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REPORT ON THE SECOND EXPERIMENT WITH BOTTOM VERTICAL LONGLINE IN THE SOUTH CHINA SEA

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INTRODUCTION

The South China Sea is dotted with many fish banks of various shapes and sizes. The waters around fish banks are thought to constitute good fishing grounds for both pelagic and demersal species.

In 1982 the SEAFDEC Training Department conducted experimental fishing with the bottom vertical longline at the Vanguard Bank. As the results were encouraging, it was decided to continue with this project, in the course of fishing practice during a training cruise for the Regular Course trainees.

The second experiment with bottom vertical longline in the South China Sea was carried out on 2-4 October 1984 near the Rifleman Bank, which is located at approximately Lat 7°45'N, Long 111°38'E. The shape of this bank is almost rectangular: it is 26 miles long in the north-south direction and 13 miles wide. It is one of the largest banks in the South China Sea. The depth of water at the edge of the bank is about 100 meters. There are many reefs on the bank; in the shallowest parts the water is only 2 meters deep.

We conducted the experiment with two purposes in mind: (i) to study the catching efficiency of the bottom vertical longline gear, and (ii) to survey the demersal resources in the Rifleman Bank area. The present report combines our findings on both points.

MATERIALS AND METHODS

Five fishing operations were carried out at the Rifleman Bank. Figure 1 shows a location chart of fishing stations, which are marked consecutively I-V, and the shooting direction of the gear.

The first three operations were conducted near the edge of the bank where demersal fish schools usually form. The fourth and fifth operation were carried out over the bank, in an area of deeper water.

A general outline drawing of the bottom vertical longline gear which was used for this experimental fishing operation is shown in Figure 2. The essential dimensions are also given in the figure.

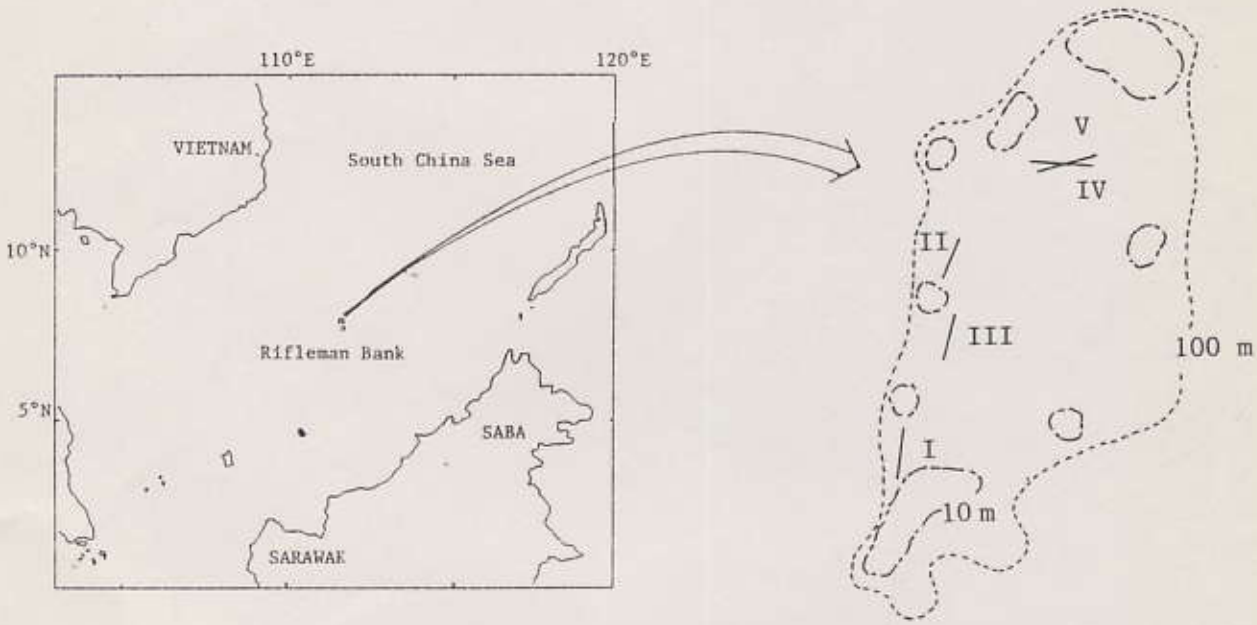


Fig. 1 Map showing the location of fishing ground at Rifleman Bank and fishing stations I-V.

