PRELIMINARY RESULTS OF TRAWLING INVESTIGATIONS OFF PENANG

by

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ABSTRACT

The preliminary results of the otter-trawling investigations conducted in the coastal waters, from 9-46 m (5-25 fathoms), are presented. Fluctuations in catch-rates at the same depth were noted. With increasing depth, a sharp drop in catch-rates as well as a change in species composition of the catch, were observed.

While the area investigated is suitable for otter-trawling the productive area appears to be limited to depths within 20 fathoms.

INTRODUCTION

Earlier investigations on trawling in Malaysian waters by Green and Birtwistle (1927 & 1928) and Ommaney (1961), led to the conclusion that the Straits of Malacca did not provide a suitable ground for trawling owing to heavy bottom of mud and rocks, to the small catches in the deeper water of the Strait and to the enormous preponderance of small low grade fishes in the shallow coastal areas. However, in 1963, after the successful introduction of otter-trawling in the Gulf of Thailand, training employing gears similar to those used in Thailand, was taken up by Malaysian fishermen with great economic success. Soong (1964) has given a complete background on the introduction of the otter-trawl in Malaysian waters, and outlined the problems that arise therefrom.

A project on trawl fishery investigations was, therefore, initiated in 1965, with the objective of collecting the necessary data which would allow for the rational exploitation and development of the trawl fishery in Malaysian waters. This paper reports on the preliminary results which

Proc. Indo-Pacific Fish. Coun., 12(II): 181-201.

were obtained from trawling trips conducted during the year 1965 in the waters off the Island of Penang. Commercial catch statistics are being collected and will be analysed and published in a subsequent paper.

MATERIALS AND METHODS

Vessel and otter-trawl fishing gear

The details of the vessel used are:

Name:	M.V. Selayang
Structure:	Wooden
Length, overall:	16.75 M
Breadth:	6.15 M
Gross tonnage:	25
Engine:	Gardiner
H.P.:	95 (nominal)
Winch:	Flydragger
Crew:	6

The trawl gear used is as illustrated in Figs. 1 and 2.

Forty-seven plastic sponge floats with the following dimensions were used on the head-rope: length 16.3 cm, central diameter 10.0 cm, end diameter 3.8 cm, and internal diameter 2 cm. Fifty wooden rollers were attached to the foot-rope. These rollers were of the following dimensions: length 11.8 cm, external diameter 5.0 cm, and internal diameter 2 cm. The length of the bridles used was 18.3 meters.

Both the head-rope and the foot-rope were wire ropes of 10 mm in thickness. The former was threaded through a plastic tube secured at the ends, while the latter was bound with coir rope with strips of lead at 30 cm intervals.

Plan of trawling trips and fishing operation

Owing to the use of M.V. Selayang for other functions, and the lack of a suitably equipped vessel, the number of trips and kinds of observations made were necessarily limited. For each trawling trip, the boat left for the trawling grounds (Fig. 3) at dawn, carried out trawling during the daylight hours and returned to base at dusk on the same day. On the first few trawling trips, all the authors were on board, in order to standardize the various operational procedures.

The trawling was carried out over a depth range from approximately 5 to 25 fathoms; the depths were determined by a portable echo-sounder. In the shallower depths, from 5-20 fathoms, the average scope ratios (length of warp out to depth of sea) used usually ranged from 5-7 : 1, while in waters exceeding 20 fathoms, smaller scope ratios, usually of 4-5 : 1 were

used. The otter-trawl was towed from the stern and the direction of trawling was generally with the sea current. A trawling speed of 2-3 knots was maintained, and the duration of each haul was one hour.

Treatment of catches

The catch from each haul was sorted on deck into species, and when this was not possible, into genera or families. The total weight of each group thus sorted was measured, and random samples of 50-100 fish of selected species were measured for length-frequency distribution. The weights of these measured fish were taken in order to estimate the total number of fish of these species in the catch. When necessary, due to shortage of time to complete measurements on board or for the purpose of preserving specimens for laboratory study, the fish were kept in ice and brought to the laboratory for measurement on the following day.

Collection and analysis of hydrographic data

At the end of each haul, while the sorting and measuring of the fish were in progress on deck, the hydrographic cast was made. Water samples for the determinations of oxygen and salinity were collected by Nansen bottles, to each of which were attached a pair of protected reversing thermometers. Only surface and bottom samples were collected for the shallower stations, while for deeper stations, additional observations at intermediate depths, spaced at 10 m intervals, were taken. The transparency of the water was measured with a Secchi disc,and the general sea and weather conditions noted.

The collected water samples were analysed in the shore laboratory on the following day. Dissolved oxygen was determined by the modified Winkler method, as described in H.O. Pub. No. 607, while the salinity was determined with a CSIRO inductive salinometer, standardised with International Sea Water.

RESULTS AND DISCUSSION

Total number of trips and hauls

A total of 15 trips were made, during which 31 successful hauls were obtained. In the treatment of the catch data, the hauls were groups into depth-classes, each being the mid-point over a range of 5 fathoms.

Variations in catch-rates within and between depth-classes

Catch in Kg/hour varied a great deal even when the same depth was trawled on the same day. On one trip (26th of May at 15 fm), one haul produced 592.4 Kg of fish, crustaceans and cephalopods while the catch from another haul was only 123.1 Kg. Leiognathids constituted 69% of the total weight in the first haul and a negligibly small percentage in the other. In both cases, sharks and rays were of small sizes, comparable to those of the majority of bony fishes caught. Hence, at first it appeared

that a high total catch might be due to the presence of a large number of individuals belonging to the dominant shallow water family, the Leiognathidae. Examination of other data, however, showed that this was not always true and the high total catch need not necessarily depend on the predominant abundance of Leiognathids. An example was shown by the catches made on another trip (13th of May at 10 fm). One haul contained 452.5 Kg while another only 94.3 Kg, but in each case Leiognathids constituted 60-70% of the total weight.

