

A STUDY OF THE FISHERY AND ESTIMATION OF RELATIVE ABUNDANCE OF GROUND FISH OFF COCHIN.

BY T. THOLASILINGAM¹, G. VENKATARAMAN² AND K. N. KRISHNA KARTHA¹

(*Central Marine Fisheries Research Institute, Mandapam Camp*)

INTRODUCTION

Attempts to explore the fishing grounds off Cochin made in October 1923 by 'Sea Scout', a powerful sea-going launch belonging to the Government of Madras (under the command of Capt. Crib), "proved a disappointment from the start both in design and equipment for fishing with a Danish seine net" (Gravelly, 1929). Again, in 1928 'Lady Goschen', another Madras Government vessel, carried out exploration 33 miles west and south-west off Cochin in depths ranging from 31 to 35 fathoms (Sunder Raj, 1930). Later, during September 1952, 'Tai-o-Maru' of the New India Fisheries Co. conducted some trawling between 13 and 26 fathoms north-west of Cochin (George 1952). The results of these trials were not very encouraging.

With the establishment of the Indo-Norwegian Project in Kerala in 1955, however, the first phase of development of trawl fishery off Cochin had begun. Three schooners of this Project (50-70' long) carried out exploration all along the Kerala coast. As a result of this work it was found that "the most productive area seems to be north and south of Cochin where substantial shrimp beds are located", though, it was not yet possible to present reliable statistics on the availability of fish as to zones and seasons". (Per Sandven, 1959).

Encouraged by the good results of these explorations the Indo-Norwegian Project brought four medium-sized boats, known as M-boats (8.8 m. long), from Norway and commissioned them for shrimp trawling operations in these areas, in the beginning of 1957. At the same time, with the establishment of the Government of India Offshore Fishing Station at Cochin, three medium-sized trawlers also started operating for prawns in the same grounds.

A detailed study of the prawns and fish taken by these vessels on the grounds off Cochin from 1957 to 1962 was undertaken with a view to understand the distribution, fluctuations and relative abundance of the different species in relation to time and depth strata. The operations of these vessels were restricted to a radius of 20 miles off Cochin. Since these vessels were chiefly engaged in trawling for prawns they sought the grounds and depths at which prawns were found in abundance. For such species the catch per unit of

¹ Present address: Central Marine Fisheries Research Substation, Ernakulam-6.

² Present address: Central Marine Fisheries Research Substation, Kozhikode-5.

fishing effort will measure their relative abundance with considerable accuracy since the vessels will shift to grounds and depths yielding the highest catches of prawns. For other species, however, the fluctuations in actual abundance cannot be measured unless their average relative densities in different depth zones are known. Therefore, a study of the distribution of these other species by depth zones was undertaken as a necessary preliminary basis for understanding their monthly fluctuations in abundance.

Rounsefell (1957), whose methods have been followed in this study, has pointed out that "Knowledge of each species by fishing grounds is of considerable value from other standpoints. What effect is a fishery likely to have on the stock of each species? In certain cases the question arises: What effect will a change in the size of mesh of the trawl have on the catches? Only by a knowledge of the density of each species by areas and depths can these questions be answered". Further, "For many species, not extensively sought for economic reasons, it is desirable to know whether there is a possibility of the catch being increased, should it become desirable to increase production". This latter need might arise for the 'Podimeen' (trash fish) fishery which forms a large portion of the trawl catch on the west coast. Hence, a detailed study of the species composition and the fluctuations of the different species comprising this fishery, has also been considered in this paper.

MATERIAL AND METHODS

The data were collected from six M-boats of the Indo-Norwegian Project and three medium-sized trawlers of the Government of India, Offshore Fishing Station, Cochin. The boats varied from 8.8 to 10.4 in length, installed with 30-32 B.h.p. engine and fished with otter trawl of 13-18 m. length head-rope. They all maintained log-sheets where the following details were recorded:—

Size of gear and mesh; area of operation; time of shooting the net; Time hauled; depth; nature of bottom; wind direction; sea condition; major species of fish caught.

All the boats conducted daily fishing by going out in the early hours of the morning and returning in the afternoon. The actual time spent on fishing by each boat per day was limited to about 4-6 hours.

The range of operation of these boats was within 30 fathoms depth off Cochin.

The fishing ground has been divided into 3-fathom depth zones, starting from 4 fathoms depth, for analysis of prawn distribution; whereas for the fish

7-fathom intervals were chosen to emphasise boundaries of distribution. These intervals were chosen after a preliminary analysis with other variations and finding them as best suited to portray the changes in distribution and fluctuation in the abundance of the species constituting the fishery, in these grounds.

For the study of species composition, sub-samples of unsorted catch weighing 3-5 kg. were collected on board the fishing vessel soon after the cod-end of the net was untied on deck. Random samples were also collected on shore from those vessels when observers had not gone on board, after ascertaining the depths at which they were taken. These samples were then weighted against the total catch of all the boats for each day for each zone.

The relative abundance of fish and prawns in the grounds was determined by pooling together the data of all the vessels, to obtain the average catch per hour of trawling. The average catch per hour of trawling for each species for each month and for each depth zone for three years was calculated for arriving at the indices of relative abundance of the species. The three years 1960 to 1962 alone have been considered for this purpose as no details were available of the depths of operation of the trawls for the previous years.

In dealing with the general aspects of the fishery, however, six years data from 1956 have been taken into consideration.

TREND OF FISHERY

The total fishing effort put forth by the medium boats rose from about 1000 hours of actual fishing during 1957 to 5000 hours in 1961-62, with the gradual addition of more trawlers to the fleet. The total yield increased from 143 in 1957 to 655 metric tons in 1962. Except for the fishing seasons 1960-61 when fishing effort was reduced to that of 1957-58 level, there was a steady rise both in effort and total yield throughout the period. This can be seen in Fig. 1 which also depicts the annual average catch per hour of prawns and fish for each fishing season. The over-all catch per hour of trawling was highest during 1960-61, i.e., 207 kg. as compared to 111 kg. during 1957-58 with a total catch of 544 and 304 tons respectively for the two seasons. If we take 1957-58 as the base fishing season there was a steady rise in the catch per hour of 15% in 1958-59, 40% in 1959-60, and 47% in 1960-61, though in 1961-62 it was a little lower, i.e., 36%. This increase in rate of catch was mainly due to larger proportions of fish taken during 1959-60 and 1960-61 when the prawn catches were lower than in the previous years. In 1958-59 and 1961-62, however, both the prawn and fish catches were high but the fish component was relatively lower than that of the two other seasons referred to.

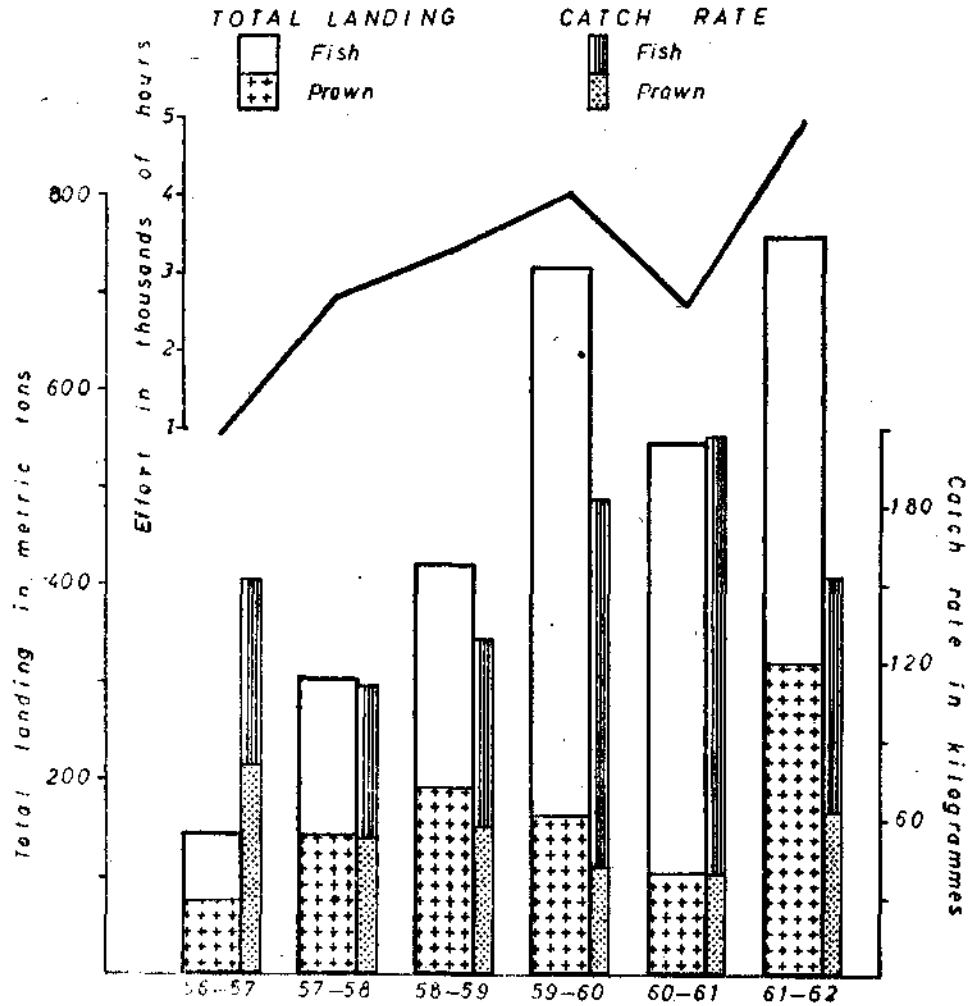


FIG. 1. Annual catch and catch per hour of trawling of fish and prawns in relation to fishing effort.

