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SOUTH CHINA SEA FISHERIES
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THE SOUTH CHINA SEA FISHERIES

test fishing for tuna and small pelagic species

TF/RAS 22 (CAN): DEVELOPMENT OF THE PELAGIC FISHERIES IN THE SOUTH CHINA SEA AND ADJACENT WATERS

A PROGRAMME SPONSORED BY THE CANADIAN INTERNATIONAL DEVELOPMENT AGENCY

TEST FISHING FOR TUNA AND SMALL PELAGIC SPECIES

Reports on the Operation of FAO Chartered Purse Seiners in Philippine and South China Sea Waters, 1974-1977

SOUTH CHINA SEA FISHERIES DEVELOPMENT AND COORDINATING PROGRAMME
Manila, Philippines
September 1978

This activity of pelagic fishery development was carried out under a Funds-in-Trust arrangement with the Canadian International Development Agency (CIDA) and FAO as a major portion of the South China Sea Fisheries Development and Coordinating Programme from 1974 through 1977.

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F O R E W O R D

The South China Sea Fisheries Development and Coordinating Programme had under its direction a trust fund project funded by the Canadian International Development Agency (CIDA) called the TF/RAS 22 (CAN): Development of the Pelagic Fisheries in the South China Sea and Adjacent Waters.

The objectives of this project formed part of the overall objectives of the programme to stimulate fish production in the region, to encourage rational stock management policies and to assist the Programme countries to fulfil their fishery development priorities in an accelerated manner. With regard to the immediate objectives it contributed to the better assessment of pelagic stocks, the location of pelagic stocks for exploitation in the region and gave guidance to rational investment programmes for commercial and small-scale development of pelagic fisheries.

The project was able to carry out its objectives as foreseen, where it visualized the activities consisting of some commercial operations utilizing 2 vessels capable to catching any schooling surface fish. The operations would be pre-planned by resource assessment which would locate the general areas of operation. Broad search support would be augmented by coordinating the activities of the various research and training vessels in the region suitably sonar equipped including the SEAFDEC vessels. Searching would be bolstered by the use of small chartered spotter aircraft. While much of this latter work was in fact carried out, it was severely limited by funding in successive years.

It should be noted that the charter arrangements including vessel and crews experienced in pelagic fishing under tropical conditions and with adequate incentives produced probably one of the most effective vessel performance records in FAO history.

In November 1974, two chartered Canadian purse seiners of 112 and 96 feet commenced operation to survey and test fish for tunas and secondarily, for small pelagic fish, in Philippine and South China Sea waters. The activities were completed by the departure of the second vessel in July 1977.

Specifically, the main purpose of the operation was to establish catch rates of major pelagic species in the region using purse seines, determine seasonal fluctuations and availability, to locate the more productive fishing areas, to test various purse seining techniques in relation to fish behaviour, and to train various officers in the region on survey and fishing techniques.

Twenty-five cruises were made from November 1974 to June 1977. The results of the cruises were reported in the SCSP working paper series. Also a mid-term report was prepared at the end of the first year of operation to summarize the results.

The present publication is the final report of this Activity and is formed by three parts.

PART I centers around the results of the fishing for tuna and tuna-like fish in the Philippine waters and discusses some biological features of the stock.

PART II reports about the survey for small pelagic conducted in waters of the Philippines and the South China Sea.

PART III discusses the operational aspects of the Programme and their implications on the tuna marketing.

The first two parts were prepared by the SCSP consultants, Dr. S. Chikuni and Mr. A. C. Simpson, and the third part was based on a report prepared by Mr. W. Murdoch, former SCSP Senior Fishery Industry Officer, who was in charge of the Programme during its execution. The report was finally edited in its completed form by Messrs. A. C. Simpson and R. B. Buzeta.

The three reports, which refer to different issues, are being published in one volume as, together, they cover most aspects of the work done by the chartered vessels.

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Part III - A discussion on the operational aspects.

Test fishing, tunas, small pelagic, Southeast Asia, catch rates, size composition.

PART I

REPORT ON FISHING FOR TUNA IN PHILIPPINE WATERS AND BIOLOGICAL FEATURES OF THE RESOURCES

Abstract

Data on fishing for tuna in Philippine waters collected by the Programme's chartered purse-seiners during November 1974-June 1977 have been analyzed. Twenty-five cruises were carried out by the two vessels and the exploratory fishing operation was performed in the Sulu Sea and the Moro Gulf.

In daytime fishing, which was an ordinary type of purse-seining, it appeared to be very difficult to hold the fish in the net due to the disadvantageous oceanographic conditions and wild nature of the fish. Nighttime fishing, on the contrary, in which lights and a shelter were used to lure firstly baitfish and secondly tunas, was successful and the method is considered to be applicable to the commercial fishing by modern purse-seiners in the areas.

The majority of fish caught were skipjack, 85% of the total catch, and yellowfin/bigeye tuna was the second important species group which accounted for 13%. Field identification of yellowfin and bigeye tunas in the catch appeared to be very difficult due to their young stage. The other species were of minor importance in the total catch or not properly represented as in the case with Auxis and Euthynnus due to the larger mesh size used and because they were given away or dumped when caught.

The CPUE of skipjack, in terms of the catch per day's fishing, in the night-time fishing in the Moro Gulf varied markedly according to the season. The CPUE showed two peaks, in spring (6-7 tons) and in autumn (3-4 tons), and was extremely low in summer (0.5-1 ton). The change in CPUE was considered to originate from the change in the feeding activity of the fish and the rough sea conditions caused by the monsoon season. The CPUE of yellowfin/bigeye tuna and the other species showed a similar seasonality to that of skipjack though the magnitude of the change was small.

The Sulu Sea was less productive for night-time fishing than the Moro Gulf mostly due to the sparse distribution of natural shelters, however, the CPUE showed a similar seasonality to that in the Moro Gulf.

The size and age structure of the catch were different between the Sulu Sea and the Moro Gulf. Skipjack caught in the Moro Gulf were mostly composed of 40-55 cm fish (age 2) and partially 30-40 cm fish (age 1) while fish taken from the Sulu Sea were 40-55 cm (age 2) and 55-70 cm (age 3). A similar phenomenon was observed on yellowfin/bigeye tuna, 40-60 cm (age 1) and 25-40 cm (age 0) in the Moro Gulf versus 40-60 cm (age 1) and 65-85 cm (age 2) in the Sulu Sea.

It is assumed that skipjack and yellowfin tuna in the area are comprised of single stocks together with a large amount of parental fish in the western Central Pacific and adjacent waters.

On the basis of the estimated catch rate for each month it is estimated that a commercial purse-seiner could achieve about 1,500 tons of annual catch, comprising 1,300 tons of skipjack, 200 tons of yellowfin/big eye tuna and 80 tons of other species.

It is important to check the interaction of the purse-seine fishery on other type of fishery which harvest the same stock because purse-seine fishery catch largely young specimens.

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Summary of Recommendations

Several recommendations on future activities to ensure the rational development of the fishery are given in the following:

1. Study the identification of the three tuna species, (yellowfin tuna, bigeye tuna and albacore), in their young stage for field identification of these species.

2. Study the stock structure and migration pattern of skipjack and yellowfin/bigeye tuna in the Philippines and adjacent waters. Tagging experiments and studies on blood isozymes should be carried out.

3. A programme for monitoring the change in year-class strength of skipjack through the analysis of catch/effort data from the local fisheries.

4. A study on the development of night-time fishing particularly in the Sulu Sea utilizing artificial (man-made) shelters.

5. Assessment of a suitable size range of seiners for specific types of operations and the number of vessels appropriate to the extent of the fishing ground, in order to seek a rational strategy for the development of the fishery including handling/processing facilities.

6. Study the effect of the increased catch of young fish in the Moro Gulf and Sulu Sea.

7. Devise a tuna research programme that will include survey activities and the improvement of the statistics data collection system.

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1. OBJECTIVES

As a major part of the action-oriented programme to help develop pelagic fisheries in the South China Sea Programme area, two modern, well-equipped Canadian purse-seiners, 112 ft. and 96 ft. registered length were engaged under the Canadian Trust Fund component to carry out fishing for tuna and other pelagic species in order to determine the catch rates obtainable with such modern fishing vessels.

A major part of the programme was devoted to catching the larger schooling pelagic species. These efforts were concentrated in Philippine waters as these species were believed to be more abundant in these waters than in other parts of the area covered by the Programme.

A progress report was published on the results of the first full year's operation for tuna by the South China Sea Programme (Simpson and Chikuni, 1976). The results described in that report have been incorporated in the present report which covers the whole of the period in which the vessels were fishing for tuna in Philippine waters, i.e. from November 1974 to June 1977.

2. OUTLINE OF THE SURVEY AND THE DATA SOURCE

Twenty-five cruises of 20-50 days' duration (port to port) were carried out by the two vessels (15 cruises by "SOUTHWARD HO" and 10 by "ROYAL VENTURE") during November 1974-June 1977. Searching and fishing covered a large proportion of the deep water around the Philippines but repeated fishing were only carried out in the Moro Gulf and Sulu Sea. Throughout the period 228 sets of purse-seining were carried out and a total of about 2,200 tons were caught. The duration of each trip, number of sets made and total catch for each trip are summarized in Table 1.

Each vessel for every cruise had on board an observer from the country in whose waters the vessel was operating who was responsible for keeping records of the fishing activities and the catches made and was also encouraged to make any additional interesting observations. To standardize the records three types of log sheets were provided covering: (a) observations made while searching for fish; (b) details of all sets made; and (c) length measurements of sample fish caught (Peterson, 1975).

A cruise report was prepared after each trip and published in the programme's series of Working Papers. Reports pertaining to the tuna survey are as follows:

Trip No.	Working Paper No.
1, 2	SCS/75/WP/8
3	SCS/75/WP/10
4	SCS/75/WP/12
5, 6	SCS/76/WP/25
7, 8	SCS/76/WP/48
9	SCS/76/WP/50
10, 11	SCS/76/WP/51
12	SCS/77/WP/56
13	SCS/77/WP/57
14, 15	SCS/77/WP/58
16, 17, 18	SCS/77/WP/59

Together with these summary reports, the original log sheets and observers' records for each cruise have been used in this analysis.

3. FISHING AREA

The main objective of the tuna purse seining operation was to determine whether the more abundant tuna of the area -- skipjack, yellowfin and bigeye tuna -- could be caught effectively by modern purse seining methods. This required identification of the areas where tuna could be caught and the establishment of catch rates. The Workshop held in Manila 28 August-4 September 1974 on the Planning and Coordination of Resources Survey and Evaluation in the South China Sea (Anon., 1974) recommended that the chartered seiners should start their work in the fishing grounds south of Luzon island and in Palawan waters. According to the literature research and in conversation with local fishermen and fisheries research staff, the southern waters, the Sulu Sea and the Moro Gulf were considered to be the most productive areas, therefore, fishing operations commenced in these areas.

Three aerial surveys (March 1975, June 1975 and March 1976) were carried out which covered the waters around the Philippines, and during each survey the majority of fish schools were sighted in the Moro Gulf and the central-western Sulu Sea (Rosenberg and Simpson, 1975; Cintas and Renwick, 1975; Maynard, 1976).

Fishing proved to be more successful in the Moro Gulf (199 sets made), than the Sulu Sea (29 sets made) (Table 1, Figs. 1 and 2). However, this may not be indicative of the tuna resource potential, but a reflection of the limited fishing techniques used and available to the exploratory purse seine vessels.

4. FISHING METHOD

4.1 Fishing Gear

The major specifications for the two vessels were as follows:

Vessel	Length (M)	Gross Tonnage	Engine Power (HP)
"SOUTHWARD HO"	24	420	1 125
"ROYAL VENTURE"	29	283	850

Approximate dimensions of the standard modern purse seine nets were:

Vessel	Trips	Stretched Length (m)	Hung Length (m)	Depth Stretched (m)	Depth Hung (m)	Body Mesh (mm)
"SOUTHWARD HO"	All	1 102	952	128	119	108
"ROYAL VENTURE"	Most	979	824	82	73	108
	No. 7	1 272	1 098	150	137	76

4.2 Type of Operation

The two vessels performed two main types of operation.

One was the day-time fishing -- an ordinary type of purse seining for tunas and the other night-time fishing in which lights and a shelter were used to lure firstly, baitfish and secondly, tunas.

The first trip of each vessel was mainly for training Philippine crews in handling the gear and equipment and was not considered to be a fishing trip for analysis purposes. The second trip, a training operation for night-time fishing was performed by "SOUTHWARD HO" but was not included in the analysis.

The vessels commenced exploratory fishing by using the day-time fishing methods similar to those they were accustomed to in the eastern Pacific. In this period many attempts failed to approach the fish school closely enough to make a set, or most sets failed to hold the fish in the net. Although many schools of tuna were seen on the move or associated with floating objects, they were usually uncontrollable and difficult to catch.

Meantime, it was learned that several small purse seiners were fishing in the Moro Gulf at night using rafts illuminated with gas lamps and were making catches of up to 5 tons a night. The chartered seiners therefore tried out a similar method and found that it was applicable for modern purse seiners. Various modifications were developed and the following method became more or less standardized.

During the day the vessel finds a shelter of floating logs or a drifting bamboo raft, ties up to it and drifts with it during the remainder of the day and following night. At dusk the vessel turns on its floodlights (4 x 400 watt mercury lamps) to attract small fish which accumulate round the vessel and shelter and act as live bait for tuna. Just before dawn, usually between 0400 and 0430 hours, 2 gas lights are fixed onto the vessel's small boat which is then lashed to the shelter and then both are released from the seiner. At the same time the lights on the vessel are gradually turned off. The shelter and small boat drift away from the vessel with small fish beneath them, mainly round scad (Decapterus spp) which have been attracted by the lights on the vessel. The vessel keeps watch on the fish under the shelter by sonar and when a good school of tuna is detected the set is made round the shelter and fish. The same shelter could be used the next night if the fish were still in abundance in the area after finishing the haul of the set.

As the vessels developed the night-time fishing technique the majority of effort was concentrated on this method, especially in the latter half of the survey period. On the whole 190 sets were made by night-time fishing out of 228 sets (Table 1).

The method used for night-time fishing requires five elements to succeed, namely:

a) finding a natural shelter;
b) presence of tuna in the area;
c) attraction of baitfish by lights;
d) attraction of tuna to the baitfish;
e) setting the net successfully.

Combination of the first and second elements were considered to be the most important factor. Sparse distribution of floating shelters made the Sulu Sea a less productive area than the Moro Gulf for night-time fishing even though the schools sighted were quite abundant throughout the area and season.

5. SPECIES CAUGHT

About 2 200 tons of fish were caught throughout the survey period (Table 1). The majority of fish were skipjack (Katsuwonus pelamis), 1 885 tons or 85% (Tables 5 and 6). Skipjack dominated the catch almost throughout the year.

Yellowfin tuna (Thunnus albacares) was the next most important species. However, there was no doubt that some bigeye tuna (Thunnus obesus) were included in the recorded catch of yellowfin tuna due to the difficulties in distinguishing bigeye from yellowfin tuna on board. Most of the catch of these species was comprised of small fish 40-60 cm in body length (Figure 14). It is very difficult to distinguish these species when they are young, (less than 60 cm), which also applies to albacore (Thunnus alalunga), (FAO, 1974). Some observers distinguished bigeye from yellowfin tuna on some cruises (Cruises: 10, 17 and 18) but there were doubts as to whether the identification of these two species had been carried out correctly.

On Cruises 11, 17 and 18 observers had recorded albacore catches. However, following an inspection made in the U.S.A. at a cannery which had bought the fish, it was revealed that the recorded albacore caught on Cruise No. 17 had, in fact, been bigeye and not albacore.

Under the circumstances, catch and length measurement data for yellowfin and bigeye tuna were dealt with as "Yellowfin/Bigeye" tuna for analysis purposes. It is considered that yellowfin tuna were most abundant among the three species in the area in question and accounted for the majority of the catch of yellowfin/bigeye tuna. It has not been possible to confirm the identification of albacore in the catches.

Consequently, yellowfin/bigeye tuna accounted for about 280 tons or 13% of the total catch (Tables 5 and 6).

Frigate tuna or Tulingan (Auxis spp.) were often caught, occasionally in large quantities, but in the small side, ranging from 30-50 cm (Figure 15), and were often extensively gilled in the net causing considerable trouble. There was no market for them so the boats avoided catching them, if possible, and those caught were usually dumped; the quantity dumped was not known. There is, however, little doubt that they are very abundant in Philippine waters, and are extensively caught by local boats using seines and by trolling and floating traps.

Eastern little tuna or Black skipjack (Euthynnus affinis) also appears in the catch -- this specie was identified as such by Dr. C. Peterson on Trip No. 2. During Trip No. 3 only Black skipjack was recorded by observers, but on landing, 7 tons were identified by the buyers as Eastern little tuna (Euthynnus affinis) and 10 tons as Frigate tuna (Auxis spp.). On Trip No. 4 the small tunas, which were not yellowfin or skipjack, were recorded as Blackies, although on landing, all were found to be Frigate tuna (Auxis thazard). There was no

market for either of these species and inconvenience was caused by the large proportion which were frequently gilled in the net, and the skippers avoided them when possible, so the numbers caught were smaller in the trips after No. 4. Unfortunately also, the identification was not always correct.

However, it is clear that both species are present in the area, sometimes in large schools and that Euthynnus affinis occurred more frequently in January to April than later in the year.

Barracuda (Sphyraena spp.), rainbow runners (Elegatis bipinnulatus) locally known as "salmon", spanish mackerel (Scomberomorus spp.) and sharks were frequently caught but in very small numbers, varying from 0 to 20 individuals per set.

The length composition for these species is given in Figure 15.

6. COMPARISON IN EFFICIENCY OF DAY-TIME AND NIGHT-TIME FISHING

6.1 Frequency of Successful Sets

The number of successful sets (i.e. with a catch of 1 ton or more) and the percentage of successful sets for each trip by the type of operation is given in Tables 2 and 3. It is quite clear that the rate of successful sets for day-time fishing was extremely low in contrast to that for night-time fishing, 34% versus 85% as a whole. It also appears that the fishing technique in night-time fishing improved as the survey progressed. By Trip No. 8 (the second year of the survey) the technique had been fully developed.

The record of unsuccessful sets for day-time fishing shows that the cause was fish escaping during the sets (Table 4). The results of bathythermometric observations show that a distinct thermocline is not formed in the area (Figures 3 and 4). In other words, there is no natural barrier which could intercept the fish escaping vertically. Even though thermocline-like phenomena were observed in the northwestern part of the Sulu Sea, the depth and magnitude of change in temperature did not seem sufficient to hold the fish and facilitate ordinary purse seining. The transparency of sea water is usually high in the area -- secchi disc readings: 25-30 m. Under these circumstances the fish can easily detect the approaching net, dive and move away from it. The difficulty of catching fish during the day is recognized to be more serious when the fish school disperses and escapes when the vessel is approaching. According to the observers' records, fish in the day-time seemed to be very wild and sensitive to noise. Quite often fish schools dispersed before the commencement of the set.

In contrast to day-time fishing, unsuccessful sets in night-time fishing were attributable to several causes (Table 4), though escaping fish was also the major cause of failure in night-time fishing. It is likely that the delay on setting or unsuccessful setting due to strong tidal currents were major factors enabling fish to escape from the net.

It is believed that there may be some effect of the full moon on luring fish, especially small baitfish. However, no direct relationship between failures in luring and the lunar calendar was found. This may be due mainly to the small number of observations, and further observations would be needed to clarify the point.

6.2 Catch per Successful Set

The catch by species and the catch per successful set in each trip by area are shown in Tables 5 and 6. Comparison of catch per successful set between day-time and night-time fishing is shown in Table 7 and Figure 5. Data used were from the trips in which both fishing methods could be compared on the same time-space basis, and the data from the Moro Gulf and Sulu Sea were combined.

Large differences in the weights of the catches between the two fishing methods were found. Though the same tendency was recognized from the seasonal changes in the catch for both fishing methods, the difference in the quantity of catch could be attributed to the difference in the success of catching in relation to the size of target school. In general, the size of the target school is difficult to estimate accurately. However, from a number of records of rough estimates of the size of the target school in the day-time and the cause of the unsuccessful set as described in the last section, it is clear that many sets in the day-time succeeded in catching only a small fraction of the target school. This is probably the main reason why the catch per successful set in day-time was so small throughout the season.

7. CATCH PER UNIT EFFORT (CPUE) IN NIGHT-TIME FISHING

As the day-time fishing was carried out only for a short period and the results were considered to be unsuccessful, analysis on the catch rate and the abundance of fish has been limited to the data collected by night-time fishing.

The unit of effort adopted is a day's fishing, comprising 24 hours used in searching for fish and shelters, drifting and awaiting the next morning's operation and waiting at sea for the weather to improve, but excluding periods in port, laid-up weather, running to and from the fishing grounds and days wholly engaged in day-time fishing or other survey activities. The number of days fishing are shown in Table 8. Occasionally there was difficulty in interpreting the observers' records to obtain the number of days fishing, in which case the record of daily radio communication maintained between the South China Sea Programme Headquarters and the vessels was utilized. However, on the whole, the records available were satisfactory. The catch per days fishing (CPUE) by species and area obtained for each trip are shown in Table 9 and Figures 6, 7 and 8.

7.1 Seasonal Changes in the CPUE

A consistent trend in the seasonal change in CPUE is recognized throughout the year in the Moro Gulf, that is, extremely low in summer and higher in the other seasons (Figures 6 and 7). Although the seasonal coverage of the observations in the Sulu Sea is not sufficient to analyze the seasonality of CPUE in the area in detail, it resembles that of the Moro Gulf in the period concerned (May-September, Figure 8). It can be seen that also in the Sulu Sea the catch rate is extremely low for a short period in the summer.

Skipjack played a leading role in the seasonal change in the total catch (Figures 7 and 8), while the seasonality on the catch of yellowfin/

bigeye tuna did not appear clearly (Figure 7). The catch rates of skipjack on Trip Nos. 16, 17 and 18 (1977) in the Moro Gulf were remarkably high. This phenomenon can be attributed to the good fishing conditions in terms of encountering a large number of schools and shelters as is discussed in the next section. The effect of learning/skill of the fishing technique of the vessels crew must also affect the CPUE level.

The seasonal pattern in the catch rates observed in the Moro Gulf is presumably a general feature of the catch rate in Philippine waters since a similar phenomenon is recognized in the catch records of the pole-and-line fishery in adjacent waters (Figure 17).

7.2 Some Factors on the Seasonal Changes in the CPUE

To investigate whether these seasonal changes in the CPUE were due to changes in abundance or vulnerability of fish, the activities of the vessels were analyzed in more detail. The total number of days fishing on each trip were divided into those on which sets were made, those in which the vessels used a shelter but did not make a set, (failure to lure fish), and the remainder of days in which the vessel was searching for fish and a shelter. The percentage of these components in the total number of days fishing is shown in Table 10 and Figure 9.

The number of days on which sets were made was high in spring, decreased towards summer and remained at a low level during summer, recovered in autumn and then decreased again in winter. This seems to be the main factor which affected the seasonal change in CPUE.

The number of days in which luring was not successful does not show a clear seasonality, however, it appears relatively large in summer. It is interesting to compare the low catch level of skipjack and yellowfin tuna in summer observed in the pole-and-line fishery (Figure 17).

The success of pole-and-line fishing is very dependent on the feeding behaviour/activity of tuna and it is probable that the reduced catch in summer is due to less active feeding and this may also be the trouble of night-time fishing by the seiners which depend greatly on the attraction of baitfish and the feeding activities of tuna. According to the observers' records, the number of schools sighted during the daytime in summer were as plentiful as in the other seasons.

The number of days which the vessels had to spend searching showed an inverse relationship to those on which sets were made. It is apparent that the possibility of encountering both a suitable shelter and a school plays the most important role in the seasonal changes in CPUE. The extremely low level of days-searching in 1977 (Trip Nos. 16, 17 and 18), seems to have supported the remarkably high CPUE in the same period. According to the observers' reports, the vessels encountered many good shelters which attracted bait/tuna fish during these trips. Several times the vessel was able to utilize the same shelter for 2-3 successive days without any searching effort. This became more frequent as fishing experience increased.

Unfortunately, data on the number of schools sighted are not available on a consistent basis throughout the trips. However, according to a number of observers' records, it is likely that the fish appeared to be more or less equally abundant throughout the season. Therefore, it is considered that the seasonal changes in the CPUE probably resulted from the behaviour of the fish and the environmental conditions in the area, existence of suitable shelters or the effect of the NE monsoon, rather than the change in stock abundance.

8. SOME BIOLOGICAL FEATURES OF THE STOCK

8.1 Size of School

Examination of the sizes of the schools has been limited to night-time fishing due to the small number of fishing operations during the day-time. It should be noted, therefore, that the size of school dealt with here means the quantity of fish which were lured by baitfish. It is not certain whether the fish attracted were composed of a single school.

Observations Made by the Captain

The size of school on which a set was made was estimated by the captain, either visually from his experience or by his interpretation of sonar records. The average of the estimated school sizes on each trip in night-time fishing in the Moro Gulf is shown in Table 11 and Figure 10. The estimate is inaccurate due to its subjective nature and to the observations made by two different captains. However, a general trend can be recognized throughout the years, that is, a low level in summer and winter and a higher level in the other seasons (Figure 10).

Catch per Successful Set by Species

It is considered that the catch per successful set by species is a good indication of the size of school. Catches in night-time fishing for each trip are shown in Table 6 and Figures 11 and 12.

The average catch of skipjack changes in a fairly regular pattern in the two areas (Figures 11 and 12), the lowest in summer (2-6 tons) and higher in the other seasons -- about 16 tons in spring and about 10 tons in autumn. So far as the average size of school is concerned there is no significant difference between the years, in contrast to those observed on CPUE, especially in spring. However, a slight doubt still remains on whether the small catch in summer represents the change in the average size of school or in the behaviour pattern of fish in connection with luring.

In contrast to the large difference in quantity of skipjack by season the catch of yellowfin/bigeye tuna showed almost the same level throughout the season -- about 2 tons (Figures 11 and 12). According to the fishing log record yellowfin/bigeye tuna were usually caught in small quantities mixed with skipjack and were seldom in a separate large school.

The catch of other species was usually very small -- about 0.8 tons (Table 6). These species were caught incidentally and no useful conclusions can be drawn from the results.

8.2 Length Composition and Age Structure

A sample of 50-100 specimens of skipjack and 25-50 of yellowfin/bigeye tuna was measured from most sets made, and occasional measurements were made on other species. The length composition of skipjack and yellowfin/bigeye tuna on each trip are given in the Appendix Table and percent frequency histograms by month and area for all species measured are shown in Figures 13, 14 and 15.

Skipjack

In the Moro Gulf skipjack caught during January-July were nearly all between 40-55 cm (Figure 13) and they are considered to be 2-year olds according to the work on the growth of skipjack (Kawasaki, 1964). During May-July, although the majority of the catch was still dependent on 2-year old fish, the recruitment of 1 year old fish, 25-35 cm in length appears in the catch. The proportion of these recruits increased thereafter and accounted for the majority of the catch in December. During July-December, these two-year classes grew about 10 cm reaching 35-45 cm at 1 year old and 50-60 cm at 2 years old respectively. A similar growth pattern has been observed in the North West Pacific (Kawasaki, 1963, 1964).

In the Sulu Sea, the seasonal change in the length composition is not clear, probably due to sparse observations. However, the exploitable stock in the Sulu Sea was one year older than that in the Moro Gulf (Figure 13). During May-September, 50-70 cm length fish dominated the catch. These are considered to be 3 years old. Recruitment of 2-year olds usually took place during May-July.

