Characteristics of an Exploited Tropical Shallow-Water Demersal Fish Community in Malaysia

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Abstract

Trawling provided insights into the characteristics of an exploited tropical shallow-water demersal fish community. A total of 6,565 fish specimens weighing 285 kg were caught at 20 sampling stations. In all, 139 species belonging to 50 families were recorded. The major families ranked by weight were Dasyatidae (19.7%), Synodontidae (18.3%), Paralichthyidae (8.9%), Dactylopteridae (8%), Nemipteridae (5.3%), Lagocephalidae (5.2%), Priacanthidae (5%); and Mullidae (4%). The overall fish trawled consisted of 53% food fish and 47% trash fish. The demersal fish community could be partitioned into four trophic groups, i.e., large zoobenthos feeders, intermediate predators, small demersal zoobenthos feeders and small demersal zooplankton feeders. Small crustaceans played an important role as food resources for all the trophic groups. They were the major food for small demersal zoobenthos feeders, the dominant group, and large zoobenthos feeders. Analysis of growth characteristics of ten common species using length-frequency data showed that *Saurida elongata* and *Trachinocephalus myops* (Synodontidae) and *Dactyloptena orientalis* (Dactylopteridae) had higher growth rates than the other fishes in the community. Exploitation rates of these three species by trawlers were also high although they have little commercial value. Annual recruitment patterns for the demersal fishes were generally protracted showing a single pulse, although some species have a second minor pulse.

Introduction

The management of tropical multispecies fisheries has long been seen as a challenge to fishery scientists. The constraints are numerous and well-defined (Pauly 1979; Marr 1982). Among some of the obvious constraints are lack of theory and databases. Larkin (1982) outlined the requirements for research ranging from basic data collection to development of theory applicable to multispecies tropical fisheries.

This study was designed to provide insights into the characteristics of an exploited demersal fish community. It had three major objectives: a) to provide information on the composition of the fish stocks; b) to determine the food habits among the demersal fishes; and c) to characterize the growth rates, exploitation rates and annual recruitment patterns for the common species.

Materials and Methods

Data were obtained through a trawling program conducted within 12 km off the coastline of Terengganu, Malaysia, where the depth of the water did not exceed 20 m (Fig. 1). This area is suitable for trawling with respect to bottom characteristics (medium coarse to fine sand with some muddy patches) and is intensively exploited by small commercial trawlers and purse seiners below 40 gross tons and by artisanal fishermen.

Trawling was conducted using an otter trawl net with an effective wing-span of 6 m and a cod-end mesh size of 38.1 mm. Trawling was maintained for approximately 60 min. at a tow speed of 2.3-2.4 knots. A total of 20 sampling stations were covered in six trawl operations conducted between July 1984 and April 1985 (Table 1 and Fig. 1). Trawling was suspended during the northeast monsoon from November to March.

Each haul was sorted to species and weighed. Samples for stomach content analysis were immediately preserved in 8% buffered formalin. Qualitative analysis of the stomach contents for the species caught enabled them to be partitioned into general feeding groups. Representative species from each group were also taken for quantitative stomach content analysis using the gravimetric method. Food groups in the stomachs were categorized as 1, intermediate predators; 2, pelagic fish; 3, small demersal zoobenthos feeders; 4, small demersal zooplankton feeders; 5, heterotrophic benthos (octopus, cuttlefish and echinoderms); 6, large crustaceans; 7, small crustaceans; 8, small molluscs and worms; 9, meiobenthos; and 10, zooplankton.

Length-frequency data were also recorded for ten common species. ELEFAN I and ELEFAN II programs described by Ingles and Pauly (1984) were used to estimate growth parameters (L_∞ and K), mortality (total mortality, Z; fishing mortality, F; and natural mortality, M), exploitation rates (E), length at first capture (L_c) and annual recruitment patterns.

Results and Discussion

The trawl data are shown in Table 1. In all; 6,565 specimens weighing 285 kg were obtained. The overall percentage contribution of food fish (53% by weight) was comparable to that of trash fish (47% by weight). These figures, although vastly different from values in one report (Anon. 1967), do not differ much from figures given by Pathansali et al. (1974), Jothy et al. (1975) and Lam et al. (1975) from research trawl surveys conducted in waters 10-20 m deep off the coast of Terengganu. However, the percentage contribution of food fish may be grossly overestimated since many of the food species caught were composed of small fish.

