PROCEEDINGS OF THE SYMPOSIUM

ON

# LIVING RESOURCES *of* THE SEAS AROUND INDIA

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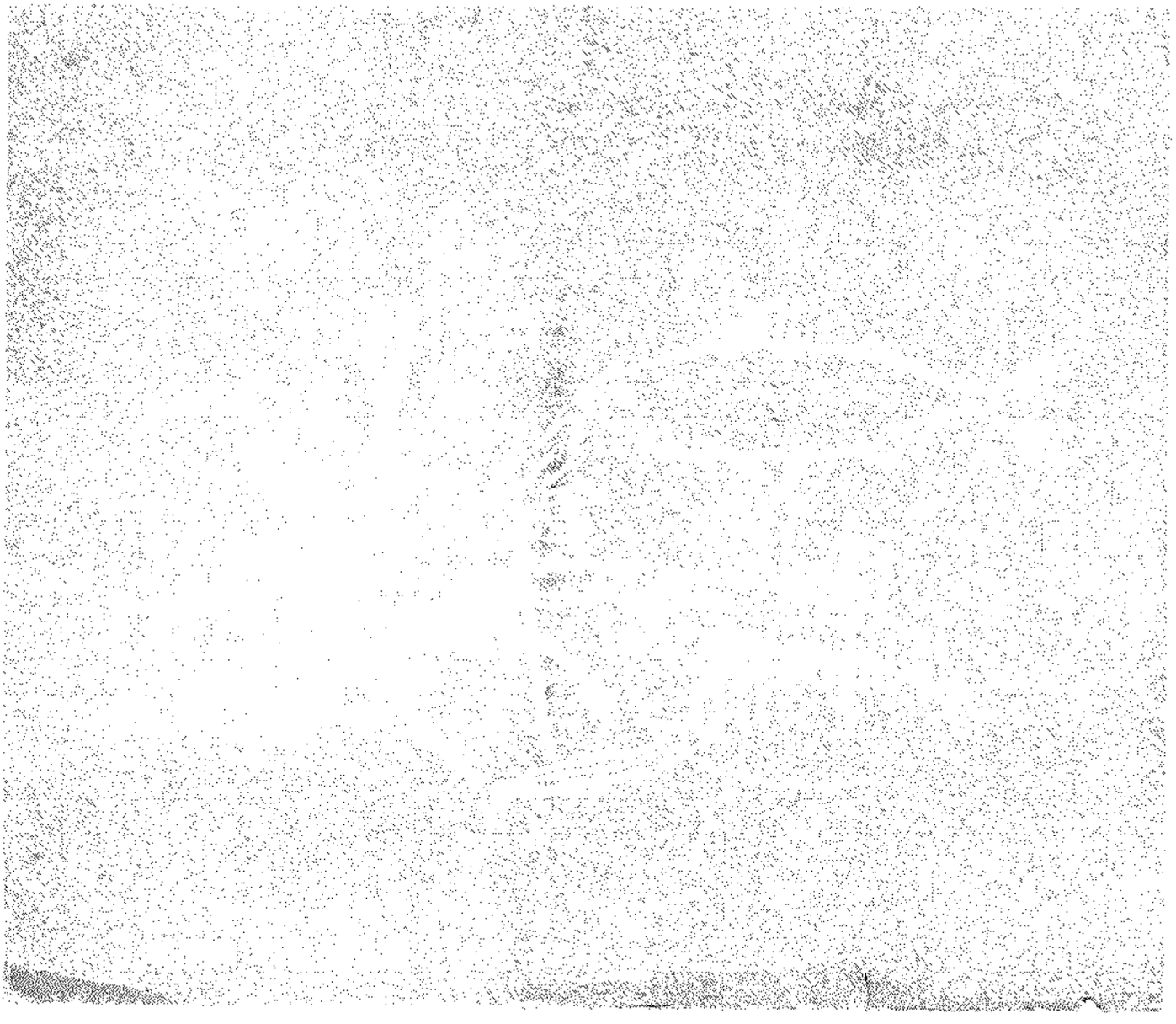

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# LIVING RESOURCES OF THE SEAS AROUND INDIA

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# CO-OCCURRENCE AND THE RELATIVE ABUNDANCE OF NARROW AND BROAD CORSELETTED FRIGATE MACKERELS *AUXIS THAZARD* (LACEPEDE) AND *AUXIS ROCHEI* (RISSO), AROUND CEYLON

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ABSTRACT

Both *Auxis thazard* and *A. rochei* appear almost always in mixed schools and rarely as independent schools, in the Ceylon waters. The relative proportion of the two species, entering the fishery each year, is dependent more on the size compositions of these species and of the other species in the mixed schools than on area or season. Seasonal and annual variations in the catch rate of those species are discussed. The relative densities of distribution of the frigate mackerels around Ceylon are given. Size and season of entry of these species into the troll and driftnet fisheries have also been determined. Selectivity of the different types of gears used in Ceylon waters is also discussed in relation to these two species.

