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STUDIES ON MESH SELECTIVITY AND PERFORMANCE OF THE NEW FISH-CUM-PRAWN TRAWL AT PESALAI, SRI LANKA

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In 1984, the small-scale fisheries project of the Bay of Bengal Programme (BOBP) introduced a new design of prawn-cum-trawl net in Pesalai, Sri Lanka, to help augment the catches of finfish and shellfish in the region. As part of this pilot activity, the project also conducted a management study: to find out the optimum mesh size of the codend of the trawl. Toward this end, some experiments were conducted off Pesalai during April and July 1984. This paper discusses and analyzes the findings of these experiments.

Three commercial prawn trawlers of the same class, and three fish-cum-prawn trawls of the same dimension and construction, were employed for the mesh selectivity experiments. A scientist from NARA (National Aquatic Resources Agency), Colombo, carried out the study, in cooperation with Mr. G. Pajot, BOBP Senior Fishing Technologist, and Dr. K. Sivasubramaniam, Senior Fisheries Biologist. The author thanks these two Scientists for their advice and help. He also thanks Mr. M.G.K. Gunawardane, Research Assistant, Mr. W.G. Sirisena, Lab Attendant, NARA, and Mr. M.J.M. Soosai, Gear Instructor, Ministry of Fisheries, Sri Lanka, for their assistance. He is grateful to Dr. S. Garcia of the FAO, Rome, for his comments on the paper.

The small-scale fisheries project of the Bay of Bengal Programme is funded by SIDA (Swedish International Development Authority) and executed by the FAO (Food & Agriculture Organization of the United Nations). The project seeks to develop, demonstrate and promote technologies and methodologies to improve the conditions of small-scale fisher-folk. The project covers five countries in the region — Bangladesh, India, Malaysia, Sri Lanka and Thailand.

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1. INTRODUCTION

Fishing for finfish and shellfish in the Palk Bay region commenced centuries ago. This region has a shallow flat bottom, averaging 9 m deep and has been identified as suitable for trawling (Malpas, 1926; Berg, 1971). The soft mud and sand bottom found in this region provide the ideal habitat for prawn. Exploratory trawling surveys carried out in the early part of this century had shown that this region has high productive potential for finfish, shellfish, and in particular for prawn (Malpas, 1926). However, in the past the finfish catch obtained from Palk Bay were mainly small fish of low commercial value dominated by Leiognathids.

The small-scale fisheries project of the Bay of Bengal Programme (BOBP) had developed a design of fish-cum-prawn trawl to help augment the catches of finfish and shellfish in the region. It introduced the trawl at Pesalai, early 1984. During this experimental phase, the project also aimed at finding out the optimum mesh size for the codend from the management point of view. Towards this end, some experiments were conducted during April and July 1984. Simultaneously a preliminary study of the status of exploited stocks was also undertaken, using the data from the experimental and traditional gear.

Because of the short period of study and the limitations in sampling, this analysis is not free of any bias or error.

2. FISHERIES

Three types of gear viz., trawl, gillnet and trammel net, are employed in the prawn fishery in Palk Bay. Trawling is conducted in a 9 m mechanized craft with a 30 hp inboard engine, popularly known as a 3½ ton boat. During the study period there were 66 active craft based at Pesalai and 88 migrant craft (from Jaffna) based at Talaimannar. Each year, the migrant craft remain at Talaimannar from May to August, the peak season for prawn. The main prawn grounds exploited by Pesalai fishermen are marked in Fig. 1. Fishing activities are intense on ground A (Palk Bay), from May to September, whereas a fair amount of fishing takes place on ground B (Gulf of Mannar) between October and March. Trawl fishing for prawns is carried out mainly during the night, between 1800 and 0600 hours; during certain months (when prawn catches are low) day-time trawling is carried out to catch pony fish.

There are over five hundred 6 m fibreglass boats with outboard motors at Talaimannar, 30 at Pesalai and 30 at Kurusipadu (a village between Talaimannar and Pesalai) undertaking seasonal prawn fishing with trammel nets and gillnets. A small number of log craft (‘theppam’) are also engaged in these types of fisheries. Their activities are confined to the morning hours. The dominant species of prawn caught by trammel and gillnets is Penaeus *indicus,* while that caught by trawling is mainly *Penaeus semisulcatus.* As a result, the two fisheries may be regarded as non-interacting, for assessment purposes.

3. MESH SELECTIVITY EXPERIMENTS

3.1 Material & Methods

There are different experimental techniques available for selectivity studies : the Alternative Haul Technique, the Simultaneous Haul Technique and the Covered Codend Technique (Pope et *al*. 1975). Apart from these an analytical technique has been recently developed, using length frequency data to obtain the selectivity pattern (Pauly, 1982). None of the techniques mentioned above are free from shortcomings. For example the Covered Codend Technique applied here has frequently been criticized on the ground that some fish which would normally escape from the codend if it were uncovered, are deterred by the presence of the cover. However, this technique was used for mesh selectivity studies in Pesalai, because of the technique's direct application in calculating trawl gear selectivity. Adequate precautions were taken to reduce the shortcomings mentioned above, by allowing enough space between codend webbing and the cover net (Fig. 2).

3.1 .1. Vessel

Three commercial prawn trawlers of the same class from Pesalai were employed for the mesh selectivity experiments. The specifications of these craft are : overall length 9 m, beam 3 m, gross tonnage 3.5 tons, Yanmar inboard engine 30 hp fitted with a 2 to 1 reduction gear ratio. A cross bar was fixed across the widest breadth, projecting 2 m outward from either side of the craft for the purpose of tying the trawl warps.

3.1.2. Trawl gear

The experiment used three fish-cum-prawn trawls of the same dimension and construction, with meshes 290 x 50 mm at the wings and top belly, 135 x 40 mm at baitings and 160 x 25 mm, 160 x 30 mm and 160 m x 40 mm at respective codends. The head rope length was 19.9 m, the foot rope 22.7 m and the bridle length 10 m.

The corresponding specifications of the traditional trawl were 255 x 45 mm at the wings and top belly, 80 x 40 mm at the lower belly, 80 x 32 mm at the baitings, 130 x 25 mm at the upper part of the codend and 250 x 22/25 mm at the lower part of the codend. The head rope was 14.9 m, foot rope 20 m and the bridle 5.5 m.

The otter boards of the experimental trawl nets (25 mm and 40 mm codend) used in one boat were lighter, 28-30 kg, while those of the other experimental trawl net (30 mm codend) and the rest of the commercial trawl nets (22-25 mm codend) weighed 35 kg each.

The codend protective net or 'chafer' was removed before connecting the fine small mesh (IO mm) cover to the codend. The circumference of the cover net and the length from the attachment at baitings to the hind margin of the cover were bigger than that of the codend. There were two iron rings attached to the cover, with a distance between them, to keep ample space between the codend and cover (Fig. 2).

3.1.3 Speed of tow

The trawling speed of the vessels employed in the experiment was estimated at 2.933 km/h, while that for the traditional trawl was 2.816 km/h.

3.2 Results

The selectivity experiment was carried out in 1984 between April 24 and 26 and from July 10 to 13. There were seven fishing trips with a total of 20 hauls made during these periods. The duration of each tow was three to four hours. The first two tows during each trip were carried out with the cover net, while the last one was without the cover net. This procedure was adopted, instead of alternate hauls with cover and without cover, in order to minimize delay and interference in carrying out commercial operations. The number of hauls made by the respective trawl nets were as follows:

Date	Codend mesh size	Number of hauls
24-4-84	25 mm	3
25-4-84	30 mm	3
* 26-4-84	40 mm	2
1 O-7-84	40 mm	3
11-7-84	25 mm	3
12-7-84	30 mm	3
13-7-84	30 mm	3

**** Net damaged during the 3rd tow.***

Trawling on fishing ground A (Fig. 1) was carried out at 9-l 2 m depths during the experimental period. Most of the traditional trawls were also operated on the same ground and in the same depth range during this period. The catches in the cover and the codend were weighed and their length measured separately at the end of each haul.

The species-wise weights of larger marketable fish were taken and the lengths of all fish measured if the catch was small ; otherwise a sample of the catch was taken for the purpose. In the case of small fish (trash fish), a sample was taken to find out the species composition and their lengths. Traditional trawl catches were also sampled to collect the same information. The stretched mesh sizes of the codend and the cover of the experimental trawl were measured at the end of the day's trawling operation.

The mean and standard deviations of the stretched mesh sizes of the codend and the respective covers are given in Table 1. The co-efficient of variations of the measurements was less than seven per cent, indicating reasonable uniformity of the mesh sizes during the experiment.

Table 2 gives the mean percentage composition of large prawn, marketable fish (large) and trash fish. The ratios in weight of prawn to by-catch varied from 1 : 4 to 1 : 18 for different codend mesh sizes.