Of the 139 species belonging to 50 families recorded, 75 were food fishes. The most abundant species by weight were *Dasyatis zugei* (15.4%), *Saurida elongata* (10.2%), *Dactyloptena orientalis* (8%), *Trachinocephalus myops* (7.8%), *Pseudorhombus javanicus* (5.9%) and *Priacanthus tayenus* (5%) (Table 2). The families are listed by weight in Table 3.

In a virgin stock before the introduction of trawling, Leiognathidae and rays (Dasyatidae included) were the two most abundant food fish families followed by Tachysuridae, Carangidae, Nemipteridae and Pomadasyidae (Anon. 1967). Data from this study, which reflect the effects of 18 years of trawling, show certain deviations from the composition of a virgin stock. While Dasyatidae still dominates in biomass, Leiognathidae had decreased significantly, presently contributing only 2.78% of the total biomass, compared to 12.79% in a virgin stock. Pauly (1979) similarly found sharp declines in the abundance of Leiognathidae as a result of trawling. Trash fish families, Synodontidae, Paralichthyidae, Dactylopteridae and Lagocephalidae seem to feature significantly in an intensively exploited stock while important food fish groups include Nemipteridae, Priacanthidae, Mullidae and Carangidae.

Qualitative stomach content analysis showed that the demersal species could be conveniently grouped into four feeding levels. These were large zoobenthos feeders (6 species), intermediate predators (29 species), small demersal zoobenthos feeders (81 species) and small demersal zooplankton feeders (8 species).

Food composition data for large zoobenthos feeders were obtained for three species, i.e., *Dasyatis uarnak, D. zugei* and *Drepane punctata* (Table 4). Small crustaceans featured as the major food group, making 66.4% of the diet by weight, followed by large crustaceans (26.3%), small molluscs and worms (7%) and heterotrophic benthos (0.3%).

The food groups of intermediate predators are shown in Table 5. Small demersal zoobenthos feeders constituted the most important food group (76.5%) followed by small demersal zooplankton feeders (8.4%), large crustaceans (7.7%) and small crustaceans (4.3%). Pelagic fish, intermediate predators and heterotrophic benthos contributed only minimally to the food items.

The most important food group for small demersal zoobenthos feeders was small crustaceans which contributed about 53.6% of the diet, followed by heterotrophic benthos (15.4%), small molluscs and worms (11.5%), large crustaceans (9.9%) and small demersal zooplankton feeders (5.7%). Small pelagic fish and small demersal zoobenthos feeders were found only in the stomachs of *Priacanthus tayenus* and *Nemipterus* spp. and played a minor role as a food group (Table 6).

Only three species of small demersal zooplankton feeders were included for stomach content analysis (Table 7). These fed only on a small range of food groups, i.e., small crustaceans, small molluscs and worms and zooplankton. *Daya jerdoni* and *Centriscus scuttatus* fed exclusively on zooplankton while *Pentaprion longimana* fed on small crustaceans and small molluscs and worms as well, but retaining zooplankton as the major food group. The overall food composition ratios are shown in Table 7.

Many species showed trophic similarities suggesting a certain degree of competition on the same food groups. Competition for the same food groups occurred within the same feeding level as well as between different feeding levels. Small crustaceans seem to play a major role as a food resource and were found in the stomachs of most of the demersal fish present. They also constituted the major food group for small demersal zoobenthos feeders and large zoobenthos feeders which made up 95% of the total biomass of the demersal fish present. The most abundant feeding group, i.e., small demersal zoobenthos feeders contributed largely to the food of intermediate predators and would account for the relative abundance of the latter (45% of the total biomass). Hacunda (1981) similarly found crustaceans to be the major prey group in all demersal predators present in a coastal area of the Gulf of Maine and concluded that predators rely on the same major food sources. He also provided data to show that trophic partitioning by prey size occurred and this would help reduce intense competition on similar food groups. Differences in daily, seasonal and spatial patterns of feeding could provide another means of reducing interspecific competition. Keast (1973) found that food overlap occurs when a particular food resource becomes superabundant. This could be the case for small crustaceans in the shallow-water habitats off Terengganu.