PRAWNS

Detailed analysis of the catches for the six fishing seasons demonstrates the importance of the prawn fishery in the trawling grounds around Cochin. On an average 35%, by weight, of the total catch consisted of prawns, 59% of 'Podimeen' and 6% of elasmobranchs.

Prawns, generally, appeared in the deeper 16-30 fathoms areas though only in small numbers at the beginning of the fishing season, i.e., around Sept-Oct., when the boats sought the deeper areas for fish as prawns had not yet appeared on their traditional fishing grounds closer inshore. Prawns consisted of *Metapenaeus affinis* and *Parapenaeopsis styliifera*. By about Nov./Dec., these species

appeared in large numbers in the 4-11 fathom zone where two other species *M. dobsonii* and *Penaeus indicus* also made their appearance and the prawn fishery became established in this zone.

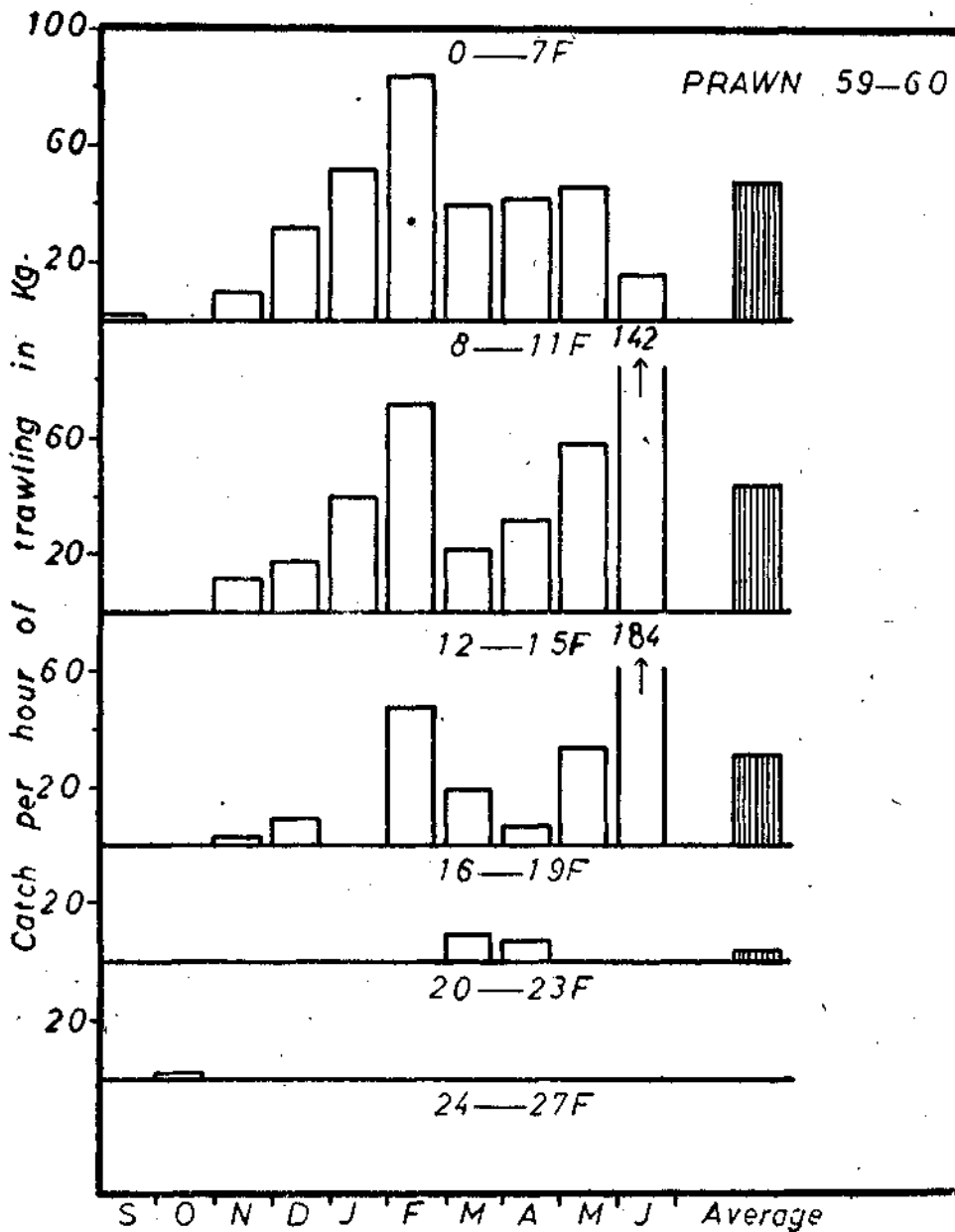


FIG. 2a Catch per hour of trawling of prawns in different depth zones from 1959 to 1962.

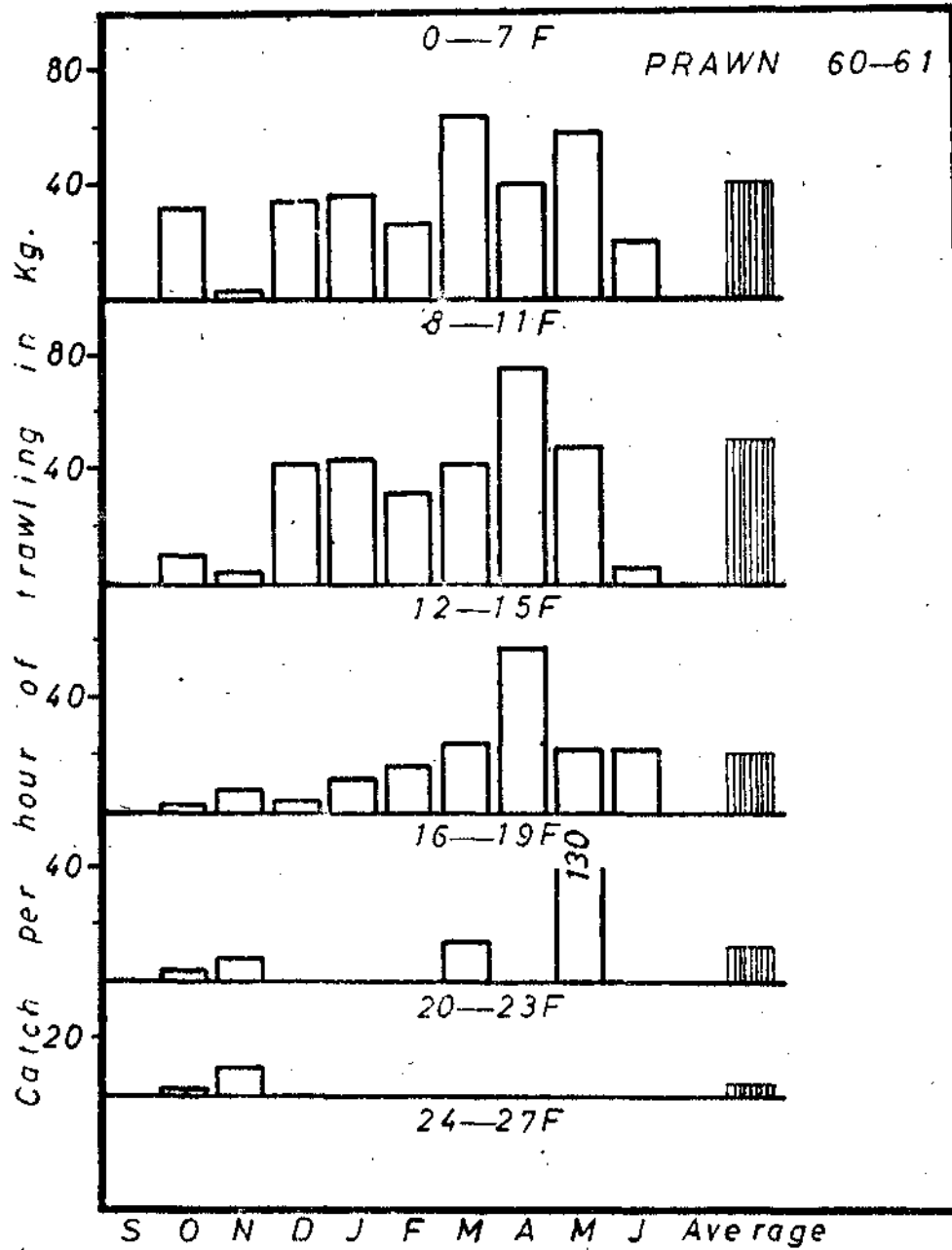


FIG. 2b Catch per hour of trawling of prawns in different depth zones from 1959 to 1962.