Yellowfin/Bigeye Tuna

The length composition of the catch of yellowfin/bigeye tuna from the Moro Gulf and Sulu Sea showed a similar phenomenon to that of skipjack (Figure 14). The majority of the catch during January-May in the Moro Gulf were 40-55 cm in length which are considered to be 1 year olds according to the study on growth of the fish (Suzuki, 1971). The recruitment of 20-40 cm fish (Age 0) began to appear in May. Both year-classes grew about 10 cm during May-December and attained a length of 30-40 cm and 50-60 cm by December.

Although a seasonal change in the length composition in the Sulu Sea was not observed because of insufficient data, it is obvious that the exploitable stock in the Sulu Sea is comprised of 2 and 3-year old fish, one year older than those in the Moro Gulf (Figure 14).

Other Species

Length composition data obtained for the other species, which were mostly incidentally caught, are shown in Figure 15. Frigate tuna were most often caught among these species, its size range was very small (30-50 cm) and it created a gilling problem in the net.

9. POTENTIAL CATCH RATES BY A PURSE SEINER

There is little doubt that purse seining for skipjack and yellowfin/bigeye tuna during the day-time is not likely to be commercially successful on its own. Night-time fishing using shelters and lights has proved to be much more productive for catching tunas by modern purse seiners in Philippine waters. Therefore, the possible potential catch rates have been

analyzed only for night-time fishing. However, this does not exclude the possibility of additionally catching tunas by day-time fishing, though the returns from such fishing are likely to be low.

Secondly, the potential catch rates have only been estimated for the Moro Gulf as the data collected from the Sulu Sea was insufficient to be dealt with separately. However, there is a possibility of utilizing fish in the Sulu Sea with the catch rates equivalent to those in the Moro Gulf. This will be discussed in the following section.

The catch rate per month was estimated by calculating the average CPUE in each month observed over three years (Table 9 and Figure 7). Interpolation was applied to estimate the CPUE for specific months in which actual observations had not been carried out. The results obtained are shown in Table 12 and Figure 16.

The seasonal change in total catch rate shows two peaks, in spring and autumn, (Figure 16). The catch rate of skipjack fluctuates remarkably and is extremely low in summer. The seasonal pattern of catch rate obtained here resembles the seasonal changes in the catches of skipjack and yellowfin tuna by the pole-and-line fishery in adjacent waters (Figure 17), though the magnitude of the change of yellowfin/bigeye tuna is not so large as that found in the pole-and-line fishery. It is interesting to note that the success of both the purse seine and pole-and-line fishing depends on catching feeding tuna. It is considered, therefore, that the decreased catch in summer and winter may be caused mostly by the feeding behaviour of the fish and partially by the rough sea conditions due to the monsoon season.

On the basis of the above estimates, a hypothetical annual catch of a purse seiner can be calculated at about 1 500 tons of total catch comprising roughly 1 300 tons of skipjack, 200 tons of yellowfin/bigeye tuna and 80 tons of other species, working on the assumption of 25 days' fishing each month. From a practical point of view, 300 days' fishing (25 days each month) is probably too much as it is necessary to allow for drydocking, etc. However, the vessel would lose only 50-60 tons if drydocking was carried out in summer for 2 months. On the other hand, it is likely that the catch rates obtained in this analysis are underestimated because the vessels had carried out multipurpose survey activities which probably affected the efficiency of the night-time fishing and also the skill and learning effect was lower than on a commercial purse seiner of the size and power of the chartered vessels should be able to achieve an annual catch of 1 500 tons or more.

10. DISCUSSIONS AND RECOMMENDATIONS

It has been ascertained through this analysis that a modern purse-seiner can obtain an annual catch of 1 500 tons or more by night-time fishing in the Moro Gulf. The seasonality of the catch rates has also been made clear. It can be said therefore that the major objectives of the tuna survey have been achieved. However, several questions have also arisen in the course of the analysis.

Identification of Yellowfin, Bigeye Tunas and Albacore

It has been revealed that identification of these three species is very difficult when their body length is less than 60 cm. The presence of yellowfin and bigeye tuna in the area has been established in this survey, however, the data on both species have not been dealt with separately due to the inaccuracy of species identification. There is no satisfactory information so far on whether or not albacore is distributed in the area. It seems to be inadequate to rely only upon the morphometric differences since the characteristics are very close or overlap among these three species. However, the striation pattern and the shape of the livers of bigeye tuna and yellowfin appear to show a consistent difference (Hackney, 1976)1/ and the appearance of the stripes on the flanks seems to differ between bigeye tuna and albacore (Klawe, 1977)2/. There seems to be the possibility of setting up criteria to distinguish the above-mentioned three tuna species in the area on a fairly satisfactory basis. It is recommended therefore that a study on the identification of the three tuna species in their young stage be undertaken. Some laboratory work would be required, such as a comparative investigation between the striation and shape of livers and the body colour and morphometric characteristics. Identification is particularly important when considering the possible interactions of a purse seine fishery on these fish with actual or potential fisheries on larger fish (see later sections).

Stock Structure and Migration Pattern

It is assumed that skipjack and yellowfin/bigeye tuna in the Moro Gulf and the Sulu Sea are composed of single stocks, each part of a large stock including adult fish, in the western Central Pacific (Fujino, 1972, Kearney, 1975 and Ueyanagi, 1969). The Moro Gulf seems to be one of the nursery grounds for these two species, and the majority of the fish in the Sulu Sea are supposedly recruited from the Moro Gulf.

1/ Letter to Mr. V.E. Mattson, President, Inter-Oceanic Factors, Inc., California, U.S.A.

2/ Letter to Mr. W.R. Murdoch, Senior Fishery Officer, South China Sea Fisheries Development and Coordinating Programme, Manila, Philippines

Skipjack in the Western Pacific are spawned in tropical and sub-tropical waters (Ueyanagi, 1969). The fish spend their larval and juvenile stages there then migrate to northern/southern temperate waters (Fujino, 1972 and Kawasaki, 1972). This migration appears to take place rapidly when they grow to about 30 cm in length (Kawasaki, 1972 and Mori, 1972). The results obtained for skipjack in this study such as the appearance of small fish at 25-35 cm in May-July in the Moro Gulf and their assumed emigration into the Sulu Sea agree well with this general migration pattern. It is not clear so far where the fish in the Sulu Sea emigrate to. It is believed, however, that the fish migrate into the northern South China Sea since substantial catches have been taken by the Japanese and Taiwanese fishery in the waters just westwards of the Palawan-Mindoro-Luzon Islands (Kume, 1973). The result of the skipjack survey by Indonesia (Dwiponggo, 1976) revealed that a substantial quantity of skipjack are distributed in the northern Indonesian waters without any gap from the Moro Gulf. These fish are also believed to originate from the same stock.

It is very difficult to estimate the size of the stock from which the catches in Philippine waters are taken using the present data due to the wide distribution of the fish. Therefore, a study on the stock structure and migration pattern of skipjack and yellowfin/bigeye tuna in both Philippine and adjacent waters is recommended. Tagging experiments are the most direct approach in this respect. Studies on blood groups and isozymes also seem to be effective. Then the assessment of the stock should be carried out as a part of the assessment of the stocks in the whole of the Western Pacific.

Variation of Year-Class Strength

The catch rates of skipjack in the Moro Gulf in 1977 suggested that the year-class strength might vary considerably from year to year. Monitoring the change in year-class strength through the analysis of catch/effort data from the local fisheries is recommended.

Development of the Night-Time Fishing Method in the Sulu Sea

In general, there were less catches from the Sulu Sea than from the Moro Gulf. The reason for this appear to be that natural shelters (drifting logs, etc.) are less abundant in the area. There is little doubt that man-made shelters (anchored floating rafts) can substitute for free-floating shelters in the Sulu Sea (Murdoch, et al., 1977). However, anchored shelters appeared to be less attractive than free-floating ones, and free-floating objects passing an anchored raft tended to lure baitfish and tuna from it. A combined fishing method, whereby a fixed floating raft was permitted to drift once it had attracted bait and tuna was considered to be more productive (Murdoch, et al., 1977). Such a development of fishing techniques should be assessed and followed up because more valuable fish in terms of fish size could be taken in the Sulu Sea if the disadvantage of the lack of natural shelters there could be overcome.

Rational Strategy for Development of the Purse-Seine Fishery

Although it has been ascertained that night-time fishing for tuna can be done by modern, well-equipped purse-seiners, the usable fishing ground would easily be saturated with an over-powered fishing fleet if a prudent scheme

on the expansion of the fishery was not adopted. It is appreciated, however, that the commercial fishery of the Philippines is expanding rapidly by the use of a variety of essentially anchored rafts (payaos). A study to determine the suitable size of seiners and the number of vessels related to the extent of the fishing ground is strongly recommended.

It should also be noted that increased fishing in the Moro Gulf/ Sulu Sea area, which depends mostly on young fish, would effect any fisheries (actual or potential) on the same group of fish later in their lives. For yellowfin, which can grow to a large size, a greater catch in weight would be taken, other things being equal, by postponing their harvest until they have grown to a better size (possibly in the range of 70-100 cm, 7-20 kg).

It is desirable for the rational development of the fishery that the survey activities be strengthened by the national institutes with a group of scientists who are specifically specialized in tuna resources survey. The improvement of the national fishery statistics is also strongly recommended.

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Table 1. Summary of cruise, sets made and catches

(SH: Southward Ho, RV: Royal Venture)

Cruise No.	Trip No.*)	Vessel	Date		Number of Set Made						Total Catch (Tons)					
			Starting Manila	Ending Manila	Moro Gulf		Sulu Sea		Total		Moro Gulf		Sulu Sea		Total	
					Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
1	1	SH	29.11.74	18.12.74	-	-	-	-	-	-	-	-	-	-	-	-
2	1	RV	29.11.74	18.12.74	(1**)	-	-	-	-	-	(0**)	-	-	-	-	-
3	2	SH	4.1.75	3.2.75	7	(2**)	-	-	7	-	17	(0**)	-	-	17	-
4	2	RV	4.1.75	3.2.75	7	-	-	-	7	-	5	-	-	-	5	-
5	3	SH	12.2.75	26.3.75	3	10	-	-	3	10	4	119	-	-	4	119
6	3	RV	9.2.75	26.3.75	2	8	-	-	2	8	0	76	-	-	0	76
7	4	SH	9.4.75	22.5.75	1	22	-	1	1	23	+	216	-	2	+	218
8	4	RV	11.4.75	24.5.75	3	17	-	2	3	19	7	161	-	40	7	201
9	5	SH	12.6.75	18.7.75	-	6	-	4	-	10	-	19	-	23	-	42
10	5	RV	12.6.75	18.7.75	-	2	1	3	1	5	-	9	0	14	0	23
11	6	RV	25.7.75	27.8.75	-	4	-	-	-	4	-	20	-	-	-	20
12	7	RV	1.10.75	7.12.75	12	10	-	-	12	10	13	84	-	-	13	84
13	8	RV	8.1.76	1.2.76	-	3	-	-	-	3	-	85	-	-	-	85
14	9	SH	8.3.76	6.4.76	-	1	-	-	-	1	-	8	-	-	-	8
15	9	RV	29.2.76	3.4.76	-	4	-	-	-	4	-	77	-	-	-	77
16	10	SH	15.4.76	31.5.76	-	4	-	-	-	4	-	36	-	-	-	36
17	11	SH	29.6.76	8.8.76	-	3	-	7	-	10	-	7	-	62	-	69
18	12	SH	21.8.76	17.9.76	-	-	-	9	-	9	-	-	-	102	-	102
19	13	SH	29.9.76	1.11.76	-	12	-	-	-	12	-	160	-	-	-	160
20	13	RV	2.10.76	5.11.76	-	8	2	-	2	8	-	28	0	-	0	28
21	14	SH	18.11.76	15.12.76	-	4	-	-	-	4	-	34	-	-	-	34
22	15	SH	6.1.77	17.2.77	-	10	-	-	-	10	-	72	-	-	-	72
23	16	SH	26.2.77	19.3.77	-	9	-	-	-	9	-	230	-	-	-	230
24	17***)	SH	16.4.77	11.5.77	-	13	-	-	-	13	-	253	-	-	-	253
25	18	SH	26.5.77	24.6.77	-	14	-	-	-	14	-	297	-	-	-	297
T o t a l					35	164	3	26	38	190	46	1 991	0	243	46	2 234

*) Sequential trip no. used in the programme, including the trips for small pelagic fish survey.

**) Operations for training crew, excluded from the total number of set made and total catch.

***) Departed Darvel Bay, Sabah.

Table 2. Number of successful sets (with the catch of 1 ton or over) by the type of operation and area

Operation	Area	Trip No.																	Total
		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Day-time	Moro Gulf	4	2	2	-	-	5	-	-	-	-	-	-	-	-	-	-	-	13
	Sulu Sea	-	-	-	0	-	-	-	-	-	-	-	0	-	-	-	-	-	0
	Total	4	2	2	0	-	5	-	-	-	-	-	0	-	-	-	-	-	13
Night-time	Moro Gulf	-	14	34	6	3	4	3	4	4	2	-	20	4	8	8	13	12	139
	Sulu Sea	-	-	3	4	-	-	-	-	-	7	9	-	-	-	-	-	-	23
	Total	-	14	37	10	3	4	3	4	4	9	9	20	4	8	8	13	12	162

Table 3. Percentage of successful sets by the type of operation

(%)

Operation	Trip No.																	Total
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Day-time fishing	29	40	50	0	-	42	-	-	-	-	-	0	-	-	-	-	-	34
Night-time fishing	-	78	88	67	75	40	100	80	100	90	100	100	100	80	89	100	86	85

Table 4. Cause and frequency of unsuccessful sets by the type of operation

Operation	Cause of failure	Number of sets
Day-time	Fish moved and escaped during the setting	15
	Fish dived and escaped during the pursing	10
	Total	25
Night-time	Fish moved and escaped *)	10
	Gear trouble	5
	Set was not well done due to bad weather	3
	Failure in luring **)	3
	Other ***)	1
	Information is not available	6
	Total	28

*) Including the set which was not well done due to strong tidal current

**) Excluding the number of failure on which set was not attempted

***) The fish taken in the net were released since the size of the fish was too small.

Table 5. Catch and catch per successful set by species in the day-time fishing

(tons)

Trip No.			2	3	4	5	7	13	Total
Moro Gulf	Mid-date of each trip		20.1.75	26.3.75	26.4.75	-	27.10.75		
	Catch by Species	Skipjack	21.2	2.9	4.9	-	8.7	-	37.7
		Yellowfin/Big eye Tuna	0.4	0.6	1.4	-	4.3	-	6.7
		Others	0.4	0.5	0.7	-	+	-	1.6
		Total	22.0	4.0	7.0	-	13.0	-	46.0
	Catch per Successful Set	Skipjack	5.3	1.5	2.5	-	1.7	-	2.9
		Yellowfin/Big eye Tuna	0.1	0.3	0.7	-	0.9	-	0.5
		Others	0.1	0.3	0.4	-	+	-	0.1
		Total	5.5	2.0	3.5	-	2.6		3.5
Sulu Sea	Mid-date of each trip		-	-	-	19.6.75	-	9.10.76	
	Catch by Species	Skipjack	-	-	-	No set was	-	No set was	-
		Yellowfin/Big eye Tuna	-	-	-	success-	-	success-	-
		Others	-	-	-	ful	-	ful	-
		Total	-	-	-	-	-		-

Table 6. Catch and catch per successful set by species in the night-time fishing

(tons)

	Trip No.		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Moro Gulf	Mid-date of each trip		5.3 75	2.5 75	6.7 75	11.8 75	26.10 75	18.1 76	18.3 76	14.5 76	26.7 76	-	16.10 76	2.12 76	2.2 77	8.3 77	28.4 77	9.6 77	
	Catch by Species	Skipjack	132.9	271.8	16.6	5.5	75.5	83.8	69.2	25.6	2.8	-	145.0	23.9	61.1	220.9	232.5	279.2	1,646.3
		Yellowfin/ Bigeye Tuna	26.5	71.4	9.1	10.3	8.5	+	3.1	6.8	4.2	-	39.7	10.1	10.9	4.9	18.3	11.9	235.7
		Others	35.6	33.8	2.3	4.2	+	1.2	12.7	3.6	-	-	3.3	+	+	4.2	2.2	5.9	109.0
		Total	195.0	377.0	28.0	20.0	84.0	85.0	85.0	36.0	7.0	-	188.0	34.0	72.0	230.0	253.0	297.0	1,991.0
	Catch per Successful Set	Skipjack	9.5	8.0	2.8	1.8	18.9	27.9	17.3	6.4	1.4	-	7.3	6.0	7.6	27.6	17.9	23.3	11.8
		Yellowfin/ Bigeye Tuna	1.9	2.1	1.5	3.4	2.1	+	0.8	1.7	2.1	-	2.0	2.5	1.4	0.6	1.4	1.0	1.7
		Others	2.5	1.0	0.4	1.4	+	0.4	3.2	0.9	-	-	0.2	+	+	0.5	0.2	0.5	0.8
		Total	13.9	11.1	4.7	6.7	21.0	28.3	21.3	9.0	3.5	-	9.4	8.5	9.0	28.8	19.5	24.8	14.3
Sulu Sea	Mid-date of each trip		-	21.5 75	4.7 75	-	-	-	-	-	20.7 76	2.9 76	-	-	-	-	-	-	
	Catch by Species	Skipjack	-	39.6	27.3	-	-	-	-	-	41.5	92.8	-	-	-	-	-	-	201.2
		Yellowfin/ Bigeye Tuna	-	2.4	9.7	-	-	-	-	-	20.5	9.2	-	-	-	-	-	-	41.8
		Others	-	0.0	+	-	-	-	-	-	+	-	-	-	-	-	-	-	0.0
		Total	-	42.0	37.0	-	-	-	-	-	62.0	102.0	-	-	-	-	-	-	243.0
	Catch per Successful Set	Skipjack	-	13.2	6.8	-	-	-	-	-	5.9	10.3	-	-	-	-	-	-	8.7
		Yellowfin/ Bigeye Tuna	-	0.8	2.4	-	-	-	-	-	2.9	1.0	-	-	-	-	-	-	1.8
		Others	-	0.0	+	-	-	-	-	-	+	-	-	-	-	-	-	-	0.0
		Total	-	14.0	9.3	-	-	-	-	-	8.9	11.3	-	-	-	-	-	-	10.6

Table 7. Comparison of the catch per successful set between the day-time and the night-time operations in 1975. The data from both Moro Gulf and Sulu Sea are combined.

(Tons)

Trip No.		2	3	4	5	6	7	Total
Day-time	Skipjack	5.3	1.5	2.5	0	-	1.7	2.9
	Yellowfin/Bigeye tuna	0.1	0.3	0.7	0	-	0.9	0.5
	Others	0.1	0.3	0.4	0	-	+	0.1
	Total	5.5	2.0	3.5	0	-	2.6	3.5
Night-time	Skipjack	-	9.5	8.4	4.4	1.8	18.9	8.4
	Yellowfin/Bigeye tuna	-	1.9	2.0	1.9	3.4	2.1	2.0
	Others	-	2.5	0.9	0.2	1.4	+	1.1
	Total	-	13.9	11.3	6.5	6.7	21.0	11.5

Table 8. Number of days fishing as a measure of fishing effort expended in the night-time fishing

Area	Trip No.																
	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Moro Gulf	42	66	26	18	22	8	20	11	10	-	36	15	22	14	18	22	350
Sulu Sea	-	5	17	-	-	-	-	-	18	16	-	-	-	-	-	-	56
Total	42	71	43	18	22	8	20	11	28	16	36	15	22	14	18	22	406

Table 9. Catch per day fishing (CPUE) by area and species in the night

Trip No.		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Moro Gulf	Mid-date of each trip	5.3 75	2.5 75	6.7 75	11.8 75	26.10 75	18.1 76	18.3 76	14.5 76	26.7 76	-	16.10 76	2.12 76	2.2 77	8.3 77	28.4 77	9.6 77	
	Skipjack	3.2	4.1	0.6	0.3	3.4	10.5	3.5	2.3	0.3		4.0	1.6	2.8	15.8	12.9	12.7	4.7
	Yellowfin/ Bigeye Tuna	0.6	1.1	0.4	0.6	0.4	+	0.2	0.6	0.4	-	1.1	0.7	0.5	0.4	1.0	0.5	0.7
	Others	0.9	0.5	0.1	0.2	+	0.2	0.6	0.3	-	-	0.1	+	+	0.3	0.1	0.3	0.3
	Total	4.6	5.7	1.1	1.1	3.8	10.6	4.3	3.3	0.7	-	5.2	2.3	3.3	16.4	14.1	13.5	5.7
Sulu Sea	Mid-date of each trip	-	21.5 75	4.7 75	-	-	-	-	-	20.7 76	2.9 76	-	-	-	-	-	-	
	Skipjack	-	7.9	1.6	-	-	-	-	-	2.3	5.8	-	-	-	-	-	-	3.6
	Yellowfin/ Bigeye Tuna	-	0.5	0.6	-	-	-	-	-	1.1	0.6	-	-	-	-	-	-	0.7
	Others	-	0.0	+	-	-	-	-	-	+	-	-	-	-	-	-	-	0.0
	Total	-	8.4	2.2	-	-	-	-	-	3.4	6.4	-	-	-	-	-	-	4.3

Table 10. Number of days fishing and its component for searching, unsuccessful luring and set made in the night-time fishing in the Moro Gulf

Trip No.		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Total
Numbers	Days fishing	42	66	26	18	22	8*)	20*)	11	10	-	36	15	22	14	18	22	322
	Days searching*)	16	19	14	8	6	?**)	?**)	6	5	-	9	6	7	2	2	2	102
	Days unsuccessful luring	8	8	4	6	6	?**)	?**)	1	2	-	7***)	5	5	3	3	6	64
	Days set made	18	39	8	4	10	3**)	5**)	4	3	-	20	4	10	9	13	14	156
% of Component	Searching	38	29	54	44	27	?	?	55	50	-	25	40	32	14	11	9	32
	Unsuccessful luring	19	12	15	33	27	?	?	9	20	-	19	33	23	21	17	27	20
	Sets	43	59	31	22	45	38	25	36	30	-	56	27	45	64	72	64	48

*) Including the days in bad weather

**) Information is not available for the trips No. 8 and 9, excluded from the total.

***) Seven trials which succeeded in luring small body-sized fish but sets were not made on them are not included.

Table 11. Average school size estimated by captain for each trip in the night-time fishing in the Moro Gulf

(Tons)

Trip No.	3	4	5	6	7	8	9	10	11	13	14	15	16	17	18
Average school size	17	18	8	32	27	50	31	40	18	29	13	20	49	20	31

Table 12. Estimated average catch per days fishing by species for each month in the night-time fishing in the Moro Gulf

(Tons)

Month	Skipjack	Yellowfin/ Bigeye Tuna	Others	Total
January	6.7	0.3	0.1	7.1
February	6.7	0.3	0.1	7.1
March	7.5	0.4	0.6	8.5
April	6.5	0.8	0.5	7.8
May	6.4	0.8	0.3	7.5
June	5.3	0.5	0.2	6.0
July	0.5	0.4	0.1	1.0
August	0.8	0.6	0.1	1.5
September	2.3	0.7	0.3	3.3
October	3.7	0.8	0.4	4.9
November	2.5	0.8	0.2	3.5
December	1.6	0.7	0.1	2.4
Total	50.5	7.1	3.0	60.6
Mean	4.2	0.6	0.3	5.1

Appendix Table 1

Length composition of the catch by area and trip

Area : Moro Gulf
Species : Skipjack

Vessel Trip	SH-3	RV-3	RV-4	SH-5	RV-5	RV-6	RV-7	RV-8	RV-9
Mid-date	6.3.75	5.3.75	1.5.75	8.7.75	6.7.75	11.8.75	26.10.75	18.1.76	18.3.76
20-24.9 cm			1						
			41		1		33		
30-			99	1	15	5	22		
	3		25	6	1	25	9	1	2
40-	155	19	368	38	10	23	17	65	36
	542	68	874	211	103	69	62	104	93
50-	110	25	56	52	27	48	168	60	23
	18	3	19	23	6	12	3	1	2
60-	4		7	1		1	1		
	3		3						
70-									
80-									
90-									
100-									
Total	835	115	1 493	332	163	183	315	231	156

Species: Skipjack (continuation)

Vessel Trip	SH-10	SH-11	SH-13	RV-13	SH-14	SH-15	SH-16	SH-17	SH-18
Mid-date	14.5.76	26.7.76	14.10.76	21.10.76	2.12.76	2.2.77	8.3.77	28.4.77	9.6.77
20-24.9 cm			1						
		3		28	2				
30-		8	16	280	7				
		12	155	134	15	40	12		6
40-	57	31	269	32	29	80	275	24	123
	245	22	129	33	10	91	240	164	588
50-	40	19	163	64	12	19	28	22	67
	3	4	25	1	8				1
60-			4				1		
70-									
80-									
90-									
100-									
Total	345	99	762	572	83	230	556	210	785

Appendix Table 2

Length composition of the catch by area and trip

Area : Moro Gulf
Species : Yellowfin/Bigeye Tuna

Vessel Trip	SH-3	RV-3	RV-4	SH-5	RV-5	RV-6	RV-7	RV-8	RV-9
Mid-date	6.3.75	5.3.75	1.5.75	8.7.75	6.7.75	11.8.75	26.10.75	18.1.76	18.3.76
20-24.9 cm			4						
			33		13		1		15
30-			143	8	60	37	1		
	1		60	34	9	85	12		
40-	22	8	20	92	30	10	17	2	
	151	30	339	37	7	19	33	12	
50-	101	35	496	110	51	85	44	7	10
	1	5	52	50	11	5	30		8
60-	2		10	11	2		34		2
		7	17				7		
70-		8	4						
		2	6						
80-		3	3						1
		2	2						
90-		2							
		4							
100-			1	1					
			3						
			(115) 1	(110) 1			(120) 1		
Total	278	106	1 194	344	183	241	180	21	36

Species : Yellowfin/Bigeye Tuna (continuation)

Vessel Trip	SH-10	SH-11	SH-13	RV-13	SH-14	SH-15	SH-16	SH-17	SH-18
Mid-date	14.5.76	26.7.76	14.10.76	21.10.76	2.12.76	2.2.77	8.3.77	28.4.77	9.6.77
20-24.9 cm									
				33	2				
30-		5	3	187	2	1			
		9	105	104	8	6		2	
40-	6	51	174	59	9	8	102	5	36
	70	41	196	72	8	38	210	107	230
50-	65	22	220	66	15	16	71	39	195
		10	154	26	6	3		9	3
60-		2	78	7	1			1	6
			10						2
70-		1	6						
		1							
80-		1							
90-					1				
		2							
100-		1	2		2				
					2				
					(120) 1				
Total	141	146	948	554	56	73	383	163	472

Appendix Table 3

Length composition of the catch by area and trip

Area : Sulu Sea
Species : Skipjack

Vessel Trip	RV-4	SH-5	RV-5	SH-11	SH-12
Mid-date	21.5.75	4.7.75	4.7.75	20.7.76	2.9.76
20-24.9 cm					
			2		
30-			18		
	1	10	7		
40-		90	39	38	7
		19	11	124	151
50-	14	35	12	225	306
	51	38	5	204	57
60-	106	105	5	64	26
	48	54	1	7	4
70-					1
80-					
90-					
100-					
Total	220	351	100	662	552

Species : Yellowfin/Bigeye Tuna

Vessel Trip	RV-4	SH-5	RV-5	SH-11	SH-12
Mid-date	21.5.75	4.7.75	4.7.75	20.7.76	2.9.76
20-24.9 cm					
			38		
30-		2	25	2	
	1	21	9	6	
40-		165	23	28	13
		73	5	131	33
50-	1	21	1	96	197
	1	5		14	22
60-				1	
	9				1
70-	26	8	1		
	63	21	2	7	
80-	28	5	1	46	12
	4	1		50	19
90-					10
100-					
		(125)1			(135)1
Total	133	323	105	341	312