Fluctuations in catch-rates seemed to be more marked at 10-15 fm than at the deeper depth-classes. Out of 8 hauls carried out at 10 fm, 3 produced less than 100 Kg of fish per hour. The minimum catch of 66.3 Kg was observed on the 17th of August. In 2 of the remaining hauls, the catches weighed more than 400 Kg, with a maximum of 486.5 Kg/hour recorded on the 15th of September. The same number of hauls was also carried out at 15 fm, but here all but 2 produced more than 100 Kg of fish per hour. The minimum of 54.2 Kg was noticed on the 17th of June and the maximum of 592.4 Kg on the 26th of May.

At 20 fm, most of the catches centred around 100 Kg/hour but the trawling ground at 25 fm was very poor in fish, crustaceans and cephalopods. Apart from one haul recorded on the 2nd of December, all produced much less than 100 Kg of fish. The average catch per hour was only 63.1 Kg. The figures for 20-25 fm would have been much lower had *Pentaprion longimanus* (Gerridae) been excluded. This species was very abundant at this depth-class, representing 13-24% of the total catch by weight. It is interesting to note that *P. longimanus* is the Leiognathid counterpart in deeper waters. Both are small fish of low commercial value.

The average catch-rates, and also the maximum and minimum catches obtained at the different depth-classes, are shown at the end of Table I. The best depth for trawling off Penang was found to be around 10-15 fm, yielding an average catch slightly exceeding 200 Kg/hour. At around 20 fm the average catch-rate of 133.1 Kg/hour was moderate, but the deepest part of the area surveyed, yielding an average catch-rate of only 63.1 Kg/hour, showed a sharp drop in the production of bottom fish.

Catch-rates and percentage compositions of species by depth

The average catch-rates in Kg/hour, and the percentage compositions of the species caught in the trawl hauls are show in Table I.

The most abundant group belonged to the family Leiognathidae, particularly at 15 fm where the average catch was 101.6 Kg/hour. The group became less prominent at 20 fm but in deeper waters Leiognathids seldom appeared in the catch. At a depth where they were dominant, Leiognathids usually represented 30 to 70% of the total catch by weight. Contrary to our results, Tiews (1965) who was working in the Gulf of Thailand found that Leiognathids were abundant at about 22-27 fm (41-50 m) where the average catch/hour was 51.2 Kg. This figure, however, was

arrived at because he grouped Leiognathidae and Gerridae together. In our investigations, *Pentaprion longimanus* (Gerridae) was found to be very abundant at 20-25 fm. The average catch per hour at 20 fm and 25 fm were 19.5 Kg and 12.3 Kg respectively. If we did not treat this species as distinct from Leiognathids, then our results would have been the same as Tiews'.

The Tachysurids were found at all depths investigated but they were most abundant at 15-20 fm where in a normal haul the group as a whole formed about 6% of the total catch by weight. The average catch per hour at 15 fm and 20 fm was 12.9 Kg and 7.9 Kg respectively. The dominant species at 20-25 fm was *Arius serratus* and here the weight of catfish caught was almsot entirely due to this single species. The catch at 10 fm was slightly lower, although more species were recorded there. In this shallower water, catfish usually represented 1-4% of the total catch, the commonest species being *Osteiogeneiosus militaris*.

The Sciaenids were abundant in water 10-15 fm deep where the catch per hour approached the 20 Kg level. At 20 fm or deeper the group became less common and the average catch of sciaenids was less than 1 Kg per hour. As usual, more species were recorded at 10 fm. *Johnius aneus* and *J. dussumieri* were the commonest. *Otolithes brunneus* and the small species, namely *Sciaena russelli* were confined to waters 10 fm deep. *Sciaena dussumieri* were seldom caught in large number even in a haul where sciaenid catch was good.

The best depth for Nemipterids was 20 fm where the average catch per hour was 13.8 Kg. They usually represented about 10% of the total catch by weight. At 15 fm and 25 fm, the catch was slightly lower though percentage at the latter depth might be higher because of the smaller number of species. The Nemipterids were found at all depths and the bulk of the weight was due to the commonest species, *Nemipterus japonicus*. Other species were *N. peronii* and *N. nemurus*, the latter being a very much smaller species. *Nemipterus hexodon*, *N. nematophorus* and *N. balinensia*? were only occasionally caught and the number of individuals in a good haul seldom exceeded five.

The Pomadasyids were identified as *Pomadasys hasta*, *P. argyreus* and *P. maculatus*. The first two species formed the bulk of the catch at 15 fm or shallower. The third species only appeared in water 20 fm deep or deeper; it seldom appeared in water shallower than 20 fm. The three species were found together at 20 fm and Pomadasyid catch here was high. It came to 19.7 Kg/hour. At other depths the catch was less than 5 Kg. Though high, the catch at 20 fm was largely due to large numbers of *P. arygreus*, a very small species. Large numbers of *P. argyreus* might also appear in water as shallow as 10 fm.

The Synodontids were most abundant at 15-20 fm where 3-17% of the total catch was due to this group. The average catch per hour at 15 fm was 8.1 Kg and at 20 fm 9.1 Kg. The Synodontids were less common in deeper water and quite rare at 10 fm. The commonest species was *Saurida tumbil* found at all depths but *Saurida undosquamis* appeared only in waters 20-25 fm deep. The number caught, however, was very much less than the other species.

The Mullids were abundant right up to 20 fm, made up entirely of *Upeneus sulphureus*. The best depth was 15 fm where the catch per hour was 16.5 Kg. At 10 fm or 20 fm the catch was about 11-12 Kg/hour. At 20-25 fm, *Upeneus bensasi* appeared with the common species but the weight contributed by this species was always low - 1 Kg or less per hour.

