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SEAFDEC Training Department

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER

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EXPERIMENT WITH BOTTOM VERTICAL LONGLINE
IN THE ANDAMAN SEA

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and
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INTRODUCTION

In 1982, the SEAFDEC Training Department conducted experimental bottom vertical longline fishing in the South China Sea at the Vanguard Bank and off Sabah. As the results were encouraging, a second experiment with bottom vertical longline was carried out during May 1984 in the Central Gulf of Thailand as a joint research project of the Department of Fisheries of Thailand and the SEAFDEC Training Department. Another experiment was carried out in the South China Sea at the Rifleman Bank during October 1984.

Recently, some undeveloped fishing grounds have been found over a topographically rough sea-bed in the Andaman Sea. Such bottom conditions pose many difficulties and less opportunities for bottom trawl fishing. Therefore, the bottom vertical longline experiments were designed to gather additional data to the experiment performed in 1987 by the Exploratory Fishing Division, DOFT, using SEAFDEC fishing gears in the Andaman Sea.

The catch records of the SEAFDEC experiments mentioned above are given in Table 1.

Table 1. Comparison of SEAFDEC catch records for BVL, 1982-88.

Item	Year	1982 ¹	1984 ²	1984 ³	1988 ⁴
No. of operations		9	6	5	14
No. of hooks used		4320	4320	4104	10830
No. of fishes caught	(x)	154	335	938	
Total catch (kg.)		564.0	163.4	445.5	1710.9
Catch/operation		62.7	27.2	89.1	122.2
Hooking rate	(x)	3.56	8.16	8.66	

1982¹ : At the Vanguard Bank and off Sabah, 13-18 June.

1984² : In the Central Gulf of Thailand, 26-29 May.

1984³ : At the Rifleman Bank, 2-4 October.

1988⁴ : In the Andaman Sea, 31 Jan. - 2 Feb. and 1 Mar. - 3 Mar.

Hooking rate = (No. of fishes caught/No. of hooks used) x 100

(x) : No. recorded.

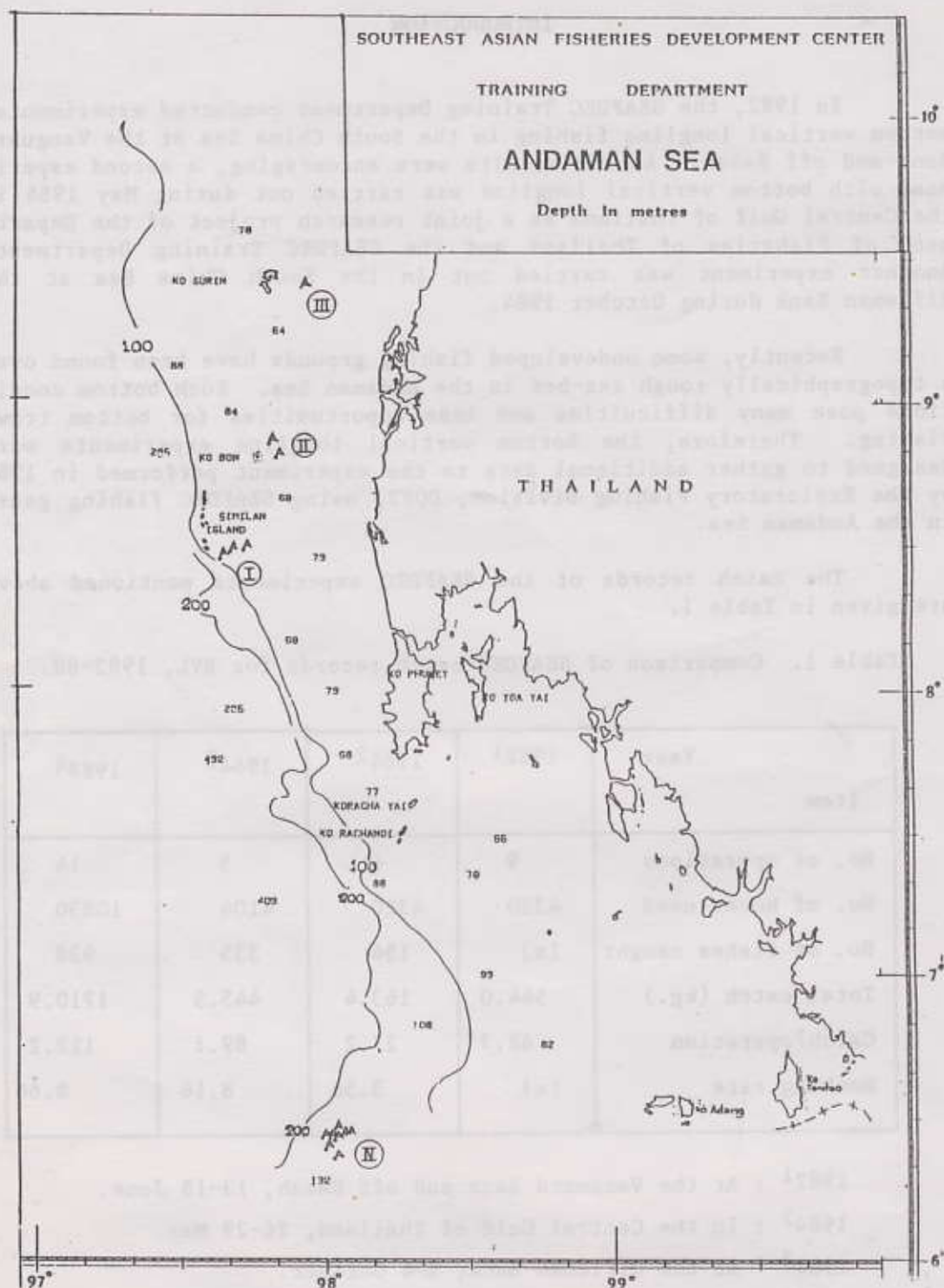


Fig. 1 Fishing grounds where experimental operations were carried out (Marked A).

Experimental operations with bottom vertical longline were carried out on board M.V. PLATOO in areas of the Andaman Sea from 31 Jan. - 2 Feb. and 1-3 March, 1988. 14 fishing operations were performed at I-IV fishing stations. The first six operations were conducted in the central part of the Andaman Sea (near Similan Island, Ko Bon and Ko Surin), and the other eight operations were conducted in the Southern part. The locations of the experimental fishing grounds are shown in Figure 1.

Fresh squid was used as bait. For the first six operations the bait was changed after each fishing operation but for the other eight operations the bait was returned and used again because of the lack of bait.

The objectives of the experiment can be summarized as follows:

1. To study the catch composition and catching efficiency of bottom vertical longline,
2. To study the demersal fish stocks in the area of Similan Island and the waters off Satun province,
3. To compare the catch between the fishing ground of Similan Island and the waters off Satun province,
4. To compare the catch with the operating time, and
5. To study the relationship between the fishes caught and the bottom topography.

In addition polyethylene braided-twine was also introduced for use in this experiment.

MATERIALS AND METHODS

The gears

In the experiment the bottom vertical longline was modified to make it suitable for use in areas where the bottom is not too rough such as the oceanic bank and also to take into account the results of the experiment in the Central Gulf of Thailand where the upper hooks provided a low catch. This experiment was carried out on board M.V. PLATOO a 65.47 gross-ton fiber glass purse seiner.

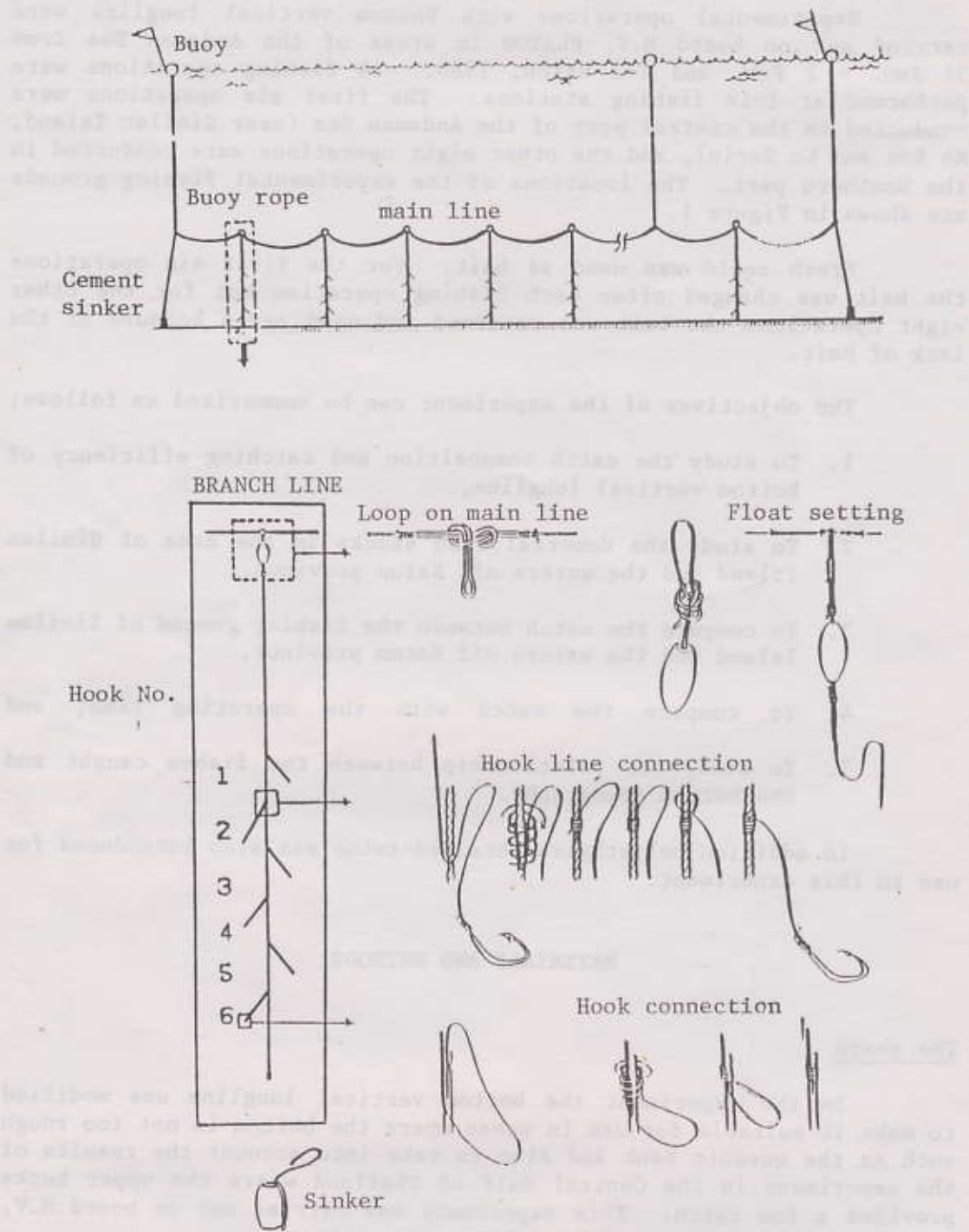


Fig. 2. Schematic diagram of bottom vertical longline gear

The main line of the gear was made of vinylon because this material has a high specific gravity which allows the gear to sink rapidly. In this way, the effect of currents on the gear is reduced. The interval between branch lines was 25 metres. Branch lines and floats were connected to the loops of the main line as shown in Figure 2.