## INTRODUCTION

IN the inshore waters, excluding the areas north and northwest of Ceylon, the fishing effort of the 3½ ton and the 11 ton classes of mechanized boats is concentrated on the tuna and tuna like fishes. It may be said that in the east, west and south coasts of Ceylon, the mechanized boats are sustained by the blood fish fishery. The smallest member of this group is the frigate mackerel and this variety is caught on a commercial scale from all the main fishing areas around Ceylon. Being the smallest member its contribution by weight to the total blood fish production may be only 15-20%, but it is the most abundant of all the tuna varieties in Ceylon waters.

Frigate mackerels are caught right round the year in the southwest and southern coasts of Ceylon and this condition is extremely valuable to the fishermen in tiding over very poor fishing seasons. Two species of frigate mackerel are found in Ceylon waters—the broad corseletted *Auxis rochei* and the narrow corseletted *Auxis thazard*. Though both species enter the commercial catches, *A. rochei* was not recognised until recently and *A. thazard* forms nearly 92% and the *A. rochei* 8% of the annual total production of frigate mackerels.

## CO-OCCURRENCE IN MIXED SCHOOLS

In the inshore waters, yellow fin (*Thunnus albacares* less than 100 cm.), skipjack (*Katsuwonus pelamis*), mackerel tuna (*Euthynnus affinis*) and the frigate mackerels appear almost always in mixed schools. As mentioned elsewhere (Sivasubramaniam, 1965), the number of these species in a mixed school decreases with the increase of average fork length of the whole school. From observations, species composition in mixed schools of different fork length groups may be as follows:

15–20 cm.—*A. rochei* and *Euthynnus affinis* (Juveniles).

20–30 cm.—*A. thazard, A. rochei* and *E. affinis*.

30–40 cm.—*A. thazard, E. affinis, K. pelamis* and *T. albacares.*

40–50 cm.— do.

50–60 cm.—*E. affinis, K. pelamis* and *T. albacares.*

60–70 cm.—*K. pelamis* and *T. albacares.*

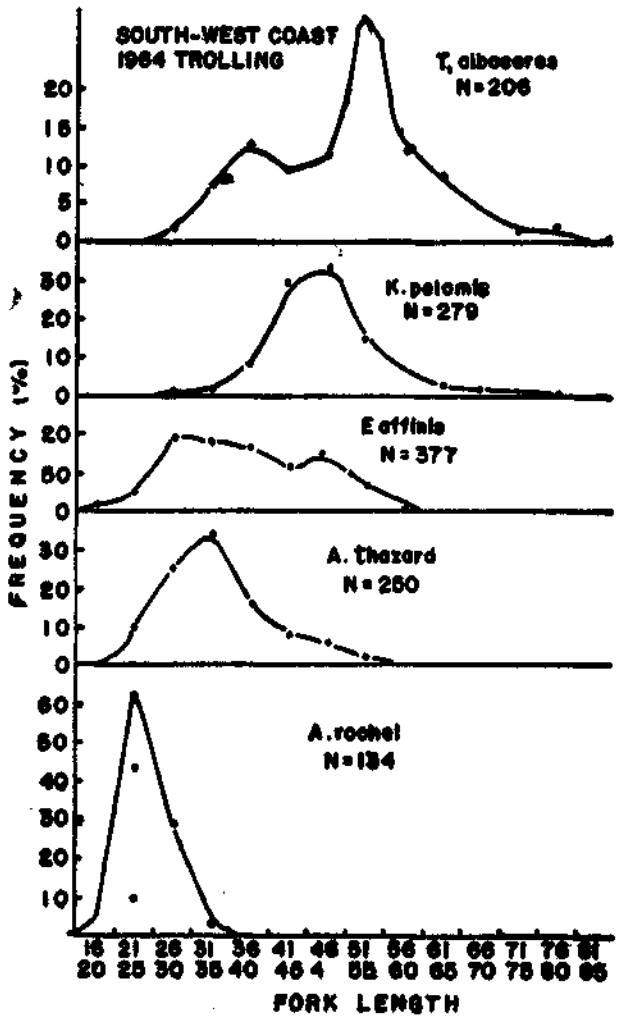


FIG. 1. Length frequency distributions for the tuna varieties caught with trolling lines off the southwest coast in 1964.

This is clearly illustrated by Fig. 1, showing length frequency distribution of the various tuna species caught with the trolling lines off the southwest coast during 1964. Though *A. rochei* of less than 20 cm. fork length have been caught with the juveniles of mackerel tuna from mixed schools, quite often it appears in unmixed schools. However, the catch size of this length group entering the commercial fishery is very small and the occurrence sporadic. The length group chiefly exploited appears with its closest relative *A. thazard.* Fig. 2 A gives the length frequencies of the exploited population of both species of frigate mackerels.