The Lactariids were represented by *Lactarius lactarius*. These fish were caught in reasonably large quantities at 10-15 fm. The catch per hour was about 7-12 Kg or 4-5%. An exceptionally large catch was recorded on the 17th of August at 15 fm off Pulau Kendi (See Fig. 3) where this group represented 31% of the total catch. Most of the fish, however, were young individuals, far below marketable size. The Lactariids seemed to be rare at 20 fm or deeper.

Among the carangids, the commonest was *Caranx malabaricus* and it was the only species that appeared regularly at all depths and in most of the hauls. They were not really abundant and although the best depth was 15-20 fm, the average catch per hour was only about 2 Kg. At other depths, the figure was under 1 Kg. Other species that occasionally appeared with *C. malabaricus* were *C. armatus*, *Selaroides leptolepis*, *Atropus atropus* and *Megalaspis cordyla*. *Caranx gallus* and *Selar kalla* were very rare. Carangid catch as a whole was low and seldom exceeded 5% of total catch in any depth.

The only Stromateid that was sometimes caught in large quantities was *Stromateus argenteus*, seldom found in depth greater than 17 or 18 fm. But even at their best, these white Pomfrets never represented more than 5% of the total catch. The average catch per hour at 10-15 fm was about 2 Kg. Another less common species found at 15-20 fm was *Psenes indicus*, a much smaller species and seldom found in the market. Only occasionally did the catch consist of *Stromateus nigra* or *S. sinensis*.

The Gerrids were a significant group at 20-25 fm where the catch varied from 11% to 50%. On one occasion (23/9/65 at 25 fm) the percentage went up to 57. At 20 fm and 25 fm the catch per hour was 19.1 Kg and 12.3 Kg respectively. The catch above 20 fm was very low. The bulk of Gerrid catch was entirely due to *Pentaprion longimanus*. *Gerres punctatus* and *G. abbreviatus* were also present but they seldom contributed more than 1% of the total catch by weight.

Groups of fish which were found in larger numbers at 20-25 fm were the Platycephalids, Priacanthids and Triacanthids. Of the three, the Platycephalids were the most abundant. They formed 2-9% of the total weight but occasionally, they might exceed the 10% level. The mean catch per hour at 20 fm and 25 fm was 2.4 Kg and 4.5 Kg. They were represented by *Platycephalus indicus*, *P. macracanthus*, *P. scaber* and *P. asper*. The Priacanthids and the Triacanthids were not found in water shallower than 20 fm. The Priacanthids were identified as *Priacanthus tayenus* and the catch per hour was about 2 Kg while the Triacanthids were represented by *Triacanthus stribilifer* and *T. biaculeatus*, the catch rate being about 1 Kg per hour.

Among the fish whose distribution was restricted to water not deeper than about 15 fm were the Clupeids represented by *Pellona spp.* and *Ophistopterus indicus* and the Polynemids represented by *Polynemus sextarius* and *P. sexfilis* and Dorosomids represented by *Dorosoma chacunda. Pellona* were equally abundant at 10 fm and 15 fm but *Ophistopterus indicus* seemed to be more common at 10 fm where the average catch per hour was 11.4 Kg. and the number caught exceeded 500 individuals. Clupeid catch in this shallow water normally represented 5-20% of the total weight. At 20 fm, Clupeids became less abundant and if present they formed only 1% or less of the total catch. Though larger numbers might sometimes be caught, the weight contributed by Polynemids was low (1-2 Kg/hour) because both were of small species 10-14 cm, about the same size as *Upeneus sulphureus.*

The Engraulids were a group restricting itself to water as shallow as 10 fm. *Thrissocles mystax, T. hamiltoni* and *Setipinna taty* were the main species. Others which were less common were *T. setirostris* and *T. dussumieria.* They were much smaller and lighter than the Polynemids. The average catch per hour was about 6 Kg although the number of individuals caught might exceed 300.

Though they were found at all depths, Flatfishes were seldom caught in large numbers. Normal catch was 1-2%. Only occasionally were good catches amounting to about 8% recorded and that this was always due to *Cynoglossus.* The best depth for *Cynoglossus* was 15-20 fm. *Pseudorhombus javanicus* were sometimes caught in large numbers but as they were small the average catch per hour was very low. *Psettodes erumei* were much less common although they were much bigger and heavier than other flatfishes.

Drepane punctata and *Ephippus orbis* did not constitute much in the trawl catches. Reasonably good numbers were caught at 15-20 fm but the average catch per hour for either species was less than 2 Kg.

The Serranids, Lethrinids and the Lutianids were commercially important but they were seldom caught in large number and so were *Trichiurus spp.* and *Sphyraena spp.*

The Lagocephalids were sometimes abundant, particularly at 15-20 fm. The percentage catch would occasionally be as high as 5-6%. But normally they formed less than 2% of the total catch. The species identified were *Lagocephalus inermis, Gastrophysus spadiceus* and *G. lunaris.*

The Uranoscopids were represented by *Uranoscopus fuscomaculatus.* They were present only occasionally. When present, they formed about $\frac{1}{2}$% of total catch. They were found in water about 15 fm deep.

Among the Elasmobranchs, the commonest and most abundant were two species of Trygonids (Stingrays). They were *Trygon zugei* and *T. walga,* found close inshore. These species were present in large numbers in almost all the hauls from 10 fm and to a lesser extent from 15 fm or deeper. Good catches contained 6-11% of thse trygonids. Less common Trygonids were *Gymnura peocilura* and *Raja lymma. Rhynchobatus djeddensis, Myliobatis sp.* and *Trygon (Himantura) uarnak* were sometimes included in the catch. The last species was gigantic in size, each weighing about 60-80 Kg.

The average catch per hour of rays were 6.7 Kg and 6.8 Kg at 10 fm, 15 fm and 20 fm respectively.