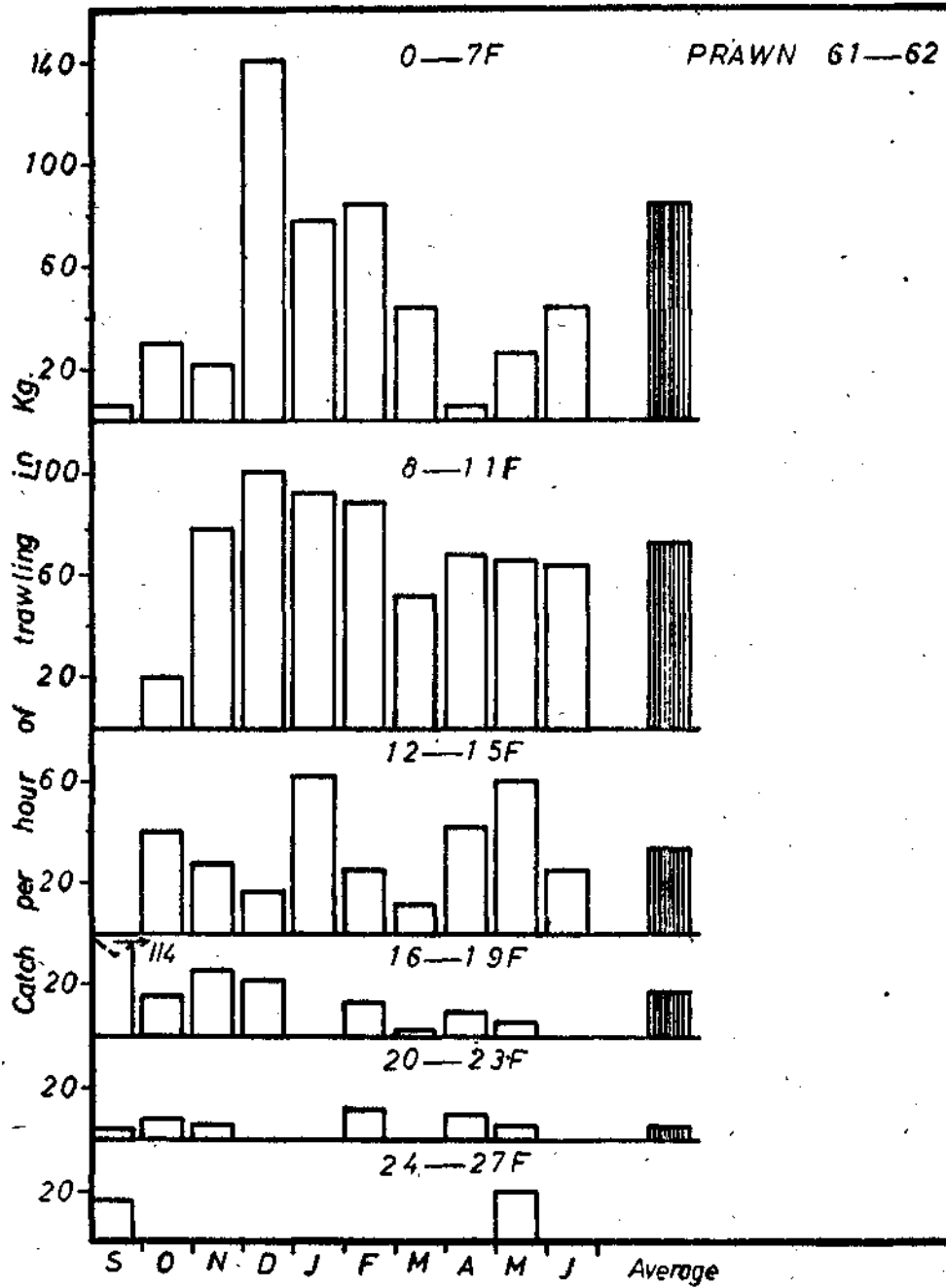


FIG. 2c Catch per hour of trawling of prawns in different depth zones from 1959 to 1962.

M. affinis was dominant in the catches in the first half of the fishing season up to December whereas *M. dobsonii* was abundant in the later half of the fishing season. *P. stylifera* was obtained in large quantities in the beginning of the season and sometimes at the end of the season also.

The monthly catch rate of prawns in the different depth zones for three fishing seasons, shown in Fig. 2 a-c, demonstrates that, in all the seasons, the shallow zones 4-7 and 8-11 fathoms were the most productive, with an average catch of 40-85 kg. and 45-73 per hour of trawling in the respective zones. In the next two zones, i.e., 12-15 and 16-19 fathoms, the catch was found to vary from 19-34 kg. to 3-18 kg. per hour respectively. In the deeper 20-23 fathom zone only 1-5 kg. per hour was recorded with practically no return in deeper zones beyond 24 fathoms.

During end of May or early June, coinciding generally with the commencement of the S.W. monsoon, the prawns disappeared abruptly from the trawling grounds around 4-11 fathoms. But, as had been observed, in the present study, just before the close of the fishing season good catches of prawns were taken either in relatively deeper regions offshore or in very shallow regions inshore. This occurred in June 1960 in the 12-15 fathoms zone and in the 16-19 fathom zone in 1961. In 1962 relatively high catches were taken in May and June in the 24-27 fathom zone, which was unusual. On the other hand at the end of June 1963 large quantities of prawns were caught for a few days from very shallow waters of 4-7 fathoms composed exclusively of *M. dobsonii*. The species caught in the deeper zones were *M. affinis* and *P. stylifera*.

In some of the seasons prawns along with fish started declining from May and completely disappeared from the grounds around 10 fathom by June. In 1957-58 and 1959-60 seasons, however, the second peak period for prawns occurred later in the season in early June when record catches of the prawns were taken. Then they abruptly disappeared from the grounds as can be seen from the data recorded below:—

Date	Fishing hours	Depth	Prawn catch
8-6-1960	15	10-12 fths.	13,959 Kg.
9-6-1960	19	10-13 fths.	11,149 Kg.
10-6-1960	16	11-13 fths.	11,097 Kg.
13-6-1960	14	11-12 fths.	Nil.
14-6-1960	10	5-10 fths.	Nil.
16-6-1960	6	9-10 fths.	Nil.
17-6-1960	6	9-10 fths.	Nil.

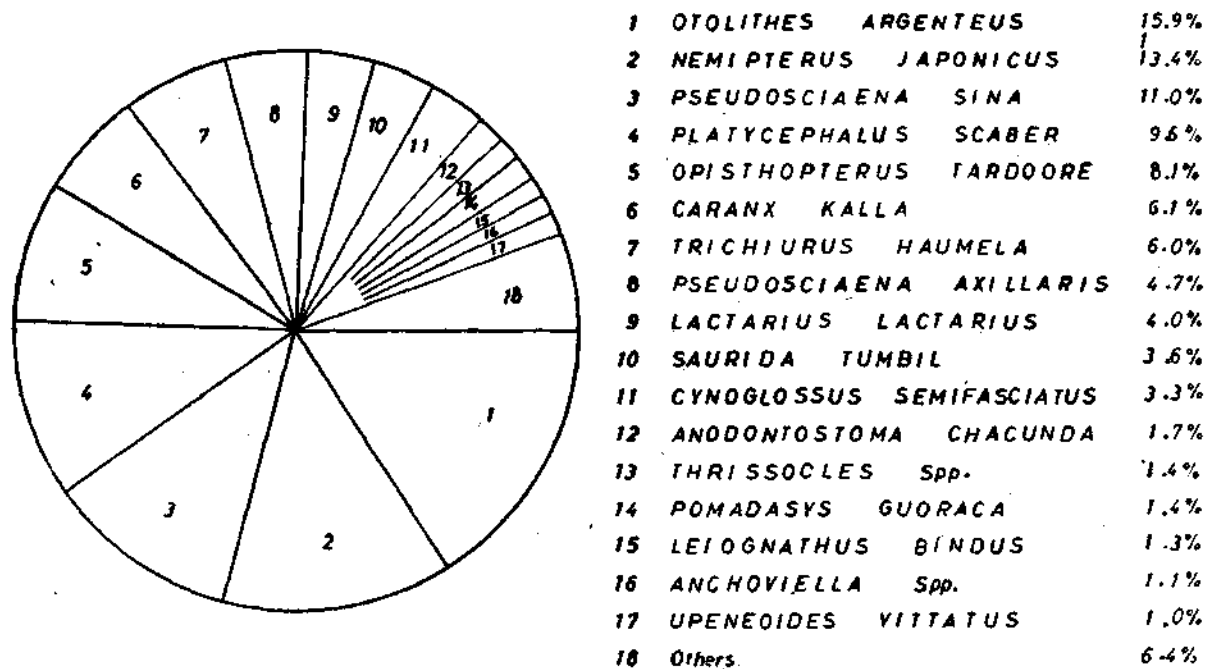


FIG. 3 Species composition of fish in percentages.