There are three kinds of material commonly used for making branch lines, vinylon two-strand twine, vinylon three-strand twine and polyethylene crossed-twine (braided-twine). To give the fisherman more choice and reduce costs, polyethylene was introduced used in this experiment.

Each branch line was 12 m. long, and six hook lines each 80 cm. in length were connected to a branch line at intervals of 1.5 m.. Nylon monofilament No. 26 (Ø 0.84 mm.) was used for the hook lines. 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 descending order from hook No. 1 nearest to the main line, to hook No. 6 closest to the bottom.

Two kinds of hooks were used: Matsu-bari No. 20 and No. 26.

The branch lines were stored in specially designed boxes, made of wood, plastic plates and with a rubberized rim around the top. Three branch lines were stored per box, each separated by a thin sheet of canvas. Hooks were stuck into the foam inside the box. Before the fishing experiment, the hooks were baited and hung out of the box through slits in the rubberized rim.

The fishing operations

Shooting of the bottom vertical longline was done from the stern of the boat. The flag and the cement sinker were shot first, followed by the light buoy and the main line. Then one end of a float rope was connected to the main line at the join loop, while the other end was connected to a branch line. A lead sinker was attached to the branch line, and dropped into the water passing over a thick bamboo pole. The buoy ropes were connected to the main line every 15 boxes. This process was continued until all the branch lines were used, then the light buoy, the flag and cement sinker were connected with the main line at the end of the last box.

During shooting every three branch lines shot into the water were marked on the recording paper of the fishfinder.

Hauling was conducted at the fore-deck of the boat. The flag and the light buoy were hauled first, then the main line was brought to pass over the side roller and the line hauler. When a branch line appeared at the side roller the crew had to stop the side roller by using the break. The branch line was taken off the main line, the float removed, and the line passed to the line keeper. The fishes were removed from the hooks and the branch lines were stored in the boxes.

For each fishing operation the following information was recorded: date, position, time of operation, direction of casting line, number of branch lines and hooks used, meteorological information, water temperature at surface, catch in number and weight by species, catch of each species by position of hooks, etc.

The records for Bottom vertical longline fishing operations are shown in Tables 2 and 3.

THE RESULTS

The operations

The 5 boxes of polyethylene crossed-twine (size $\phi = 4$ mm.) went out smoothly, no kinks occurred to the branch lines during both shooting and hauling up. However, it needed more space than vinylon two-strand. This kind of twine may be suitable for bottom vertical longline especially if the size is a bit smaller.

The 5 boxes of vinylon three-strand twine (small size $\phi = 1.5$ mm.) were often entangled during shooting. Perhaps the size was too small for the weight of the sinker when thrown out. During hauling, when there were fish attached, kinks occurred and some entangling.

The 10 boxes of vinylon three-strand twine (big size $\phi = 4$ mm.) went out smoothly during the shooting but some kinks and entangling occurred during the hauling due to the three-strand twist character.

The results of the new type of twine for making branch lines proved the polyethylene more suitable than the other types. It can replace the vinylon two-strand and the cost will also be reduced.

It took about 32 minutes to shoot the longline whose main line was 3,225 metres in length, with 129 branch lines and 774 hooks (43 boxes). The boat speed was kept at "slow ahead", which was about 3-4 knots per hour. The boat was stopped whenever there were any difficulties in shooting the line.

Fishing grounds

The first six operations were located approximately between Lat 08°27'80 N to Lat 09°23'80 N and Long 097°38'05 E to Long 097°56'00 E but the last eight operations were located approximately between Lat 06°21'40 N to Lat 06°26'40 N and Long 097°59'80 E

Table 2. Record of Bottom vertical longline fishing operations.

Operation No.	1	2	3	4	5	6	7
Station No.	I	I	II	III	II	I	IV
Date	31 Jan.	31 Jan.	1 Feb.	1 Feb.	2 Feb.	2 Feb.	1 Mar.
Position	Shooting	Lat. 08°27'80 N	08°48'20 N	09°23'80 N	08°51'30 N	08°27'90 N	06°24'60 N
	λ	097°38'05 E	097°43'10 E	097°48'60 E	097°48'60 E	097°38'90 E	098°02'00 E
Time	Shooting	Lat. 08°20'90 N	08°31'50 N	08°48'60 N	08°50'20 N	08°27'20 N	06°23'04 N
	λ	097°39'60 E	097°43'20 E	097°47'00 E	097°47'50 E	097°39'80 E	097°58'69 E
Time	Shooting	Start 05h 30m	16h 25m	06h 15m	09h 26m	18h 07m	05h 42m
	Shooting	Finish 06 15	17 20	06 50	09 59	18 41	06 25
Time	Hauling	Start 07 57	18 00	08 00	12 04	19 30	08 03
	Hauling	Finish 08 50	18 50	08 51	13 11	20 45	09 21
No. of branch lines	150	150	141	129	129	129	144
Course	120°	000°	270°	220°	270°	120°	225°
Wind	NW-10	NW-8	E-8	E-6	E-1	S-3	NE-5
T°(c), Atm. press (mb)	27.5 1015.5	31.0 1014.7	25.0 1015.5	30.5 1014.8	31.0 1018.7	29.5 1015.5	25.5 1015.0
Water T°(c) at surface	30.3	30.0	29.5	29.7	29.5	32.0	31.0
Depth (m)	36-78	71-86	57-75	49-60	55-70	45-75	140
No., Wt (kg)	20, 29.20	14, 9.50	26, 17.90	1, 2.30	20, 13.20	7, 11.40	136, 243.50

Table 2. (continued)

Operation No.	8	9	10	11	12	13	14
Station No.	IV	IV	IV	IV	IV	IV	IV
Date	1 Mar.	1 Mar.	2 Mar.	2 Mar.	2 Mar.	3 Mar.	3 Mar.
Position	Shooting	Lat. 06°25'58.80 N	06°26'10 N	06°23'40 N	06°25'68 N	06°26'40 N	06°25'40 N
		λ 098°01'50 E	098°02'30 E	098°00'00 E	098°01'23 E	098°01'40 E	097°59'80 E
	Hauling	Lat. 06°24'30 N	06°20'02 N	06°20'20 N	06°25'68 N	06°25'70 N	06°24'70 N
		λ 097°57'80 E	097°58'10 E	097°58'10 E	098°00'24 E	098°02'00 E	097°59'20 E
Time	Shooting	Start 11h 19m	17h 48m	06h 30m	10h 03m	15h 19m	11h 50m
	Finish	11 54	18 23	06 50	10 25	15 51	12 21
	Shooting	Start 13 04	19 37	08 03	12 01	18 00	16 02
	Hauling	Finish 14 06	20 51	09 01	13 04	19 15	17 09
No. of branch lines	141	135	90	90	138	129	135
Course	250°	270°	225°	270°	250°	280°	250°
Wind	NE-10	NE-0.5	NE-12	E - 9	E - 9	SW - 10	E - 8
T°(c), Atm.press (mb)	29.6 1017.2	30.0 1014.5	26.0 1015.5	29.0 1018.4	29.8 1014.8	26.0 1016.8	28.5 1017.8
Water T°(c) at surface	30.8	31.4	31.1	31.2	31.4	33.8	33.8
Depth (m)	146-164	134-170	142	150-170	142-178	135-145	148-210
No., Wt (kg)	162, 311.50	14, 61.90	55, 60.85	82, 249.70	204, 308.65	86, 164.35	111, 227.40

Table 3. The total number of branch lines which caught fishes and the number of branch lines by number of fishes caught on a branch line, for each station:

Operation No.	Number of branch lines				C/B	Number of fish caught by Hook's position						
	A	B	C	D		1	2	3	4	5	6	Total
1.	150	145	17	5	0.117	0	0	3	2	6	9	20
2.	150	148	12	2	0.081	0	0	2	2	3	7	14
3.	141	138	19	3	0.138	2	0	1	3	11	9	16
4.	129	129	1	0	0.008	0	0	0	0	0	1	1
5.	129	129	18	0	0.140	0	0	2	5	7	6	20
6.	129	125	7	4	0.056	0	1	0	1	4	1	7
7.	144	143	74	1	0.517	5	9	18	20	41	43	136
8.	144	140	94	3	0.671	15	13	28	29	38	39	162
9.	135	135	11	0	0.081	1	0	2	2	4	5	14
10.	90	88	39	2	0.443	0	6	6	9	12	22	55
11.	90	88	47	2	0.534	3	12	8	15	17	27	82
12.	138	136	88	2	0.647	13	36	40	41	40	34	204
13.	129	128	56	1	0.438	3	8	12	15	24	24	86
14.	135	133	68	2	0.511	12	19	9	18	23	30	111
Total	1,832	1,805	551	27	0.305	54	104	131	162	230	257	938

A : Number of branch lines shot.