Small sharks measuring 15-25 cm were common above 15 fm. The dominant species was *Scoliodon (Carcharias) sorrakowah*. Another small species was *S. pallasorah*. However abundant these small sharks might be, they, even at their best, never represented more than 4% of the total catch. Other sharks which were bigger though less abundant, were *Mustellus manazo, Scyllium marmoratum* and *Pristis cuspidatus*. Most of the sharks encountered during the investigations came from water 10 fm deep where the average catch was 6.7 Kg/hour. At other depths, shark catch was small.

Among the crustaceans, the commonest were the Penaeids. Reasonably large quantities of them were caught in waters 10-15 fm deep, off Pulau Kendi. The largest species, measuring 20-30 cm from tip of rostrum to tip of telson, was *Penaeus monodon*. The average catch of penaeids at 10-15 fm was about 4-6 Kg per hour. Normally they contributed 2-4% of the total catch but on two occasions at 10 fm they represented 11.6% and 17.2% of the total catch by weight. At 20-25 fm the penaeids were much less in number and the dominant species was *Thenus orientalis* (1-2% of total catch). On one occasion at 25 fm *Thenus orientalis* formed 5.1% of total catch. Crabs were rare and two of the species occasionally encountered were *Neptunus pelagicus* and *Charybdis cruciata*.

Loligo and *Sepia* were found in all depths investigated, constituting $\frac{1}{2}$-3% of the trawl catch. They were present in almost all the hauls. Occasionally when the catch was good, they might contribute 4-7% of the total catch. Octopus was very rare and seldom caught.

Bathymetric distribution of fish fauna

Our investigations showed that most of the fish caught could be classified into three major groups, based on their depth of distribution. The ranges were 10-15 fm, 20-25 fm and 10-25 fm.

The greatest number of species were represented in the shallow zone of 10-15 fm. The fish which were caught here in reasonably good numbers included most of the Tachysurid species, *Lactarius lactarius, Pellona spp., Ophistopterus indicus*, the sciaenids, *Stromateus argenteus, Polynemus sextarius, P. sexfillis, Setipinna taty, Thrissocles mystax*, the Leiognathids, sharks, rays and the penaeids. The Sharks were mostly represented by *Scoliodon sorrakowah* and the rays were made up chiefly of two small species of trygonids, namely *Trygon zugei* and *T. walga*. Of all the fish observed within this depth range, the commonest and the most abundant, sometimes almost to the exclusion of the others, were the Leiognathids. Some of the species mentioned above could also be found in water 20 fm deep but their percentage catch was very much lower.

At 20-25 fm, most of the fish caught were of little commercial value. *Pentaprion longimanus* (Gerridae) which was insignificant above 20 fm now appeared in exceptionally large numbers forming the bulk of the catch in most of the hauls. Other families which were not as abundant

but were characteristically represented in these trawl catches were the Triacanthidae (Tripod fish), Priacanthidae (Bullseye), Platycephalidae (Flathead) and Scolopsidae (Monocle bream). The only Tachysurid which was very significant within this depth range was *Arius serratus*. *Pomadasys maculatus*, *Upeneus bensasi* and *Saurida undosquamis* seldom appeared in large number but it is interesting to note that they were not present in hauls obtained from above 20 fm.

The third group consist of species which could be found in water as shallow as 10 fm and whose range of distribution extended to 25 fm. They were *Pomadasys hasta*, *P. argyreus*, *Caranx malabaricus*, *Upeneus sulphureus*, *Nemipterus japonicus*, *N. peronii*, *N. nemurus*, *Saurida tumbil*, *Cynoglossus spp.*, *Pseudorhombus javanicus*, *Ephippus orbis*, *Drepane punctata* and the lagocephalids (Blowfish). Most of the species, however, could be regarded as abundant at 15-20 fm only.

Variations of mean lengths of fish with depth

Besides the decline of catch-rate and the change of species composition with depth there is indication, as shown in Table II, of different types of variations of the mean lengths of fish with depth. One type of variations is exemplified by the species, *Upeneus sulphureus* and *Nemipterus japonicus*, which show a progressive increase in the mean lengths of the fish with depth. The species, *Caranx malabaricus* and *Cynoglossus macrolepidotus*, show, on the other hand, a decrease in size with depth, while in *Lactarius lactarius* and *Pomadasys argyreus*, the greatest mean lengths are seen in the middle depth-class of their range of distribution. Some species, e.g. *Ephippus orbis* and *Dorosoma chacunda*, however, were found to have more or less constant mean lengths irrespective of their depth of occurrence.

Relationship of catch with hydrographic factors

Apart from the relationship of depth with trawl catch, it is still not possible to discern the respective influence of the different characteristics of the water on trawl catch because of the small number of hauls obtained and the limited amount of hydrographic data collected. The lowest oxygen values observed of the bottom water in the deep trawl stations (depths approximately 45 m) were around 2 ml/L, a concentration which seems unlikely to have any limiting influence on the bottom fish; while the highest oxygen value of the bottom water recorded was 4 ml/L. At almost equal oxygen values in the range from 2-4 ml/L, both high and low catch-rates were observed, so that no correlation of catch-rate with dissolved oxygen content was apparent. The differences in bottom temperatures and salinities between shallow water of about 10 m and deeper water of 45 m - 1°C and 1.5% - seem too small to be of any significance for the distribution of fishes.

The exact causes for the gradation of catch-rates with depth, as well as for the variations in catch-rates within the same depth-classes, are therefore yet to be determined. Doty, et al. (1962?) described decreasing trends, with increasing distance from shore, of the primary

productivity values of coastal waters on the east coast of Sumatra. It would seem that this phenomenon could ultimately result in the declining catches with depth, which is proportional to distance from shore off the coast of Penang. However, Longhurst (1966) stated that the level of production of demersal fisheries in intertropical areas is more determined by deposition of riverine organic material than the results of primary production.