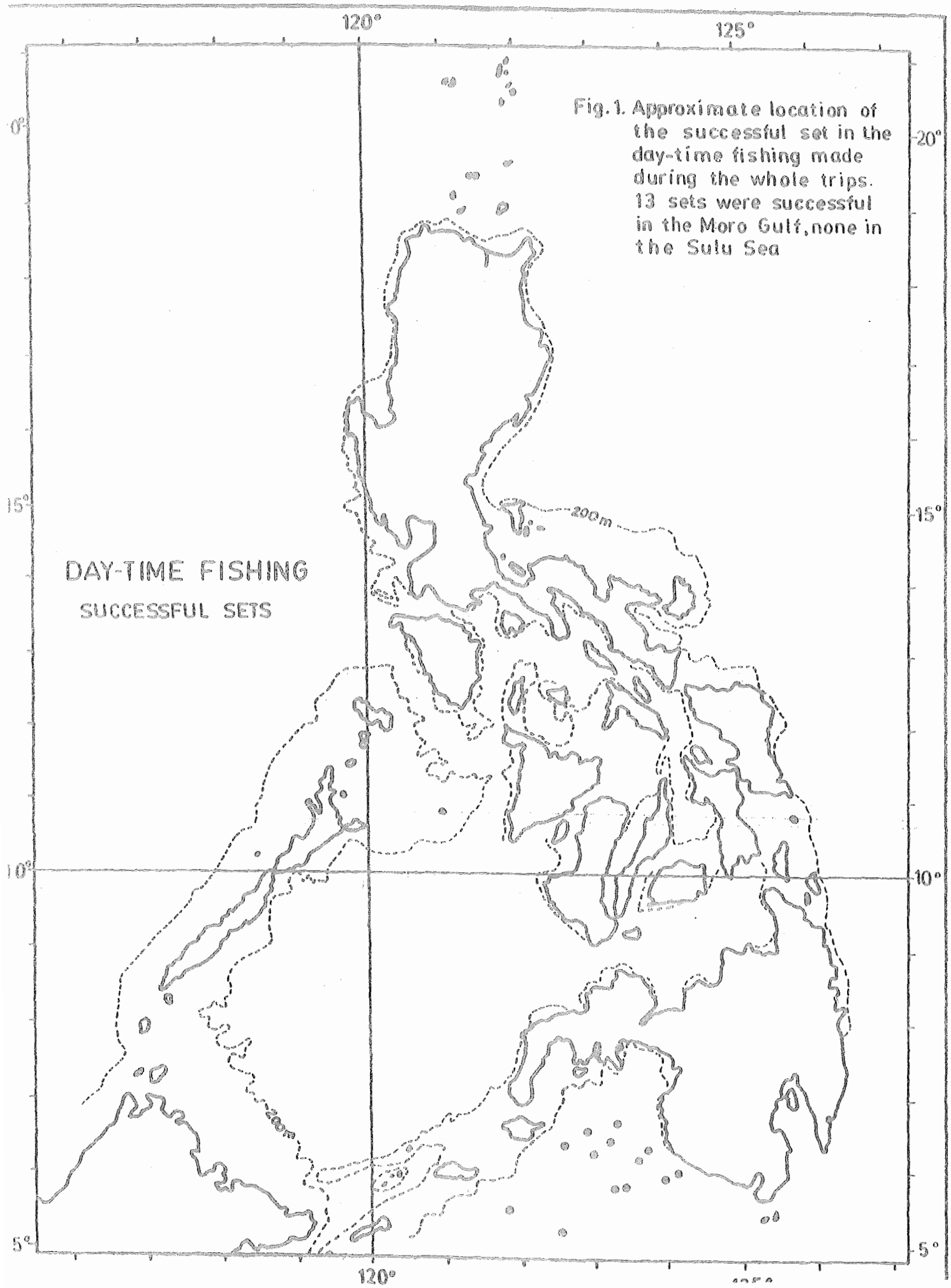

Fig. 1. Approximate location of the successful set in the day-time fishing made during the whole trips. 13 sets were successful in the Moro Gulf, none in the Sulu Sea

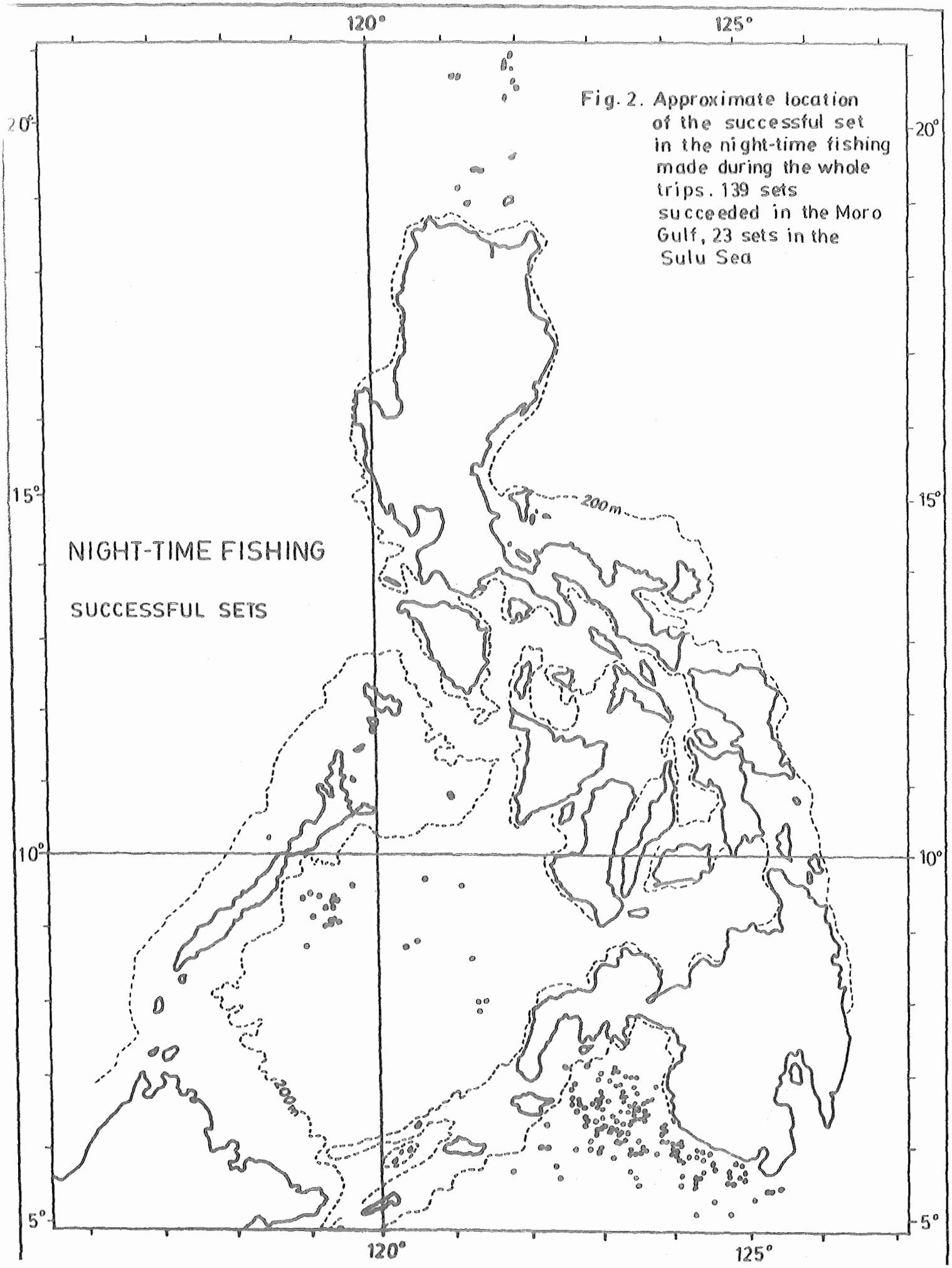

Fig. 2. Approximate location of the successful set in the night-time fishing made during the whole trips. 139 sets succeeded in the Moro Gulf, 23 sets in the Sulu Sea

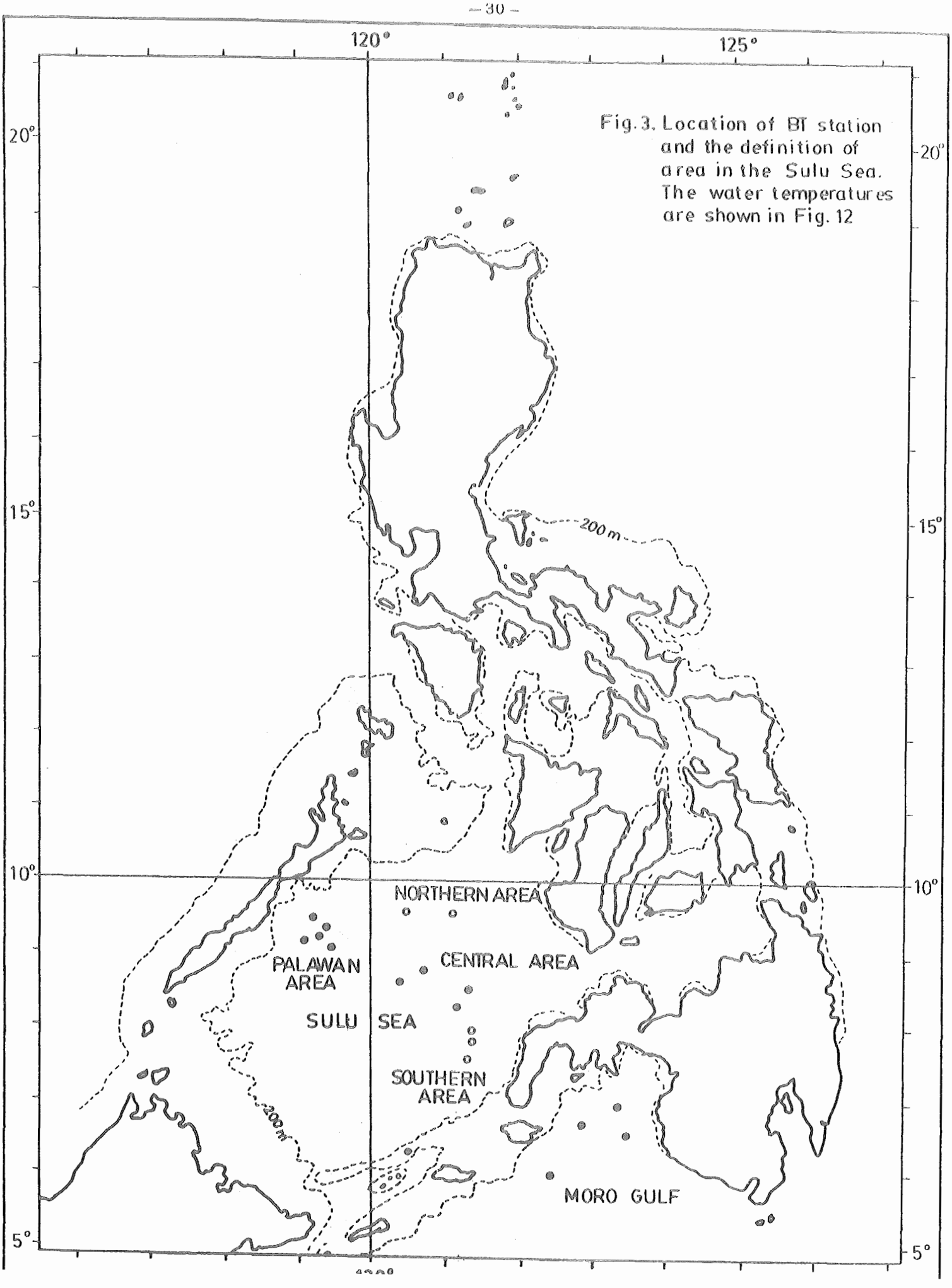

Fig. 3. Location of BT station and the definition of area in the Sulu Sea. The water temperatures are shown in Fig. 12

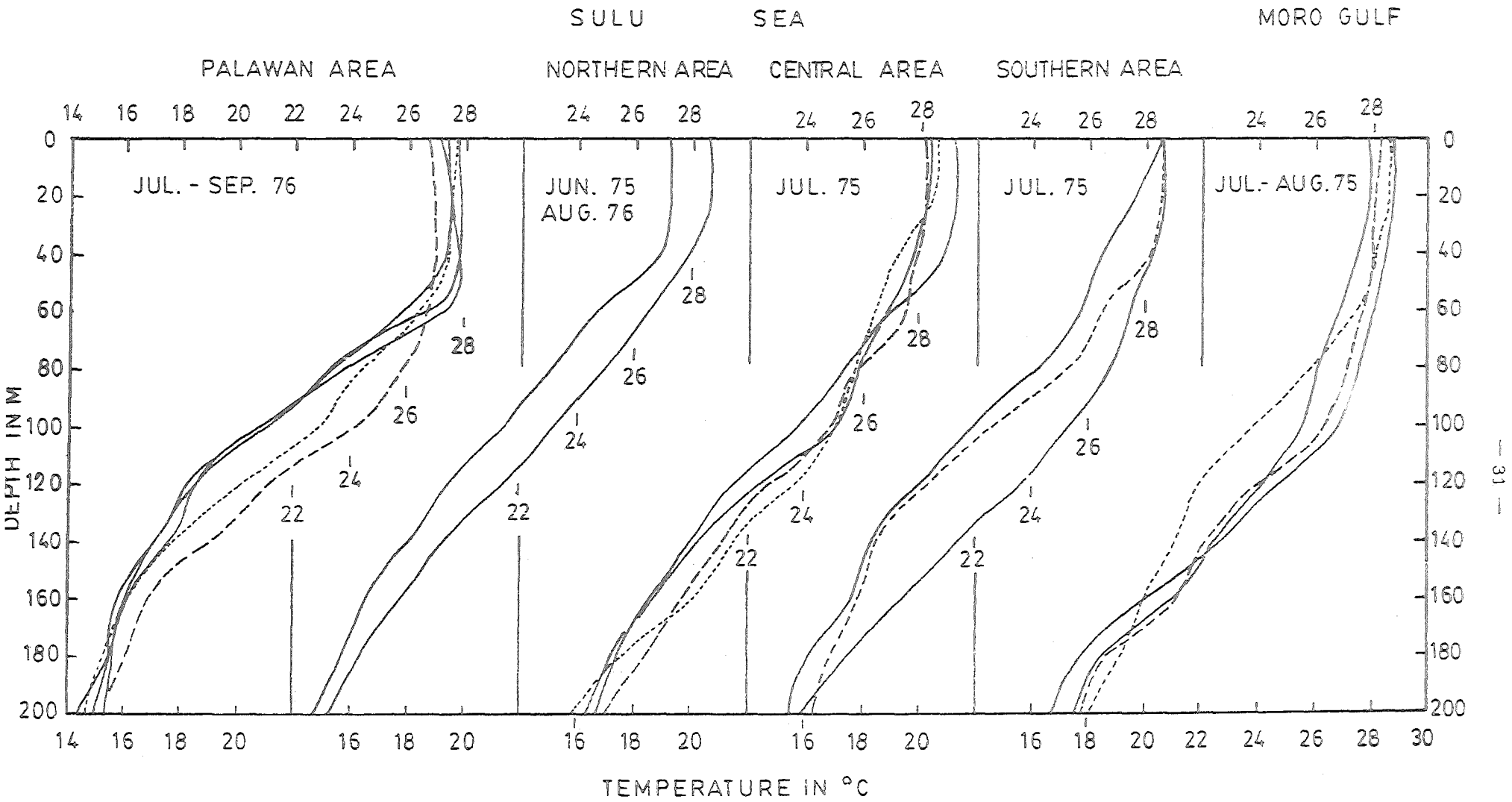

Fig. 4. Bathymetric distribution of water temperature in the Sulu Sea and the Moro Gulf. The location of BT station and the definition of area in the Sulu Sea are shown in Fig. 3

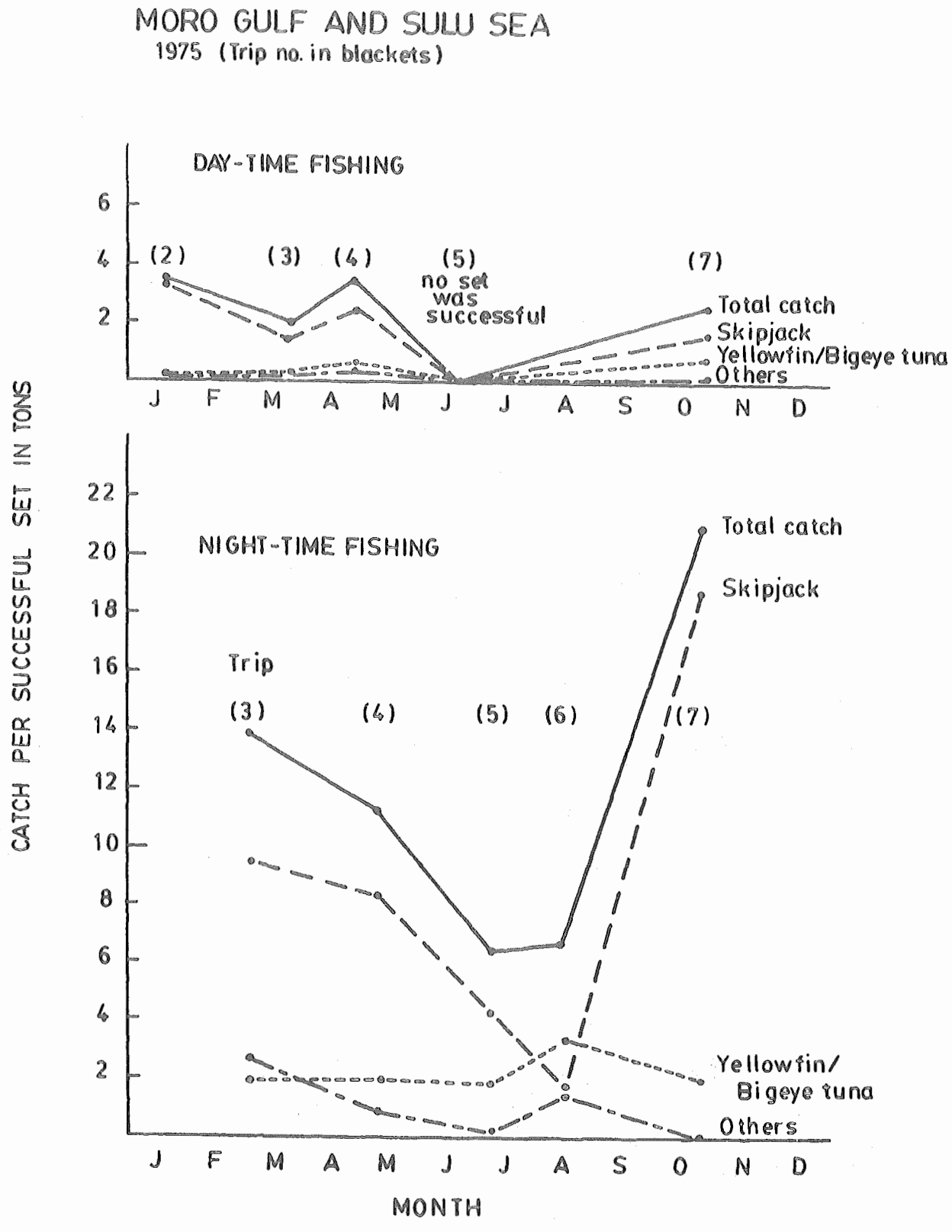

Fig. 5. Comparison of the catch per successful set between the day-time and the night-time fishings in Moro Gulf and Sulu Sea in 1975.

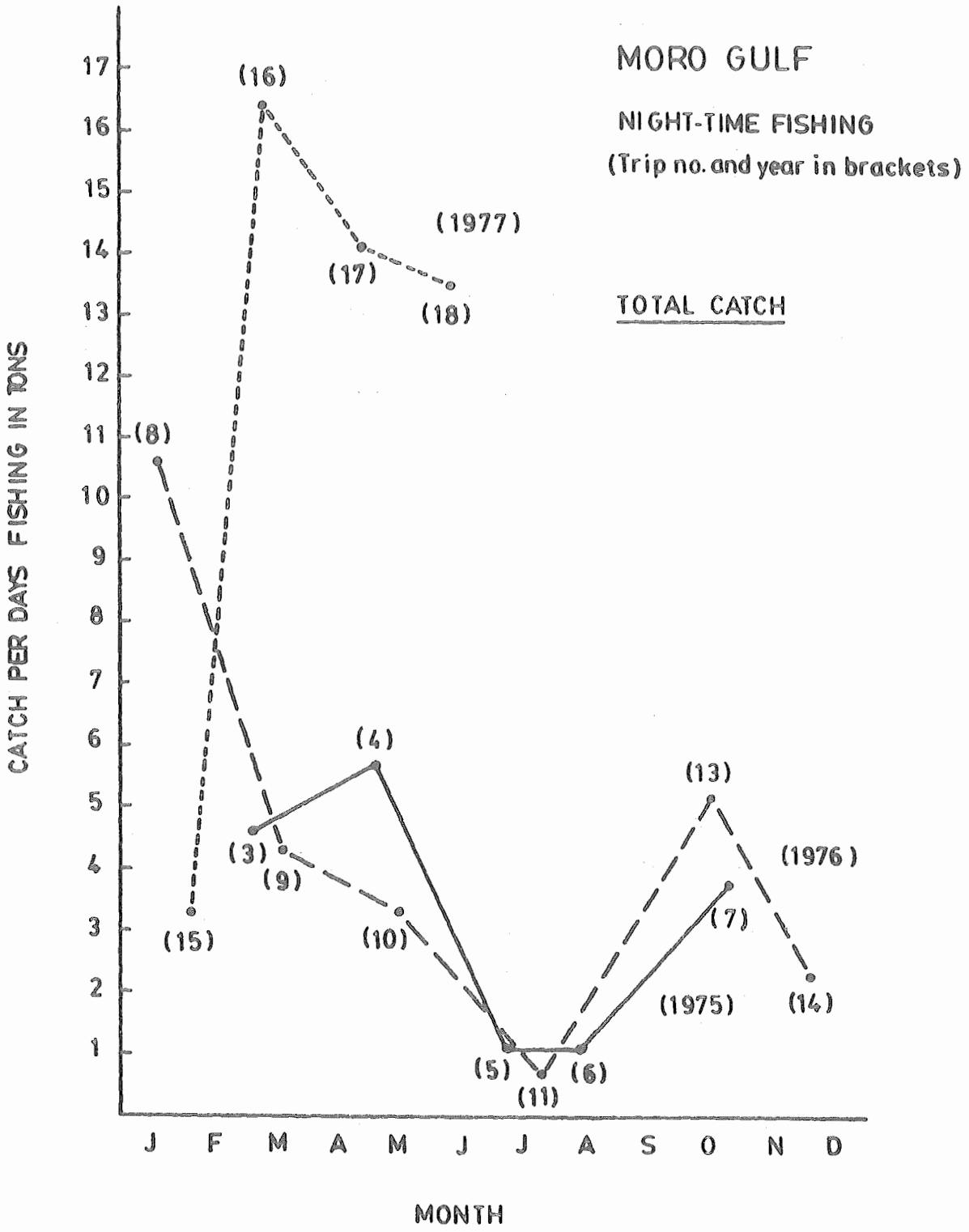

Fig. 6. Seasonal changes in the total catch per days fishing in the night-time fishing in the Moro Gulf.

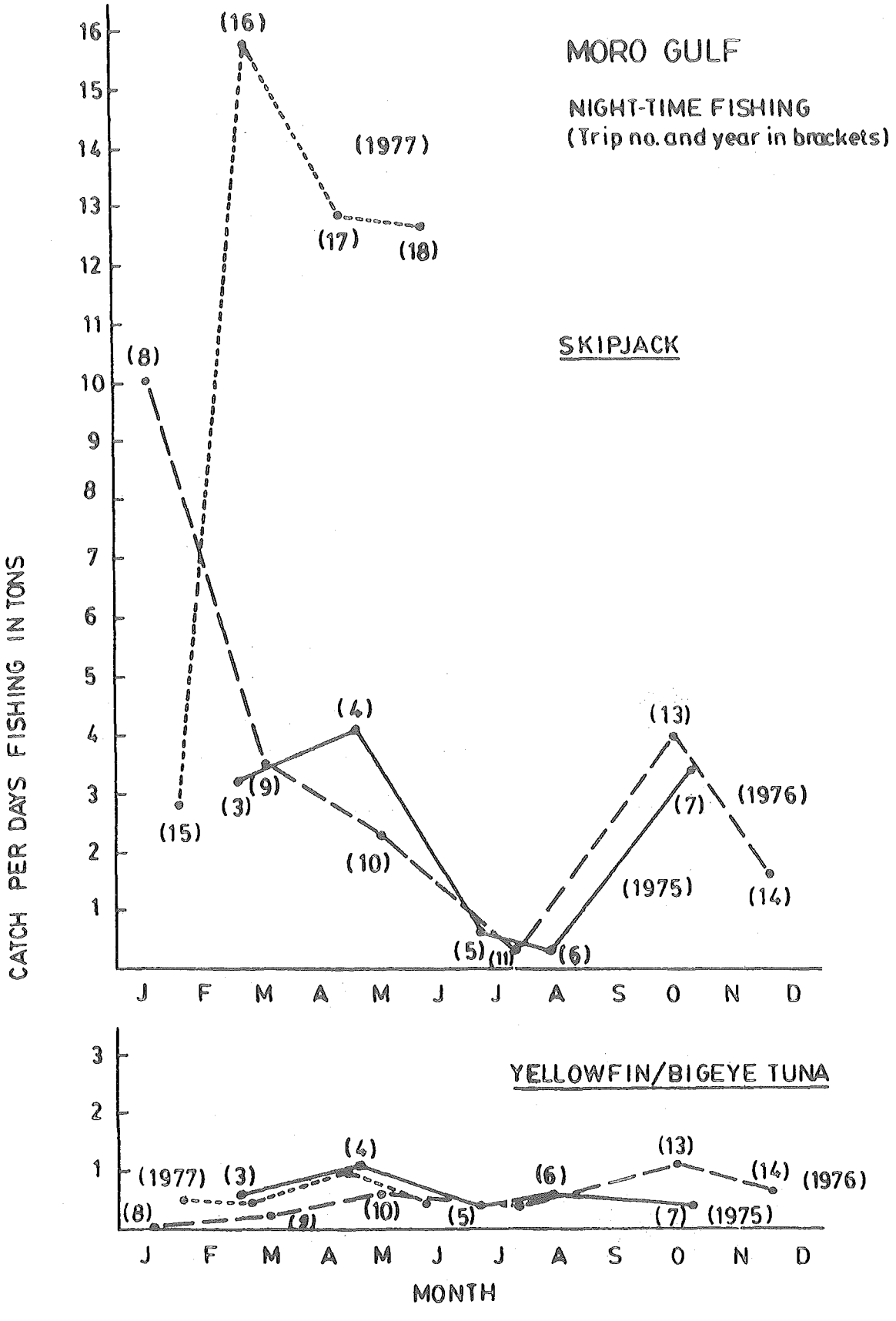

Fig. 7. Seasonal changes in the catches of skipjack and yellowfin/bigeye tuna per days fishing in the night-time fishing in the Moro Gulf