B : Number of branch lines hauled

C : Number of branch lines with catch.

D : Number of branch lines lost.

to Long 098°02'90 E, about 75-90 nautical miles West, off Tarutao Island. The species found in the first six operations seem to be different from those found in the last eight operations, the best represented species in the first six operations in terms of number of fish were: *Gymnocranius robinsoni*, and *Abalistes stellatus*, however, in the other eight operations they were: *Lipocheilus carnolabrum*, *Epinephelus epistictus*, *Satyrichthys* sp. and *Chiloscyllium indicum*.

The range of sea depths was also an indicator of the fish species to be found in the different fishing grounds.

Species composition

The fishes captured by bottom vertical longline were 1710.90 kgs, in weight and 938 individuals in number, belonging to 21 families and 31 species. A list of the fishes captured is given in Tables 4 and 5.

Table 4. Fishes caught in terms of number and weight by family.

Family	Catch		% by	
	No. (pcs.)	Wt. (kgs)	No. (pcs.)	Wt.(kgs)
Ariidae	1	2.3	0.11	0.13
Balistidae	22	22.4	2.36	1.31
Carangidae	1	3.10	0.11	0.18
Carcharhinidae	2	8.30	0.22	0.48
Dasyatididae	2	3.0	0.22	0.17
Echeneididae	1	0.70	0.11	0.04
Holocentridae	2	2.50	0.22	0.15
Lethrinidae	32	27.30	3.42	1.59
Lutjanidae	343	812.40	36.58	47.48
Muraenidae	12	2.40	1.28	0.14
Nemipteridae	22	8.70	2.36	0.51
Orectolobidae	90	29.75	9.60	1.73
Scaridae	1	2.50	0.11	0.15
Scorpaenidae	5	0.80	0.54	0.04
Scyliorhinidae	37	97.80	3.95	5.71
Serranidae	184	549.35	19.63	32.10
Soleidae	12	2.50	1.28	0.15
Sphyraenidae	1	0.20	0.11	0.01
Squalidae	34	22.50	3.63	1.31
Synodontidae	2	0.60	0.22	0.03
Triglidae	119	112.80	12.70	6.59
Total	938	1710.90		

Table 5. Species composition of fish caught, total length and sea depth.

Family (Species)	No. of catch (pcs.)	Length (cm.)	Depth (m.)
Ariidae			
<i>Arius thalassinus</i>	1	42	58
Balistidae			
<i>Abalistes stellatus</i>	19	31-42	36-86
<i>Balistoides</i> sp.	2	25-39	45-58
<i>Odonus nigar</i>	1	35	58
Carangidae			
<i>Carangoides</i> sp.	1	64	39
Carcharhinidae			
<i>Carcharhinus longimanus</i>	2	75-95	36-45
Dasyatididae			
<i>Dasyatis</i> sp.	2	60-65	60
Echeneididae			
<i>Echeneis naucrates</i>	1	56	74
Holocentridae			
<i>Ostichthys</i> sp.	2	38	142
Lethrinidae			
<i>Gymnocranius robinsoni</i>	28	24-54	36-73
<i>Lethrinus elongata</i>	1	57	58
<i>Lethrinus</i> spp.	3	42-57	36-86
Lutjanidae			
<i>Lipocheilus carnolabrum</i>	338	30-65	134-200
<i>Lutjanus quinquelineatus</i>	4	25-30	58
<i>Pristipomoides typus</i>	1	67	36
Muraenidae			
<i>Gymnothorax</i> sp.	12	32-35	142-180
Nemipteridae			
<i>Nemipterus</i> sp.	8	21-39	36-140
<i>Scolopsis vosmeri</i>	14	19-29	150

Table 5. (Continued)

Family (Species)	No. of catch (pcs.)	Length (cm.)	Depth (m.)
Orectolobidae			
<i>Chiloscyllium indicum</i>	90	32-45	135-210
Scaridae			
<i>Scarus fasciatus</i>	1	40	40
Scorpaenidae			
<i>Scorpaena</i> spp.	5	14-24	137-160
Scyliorhinidae			
<i>Atelomycterus</i> sp.	37	48-120	135-210
Serranidae			
<i>Cephalopholis</i> sp.	5	27-35	63-160
<i>Epinephelus amblycephalus</i>	5	20-48	148-180
<i>E. epistictus</i>	156	27-76	135-178
<i>Epinephelus</i> sp.	18	20-32	36-86
Soleidae			
<i>Soles</i>	12	22-28	158-175
Sphyracnidae			
<i>Sphyracna</i> sp.	1	37	75
Squalidae			
<i>Squalus mitoukuri</i>	34	47-79	140-210
Synodontidae			
<i>Saurida</i> sp.	2	27-29	160
Triglidae			
<i>Satyrichthys</i> sp.	119	34-60	135-210

Lutjanidae were dominant both in weight, 812.40 kgs, and in number, 343 individuals of the economically important fishes caught. *Lipocheilus carnolabrum* was the major Lutjanidae species and also the dominant species among all the fishes caught, both in weight, 807.60 kgs, and in number 338 individuals.

Next came Serranidae at, 549.35 kgs. in weight and 184 individuals in number. *Epinephelus epistictus* were the only major species both in weight 543.90 kgs, and in number with 156 individuals.

The species composition of the catch did not differ widely at stations I, II and III (the first six operations). However, when compared with station IV (the last eight operations) the species composition of the catch was very different. The catch in the first six operations and the last eight operations is shown in Figures 3 and 4. The catch in weight and percentage of each family are given. 32.87% of the fishes caught by weight in the first six operations were Lethrinidae and 26.97% were Balistidae. However, in the last eight operations, 49.61% and 33.40% of the fishes caught by weight were Lutjanidae and Serranidae, respectively.

Figures 5 and 6 show the length composition of the two main species caught during operations No. 7-14. The size of *Lipocheilus carnolabrum* and *Epinephelus epistictus* was in the range of 30 to 65 cm. and 27 to 76 cm., respectively. The mean length (x) of both was 50.84 cm. and 59.03 cm., respectively. The water depth where they were found ranged from 135 to 200 metres.

The relationships between fishes caught in terms of number and weight by fishing operation are shown in Figure 7. The size of fish captured at station IV (the last eight operations) was larger than at the other stations. The number of fishes in the twelfth operation was highest, 204 individuals but in terms of weight, comparatively, less than the eighth operation in spite of a smaller catch in number 162 individuals. The smallest catch in terms of number and weight was in the fourth operation.

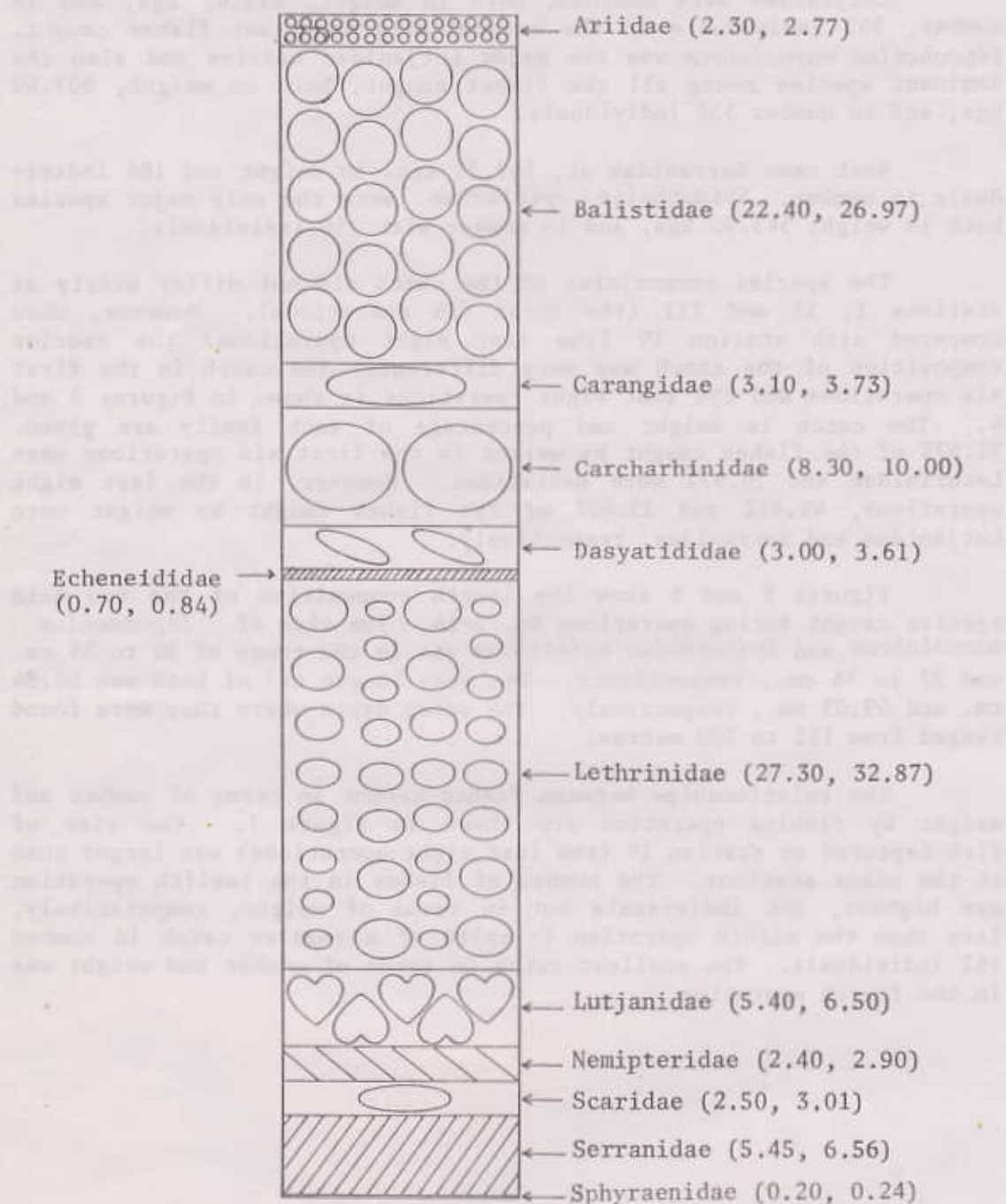


Fig. 3 Catch in operations No. 1-6, in weight (kgs) and as a percentage of total weight.