*A. rochei* appears in very large proportion in the schools in which the smallest fork length group of *A. thazard* is commercially exploited. This proportion of *A. rochei* declines when the fork length of *A. thazard* increases and ultimately it disappears from the schools in which *A. thazard*

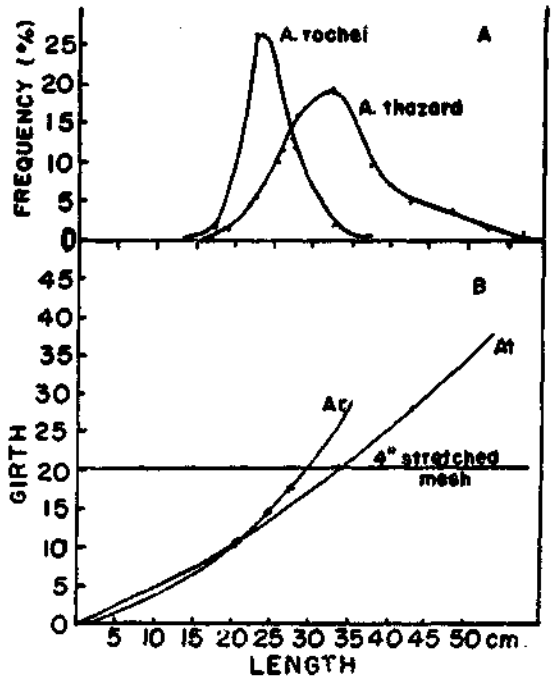


FIG. 2. (A) Size frequency distributions of *A. thazard* and *A. rochei* caught around Ceylon, and Length Girth relationships for the two species.

is of the modal length group (Fig. 1). *A. rochei* has seldom been caught from any fishing area where *A. thazard* exploited are over 35 cm. in length. Thus, the appearance of *A. rochei* in noticeable quantities has almost always coincided with the appearance of the corresponding length groups, of *A. thazard* in that area, irrespective of the season.

## DENSITY OF DISTRIBUTION

Though frigate mackerels are exploited from the waters off the north, east, south and the west coasts of Ceylon, the densities of their distribution are widely different. As in the case of the tuna longline catches, the parameter for the density of distribution has been derived by fixing the trolling gear with a fixed number of hooks as the standard unit and estimating the average catch number per unit for each area. Accordingly, for *A. thazard*, the area of highest density of distribution is the southwest coast (21·7). The southern coast also has almost an equal value (21·3). Towards the east (18·9) and west (14·3) coasts, the density declines gradually, but beyond the east and west coasts and towards the north, it declines rapidly to the minimum density in the northern area (4·2). Even the broad corseletted form follows a similar pattern. However, the percentage composition by species will show values for the frigate mackerel, in the reverse order, because in spite of the low density in the northern, northwestern and the northeastern areas, frigate mackerels and

mackerel tuna are the two main varieties of tuna caught unlike in the other areas where Skipjack and the yellow fin are also abundant, in addition to the frigate mackerels and mackerel tuna (Sivasubramaniam, 1965). The frequency of meeting schools of tuna in the coastal waters has also been dealt with earlier. On an average, the fishing crafts come across 2-3 mixed schools a day.

## Size Composition and Sex Ratio

The size range of *A. thazard* and *A. rochei* exploited from Ceylon waters have been observed to be 20–58 cm. and 16–34 cm. respectively. The size range mainly exploited on the commercial scale are 22-30 cm. for *A. rochei* and 22-40 cm. for *A. thazard* (Fig. 2 A). The length-weight relationships for the two species are given in Fig. 3.