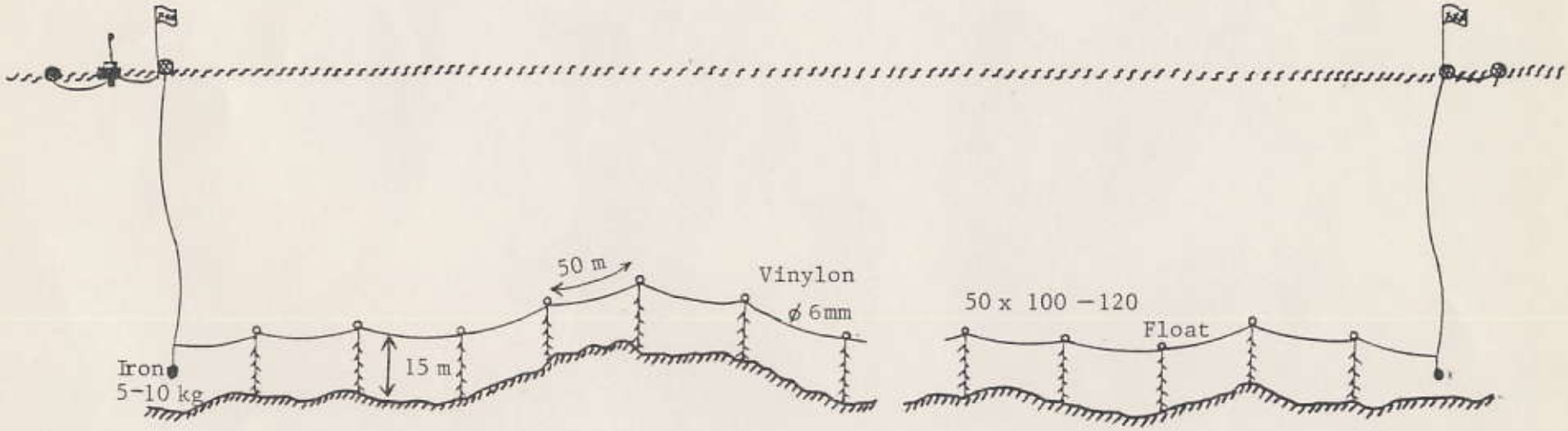


Fig. 2 Bottom vertical longline gear

As can be seen from Fig. 2, the main line has branch lines fastened to it at regular intervals of, say, 50 meters. At the upper end of each branch line there is a float and at the lower end there is a sinker. The sinker ensures that the branch line touches the bottom, whereas the buoyancy of each float is sufficient to hold the main line suspended above the bottom as high as the length of the branch lines allows. In this way the main line follows the contour of the bottom without actually touching it. Such an arrangement presents a definite advantage in fishing grounds with uneven bottom configuration, particularly where rocks, coral and other obstacles expose the gear to damage. The main line stays out of reach of potential hazards, even if a branch line is caught and torn off.

With the bottom vertical longline hooks are spaced evenly between the seabed and the main line. Thus the gear is effective for catching fish which live at or near the bottom.

A general outline drawing of a branch line is shown in Figure 3. Branch lines have to be soft enough to coil easily, without kinks occuring in the process. It is therefore advisable to use two-strand twine in this case because it is softer than the three-strand twine. In the present experiment, each branch line was 15 m long and had eight hook lines attached at 1.5 m intervals. The relative distance of each hook from the sea bed was an important factor in our analyses. For this reason the hooks were named in a descending order, as shown in Fig. 3, from hook No. 1 nearest to the main line, to hook No. 8 close to the bottom.

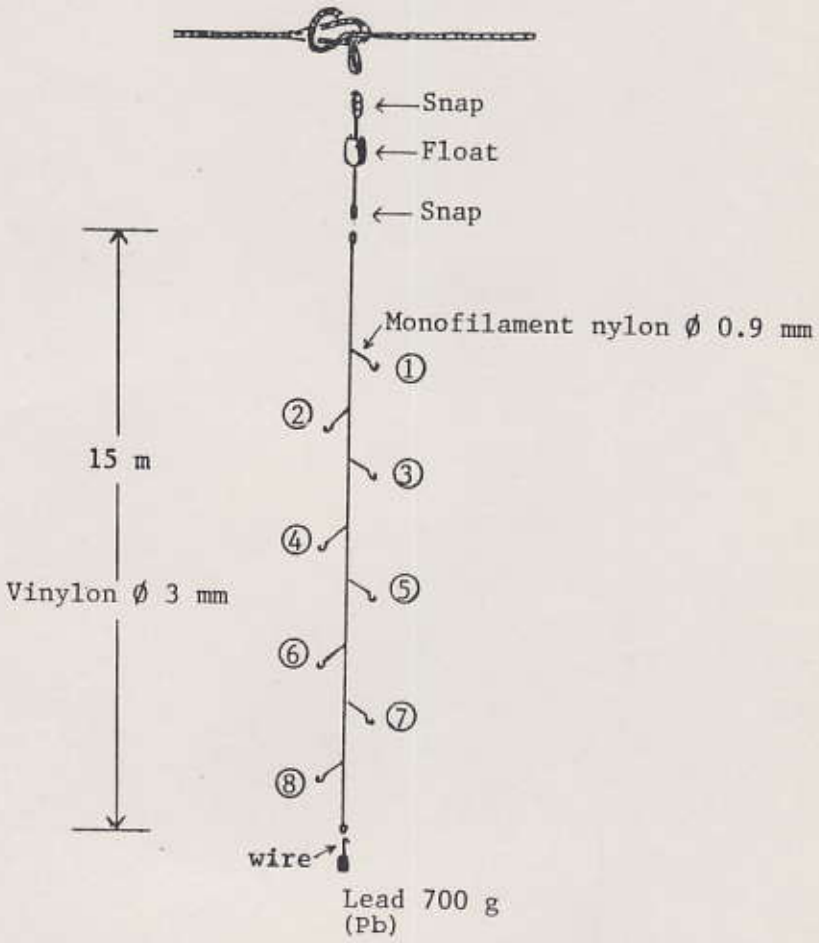


Fig. 3 General outline drawing of branch line.
Circled numbers show the position of hooks.

The material used for the hook lines was nylon monofilament, No. 30 (ø 0.9 mm). The hook lines were 75 cm long.

Figure 4 shows the shape and actual size of hooks. The barb of this type of hook is bent inwards so that shooting of the gear can proceed smoothly.

Fig. 4 Actual size of hook.

A detailed description of the operation method of this gear is given in the "Report on the experiment with bottom vertical longline in the South China Sea" (SEAFDEC, TD/CTP/16).

The catch by vertical position of hooks was recorded while the branch lines were hauled. Captured fishes were arranged in the order of hauling for identification of species and measurement of body length. Four fishes out of the total catch were partly eaten by predators, so that these fishes were counted in the number of catch, but were not used in the analysis of the body length frequency. Besides, the total catch in weight shown in this paper excluded the weight of these four fishes.

RESULTS

Fishing Operation and Bottom Topography

The time required for a fishing operation at each fishing station is shown in Table 1. Except for the first operation at station I, the shooting of gear proceeded at the rate of 3.4 branch lines per minute, or about 170 m of main line per minute. In other words, the time required for shooting one branch line (which means 50 m of main line), was 17.4 seconds. We think, however, that the shooting speed could be improved through more experience.

The number of branch lines shot and hauled at each fishing station is shown in Table 1. The proportion of branch lines lost during operation in relation to all shot branch lines was high at stations I, II and III; about 9-10%. This may have been caused by particularly rough bottom conditions.