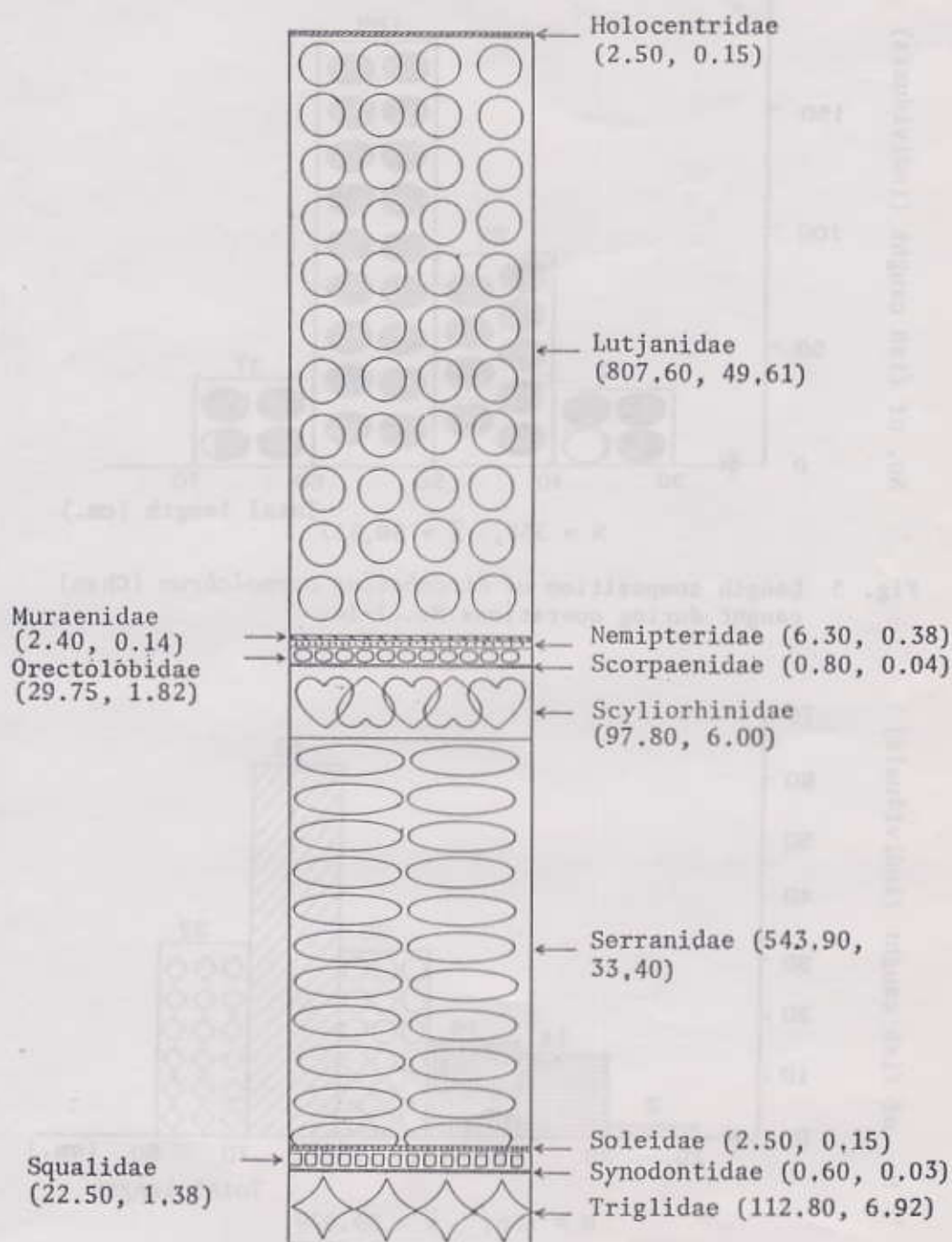


Fig. 4 Catch in operations No. 7-14, in weight (kgs) and as a percentage of total weight.

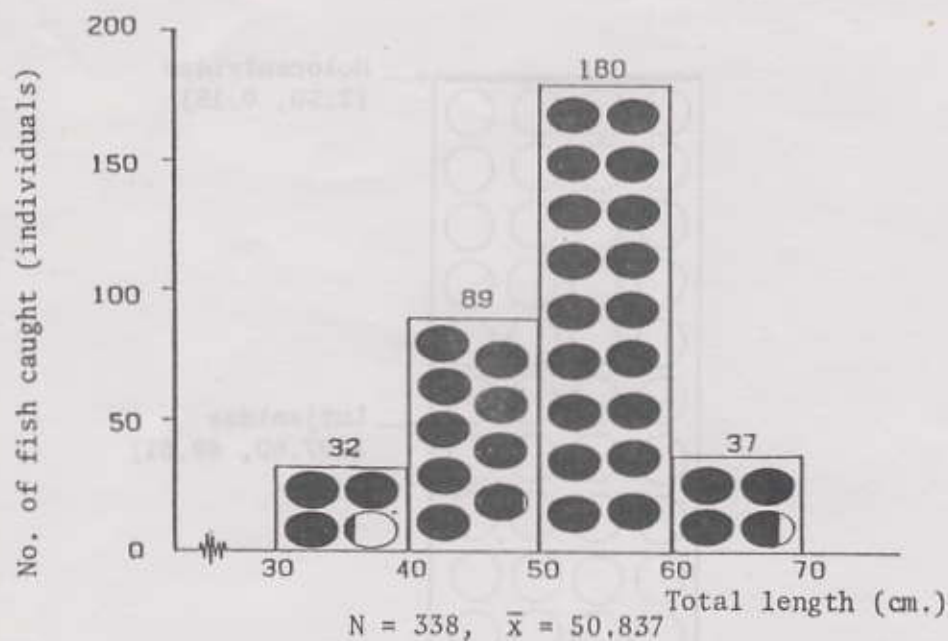


Fig. 5 Length composition of *Lipochelilus carnolabrum* (Chan) caught during operations No. 7-14.

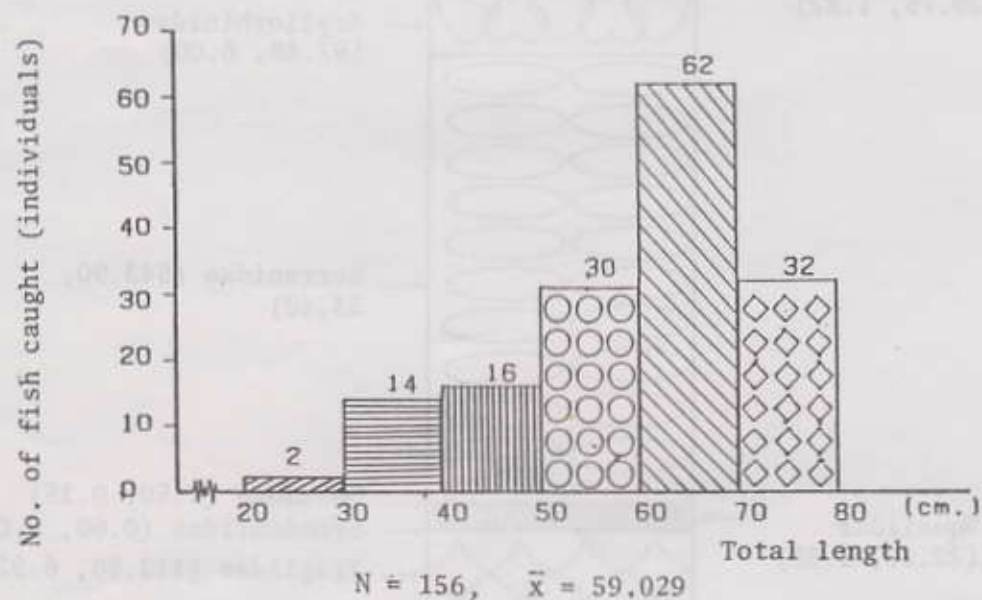


Fig. 6 Length composition of *Epinephelus epistictus* (Temminc & Schlegel) caught during operations No. 7-14.