A summary of the growth parameters, mortality rates, exploitation rates and annual recruitment patterns of 10 common species caught are given in Table 8. Higher growth rates, as indicated by the growth coefficient, k, were observed in *Saurida elongata, Trachinocephalus myops, Dactyloptena orientalis* and *Gastrophysus*

scleratus than in *Priacanthus tayenus, Leiognathus elongatus* and *Daya jerdoni*. Exploitation rates were also high for *Saurida elongata, Trachnicephalus myops* and *Dactyloptena orientalis* although these fishes have little commercial value. Annual recruitment patterns for the demersal fishes analyzed are shown in Fig. 2. Recruitment patterns were generally protracted, showing a single pulse as in *Upeneus sulphureus, Gastrophysus scleratus, Saurida elongata, Trachinocephalus myops* and *Pseudorhombus javanicus*. However, *Pentaprion longimana* had a second pulse, similar to that reported by Ingles and Pauly (1984) for this species in the Philippines.

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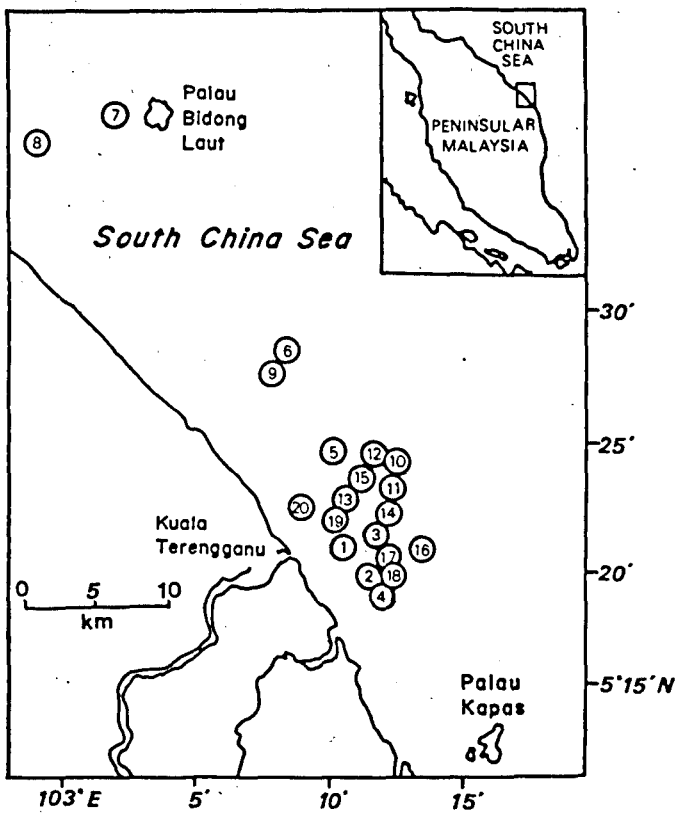

Fig. 1. Study area showing the location of sampling stations.

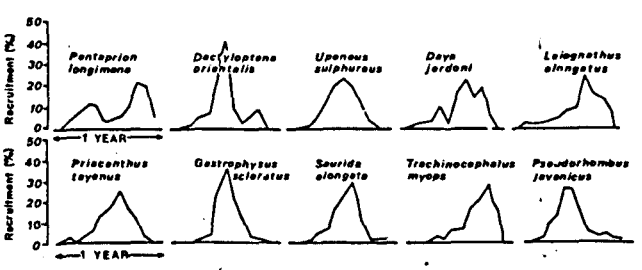

Fig. 2. Annual recruitment patterns for common demersal fish.

Table 1. Summary of trawl data, Terengganu, Malaysia, July 1984-April 1985.

Station	Sampling date	Total wt. of fish (g)	Total no. of fish	Food fish % by no.	Food fish % by wt.	Trash fish % by no.	Trash fish % by wt.
01	22.07.84	2,176	103	77	43	23	57
02	22.07.84	28,136	830	43	49	57	51
03	16.08.84	36,504	841	67	66	33	34
04	16.08.84	22,336	606	63	45	37	55
05	23.08.84	23,831	393	44	56	56	44
06	23.08.84	6,900	388	5	3	95	97
07	23.08.84	16,138	35	20	82	80	18
08	23.08.84	1,870	129	30	54	70	46
09	17.09.84	6,109	124	1	1	99	99
10	17.09.84	34,135	831	18	15	82	85
11	17.09.84	15,739	406	24	33	76	67
12	17.09.84	12,090	284	26	16	74	85
13	22.10.84	9,587	346	64	51	36	49
14	22.10.84	1,810	52	83	79	17	21
15	07.04.85	19,453	58	47	92	53	8
16	07.04.85	2,226	122	14	20	86	80
17	07.04.85	14,707	108	56	92	44	8
18	07.04.85	4,818	251	52	63	48	37
19	07.04.85	8,788	225	52	75	48	25
20	07.04.85	17,749	435	69	78	31	22
Total		284,897	6,565	mean = 44	mean = 53	mean = 56	mean = 47