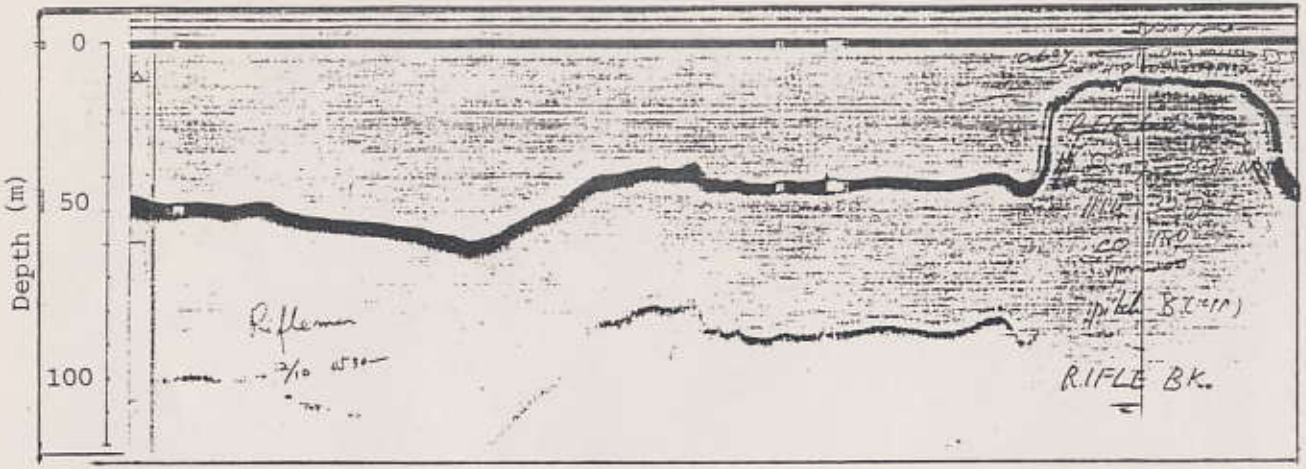
Table 1. Duration of fishing operations, and the number of branch lines lost.

Station No.	Time		Number of branch lines		
	Shooting	Hauling	Shot	Hauled	Lost
I	0530-0609	0801-0855	99	90	9
II	1025-1059	1338-1534	120	108	12
III	0508-0545	0735-0844	120	108	12
IV	1206-1236	1318-1411	108	102	6
V	0515-0546	0639-0800	105	105	0

Figure 5 shows recordings of bottom topography, made by fish-finder at each of the five fishing stations. These indicate that the sea bottom at stations II and III was very uneven compared to stations IV and V. The proportion of lost branch lines was 6% and 0% at stations IV and V, respectively.

However, the relation between the position of each lost branch line and the bottom conditions at the place of loss was not observed, except for station I. On that occasion, all lost branch lines were the ones which were set on a shallow coral reef.

Station I



Station II

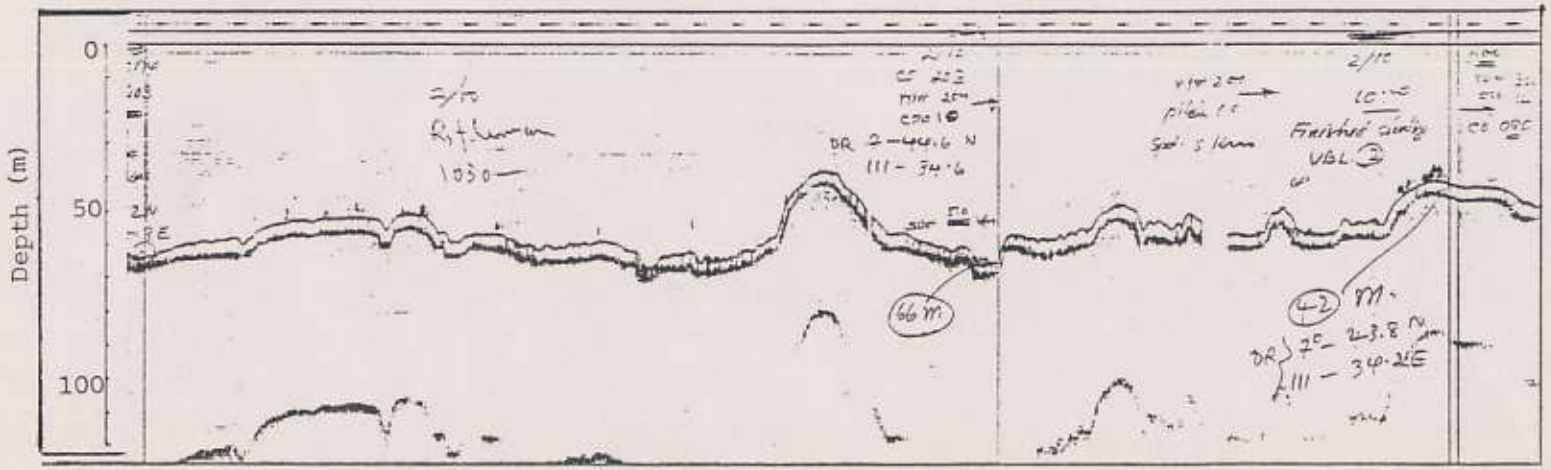
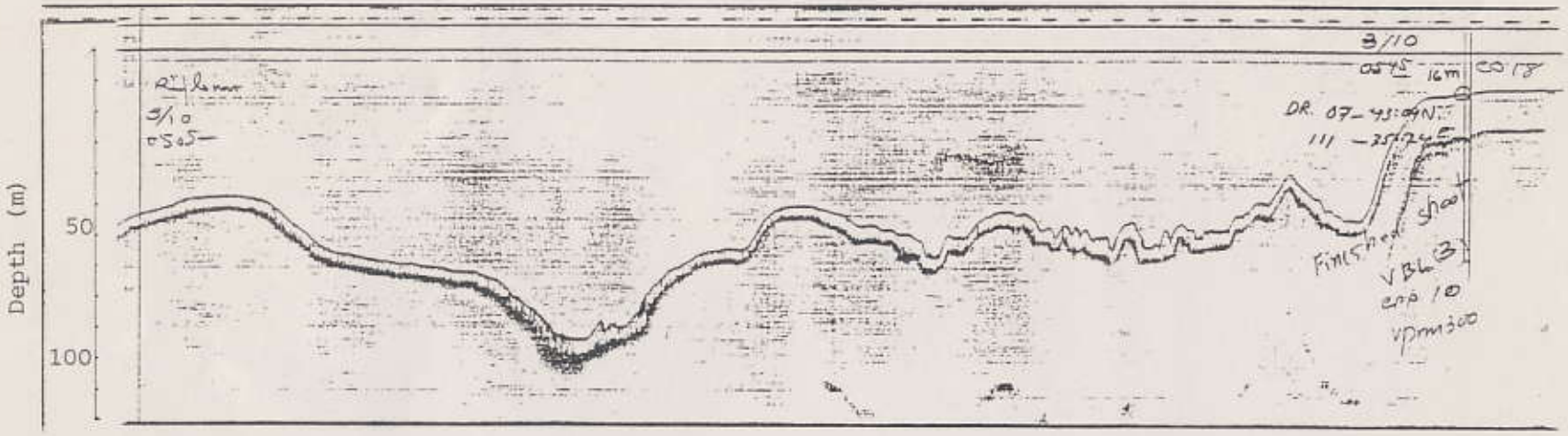


Fig. 5 Fish-finder recordings of bottom topography.