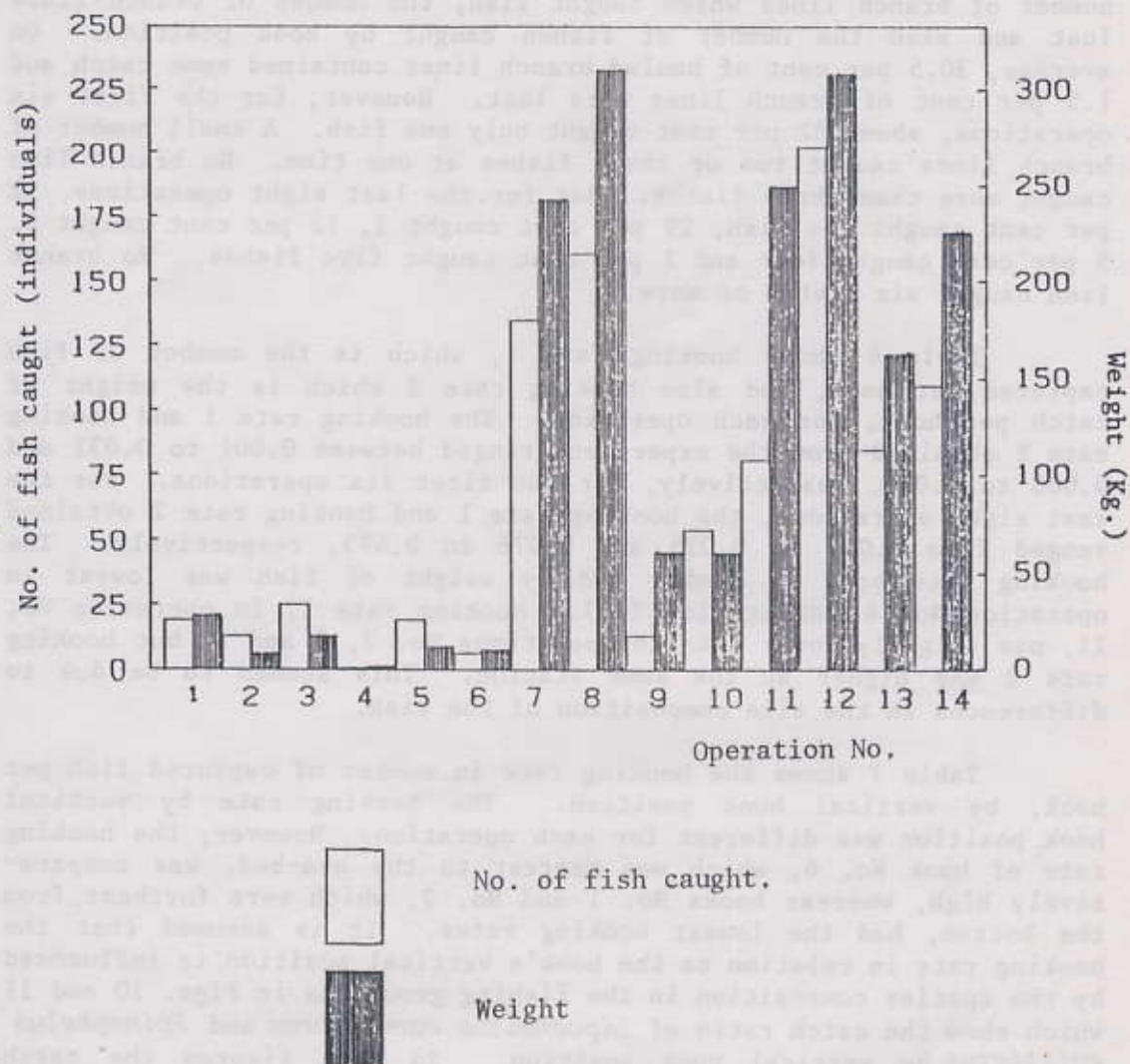


Fig. 7 Relationships between fishes caught in terms of number and weight by fishing operation.

Hooking rate and catch ratio

From Table 3 one can see the number of branch lines used, the number of branch lines which caught fish, the number of branch lines lost and also the number of fishes caught by hook position. On average, 30.5 per cent of hauled branch lines contained some catch and 1.5 per cent of branch lines were lost. However, for the first six operations, about 82 per cent caught only one fish. A small number of branch lines caught two or three fishes at one time. No branch line caught more than three fishes. But for the last eight operations, 52 per cent caught one fish, 29 per cent caught 2, 13 per cent caught 3, 5 per cent caught four and 1 per cent caught five fishes. No branch line caught six fishes or more.

Table 6 shows hooking rate 1, which is the number of fish captured per hook, and also hooking rate 2 which is the weight of catch per hook, for each operation. The hooking rate 1 and hooking rate 2 obtained from the experiment ranged between 0.001 to 0.031 and 0.003 to 0.034, respectively, for the first six operations. For the last eight operations, the hooking rate 1 and hooking rate 2 obtained ranged from 0.017 to 0.025 and 0.076 to 0.473, respectively. The hooking rate both by number and by weight of fish was lowest in operation No. 4 (at station III). Hooking rate 1, in operation No. 11, was slightly lower than in operations No. 7, 8 and 12 but hooking rate 2 was higher at the same station. This seemed to be due to differences in the size composition of the fish.

Table 7 shows the hooking rate in number of captured fish per hook, by vertical hook position. The hooking rate by vertical hook position was different for each operation. However, the hooking rate of hook No. 6, which was 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 rates. It is assumed that the hooking rate in relation to the hook's vertical position is influenced by the species composition in the fishing ground as in Figs. 10 and 11 which show the catch ratio of *Lipocheilus carnolabrum* and *Epinephelus epistictus* by vertical hook position. In both figures the catch ratios for hooks No. 5 and 6 were highest, whereas hook No. 1 had the lowest catch ratio.

Table 6. Hooking rate 1 and hooking rate 2 by fishing operation.

FISHING OPERATION	No. of BRANCH LINES	No. of HOOKS	FISH CAUGHT	HOOKING RATE 1	WEIGHT OF CATCH	HOOKING RATE 2
1	145	870	20	0.023	29.20	0.034
2	148	888	14	0.016	9.50	0.010
3	138	828	26	0.031	17.90	0.022
4	129	774	1	0.001	2.30	0.003
5	129	774	20	0.026	13.20	0.017
6	125	750	7	0.009	11.40	0.015
7	143	858	136	0.159	243.50	0.284
8	140	840	162	0.193	311.50	0.371
9	135	810	14	0.017	61.90	0.976
10	88	528	55	0.104	60.85	0.115
11	88	528	82	0.155	249.70	0.473
12	136	816	204	0.250	308.65	0.378
13	128	768	86	0.112	164.35	0.214
14	133	798	111	0.139	227.40	0.285
TOTAL	1805	10830	938	0.087	1710.90	0.158

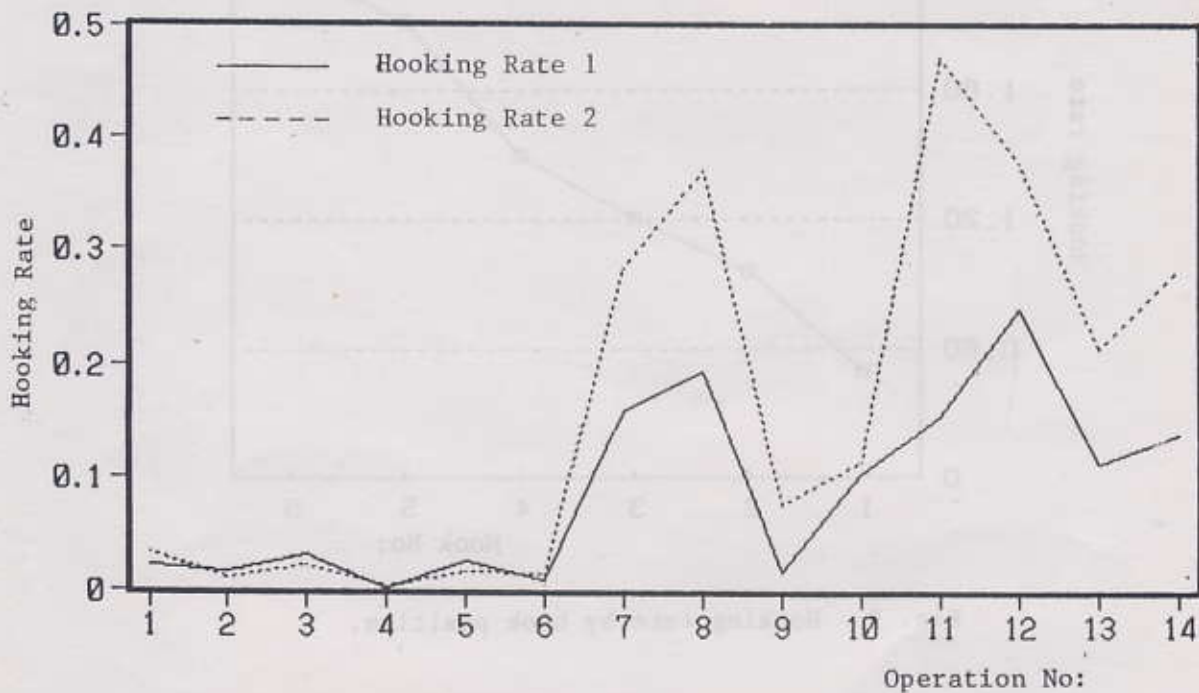


Fig. 8 Relationship between hooking rate 1 and hooking rate 2.

Table 7 Hooking rate by vertical hook position.

Hook's position	Fishes caught (individuals)	Hooking Rate (%)
1	54	0.499
2	104	0.960
3	131	1.210
4	162	1.496
5	230	2.124
6	257	2.373
Total	938	8.700

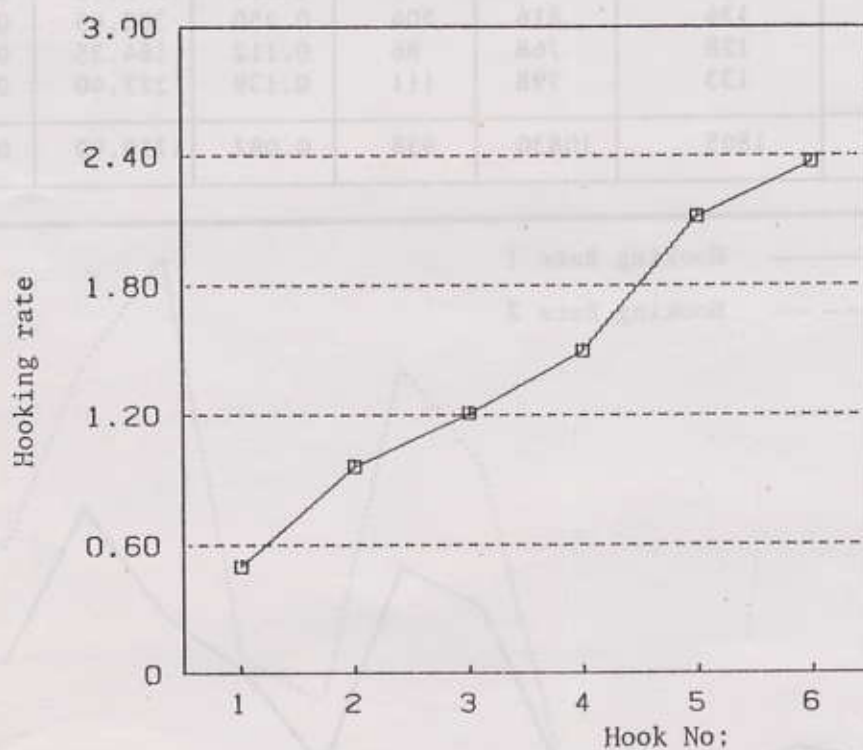


Fig. 9 Hooking rate by hook position.