Table 2. Major species caught by demersal trawls listed in descending order by weight.

Species	Family	Weight (g)	% by wt.
Dasyatis zugei	Dasyatidae	43,900	15.41
Saurida elongata	Synodontidae	28,942	10.16
Dactyloptena orientalis	Dactylopteridae	22,890	8.03
Trachinocephalus myops	Synodontidae	22,343	7.84
Pseudorhombus javanicus	Paralichthyidae	16,820	5.90
Priacanthus tayenus	Priacanthidae	14,358	5.04
Gastrophysus sclieratus	Lagocephalidae	9,724	3.41
Dasyatis sp.	Dasyatidae	9,000	3.16
Upeneus sulphureus	Mullidae	6,887	2.42
Arius thalassinus	Ariidae	4,970	1.75
Daya jerdoni	Pomacentridae	4,622	1.62
Carangoides malabaricus	Carangidae	4,279	1.50
Leiognathus elongatus	Leiognathidae	4,038	1.42
Pseudorhombus sp.	Paralichthyidae	4,038	1.42
Scolopsis taeniopterus	Nemipteridae	3,800	1.33
Gastrophysus spadiceus	Lagocephalidae	3,600	1.26
Drepane punctata	Drepanidae	3,315	1.16
Gymnocranius griseus	Pentapodidae	3,135	1.10
Sphyraena sp.	Sphyraenidae	3,100	1.09
Dasyatis uarnak	Dasyatidae	2,910	1.02

Table 3. Fish families in the demersal trawls listed according to weight.

Family	Weight (g)	% by weight
Dasyatidae	56,170	19.715
Synodontidae	52,039	18.266
Paralichthyidae	25,438	8.928
Dactylopteridae	22,890	8.034
Nemipteridae	15,038	5.278
Lagocephalidae	14,734	5.171
Priacanthidae	14,368	5.043
Mullidae	11,718	4.113
Carangidae	7,951	2.790
Leiognathidae	7,918	2.779
Ariidae	5,470	1.919
Pomacentridae	5,082	1.783
Pentapodidae	4,650	1.632
Lutjanidae	3,584	1.261
Sphyraenidae	3,534	1.240
Drepanidae	3,315	1.163
Platycephalidae	3,230	1.133
Apogonidae	3,187	1.118
Pomadasyidae	2,941	1.032
Gerridae	2,662	0.941
Bothidae	2,522	0.886
Siganidae	2,201	0.772
Pentodidae	2,026	0.711
Drepaneidae	1,800	0.631
Callionymidae	1,547	0.543
Monacanthidae	1,076	0.377
Triacanthidae	1,070	0.375
Sciaenidae	743	0.260
Lethrinidae	729	0.255
Belonidae	624	0.219
Soleidae	569	0.199
Sillaginidae	568	0.199
Cynoglossidae	540	0.189
Ostraciidae	425	0.149
Cordae	350	0.122
Diodontidae	346	0.121
Centriscidae	325	0.114
Tetraodontidae	320	0.112
Serranidae	256	0.089
Therapontidae	248	0.087
Fistulariidae	196	0.068
Torpedinidae	115	0.040
Ephippidae	109	0.038
Scatophagidae	50	0.017
Synanceiidae	50	0.017
Uranoscopoidae	50	0.017
Gobiidae	45	0.015
Formionidae	26	0.009
Pegasidae	15	0.005
Tripteridae	10	0.003
Total weight	284,897	

Table 4. Food composition ratios for large zoobenthos feeders. See text for food group designations.