CONCLUSION

The preliminary results are similar to the observations made in the Philippines (Warfel and Manacop, 1950), in the Gulf of Thailand (Tiews, 1965; Ruamragsa and Isarankura, 1965) and on the west coast of Africa (Salzen, 1957), on the declining trends of the fishable resource with increasing depth. Green and Birtwistle (1927 and 1928) and Ommaney (1961) using larger vessels and heavier gears in Malaysian waters also observed a gradation of fish fauna with depth.

While the area suitable for trawling is quite extensive the productive area, where the familiar, acceptable and more valuable fish are to be found, is limited off Penang. The seawater slope of the bottom is greater here than either to the north or south where the productive depth-classes are more extensive and should support a fairly large number of trawlers. At present, 35 trawlers have been licensed for operation in the area north-west off Penang and their catches per trip - about 10 hours on the fishing ground in which 3 hauls of approximately 3 hours duration each are made - have varied between 600-900 Kg, or approximately 66-100 Kg per hour. Even though these commercial trawlers tend to operate in the most productive areas their catch-rates are lower than that recorded here. The probable causes are poorly equipped vessels and inexperience.

Comparisons of catch-rates of M.V. Selayang and local commercial trawlers with those of Thailand and Philippines are not possible because of obvious differences in vessels, gear and facilities, which together with experience, result in differences in the efficiency of the fishing operation.

ACKNOWLEDGEMENTS

We wish to expres our deep gratitude to Mr. Soong Min Kong, Director of Fisheries, Malaysia for valuable advice and encouragement throughout the course of these investigations.

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Table I Average catch in Kg/hr and percentage compositions of various species at different depth-classes.The figures in parenthesis refer to the average number of fish caught in one haul.

Depth-class	10fm(18.3m)		15fm(27.4m)		20fm(36.5m)		25fm(45.7m)	
Species	Kg/hr	%	Kg/hr	%	Kg/hr	%	Kg/hr	
ENGRAULIDAE								
Setipinna taty	5.6(273)	2.9	-		-		-	
Thrissocles mystax	0.4(37)	0.2	-		-		-	
POLYNEMIDAE								
Polynemus sexterius & P. sexfilis	1.6(58)	0.8	1.5(41)	0.6	-		-	
DORCSOMIDAE								
Dorosoma chacunda	0.5(11)	0.3	0.3(5)	0.1	-		-	
STROMATEIDAE								
Stromateus argenteus	2.6(30)	1.4	1.6(7)	0.7	-		-	
Psenes indicus	-	-	0.3(4)	0.1	0.6(10)	0.4	0.2(3)	0.4
SCIAENIDAE								
Otolithes brunneus	1.2(10)	0.6	-		-		-	
Sciaena russelli	0.6(43)	0.3	-		-		-	
Otolithes ruber	4.0(38)	2.1	5.2(38)	2.2	-		-	
Johnius dussumieri	5.9(162)	3.1	5.5(43)	2.4	-		-	
Pseudosciaena soldado	0.9(6)	0.5	3.1(17)	1.3	0.1	0.1	-	
Sciaena dussumieri	-		0.7(12)	0.3	-		-	
Johnius sneus	4.0(89)	2.1	4.3(73)	1.8	0.3(5)	0.2	0.2(4)	0.4
TACHYSURIDAE								
Arius caelatus & A. jella	1.3(12)	0.7	-		-		-	

Table I. Contd.

Depth-class	10fm(18.3m)		15fm(27.4m)		20fm(36.5m)		25fm(45.7m)	
Species	Kg/hr	%	Kg/hr	%	Kg/hr	%	Kg/hr	%
A. leiotetocephalus & A. venosus	0.6(3)	0.3	3.5(17)	1.5	-		-	
A. gegora	1.3(6)	0.7	1.9(9)	0.8	1.1(11)	0.8	-	
A. serratus	0.2(5)	0.1	0.9(12)	0.4	6.8(80)	4.7	4.7(81)	9.4
Osteiogeneiosus militaris	3.3(44)	1.7	0.8(6)	0.3	-		-	
Mixed species	-		5.8(49)	2.5	-		-	
CLUPEIDAE								
Ophistopterus indicus	11.4(518)	6.0	2.3(78)	1.0	-		-	
Pellona spp	6.7(138)	3.5	8.7(136)	3.7	0.4(4)	0.3	-	
LACTARIIDAE								
Lacterius lacterius	7.7(334)	4.0	12.1	5.2	0.1	0.1	-	
POMADASYIDAE								
Pomadasys hasta & P. argyreus	3.6(102)	1.9	2.9(110)	1.2	16.5(999)	11.5	-	
P. maculatus	-		-		3.2(177)	2.2	2.3(51)	4.6
CARANGIDAE								
Caranx malabaricus	0.8(11)	0.4	2.1(30)	0.9	2.3(47)	1.6	0.8(10)	1.6
Megalaspis cordyla	1.3(5)	0.7	-		-		-	
MULLIDAE								
Upeneus sulphureus	11.6(716)	6.1	16.5(967)	7.1	11.4(361)	7.9	1.1(28)	2.2
U. bensasi	-		-	1	1.1(20)	0.8	0.7(26)	1.4

Table I. Contd.