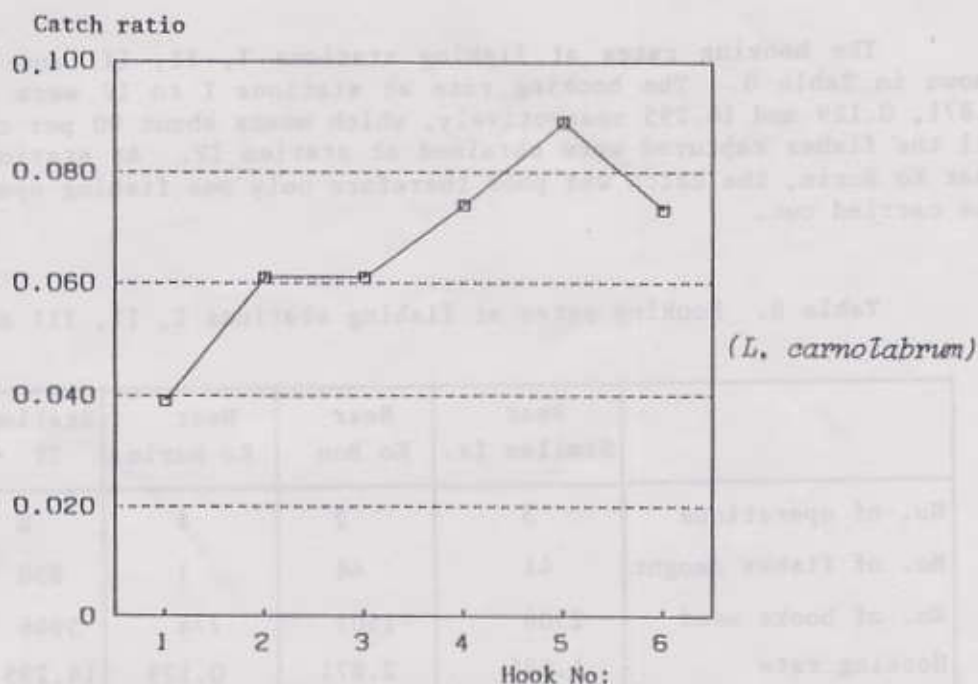


Fig. 10 Catch ratio of *L. carnolabrum* by vertical hook position.

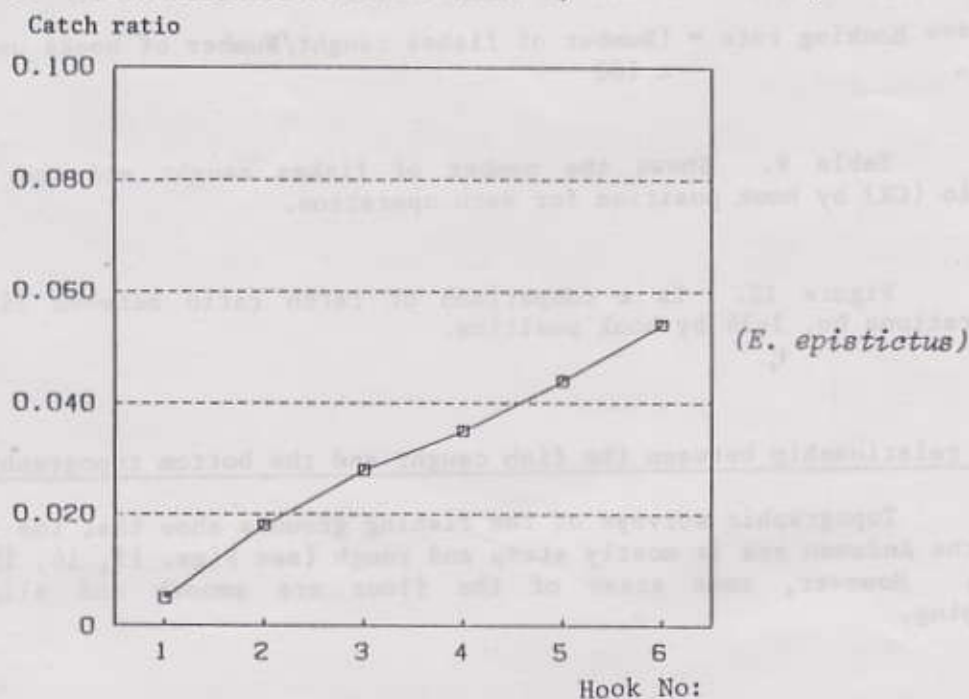


Fig. 11 Catch ratio of *E. epistictus* by vertical hook position.

Catch ratio : proportion of hook position to the total catch of all hooks in fishing operations No. 7-14.

The hooking rates at fishing stations I, II, III and IV are shown in Table 8. The hooking rate at stations I to IV were 1.635, 2.871, 0.129 and 14.295 respectively, which means about 90 per cent of all the fishes captured were obtained at station IV. At station III, near Ko Surin, the catch was poor therefore only one fishing operation was carried out.

Table 8. Hooking rates at fishing stations I, II, III and IV.

	Near Similan Is.	Near Ko Bon	Near Ko Surin	Station IV
No. of operations	3	2	1	8
No. of fishes caught	41	46	1	850
No. of hooks used	2508	1602	774	5946
Hooking rate	1.635	2.871	0.129	14.295

*** Hooking rate = (Number of fishes caught/Number of hooks used)
x 100

Table 9. Shows the number of fishes caught and the catch ratio (CR) by hook position for each operation.

Figure 12. Is a comparison of catch ratio between fishing operations No. 1-14 by hook position.

The relationship between the fish caught and the bottom topography.

Topographic surveys of the fishing grounds show that the floor of the Andaman sea is mostly steep and rough (see Figs. 13, 14, 15 and 16). However, some areas of the floor are smooth and slightly sloping.

Table 9. Number of fishes caught and Catch Ratio (CR) by hook position.

Hook's Position Operation		1	2	3	4	5	6	Total
1	Catch	0	0	3	2	6	9	20
	CR	0	0	0.150	0.100	0.300	0.450	0.021
2	Catch	0	0	2	2	3	7	14
	CR	0	0	0.143	0.143	0.214	0.500	0.015
3	Catch	2	0	1	3	11	9	26
	CR	0.077	0	0.038	0.115	0.425	0.346	0.031
4	Catch	0	0	0	0	0	1	1
	CR	0	0	0	0	0	1	0.001
5	Catch	0	0	2	5	7	6	20
	CR	0	0	0.100	0.250	0.350	0.300	0.021
6	Catch	0	1	0	1	4	1	7
	CR	0	0.143	0	0.143	0.571	0.143	0.007
7	Catch	5	9	18	20	41	43	136
	CR	0.037	0.066	0.132	0.147	0.301	0.316	0.145
8	Catch	15	13	28	29	38	39	162
	CR	0.093	0.080	0.173	0.179	0.235	0.241	0.173
9	Catch	1	0	2	2	4	5	14
	CR	0.071	0	0.143	0.143	0.286	0.357	0.015
10	Catch	0	6	6	9	12	22	55
	CR	0	0.109	0.109	0.164	0.218	0.400	0.059
11	Catch	3	12	8	15	17	27	82
	CR	0.037	0.146	0.098	0.183	0.207	0.329	0.087
12	Catch	13	36	40	41	40	34	204
	CR	0.064	0.176	0.196	0.201	0.196	0.167	0.217
13	Catch	3	8	12	15	24	24	86
	CR	0.035	0.093	0.114	0.176	0.279	0.279	0.092
14	Catch	12	19	9	18	23	30	111
	CR	0.108	0.171	0.081	0.162	0.207	0.270	0.118
Total	Catch	54	104	131	162	230	257	938
	CR	0.058	0.111	0.140	0.173	0.245	0.274	0.100

CR = The number of fishes caught in each hook position per operation.