Large zoobenthos feeders	Food groups 5	6	7	8	Weight (kg) caught	Relative fraction
Dasyatis uarnak	0	0	.88	.12	2,910	.058
Dasyatis zugei	0	.30	.70	0	43,900	.876
Drepane punctata	.05	0	0	.95	3,315	.065
Overall ratio	.003	.263	.664	.070		

Table 5. Food consumption ratios for intermediate predators. See text for food group designations.

Intermediate predators	Food groups 1	2	3	4	5	6	7	Weight (kg) caught	Relative fraction
Saurida elongata	0	0	.646	.120	0	.234	0	25.33	.304
Pseudorhombus spp.	0	0	.800	.088	0	0	.112	23.11	.277
Trachinocephalus myops	0	0	.989	.011	0	0	0	21.47	.258
Arius thalassinus	0	0	.700	0	0	.100	.200	4.97	.060
Sphyraena spp.	.100	.500	.200	.200	0	0	0	3.53	.042
Lutjanus spp.	0	0	.726	.089	.179	.006	0	2.97	.036
Psettodes erumei	0	0	.700	.300	0	0	0	1.41	.017
Saurida undosquamis	0	0	.850	.130	0	.020	0	.35	.004
Fistularia spp.	0	0	0	1.000	0	0	0	.16	.002
Overall ratio	.004	.021	.765	.084	.006	.077	.043		

Table 6. Food consumption ratios for small demersal zoobenthos feeders. See text for food group designations.

Small demersal zoobenthos feeders	Food groups 2	3	4	5	6	7	8	9	10	Weight (kg) caught	Relative fraction
Dactyloptena orientalis	0	0	0	0	.108	.892	0	0	0	18.58	.250
Priacanthus tayenus	.139	0	.081	0	.012	.728	.030	0	0	7.20	.097
Upeneus spp.	0	0	0	0	.143	.857	0	0	0	10.23	.138
Nemipterus spp.	0	.101	.215	.295	.366	.023	0	0	0	8.87	.120
Gastrophysus spp.	0	0	0	.914	0	.086	0	0	0	9.46	.127
Leiognathus spp.	0	0	0	0	0	.400	.600	0	0	5.46	.073
Gymnocranius griseus	0	0	0	0	0	0	1.000	0	0	2.86	.039
Scolopsis taeniopterus	0	0	.026	0	.206	.510	.258	0	0	2.62	.035
Engyprosopon spp.	0	0	0	0	0	.800	.200	0	0	2.16	.029
Apogon spp.	0	0	0	0	0	.800	0	0	.200	3.06	.041
Siganus spp.	0	0	0	.100	0	.200	.500	.200	0	1.99	.026
Gazza minuta	0	0	.843	0	0	.102	.055	0	0	1.83	.025
Overall ratio	.014	.012	.057	.154	.099	.536	.115	.006	.008		

Table 7. Food consumption ratios for small demersal zooplankton feeders. See text for food group designations.

Small demersal zooplankton feeders	Food groups 7	8	10	Weight (kg) caught	Relative fraction
Pentaprion longimana	.18	.20	.62	1.61	.308
Daya jerdoni	0	0	1.00	3.29	.629
Centriscus scuttatus	0	0	1.00	.33	.063
Overall ratio	.055	.062	.883		

Table 8. Growth, mortality and exploitation parameters for 10 common demersal species.

Species	L_{∞} (cm)	K	Z	M	F	E	Lc (cm)
Pentaprion longimana	16.0	1.1	3.8	2.3	1.5	0.4	8.7
Dactyloptena orientalis	23.0	1.5	10.6	2.5	8.1	0.8	12.5
Upeneus sulphureus	23.0	1.1	5.0	2.1	2.3	0.6	11.0
Daya jerdoni	17.0	0.8	3.1	1.8	1.3	0.4	5.6
Leiognathus elongatus	13.5	0.8	2.4	1.9	0.5	0.2	8.2
Priacanthus tayenus	27.0	0.6	2.9	1.3	1.6	0.6	13.0
Gastrophysus sclieratus	18.0	1.5	4.2	2.7	1.5	0.4	10.9
Saurida elongata	37.0	1.6	7.5	2.3	5.2	0.7	21.9
Trachinocephalus myops	36.5	1.6	8.0	2.3	5.7	0.7	17.4
Pseudorhombus javanicus	26.5	1.2	2.4	2.1	0.3	0.1	21.1