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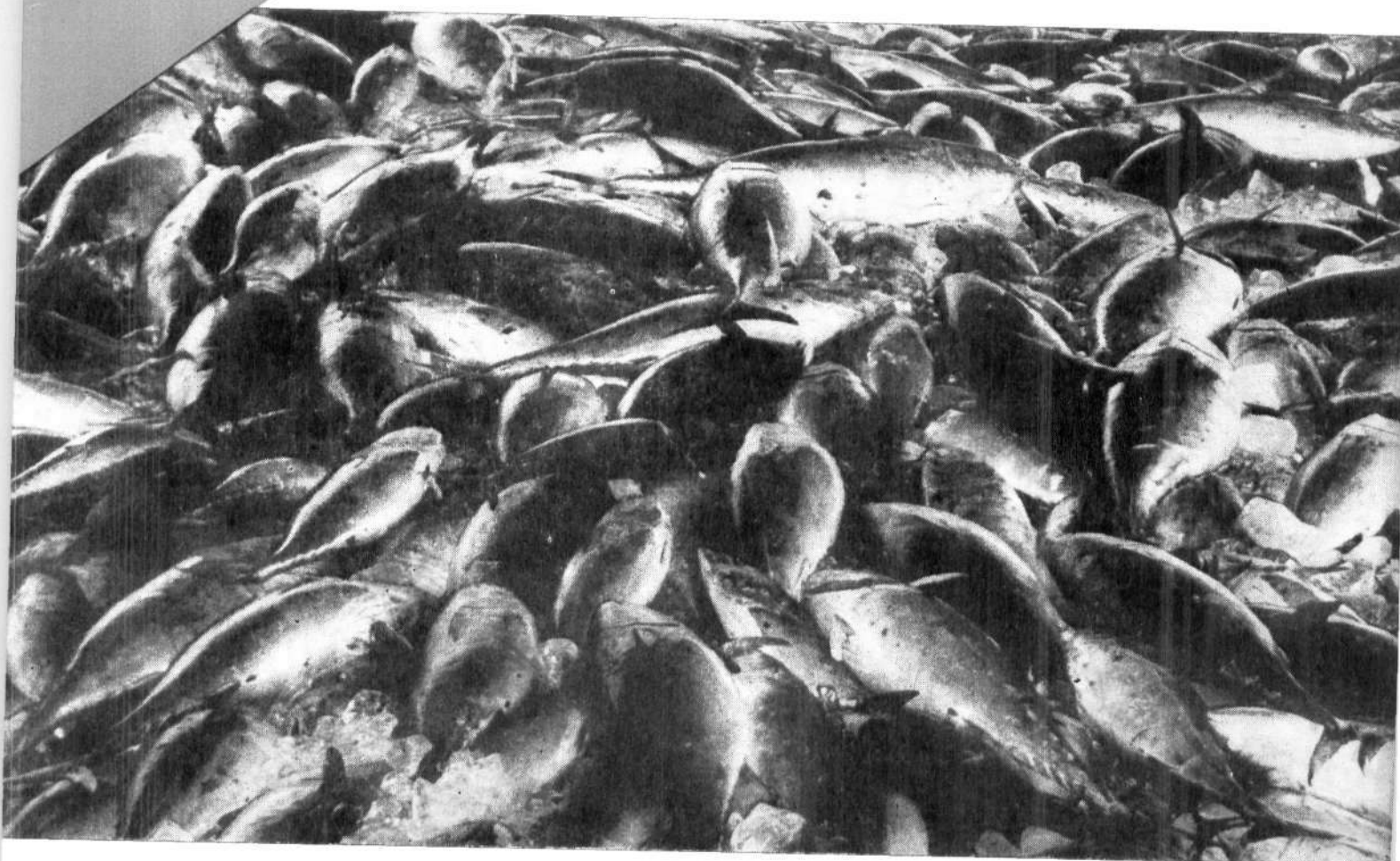
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**TUNA FISHERIES OF THE EXCLUSIVE ECONOMIC ZONE
OF INDIA: Biology and Stock Assessment**

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FISHERY AND BIONOMICS OF TUNAS AT MANGALORE

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Karnataka waters, on the upper part of S.W. coast of India produce an average total of 786 tonnes of tuna annually (1972-'81) forming 0.7% of the state's marine fish catch and 5% of the total tuna catch of India. Of late, the production rate of this resource in the state had gone upto an average of 1,729 tonnes per year (1979-81). This rapid progress was achieved by the introduction of modern fishing techniques such as purse seining, deployment of mechanised crafts for drift gill netting and synthetic materials for gears.