Station III



Station IV

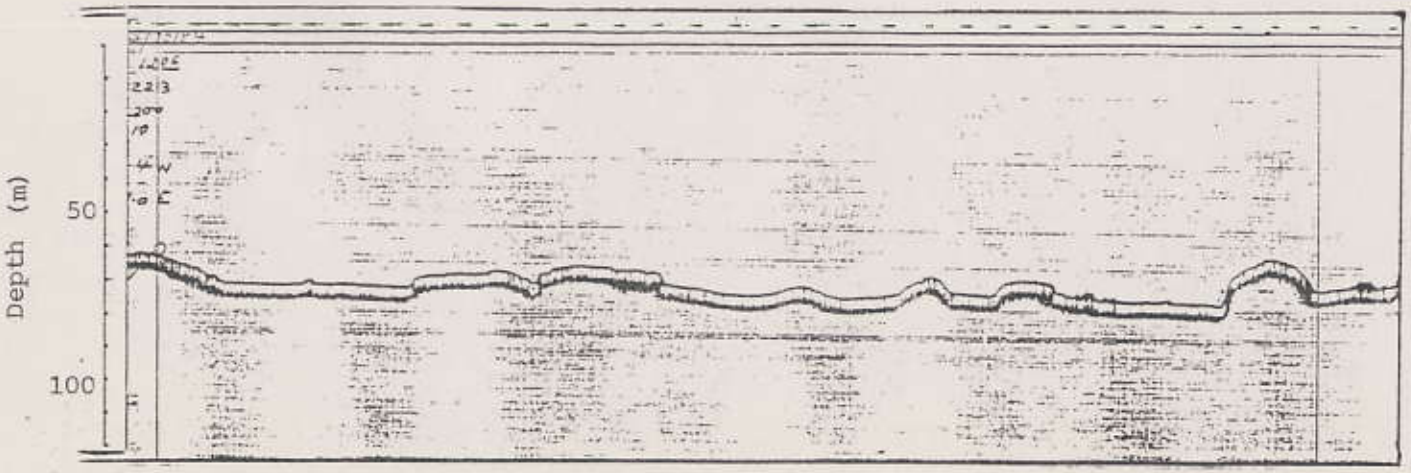


Fig. 5 (Continued)

Station V

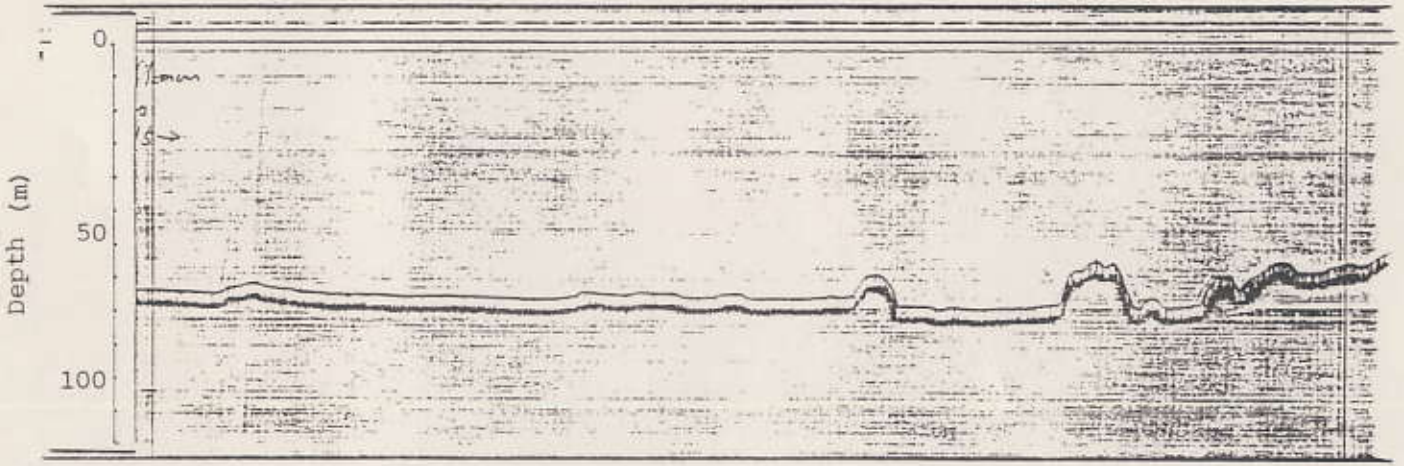


Fig. 5 (Continued)

Branch Lines and Catch

The catch was 79.2 kg (65 fishes) at station I; 48.9 kg (44 fishes) at station II; 100.3 kg (85 fishes) at station III; 101.8 kg (56 fishes) at station IV; and 114.3 kg (85 fishes) at station V.

Table 2 shows the number of branch lines which caught fish and the number of branch lines by the quantity of catch on them and by station. On the average, 40 per cent of hauled branch lines contained some catch. However, more than a half of those (62%) caught only one fish. A small number of branch lines caught four or more than four fish at a time. There was no branch line which caught seven or eight fishes in one operation.

Table 2. The total number of branch lines which caught fish, and the number of branch lines by number of captured fish on a branch line, for each station. (A): Number of branch lines hauled, (B): Number of branch lines with catch.