Table 3 gives the percentage catch (by weight) of each species in the codend and the cover for different codend mesh sizes of fish-cum-prawn trawl nets. It may be seen that the 25 mm codend retained aimost all the large prawns, while the degree of escapement increased with increase in the codend mesh sizes. This was also true of the by-catch. The escapement of marketable fish was only in the 40 mm codend mesh, even where it was only 4 per cent.

Fig. 3 shows that there seems to be no correlation between the percentage of ***P. semisulcatus*** (by weight) which escaped to the cover and the total catch in the codend, for the 30 mm and 40 mm mesh codend of the fish-cum-prawn trawl; there was some indication that the percentage of escapement decreased with increasing codend catch in 25 mm mesh codend. It is possible that the codend load did not interfere with the selectivity process of capturing prawn, and the presence of the cover might not have had a "masking" effect on the prawn. Briggs (1983) observed a significant correlation between the amount of bulk fish in the codend and the proportion of available ***Nephrops*** retained by the codend. The results of the present experiment appear to be at variance with his observations. Although it has to be admitted that the mesh selectivity data in the present study are limited, it should be borne in mind that during the study period, the density of the by-catch was observed to be low most of the time-a condition which might otherwise have masked the selectivity of prawn.

fig. 4 shows the length frequency polygon of ***P. semisulcatus*** in the codend and the cover separately for 25 mm, 30 mm and 40 mm codend mesh sizes. While there was no escapement to the cover in the 25 mm codend mesh size, the 30 mm codend released a fair number of ***P. semisulcatus*** of carapace length 1.25 to 2.75 cm, while the 40 mm codend released a larger number of the same length range. The modal lengths (carapace) of capture in the codend and the cover were of the same value (2.25 cm), indicating the predominance of this length group in the fishing area during the study period.

Table 4 summarizes the size particulars of the dominant *P. semisulcstus* and the important fish species in the codend and cover catches. The quartile length ranges were estimated to the nearest group interval to indicate the size ranges mostly caught. These summaries were computed from the April data alone because the intensity of sampling for the traditional trawl catches for length data was low during the month of July. The mean carapace lengths of *P. semisulcatus* escaping to the cover were observed to have increased with increase in mesh size. The same was true of inter-quartile length range (i.e., 25 to 75 per cent cumulative frequency length range).

The mean lengths and the ranges of lengths of the cover as well as the codend catches of fish species were generally smaller for the 40 mm codend mesh. This may be due to the fact that the data was obtained from the trawl exercises conducted south of Pesalai where juveniles of finfish were predominant. There was no escapement from the 25 mm codend in the case of *Upeneus vitatus,* while no specimen of *Seleroides leptolepis* was found in the cover of the 30 mm fish and 40 mm codend trawls (Table 3).

The figures for the traditional trawl show slightly higher values in the sizes of *P. semisulcatus* and fish, when compared with the 25 mm codend trawl. However, limitations in the coverage of traditional trawls for length sampling prevent any firm conclusions.

Fig. 5 gives the selectivity curves for the 30 mm codend and 40 mm codend. The April experimental data were used for this purpose, because the coverage by both the experimental trawl and the traditional trawls was the same in respect of season and depth. The curves were drawn free hand. The 50 per cent retention lengths, and the selection range (25 and 75 per cent retention lengths) were read from the curves. The 50 per cent retention lengths were also calculated by the method of moving averages (Pope *et al.,* 1975). They are summarized below:

Codend mesh size	50 per cent retention length (carapace)	Selection range (carapace)	Method
(a) 30 mm	1.95 cm	1.50-2.35 cm	Free hand drawing
40 mm	2.25 cm	1.70-2.75 cm	"
(b) 30 mm	1.96 cm	—	Moving average
40 mm	2.27 cm	—	"

It may be seen that the 50 per cent retention length of 40 mm codend mesh was 2.27 cm and that of the 30 mm codend mesh, 1.96 cm. It may be recalled that the modal size in the fishing area was 2.25 cm (Fig. 4). Theoretically therefore, there is the possibility of a larger number of sizes escaping from the 40 mm mesh codend as compared to the 30 mm mesh codend. However, the selection ranges of both codends overlap (see also Fig. 4), indicating that no clear-cut selection process takes place from these two mesh sizes, as reported by others (Gulland, 1983). Van Zalinge *et al.* (1981), gave a selection range, 1.74-1.96 cm carapace length, from a selection curve obtained by the alternate haul technique with a 43 mm codend net for *P. semisulcatus* in the Gulf between Iran and the Arabian Peninsula. El Musa (1982) obtained a selection range 1.04-1.34 cm carapace length, for the Gulf *Parapenaeopsis stylifera* with a 35.2 mm mesh codend net using the Covered Codend Technique. He speculated that this selection range is largely valid for *P. semisulcatus.* However, the present experiment gave higher selectivity length values for the two comparable codend mesh sizes.

4. COMPARISON OF PERFORMANCE OF FISH-CUM-PRAWN TRAWL AND TRADITIONAL TRAWL

Table 5 gives the index of relative occurrence of different species of finfish and shellfish caught by the fish-cum-prawn trawl and the traditional trawl. The indices were computed from the following formula :

$$\text{Index of occurrence of a species} = \frac{\text{Number of hauls containing the species}}{\text{Total number of hauls}} \times 100$$

There was no appreciable change in the indices of occurrence apart from sampling variations and presence of a few less abundant species, in one or the other trawl.

Table 6 gives the species composition of the catch by the fish-cum-prawn trawl with 25 mm, 30 mm, and 40 mm codend and the traditional trawls with 22-25 mm codend, for April and July respectively. It is seen that the contribution of Leiognathids was higher in the 30 mm and 25 mm codends and that of crabs was higher in the 40 mm and also in the 25 mm codends. Otherwise, no definite pattern could be seen with respect to other components.

Fig. 6 compares the monthly catch-per-unit effort values of prawn and by-catch between the traditional trawl and the fish-cum-prawn trawls of 25 mm and 30 mm codend categories. The 40 mm codend catch rates were not considered because of the lack of data between January and June 1984. The increase in the catch per unit effort values in the fish-cum-prawn was small for *P. semisulcatus* but substantial with respect to by-catch.

Fig. 6 also compares the net earnings per running hour of the traditional trawl with the fish-cum-prawn trawl. It shows that the net earnings for the fish-cum-prawn trawl were more than those for the traditional trawl for all months except May. Both types of trawl brought in similar quantities of prawn, which contributed to the major share of earnings. The catch, effort and economic data are given in Table 7 for the month of April 1984. The gross earnings from the fish-cum-prawn trawl were marginally higher than that from the traditional trawl, although the quantity of catch was distinctly more for the former gear. This was because the average price of the prawn landed by the traditional trawl was more than that of the fish-cum-prawn trawl. It may be recalled that the mean length and the selection range of *P. semisulcatus* were slightly higher for the traditional trawl than for the fish-cum-prawn trawl with 25 mm and 30 mm codend mesh sizes (Table 4). The average prices of the fish landed by the traditional trawl and the fish-cum-prawn trawl were more or less the same. However, the fish-cum-prawn trawl netted larger quantities and this contributed to higher earnings.

Since the observation period was limited to just one month it cannot be said that the fish-cum-prawn trawl would perform better during the lean prawn season by bringing more fish and prawn than the traditional trawl; the present results should be viewed as indicative.

5. ESTIMATION OF STANDING STOCKS

The average standing stocks of *P. semisulcatus* and the by-catch on fishing ground A (Fig. 1), an area of approximately 80,000 ha (seen from the admiralty map), were estimated by the swept area method. These estimates were made for each month from January to June 1984.

Let A = total area fished by the fishery
a = area swept by the trawl per hour
Y = average catch per unit effort for a given month
l = length of effective horizontal opening of the trawl
v = trawling speed
e = trawl efficiency
d = density of the prawn/by-catch population
B = corresponding biomass available in area A.

The following computations can be made for each month.

$a = lv$

$d = Y/(e.a)$

$B = d.A$

Since the fishery selects the highest density area, estimates of d and B are probably overestimates. However, a multiplying factor of 0.7 was used instead of the 0.5 considered by Antony Raja (1984) when analyzing the fish-cum-prawn trawl data obtained from the Indian side of the Palk Bay region, to calculate the length of effective horizontal opening of the trawl, in order not *to* overestimate the stocks (Garcia and Van Zalinge, 1982). The density of the stocks on ground A is thus estimated as follows:

A = 80,000 ha (Ground A on Fig. 1)

Length of trawl head rope: fish-cum-prawn trawl (HFPT) : 19.9m
traditional trawl (TT) : 14.8 m

l = 0.7 x 19.9 = 13.93 m (HFPT)
= 0.7 x 14.8 = 10.36 m (TT)

v = 2.933 km/h (HFPT)
= 2.816 km/h (TT)

a = 40,853 m^2/h (HFPT)
= 29,177 m^2/h (TT)

e = 0.5

$$d = \frac{CPUE}{0.5 \times a}$$

The catch and effort data from January to June 1984 were considered for the monthly catch-per-unit effort estimation. During certain months the catch rates were estimated from the traditional trawlers and in the other months from the fish-cum-prawn trawlers. The catch and effort statistics from five traditional craft selected were collected for a whole month to estimate the catch rate for that particular month. In the case of the fish-cum-prawn trawl data, these statistics were collected five days per month.