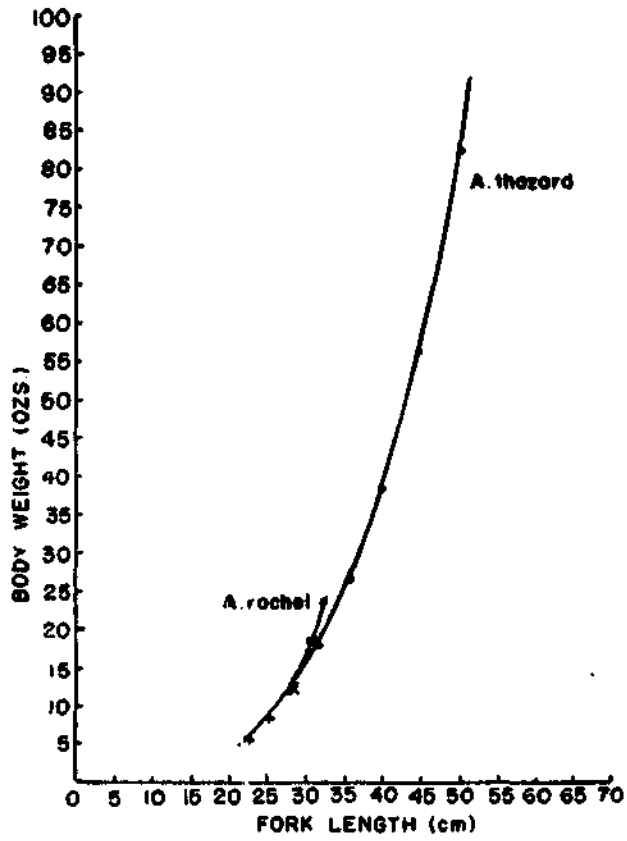


Fig. 3. Length-Weight relationships for the two species of frigate mackerel.

Major recruitment to the exploitable stock along the south and southwest coasts occur annually between March and August. Besides this, recruitment of frigate mackerels occurs to a lesser extent and sporadically during the rest of the year. In the east coast, such recruitments have been observed between July and September, but no clear trends of recruitment are evident from the catches of the fishing areas in the north.

Difference in the size composition according to sex was not noticeable from the catches of *A. thazard*. Observations indicate a slightly larger proportion of females (1 : 1·5) especially off the southwest coast during the southwest monsoon.

Though no direct evidences are available on the recruitment of *A. rochei*, it is conjectured that it takes place around the same periods as that of *A. thazard.*

Thus, the exploitation of the freshly recruited frigate mackerels commence around the middle part of the year and the catches shift to larger size classes until the following year's recruitment (Figs. 4 and 5).

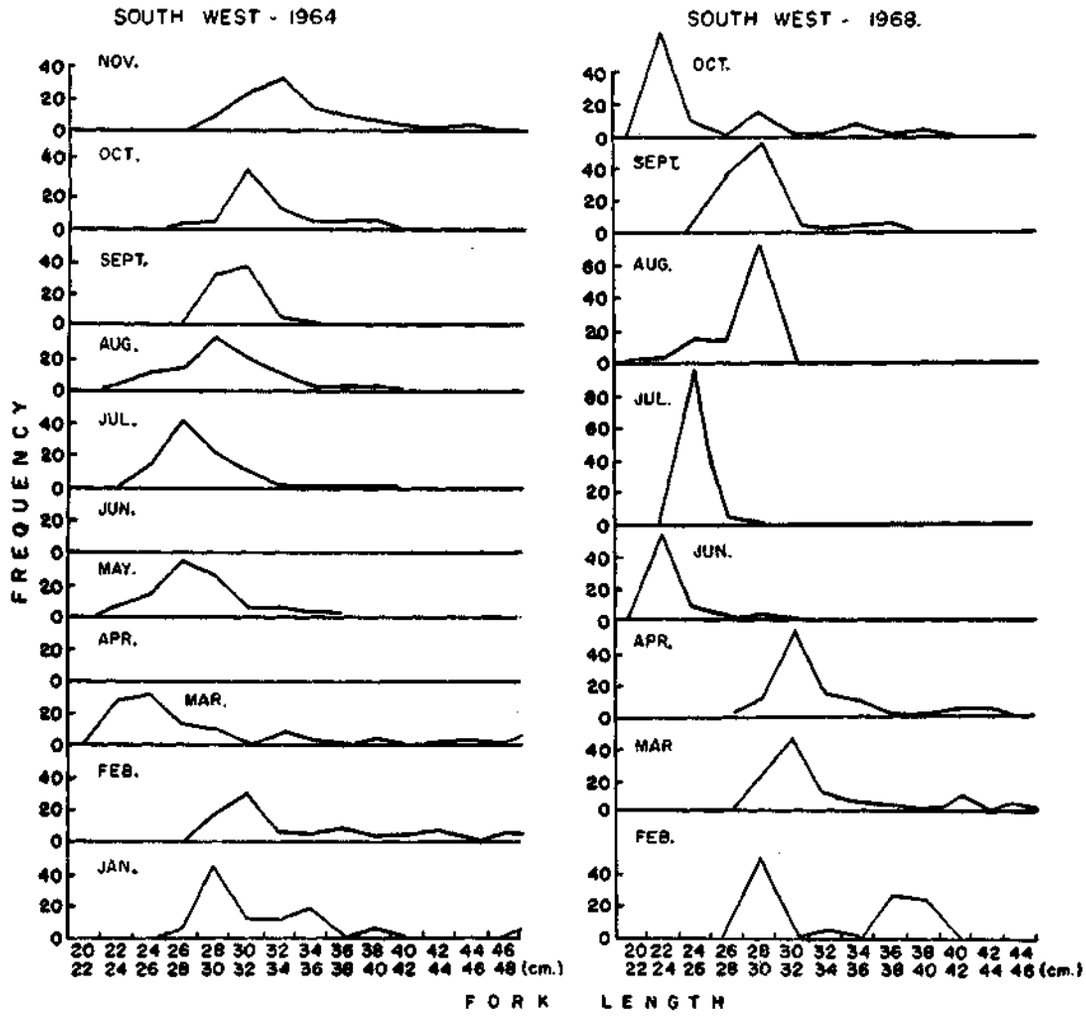


FIG. 4. Length frequency distributions by months for *A. thazara* in the sout west coast.