Station	(A)	(B)	(B)/(A)	(Number of fish caught by a branch line)							
				1	2	3	4	5	6	7	8
I	90	41	0.46	28	6	4	2	1	0	0	0
II	108	36	0.33	30	5	0	1	0	0	0	0
III	108	48	0.44	21	18	8	1	0	0	0	0
IV	102	40	0.39	30	6	2	2	0	0	0	0
V	105	42	0.40	19	11	7	3	1	1	0	0
Total	513	207	0.40	128	46	21	9	2	1	0	0

Except in station I, the positions of lost branch lines were not recorded; therefore, it is difficult to see the horizontal distribution of catch by branch line precisely. Figure 6 shows the distribution of catch by branch lines, as they were hauled. The data for the lost branch lines is missing in this figure, except for station I. The direction of hauling was not consistent at station II, because the main line had broken several times, therefore the catch data for station II was not used in the analysis of horizontal catch distribution.

There seems to be some unevenness in catch at each fishing station. That is to say, there were spots where the catch was good both horizontally and vertiçally, and there were other spots where during the same operation no fish was caught on several adjacent branch lines. Such an occurrence can be attributed to the locations of fish schools and their density. On the whole, however, fish were found to spread fairly widely and evenly in the waters of the Rifleman Bank.

More details on the horizontal catch distribution are given later in this report.

Hooking Rate

Table 3 shows the hooking rate 1, which is the number of captured fish per hook, and also the hooking rate 2 which is the weight of catch per hook, for each station. The hooking rate both by numbers and by weight of fish was the lowest at station II. Hooking rate 1 at station IV was slightly lower than at other stations but hooking rate 2 was higher. This seems to be due to a difference in species composition of catch, or a difference in size composition.

Table 4 shows the hooking rate in numbers of captured fish per hook, by the vertical position of hook and by fishing station. The highest hooking rate by vertical position of hook was different for each fishing station. Generally speaking, however, the hooking rate of hooks No.7 and No.8, which were nearest to the sea bed, was comparatively high, whereas hooks No.1 and No.2, which were furthest from the bottom, had the lowest hooking rate. It is assumed that the hooking rate in relation to the hook vertical position is influenced by the species composition in the fishing station. Detailed results on hooking rate and catch ratio by the vertical position of hooks will be described later.

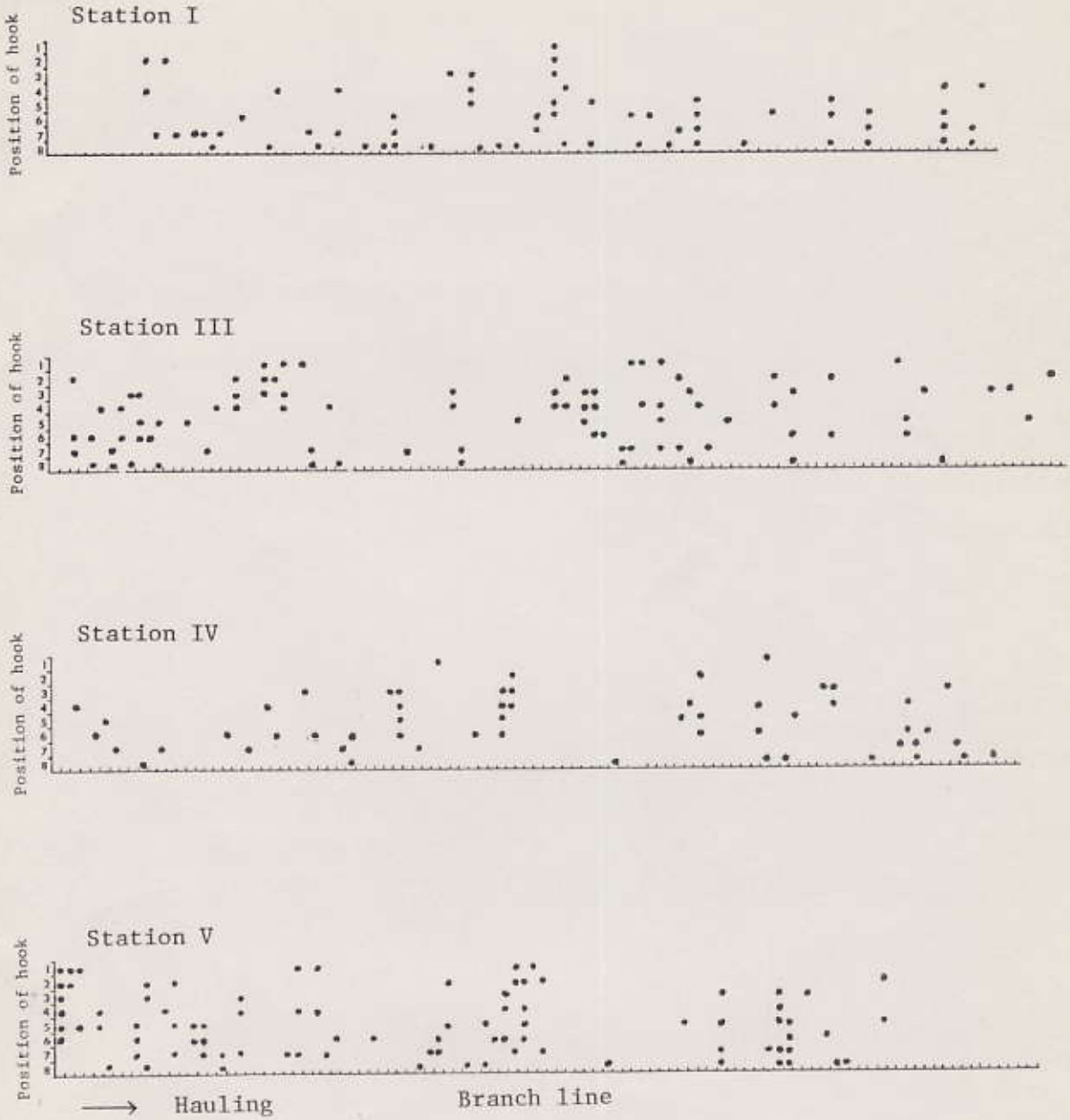


Fig. 6 Horizontal and vertical distribution of catch by branch line, by fishing station.

Table 3. Hooking rate (number of fish per hook and weight of catch per hook).

Fishing station	Number of branch lines	Number of hooks Ⓐ	Number of fish caught Ⓑ	Hooking rate 1 Ⓑ/Ⓐ	Weight of catch Ⓒ kg	Hooking rate 2 Ⓒ/Ⓐ
I	90	720	65	0.09	79.2	0.11
II	108	864	44	0.05	48.9	0.06
III	108	864	85	0.10	100.3	0.12
IV	102	816	56	0.07	101.8	0.13
V	105	840	85	0.10	114.3	0.14
Total (mean)	513	4,104	335	(0.08)	445.5	(0.11)

Table 4. The number of fish caught and the hooking rate (HR) by position of hook.