Table 8 gives the estimates of the monthly catch-per-unit effort, density (kg/ha) and the average biomass for *P. semisulcatus* and the by-catch. The density of *P. semisulcatus* in the Pesalai-Talaimannar region of Palk Bay was estimated to be within 0.05 to 0.11 tonnes/km^2 in 1984 while that in the Tuticorin region of Gulf of Mannar was in the range of 0.023 to 0.034 tonnes/km^2 in 1981 (Antony Raja, 1984). The density of the by-catch estimated from the fish-cum-prawn trawl in the Pesalai-Talaimannar region of Palk Bay was 0.291 to 0.728 tonnes/km^2 while in the Tuticorin region it was 1.9 tonnes/km^2

6. ESTIMATION OF MONTHLY FISHING MORTALITY COEFFICIENTS

Since the estimates of the average biomass concerned the stocks on ground A, it was possible to estimate the monthly fishing mortalities inflicted on the partial biomass on ground A. The monthly fishing mortalities were estimated by the formula :

$$C = F \times \bar{B} \text{ (where } \bar{B} \text{ is the average biomass)}$$

The monthly catches were estimated from the catch-per-unit effort values, the average fishing time, the average fishing days and the average number of craft operated each month. The average fishing time was estimated as 10 hours per day, and the average number of fishing days in a month as 22 days. The average number of craft operating on ground A during January to April 1984 was 40, while the figure for May to June was 66. The estimates of monthly fishing mortality values are given in Table 8.

7. YIELD PER RECRUIT

The limitations of the data due to infrequent sampling as well as the difficulties in ageing shrimp prevented the use of the analytical model (Beverton and Holt, 1957) in the yield per recruit estimation. The growth parameters were also difficult to estimate using modal progression methods, for the same reason. However, as a first approximation, a modal progression of a few months' length-frequency data was followed in estimating the average growth rate of the commercially exploited length range.

The average growth rate of *P. semisulcatus* was estimated from the modal progression of the April and July length frequency data, where both sexes were pooled. The catches from the 25 mm mesh codend fish-cum-prawn trawl were considered for this estimation, since this gear was found to be non-selective as far as the size distribution of the *P. scmisulcatus* population was concerned, for this particular time and area. The modal length was found to have increased from 2.25 cm (carapace length) at the end of April to 2.75 cm during the early part of July, giving an average value of 0.25 cm as the monthly growth. This result was assumed to be valid for the exploitable length range 1.5 to 4.5 cm. The average weight at each length group was also calculated by estimating the mean weights from the sample of prawn (both sexes pooled) in each length group. The price for each grade was also related to the size range in order to estimate the price at each length group.

In order to construct a Thompson and Bell type yield-per-recruit curve (Ricker, 1975), a value for the instantaneous natural mortality (M), a set of values for the instantaneous fishing mortalities and the weight at each length group are required. In the absence of an independent estimate of M, a value of 3, accepted as a reasonable value in the Gulf region, was assumed (Van Zalinge *et al*., 1981 ; Anon 1982). The average monthly fishing mortality vector on this ground was assumed to be 0.16, 0.16, 0.16, 0.16, 0.38, 0.38, 0.38, 0.38, 0.38, 0.16, 0.16, 0.16 from January to December respectively. In order to draw Y/R curves, different levels of fishing mortalities were assumed in estimating the Y/R values, conforming to the above seasonal pattern. The Y/R curves in weights as well as in values were constructed separately for the 30 mm stretched mesh and 40 mm stretched mesh codends selections.

In the case of the 30 mm stretched mesh codend selection, the Y/R computation was performed assuming 1000 recruits of 1.25 to 1.50 cm carapace length range entering the fishing ground during March (spring recruits), and dying solely from natural causes until they attain the size range 1.75 to 2.00 cm carapace length. Thereafter, fishing mortality acts along with the natural mortality according to the mortality pattern given above. In the case of the 40 mm stretched mesh codend, the fishing mortality commenced when the recruits reach the length range 2.25 to 2.50 cm (carapace length).

The Y/R curves in respect of weight and value for the 30 mm stretched mesh codend and the 40 mm stretched mesh codend are given in Fig. 7. In both cases, the Y/R values for the 30 cm stretched mesh codend were higher than those for 40 mm stretched mesh codend. The present fishing mortality vector 0.16 [4 (l), 5 (2.38), 3 (1)] gives Y/R values at the rising limb of the curve, indicating that there is room for a slight increase in the fishing effort without fear of growth overfishing with the new larger mesh codend trawls. It is also important to note the Y/R curve in weight has no maximum as generally observed in shrimp population (Anon, 1982). On the other hand, the Y/R curve based on value for the 30 mm stretched mesh codend shows a maximum at the fishing mortality vector 0.35 [4 (1), 5 (2.38), 3 (1)].

8. SUMMARY

(i) Three types of gear viz., trawl, gillnet and trammel net, were employed in the prawn fishery in the Palk Bay. The dominant penaeid species caught by gillnets and trammel nets was *P. indicus,* while that caught by trawl nets was *P. semisutcatus.*

(ii) Twenty experimental trawling operations were carried out in Palk Bay for mesh selectivity studies employing the covered codend technique. The gear was a new design of fish-cum-prawn trawl having 25 mm, 30 mm and 40 mm mesh codends. In the case of the 25 mm mesh codend there was hardly any commercially valuable size of *P. semisulcatus* passing through the codend, while the larger meshes released a fair number of *P. semisulcatus* of a certain size range.

(iii) The 50 per cent retention length (carapace) values of *P. semisulcatus* were found to be 1.96 cm and 2.27 cm for the 30 mm and 40 mm codends respectively.

(iv) There was no appreciable change in the composition or increase in mean length of the by-catch between the fish-cum-prawn trawl and the traditional trawl. This may be due to their operations being confined to shallower depth ranges during the study period. The same could be said of *P. semisulcatus* caught by both types of trawls.

(v) The comparison of catch rates by the fish-cum-prawn trawls of 25 mm, 30 mm and 40 mm codends with the traditional trawl indicated a marginal increase in respect of *P. semisulcatus* and a substantial increase in the by-catch in the fish-cum-prawn trawl.

(vi) The net earnings from the fish-cum-prawn trawl were higher than those of the traditional trawl, mainly because of the higher fish component.

(vii) When compared with the 30 mm and the 40 mm codend trawl, the mean length of *P. semisulcatus* escaping from the 25 mm codend to the cover was smaller (1.25 cm, carapace length). Therefore, in order to enhance the yield of prawn in the long run, introduction of a mesh size above 25 mm in the codend of the fish-cum-prawn trawl is recommended.

(viii) Of the two larger mesh sizes tested, the Y/R values of *P. semisulcatus* for the 30 mm codend were higher than those of the 40 mm codend.

(ix) The estimated monthly (January to June 1984) values of the biomass on ground A (Fig. 1) for *P. semisulcatus* ranged from 40.8 to 88.0 tonnes, while the by-catch ranged from 232.8 to 582.4 tonnes. The corresponding monthly instantaneous fishing mortality values ranged from 0.16 to 0.38 for *P. semisulcatus* and 0.09 to 0.37 for the by-catch.