## Seasonal Variation

In the southwest and south coasts, *A. thazard* is caught twelve months of the year. In the east coast, good fishing season for this variety is limited to the period June to September, with sporadic but poor catches during the early part of the year specially in March and April. In the northern waters, the catch rates are relatively poor, but the seasonal changes are similar to that existing in the east coast (Fig. 6). It is quite evident that in spite of these differences all round Ceylon the catch rate for frigate mackerels reaches a peak during and at the tail end of the south-west monsoon. This is perhaps due to the heavy recruitment season and the vulnerability of the newly recruited to the fishing gear like the trolling lines.

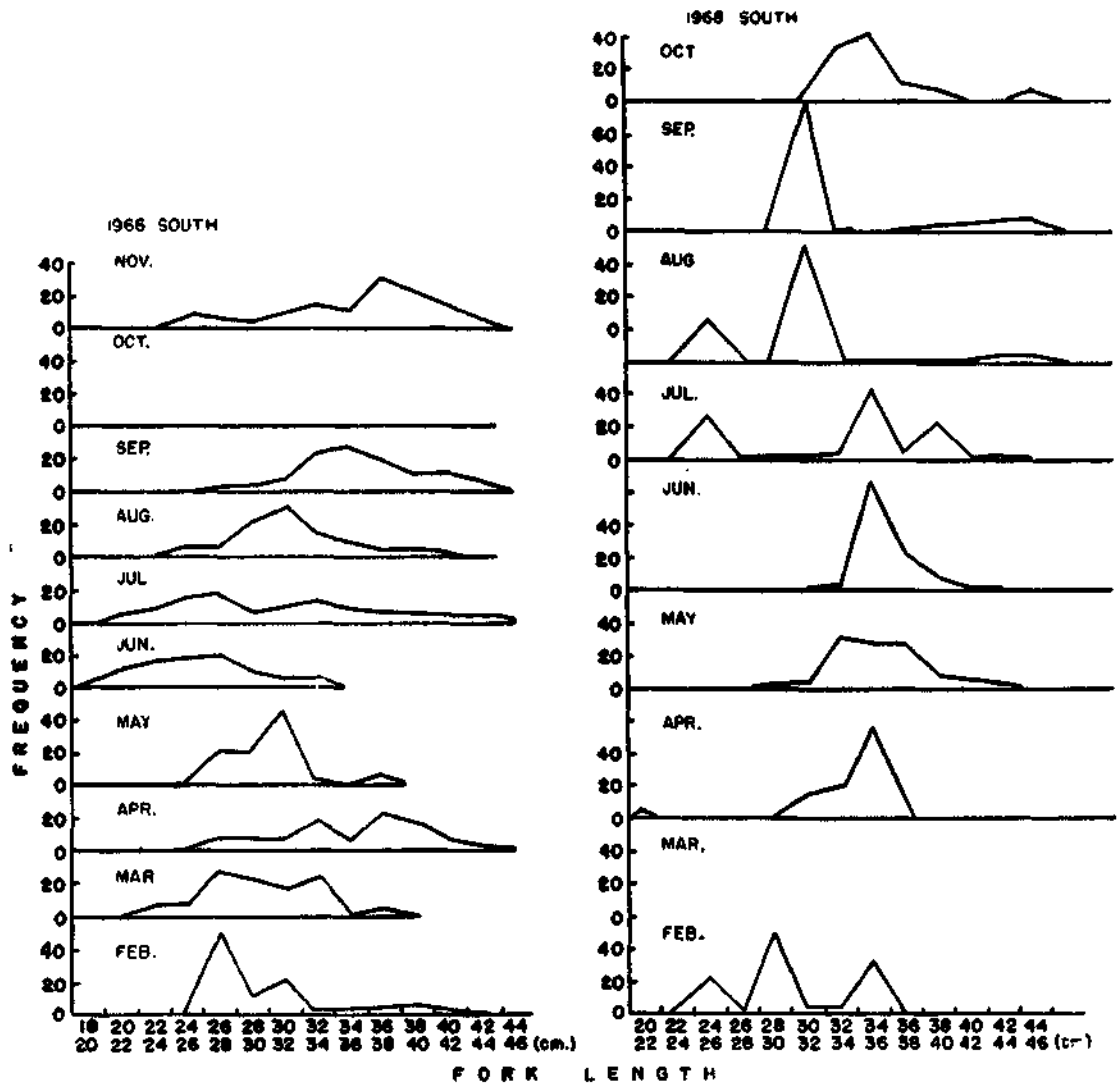


Fig. 5. Length frequency distributions by months for *A. thazard* in the south coast.

