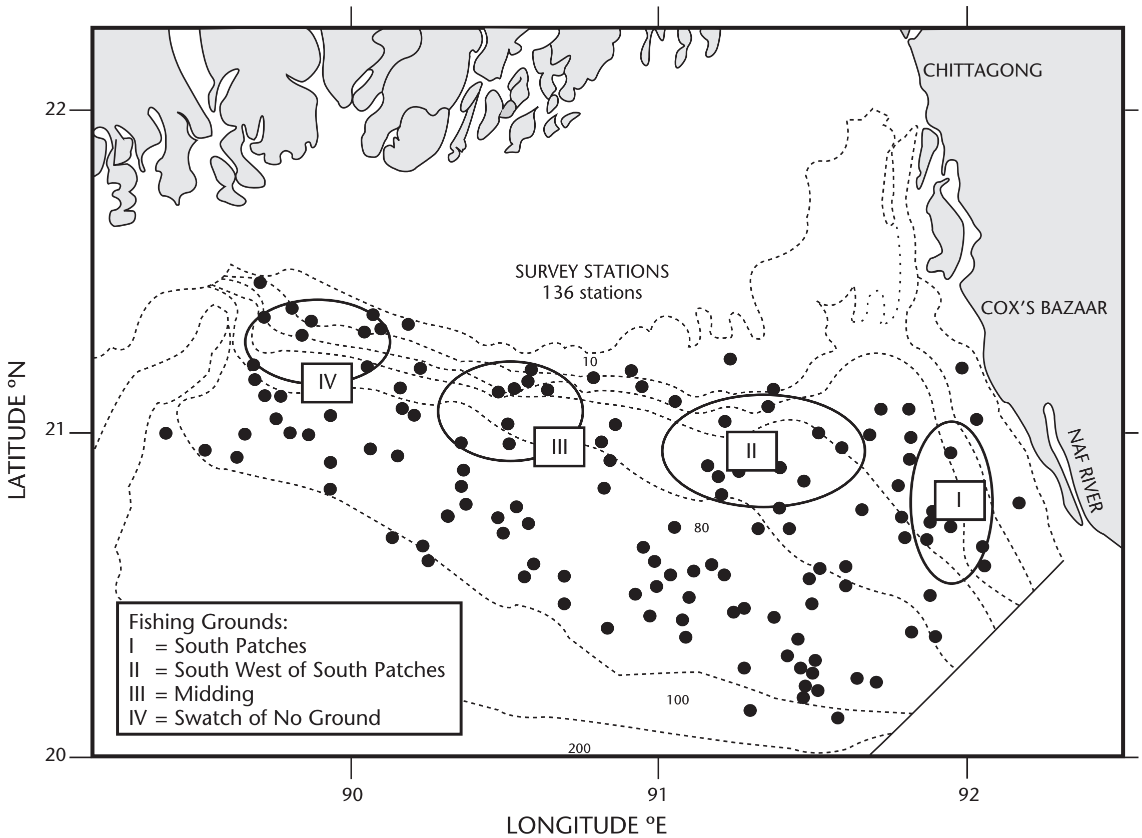

Fig. 1. Map of the survey areas within the Bangladesh EEZ, indicating the trawl fishing stations.

Data Analysis

Catch composition data were collected from the Marine Fisheries Survey Management Unit, Agrabad, Chittagong. Survey cruises were conducted by R.V. Anusandhani from January to February 1985 for this study. A total of 3 fish trawl cruises were utilized comprising 135 stations (Table 4) to examine the spatial distribution of the species assemblages using multivariate techniques.

Following the analysis of the demersal assemblages on the coast of several tropical areas, viz, the Pacific coast of Central America (Bianchi 1991), Angola (Bianchi 1992a) and Congo-Gabon (Bianchi 1992b), Detrended Correspondence Analysis (DCA) (Gauch 1982) and Two-way Indicator Species Analysis (TWIA) (Hill 1979) were used in this study.

TWIA (Hill 1979) is a classification technique implemented by the program TWINSPAN, while DCA (Hill and Gauch 1980) is an ordination method included in the program package of CANOCO. TWIA is a divisive clustering method that classifies sites and species and produces a sorted species-by-station table, showing hierarchical classification in a binary notation. Input data were catches from trawl surveys, i.e. stations vs. species matrices containing catches in terms of weight per standard haul of each species. Since expressing abundance on relatively crude scales retains much of the quantitative information, the original abundance values are re-scaled in TWINSPAN by defining "pseudospecies" cut levels (Hill, 1979). Five abundance cut levels were used to define pseudospecies corresponding to classes with lower limits set at 0, 2, 5, 10 and 20 kg. As recommended (Hill 1979), the class limits were set to suit the observed range of the catches without over-weighting the effect of dominance. The catch of individual species in surveys varied between 0 and 999 kg.