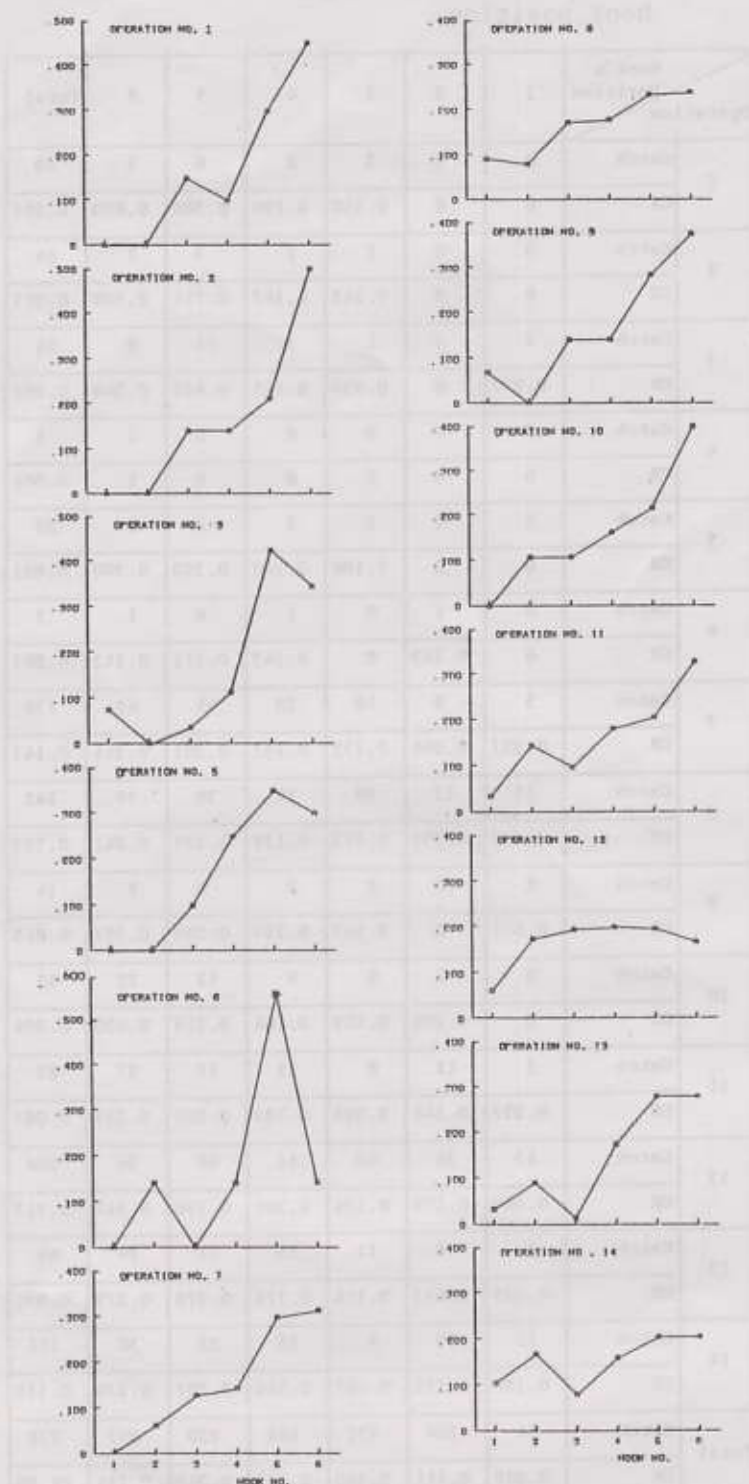


Fig. 12 Comparison of Catch Ratio Between fishing operations No. 1-14 by hook position.

Figs. 13, 14, 15 and 16 show the catch distribution by branch line and by species compared with the bottom topography in fishing stations I, II, III, and IV, respectively. The floor of fishing station I is rather rough and steep, looking like an underwater mountain. The depth of the sea ranges from 36 metres to 78 metres.

The fishfinder detected some small schools of demersal fish in this area. The floor of fishing station II is also rather rough and steep. The fishfinder detected rather big schools of small fishes, such as *Lutjanus quinquelineatus*. However, only 4 *L. quinquelineatus* were caught. On the contrary *Abalistes stellatus*, *Gymnocranius robinsoni* and *Epinephelus* sp. appeared in widely spread formations.

The floor of fishing station III is rather smooth and slightly sloping. This fishing ground is not suitable for bottom vertical long-line gear.

The floor of fishing station IV was part of the continental-shelf and rather rough. The schools of demersal fish did not show on the recording paper of the fishfinder because the equipment was not properly adjusted, however, there appeared to be an evenness in the catch at this fishing station since the catch was good both horizontally and vertically. No differences in the swimming layers of the demersal species were found but, there seemed to be some differences in school formation. *Lipocheilus carnolabrum*, *Satyrichthys* sp., *Scolopsis* sp. and shark appeared in widely dispersed formations, however, *Epinephelus epistictus* and *Soles* seemed to form dense schools.

Immersion time

Fig. 17 shows the relationship between the hooking rate and immersion time at each fishing operation. From the experimental fishing operations it was found that the length of immersion time of bottom vertical longline did not seem to affect the catch considerably, however, results show that an immersion time in the range of 130 minutes to 270 minutes. The time of day was more important than the immersion time is most effective. Table 10 shows the hooking rate by time of operation. At fishing station IV, the hooking rate differed with the time of operation, it was found that the daytime hooking rate (1001-1700 hrs) was 20.51 and the morning rate (0500-1000 hrs) was 12.86. However, at fishing stations I, II and III, on the contrary, the better catch or higher hooking rate was during the morning. Furthermore, it was found that a bad catch (low hooking rate) occurred in the evening (1701-2100 hrs) at all fishing stations.

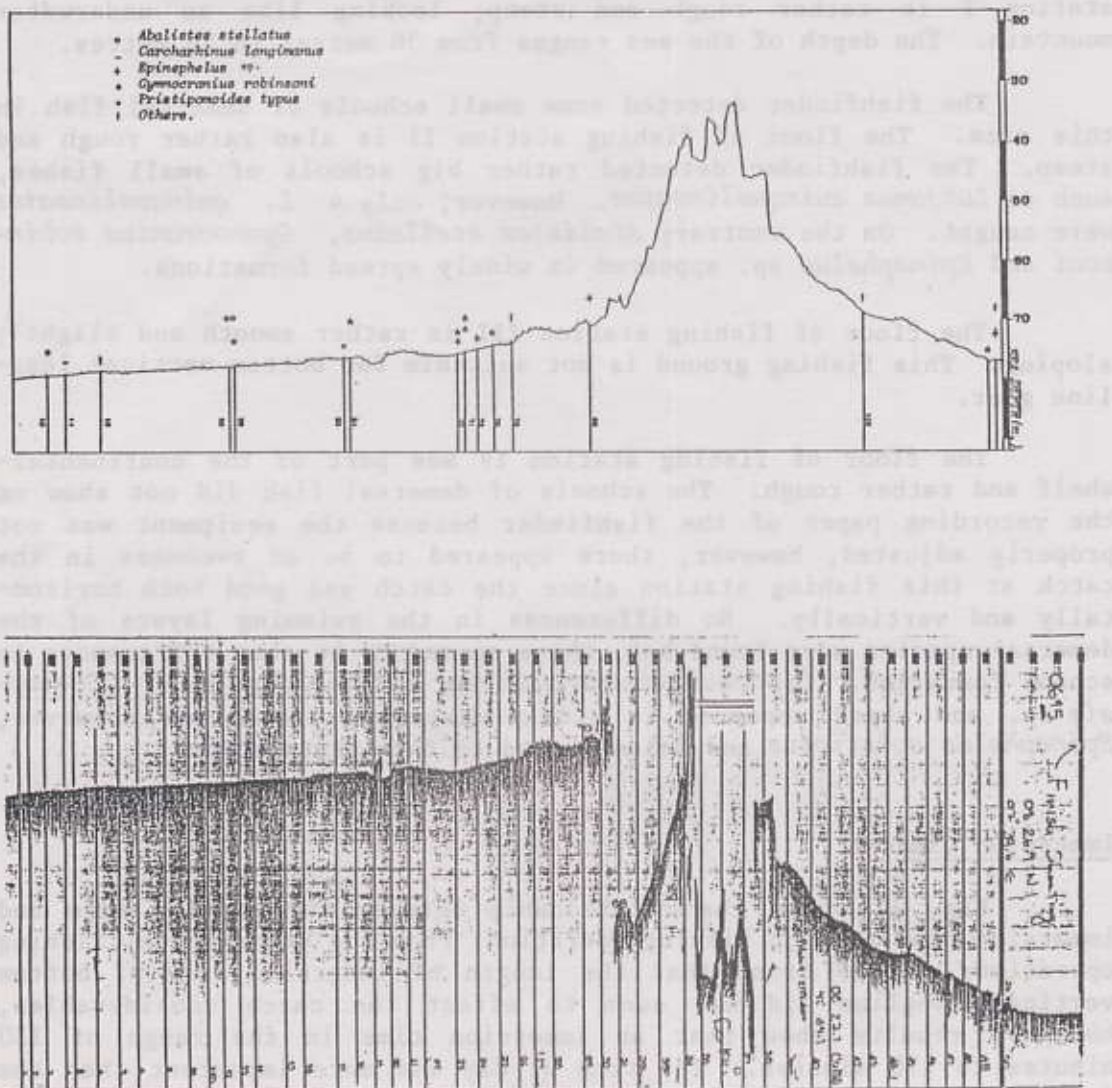


Fig. 13 Catch distribution by branch line and by species compared with the bottom topography at fishing station I (Operation No. 1)