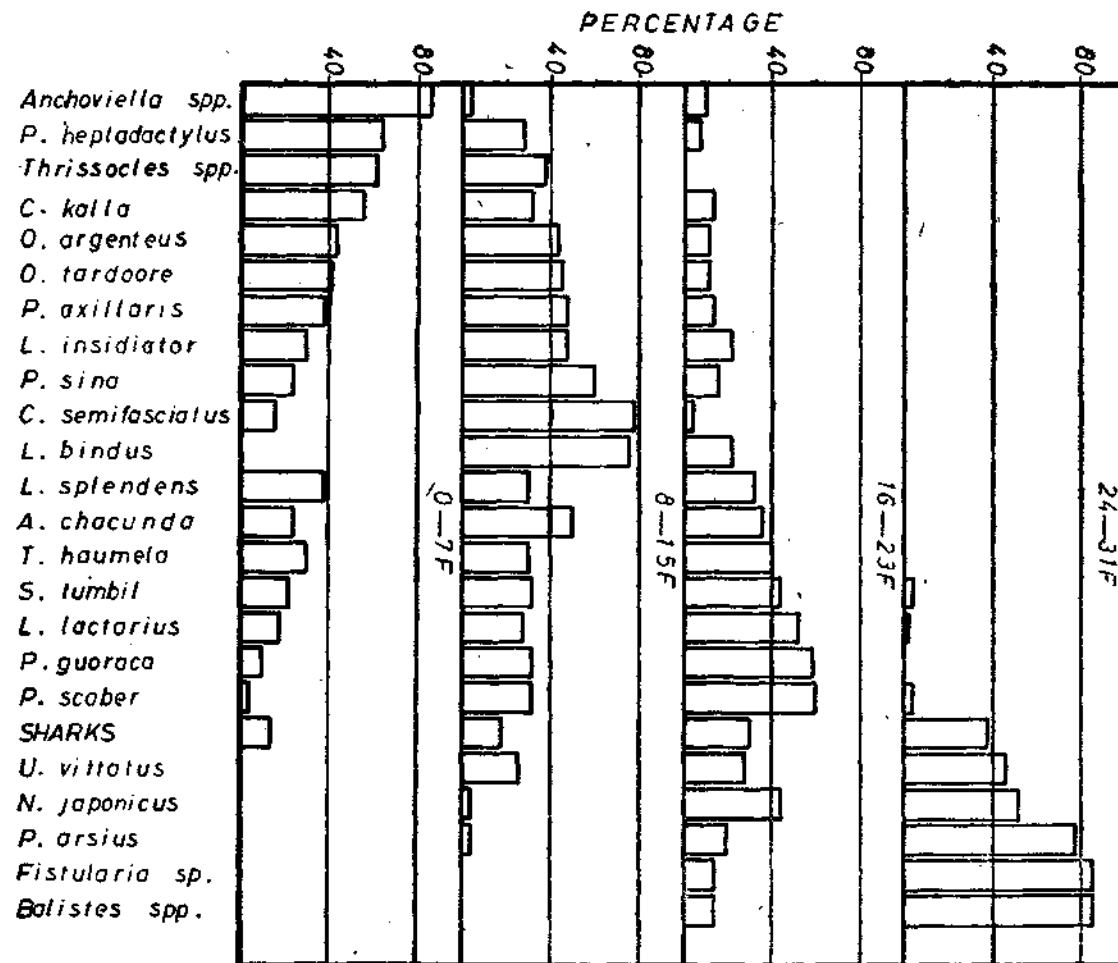


FIG. 4 Percentage distribution of fish species in relation to depth zones.

FISH

59% of the catch taken by the trawlers consisted of 'Podimeen' which are poor quality fish and can be categorised as trash fish. The major species composing this group, in order of abundance by weight, were *Otolithes argenteus* 15%, *Nemipterus japonicus* 13%, *Pseudosciaena sina* 11%, *Platycephalus scaber* 10%, *Opisthopterus tardoore* 8%, *Caranx kalla* 6%, *Trichiurus haumela* 6%, *Pseudosciaena auxillaris* 5%, *Lactarius lactarius* 4%, *Saurida tumbil* 4%, and *Cynoglossus semifasciatus* 3%. Other species found were each less than 2% and amounted to 14% of the fish catch. Percentage distribution of all species of fish in different depth zones is shown in Fig. 4.

Otolithes argenteus (Figs. 5a & 6a):

This fish occurred mainly in the shallower 4-7 and 8-15 fathom zones throughout the fishing season from September to June, in moderate quantities, with a rate of around 20 kg. per hour of fishing gradually declining to 4 kg. per hour at the end of the season.

The seasonal average amounted to 13 kg. per hour in shallow zones up to 15 fathoms and 4 kg. in 16-23 fathom zone. The trawl catches from the deeper areas beyond 24 fathoms were devoid of this fish.

Nemipterus japonicus (Figs. 5b & 6b):

Largest concentrations of this species occurred in 16-27 fathom zones at the commencement of the fishing season in September following the break of the SW. monsoon. The catch per hour in September, when 37% of the season's catch was obtained, ranged from 258 to 379 kg., the highest recorded for any species. By October this declined to 40-70 kg. per hour and in the next five months these fish were found between 8 and 23 fathoms but mainly around 16-23 fathom zone. During April/May again they moved to the deeper 24-27 fathom zone completely disappearing from the shallower 8-15 fathom zone. At this time, near the end of the fishing season the catch rate showed a second peak of over 150 kg. per hour in the 24-27 fathom zone in May.

The seasonal average catch was highest, i.e., 120 kg. per hour, in the 24-31 fathom zone when the 4 months during which the boats operated in these depths are considered, whereas in the 16-23 fathom zone it was 100 kg. for all months of the season. The 8-15 fathom zone showed a poor return of only 3 kg. per hour. The overall seasonal averages, considering all months in all zones, amounted to 10 kg. per hour of trawling.

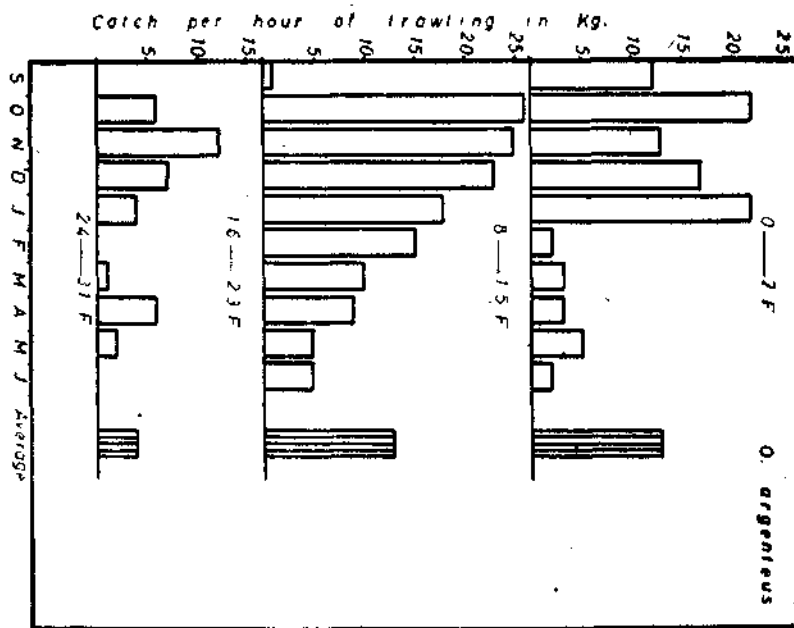
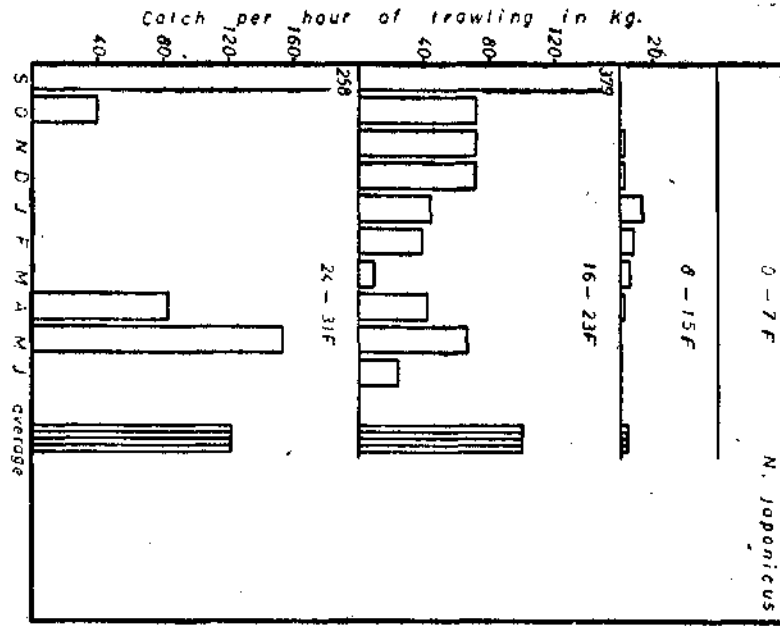


FIG. 5a, 5b Seasonal average distribution of 11 species of fish in different depth zones for 1959 to 1962.