Depth-class	10fm(18.3m)		15fm(27.4m)		20fm(36.5m)		25fm(45.7m)	
Species	Kg/hr	%	Kg/hr	%	Kg/hr	%	Kg/hr	%
NEMIPTERIDAE								
Nemipterus japonicus	1.6(47)	0.8	7.9(178)	3.4	8.4(168)	5.9	6.0(83)	12.0
N. peronii & N. nemurus	0.1(3)	0.1	0.3(7)	0.1	5.4(117)	3.8	2.3(58)	4.6
LUTIANIDAE								
Lutianus malabaricus, L. argentimaculatus & L. russelli	0.1(1)	0.1	1.2(4)	0.5	0.5(4)	0.4	0.4(1)	0.8
SYNODONTIDAE								
Saurida tumbil	1.8(9)	0.9	8.1(120)	3.5	9.1(84)	6.3	3.3(26)	6.6
SPHYRAENIDAE								
Sphyraena obtusata & Sphyraena spp	0.7(6)	0.4	0.1		0.1	0.1	-	
THERAPONIDAE								
Eutherapon theraps	0.2(4)	0.1	0.7(10)	0.3	0.4(6)	0.3	-	
MURAENESOCIDAE								
Muraenesox cinereus	0.2	0.1	0.1		0.2	0.1	-	
LEIOGNATHIDAE								
Leiognathus splendens, L. equulus & Leiognathus spp.	85.9	45.0	101.6	43.5	25.5	17.8	0.1	0.2
CYNOGLOSSIDAE								
Cynoglossus macrolepidotus & Cynoglossus spp	0.7(9)	0.4	6.3(96)	2.7	1.8(25)	1.3	0.1(1)	0.2
PSETTODIDAE								
Psettodes erumei	0.3(2)	0.2	1.4(6)	0.6	0.5(2)	0.4	0.1	0.2

Table 1. Contd.

Depth-class	10fm(18.3m)		15fm(27.4m)		20fm(36.5m)		25fm(45.7m)	
Species	Kg/hr	%	Kg/hr	%	Kg/hr	%	Kg/hr	%
BOTHIDAE								
Pseudorhombus javanicus	-		0.4(7)	0.2	1.0(16)	0.7	0.5(9)	1.0
PLATYCEPHALIDAE								
Platycephalus spp	0.3(3)	0.2	0.1(1)		3.4	2.4	4.5	9.0
EPHIPPIDAE								
Ephippus orbis	0.6(8)	0.3	1.1(14)	0.5	1.9(23)	1.3	0.4(5)	0.8
DREPANIDAE								
Drepane punctata	-		1.6(16)	0.7	0.5(5)	0.4	0.3(3)	0.6
LAGOCEPHALIDAE								
Lagocephalus lunaris, Gastrophysus inermis & G. spadiceus	0.2(1)	0.1	2.7(17)	1.2	1.9(21)	1.3	0.1	0.2
URANOSCOPIDAE								
Uranoscopus fusconaculatus	-		1.0(46)	0.4	-		-	
SIGANIDAE								
Siganus oramin	-		0.3(10)	0.1	1.6(29)	1.3	0.9(10)	1.8
GERRIDAE								
Gerres abbreviatus & G. punctatus	-		0.2(4)	0.1	0.6(6)	0.4	0.1(2)	0.2
Pentaprion longimanus	-		1.4(82)	0.6	19.1(904)	13.3	12.3(623)	24.6
BALISTIDAE								
Abalistes stellaris	-		0.2	0.1	9.7(5)	0.5	2.0(12)	4.0
CALLYODONTIDAE								
Callyodon fasciatus	-		-		0.2	0.1	-	

Table 3. Contd.

Depth-class	10fm(18.3m)		15fm(27.4m)		20fm(36.5m)		25fm(45.7m)	
Species	Kg/hr	%	Kg/hr	%	Kg/hr	%	Kg/hr	%
PLECTORHYNCIDAE								
Diagramma punctatum	-		-		0.3	0.2	0.2	0.4
LETHRINIDAE								
Lethrinus miniatus	-		-		1.1(3)	0.8	0.4(1)	0.8
SCOLOPSIDAE								
Scolopsis vosmeri	-		-		0.6(8)	0.4	0.1(1)	0.2
PRIACANTHIDAE								
Priacanthus tayenus	-		-		2.1(68)	1.5	2.0(53)	4.0
TRIACANTHIDAE								
Triacanthus strigilifer & T. biaculeatus	-		-		1.1(22)	0.8	1.3(27)	2.6
TRICHIURIDAE								
Trichiurus sp.	-		-		1.9	1.3	-	
CRUSTACEA								
Penaeids	5.9	3.1	4.4	1.9	0.2	0.1	-	
Thenus orientalis	-		-		0.8	0.6	1.0	2.0
CEPHALOPODA								
Sepia & Loligo	1.7	0.9	3.6	1.5	1.6	1.1	1.6	3.2
SHARKS								
Scoliodon sorrakowah	1.1(26)	0.6	-		-		-	
Scyllium marmoratum	0.2	0.1	-		-		-	
Pristis cuspidatus	5.4	2.8	-		—		-	
Mustellus manazo	-		0.4	0.2	0.3	0.2	0.1	0.2

Table I. Contd.

Depth-class	10fm(18.3m)		15fm(27.4m)		20fm(36.5m)		25fm(45.7m)	
Species	Kg/hr	%	Kg/hr	%	Kg/hr	%	Kg/hr	%
RAYS								
Trygon sugei & T. walga	6.0(47)	3.2	3.7(8)	1.6	3.6(2)	2.5	-	
Gymnura poecilura	0.7	0.4	4.9	2.1	-		-	
Rhynchobatus djeddensis	-		-		0.9	0.6	-	
Himentura uarnak	-		-		2.3	1.6	-	
Average total catch per Haul	190.8	100.2	233.7	99.9	143.7	100.4	50.1	100.2
Minimum catch of all species	66.3		54.2		70.7		11.5	
Maximum catch of all species	486.5		592.4		263.0		126.6	
Total number of hauls	8		8		8		7	

Table II . Variations of mean lengths (Dorsal extreme length, in cm) of fish with depth. The number of fish measured are given in parentheses.