Therefore during the peak season the catch number shows a steep rise but the nett weight of the catch will not be proportionately high. In the case of *A. rochei* too the catch rate reaches a peak during the same season in all the areas, but only in the southwest coast is this species caught right throughout the year. These findings are not in agreement with those reported elsewhere (Williams, 1962), according to which the main fishing season for frigate mackerel is October/November to May. This period covers the northeast monsoon and the inter monsoon periods during which beach seine could be operated off the west, southwest and south coasts of Ceylon. The catches of frigate mackerels made with this gear formed the major contribution to the frigate mackerel production before mechanization. With mechanization, this trend has changed and fishing along the above coasts continue even during the southwest monsoon during which period the peak catches are presently obtained.

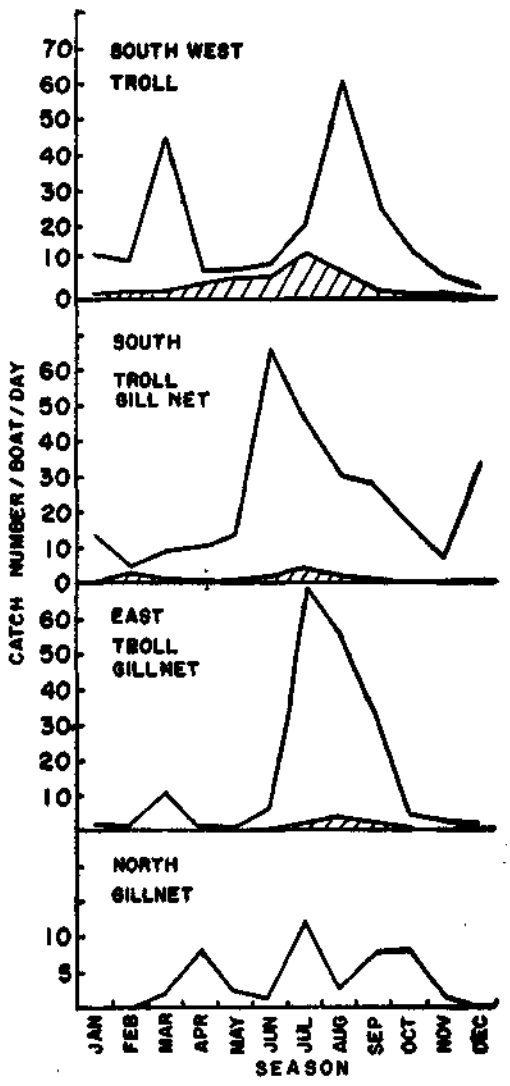


FIG. 6. Seasonal variations in the catch rates of *A. thazard* and *A. rochei* (striped area).

## Annual Variation

The annual variation in the catch rate and production are so large that it is difficult to make any prediction or forecast. In fact, there are years during which hardly any *A. rochei* have been observed in the catches. In the case of *A. thazard*, there were peak years like 1964 and 1968 during which the production was about 120% more than the average production for the years 1963, 1965, 1966 and 1967.

The annual variation in the production depends considerably on the season of major recruitment. If the recruitment occurs during the southwest monsoon, then the chances of these schools being available to the fishery until the beginning of the northeast monsoon, are better because of the poor relative abundance of the larger and competitive relatives like skipjack, yellow fin or even mackerel tuna. On the other hand, when recruitment occurs towards the latter part of the year, as it happens sometimes, (*see* Figs. 4 and 5), the availability declines soon due to the appearance of the above-named competitors into the fishing area and further, there is a preferential shift in the concentration of fishing effort from frigate mackerel to skipjack and yellow fin. Thus, resulting in the decline in trolling and increase of pole and line, longline and even drift netting.

However, the large size frigate mackerels (40–50 cm.) appearing in the mixed schools with skipjack and yellow fin are exploited to a certain extent during the period October to March. The period November to March is the peak season for skipjack tuna pole and line fishery in the south and southwest coasts of Ceylon.

Since the latter part of 1967, fishing effort on the blood fish, especially along the south, southwest and west coasts, has changed drastically due to the introduction of 11-ton vessels operating only drift nets and also due to a large-scale shift from longline, pole and line an even trolling, to drift net fishing with the 3½ ton class of boats.

Before these introductions, it was estimated that frigate mackerels form about 15% of the total blood fish production, but presently this value is estimated to be over 20 % due to the increase in the exploitation of larger frigate mackerels with drift nets.