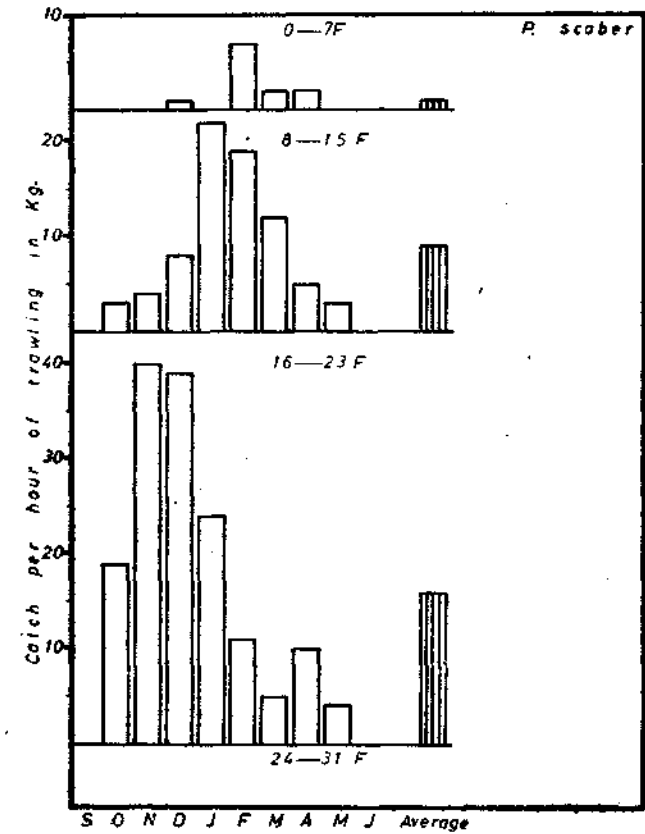
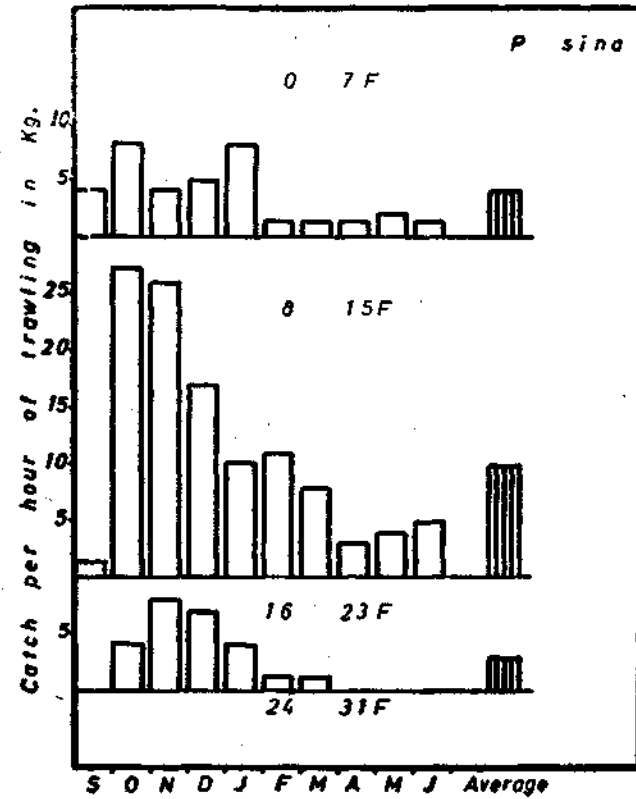


FIG. 5c, 5d Seasonal average distribution of 11 species of fish in different depth zones for 1959 to 1962.

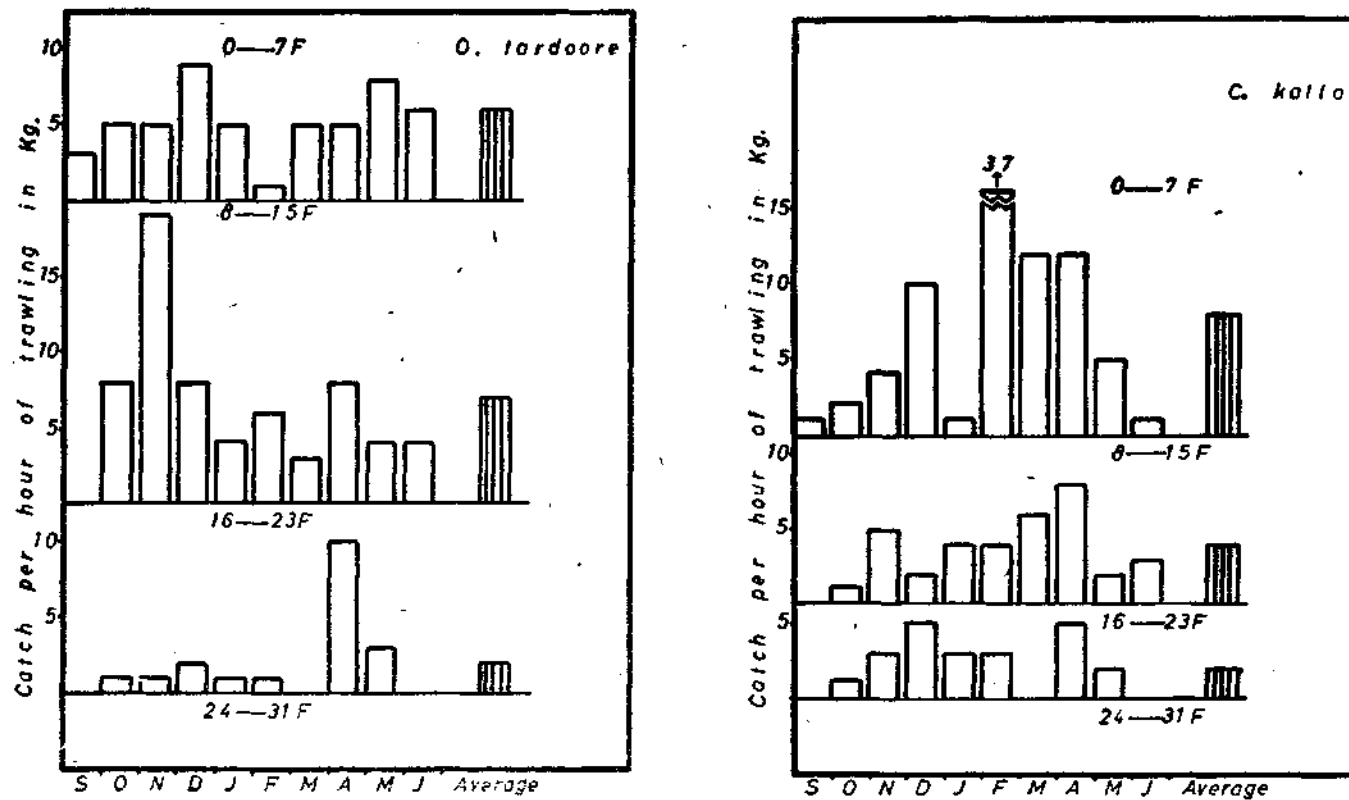


FIG. 5e, 5f Seasonal average distribution of 11 species of fish in different depth zones for 1959 to 1962.

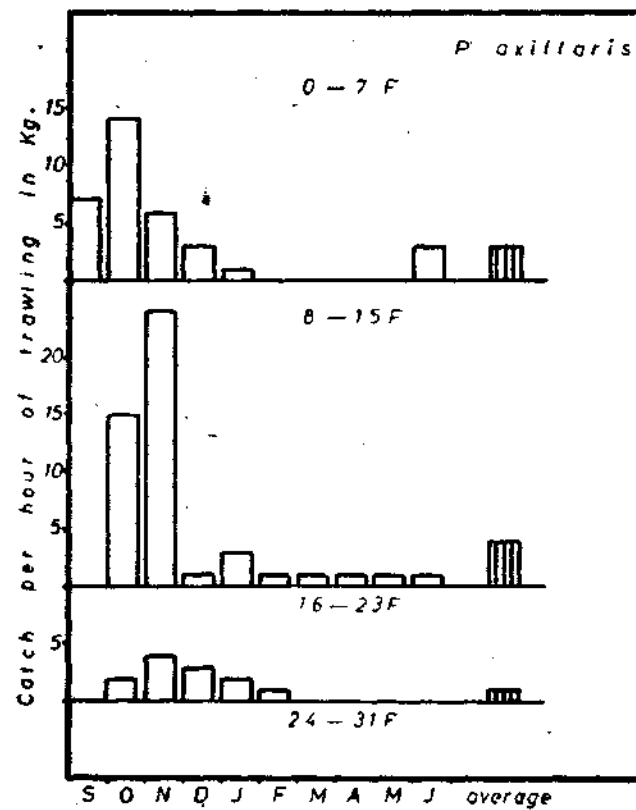
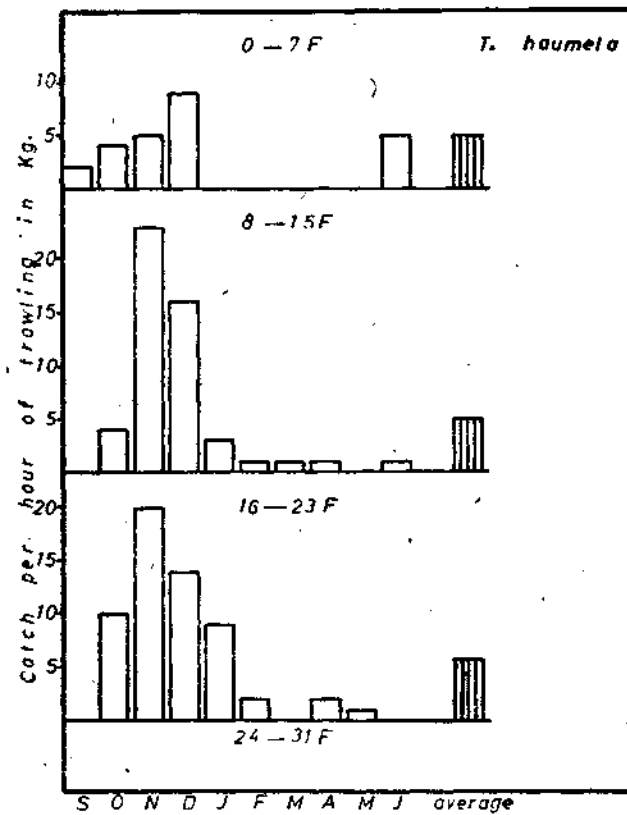


FIG. 5g, 5h Seasonal average distribution of 11 species of fish in different depth zones for 1959 to 1962.