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Table 1

Means and standard deviations of stretched mesh sizes (mm) of the codends and the respective covers

	40 mm codend		30 mm codend		25 mm codend	
	mean	std. dev.	mean	std. dev.	mean	std. dev.
Codend	39.18	0.80	30.04	0.96	23.88	1.07
Cover	11.85	0.78	9.47	0.62	9.47	0.62

Table 2

Percentage composition of large prawn, marketable fish and trash fish in the codend catches of different codend mesh sizes of fish-cum-prawn trawl and traditional trawl

	Fish-cum-prawn trawl			Traditional trawl
	40 mm	30 mm	25 mm	22-25 mm
Large prawn	13.18	19.72	5.26	18.52
Marketable fish	17.28	18.20	12.68	8.84
Trash fish	69.54	62.08	82.06	72.64

Table 3

Percentage contribution of each species of prawn/fish in the codend and the cover catches with respect to different codend mesh sizes of the fish-cum-prawn trawl nets

	25 mm		30 mm		40 mm	
	Codend	Cover	Codend	Cover	Codend	Cover
Penaeus semisulcatus	99.35	0.65	79.58	20.42	68.68	31.32
Penaeus latisulcatus	100.00	0.00	0.00	100.00	29.41	70.59
Penaeus monodon	100.00	0.00	100.00	0.00	—	—
Small prawn	71.57	28.43	4.38	95.62	48.51	51.49
Leiognathidae	94.95	5.05	70.78	29.22	27.58	72.42
Sillago sihama	89.74	10.26	7.95	92.05	54.31	45.69
Gerridae	95.63	4.37	81.66	18.34	60.54	39.46
Upeneus vittatus	100.00	0.0	92.19	7.81	63.87	36.13
Theraponidae	53.65	46.35	40.61	59.39	31.34	68.66
Clupeidae	96.34	3.66	7.05	92.95	48.03	51.97
Seleroides leptolepis	77.70	22.30	100.00	0.0	100.00	0.0
Siganidae	—	—	71.39	28.61	100.00	0.0
Sciaenidae	100.00	0.0	70.48	29.51	—	—
Lethrinidae	100.00	0.0	—	—	100.00	0.0
Anchoviella spp.	4.47	95.53	0.0	100.00	16.67	83.33
Pleuronectiformes	100.00	0.0	100.00	0.0	42.92	57.08
Trygonidae	100.00	0.0	100.00	0.0	100.00	0.0
Loligo spp.	—	—	100.00	0.0	100.00	0.0
Sepia spp.	100.00	0.0	100.00	0.0	100.00	0.0
octopus spp.	0.45	99.55	26.73	73.27	37.41	62.59
Portunus pelagicus	100.00	0.0	100.00	0.0	98.25	1.75
Large prawn (Total)	99.35	0.65	78.37	21.63	68.21	31.79
Marketable fish (total)	100.00	0.0	100.00	0.0	96.04	3.96
Trash fish (total)	76.02	23.98	49.40	50.60	39.11	60.89

Table 4

Mean length (L), lower quartile to upper quartile range (L_{Q1-Q3}) and absolute range (L_R) of lengths (cm) of commercially important prawn and fishes caught in the codend and the cover of different codend mesh sizes of the fish-cum-prawn trawl and the traditional trawl nets in April, 1984

(Figures in the upper row against each species correspond to the cover; figures in the lower row correspond to the codend)

	25mm			30mm			40mm			Traditional 22-25 mm		
	L	L_{Q1-Q3}	L_R	L	L_{Q1-Q3}	L_R	L	L_{Q1-Q3}	L_R	L	L_{Q1-Q3}	L_R
P. semisulcatus	1.25	1- 1.4	1- 1.4	2.04	1.5-2.4	1- 2.9	2.11	1.5- 2.4	1- 2.9	—	—	—
	2.41	2- 2.4	1- 4.4	2.33	2- 2.4	1.5- 3.9	2.46	2- 2.9	1.5-4.9	2.44	2- 2.9	1.5-3.4
Leiognathidae	4.27	3- 4.9	3- 5.9	4.91	4- 5.9	1- 3.9	4.27	3- 4.9	1- 8.9	—	—	—
	6.09	5- 7.9	3- 7.9	6.56	7- 7.9	3- 9.9	6.98	6- 7.9	4-11.9	6.57	6- 6.9	5-11.9
Silago sihama	8.50	7- 9.9	7- 9.9	8.81	7- 9.9	5-13.9	7.35	6- 8.9	5-11.9	—	—	—
	13.76	13-13.9	11-19.9	11.84	9-13.9	9-19.9	8.29	6- 8.9	5-21.9	—	—	—
Gerridae	—	—	—	7.04	6- 7.9	5- 8.9	6.85	6- 7.9	5- 8.9	—	—	—
	7.25	6- 7.9	5-10.9	8.39	7- 9.9	5-17.9	7.93	6- 8.9	4-11.9	8.42	7- 9.9	6-12.9
Upeneus vittatus	—	—	—	8.00	7- 8.9	7- 8.9	4.17	3- 4.9	3- 4.9	—	—	—
	7.89	7- 7.0	7-14.9	13.62	13-14.9	11-15.9	10.61	9-12.9	7-14.9	—	—	—
Theraponidae	8.18	7- 7.9	4-11.9	8.39	7- 9.9	3-11.9	7.13	6- 7.9	3-12.9	—	—	—
	9.12	8-10.9	6-11.9	9.60	7-11.9	6-12.9	9.56	8-11.9	5-12.9	—	—	—
Seleroides leptolepis	—	—	—	—	—	—	—	—	—	—	—	—
	9.51	9- 9.9	8-11.9	9.50	8-11.9	4-11.9	—	—	—	—	—	—

Table 5

Indices of occurrence of finfish and shellfish in the fish-cum-prawn trawl net and the traditional trawl net

Species/groups	Fish-cum-prawn trawl net	Traditional trawl net
P. semisulcatus	100	100
P. latisulcatus	25	33
P. monodon	20	33
Metapenaeus monoceros	40	33
Metapenaeus moyebi	40	33
Metapenaeopsis stridulans	40	33
Trach ypenaeus granulosus	40	33
Metapenaeopsis ceylonica	40	33
Parapenaeopsis cornuta	40	33
Leiognathus daura	80	100
Gaza minuta	80	100
Leiognathus splendens	80	100
Leiognathus brevirostris	80	100
Secutor insidiator	80	100
Other leiognathus spp.	80	100
Gerres abbreviatus	95	100
Other Gerres spp.	95	100
Nematalosa nasus	20	—
Therapon theraps	80	33
Other Therapon spp.	80	33
Upeneus vittatus	90	100
Sillago sihama	75	66
Seleroides leptolepis	60	100
Siganidae	35	33
Scianidae	35	100
Caranx spp.	40	—
Anchoviella spp.	25	—
Lethrinidae	15	33
Epinephefus spp.	10	33
Saurida tumbil	20	—
Ephippus orbis	5	33
Sphyraenidae	20	—
Tachysuridae	10	—
Sardinella longiceps	15	—
Other sardines	55	33
Dussumieria acuta	5	33
Stcomateus spp.	25	—
Triacanthus spp.	55	33
Thrissocles spp.	15	33
Tetrodon spp.	45	33
Ostracion spp.	35	33
Trygonidae	45	33
Pleuronectiformes	25	—
Platycephalus spp.	20	33
Portunus pelagicus	90	100
Thenus orientalis	15	—
Holothuridae	25	—
octopus spp.	75	66
Loligo spp.	40	66
Sepia spp.	80	100

Table 6

Species composition in the catches of the fish-cum-prawn trawl nets with different codend mesh sizes and the traditional trawl net, during the experimental period

Scientific Name	April 1984				July 1984		
	40 mm	30 mm	25 mm	Traditional 22-25 mm	40 mm	30 mm	25 mm
P. semisulcatus	12.47	18.72	3.85	15.79	5.10	1.10	4.37
P. latisulcatus	0.09	0.77	+	0.01	0.02	—	0.01
P. monodon	—	0.39	—	0.03	—	—	0.09
Small prawn	—	0.26	2.40	0.56	5.58	—	1.07
Leiogna thidae	8.70	22.68	30.93	21.35	4.07	50.44	31.30
Silago sihama	7.98	3.47	2.55	4.92	1.70	0.02	0.01
Gerridae	15.47	18.92	5.76	12.96	2.17	6.04	5.71
Upeneus vittatus	3.23	1.83	3.24	3.41	0.90	3.03	1.19
Theraponidae	29.58	13.29	25.62	7.41	0.94	9.93	11.95
Clupeidae	3.11	1.02	1.68	1.37	4.04	0.01	—
Selaroides leptolepis	—	0.45	2.03	1.21	0.27	1.09	0.29
Siganidae	0.11	0.26	0.24	1.38	—	1.56	—
Lethrinidae	0.34	—	0.71	0.12	—	—	0.18
Sciaenidae	—	0.99	0.28	3.8	—	0.01	0.01
Pleuronectiformes	—	—	0.05	—	0.77	0.73	—
Trygonidae	3.48	—	1.05	4.46	1.92	0.21	0.44
Loligo sp.	0.22	0.23	—	—	0.38	3.21	—
Sepia sp.	0.67	3.45	0.66	—	7.48	0.46	2.24
octopus sp.	1.33	2.79	0.33	—	7.60	—	3.65
Portunus pelagicus	7.10	6.96	4.29	15.07	45.66	5.12	24.16
Holothuroidae	(1)	—	(2)	—	(1)	—	(3)
Thenus orientalis	—	(1)	—	—	(1)	—	(1)
Unsorted fish	6.13	3.51	15.31	6.15	11.40	17.05	13.35
Total	100.01	99.99	99.98	100.00	100.00	100.00	100.02