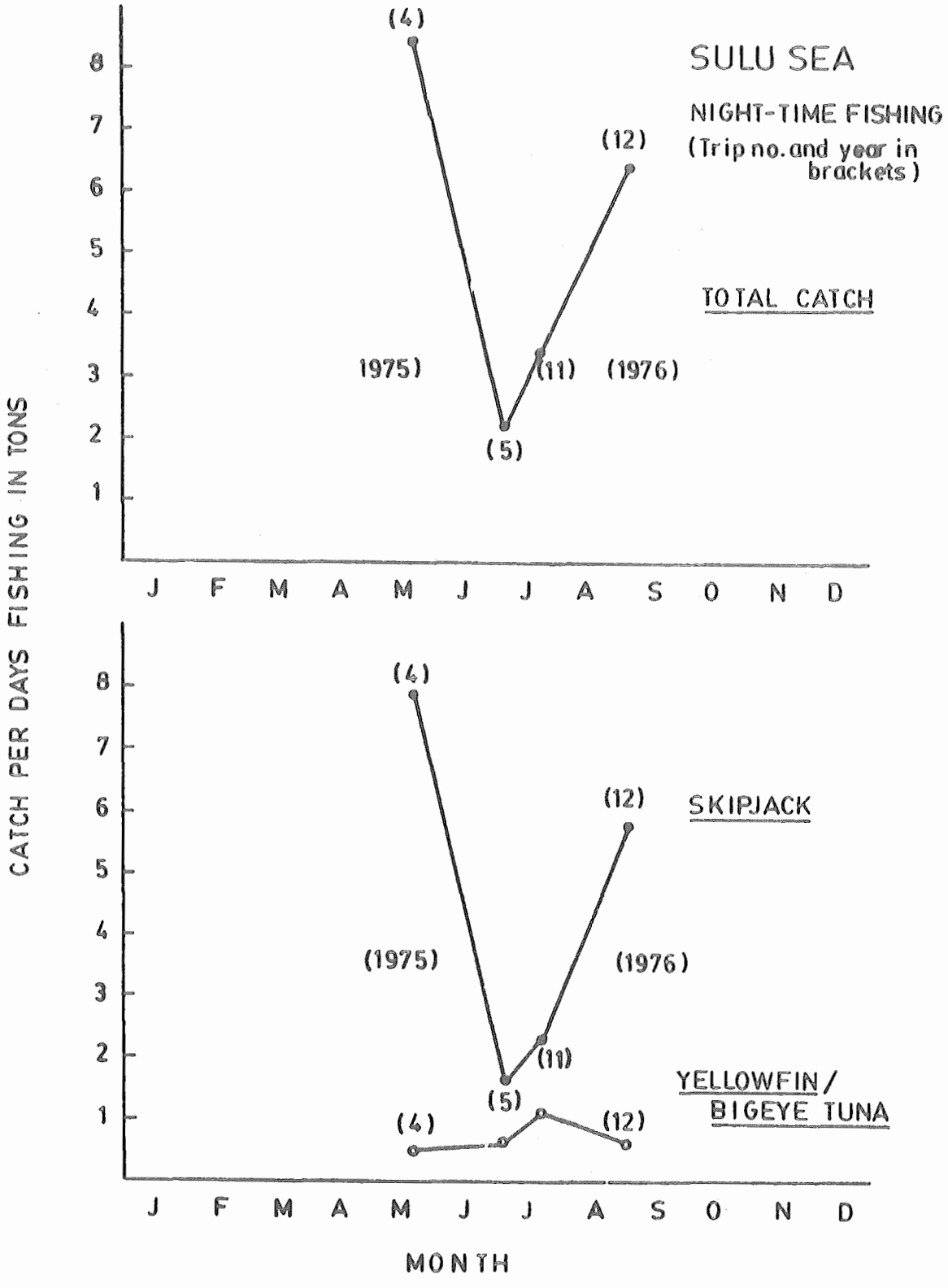

Fig.8. Seasonal changes in the catch per days fishing in the night-time fishing in the Sulu Sea

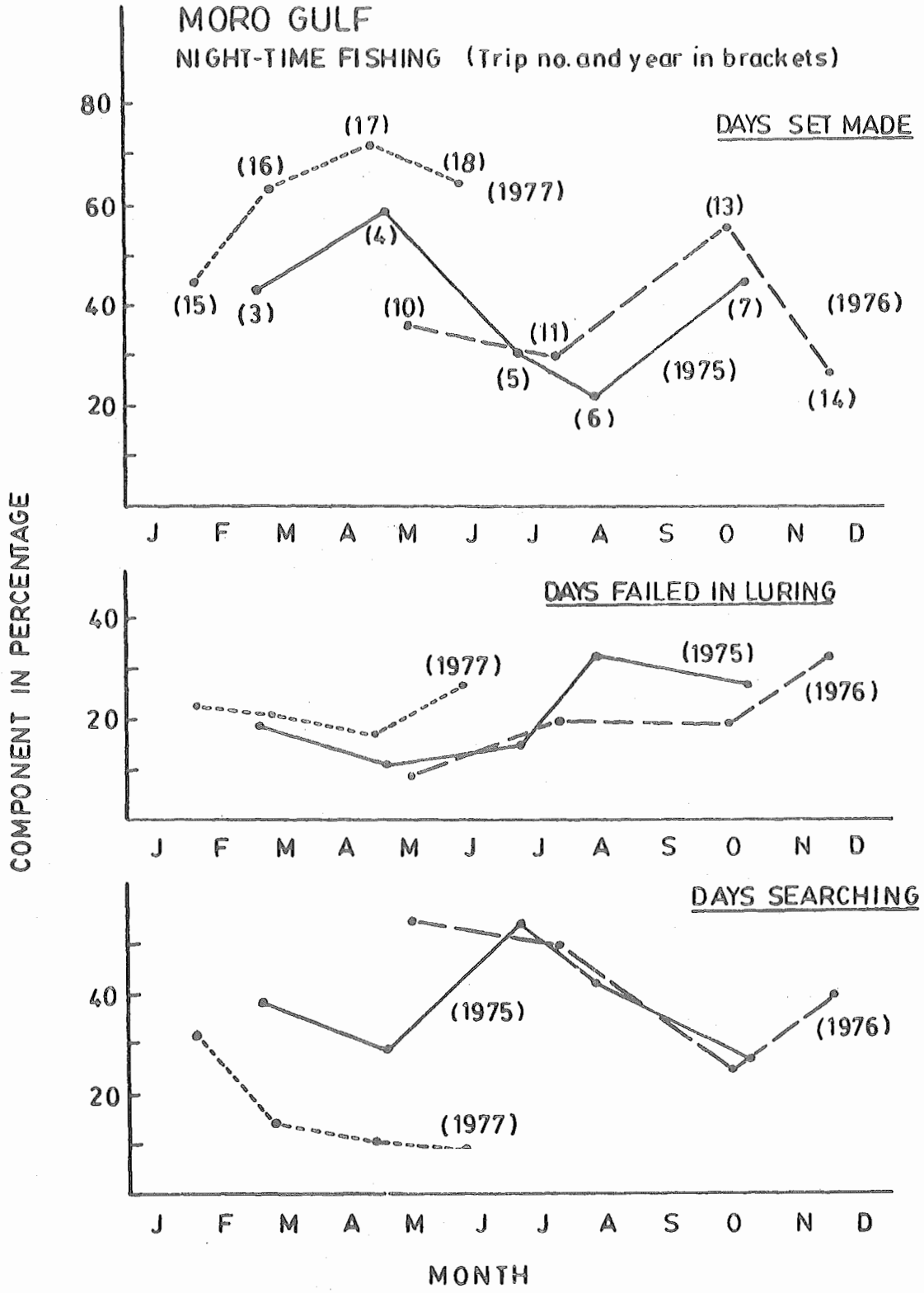

Fig. 9. Seasonal change in the percentage component of days set made, days failed in luring and days searching in the night-time fishing in the Moro Gulf.

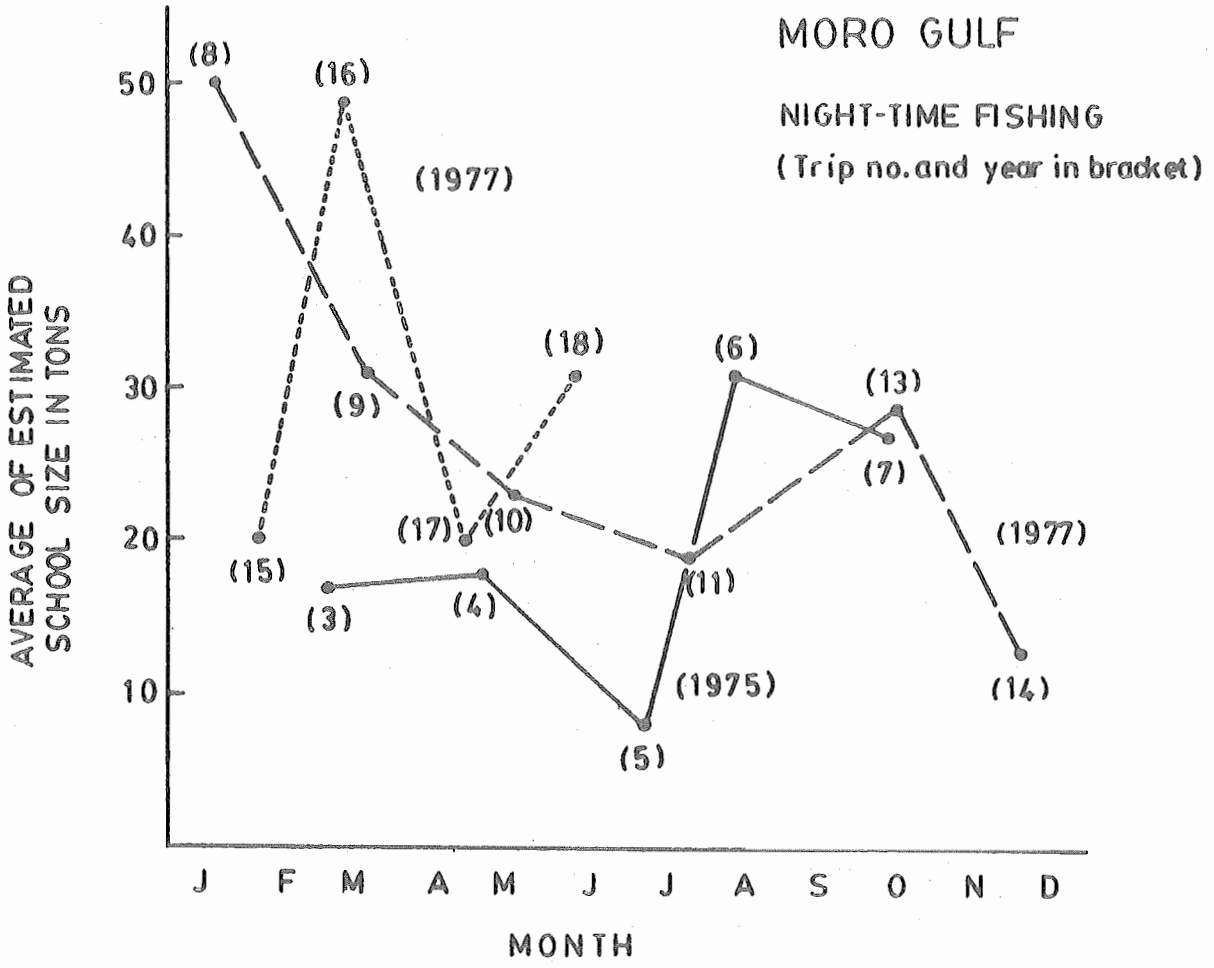

Fig. 10. Seasonal change in the average school size estimated by captain for each trip in the night-time fishing in the Moro Gulf

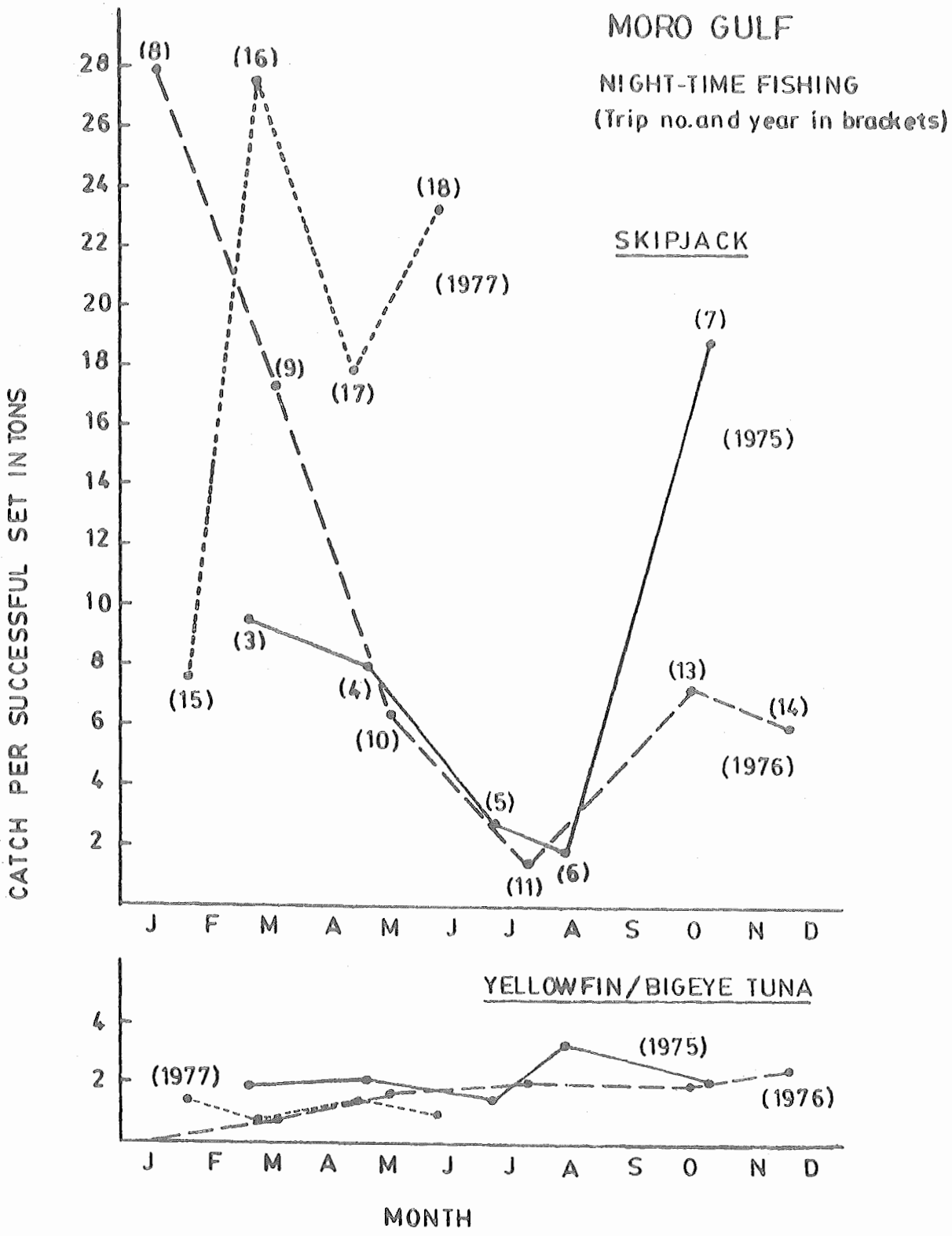

Fig.11. Seasonal changes in the catches of skipjack and yellowfin/ bigeye tuna per successful set in the night-time fishing in the Moro Gulf

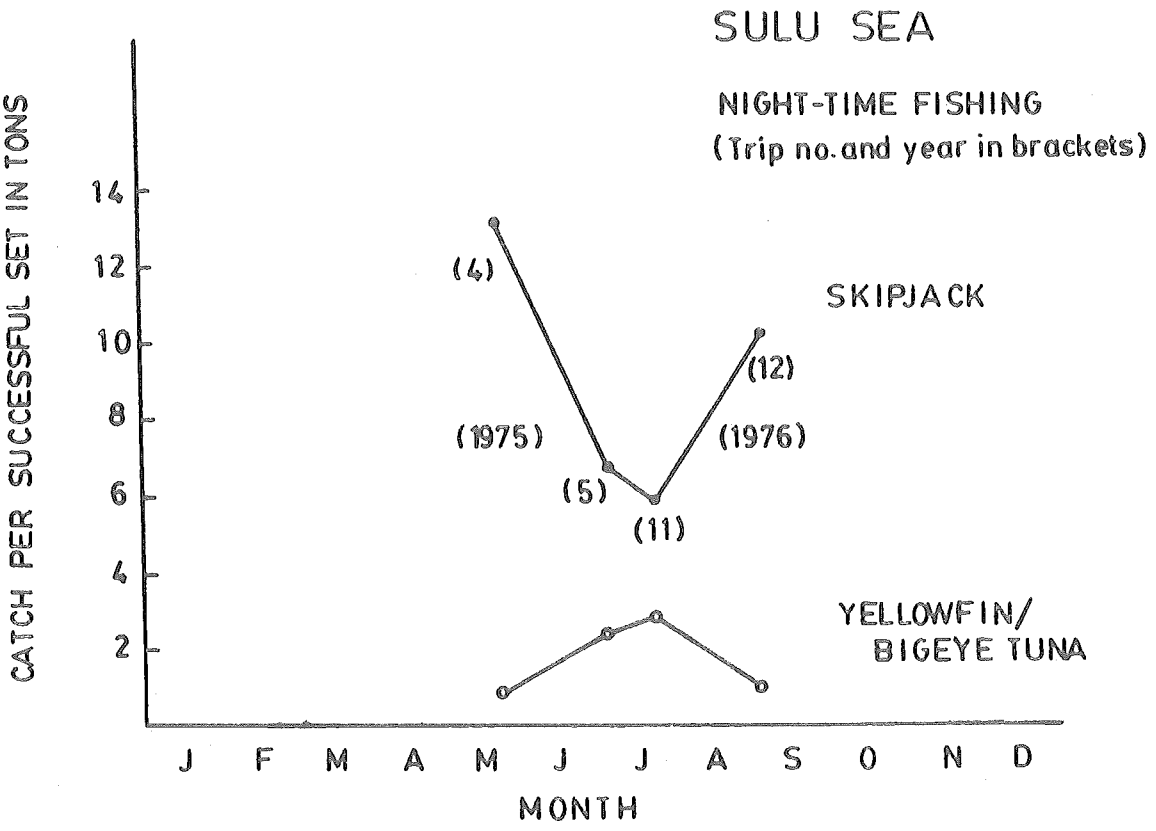

Fig.12. Seasonal changes in the catch of skipjack and yellowfin/ bigeye tuna per successful set in the night-time fishing in the Sulu Sea

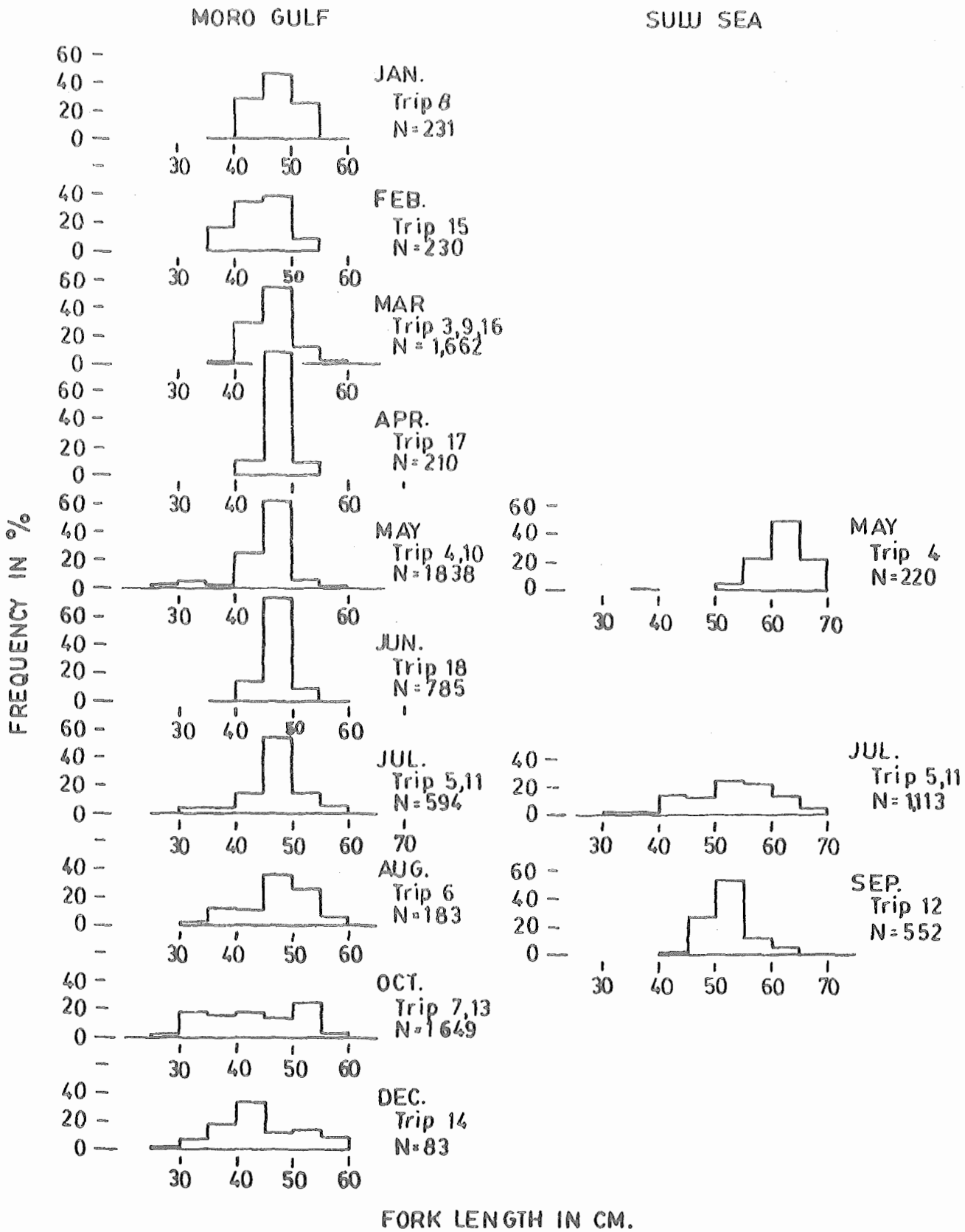

Fig. 13. Seasonal change in the length composition of the catch of skipjack

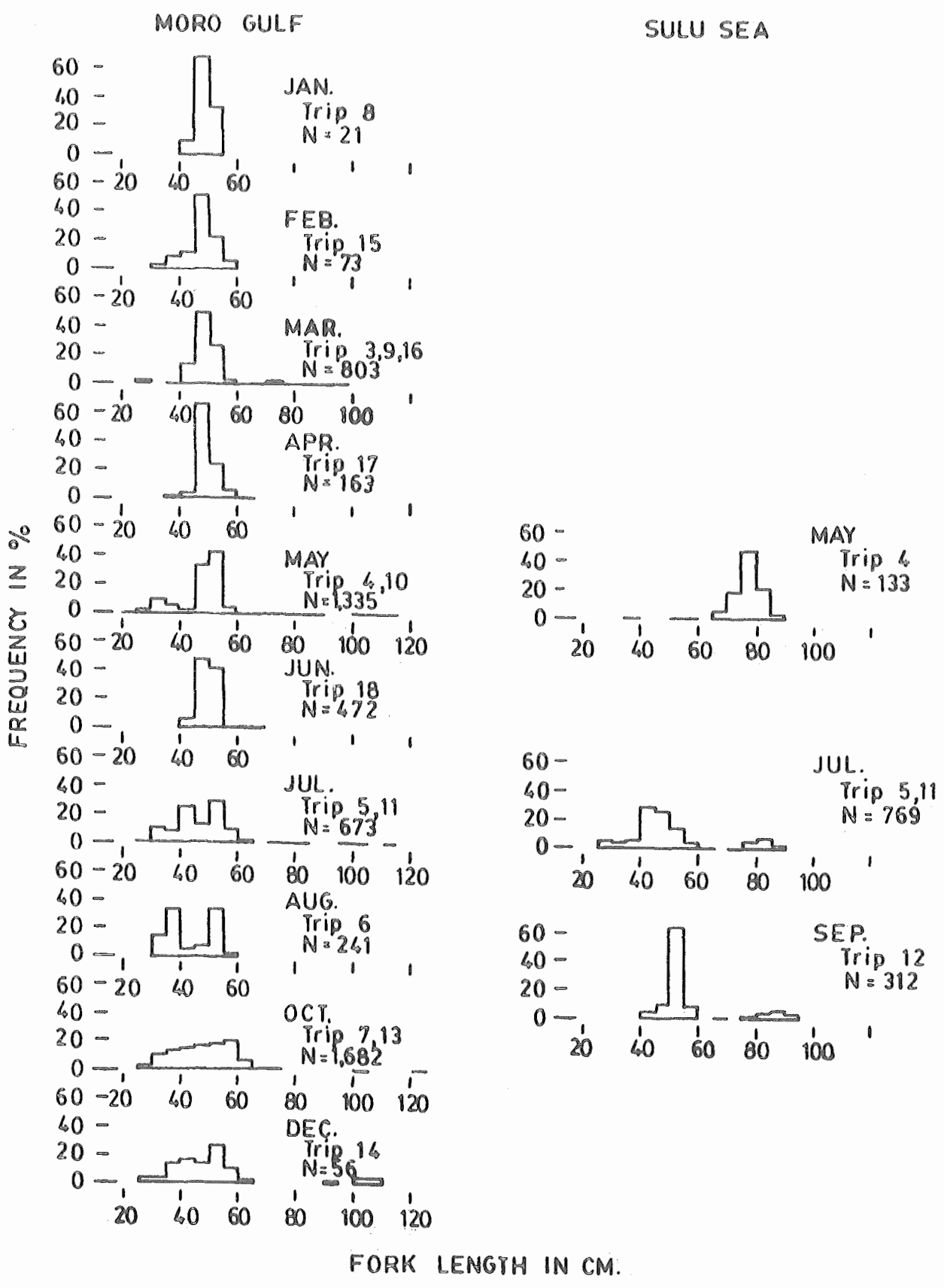

Fig. 14. Seasonal change in the length composition of the catch of yellowfin / bigeye tuna

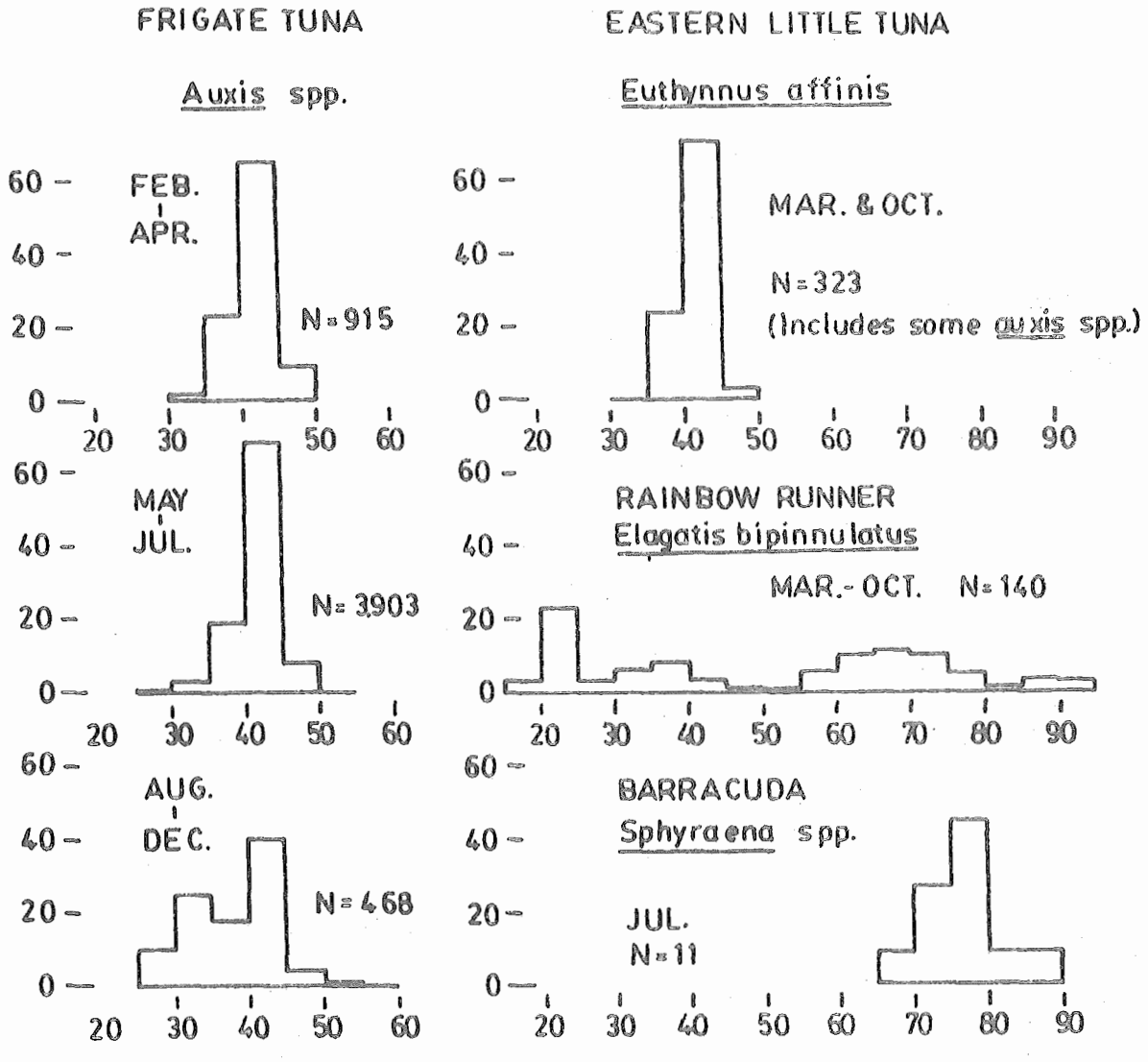

Fig.15. Length composition of the catches of some minor species. Data from the Moro Gulf and the Sulu Sea are combined