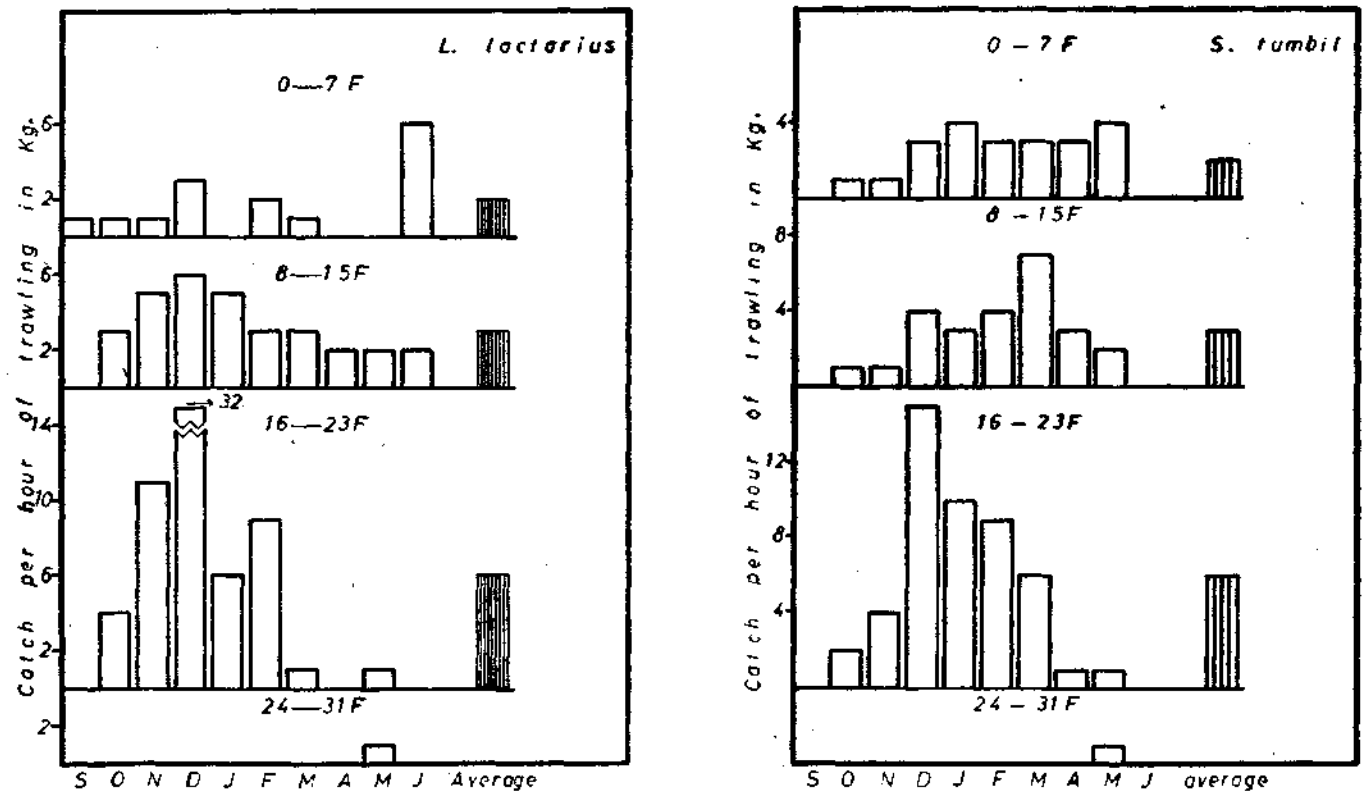


FIG. 5i, 5j. Seasonal average distribution of 11 species of fish in different depth zones for 1959 to 1962.

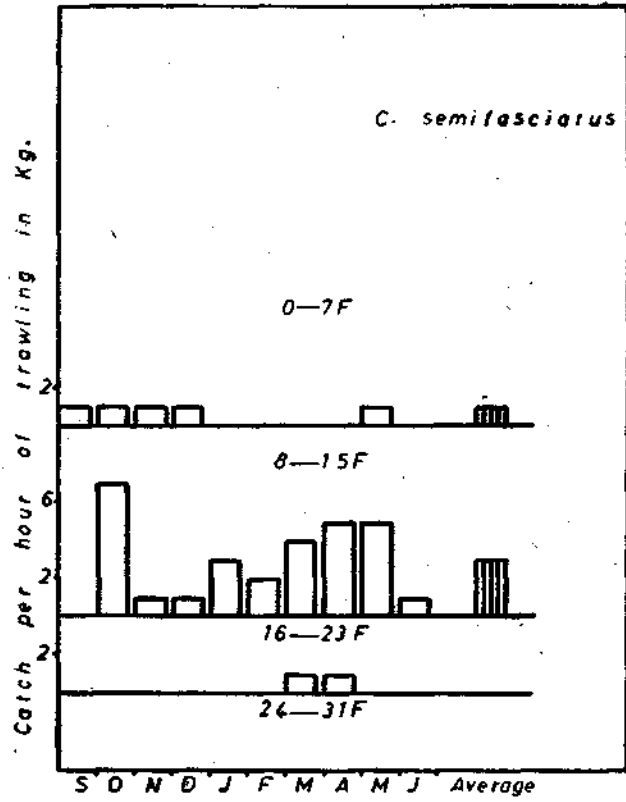


FIG. 5k Seasonal average distribution of 11 species of fish in different depth zones for 1959 to 1962.

Pseudosciaena sina (Figs. 5c & 6c):

The fishery of this species was mainly centred around the 8-15 fathom zone where they started appearing in moderate quantities from October/November with an average catch of over 25 kg. per hour declining to less than 5 kg. per hour by the end of the fishing season.

The seasonal average rate, in the 8-15 fathom zone, amounted to 10 kg. per hour and less than 5 kg. in 4-7 and 16-23 fathom zones.

Platycephalus scaber (Figs. 5d & 6d):

These fish first appeared in the 8-23 fathom zone in the month of October and were taken at 40 kg. per hour in the 16-23 fathom area and later moved into the 8-15 fathom zone where the catch varied from 22 kg. in January to 12 kg. in March. The fishery came to a close by the end of May.

The seasonal average ranged from 8 kg. in the 8-15 fathom zone to 16 kg. per hour in the 16-23 fathom zone.

Opisthopterus tardoore (Figs. 5e & 6e):

These fish were found in the shallower depths between 4 and 15 fathoms, more or less throughout the season with a catch rate of 3-9 kg. per hour except for November when in the 8-15 fathom zone 19 kg. per hour was recorded.

The seasonal average was found to be 6-7 kg. per hour in these depths.

Caranx kalla (Figs. 5f & 6f):

Found mainly in the shallower 4-15 fathom zones these fish were taken in small quantities throughout the season except for moderately good catches of 12-37 kg. per hour from February to April in the 4-7 fathom zone.

The best return of an average of 8 kg. per hour was recorded in the 4-7 fathom zone.

Trichiurus haumela (Figs. 5g & 6g):

This species occurred mainly in the 8-33 fathom zones during the months of October to January though in moderate numbers, with a peak period in November, when catch exceeded a little over 20 kg./hour. They were completely absent from January onwards till the end of the fishing season in the shallower zone of 4-7 fathoms.

The average catch per hour for the season was around 5-6 kg.

Pseudosciaena auxillaris (Figs. 5h & 6h):

This species occurred mainly during October/November in the shallower 4-15 fathom zones with a catch of 14-24 kg. per hour.

The seasonal average in these zones was 3-4 kg. per hour.