At present, there is no indepth information available on the resource characteristics of tunas and allied forms from Karnataka waters except for those by Silas *et al.*, (1979), Dhulkhed *et al.* (1982) and Muthiah (1982). In view of this, a detailed investigation on the resources of tunas and allied species of Mangalore area (South Kanara District of Karnataka State) was undertaken from 1979 through 1982 and the results are given here. Since purse seiners and mechanised and non-mechanised drift gillnetters equally contributed to the tuna fishery at this centre, the results of observations on the landings of these gears are dealt with separately.

FISHING AREA

Purse seining in Karnataka waters is carried on between Manjeswar in the south and Bindur in the north extending over an area of 150 km (Rao *et al.*, 1982) (Fig. 1). The purse seiners based at Mangalore usually operate between Kasaragod in the south (40 km) and Kaup in the north (45 km). But concentration is seen in the southern region because of competition offered by purse seiners of Malpe in the northern area. Fishing is done from 10-35 m depth and it varies from season to season. During September-January fishing is carried out in the 10-20 m depth because during this season shoals of pelagic species are sighted in good concentration at this depth. After February, operation is extended to waters upto 30-40 m depth because

of thinner shoals or non-availability of shoals in the shallow inshore waters (Dhulkhed *et al.* 1982). The operation is suspended during June-August owing to south west monsoon. However, if the monsoon delays and the weather permits fishing is done even upto the middle of June.

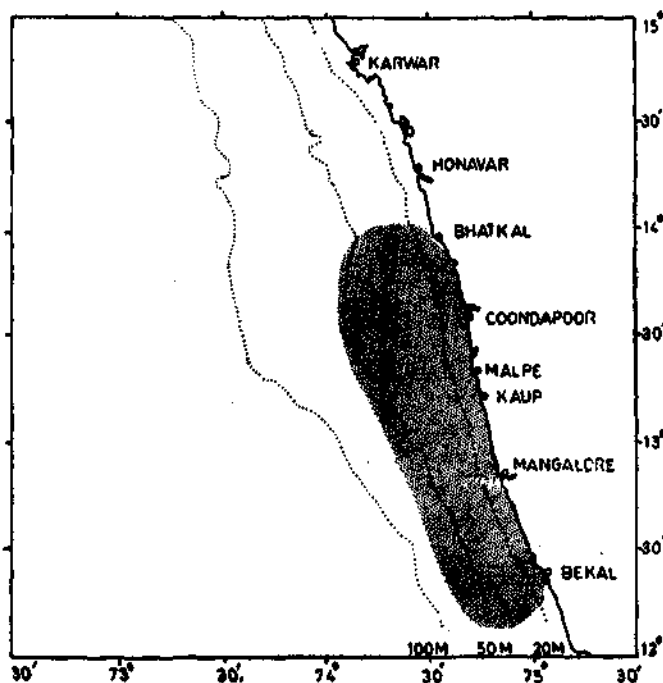


Fig. 1. Operational area of drift gillnetters and purse seiners at Mangalore.

The operation of drift gill nets are restricted to 20-60m depth and the fishing season extends from September to March/April. The areas of operation are off Mangalore, Suratkal, Hejmady, Kaup, Malpe and Gangoli, of which the major areas are off Kaup and off Mangalore (Fig. 1).