Species \ Depth	10fm(18.3m)	15fm(27.4m)	20fm(36.5m)	25fm(45.7m)
Upeneus sulphureus	9.6 (177)	11.4 (74)	12.8 (167)	13.3 (88)
Nemipterus japonicus	12.8 (35)	13.5 (192)	14.6 (200)	16.2 (85)
Caranx malabaricus	16.2 (51)	15.3 (91)	15.2 (209)	14.9 (71)
Cynoglossus macrolepidotus	24.5 (39)	24.8 (86)	20.8 (61)	18.5 (9)
Lacterius lacterius	11.0 (51)	15.5 (77)	12.4 (22)	-
Pomadasys argyreus	9.2 (32)	17.3 (17)	10.3 (105)	-
Ephippus orbis	12.2 (31)	13.2 (60)	13.0 (96)	12.7 (32)
Dorosoma chacunda	14.2 (68)	14.9 (8)	14.4 (26)	-

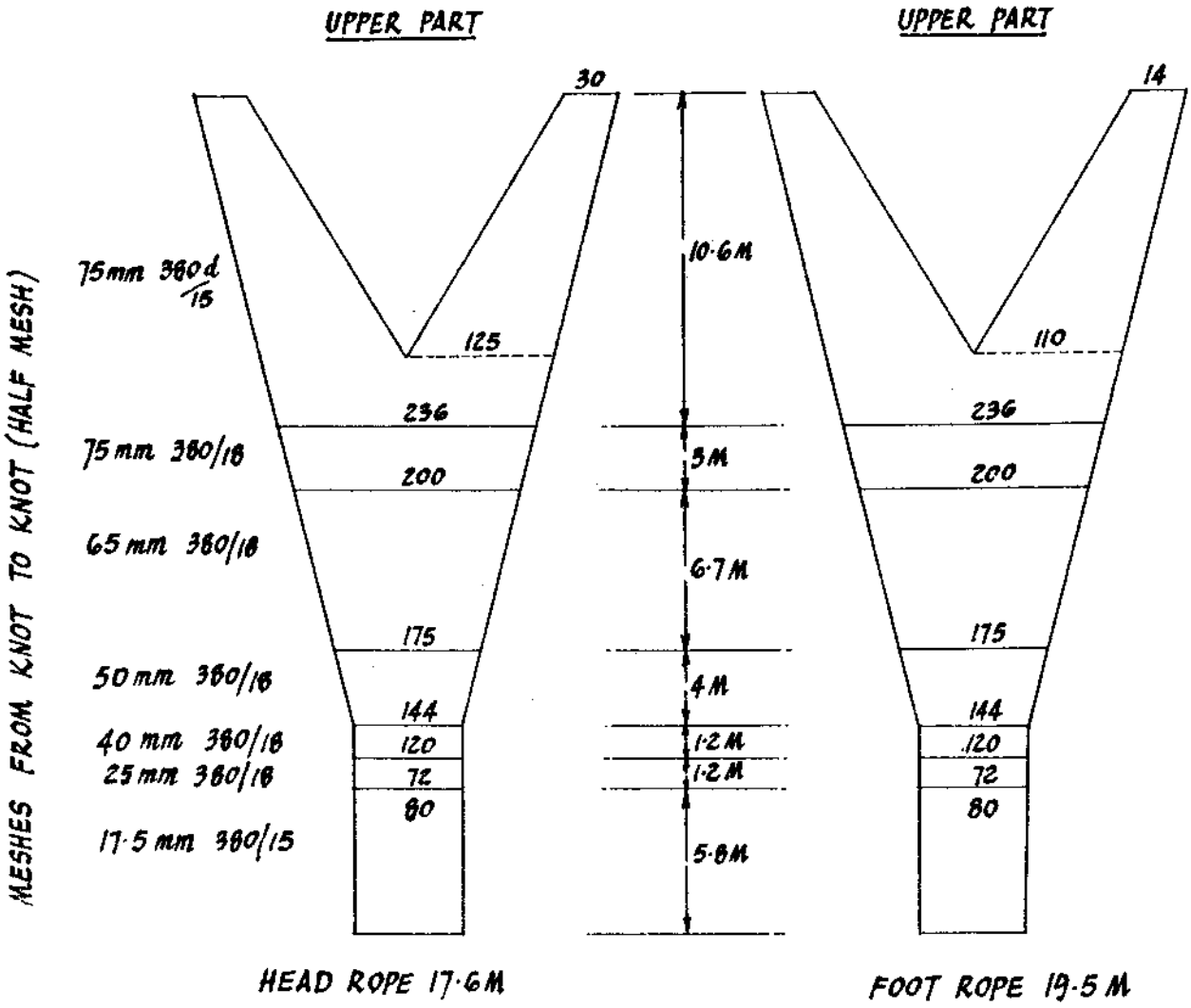
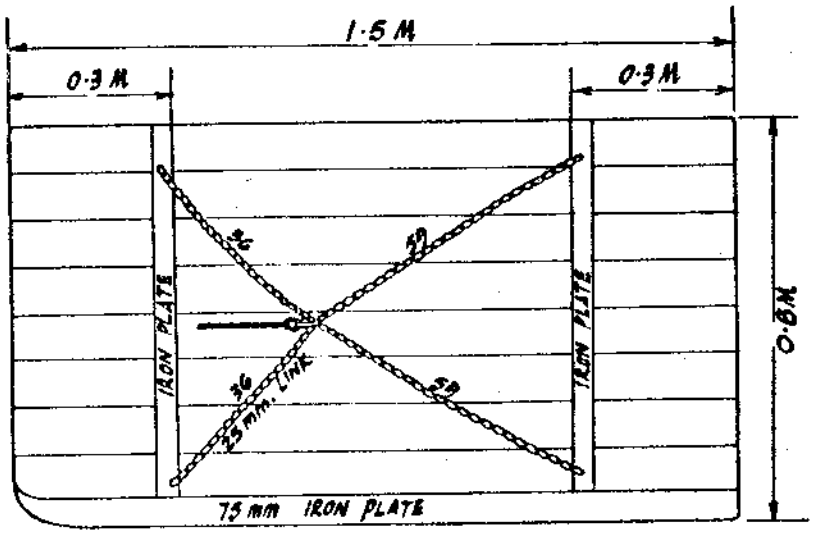


Fig. 1. Plan of the Otter-Trawl Net Used



SKIDS : 30 mm.
WEIGHT : 41 kg.