Table 7

Catch, effort and economic data summary for the fish-cum-prawn trawl net and the two traditional trawl nets for the month of April 1984

Craft	Fish-cum-prawn trawl		Traditional trawl (22-25 mm)	
	25 mm codend	30 mm codend	No. 1	No. 2
No. of trips	18	16	14	14
Total catch of prawn (kg)	289.2	170.8	204.7	153.8
Total catch of fish (kg)	2986.6	1819.0	1229.0	739.0
Catch per fishing hr. prawn (kg)	1.5	1.0	1.2	1.0
Catch per fishing hr. fish (kg)	14.9	10.9	7.0	4.8
Gross earning — prawn (Rs.)	16770.05	10953.00	16539.55	10522.05
Gross earning -fish (Rs.)	5106.65	3156.25	2083.30	1328.35
Gross earning -Total (Rs.)	21876.70	14109.25	18622.85	11850.40
Average price of prawn per kg (Rs.)	58.00	64.10	80.80	68.40
Average price of fish per kg (Rs.)	1.75	1.75	1.70	1.80

Table 8

Seasonal variations of the fishing mortality, the biomass of P. semisulcatus and by-catch in the fishing ground between Pesalai and Talai Mannar (ground A, Fig. 1)

1984	P. semisulcatus				By-catch			
	CPUE kg/h	Density kg/ha	F	Biomass t	CPUE kg/ha	Density kg/ha	F	Biomass t
January	1.61[a]	1.10	0.16	88.00	4.25[b]	2.91	0.16	232.80
February	1.12[a]	0.77	0.16	61.60	9.46[b]	6.48	0.16	518.40
March	1.05[b]	0.51	0.20	40.80	10.9[b]	5.34	0.10	427.20
April	1.47[b]	0.72	0.16	57.60	14.88[b]	7.28	0.09	582.40
May	1.50[b]	0.73	0.38	58.40	11.08[b]	5.42	0.21	433.60
June	1.92[b]	0.94	0.37	75.20	11.41[b]	5.59	0.37	447.20

a — estimated from the traditional trawl catch
b — estimated from the 25 mm codend fish-cum-prawn trawl catch
c-estimated from the 30 mm codend fish-cum-prawn trawl catch.

Figure 1

The two fishing grounds (A and B) frequented by prawn trawlers stationed at Pesalai

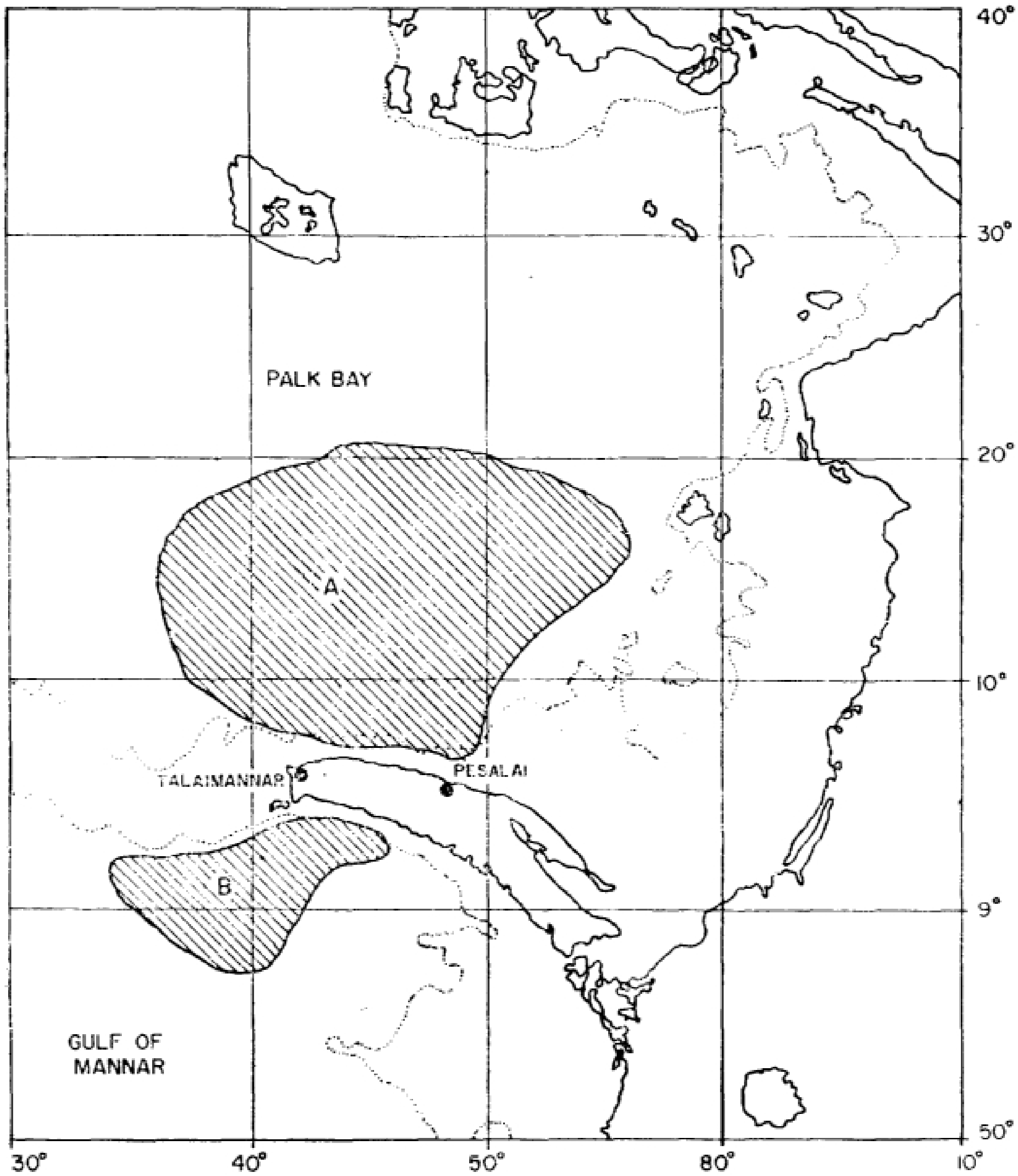


Figure 2

Rigging of codend cover with iron rings

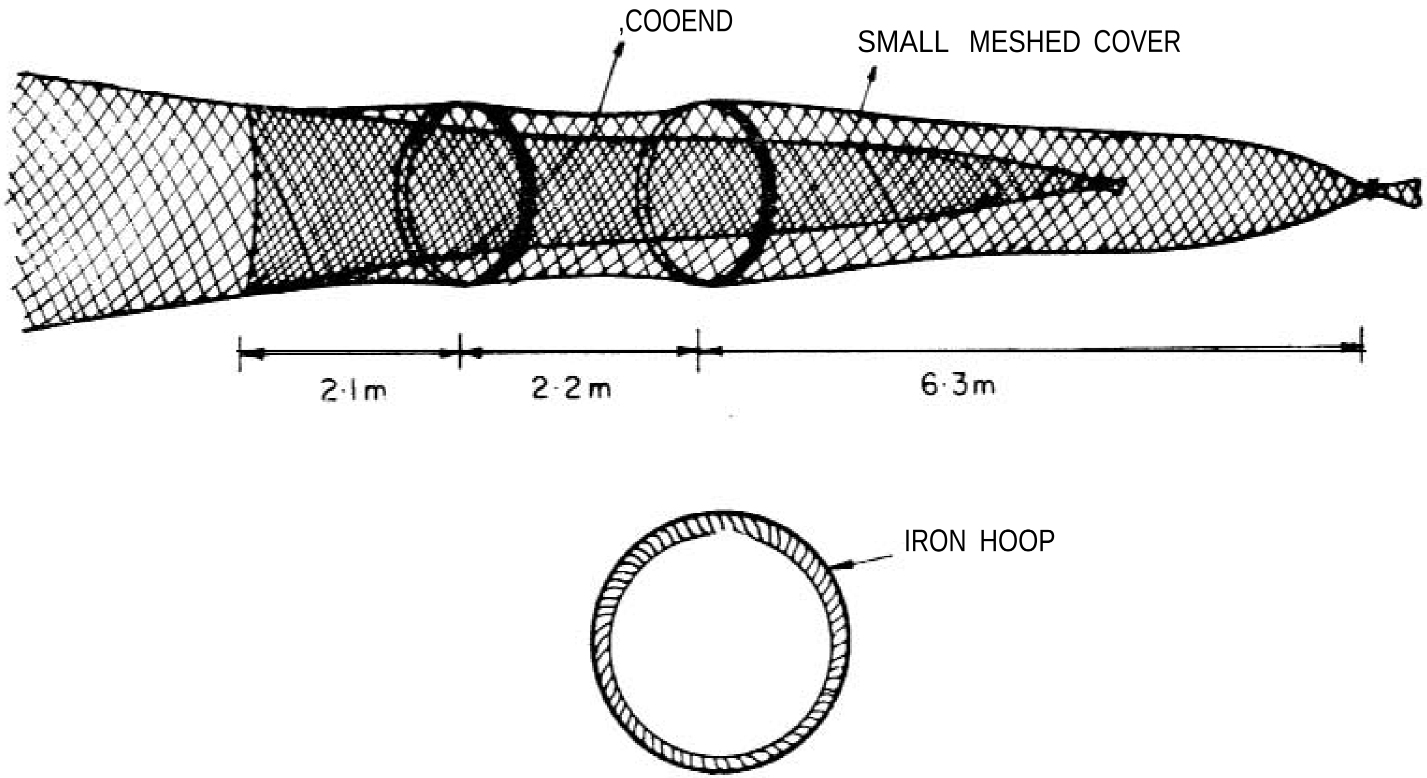


Figure 3

Relationship between percentage of prawn that escaped to the cover and total catch in the codend