The coastal waters of Karnataka spread over a distance of 300 km in two districts viz., South Kanara and North Kanara. Its continental shelf area amounts to 25,000 sq. km and the depth of shelf extends upto 120 m and 88% of the shelf area lies between 0-72 m depth. The bottom area is mostly sandy and muddy upto 60 m depth slightly uneven from 60-90 m depth and rocky coral formation from 90-120 m depth (Anon., 1978). At present only about 20% of the shelf area are exploited (George, 1981). A number of rivers and backwaters enter the coastal waters making the salinity and temperature low during the south west monsoon (August). The salinity shows an increasing trend from September-October and February-May. Suresh and Reddy (1980) have observed that sea water temperature in the Mangalore area showed two peaks, one in April and the other in October, corresponding to the two dry periods and two minima during the periods of south west monsoon and winter season. They also observed that salinity increased from February to May and then decreased recording its lowest in August. In September, salinity values increase and continue upto October followed by a decrease in November and subsequently an increase in December. Lower values of salinity occurred with fall in temperature and with occurrence of rainfall. Upwelling was observed in the deeper water in February/March and in coastal water from May to August. According to them, the coastal waters are rich in nutrients during the south-west monsoon due to the upwelling, river discharge and land drainage. It was observed earlier that currents are directed towards north from October to February and towards south from April-May to September and March appears to be a transition period. The average rainfall in this region is 300 cm of which 75 % fall between May and September.

Constant watch on the purse seine landings was made by making almost daily observations at Bunder (Mangalore) where more than 100 purse seiners land their catches every day. Catch of 10 to 20% of the total boats landed in a day were recorded from which the day's total catches were calculated. Further computing the day's average catch to the total number of fishing days in a month gave the monthly estimated catch. In seasons, whenever there are bumper catches, the purse seine boats usually employ carrier boats to transport fish after a successful haul. Each carrier boat was considered as one unit for computing day's catch in the present study. For CPUE analysis actual number of purse seine units which operated sets were only considered i.e., the total catch for the day or month is divided by the purse units to work out CPUE.

For the purpose of estimation of drift gill net landings, all the six centres were considered as a single unit

in view of the fact that all these centres are located within a range of 100 km and the catch composition of species remaining more or less the same. Of the six centres, Kaup and Mangalore where maximum number of units are in operation (more than 60% of the total drift gill nets of South Kanara) were visited twice a week, whereas the other centres namely, Suratkal, Hejmady and Malpe where fishing activities are in lesser magnitude due to fewer number of units in operation were visited once a week and the last centre, Gangoli once a month. Although the sampling from this centre may be inadequate because this centre is far away and due to practical difficulties to visit more often this centre was included for the study in order to give a complete picture of drift gill net fishery of South Kanara. It was noticed that, very often, the drift gill net units shift their operational base because of prolonged poor catch returns from a particular centre or when the operators hear of better catches from neighbouring centres. The methodology of estimation of the catches and standard effort between non-mechanised and mechanised catches was as per that dealt with in Chapter 2.

CRAFTS AND GEARS

Along the Karnataka Coast, tunas and allied fishes form a minor fishery. In the past, they were taken along with larger pelagics such as seerfishes, catfishes and sharks by 'odubale' a type of drift gill net operated from small dugout canoes. This 'odubale' along with other traditional crafts such as 'rampani', 'kanthabale', and 'pattabale' had contributed upto 75% of the state's annual catches (George, 1981). With the introduction of mechanisation in the state in 1956 for trawling and purse-seining during 1975-76, the operation of 'odubale' by the local fishermen became phased out. This lacunae has been filled by fishermen from Kanyakumari District of Tamil Nadu, who migrate to Karnataka Coast during September to March and employ the drift gill nets, of the size 450-700 m length, landing a good amount of tunas and billfishes. They deploy this gear from Mangalore, Suratkal, Hejmady, Kaup, Malpe and Gangoli along South Kanara Coast. The concentration of these fishermen are more at Kaup and Mangalore because of better market and other infrastructure facilities. The 'odubale' fishery by these fishermen has become so successful in terms of quality fish catches such as sharks, seerfishes, tunas and catfishes, that due to good financial returns the local fishermen are once again being attracted to take up this fishery. The number of 'odubale' units of local fishermen is on the increase now. At present local fishermen employ this gear with motorised canoes with OBE or mechanised boats.