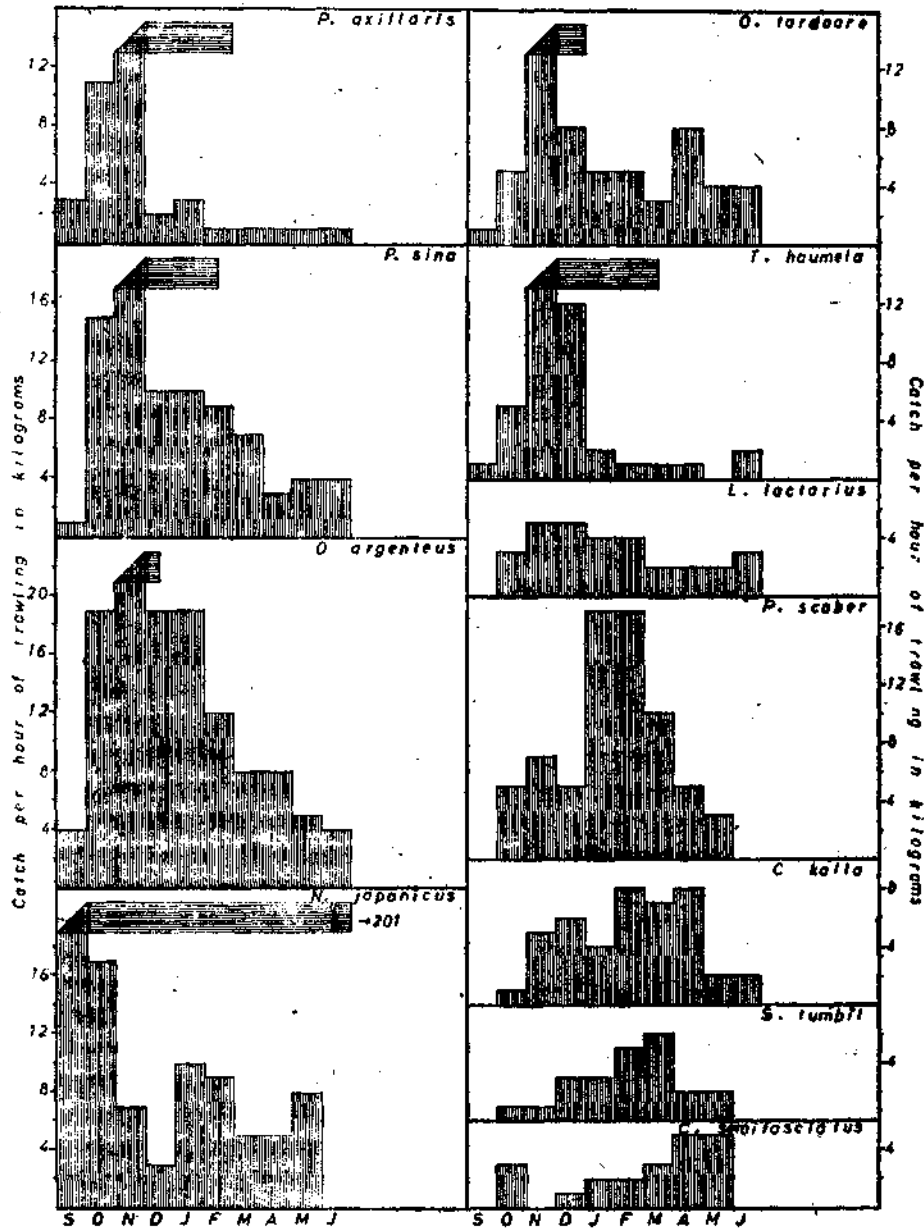


FIG. 6(a-k) Seasonal fluctuation in the catch rate of 11 species of fish.

Lactarius lactarius (Figs. 5i & 6i):

Though available throughout the fishing season in the shallower zones, within 15 fathoms, this fish was taken in larger quantities in the 16-23 fathom zones from October to February with a peak in December of 32 kg. per hour gradually declining till the end of the fishing season but with a slight improvement during June in the shallow 4-7 fathom zone.

The seasonal average ranged from 2 to 6 kg. from the shallow to the deeper areas.

Saurida tumbil (Figs. 5j & 6j):

Taken throughout the fishing season in the shallow water but more abundant in the 16-23 fathom zone especially from December to February when it reached a peak period in December with a return of 15 kg. per hour.

Cynoglossus semifasciatus (Figs. 5k & 6k):

Mainly taken in the 8-15 fathom zone this fish occurred throughout the fishing season with a peak of 7 kg. per hour during December and another peak of lesser magnitude in April/May.

The seasonal average was limited to 1-3 kg. per hour of trawling.

Among these important species of fish *C. kalla*, *O. argenteus*, *O. tardoore*, *P. auxillaris*, *P. sina*, and *C. semifasciatus* were found in good quantities in the shallower zones and *N. japonicus*, *T. haumela*, *S. tumbil*, *L. lactarius* and *P. scaber*, in the deeper zones (Fig. 5).

RELATIVE ABUNDANCE OF PRAWNS AND FISH

The picture that emerges from a study of the average catch per hour of trawling for the three years from 1959 to 1962 for each month for each depth zone depicts the pattern of relative abundance of prawns and fish on the fishing grounds as seen in Fig. 7.

The zonal average catch per hour of trawling of prawns in the 4-11 fathom zone, where fishing was mainly concentrated, gave an index of 50 kg. which gradually decreased to 35 kg. in the 12-15 fathom zone, to 15 kg. in the 16-19 fathom zone, to less than 5 kg. in 20-23 fathom and to practically nil in depths beyond 24 fathoms. On the other hand fish showed a reverse pattern with 75 kg. per hour of trawling in the 4-7 fathom zone, 100 kg. in 8-11 fathoms, 125 kg. in 12-15 fathoms and 145 kg. in 16-19 fathoms. Beyond this the indices of fish catch were not comparable as fishing effort was not well distributed in the deeper zones throughout the fishing season.

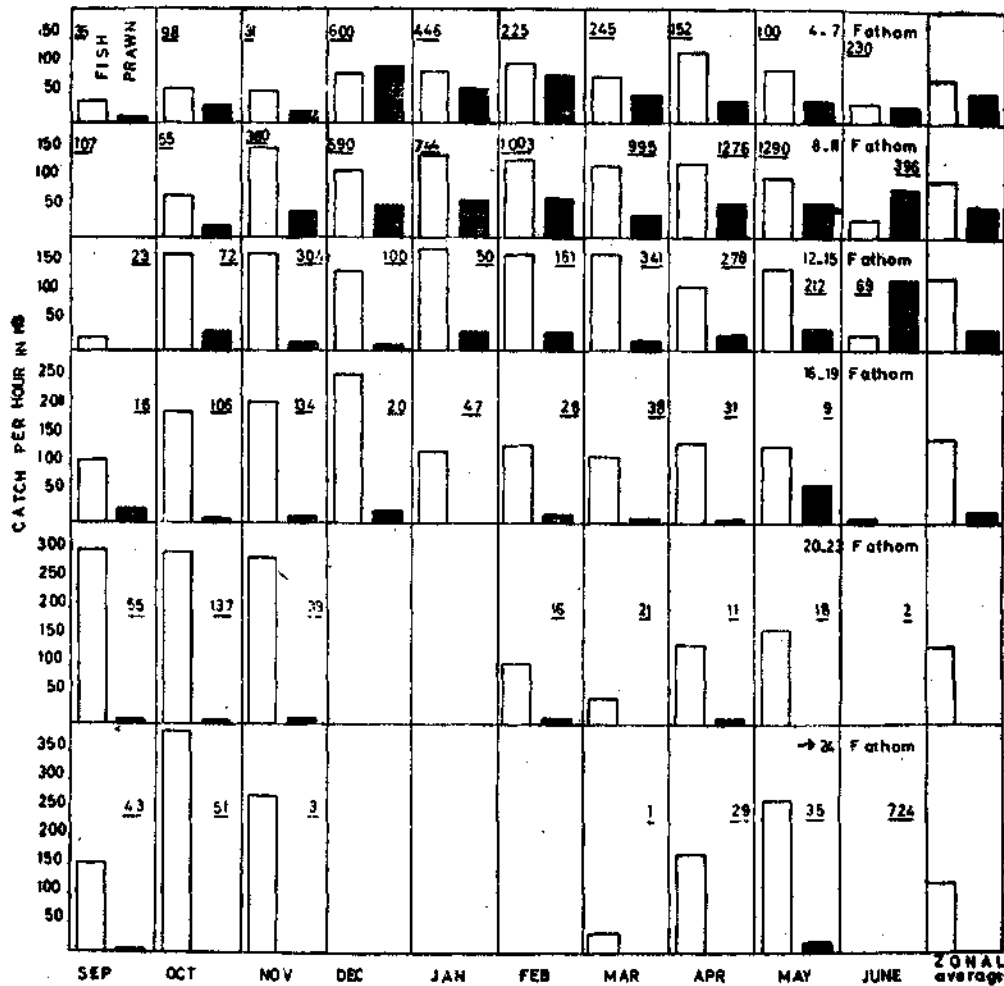


FIG. 7. Relative abundance of fish and prawns in different depth zones in different months. Figures underlined denote the total fishing effort made each month in each depth zone.

The seasonal average catch of prawns obtained in the 4-11 fathom zone was at the rate of 20-30 kg. per hour during October reaching a peak of 55-100 kg. in December and remaining at 60-80 kg. during January/February. In the next three months the rate decreased to 40-60 kg. in this zone but reached a peak of 80 kg. per hour in June particularly in the 8-11 fathom zone. Though, in the 12-15 and 16-19 fathom zones the catch of prawns varied from 10 to 40 kg. per hour during most of the season a high rate of 70 kg. was recorded in the 16-19 fathom zone in May and the highest of 125 kg. in the 12-15 fathom zone in June prior to the close of the fishing season before the commencement of the SW. monsoon.

The relative abundance of fish as compared to prawns was greater in all the months in all the zones up to 19 fathoms depth except in December in the 4-7 fathom zone and in June in the 8-11 and 12-15 fathoms. Fish obtained at over 100 kg. per hour of trawling in all the months from October to May in the 12-15 fathom area, between 125-260 kg. in 16-19 fathoms, between 75-155 kg. in 8-11 fathoms and 55-125 kg. in 4-7 fathoms.