Table 2. Fish trawl cruises from September 1984 to December 1986.

Cruise No.	Data/Duration	Valid Hauls
1	15 - 25 September 1984	42
2	03 - 13 October 1984	45
3	20 - 30 October 1984	43
4	09 - 19 November 1984	44
5	27 November - 05 December 1984	40
6	13 - 20 December 1984	41
8*	06 - 16 January 1985	46
9*	31 January - 11 February 1985	49
10*	17 - 24 February 1985	40
12	19 - 24 May 1985	13
13	12 - 17 July 1985	13
14	21 - 24 August 1985	1
15	28 September - 06 October 1985	15
16	22 - 31 December 1985	35
20	25 January - 04 February 1986	41
22	02 - 11 March 1986	31
24	02 - 11 April 1986	22
26	12 - 21 May 1986	25
27	1- 4 June 1986	7
30	02 - 04 December & 15 - 21 December 1986	26

Note: * cruises covered in the analysis for this study

Table 3. The distribution of trawl stations by depth, from the trawl surveys conducted by RV Anusandhani (1984 - 86), Cruise No. refers to Table 2.

Cruise No.	Number of stations by depth zone (m)				
	10 - 20	20 - 50	50 - 80	80 -100	>100
1	10	10	7	15	0
2	2	7	13	21	2
3	6	9	9	17	2
4	3	6	10	24	1
5	6	7	8	16	3
6	2	9	11	16	3
8	7	8	8	19	4
9	6	10	10	19	4
10	0	8	3	29	0
12	3	4	3	3	0
13	4	8	1	0	0
14	0	1	0	0	0
15	0	6	7	2	0
16	4	8	5	11	7
20	2	10	9	16	4
22	3	14	7	6	1
24	0	4	5	7	6
26	2	14	10	6	0
27	0	4	3	0	0
30	0	5	12	9	0
TOTAL	60	152	141	236	37

Table 4. Depth distributions of trawl stations of the surveys conducted by the R.V. Anusandhani in 1985.

Cruise No.	Data/Duration	Valid stations by depth zone (M)					Total
		10 - 20	20 - 50	50 - 80	80 - 100	> 100	
8	06 - 16 January	7	8	8	19	4	46
9	31 January - 11 February	6	10	10	19	4	49
10	17 - 24 February	0	8	3	29	0	40
	TOTAL	13	26	21	67	8	135

DCA is an ordination method based on the abundance values of the species. The program CANOCO was used to run DCA, the input was catches in terms of weight, and detrending by second order polynomials was applied. All species were given equal weight in the analysis. The method does not assume linear relationships between species abundance and environmental variables and thus is considered particularly useful in ecological studies (Ter Braak 1990). Both TWINSPAN and DCA are based on correspondence analysis hence it is possible to compare the results directly. (Bianchi 1991) has discussed the detailed methods and their suitability to this type of study.

The DCA analysis enables the relationship between the patterns observed and environmental variables to be examined. In the current analysis the Spearman rank correlations between the station scores on the DCA Axes and depth were examined.

Results and Discussion

The classification results from TWINSPAN show the clusters of stations among the 135 fish trawl stations from the survey during 1985 (Fig 1). The first division separated the major shallow water stations (A) from the deep area stations (B). The geographical distribution of the stations between the two groups is shown in Fig. 2.

The DCA results in which data for 135 stations were included, showed similar patterns to those revealed by TWINSPAN output, but DCA provides information on variation in several dimensions. The eigenvalues of the four axis in DCA were 0.859, 0.727, 0.702 and 0.539 respectively. Eigenvalues are measures of importance of the corresponding axis, and typically values above 0.5 reflect good separation of the stations along that axis (Jongman et al. 1987). Thus all four axes in this