Fishing station / Hook position	I		II		III		IV		V		TOTAL	
	Number of fish	HR	Number of fish	HR	Number of fish	HR	Number of fish	HR	Number of fish	HR	Number of fish	HR
1	1	0.01	1	0.01	7	0.06	2	0.02	7	0.07	18	0.04
2	3	0.03	8	0.07	8	0.07	2	0.02	9	0.09	30	0.06
3	3	0.03	11	0.10	14	0.13	8	0.08	7	0.07	43	0.08
4	8	0.09	3	0.03	15	0.14	9	0.09	9	0.09	44	0.09
5	5	0.06	7	0.06	9	0.08	6	0.06	14	0.13	41	0.08
6	11	0.12	5	0.05	10	0.09	12	0.12	12	0.11	50	0.10
7	14	0.16	4	0.04	11	0.10	8	0.08	16	0.15	53	0.10
8	20	0.22	5	0.05	11	0.10	9	0.09	11	0.10	56	0.11
Total	65	0.09	44	0.05	85	0.10	56	0.07	85	0.10	335	0.08

Species Composition and Size Composition of Catch

The species found in the catches by bottom vertical longline at the Rifleman Bank are listed in Table 5. The best represented species in the catches, in terms of numbers of fish, were: *Lethrinus miniatus*, *Gymnocranius griseus*, *Pristipomoides filamentosus*, *Gymnocranius robinsoni* and *Lethrinus variegatus*.

However, the species composition of catch was different for each station. *L. miniatus* was a dominant species in the catch at stations I and III. *P. filamentosus* was caught at stations III, IV and particularly at station V, but neither species was found at stations I and II.

Figure 7 shows the body length frequency histograms of the main four species. The size of captured fish at station IV seems to have been larger than at the other stations. This accounts for the relatively high weight in spite of the small number of catch at station IV.

Horizontal and Vertical Distribution of Dominant Species

The horizontal distribution of dominant species has been estimated from the catch records which are shown in Figure 8. *P. filamentosus* and *L. miniatus* seem to form dense schools. *G. griseus* and *G. robinsoni*, on the contrary, appeared in widely spread formations.

Figure 9 shows the catch ratio by the vertical position of hook. From this, it was possible to determine at which distance from the sea bottom we can expect to find various dominant species of demersal fish. For *G. griseus*, the lowest hooks had the highest catch ratio, indicating that this species dwells near the bottom. The highest placed hooks generally showed very low catch ratios, except for *P. filamentosus*. In the case of this species, the bottom hooks had very low catch and the highest hooks had relatively good catch, showing that the swimming layer is somewhat higher than that of the other species.

Table 5. Fishes caught at the Rifleman Bank in the South China Sea during 2-4 October 1984.

Scientific name	Common English name	Number of fish
1. Fam. Carcharhinidae		
Carcharhinus menisorrah (Müller et Henle)	Grey shark	9
2. Fam. Serranidae		
Cephalopholis sonnerati (Cuvier & Valenciennes)	Red rock-cod	3
Epinephelus areolatus (Forsskal)	Yellow-spotted rock-cod	7
Epinephelus cometae Tanaka	Narrow curve-banded grouper	1
Epinephelus solonots Smith et Smith	Saddle-banded rock-cod	1
Variola louti (Forsskal)	Lunar-tailed cod	10
3. Fam. Carangidae		
Carangoides ferdau (Forsskal)	Yellow spotted crevalle	8
Caranx elacate (Jordan et Evermann)	Large-mouth trevally	3
4. Fam. Lutjanidae		
Aprion virescens Volenciennes	Green jobfish	7
Lutjanus bohar (Forsskal)	Twospot red snapper	5
Pristippomoides filamentosus (Valenciennes)	Small-tooth fusiform-snapper	62
Aphareus rutilans Cuvier	Small-toothed jobfish	10

Table 5. (Contiuned)

Scientific name	Common English name	Number of fish
5. Fam. Lethrinidae		
Lethrinus variegatus (Valenciennes)	Variegated pigface bream	24
Lethrinus miniatus (Bloch et Schneider)	Longface emperor	86
6. Fam. Pentapodidae		
Gymnocranius griseus (Temminck et Schlegel)	Naked-headed sea bream	69
Gymnocranius robinsoni (Gilchrist et Thompson)	Large-eyed bream	29
7. Fam. Tetraodontidae		
Lagocephalus sp.	Puffer fish	1
	Total	335