## Fishing Gears and Their Relative Efficiencies

The gears used in the commercial fishery for frigate mackerel are:

1. *Beach seine.*—Operated within ½ mile range from shore; 30 men for hauling.
2. *Troll.*—3 main lines, each with 30 branch lines ending in jigs; crew at least 3.
3. *Pole and line.*—Live bait carried in cane baskets partly submerged alongside the craft, wooden spade for spraying water; at least 5 men in the crew.
4. *Drift nets.*—15 pieces on 3½ tonner, 60 pieces on 11 tonner; 4″–5½″ mesh of synthetic fibre; crew of 5.

### *Beach Seine*

Long before the introduction of mechanized fishing crafts in Ceylon, almost the entire catch of frigate mackerel was made with the beach seine, except for a little contribution by the pole and line fishery from orus (outrigger canoes with sails). The operation of beach seine is limited by the condition of the sea and is not normally used for catching blood fish, but whenever schools of frigate mackerels and mackerel tuna move close to the shore (about ½ mile) they have been encircled with the beach seine. Though good catches are generally made especially off the northwest, east and

south coasts, quite often large percentage of the school escape the net because of the slow speed involved in the operation of the gear. The contribution to the production of frigate mackerels by this primitive method has declined since mechanization of crafts and introduction of methods like trolling and drift netting and today the contribution by beach seine to the frigate mackerel production is very negligible. In fact, there has been a steep decline in the frequency of appearance of frigate mackerels in the beach seine catches, but the average number of frigate mackerels caught during an operation does not show a statistically significant decline. The former fact may be due to more and more of the schools of this fish being intercepted and caught out at sea, using other methods.

The beach seine is not a selective gear as far as the schools moving inshore are concerned, but it is biased as far as the size frequency sampling of the population is concerned, because the large length group of *A. thazard* present in the population of that area and caught by other methods, is not proportionately represented in the beach seine catches. Medium sized frigate mackerels (30–40 cm.) often enter the catches with this gear (Fig. 7) and occasionally large schools of *A. rochei* have also been caught with this gear.

*Troll*

Trolling was introduced before mechanization of crafts, but the efficiency of operation of this gear from orus (outrigger canoes with sails) was poor due to the difficulties in manoeuvring the craft

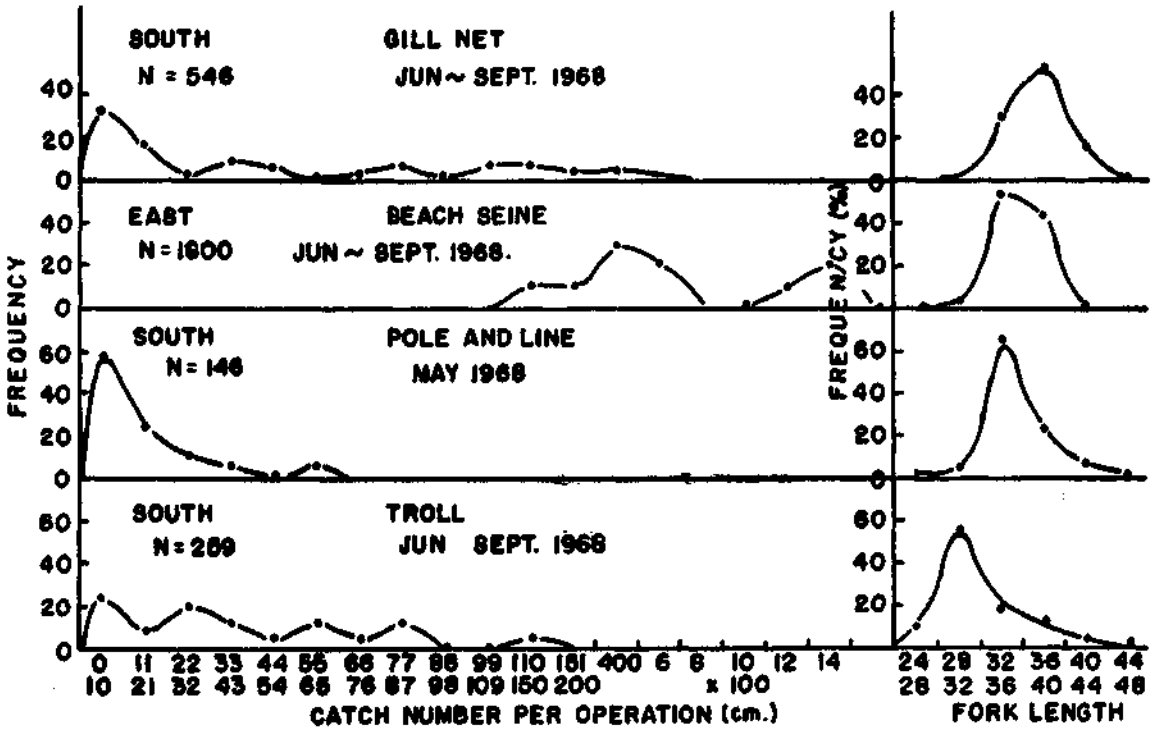


FIG. 7. Catch frequencies and length frequencies for *A. thazard* caught with different gears.