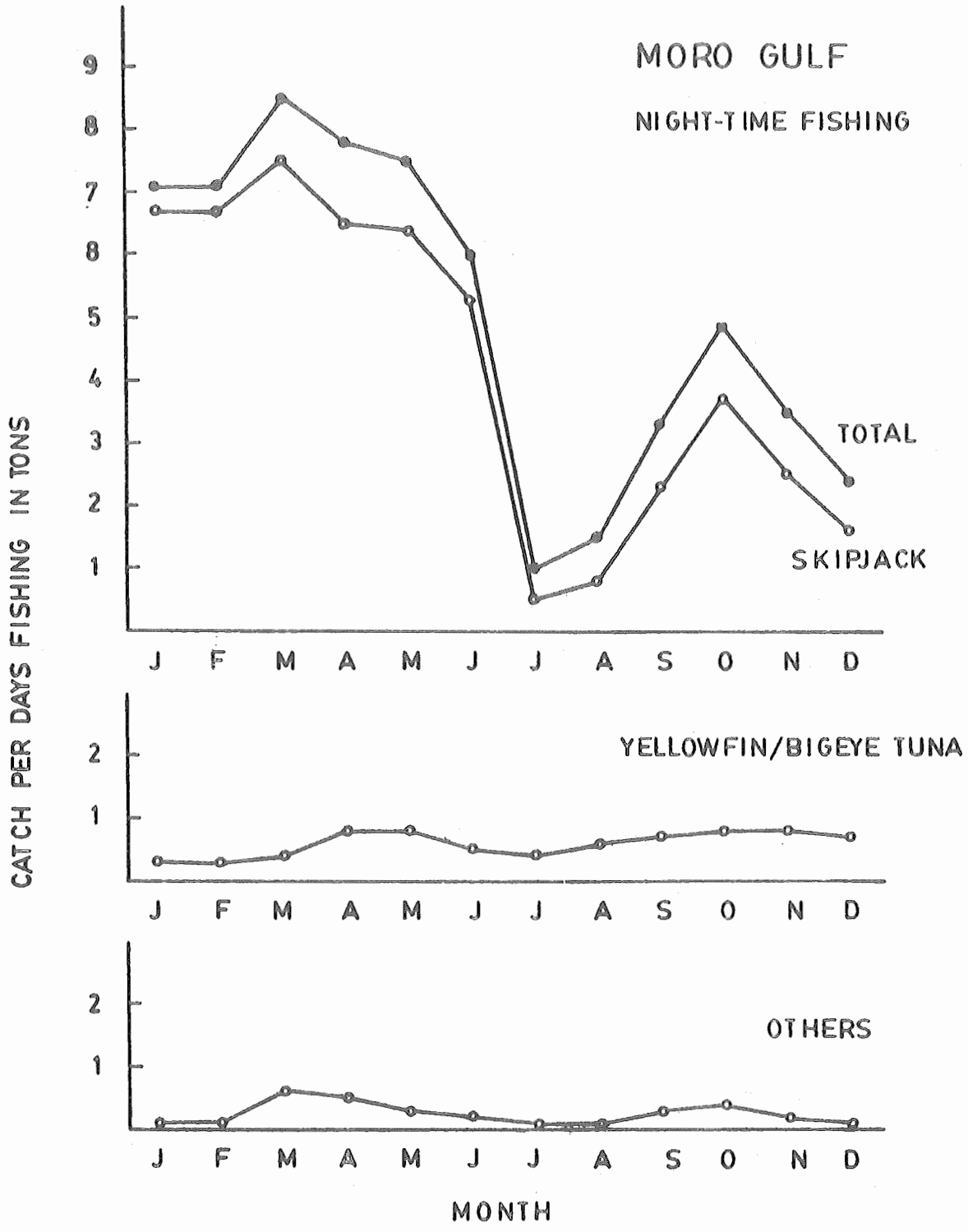

Fig. 16. Estimated average catch per days fishing by species for each month in the night-time fishing in the Moro Gulf

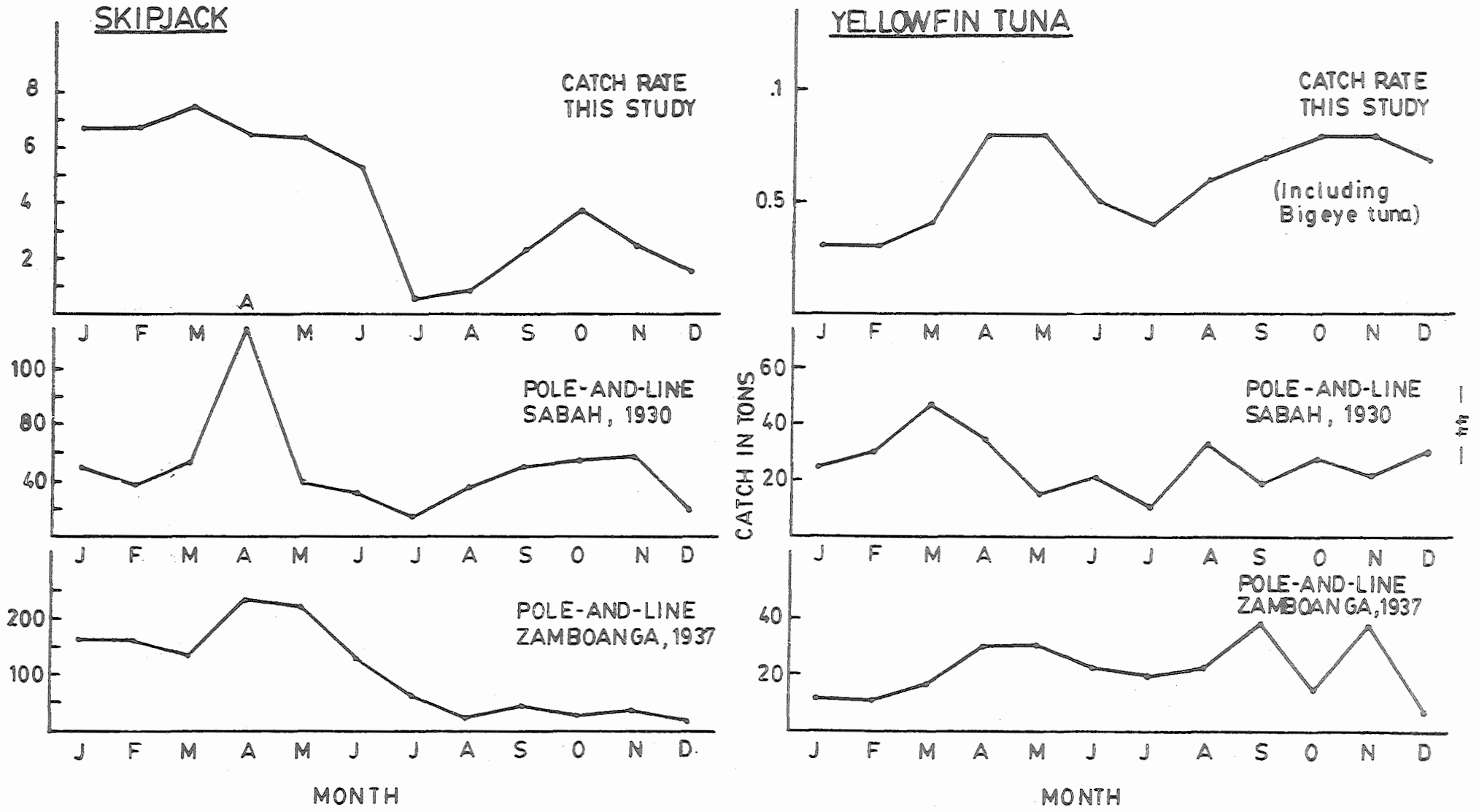

Fig. 17. Comparison of the seasonality of the catch between the result obtained in this study and the pre-war catches of pole-and-line fishery in adjacent waters based at Tawau, Sabah and Zamboanga, Philippines (After Kume, 1973)

PART II

TEST PURSE SEINE FISHING FOR SMALL TUNAS AND OTHER SMALL PELAGIC FISH OFF THE COASTS OF THAILAND, PENINSULAR MALAYSIA, SABAH AND SARAWAK (1975-1977)

TEST PURSE SEINE FISHING FOR SMALL TUNAS AND OTHER SMALL PELAGIC FISH OFF THE COASTS OF THAILAND, PENINSULAR MALAYSIA, SABAH AND SARAWAK (1975-1977)

ABSTRACT

Two modern Canadian Purse Seiners, Southward Ho and Royal Venture made several visits and spent some 180 days between August 1975 and April 1977 in fishing for small tunas and other small pelagic fish off the east and west coasts of Peninsular Malaysia and Thailand and also off Sabah and Sarawak.

Small tunas (tonggol, eastern little tuna and frigate tuna) were common as small wild schools of up to 10 tons in most areas, but were found to be extremely difficult to catch by standard daytime purse seine fishing.

Attracting small pelagic species to lights at night was successful and out of 35 pre-dawn sets, 28 caught over 1 ton with an average of 11 tons or an overall average of 8.3 tons per set. Roundscad (Decapterus spp.) and mackerels (Rastrelliger) comprised over 80% of the fish caught with round herring (Dussumieria spp.) and sardines (Sardinella spp.) making up about 10%. Hard tail scad (Megalaspis cordyla) appeared to be more readily caught during daytime fishing than other small pelagic species.

Small tunas and other small pelagic species were found in most areas to be common out to at least 40 miles from the shore, beyond which their abundance was frequently less.

Data are presented on the size composition of the various species caught in each area.

Several days were spent in searching for large tuna (Yellowfin and Skipjack) over the deep water in the northern Andaman Sea, but without success.

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1. INTRODUCTION

One of the major "action-oriented" objectives of the SCSP has been to aid the speedy development of fisheries for pelagic species as the evidence available suggested that the resources of pelagic species in the SCSP area offered a very substantial potential for increased exploitation (Anon. 1974). To this end two modern Canadian purse seine vessels were contracted for 2 years to carry out "semi-commercial test fishing for pelagic species in the South China Sea ....." (Anon. 1974, p. 104).

With the large area involved and the many pelagic species, priority was given to test fishing for the large tunas for which these purse seine vessels were particularly suited. However, time was allocated to carry out testing fishing for small tunas and other small pelagic species and this report brings together the results of this test fishing done at intervals between August 1975 and April 1977 which included the southern Andaman Sea, the east and west coasts of Peninsular Malaysia, the Gulf of Thailand and the waters off Sabah and Sarawak.

2. OBJECTIVES

The expansion of the fisheries for the small tunas and other small pelagic species by the countries of the SCSP requires information at two main levels. One concerns national planning and is information on the maximum sustainable yield of each species of fish and the extent to which that potential is being reached. The other concerns fishing activities and is information on distribution and abundance of each species and the suitable methods for catching them.

The work reported here of two vessels fishing for a short period in a very large area can add little to the former requirement but can add useful information on the abundance of small tunas and other small pelagic fish in areas little fished at present - especially at increasing distances from the shore and off Sabah and Sarawak, and also on the suitability of the larger modern purse seiners for catching these pelagic fish in the waters of the member countries of the SCSP.

Peninsular Malaysia and Thailand already have well established ring net and purse seine fisheries for small pelagic fish, catching especially mackerels, but also the lower priced scads and sardines, and substantial information exists on their more inshore distribution, seasonal availability and catchability. Little was known, however, on the availability and catchability of the small tunas -- tonggol (Thynnus tonggol), eastern little tuna (Thynnus affinis) or frigate tuna (Auxis spp.) though they are caught in considerable numbers by seines and gill nets in Thailand and by trolling, gill nets and seines in Malaysia.

The main objectives, therefore, of the two chartered purse seiners, Southward Ho and Royal Venture, were to search for and catch the small tunas and also to add as much information as possible on the distribution and catching of other small pelagic species.

While the vessels were in the Andaman Sea area, special attention was to be devoted to determining the availability of large tuna in that area. This aspect of the work is covered in section 4.1 of this report

3. FISHING GEAR AND METHODS

Essential information on the two modern Canadian purse seiners that carried out the fishing reported here are given below (more details are given in Simpson and Chikuni, 1976).

Vessel	Length(m)	Gross Tonnage	Engine Power (HP)
Southward Ho (SH)	34	420	1,125
Royal Venture (RV)	29	283	850

The test fishing was started in August 1975 on trip SH 6 using a typical purse seine used for catching herring in British Columbia, however, it had two limitations for the planned test fishing. In the first place, the mesh of 1-1/4 inches (32 mm) while satisfactory for small tunas was too large for the small pelagic species in the area which became caught in the meshes in great quantities making cleaning the net very tedious and time taking. Also, the hung depth of the net (45 fm) was too great for many of the areas where it was planned to fish. The net was, therefore changed after set 8 on trip SH 7 for a purse seine belonging to the Fishermen's Training Institute at Penang, Malaysia which had a mesh of 20 mm (3/4 inch approximately) and a hung depth of 25 fm. However, this net sank slowly and was generally smaller than the herring net, and in order to improve the chances of catching smaller tunas it was decided to resort to the herring net lengthened by the addition of 100 fms of net taken from the Penang net.

This was done after the set 17 and the modified herring net was used for the next trip 7 (sets 18-39).

This modified herring net was not used after trip 7 and the fishing on trips 8, 10, 11 and 12 was done with the small meshed Penang net.

On the final trip to Sabah in April 1977, the original Canadian herring net was again used. These details are summarized in the following table.

Trips	Net	Hung length fms	Hung depth fms	Mesh inches	Mesh mm
SH6, SH7 (sets 1-8), SH17	1. Canadian herring	320	45	1-1/4	32
SH7 (sets 9-17), SH8, RV10, RV11, RV12	2. Small mesh Penang	280	25	3/4	20
SH7 (sets 18-39)	3. Modified herring net	about 420	45	mixed	

On each trip the vessel took aboard one or more biologists and other observers from the country along whose coast the vessel was to operate and the observers were asked to keep a record of the searching operations of the vessel and full details of all sets made, similar to the records kept for the test fishing for tuna (Peterson, 1975). These records and additional reports prepared by some of the observers are the basis of this summary report.

The general pattern of operation was to spend the daytime running and searching for schools of small pelagic fish, with special attention to the small tunas, recording the schools sighted and fishing for small tunas or other small pelagics when suitable schools could be found and approached.

At nighttime, the vessel would drift or anchor with its mercury lamps on all night and if before dawn a sufficient quantity of pelagic fish had been concentrated by the lights, an attempt would be made to catch them, or at least a proportion of them, to take samples for species identification and length measurements.

The pre-dawn catch would be made as follows. Powerful lamps were put on a small light motor boat which put off from the seiner and stopped over the school of fish. The lamps on the purse seiner were then switched off. Thus, the fish were held below the small lighted motor boat. Then the purse seiner maneovered into position and, keeping a watch on the fish by sonar, started the purse seining operation round the speed boat and the school of fish. Once pursing was complete, the motor boat would leave by passing over the head rope.

4. RESULTS

4.1 Yellowfin tuna and skipjack in the Andaman Sea

Vessel	Trip No.	Duration	SCSP Reports
Southward Ho	7	Nov. 15-Dec. 15, 1975	WP/28, WP/49
Southward Ho	8	Jan. 13-25, 1976	WP/49
Royal Venture	12	August 1-7, 1976	-

The searching for larger tuna (yellowfin, big eye and skipjack) was a major objective of the visits of the Southward Ho to this area in November/December 1975 and in January 1976 and to a lesser extent of the visit of the Royal Venture in August 1976.

These larger tuna are regularly caught by vessels from Korea, and Japan landing their catch in Penang. However, interviews with processing factory managers in Penang indicated that the majority of these tuna were in fact caught in the Indian Ocean, outside the Andaman Sea and that in recent years, the catch rates had been falling off and fewer vessels were now landing their catches in Penang.

The visit of the Southward Ho was largely to search the deeper water areas from the Thai coast towards the Nicobar Islands to obtain further information on the abundance of these larger tuna in the area and whether they could be readily caught by modern purse seining. These observations were particularly important, as the Thai Government was at the time considering supporting substantial investment in larger purse seine vessels for tuna fishing in the Andaman Sea.

Aerial spotting for tuna was arranged and carried out to coincide with the visit of the Southward Ho in late November 1975.

The details of the surveys by the Southward Ho in November/December 1975 and January 1976 (Trips 7 and 8) have been set out in Working Paper No. 49 of the SCSP, and the results of the aerial spotting has been described in Working Paper No. 28. The results described there are summarized here with the as yet unpublished results of the Royal Venture's visit in August 1976.

Between November 15 and December 15, 1975 and between January 13-25, 1976 the Southward Ho devoted most of its daytime work to a series of east-west runs from Phuket and other parts of the Thai coast to as far west as 95°E during November and December 1975 and to 94°E in January 1976, between 6°N and 9°N, looking for large tuna. No track charts are available of the actual runs made but most of this deep water area was covered in each of the two periods (Fig. 1). In August 1976, only a few short runs were made beyond the 200 m edge of the continental shelf. (Maynard, 1976).

On no occasion were yellowfin, big eye or skipjack tuna seen on any of these runs. Nor were any tuna sighted during the aerial spotting, which extended as 6 separate transects between the Thai coast and some 250 miles west, reaching almost to the Nicobar Islands.

The reports from the spotter on the plane and the observers on the vessel were consistent in their reporting extremely little visual evidence of any marine life in the whole area of deep water beyond the continental shelf.

Although the work in November-January was during the NE monsoon, weather conditions were good for visual observations and there is little doubt that during that period very little large tuna were present in the area.

The visit in August 1976 obtained no evidence or indications of large tuna being present in the area at this time of year, but no runs were made beyond the continental shelf.

While it has not been shown conclusively that larger tuna do not enter the Andaman Sea in commercial quantities, there is little evidence to suggest that they do. There certainly is not sufficient evidence to support the establishment of a fleet of large purse seiners depending to any extent on catching large tuna in the southern part of the Andaman Sea.

4.2 Small tunas and other small pelagic species by areas

4.2.1 West coasts of Thailand and of Peninsular Malaysia (Fig. 1)

Country	Vessel	Trip No.	Duration	Net	SCSP Report
Thailand	Southward Ho	7	15 Nov.-15 Dec. 1975	2	WP/49
Thailand	Southward Ho	8	13-25 January 1976	2	WP/49
Malaysia	Royal Venture	12	19-23 July 1976	2	-
Thailand	Royal Venture	12	1-7 August 1976	2	-

Daytime fishing off Thailand. The vessel spent most of the daylight hours looking for larger tuna over the deep waters of the southern part of the Andaman Sea (see section 4.1) but at the same time the crew and observers kept a watch out for smaller tuna and other pelagic species. Very little life was seen beyond the edge of the continental shelf but over the shelf and especially towards the coast, considerable numbers of small schools of 1-10 tons of tonggol, little tuna, frigate tuna, chub mackerel, roundscad, round herring and sardines were recorded as having been seen.

When schools of small tuna were approached during daylight, they scattered and rarely were conditions suitable for making a set. However, on two occasions, sets were made. On one (SH7, set 31, 25.11.75) 2 tons of a school of about 5 tons of frigate tuna were caught; on the other (SH7, set 38, 7.12.75), there was trouble getting the skiff away and the school of about 5 tons of frigate tuna escaped. Rather less fish were seen on the January 1976 trip compared with the previous November/December one.

Daytime fishing off Malaysia. The 4 1/2-day trip by the Royal Venture off Malaysia in July 1976 made similar observations, sighting small schools of tonggol, frigate tuna and small pelagic species during

scouting over an area up to some 70 miles north, west and south from Penang. No opportunities occurred for setting on the small tunas during the daytime as the fish scattered or dived.

Nighttime fishing. At night, the vessel anchored or drifted with mercury lights on and made a set shortly before dawn if sufficient fish had been attracted. It was found that good attraction occurred in most nights with little or no moon, but on moonlit nights, few were attracted and the fish were wild.

Eight pre-dawn sets were made off Thailand in November/December 1975 and two off Malaysia in July 1976, with the following results.

	Thailand (1975)									Malaysia (1976)	
Trip/Set	7/30	7/32	7/33	7/34	7/35	7/36	7/37	7/38	7/39	12/2	12/3
Date	Nov 25	Nov 27	Nov 28	Dec 1	Dec 2	Dec 5	Dec 6	Dec 7	Dec 9	July 22	July 23
Size of school (tons)	2	10	6	8	12	10	2	5	3	10	15
Catch (tons)	2	10	5	8	12	10	2	0	0	2	2
	Estimated % Composition										
Little tuna*/	-	-	-	-	-	-	-	-	-	-	2
Tonggol	-	-	-	-	-	-	-	-	-	15	95
Frigate	-	-	-	-	-	-	-	-	-	80	3
Roundscad	5	99	9	80	99	10	-	-	-	2	-
Rastrelliger spp	5	-	-	-	-	1	-	-	-	-	-
Round herring	60	-	-	-	-	-	-	-	-	-	-
Spanish mackerel	30	-	1	-	-	-	-	-	-	-	-
Sardines	-	1	90	20	-	3	100	-	-	-	-
Hard tail	-	-	-	-	-	78	-	-	-	-	-
Others	-	-	-	-	1	8	-	-	-	2	-

*/ For scientific names, see Appendix II.

It is interesting to note that the two pre-dawn sets off Malaysia caught largely small tunas while the pre-dawn sets off Thailand caught a variety of small pelagic species. It is not considered that there is much significance in this as all three small tunas and the common small pelagic species appeared from daytime sightings to be more or less equally distributed northward from about 5°N and the number of sets was small.

It is also clear that while there was some mixing of species in many of the sets, one species usually predominated, making up 60%-100% of the catch.

4.2.2 East coast of Peninsular Malaysia and Gulf of Thailand (Fig. 2)

Area	Vessel	Trip No.	Duration	Net	SCSP Reports
Malaysia	Southward Ho	6	Aug. 17-27, 1975	1	WP/25
	Southward Ho	7	Sept. 10-26, Oct. 16-31, 1975	1 & 2	WP/49
	Southward Ho	8	Feb. 1-3, 17-18, 1976	2	WP/49
	Royal Venture	11	June 25-July 12, 1976	2	-
	Royal Venture	12	Aug. 15-24, 1976	2	-
Gulf of Thailand	Southward Ho	7	Oct. 1-15, 1975	2	WP/49
	Southward Ho	8	Feb. 11-16, 1976	2	WP/49

East Coast of Peninsular Malaysia. In all, some 74 days were spent in this area running and searching for schools of small tuna and other small pelagic fish. The observations extended from off Singapore to the border with Thailand, but most time was spent in the northern half of this area working from about 10 miles to 65 miles offshore.

During daytime, special attention was paid to locating schools of small tuna and many small schools of all three species of 2-10 tons each were seen and a few were estimated as reaching 20 tons. In all, 29 sets were made during daylight mostly to try to catch schools of small tuna, however in the majority of cases, the tuna escaped from the net before the ring was closed or before pursing was complete and only in 5 sets were any small tuna caught, and in all cases, there were only a few individuals retained, admixed with a small quantity of small pelagic fish. In 10 other

sets no tuna was caught, but up to 6 tons of small pelagics. These included three attempts in September 1976 to catch schools of hard tail scad (Megalaspis cordyla) which were successful, catching the whole schools and yielding 2, 4 and 6 tons respectively, with a very small quantity of mackerel on each occasion (Trip 7 sets 2, 3 and 24). The first two of these sets were made with net 1 and the third with net 2. In 14 sets, no fish were caught.

An examination of the positions of the sets in which some small tunas were caught and of definite visual identification of schools seen indicated their presence along the whole coast and out to at least 60 miles from the shore, both tonggol and little tuna being specifically recorded from over 40 miles from the coast.

Throughout the running and searching, small schools of mackerel and roundscad were frequently seen with hard tail (M. cordyla), round herring (Dussumieria spp.) sardines, and Malabar Cavalla (Carangoides malabaricus) also being reported. These species were found near the coast to well offshore and some at least to 40 miles and probably very much more, though further from the shore the schools were more scattered.

Nighttime fishing. Fifteen pre-dawn sets were made off the Malaysian east coast with the following results.

Trip	6	6	6	7	7	7	7	7	11	11	11	11	12	12	12
Set	2	4	5	1	8	20	25	26	1	2	4	5	8	9	10
Size of school (tons)	50	?	?	80	75	10	6	3	1	2	1	2	12	10	25
Catch (tons)	20	30	40	30	10	6	6	0.3	0	10kg	1	0.5	10	0.5	20
							% Composition								
Tonggol	-	-	-	-	-	-	-	-	-	-	-	-	-	50	-
Little tuna	-	-	-	12	-	1	-	-	-	-	-	-	-	20	-
Frigate	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-
Mackerel	35	35	35	74	-	99	35	-	-	-	5	10	10	2	75
Roundscad	60	65	65	7	100	-	65	-	-	-	40	40	90	18	25
Round herring	-	-	-	7	-	-	-	-	-	-	40	40	-	-	-
Malabar Cavalla	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	100	-	100	14	-	-	-	-

It is seen that small tunas were only caught in appreciable quantities in 1 set (7/1) when some 4 tons, 12% of a 30-ton catch, were little tuna. In one other set (12/9), a small catch of 0.5 ton was largely a mixture of the three small tunas. The main feature of these 15 sets was the dominance of mackerel or roundscad in all the 10 sets in which 1 ton or more was caught.

Gulf of Thailand. Of the two visits to the Gulf of Thailand, the first, which included 13 days of fishing in September/October 1975, was during the SW monsoon while the second for 6 days in February 1976 was during the NE monsoon.

On the first trip, observers were aboard for only 7 days and information on the results is very limited. However, daytime searching for fish indicated the presence of small schools of a variety of small pelagic species and small tunas but no schools were reported as being of more than 5 tons. Most of the schools dispersed on being approached and on no occasion was it considered worth making a set.