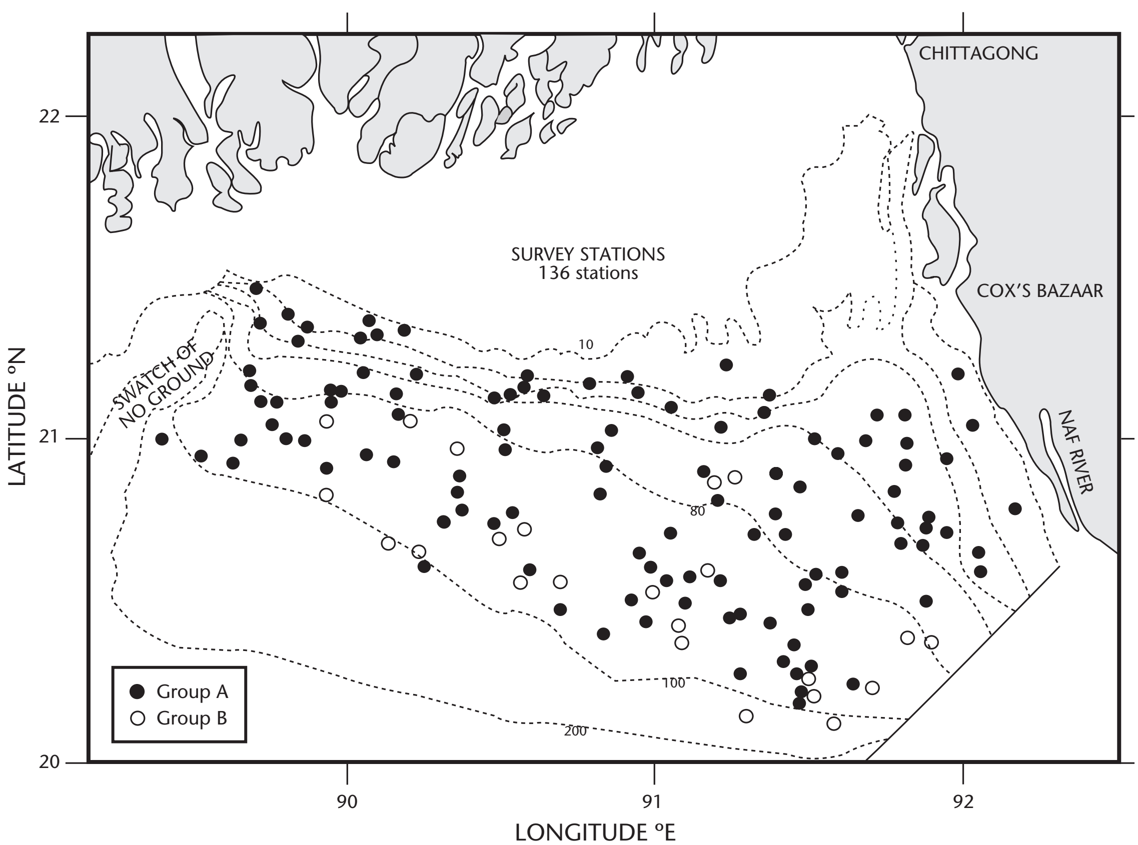

Fig. 2. Spatial distribution of trawl stations based on the classification analysis using TWINSPAN .

analysis were likely to reveal ecologically significant information. The DCA plot in Fig 3. shows the distribution of TWINSPAN groups stations according to their scores on Axis-1 and Axis-2. Axis-1 represented essentially a depth gradient (Spearman rank order correlation of station scores on Axis-1 and depth). For DCA plot station clusters were grouped as A and B, based on the TWINSPAN analysis. Group A stations are associated with shallow water areas less than 90 m in depth, while Group B stations belong to deeper areas more than 90 m in depth. However other environmental factors, e.g. salinity may also affect spatial distribution patterns, this may explain the overlap of station distribution between 80 to 100 m depth (see Fig. 2).

The DCA plot for 74 species is shown in Fig. 3. Species forming clusters were grouped as A and B. In the DCA plot, major species within group A include *Nemipterus japonicus, Lepturacanthus savala, Pennahia* spp., *Pentaprion longimanus*, *Upeneus* spp., *Arius* spp., *Pomadasys maculatus, Triacathus brevirostris, Leiognathus bindus, Rastrelliger kanagurta, Leiognathus spp.* and *Upeneus sulphureus*. Species within group B were *Penaedae, Priacanthus hamrus, Priacanthus* spp., *Johinus* spp., *Saurida elongata* and *Nemipterus* spp. Species distributions within groups (A and B) and their percentage composition are presented in Table 5. Further analysis of the data needs to be undertaken to determine the environment factors that influence these species assemblages.