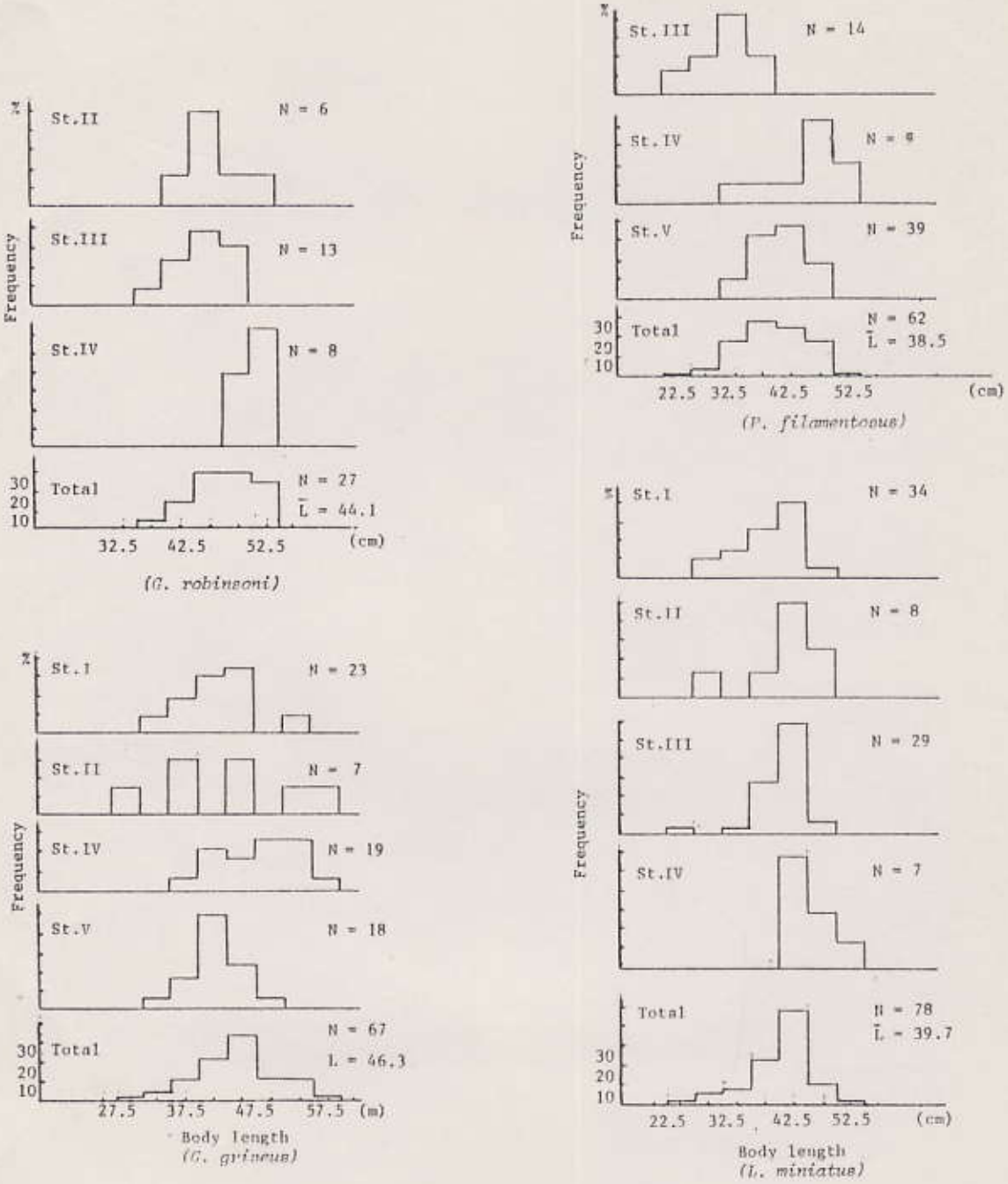


Fig. 7 Body length frequency histograms of the four main species, by fishing station.

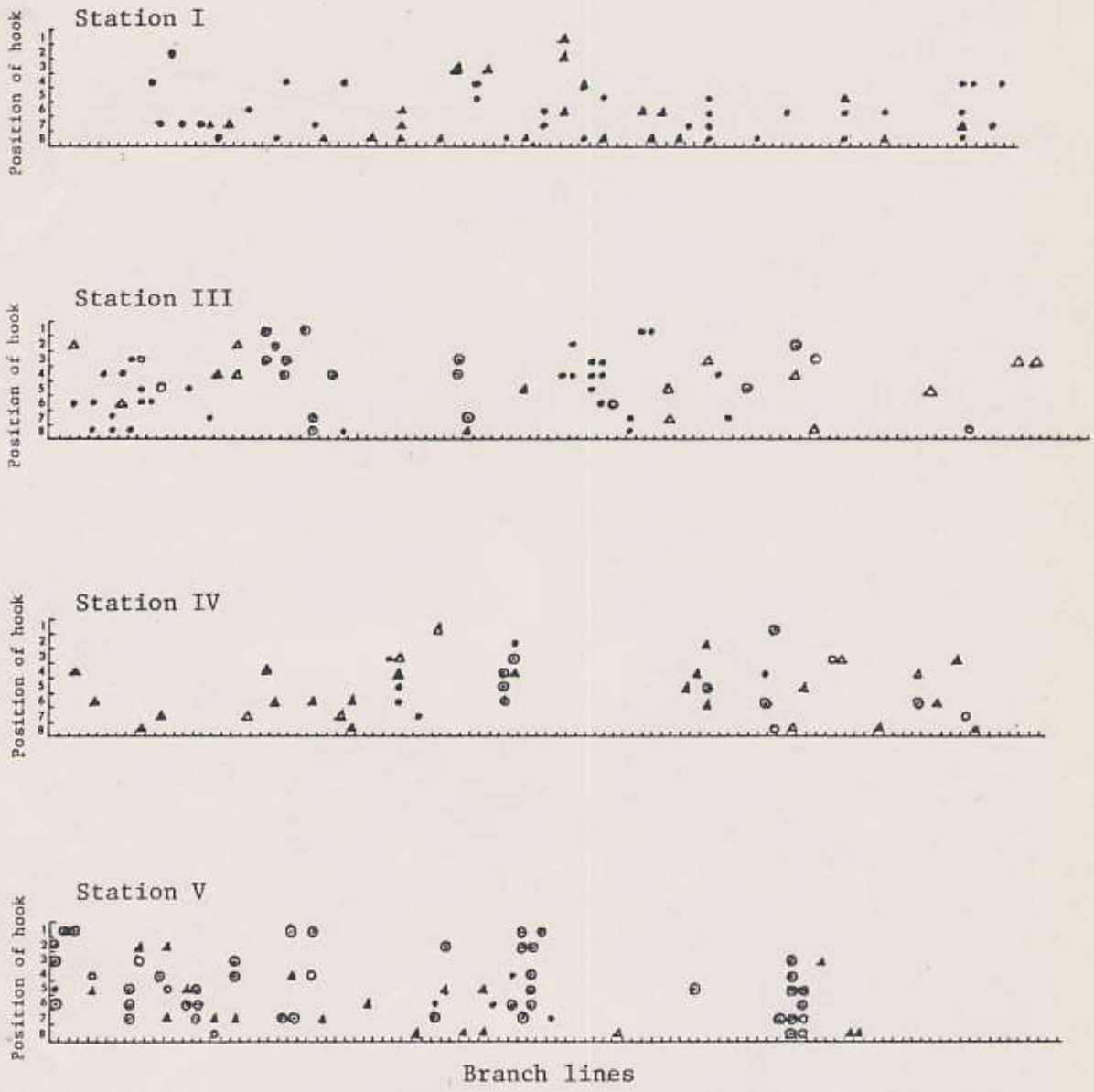


Fig. 8 Horizontal and vertical catch distribution by branch lines and by species.