to catch up with schools of fish changing the direction of their movement and also in turning around to run over the schools repeatedly and quickly. Introduction of the 3½ ton mechanized boat has

improved the efficiency of the operation and since 1959 this method has become most popular for catching blood fish because of the low initial cost of the gear, very low cost of repair and maintenance, absence of bait problem and the low cost of operation. During trolling, the number of hours out at sea is reduced because the sailing time includes the fishing time and the fishing is effectively carried out in the mornings when the schools of frigate mackerels are at the surface. The catches made with this gear contribute over 50% of the total frigate mackerel production. Every mechanized boat in Ceylon, except those in the north, is equipped for this method of fishing and even when these boats go out for other methods of fishing, trolling lines are cast while sailing to and from the fishing grounds. Hence this method may be considered as a standard one for mechanized boats, mechanized orus and even some non-mechanized orus, with the possibility of year round operation. The average catch of frigate mackerels for a boat per day has been estimated at 20 lb. which is an improvement on the average catch of 26 lb. of all tuna species realised during the first few years following mechanization (Fig. 7). The improvement is partly due to the increase in the average number of days of fishing during the southwest monsoon. *A. rochei* appears frequently in the catches with this gear, because of its effectiveness for the smaller length groups as well. Though juveniles of *Auxis* are seldom caught with this gear, juveniles of *Euthynnus* (15–20 cm) are frequently caught. Unlike the beach seine, this gear samples a very wide length-range, but the modal group lies between 28 and 32 cm and none of the other gears applied on this species is equally effective for this length group (Fig. 7). Trolling with jigs for tuna varieties in general has been found to be relatively more effective in the turbid waters of the monsoon season than in very clear waters.

*Pole and Line*

This method has been in use over the last 40 years, but the technique and the implements have hardly changed over the years. Though it is very effective for skipjack tuna, it has not proved to be equally effective for frigate mackerels. One main reason being that their response to chumming is relatively poor and the size of the live-bait used happens to be larger than the common food items observed in the stomachs of frigate mackerels. Added to it, the modal length groups of skipjack and yellow fin exploited by this method are generally of the 45–55 cm class and the percentage of frigate mackerel in these mixed schools of this length range is also low (Fig. 1). Exploitation of frigate mackerels and other tuna by this method takes place between October and February or March and cannot be efficienttly carried out during the southwest monsoon. The turbidity of the water makes it difficult to locate shoals of bait fish near the bottom. However, pole and line method is relatively a more effective gear than the trolling line for catching mixed schools of tuna, in very clear water.

The technique in use is so crude and time-consuming (searching for bait fish and then searching for tunas) that this method of fishing is losing popularity and is giving its place to drift netting. Improvement of the technique along modern lines would show out the high efficiency of the pole and line method for the skipjack population in the inshore and off shore waters of Ceylon.

*Drift Net*

This type of gear has been in operation for over a decade in the north and for a little lesser period in the east, but it was introduced to the west coast about 5 years back and to the south and southwest coasts towards the latter part of last year. Therefore, this method is in operation all round the island. The mesh size used is such that it is effective for the tuna like the skipjack and the large sized mackerel tuna which are usually found enmeshed by their opercular or the first dorsal regions. The relatively larger tuna like the yellow fin is caught by the snout or orbital region and the chances of their dropping off is high. The girth of the frigate mackerels under 30 cm in length is too small to be enmeshed in these nets (Fig. 2 B), but those over 30 cm in length, are found enmeshed and that too by their belly (behind their first dorsal). An average catch of 2–3 lb of frigate mackerels per piece of net per day is being realised in the south, southwest and west coasts. This amounts to about 40 lb per 3½ ton boat operation and 120 lb for the 11-ton boat operation.

*A. rochei* are extremely rare in these catches. The effort by this gear is concentrated only on the large sized frigate mackerels and therefore would be in competition with the pole and line fishery which is declining in popularity due to the difficulty of obtaining and keeping suitable live bait and on the other hand due to the convenience of operating drift nets. The entry of frigate mackerels into the drift net fishery also takes place from about September to March.

It is evident that due to intensified exploitation of the young frigate mackerels recruited to the troll fishery, successive entry into the pole and line and drift net fisheries are considerably reduced. The troll fishery also reduces the entry of yellow fins into the longline fishery. But, recent trend in the changes in distribution of effort through the different gears indicates the possibility of a reduction in the intensity of trolling operations and an increase in drift net operations which may be considered favourable for an increase in the production by weight of frigate mackerels.

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