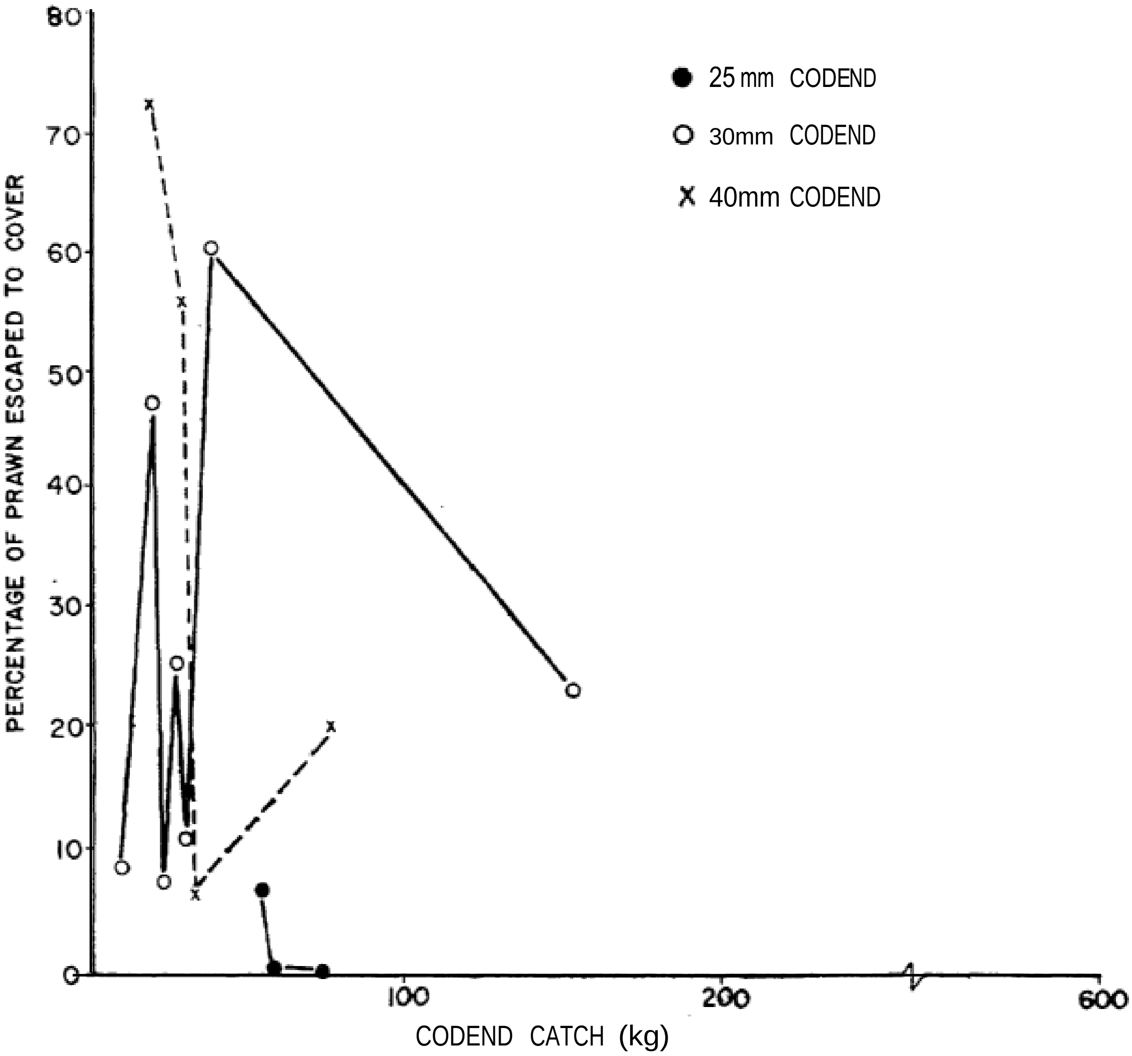


Figure 4
Frequency polygon of the carapace length of *P. SemisulcatuS*
caught in the codend (—) and the cover (——--—) in April 1984
by (a) 25 mm, (b) 30 mm and (c) 40 mm codends

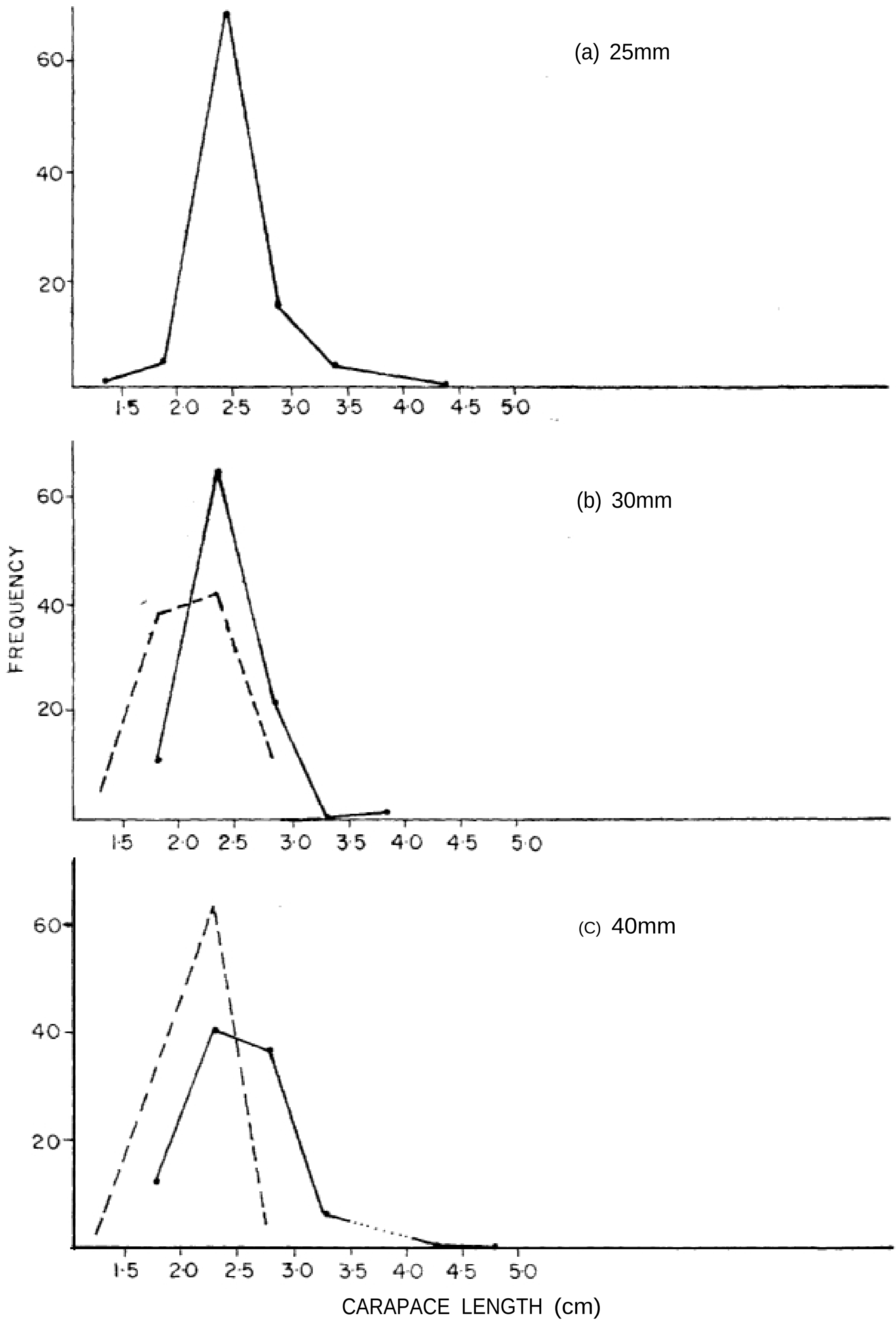


Figure 5
Selection Ogives of *P. Semisulcatus* for 30 mm stretched *(mesh)* codend and 40 mm stretched *(mesh)* codend