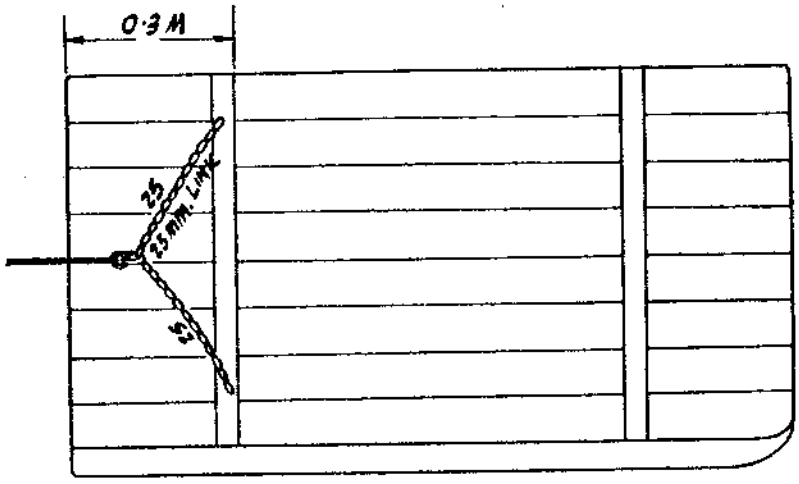


Fig. 2. Plan of the Otter-Boards Used

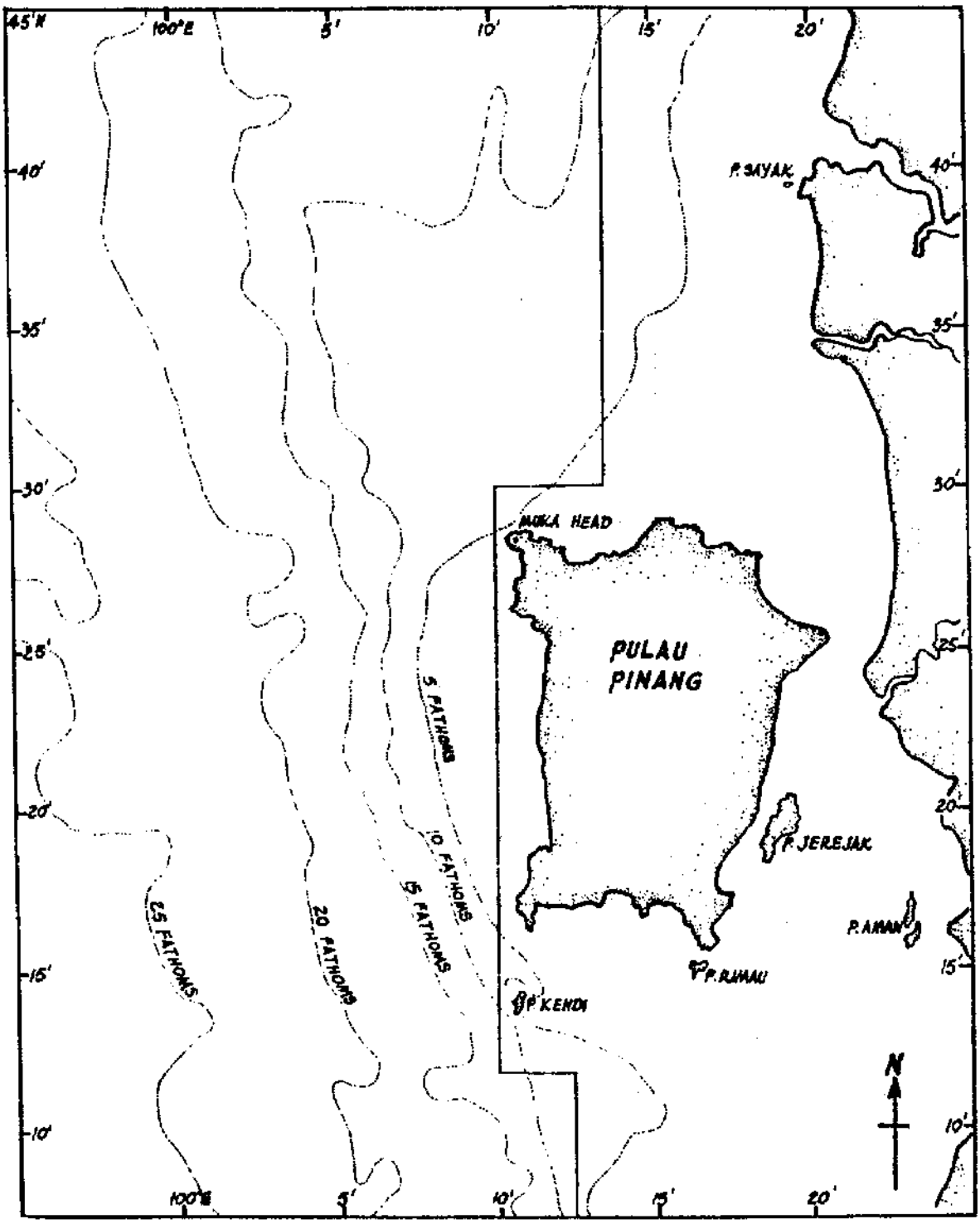


Fig. 3. Map of the Area off Penang. Traling Hauls were Spread Out Over the Area Outside the Demarcation Line