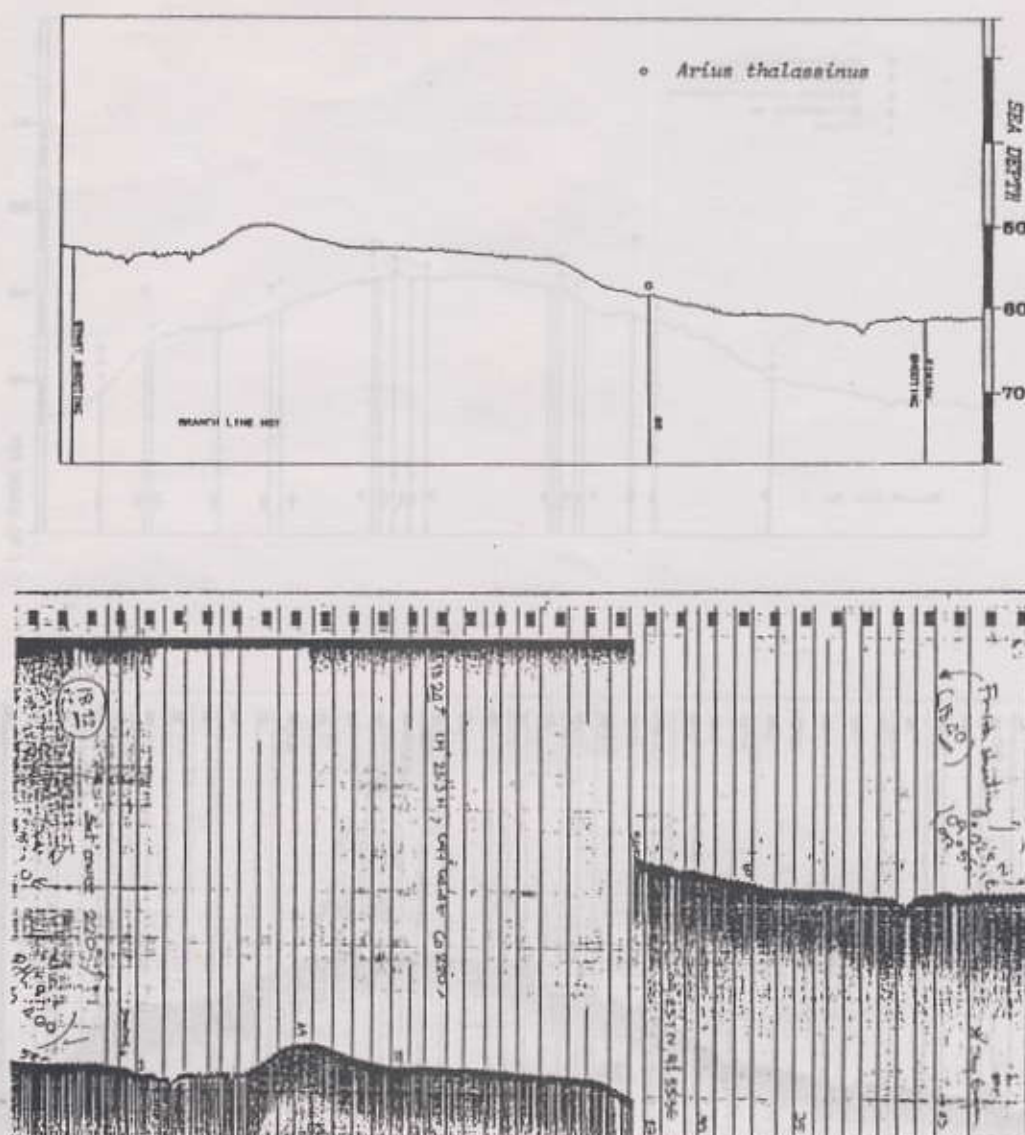


Fig. 15 Catch distribution by branch line and by species compared with the bottom topography at fishing station III (Operation No. 4)

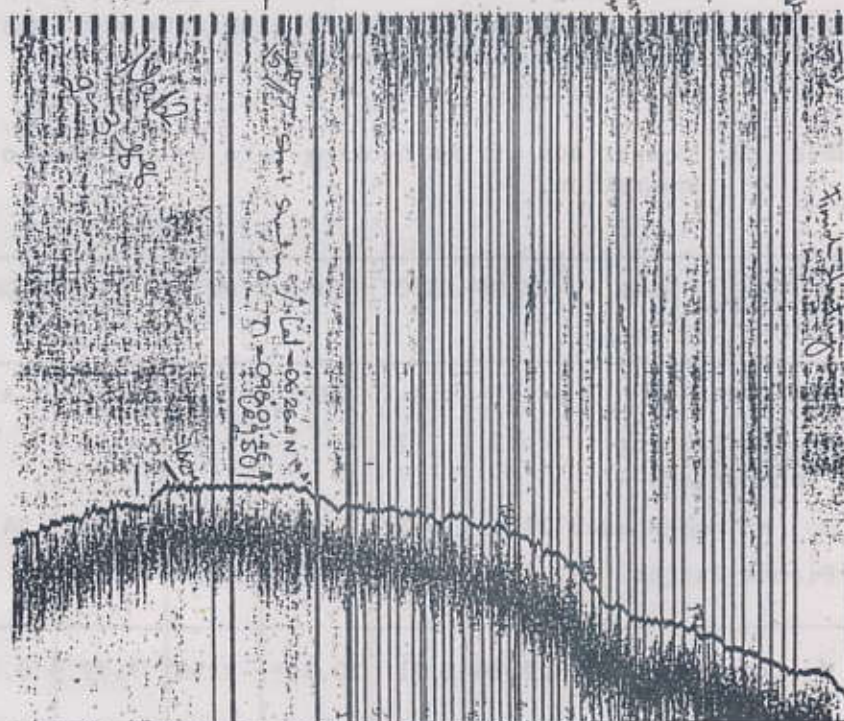
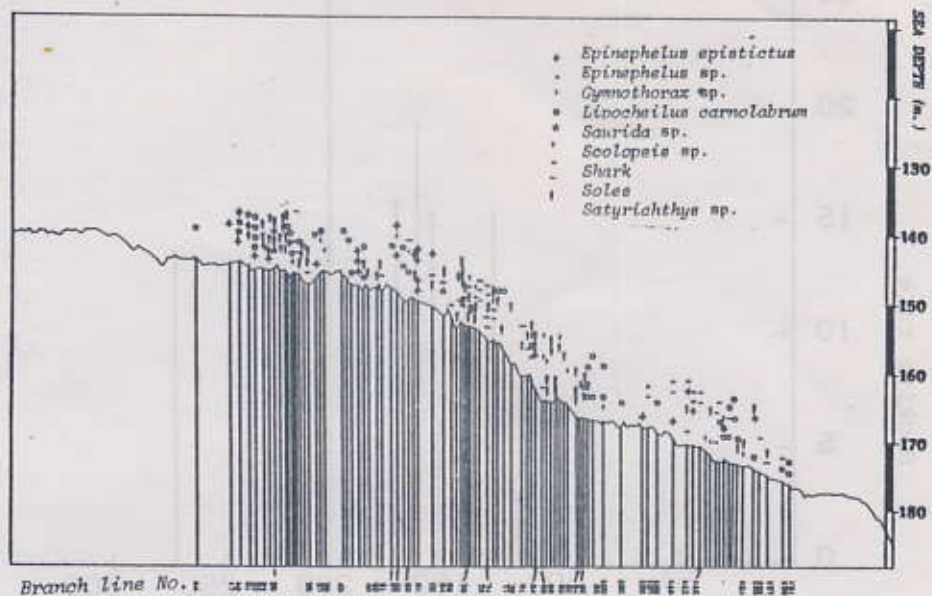


Fig. 16 Catch distribution by branch line and by species compared with the bottom topography at fishing station IV (Operation No. 12).

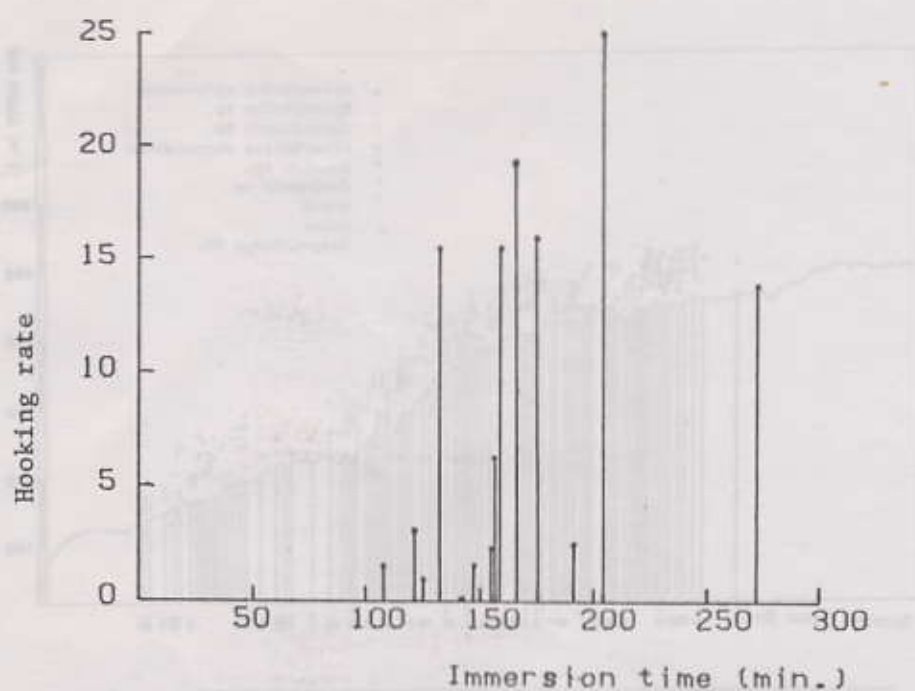


Fig. 17 Relationship between the hooking rate and immersion time of each fishing operation.

Table 10. Comparison of the hooking rate by the time of operation.

Item \ Time	0500-1000		1001-1700		1701-2100	
	IV	A	IV	A	IV	A
No. of fishing operations	3	2	3	1	2	3
No. of hooks used	2154	1698	2184	774	1608	2412
Fishes caught	277	46	448	20	125	22
Hooking Rate	12.86	2.71	20.51*	2.58	7.77	0.91

A : Fishing station Nos. I, II, III

SUMMARY

The fish caught by bottom vertical longline belonged to 21 families, namely, Ariidae, Balistidae, Carangidae, Carcharhinidae, Dasyatidae, Echeinidae, Holocentridae, Lethrinidae, Lutjanidae, Muraenidae, Nemipteridae, Orectolobidae, Scaridae, Scorpaenidae, Scyliorhinidae, Serranidae, Soleidae, Sphyraenidae, Squalidae, Synodontidae and Triglidae: and 31 species.

Total catch both in number and weight were 938 individuals and 1710.9 kgs, respectively.

Lipocheilus carnolabrum was the dominant species of the economically important fish caught 807.6 kgs in weight, and 338 individuals in number. Next was *Epinephelus epistictus*, 543.9 kgs in weight, and 156 individuals in number.

The hooking rate percentage obtained from the experiment ranged between 0.10-3.10 per cent for the first six operations, and 1.70-25.00 per cent for the last eight operations.

The overall hooking rate was about 8.70 per cent. However, the hooking rate of the hooks nearest the sea-bed (Hook No. 6) were comparatively high, whereas the hooks furthest from the sea-bed had the lowest hooking rate.

About 30.51 per cent of hauled branch lines held some catch and 1.47 per cent of branch lines were lost.

There seemed to be some unevenness in the catch obtained at each fishing station. That is to say there were spots where the catch was good both horizontally and vertically, and there were other spots where during the same operation no fish were caught on adjacent branch lines.

The fishing ground off Satun from Lat. 06°21.40 N to 06°26.40 N and Long 097°59.80 to 098°02.90 E., ranged from 134 metres to 210 metres in depth and featured a concentrated catch of *Lipocheilus carnolabrum* and *Epinephelus epistictus* compared to the other fishing grounds.

The immersion time for bottom vertical longline was in the range of 130 to 270 minutes. However, the time of the operation was of more relevance. The mean catching efficiency was very high in the day-time.

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