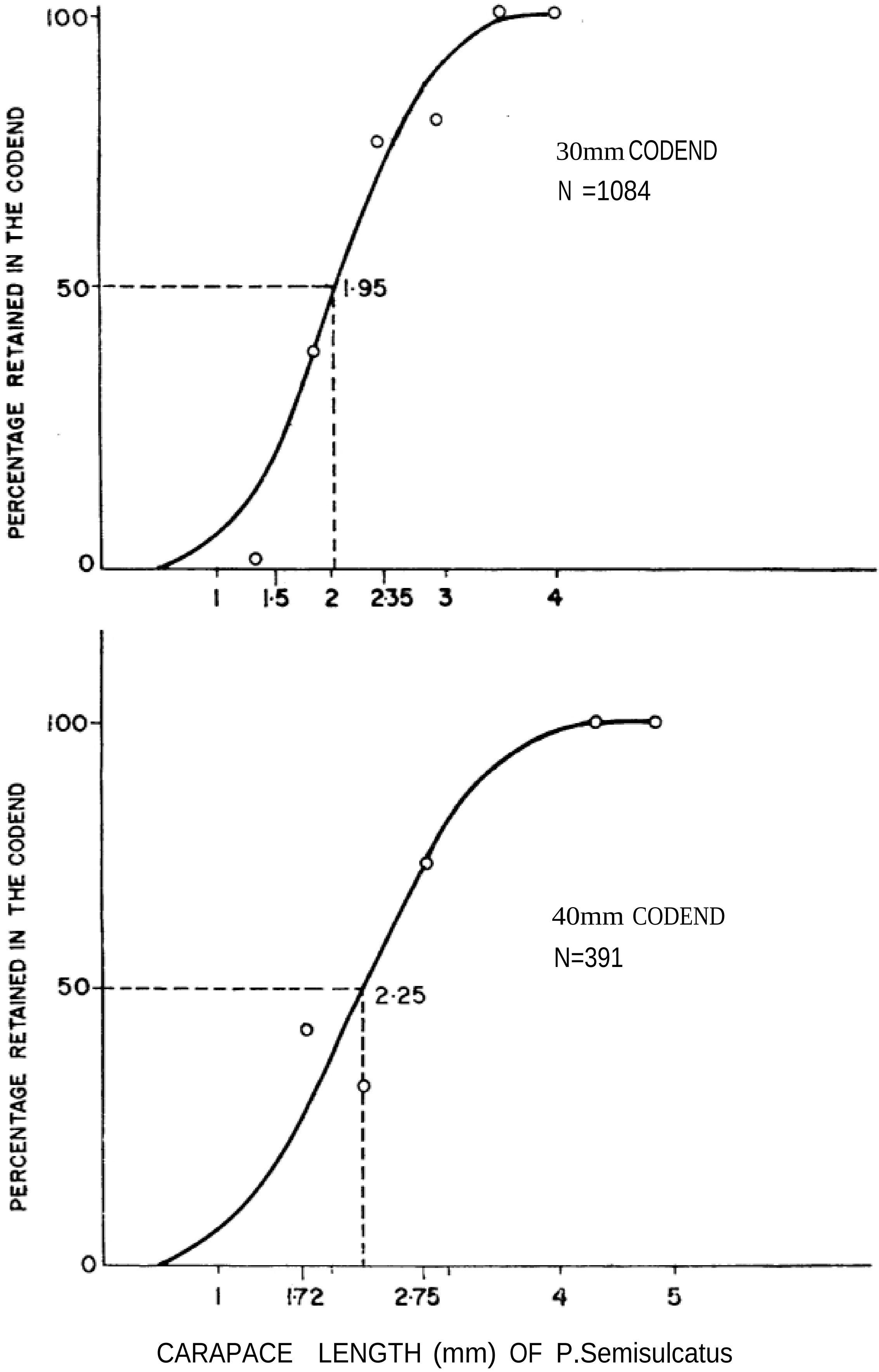


Figure 6
comparison of seasonal CPUE values of *P. Semisulcatus* and by-catch from 25 mm and 30 mm codend mesh of fish-cum prawn trawl with the traditional trawl and comparison of seasonal net profit per running hour between them

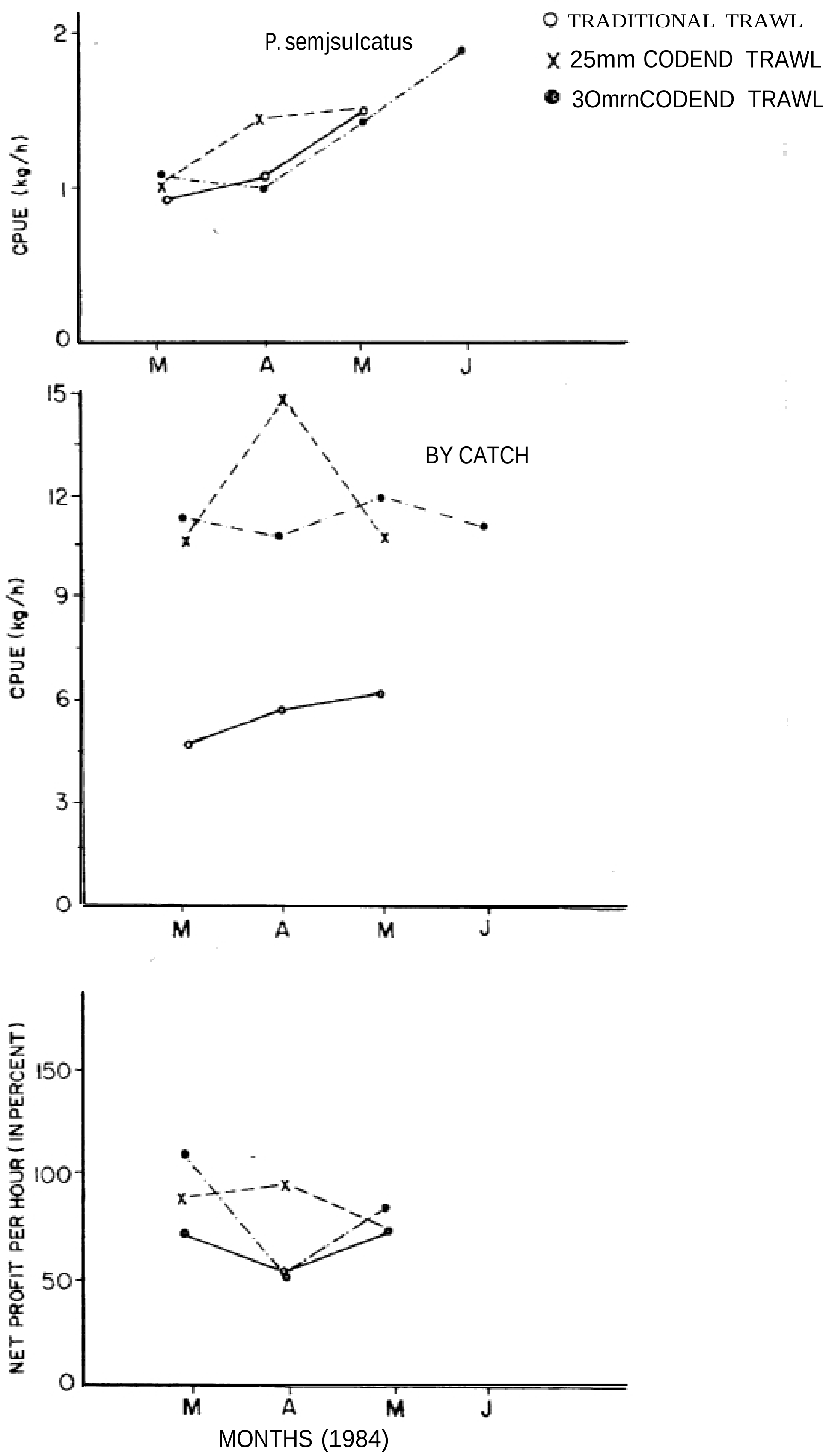
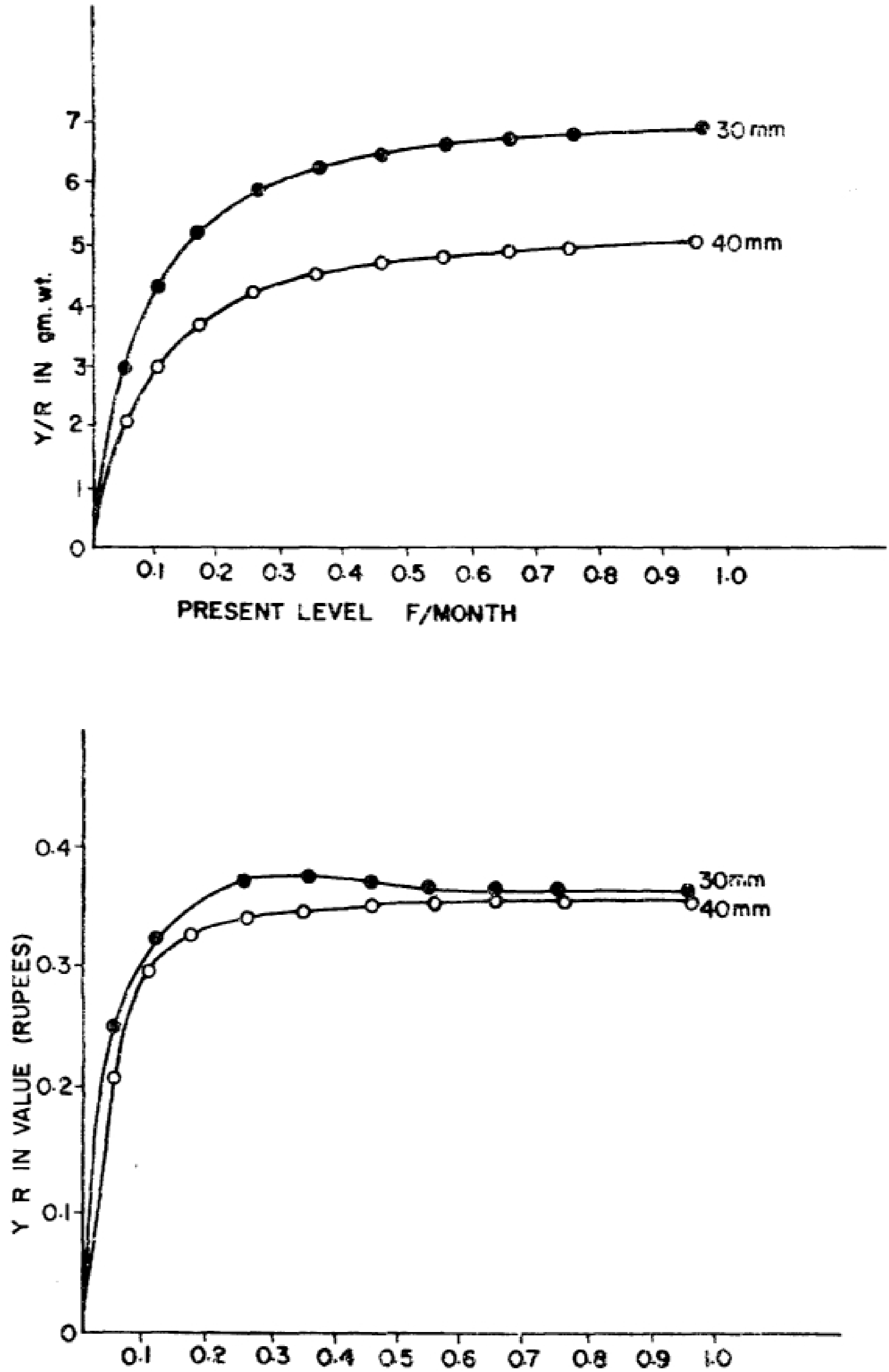