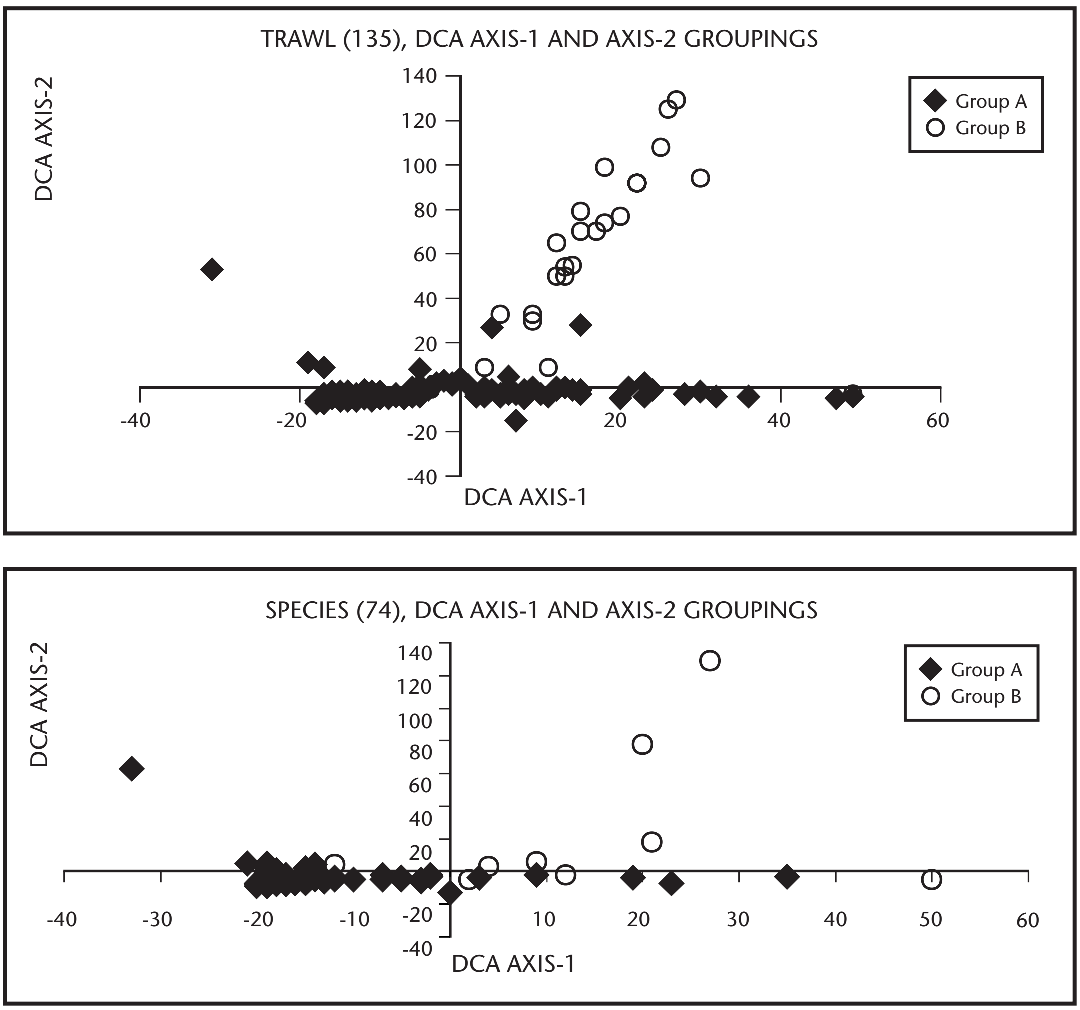

Fig. 3. Ordination plots generated from DCA of 135 stations and 74 species from three survey cruises, the Group A and B are from the TWINSPAN analysis (see fig. 2.).

Table 5. Relative abundance (%) of the dominant taxa within the groups identified by the TWINSPAN and DCA ordination of 135 trawl stations in the Bay of Bengal.

Group A				Group B			
Group A1		Group A2		Group B1		Group B2	
Taxa	%	Taxa	%	Taxa	%	Taxa	%
Nemipterus japonicus	5.79	*Arius* spp.	12.07	*Priacanthus hamrur*	1.50	*Nemipterus* spp.	19.58
Trash fish	4.76	*Pomadasys maculatus*	3.88	Penaedae	1.26	*Johnious* spp.	4.34
Lepturacanthus savala	2.70	*Rastrelliger kanagurta*	2.61	Other crustaceans	0.89	*Priacanthus* spp.	2.69
Rays	0.85	*Triacathidus brevirostris*	2.54	*Decapterus kurroides*	0.25	*Saurida elongata*	1.59
Sciaenidae	0.79	*Upeneus sulphureus*	2.38			*Saurida undusquamis*	0.93
Apogon spp.	0.29	*Pennahia* spp.	2.08			*Parakuhlia macrophtalmus*	0.38
Decapterus spp.	0.24	*Upeneus* spp.	2.08				
Crabs	0.21	*Pentaprion longimanus*	1.97				
Cynoglossus spp.	0.19	*Leiognathus* spp.	1.51				
Argyrops spinifer	0.16	*Setipinna taty*	0.99				
Arioma indica	0.10	*Decapterus maruadsi*	0.98				
Decapterus macrosoma	0.07	*Sphyraena forsteri*	0.88				
Muraenesox spp.	0.07	*Parastromateus niger*	0.87				
Rastelliger spp.	0.04	Cuttlefish	0.85				
		Pampus argenteus	0.79				
		Metapeneaus monoceros	0.78				
		Pomadasys hasta	0.75				
		Tetradontidae	0.73				
		Megalaspis cordyla	0.69				
		Ilisha megaloptera	0.61				
		Terapon jarbua	0.55				
		Protonibea spp.	0.43				
		Atropus atropus	0.43				
		Lutjanus johni	0.41				
		Triacanthus spp.	0.41				

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