At night, the mercury lights were put on, but only twice was there a sufficient accumulation of fish to merit making a set. These two sets (Trip 7, sets 9, 10), which were made some 50 miles east of Chumphon (Fig. 2), caught 5 tons of round herring and sardines and 1/2 ton of mackerel, roundscad and sardines, respectively.

During the trip in February 1976, most of the 6 days were spent east of Chumphon and pelagic fish appeared to be much scarcer than during the September/October visit, and only scattered schools of small tuna were seen and the fish were very wild. Few fish were attracted to the lights at night. No sets were made during the day or night.

4.2.3 Sarawak and the West Coast of Sabah (Fig. 3)

Area	Vessel	Trip No.	Duration	Fishing Days	Sets Day	Sets Night	Net	SCSP Report
Sarawak	Royal Venture	10	26 May-8 June 76	10	1	7	2	-
Sarawak	Royal Venture	12	7-10 Sept. 1976	4	1	1	2	-
Sabah	Royal Venture	10	28 April, 4-17 May 1976	13	-	2	2	-
West Coast	Royal Venture	12	14-19 Sept. 1976	6	1	2	2	-
West Coast	Southward Ho	17	7-8 April 1977	2	-	-	1	-

Sarawak. As in the fishing off the other countries, the daytime fishing involved general scouting for schools of small pelagic fish with special attention to small tunas. The 14 days fishing off Sarawak was largely within about 70 miles of the coast but also included one run out to the 100 m contours some 200 miles from the coast. Schools were relatively common in the waters up to about 60 miles offshore, but beyond that, practically no fish life was seen, either on the surface or on the sonar. In the more coastal area, schools of small tunas, mackerel, sardines and round herring were recorded with rather less small tuna than seen off Peninsular Malaysia or the west coast of Thailand. Schools were small, usually less than 5 tons but fairly common, though one of some 10 tons of sardines was recorded. Also one fast moving school of about 35 tons of skipjack was seen in some 40 fm water, 75 n. miles NNE of Kuching (26.5.76).

Two daytime sets were made (Trip 10, set 5 and Trip 12, set 11) on mackerel and small tuna, respectively but no fish were caught.

West Coast Sabah. During the two visits, in April/May and September 1976, several runs were made along the whole coastline and out to about 40 miles from the coast. In addition, in April 1977, two days were spent running west about 75 from the coast west of the northernmost part of Sabah, searching primarily for large tuna but a look out was kept for small pelagic species.

Few schools of fish were seen during the searching in April/May 1976 and only small schools of sardines and round herring were recorded. This survey coincided with a substantial occurrence of red tide along much of the Sabah/Brunei South China Sea coast when many fish in inshore waters died. There is no way of telling to what extent the local abundance in the areas searched were affected by the red tide, but it is probable that it was considerable.

The repeat visit in September 1976 recorded considerable number of schools up to 30 tons, of small pelagic fish, but it is not clear what species were represented. Off Sabah, there appears to have been rather less fish than observed off Kuching or in the southern part of the east coast of Sabah. One daytime set was made (Trip 12, set 13, Fig. 3) on small pelagic fish but no fish were caught. Two pre-dawn sets (Trip 12, sets 14, 15, Fig. 3) were made in the north, but strong currents made setting the net difficult and only a few hundred kg were caught in each case, the majority of the catch being round herring with some roundscad and mackerel.

No fish, either large tuna or small pelagic species, were sighted during the 2-day run into deep water in April 1977.

During Trip 10 of the Royal Venture in April/May 1976, considerable quantities of fish were attracted by the lights at night and the 5 sets made yielded the following catches (for positions, see Fig. 3 and Appendix I).

Set	6	7	8	9	10	11
Catch	150 kg	2-3	1.5	0	2.5	60 kg
			% Composition			
Rastrelliger	70	-	-	-	-	-
Roundscad	5	-	-	-	-	-
Sardines	-	90	90	-	-	-
Round herring	-	-	-	-	90	-
Spanish mackerel	5	-	9	9	9	9
Barracuda	10	-	-	-	-	-
Priacanthus sp.	-	-	-	-	4	95
Others	10	10	1	-	6	5

On the September 1976 trip (RV12), the moon was full during the 4 days of fishing and no fish were attracted to the lights.

It is interesting to note that more sardines and round herrings were caught than mackerel and roundscad, but the number of sets was very small.

4.2.4 East coast of Sabah

Vessel	Trip No.	Duration	Fishing Days	Sets Day	Sets Night	Net	SCSP Rpts.
Southward Ho	10	29 April-3 May 76	5	-	2	2	-
Southward Ho	17	6, 9-15 April 77	8	-	2	1	-

The two trips into this area gave very similar results. Off the northern half of the coast, a few small schools were recorded but in the south, especially near the coast near Tambisan Island and well into Darvel Bay, numerous fish schools of many species were recorded.

No daytime sets were made as few small tunas were seen. The details of the four pre-dawn hauls were as follows, no attempt being made to catch the whole school seen.

Trip/Set	10/1	10/2	17/1	17/2
Size of school (tons)	10	15	10	20
Catch (tons)	3	5	1.5	7.5
		% Composition		
Little tuna	10	-	-	-
Rastrelliger	-	10	14	11
Roundscad	-	45	-	-
Round herring	72	10	76	73
Big eye scad	-	33	-	15
Sardine	-	-	10	-
Anchovies	2	-	-	-
Spanish mackerel	4	-	-	-
Barracuda	4	-	-	-
Others	8	2	0	1

It is seen that in these four sets a wide variety of small pelagic species were caught including some little tuna and it appears that at least in April/May these species are abundant in this area. It is interesting that off Sabah and Sarawak round herring were considerably more frequently caught than off Thailand and Peninsular Malaysia.

4.3 Distribution of the fish in relation to the distance from the shore

In order to look at the general distribution of the small pelagic fish in relation to their distance from the coast, the catches of 26 successful pre-dawn sets have been tabulated below according to their distance from the shore. It would have been interesting to study the distribution of the species separately, but there were not enough observations to justify this.

Distance from coast (n. miles)	No. Successful Sets	Total Catch	Catch per Set
0 - 10	4	17	4.3
11 - 20	10	194	19.4
21 - 30	5	45	9.0
31 - 40	3	27	9.0
41 - 50	1	3.5	3.5
Over 50	3	14	4.7

These sets were made from 6 t. 74 miles from the coast and the depth of the water varied from 30 t. 200 m.

Most sets were made in 11-20 miles from the shore and this probably partly reflected the experience of the crews of the vessels that this was a distance from the shore where fish were often present. It should be noted that it was also in this zone that the two largest catches of 80 and 40 tons were made.

The actual values are somewhat reduced by the fact that on some occasions the crew deliberately caught only part of the school. However, there is no reason to suspect that this was done more often in one distance zone than another.

From the table, it is evident that for the area as a whole the small pelagic fish were commonly found out to at least 40 miles from shore, beyond the mean catch was less. Also it would appear that the zone of greatest abundance was on average at 10-20 miles from the shore.

An alternative interpretation of the distribution seen in the table is that the small number of observation mashes a steady fall off and one move offshore from a maximum of 10-20 miles. In either case, the figures show that the small pelagic fish were abundant out to some 40 miles from the coast.

4.4 Length composition of the fish caught

The length composition observations made on the more common species caught are summarized in Figs 4-8, but more detailed information is given in Working Papers 25 and 49 for observation made between August and October 1975 on Trips 6 and 7.

It is relevant to note that with the mackerel, roundscad, hard tail scad and little tuna, the observations show two separate size groups which may be distinct year classes. However, without many more observations

it is not possible to distinguish year classes from groups which have kept together from an early age, but which may have been spawned at any time over a prolonged spawning period.

5. DISCUSSIONS

5.1 Small tunas

The extensive searching for the three species of small tunas showed them to be common in all the coastal waters of the countries visited, with tonggol more abundant off the Peninsular Malaysia and Thailand than off Sabah and Sarawak. They were typically present as rather wild small school of under 10 tons that scattered on being approached but occurred commonly from the coast out to some 40 miles offshore but were only occasionally seen more than 60 miles from land. No doubt the extent of shallow water and width of the continental shelf would be important in their offshore distribution.

Thirty-five sets were made during daytime and many were aimed at schools of small tuna, but on only one occasion did the catch of small tunas reach 1 ton when 2 tons of frigate tuna were caught (SH Trip, Set 31), though a few small tunas of all three species were caught on several sets. The skippers of the vessels considered that net 2, the 20 mm smaller seine, was too small and slow sinking for catching these fast wild fish, but in fact net 1, the rather larger herring net used on 7 out of the 35 daytimes' sets, also failed to make a good catch of small tunas, though the number of sets was small. The enlarged herring net that was used for 12 daytime sets on Trip 7, was partially successful in only the one set when 2 tons of frigate tuna were caught out of a 5-ton school. The larger net would have been used more frequently, but for the fact that its 1-1/4 inch meshes were too large for the small pelagic species in the areas which became meshed in large quantities.

It would appear, therefore, that daytime purse seining primarily for small tunas is unlikely to be successful, at least with the sizes of nets used in these trips.

5.2 Other small pelagic species - Roundscads (Decapterus spp.)

The following small pelagic species were commonly encountered in all areas, though there were not enough systematic observations to make any useful appraisal of their relative importance.

Mackerel	Rastrelliger spp.
Roundscad	Decapterus spp.
Round herring	Dussumieria spp.
Hard tail	Megalaspis cordyla
Big eye scad	Selar crumenopthalmus
Torpedo trevally	Selaroides leptolepis
Sardines	Sardinella spp.

Observers' reports indicated that mackerels and roundscad and round herring were the fish most commonly caught throughout the area, though this will reflect not only abundance but also attraction to light and vulnerability to the method of fishing.

It is relevant to note that commercial fishing for small pelagic species, especially off the east coast and of Peninsular Malaysia, was seen to be largely confined to within about 10 miles from the coast, while the fishing on these trips showed small pelagic species in that and other areas to be more or less evenly distributed out to at least some 40 miles from the coast, beyond which the abundance seemed to fall off in most areas. So long as there is good fishing inshore, there is no advantage in going further, but it does mean that in some areas the stocks of these species may extend seaward considerably further than is indicated by the current distribution of the commercial fishing.

While daytime fishing was directed primarily to catching small tunas, some sets were made on small pelagic species when the size of the school merited it and it was approachable. This occurred most with schools of hard tail scad (Megalaspis cordyla), resulting in three schools of 2, 4 and 6 tons being caught on the September/October trip off the east coast of Peninsular Malaysia and small catches of this species being made on other occasions. Other small pelagic species were not often found in school of more than 1 or 2 tons and were difficult to approach.

However, the use of light at night often attracted considerable quantities of the other small pelagic species and resulted in many good catches being made. Out of a total of 46 pre-dawn sets, 26 caught 1 ton or more and these successful sets yielded an average catch of 11.6 tons each (see Appendix III). Roundscads and Rastrelliger were the most commonly caught species in most areas with round herring and sardines third and fourth, the other species being only rather rarely attracted to the light in any quantity. The observers reported that when the moon was full or nearly full, few fish were attracted to the light of the mercury lamps on the seine. It is evident that on several days of each month, the moonlight is too strong to permit fishing by this method. It was also noted that in certain areas, such as north of Sabah, the tides and currents severely interfered with the setting of the seine.

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APPENDIX 1

Date, time and position of sets made and estimated size of school (tons) on Trips 10, 11, 12 of the Royal Venture and on Trip 17 of the Southward Ho. Details of sets made on Trips 6 and 7 are given in SCS/76/WP/25 and SCS/76/WP/49, respectively.

Trip 10 - Royal Venture (1976)

Set	Date	Time	Long. °	Long. '	Latitude °	Latitude '	Tons	Set	Date	Time	Long. °	Long. '	Lat. °	Lat. '	Tons
1	May 2	0450	4	50	118	29	10	7	May 28	0530	3	50	110	55	?
2	3	0455	5	33	119	04	15	8	29	0530	3	20	111	20	5
3	7	0450	6	13	115	42	10	9	June 6	0530	3	36	110	40	5
4	17	0440	5	10	115	05	?	10	7	0550	3	12	111	10	5
5	26	0920	2	45	110	12	35	11	8	0550	3	12	111	10	4
6	27	0530	3	32	110	30	10								

Trip 11 - Royal Venture (1976)

Set	Date	Time	Long. °	Long. '	Latitude °	Latitude '	Tons	Set	Date	Time	Long. °	Long. '	Lat. °	Lat. '	Tons
1	June 29	0545	5	23	103	49	1	5	July 4	0550	6	28	102	25	2
2	July 2	0535	6	00	103	03	1	6	4	1810	6	33	102	31	8
3	2	1729	6	30	102	21	5	7	4	1930	6	29	102	30	?
4	3	0440	6	28	102	23	?	8	5	1807	6	30	102	24	4

Trip 12 - Royal Venture (1976)

Set	Date	Time	Long. °	'	Latitude °	'	Tons	Set	Date	Time	Long. °	'	Lat. °	'	Tons
1	July 20	1925	5	42	98	55	?	9	Aug 20	0526	6	20	102	40	10
2	22	0420	5	30	99	57	10	10	22	0543	6	09	103	3	25
3	23	0512	5	30	99	57	15	11	Sept 7	1745	2	05	110	30	3
4	Aug 3	0510	8	45	97	35	10	12	8	0530	2	09	110	29	?
5	4	0430	8	20	97	30	30	13	17	1030	6	52	116	27	30
6	4	0630	8	20	97	30	3	14	18	0545	7	10	116	53	?
7	15	1331	2	33	104	40	5	15	19	0540	7	9	116	53	5
8	18	0527	5	26	103	24	10								

Trip 17 - Southward Ho (1977)

Set	Date	Time	° Long. '	° Lat. '	Tons
1	April 12	0530	5 49	118 23	10
2	13	0445	4 50	118 17	20

APPENDIX II

Common names of fish and their corresponding scientific names used in this report (following FAO terminology)

Common Names	Scientific Names
Yellowfin tuna	Thynnus albacares
Big eye tuna	Thynnus obesus
Skipjack	Katsuwonus pelamis
Little tuna	Euthynnus affinis
Tonggol	Thynnus tonggol
Frigate tuna	Auxis spp.
Mackerel	Rastrelliger spp.
Roundscad	Decapterus spp.
Big eye scad	Selar crumenophthalmus
Hard tail (torpedo trevally)	Megalaspis cordyla
Sardine	Sardinella spp.
Round herring	Dussumieria spp.
Anchovy	Stolephorus spp.
Barracuda	Sphyraena spp.
Spanish mackerel	Scomberomorus spp.

APPENDIX III

Total catch and catch composition of successful set in the nighttime fishing by area and trip

Area	Gulf of Thailand	East Coast of West Malaysia					Sabah	Sara-wak	West Coast Malay-sia	West Coast of Thailand			Total
Trip	7	6	7	11	13	Total	10	10	12	7	12	Total	
Mid-date	4 Oct	28 Aug	5 Oct	2 Jul	19 Aug		10 May	2 Jun	21 Jul	3 Dec	3 Aug		
No. of successful set	1	3	4	1	2	10	3	3	2	6	1	7	26
Catch by species													
Thynnus tonggol	-	-	-	-	-	-	-	-	2.20	0.20	-	0.20	2.40
Euthynnus affinis	-	-	10.46	-	-	10.46	0.30	-	-	-	-	-	10.76
Auxis spp	-	-	-	-	-	-	-	-	1.70	-	-	-	1.70
Rastrelliger spp.	-	31.50	61.30	0.05	18.25	111.10	0.60	-	-	-	0.14	0.14	111.84
Decapterus spp.	0.50	57.70	25.44	0.40	14.75	98.09	2.70	-	-	31.03	2.45	33.48	134.77
Megalaspis cordyla	-	-	-	-	-	-	-	-	-	7.80	-	7.80	7.80
Selar crumenopthalmus	-	-	-	-	-	-	1.98	-	-	-	-	-	1.98
Selaroides leptolepis	-	-	-	-	-	-	-	-	-	0.45	-	0.45	0.45
Caranx spp.	-	-	-	0.10	-	0.10	-	-	-	-	-	-	0.10
Carangoides malabaricus	-	1.00	-	-	-	1.00	-	-	-	-	-	-	1.00
Sardinella spp.	-	-	-	-	-	-	-	4.05	-	6.32	-	6.32	10.37
Dussumieria spp	0.50	-	4.80	0.40	-	5.20	5.73	2.25	-	1.20	0.87	2.07	15.75
Other fish	-	-	-	0.05	-	0.05	0.69	0.70	0.10	-	0.04	0.04	1.58
Total Catch	1.00	90.00	102.00	1.00	33.00	226.00	12.00	7.00	4.00	47.00	3.50	50.50	300.50
Catch/Set	1.00	30.00	25.50	1.00	16.50	22.60	4.00	2.30	2.00	7.80	3.50	7.20	11.60

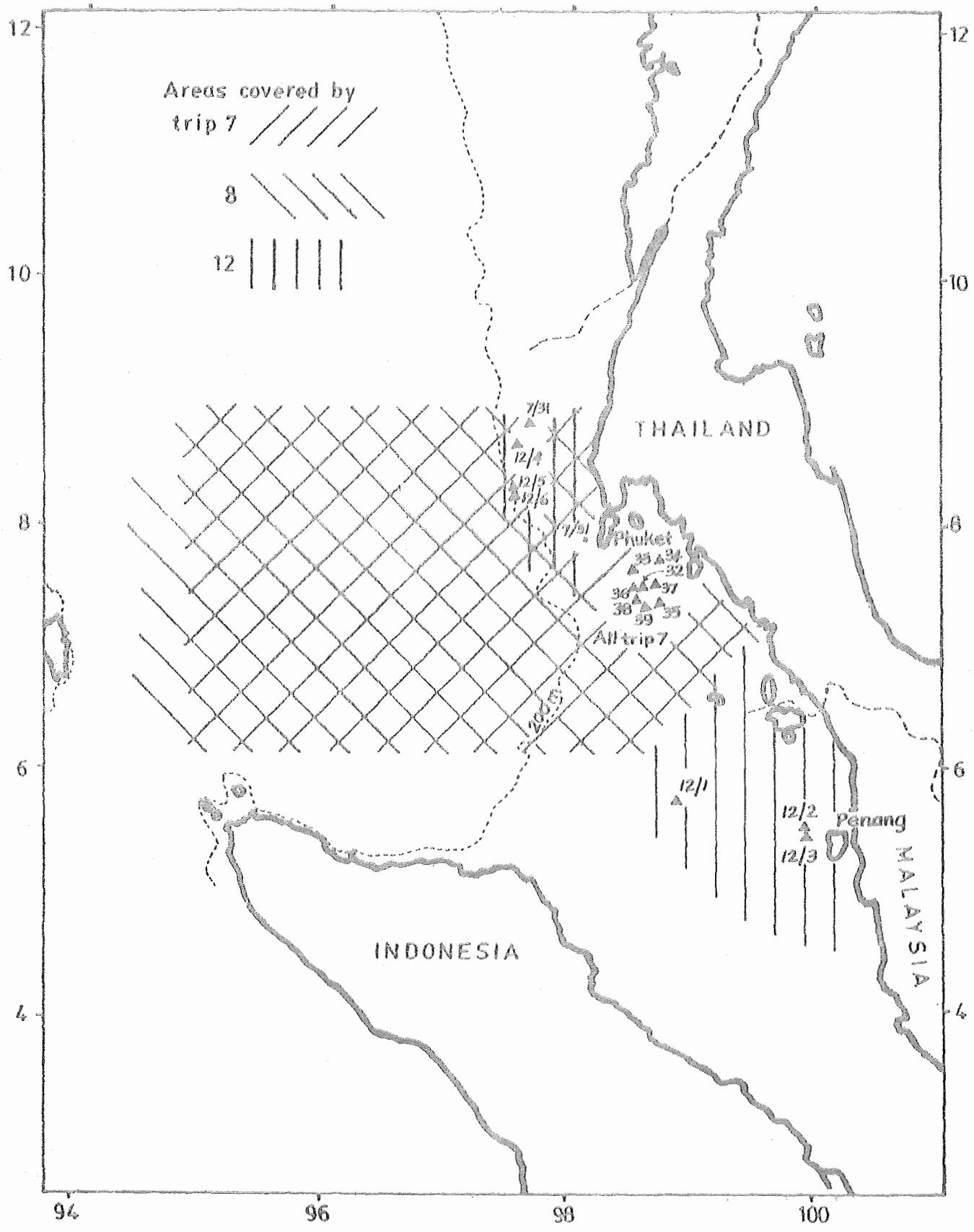

Figure 1. Area covered and sets made off the west coasts of Thailand and peninsular Malaysia

Figure 2. Area covered by scouting and the positions of the sets made

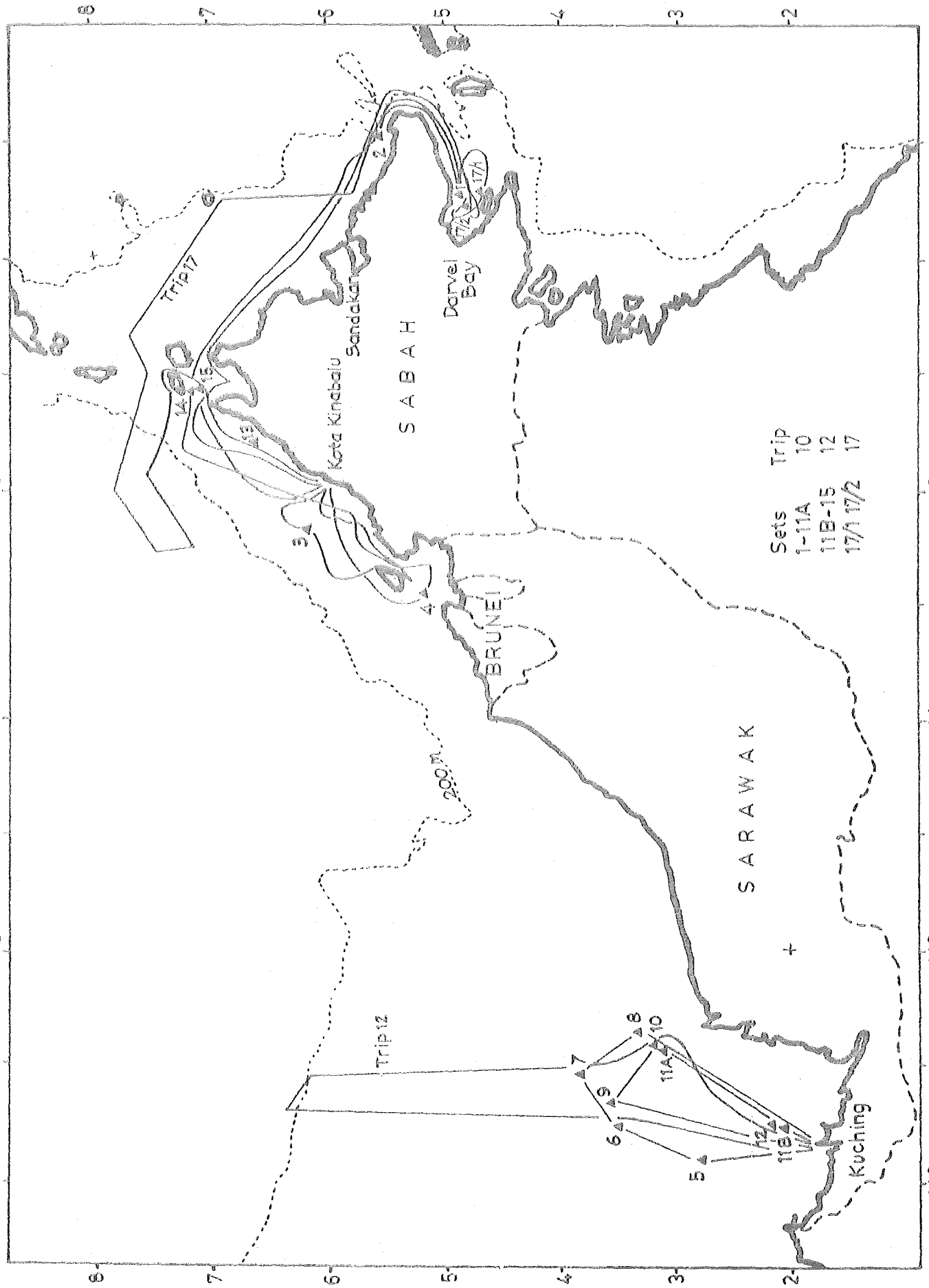

Figure 3. Approximate courses and sets made off Sarawak and Sabah

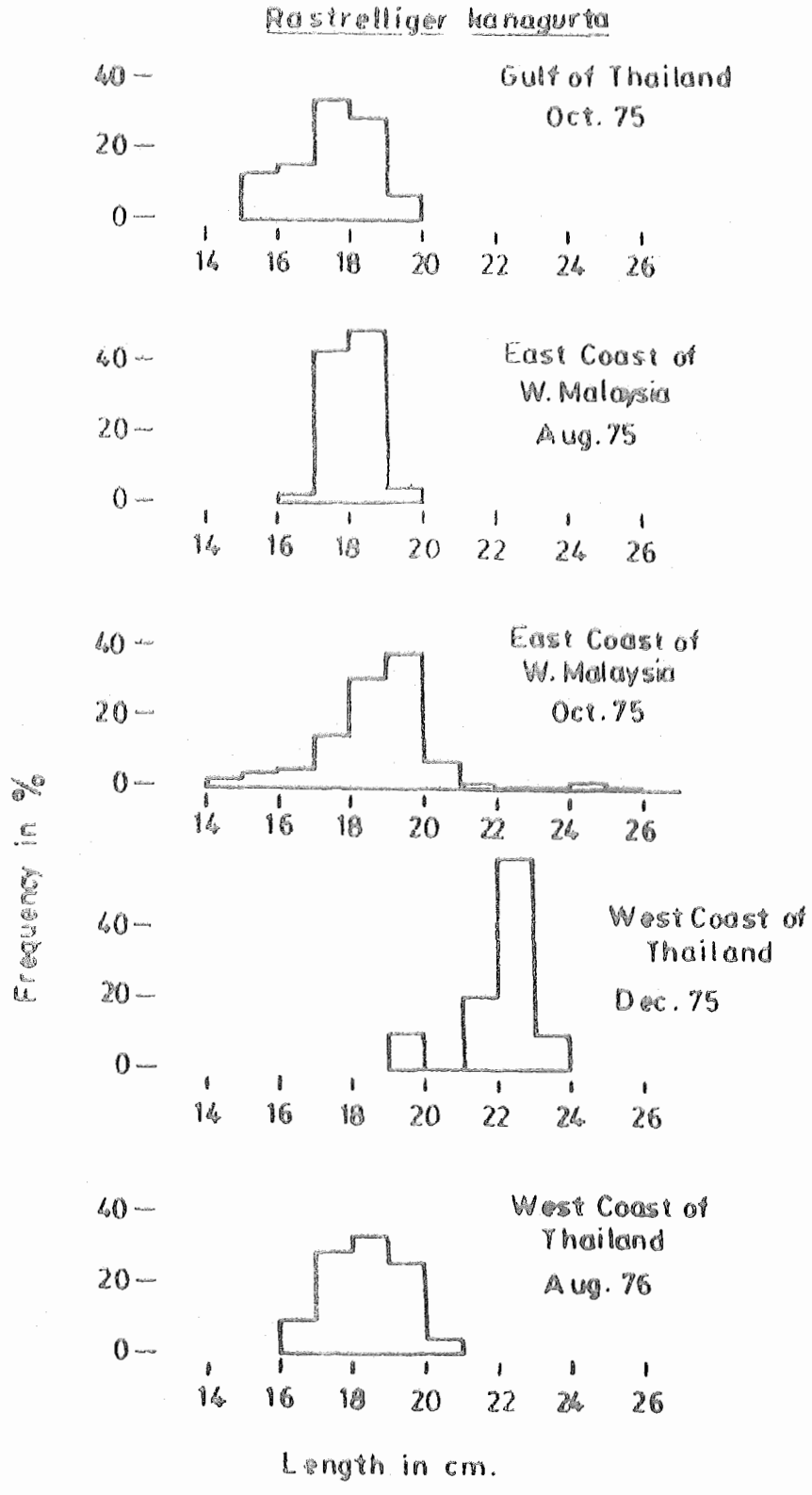

Fig. 4. Length composition of Indian mackerel (Rastrelliger kanagurta)