Figure 7
Variation of yield per recruit of *P. Semisulcatus* in weight (a), in value (b) with F, for M=3/year



PRESENT LEVEL F/MONTH

Publications of the Bay of Bengal Programme (BOBP)

The BOBP brings out six types of publications:

Reports (BOBP/REP/ . . . .) describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and projects in member-countries for which BOBP inputs have ended.

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***Newsletters (Bay of Bengal** News),* issued quarterly, contain illustrated articles and features in non-technical style on BOBP work and related subjects.

A list of publications follows.

Reports (BOBP/REP/ . . .)

1. Report of the First Meeting of the Advisory Committee. Colombo, Sri Lanka, 28-29 October 1976. (Published as Appendix 1 of IOFC/DEV/78/44.1, FAO, Rome, 1978)
2. Report of the Second Meeting of the Advisory Committee. Madras, India, 29-30 June 1977. (Published as Appendix 2 of IOFC/DEV/78/44.1, FAO, Rome, 1978)
3. Report of the Third Meeting of the Advisory Committee. Chittagong, Bangladesh, l-10 November 1973 Colombo, Sri Lanka, 1978. (Reissued Madras, India, September 1980)
4. Role of Women in Small-Scale Fisheries of the Bay of Bengal. Madras, India, October 1980.
5. Report of the Workshop on Social Feasibility in Small-Scale Fisheries Development. Madras, India, 3-8 September 1979. Madras, India, April 1980.
6. Report of the Workshop on Extension Service Requirements in Small-Scale Fisheries. Colombo, Sri Lanka, 8-12 October 1979. Madras, India, June 1980.
7. Report of the Fourth Meeting of the Advisory Committee. Phuket, Thailand, 27-30 November 1979. Madras, India, February 1980.
8. Pre-Feasibility Study of a Floating Fish Receiving and Distribution Unit for Dubla Char, Bangladesh. G. Eddie, M. T. Nathan. Madras, India, April 1980.
9. Report of the Training Course for Fish Marketing Personnel of Tamil Nadu. Madras, India, 3-14 December 1979. hiadras, India, September 1980.

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16. Report of the Seventh Meeting of the Advisory Committee. New Delhi, India, January 17-21, 1983. Madras, India, March 1983.
17. Report of Investigations to Improve the Kattumaram of India's East Coast. hiadras, India, July 1984.
18. Motorization of Country Craft, Bangladesh. Madras, India, July 1984.
19. Report of the Eighth Meeting of the Advisory Committee. Dhaka, Bangladesh, January 16-19, 1984. Madras, India, May 1984.

20. Coastal Aquaculture Project for Shrimp **and** Finfish in Ban Merbok, Kedah, Malaysia. Madras, India, December 1984.

21. Income-Earning Activities for Women from Fishing Communities in Sri Lanka. Edeltraud Drewes. Madras, India, September 1985.

22. Report of the Ninth Meeting of the Advisory Committee. Bangkok, Thailand, February 25-26, 1985. Madras, India, May 1985.

23. Summary Report of BOBP Fishing Trials and Demersal Resources Studies in Sri Lanka. Madras, India, March 1986.

24. Fisher-women's Activities in Bangladesh: A Participatory Approach to Development. Patchanee Natpracha. Madras, India, May 1986.

25. Attempts to Stimulate Development Activities in Fishing Communities of Adirampattinam, India. Patchanee Natpracha, V.L.C. Pietersz. Madras, India, May 1986.

26. Report of the Tenth Meeting of the Advisory Committee. Male, Maldives. 17-18 February 1986. Madras, India, April 1986.

27. Activating Fisherwomen for Development through Trained Link Workers in Tamil Nadu, India. Edeltraud Drewes. Madras, India, May 1986.

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30. Summary Report of Fishing Trials with Large-Mesh Driftnets in Bangladesh. Madras, India, May 1986.

31. In-Service Training Programme for Marine Fisheries Extension Officers of *Orissa,* India. U. Tietze. Madras, India, August 1986.

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3. Improvement of Large-Mesh Driftnets for Small-Scale Fisheries in Sri Lanka. G. Pajot. Madras, India, June 1980.

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6. Fishing Trials with Bottom-Set Longlines in Sri Lanka. G. Pajot, K. T. Weerasooriya. Madras, India, September 1980.

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15. Pilot Survey of Driftnet Fisheries in Bangladesh. M. Bergstrom. Madras, India, May 1982.

16. Further Trials with Bottom Longlines in Sri Lanka. Madras, India, July 1982.

17. Exploration of the Possibilities of Coastal Aquaculture Development in Andhra Pradesh. Soleh Samsi, Sihar Siregar and Martono. Madras, India, September 1982.

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20. Further Trials of Mechanized Trawling for Food Fish in Tamil Nadu. G. Pajot, J. Crockett, S. Pandurangan, P. V. Ramamoorthy. Madras, India, December 1982.

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31. Tuna Fishery in the EEZs of India, Maldives and Sri Lanka. Colombo, Sri Lanka, February 1985.

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33. Factors that Influence the Role and Status of Fisherwomen. Karuna Anbarasan. Madras, India, April 1985.

34. Pilot Survey of Set Bagnet Fisheries of Bangladesh. Abul Kashem. Madras, India, August 1985.

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36. Marine Fishery Resources of the Bay of Bengal. K. Sivasubramaniam. Colombo, Sri Lanka, October 1985.

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