● : *L. miniatus*
▲ *G. griseus*
⊙ : *P. filamentosus*
○ : *L. variegatus*
△ *G. robinsoni*

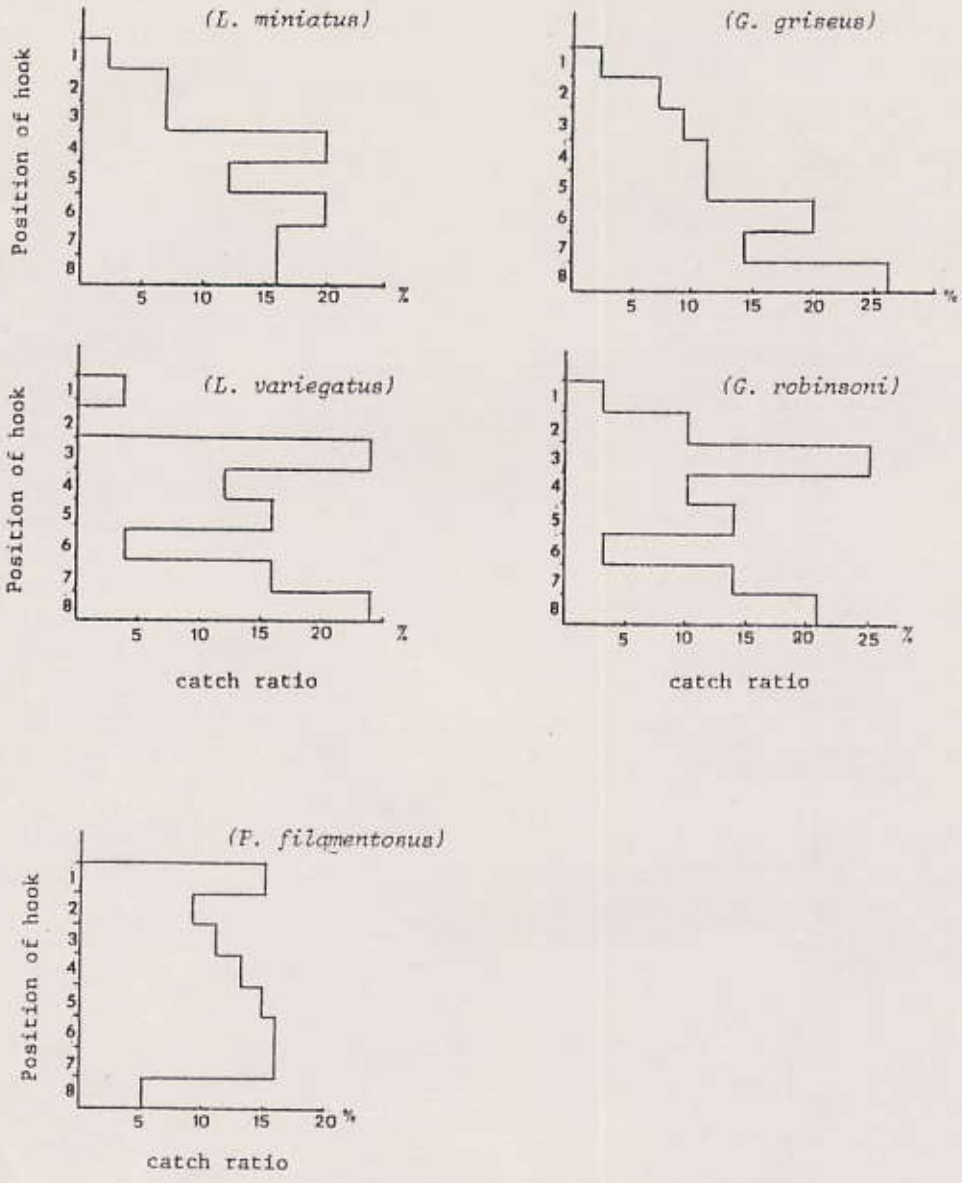


Fig. 9 Catch ratio by vertical position of hook.

Catch ratio: Proportion of catch by hook position to the total catch of all hooks.

DISCUSSION

In the present experiment, the bottom vertical longline gear was operated without any serious problems. Generally, however, it is necessary to exercise great care in handling of this gear and in maneuvering of the vessel, especially when hauling in waters with rough bottom, in order to avoid damage to the main line.

About 40 per cent of the hauled branch lines contained some catch on them, but more than a half of those caught only one fish.

The overall hooking rate was about 8 per cent. However, the hooking rate of the hooks which were nearest to the sea bed was comparatively high, whereas the hooks which were furthest from the sea bed had the lowest hooking rate.

The captured fishes were found to belong to seven families and seventeen species. The best represented species were *Lethrinus miniatus*, *Gymnocranius griseus*, *Pristipomoides filamentosus*, *Gymnocranius robinsoni* and *Lethrinus variegatus*.

P. filamentosus and *L. miniatus* seem to form dense schools, while *G. griseus* and *G. robinsoni* seem to spread widely in these waters.

The mean body sizes of fish were: 39.7 cm for *L. miniatus*, 46.3 cm for *G. griseus*, 44.1 cm for *G. robinsoni* and 38.5 cm for *P. filamentosus*.

There seem to be some differences in swimming layers of the dominant demersal species. *G. griseus* was found to dwell very near the sea bottom while *P. filamentosus* preferred the layer a little above the sea bed.

It was found that the bottom vertical longline was an effective fishing gear for catching bottom fish. However, in order to make this gear more effective, some modifications and further testing should be carried out.

Since the two highest hooks proved to be quite ineffective, their height from the sea bottom should be altered. That is to say, branch lines should be shortened from the present 15 m to 10 m. There should still be eight hooks, but with shorter intervals between them. The length of the hook lines should be 50 cm instead of 75 cm.

In consequence of shortening of branch lines, the intervals between branch lines can also be shortened from 50 m to 30 m. The number of branch lines can thus be increased, which means that more hooks are set above the sea bed horizontally.

ACKNOWLEDGEMENTS

We thank Captain Lt. Vichitra Sitothai, RTN., and the crew of the SEAFDEC training vessel M.V. PAKNAM for their help with the fishing operations. All SEAFDEC trainees (1983-1985) actively participated in fishing and their work was much appreciated.

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