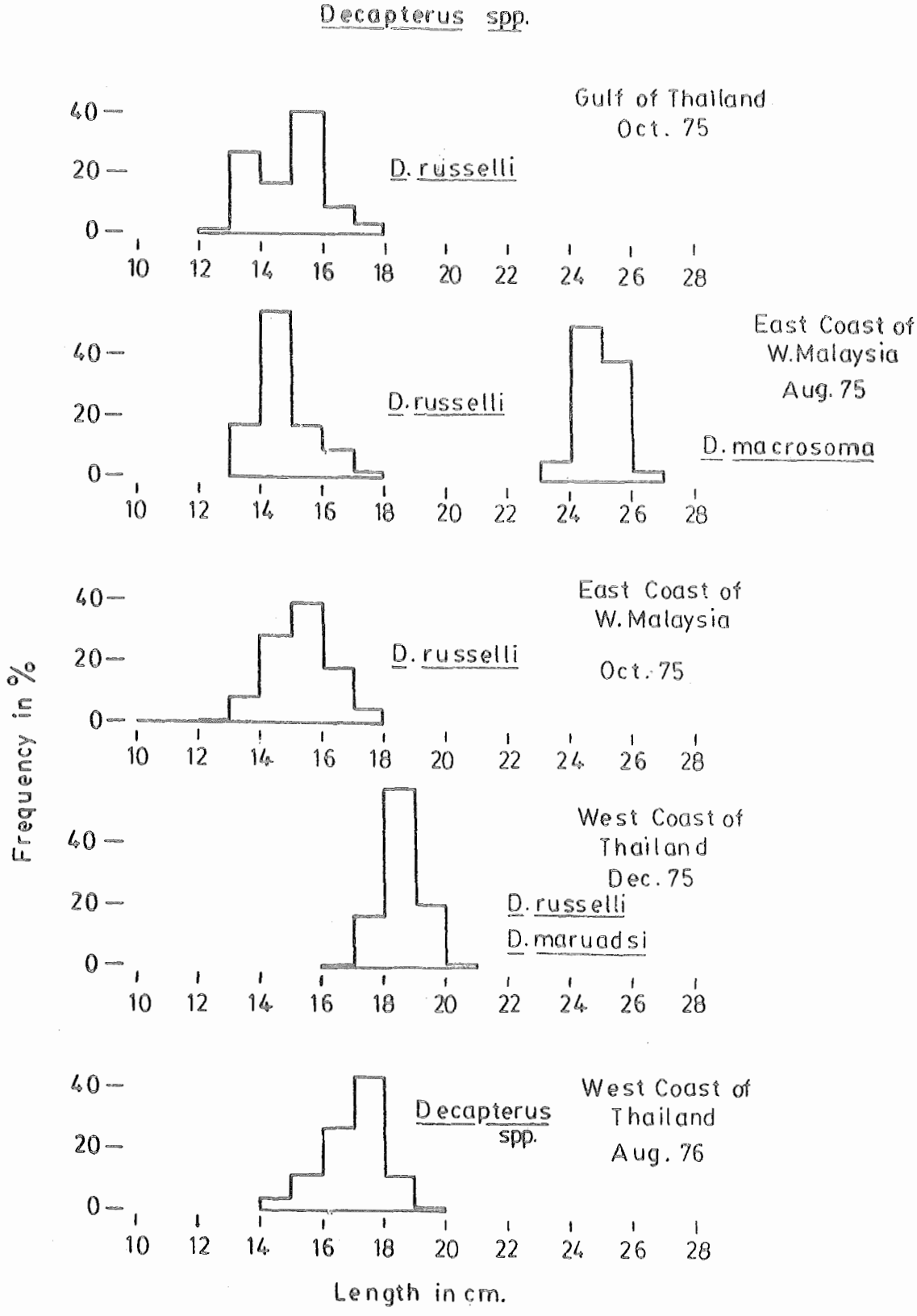

Fig. 5. Length composition of Round scad (Decapterus spp.)

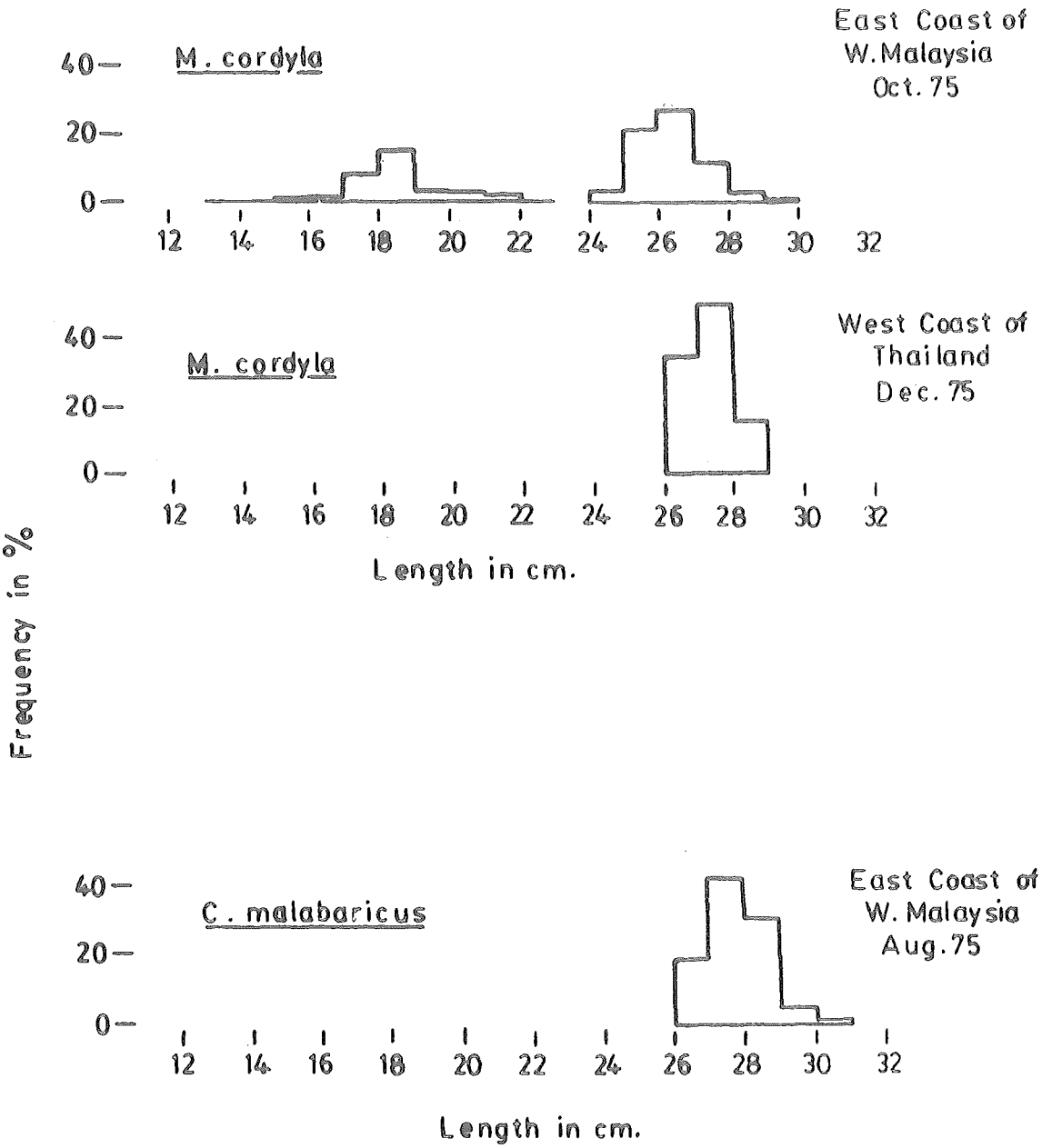

Fig. 6. Length composition of Hardtail scad (Megalaspis cordyla) and Malaba cavalla (Carangoides malabaricus)

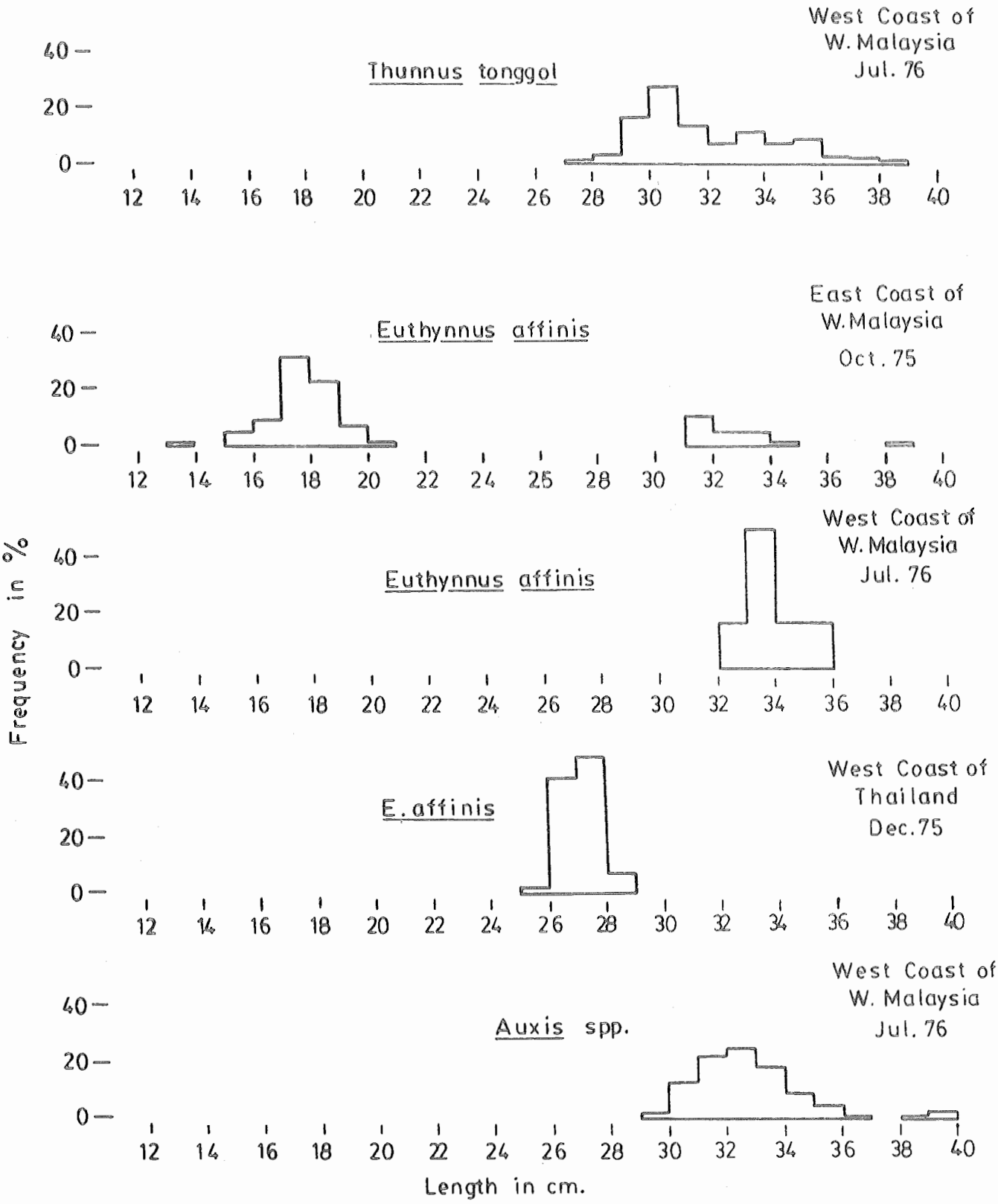

Fig. 7. Length composition of some small tunas

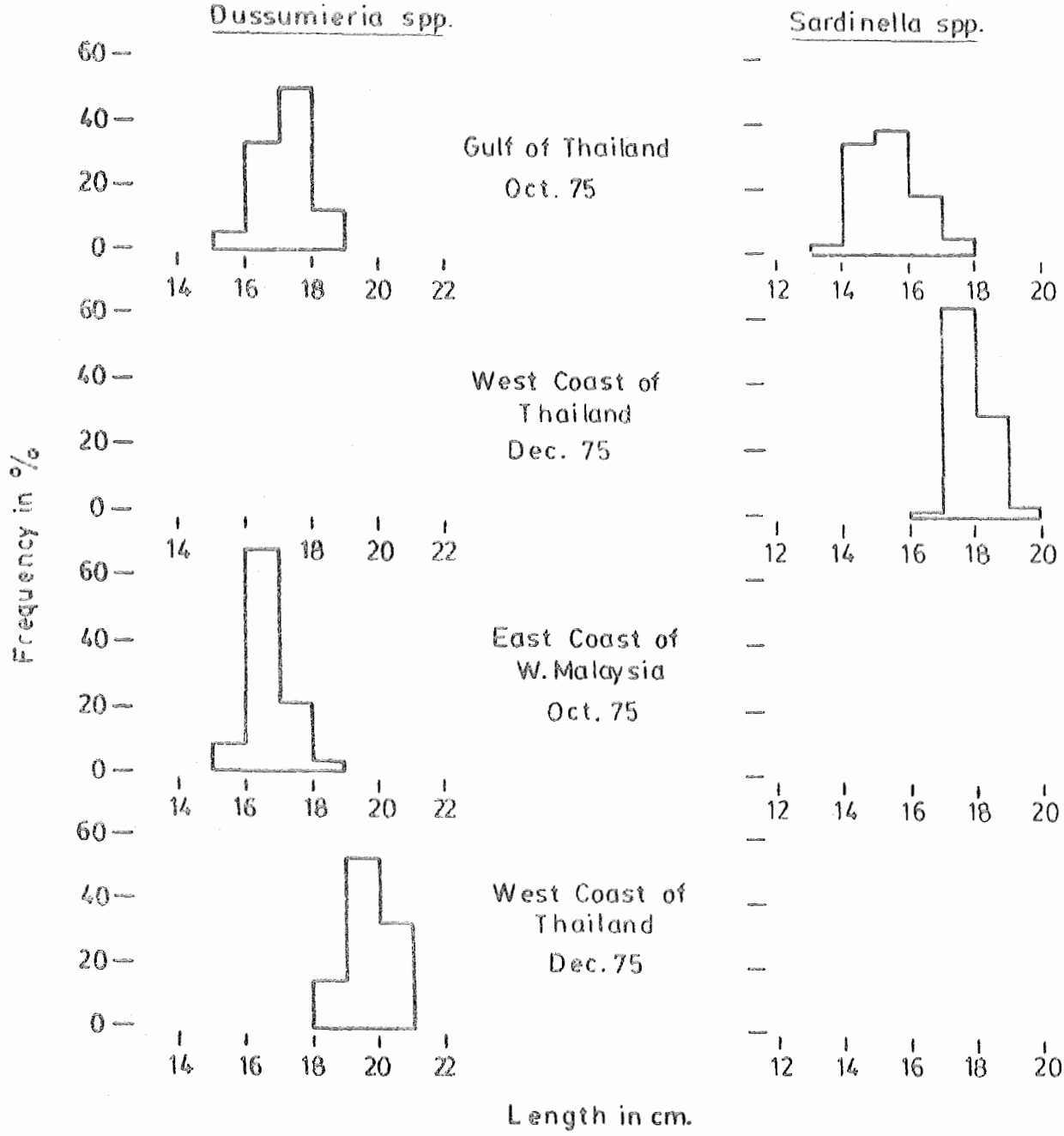

Fig.8. Length composition of Round herring (Dussumieria spp.) and Sardine (Sardinella spp.)

PART III

A DISCUSSION ON THE OPERATIONAL ASPECTS

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PART III

1. BACKGROUND

The basis for chartering commercial fishing vessels under contract TF/RAS/22 Canada, with execution by the South China Sea Fisheries Development and Coordinating Programme, was to establish by catch demonstration areas of the South China Sea and adjacent waters for commercial quantities of pelagic species either under or not exploited. With an immediate need for additional supplies of high protein foods, plus generating foreign exchange, the Programme elected to mount an exploratory fishing project that could provide results, that, if positive, would give direction for the exploitation of the pelagic fishery of all levels.

The pelagic fishery

As purse-seining for tunas (and small pelagics to a lesser extent) is by nature capital intensive, it was considered necessary to demonstrate fishing and fish handling techniques that were not generally practised in the Southeast Asia Region, and demonstrate by actual catch rates the viability of the resource related to the capital employed. Complementing this activity would be further stock assessment activities such as acoustic surveys by research vessels of the participating countries that, over a longer period of time, combined with catch per effort statistics, would give a broader picture of the standing stocks and sustainable yields for the major pelagic species.

2. VESSEL DEPLOYMENT

The vessels had a capability of staying at sea for extended periods of time, as much as 45 days if fuel requirements were planned, and catch rates low, as the steel or aluminum-lined fish tanks (6 in each vessel) could switch from the storage of fuel, water or fish as required and the fish could be stored fresh or frozen. Deployment was therefore scheduled on the basis of 3 to 4 weeks at sea, and up to 10 days for a turn-around in port, the latter variable according to the sale and discharging of the catch. Tables 1a and 1b show the deployment of the two vessels according to activities performed during the charter.

In summary they performed exceptionally well as follows:

Tuna - Days Deployment

Vessels/Days	Total	Fishing	Travel	Laid-up Weather	Repairs Net	Repairs Boat	In Port
Southward Ho	731	304	121	45		46	215
Royal Venture	560	204	92	50	29	15	170
Sub-total	1,291(72%)	508	213	95	29	61	385

Small Pelagics

Vessels/Days	Total	Fishing	Travel	Laid-up Weather	Repairs Net	Repairs Boat	In Port
Southward Ho	214	79	49	3	0	1	82
Royal Venture	161	80	24	1	0	19	37
Sub-total	375(21%)	159	73	4	0	20	119
Travel to and from Canada/Philippines							
Southward Ho*	41		33				8
Royal Venture	87		79				8
Sub-total	128(7%)		112				16
Total	1,749	667	398	99	29	81	520
Percent		37.1%	22.2%	5.5%	1.6%	4.5%	29%

The total time spent at sea (fishing, travel and laid-up weather) accounted for 64.8% of the charter time, and attested to the efficient manner in which the owners and crew carried out instructions and performed their duties. It can be seen that down-time for repairs was minimal, 6.1% for both net and boat repairs.

All of the net repair down-time was spent repairing a larger purse-seine from the FAO Fisheries Training Centre, Cavite, in order to test this type of larger gear (used during trip #7, Royal Venture), so there was actually no lost time apart from minor repairs to the vessels own fishing gear. Similarly, repairs to the hull and equipment were minimal at 4.5% of total charter time. This included one haul-out for underwater inspection and painting per vessel. Unforseen minor repairs to the refrigeration system, the main engine of one vessel, and the auxiliary engine of the other. Otherwise, the vessels operated under tropical conditions in an extremely efficient manner.

The general scheduling priority of the vessels was decided at a workshop of all the participating countries where the cooperation stock assessment activity using national vessels was determined as well. The detailed scheduling during the period was based on periodic consultation with each participating country. A consultant was also engaged to propose an aerial survey pattern to complement the activities.

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* The return to Canada journey of 30 days was carried out after the charter period had expired.

Since tuna operations required a different net from that used for small pelagics, deployment was segregated into the two categories plus travel time between Canada and the Philippines. Of the total 1,794 charter days, 1,291 or 72% was spent on tuna, 375 days or 21% on small pelagics, and 128 days or 7% on travel to and from Canada. The latter includes only the initial journey from Canada for the Southward Ho, as the owners elected to fish the last month of the charter as they considered that the bonus sharing arrangement would prove to their advantage rather than accepting 30 days charter for the return voyage.

The Philippines has a well established and relatively modern fleet of purse-seine vessels that prosecute the round scad (Decapterus spp.). Annual statistics reported this purse-seine that fleet peaking in 1973 at 470 vessels (299 over 506 tons) catching 232,587 m. tons but the latest figure for 1975 is closer to the average of the last 5 years, with 313 purse-seine vessels (160 over 50 G tons) catching 168,214 m. tons. Of this tonnage, round scad accounted for 132,618 m. tons or 79%. Of the balance, other scads, sardines and mackerels were the major species, while skipjack (Katsuwonus pelamis) and yellowfin tuna (Thunnus albacares), bonito (presumably Auxis spp. and Euthynnus affinis which will be referred indistinctly to as "frigate tuna"), were reported in total as only 8,323 m. tons from purse-seine gear, or less than 5% of the total purse-seine catch. The Philippine purse-seine fleet has concentrated on the smaller pelagics, and have reasonably good catch per unit of effort as reported with a high of 731 m. tons in 1974 and 537 m. tons in 1975. Biologists and operators reported year-round sightings of skipjack and yellowfin, and to a lesser extent the frigate tuna in quantities that appeared out of proportion to that reported in the annual statistics. It therefore appeared that the resource was there, particularly in the Sulu Sea and Moro Gulf area of the Celebes Sea, so it was decided that the concentration of effort should be directed to the tunas in the above areas, with exploratory cruises in other Philippine deep coastal waters.

Similarly, the other participating countries have fairly extensive purse-seine fisheries, but are basically limited to a narrow coastal belt because the vessels are small, and fishing gear of light construction, usually employing manpower with possible assistance from powered capstans for purse line hauling only. By comparison to the Philippines, other countries in which exploratory small pelagic purse-seining was conducted have fisheries as reported in annual statistics reports, as follows:

	Fishing units	Catch M. tons	Catch/unit effort
1973 - Thailand (Thai and Chinese type only)	437	50,886	116 M tons
1975 - Malaysia	2,514	67,667	27 M tons

In Thailand, 145 of the vessels were reported over 18 meters length (close to 50G tons) and in Malaysia, only 183 were reported over 50 G tons. With both countries having expansive shallow continental shelf areas of less than 50 fathoms, and the purse-seine fishery extensive in numbers of units but lacking in the capacity to prosecute the fishery beyond the limits of the small boats fishing on a daily return basis, the small

pelagic exploratory fishing was considered of greater importance in these two countries. Due to foreign vessel licensing restrictions in Indonesia, the vessels did not fish any territorial waters of Indonesia. Similarly, although a cruise was planned for the international waters in the northern sector of the South China Sea, in areas accessible to the Hong Kong fishing fleet, this was not instituted.

Using the above background for the logistics in planning the timing, duration and areas for each trip, Table 2 shows the areas fished during the charter period, and the trip numbers and time of year.

Good catches of small pelagics were made seasonally in the Andaman Sea, east coast of Peninsular Malaysia and the Darvel Bay area of Sabah, as outlined in the statistical analysis section for small pelagics.

Catching small pelagics species requires a small mesh net and the two vessels carried only one small mesh net which was not too well suited to the extremely small pelagics (particularly in shallow water). The nets were however satisfactory in establishing indicative catching rates. The main constraint, however, preventing a more intensive effort was the problem of marketing locally larger landings of fish in areas where present exploitation and marketing have been limited.

Due to the lack of ready markets, and the very shallow draft in most fishing villages, the vessels were discouraged from making optimum catches, and invariably would set only around a small portion of the school, sample for species and size composition then spill or give away to local fishermen the remainder of the catch.

The emphasis was therefore largely confined to the tuna species. From Table 2 it is clearly evident that the vessels concentrated on Moro Gulf. This should not be construed to mean that the Sulu Sea area did not have a good standing stock of skipjack and yellowfin. On the contrary, visual sightings were good, but there was almost a void of drifting objects, which has proven to be the main key to catching tuna in these waters. Trips #11 and 12 by the Southward Ho demonstrated satisfactory catch rates in this area, but these tuna were mostly associated with anchored rafts (payaos). From previous experience early in 1975, the Programme had several anchored rafts built but without proper surveillance, they soon disappeared. Since they must remain a considerable time in the water to "season" with marine growth, they cannot be effective if removed when the vessel leaves the area. A working arrangement was attempted with the owner of the floating rafts but could not be satisfactorily agreed to. Rather than attempt the building and servicing of enough rafts (8 to 12) to cover a particular area, it was decided to concentrate in the Moro Gulf where drifting objects are common, particularly in the eastern side.

3. TUNA PURSE-SEINE

The tuna seines aboard the vessels were designed basically for yellowfin in the Eastern Pacific, where the average size of skipjack and yellowfin are larger, being at least one year class older. The mesh size of a purse-seine should be as large as possible without causing fish to gill in the net, to permit less resistance in the water for both a faster sinking rate when

setting, and also to minimize against tidal current so that the net will stay as vertical as possible. The 4-1/4" stretched mesh size of both nets proved to be too big for the average mean size of 45-50 cm forklength for skipjack and 45-55 cm forklength for yellowfin. To further complicate the fishing operation, besides the mix of skipjack and yellowfin, the frigate tuna could sometimes represent up to 1/3 the catch, and with an average mean size of 35-40 cm forklength, gilling became a problem in that they had to be handpicked out of the net so that the bulk of the net would go through the limited opening of the power block.

The purse-seine must be "dried up" and the catch brailed as quickly as possible (5 or 6 hours in tropical water after drying can deteriorate quality below an acceptable canning grade), cleaning the net is a time-consuming procedure. Failing this, the power block is abandoned, and the net is fleeted in by block and tackle, and the gilled fish picked from the net and discarded later.

With an intermix of tunas with the smaller pelagics which also are of commercial value, some operators feel that a purse-seine operation will be more viable if the mesh size is small enough to catch most of the smaller species associated with the tunas. From the fishing experience of the chartered vessels, a floating object is only effective in attracting tuna when it has previously attracted the smaller pelagic bait fish. The more recent trips clearly proved this phenomenon when as many as four consecutive daily sets were made, using the same floating object and bait. Furthermore, the catch at times showed a portion of 0 year class skipjack and yellowfin, and these immature sizes might form a larger segment of the catch if the net mesh size is reduced considerably. It is therefore recommended that the mesh sizes be either 3" or 3-1/2" stretched mesh in the body, and no smaller than 2-1/2" stretched mesh size in the bunt. A proposed plan for a tuna purse-seine for Philippine waters, modified from the one used on the Southward Ho, is shown in Fig. 1a. This net measures 520 fathoms hung, and should fish a depth of from 55 to 65 fathoms, depending on the pursing speed. The Royal Venture used a smaller purse-seine measuring 450 fathoms hung length, and is reported to fish to about 40 fathoms deep. Although the catch records did not indicate the superior fishing ability of one net over the other, both captains agreed that when fishing waters without a thermocline, the deeper it fished the better. It is therefore recommended that this net could be shortened to 450 fathoms hung length if the vessel size will not allow a larger net, but the depth should not be altered.