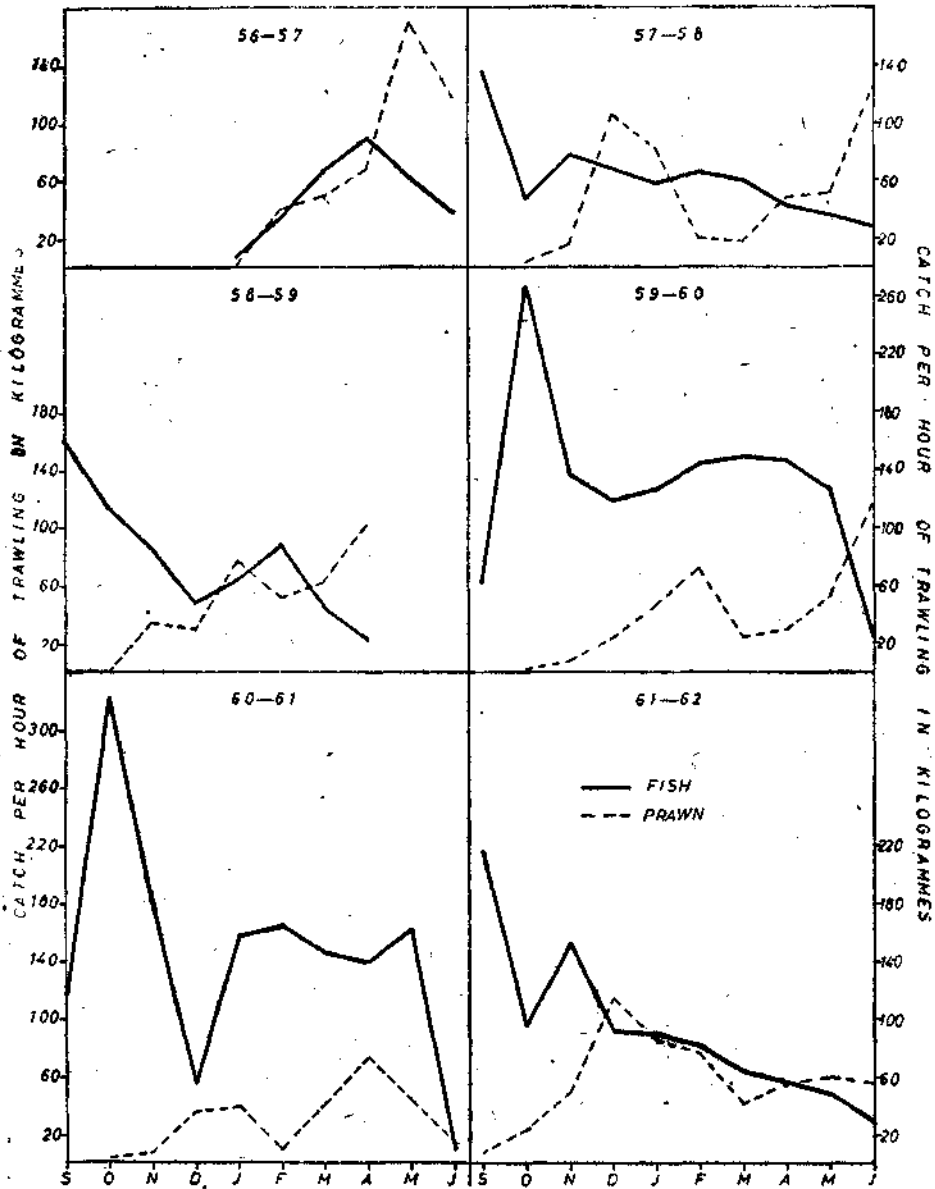
It is of interest to note here that even though the deeper zones beyond 20 fathoms were not fished at all during the months of December/January and very little up to the end of the fishing season in June, the highest catch of 275-385 kg. per hour fish was obtained in these zones at the beginning of the fishing season from September to November, dominated mainly by catches of *Nemipterus japonicus*.

DISCUSSION

The proportion of prawns, taken by trawls on the grounds off Cochin, during each fishing season varied from 53% in 1956-57 to as low as 19% in 1960-61. During the intervening years 1957-58 and 1958-59 it formed 46% and 47% respectively and declined to 22% in 1959-60. But there was a recovery to 42% during 1961-1962. (Fig. 1). These fluctuations closely followed the catch per hour of trawl of prawns taken in grounds, in the corresponding years, the decline in prawns being amply compensated by an increase in the catch of fish during such seasons.

The years of successful prawn fishery showed a relatively high catch rate of over 100 kg. per hour of prawns during the period from October to January of the following year, followed by moderate catches in the later half of the fishing season as seen in 1957-58 and 1961-62. Such high rates of catch around April/June in the later half of the fishing season as those obtained in 1956-57 and 1958-59 also resulted in good years for the prawn fishery (Fig. 8).

The dominant species contributing to the fishery of prawns were *M. affinis* and *P. stylifera* in the catches during the early half of the fishing season and *M. dobsoni* in the later half. George *et al.* (1964 unpublished) who studied the age composition of these species of prawns have demonstrated that the dominant size groups in these species occurring in the early half of the fishing season consist of the 2 year class. Therefore, the success of the prawn fishery, based on good catches in the early part of the fishing season was further enhanced due to the dominance of *M. affinis* & *P. stylifera* of larger sizes, and thus more valuable to the fishing industry. In case of *M. dobsoni* which contributes to the bulk of prawn landings in the later half of the fishing season the smaller first year classes are recruited into this fishing zone (George *et al.*, loc. cit.).



Relative seasonal fluctuation in the catch per hour of fish and prawns for six years from 1956-57 to 1961-62.

The commercial fishery for prawns by trawling is mainly concentrated in the area within 11 fathoms depth where mainly *M. affinis* and *P. stylifera* appear in abundance during October/November from the deeper offshore waters and were found to migrate back into the offshore areas by May/June before the

commencement of the SW. monsoons. Menon (1958) while studying the bio-nomics and fishery of *P. stylifera* found indications that they move away from inshore waters during the monsoon months to reappear in inshore waters again during October/November. The observations made in the present study show that *M. affinis* also follows the same pattern of migration, as also seen from the sequence of their appearance in the different depth zones during the season.

M. dobsoni on the other hand seems to move closer inshore as evidenced by heavy catches of this species within 7 fathoms depth at the end of June, 1963. Panikkar and Menon (1955) have recorded dense shoals so close to the shore along the Malabar coast that the fishermen use cast nets for catching them. George (1961) has recorded their occurrence in the inshore waters off Alleppey, Chellanam and Narakkal during the monsoon months constituting over 90% of the prawn catch.

The behaviour pattern of these prawns, in response to changes in hydro-graphic conditions of the waters, is not clearly understood though Banse (1959) attributes the migration of dense shoals of fish (and prawns) into the inshore waters during the monsoon season to the presence of highly aerated waters in the zone by vertical mixing on account of wave action. Patil (1964 unpublished) while reviewing our present knowledge of oceanography of the west coast of India, has shown that there are seasonal and regional variations in the time and intensity of upwelling as well as other physio-chemical properties of the waters along the Kerala and Kanara coasts, though precise knowledge of the range and delimitation of these factors is yet to be had by more intensive studies. The extent of the distribution of the different dominant species of prawns, the identification of stocks and the routes of migration as well as other relevant biological details, along with environment studies, are necessary to facilitate proper assessment and forecasting of the fishery.

The shallow zone within the 11 fathom depth where the major portion of fishing effort of the fleet was concentrated was the centre of abundance of prawns. The boats sought deeper grounds at times when the prawns were not available in abundance in these depths. Since the boats were primarily fishing for prawns the catch per hour of trawling of prawns gives a fairly accurate index of their relative abundance in the grounds. But, even though fishing effort was fairly well distributed up to 19 fathoms, the zonal indices of catch of fish does not give a true picture of their relative abundance for the difference in relative population densities between depth zones cannot be used as a measure for these species unless accurate estimates of the area occupied by each depth zone are carried out to permit proper weighting of the index for each depth zone according to the proportion of the population represented. Such a picture of distribution cannot be obtained from operations of the

commercial fishery. Therefore, final abundance indices depend upon surveys of distribution by a research vessel.

SUMMARY

1. The trawl fishing operations, off Cochin, for six years from 1956 have been described to show the seasonal and vertical distribution of the different species of fish and prawns taken by trawlers, by an analysis of the total effort, catch, species composition and catch per hour of trawling. The data were collected from records of log-sheets maintained by these vessels as well as haul-wise sampling of the catch on board the fishing vessels and at landing places.
2. The fishing grounds have been divided into depth zones and it was found that the maximum fishing effort of 8916 hours (77% of time) was expended in the 4-11 fathom zone mainly for the purpose of capturing prawns during 1959-62.
3. The relative abundance of fish and prawns was determined in each depth zone from 11,513 hours of actual fishing landing 2022 m. tons of ground fish from 1959 to 1962.
4. Prawns occurred mainly within the 11 fathom zone from November to June. The dominant species occurring during the first half of the fishing season were *Metapenaeus affinis* and *Parapenaeopsis stylifera* and in the later half *Metapenaeus dobsoni*. It was observed that the former two species migrated into the fishing zone from the offshore areas and the latter from closer inshore areas.
5. The relative abundance of prawns in the different depth zones as seen from the indices of catch per hour of trawling, gives a fairly accurate picture of their distribution since the boats sought the depths at which they were found in abundance. This, however, does not apply to the fish species as they were taken only as incidental catches and the differences in relative population densities between depth zones cannot be used as a measure for them unless accurate estimates of the area occupied by them in each depth zone are carried out by a research vessel to permit proper weighting of the index for each depth zone according to the proportion of population represented.

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