4. MARKETING

The marketing aspects of the chartered vessel programme were originally designed to do test marketing of brine frozen tuna and frigate tuna, preferably for local consumption or processing. It soon became apparent during trip #4 in May 1975 when the two vessels arrived in Manila with over 400 tons between them, that the local market, processors and handling and storage facilities were incapable of disposing of such a quantity in a reasonable time. All avenues of local servicing were tried,

and less than 300 tons were offloaded in a two-week period, the balance being left on board and discharged at the end of the next trip. Results of the test marketing of tunas direct from the vessel, and over a period of time from cold storage, to several medium-sized town markets while interesting from an acceptability point of view were discontinued for practical reasons. Details of the results are contained in the South China Sea Programme Working Paper series, WP/12 Voyage #4 and WP/25 Voyage #5. Marketing was therefore concentrated on the canning markets, both local and export. A summary of the annual revenues from tuna is as follows:

	1974-75	1976	1977	Total
Short tons sold	831	630	897	2,358
Gross value	US$ 251,308	$ 287,951	$718,075	$1,257,334
Less shipping costs	49,940	37,978	101,092	189,010
FOB vessel net value	US$ 201,368	$ 249,973	$616,983	$1,068,324
FOB vessel price per ton	$ 242.32	$ 396.78	$687.83	$453.06

With the lack of facilities, the main concern was to ensure that the vessel could be discharged within a reasonable turn-around time. Preference was given to local canners, to the extent of their handling facilities, if their ex-vessel price equated to within 10 or 15% of the export price worked back to an ex-vessel return. In 1977, this difference was widened substantially due to an unprecedented rise in the export price which went from US$670.00 in January to $950.00 in June, C and F West Coast, or $544.00 to $820.00 ex-vessel. During this same period, the local canner price went from the equivalent of $362.00 to only $608 ex-vessel, but small lots were sold to them as canned tuna inventories were low in the country, and refrigerated shipping containers were limited.

For the development of this fishery, the vessels or support vessels should have a capability of sorting as to size, species and quality, so that the catch can be distributed to the respective market channels. This was impossible with brine freezing without a sorting facility, the catch being dropped directly from the sea into the refrigerated tank.

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Table 1a - SOUTHWARD HO - TRIP SUMMARIES IN DAYS

Trip No./Date	Total Days	Fishing	Travel	Laid up Weather	Repair Net	Repair Boat	In Port	Tons Catch T - tuna P - small pelagics	Sets Made	C o m m e n t s
To Philippines 19/10-28/11/74	41		33				8			
#1 29/11/74-4/1/75	37	14	6	0	0	0	17	0	0	In port X'mas holidays 19/12/74-4/1/75
#2 5/1-11/2/75	38	17	8	5	0	0	8	17 T	9	
#3 12/2-8/4/75	56	21	11	9	0	0	15	98 T	13	Nothing irregular while in port.
#4 9/4-11/6/75	64	30	5	9	0	0	20	239 T	24	Excessive discharge time due to inability of cold storage -- only partially unloaded
#5 12/6-3/8/75	52	16	10	2	0	9	15	43 T	10	Boat repairs - brine pump rebuilt. Two days discharging; cold storage inability.
#6 4/8-30/9/75	58	25	11	2	0	0	20	90 P	5	In Singapore twice, K. Trengganu twice
#7 1/10/75-9/1/75	102	34	19	1	0	1	47	60 P	29	In port Bangkok 8 days, Singapore 7 Phuket 3 days, X'mas Singapore 25 days.
To end 1975										
tuna	247	98	40	25		9	75	397 T	56	
small pelagics	160	59	30	3	0	1	67	150 P	34	
Travel to Phil.	41		33							
1976										
#8 10/1-3/3/76	54	20	19	0	0	0	15	0 P	0	In port Songkhla 4 times for 8 days Singapore 4 days, Manila 3 days.
#9 3/3-14/4/76	43	14	11	1	0	0	17	8 T	1	In port preparing bait tank 5 days, getting bait 4 days, Manila end of trip - 8 days.
#10 15/4-28/6/76	74	25	9	2	0	26	12	38 T	4	Annual overhaul in Manila.
#11 29/6-20/8/76	53	28	8	2	0	2	13	82 T	11	Nothing irregular.
#12 21/8-28/9/76	39	16	5	7	0	0	11	102 T	9	Nothing irregular.
#13 29/9-17/11/76	49	21	8	1	0	0	19	170 T	11	Vessel held "open house" at Iloilo & Manila.
#14 18/11-5/1/76	50	15	8	6	0	0	21	34 T	4	X'mas lay up.
1976 sub-total										
tuna	308	119	49	19	0	28	93	434 T	39	
small pelagics	54	20	19	0	0	0	15	0	0	

Table 1a (continuation)

Trip No./Date	Total Days	Fishing	Travel	Laid up Weather	Repair Net	Repair Boat	In Port	Tons Catch T - tuna P - small pelagics	Sets Made	Comments
1977										
#15 6/1-25/2/77	51	23	10	1	0	9	8	82 T	10	Auxiliary engine breakdown parts unavailable.
#16 26/2-30/3	33	14	5	0	0	0	14	251 T	9	Containers scarce -- could not unload immediately.
#17A 31/3-15/4	16	10	3	0	0	0	3	10 P	2	Sabah
#17 16/4-25/5	40	18	6	0	0	0	16	285 T	13	Containers scarce -- could not unload immediately.
#18 26/5-30/6	36	22	8	0	0	0	6	279 T	14	Tons caught not final.
#19	0									Owners elected to fish until termination of charter 30/6/77 instead of taking allowance of 30 days for return travel.
1977 Total Tuna	176	87	32	1	0	9	47	897	48	
TOTAL TO DATE										
Tuna	731	304	121	45	0	46	215	1,728	143	
Small pelagics	214	79	49	3	0	1	82	150	34	
Travel to/from Philippines	41		33				8			

GRAND TOTAL

Table 1b - ROYAL VENTURE - TRIP SUMMARIES IN DAYS

Trip No./Date	Total Days	Fishing	Travel	Laid up Weather	Repair Net	Repair Boat	In Port	Tons catch T - tuna P - small pelagics	Sets Made	Comments
1974-75										
Philippines 10-28/11/74	44		36				8			
29/11/74-5/1/75	37	14	6	0	0	0	17	0	1	In port, X'mas 19/12/74-4/1/75
1975										
5/1/75-8/2/75	35	16	9	5	0	0	5	5 T	7	
9/2-10/4/75	61	19	14	9	0	4	15	40 T	10	Nothing irregular in port.
11/4-11/6/75	62	28	5	9	0	0	20	49 T	22	Problems discharging to cold storage.
12/6-25/7/75	44	21	9	5	0	0	9	23 T	6	
26/7-30/9/75	67	18	6	7	29	0	7	24 T	4	Repairing big seine ex UNDP project for use.
1/10/75-10/1/76	100	42	11	8	0	0	39	112 T	22	In port 5 days various times during Manila end of trip. X'mas holidays days. 8/12-7/1 - nothing irregular.
end 1975 Phil. travel	44		36	-	-	-	8			
Sub-Total	406	158	60	43	29	4	112	433 T	72	
1976										
11/1-28/2/76	52	8	8	7	0	11	18	82 T	3	Annual drydock and repairs 11 days, unloading took 10 days, end trip 6 after drydock.
29/2-22/4/76	54	20	10	0	0	0	24	81 T	3	In port discharging 9 days getting clearance foreign seining 11 days.
23/4-28/6/76	62	27	8	0	0	10	17	19 P	11	Sabah & Sarawak replacing refrigerated heat exchanger units, 10 days Singapore.
29/6-24/8/76	62	41	9	1	0	0	11	45 P	17	Malaysia and Thailand
26/8-30/9/76	37	12	7	0	0	9	9	1 P	5	Sabah and Sarawak
1/10-17/11/76	48	18	14	0	0	0	16	33 T	10	West Coast Luzon, Sulu Sea, Moro Gulf catch latter area only.
18/11-31/12/76	43		43							Return to Canada.
Sub-Total 1976										
Tuna	154	46	32	7	0	11	58	196 T	16	
Small pelagics	161	80	24	1	0	19	37	65 P	33	
Return travel	43		43							
TOTAL TO DATE										
Tuna	560	204	92	50	29	15	170	629	88	
Small pelagics	151	80	24	1	0	19	37	65	33	
Travel to/from Philippines	87	-	79				8			
TOTAL	888	284	195	51	29	34	215			

Table 2. Areas fished by months and trip numbers by the SCSP chartered purse-seine vessels

Area/Trip No. and Vessel	Tuna Trips	Small Pelagic Trips Trip No. and Vessel
A. Southern portion Andaman Sea (combined tuna/small pelagics)		
7 SH	Nov-Dec/75	Nov-Dec/75
8 SH	Jan-Feb/76	Jan-Feb/76
10 RV	July/76	July/76
B. Gulf of Thailand		
7 SH	Sept-Oct/75	
C. East coast Peninsular Malaysia (combined tuna/small pelagics)		
7 SH	Aug-Sept/75	Aug-Sept/75
10 RV	July-Aug/76	July-Aug/76
D. Sarawak		
10 RV		June/76
12 RV		Sept/76
E. Sabah		
10 RV		May/76
12 RV		Sept/76
17 SH	Apr/77 (combined)	Apr/77
F. Sulu Sea		
5 SH - RV	June-July/75	
11 SH	July/76	
12 SH	Aug-Sept/76	
G. Moro Gulf		
1 SH & RV	Dec/74	
2 SH & RV	Jan/75	
3 SH & RV	Feb-Mar/75	
4 SH & RV	Apr-May/75	
5 SH & RV	June/75	
6 SH & RV	Aug/75	
7 RV	Oct/75	
8 RV	Jan/76	
9 RV & SH	Mar/76	
13 RV & SH	Oct/76	

Table 2 (continuation)

14	SH	Nov-Dec/76
15	SH	Jan-Feb/77
16	SH	Mar-Apr/77
17	SH	Apr-May/77
18	SH	June/77

H. South China Sea - West coast Palawan

12	RV	Sept/76

I. Bohol Sea - Leyte

10	SH	May/76

J. Luzon and northern Philippine waters

10	SH	April/76

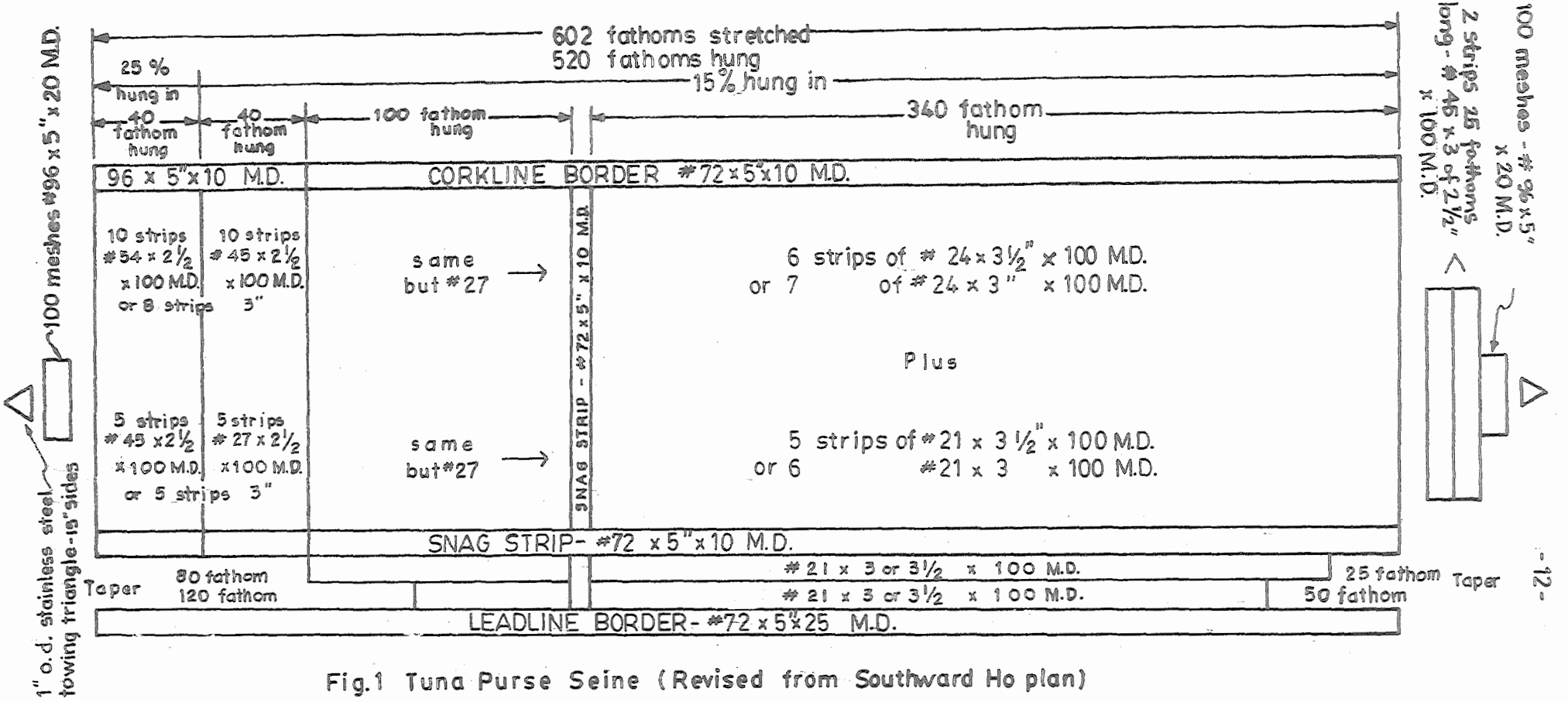


Fig.1 Tuna Purse Seine (Revised from Southward Ho plan)

Netting	-	all 210 denier knotted nylon - M.D. means "meshes deep"
Corkline	-	7/8" dia. braided nylon for 50 fathoms each end and balance 3/4" dia.-soft lay
Leadline	-	11/16" dia. braided nylon - 160# (73 kg) per stretch of 9 2/3 fathom to 10 fathoms corkline
Floats	-	#F-1 or equivalent floats (186 x 141 mm x 25 mm hole and 2300 gr. buoyancy - body 78 per 10 fathoms bunt - 90 per 10 fathoms
Purseline	-	500 fathoms 5/8" dia. with 3 pieces 50 fathoms each x 3/4" dia. with split links in mid section
Ring straps	-	up to 20 feet long x 3/8" chain - 90 pieces - 1st strap 10 fathoms from triangle. If nylon used, increase leadline weight to 220 lb. (100 kg) per stretch.
Purse rings	-	10" dia. x 3/4" stock with welded link of 5/8 dia. with opening about 2 1/2" x 4" for use with "ring stripper"
Minimum dimensions	-	450 fathoms hung length, same depth

ANNEX I

MFV/"ROYAL VENTURE
(Vessel plan and particulars)

Vessel Particulars:

Official Number	:	329609
Port of Registry	:	New Westminster, British Columbia, Canada
Where and Year Built	:	New Westminster, 1969
Length	:	96 feet
Gross Tonnage	:	283
Registered Tonnage	:	184
Powered by	:	Caterpillar Turbo Charged Diesel Engine, Model D-379, 850 H.P. at 1200 RPM
Fish Carrying Capacity of Refrigerated Sea Water or Freezing Brine Storage	:	325 tons of Herring or 240 tons of Frozen Tuna

Equipment and Gear

1	Main Engine	:	Caterpillar, Model D-379, 850 h.p. at 1200 r.p.m.
2	Skania auxiliary	:	60 k.w., 110 volt, 3-phase AC
1	Ruston auxiliary	:	15 k.w., 110 volt, 3-phase AC, hand start
2	Power blocks		
1	Winch	:	Ideal Iron Works, 2 spools each: 600 fathoms, 3/4" wire, and 200 fathoms, 5/8" for towline
1	Power Skiff	:	26 foot, aluminum, Skania engine, 160 h.p.
10	Speed Boat Receivers	:	Williams, 1 channel
1	Fish Pump	:	Sikich, portable, 10"

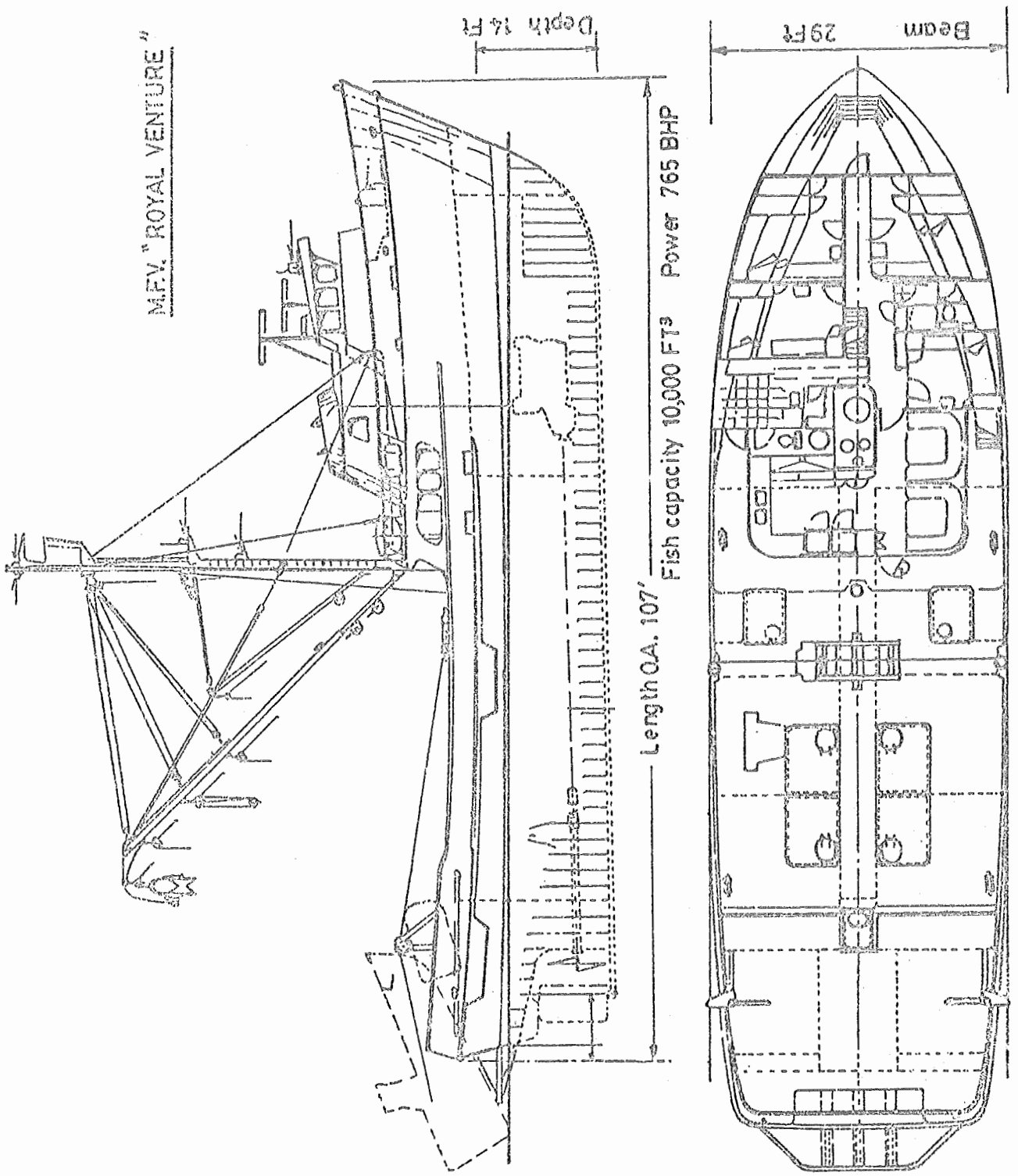
	Refrigeration	:	Refrigerated sea water and brine freezing in aluminum tanks by General Refrigeration Company
6	Mercury fishing lamps	:	500 watt, 110 volts AC
1	Binoculars	:	Nikon, 20 x 120, 15 mile range

NETS

1	Tuna Net	:	465 fathoms x 40 fathoms

Communications and Electronic Equipment

2	Radars	:	Kelvin Hughes, 64 mile range
1	Sonar	:	Westmar, Model 300
2	Lorans	:	Furuno, A and B
1	DF	:	Furuno
2	Automatic pilots	:	Wagner and Arkas
1	Sounder	:	Simrad, 1000 FDH, 2 oscillators
1	Sounder	:	Ekolite, herring model
1	SSB Phones	:	Furuno, 100 watt, 6 channel
1	SSB Phones	:	Furuno, 150 watt, 2 channel
2	AM Phones	:	Daniels, 80 watt, 10 channel
1	VHF Phones	:	Mariner, 20 watt, 12 channel
4	Citizen Band Phones	:	Johnson, 5 watt, 23 channel
1	Intercom	:	Kelvin Hughes
2	Televisions	:	RCA


M.F.V. "ROYAL VENTURE"
Depth 14 Ft
Length OA. 107'
Fish capacity 10,000 FT³ Power 765 BHP
Beam 29Ft

ANNEX II

MFV/"SOUTHWARD HO"
(Vessel plan and particulars)

Vessel Particulars:

Port of Registry	:	Vancouver, British Columbia, Canada
Where and Year Built	:	Vancouver, 1972
Length	:	112.5 feet
Gross Tonnage	:	420.64
Registered Tonnage	:	213.39
Powered by	:	1125 H.P. Caterpillar Turbo-charged Diesel Engine Model D3999-16 cylinders
Fish carrying capacity of refrigerated Sea Water or Freezing Brine Storage	:	400 tons of Herring or 300 tons of Frozen Tuna

Equipment and Gear:

Boats and Motors

1 26 ft. aluminum power skiff

Nets:

1 tuna seine

2 herring seine

Communication Equipment:

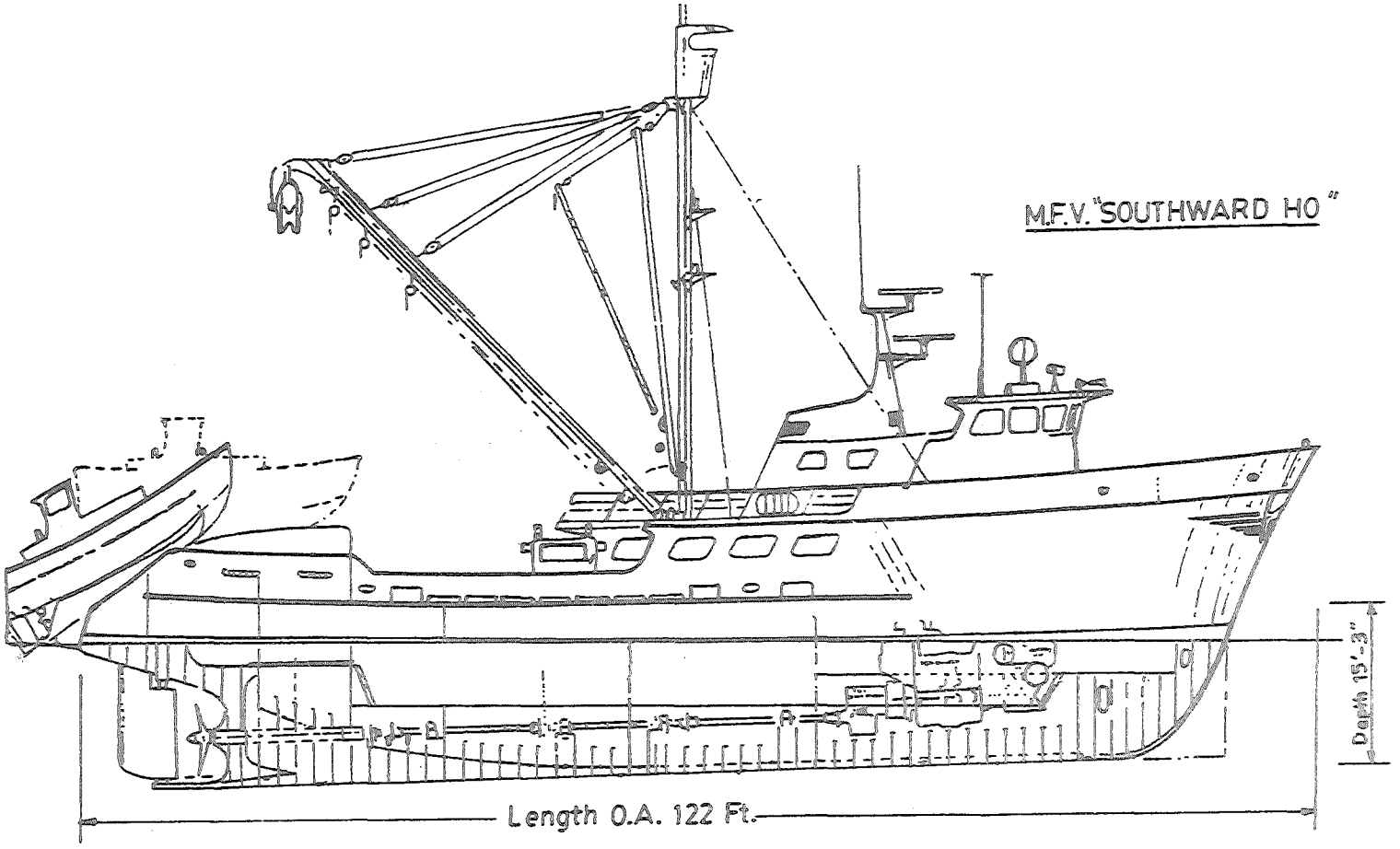
1 Marconi CH 86	:	10 channels: 2020, 2134, 2182, 2015, 2318, 2598, 2670, 2638, 2738
1 Banmar DF 200		
1 Omega Navigator	:	700 with recorder
3 Broadcast Radios	:	2 Sony and 1 Sailor type 46T
1 Loran - Benmar	:	Atl 730
2 Sets Binoculars	:	Nikon, 20 x 120, 15 mile range
2 Radar	:	18-9, 68 mile range
1 Sonar	:	Model SS 150

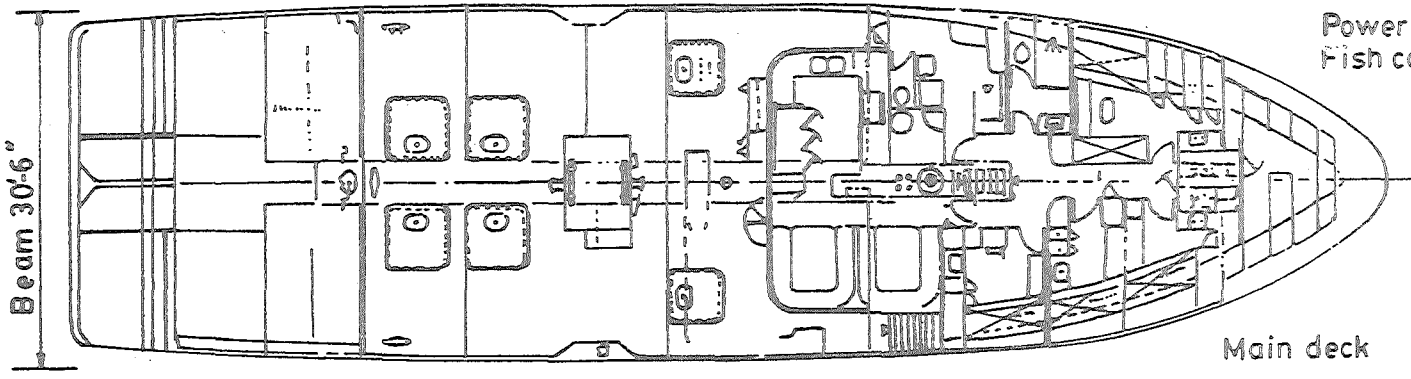
1	Intercom	:	Al Phone
3	Echo Sounders	:	In wheelhouse (1 spare and 1 in skiff)
8	Mercury lamps		
1	VHF Mariner intercom	:	V-108 (wheelhouse), Channels 10, 18A- 19A- 72- 80A- W2- 6- 16- 26- 7A- 8-
1	Citizen band	:	Johnsson
1	VHF	:	16 channel (in crow's nest)
6	Sets earphones	:	for speed boats
1	Wagner Auto Plate	:	NK3

SS Band

Receiver		Transmitter	
Tel A	Tel B	Tel A	Tel B
8735.2	4422.2	8201.2	4123.6
13151.0	8792.5	12372.0	8258.8
17304.0	13137.0	16509.0	12358.0
	17339.0		16544.0

Ship A	Ship B
4136.3	4139.5
8281.2	8284.4
12421.0	12428.0
16565.0	16572.0
22094.5	22101.5





Power 1125 BHP
Fish capacity 14000 FT³

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