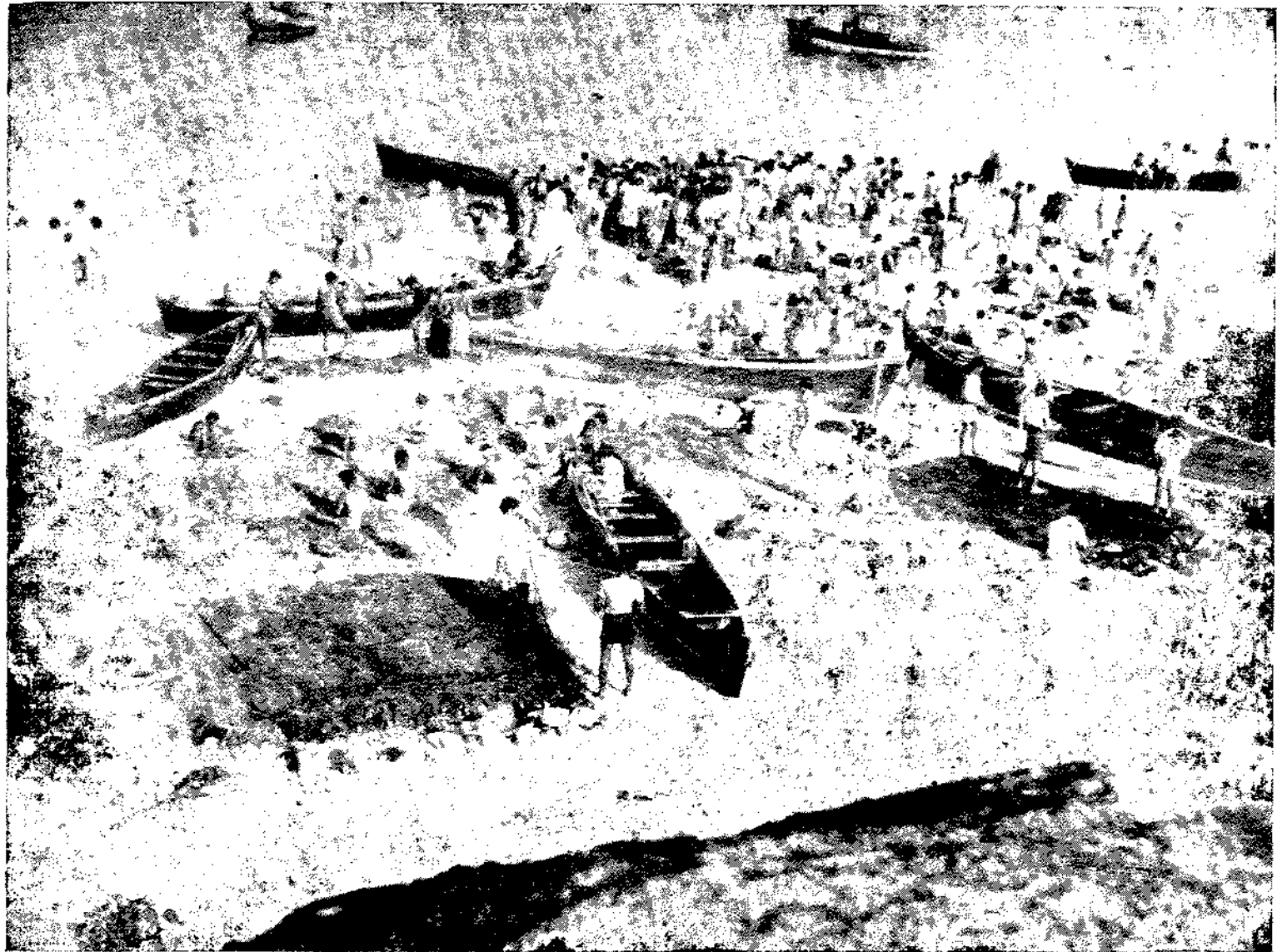


PLATE I. Drift gillnet Landing Centre at Kaup, Karnataka State.



PLATE II. Little tuna (*Euthynnus affinis*) landed by drift gillnets at Kaup Landing Centre.



PLATE III. Black marlin (*Makaira indica*) landed by drift gillnet at Kaup Landing Centre.

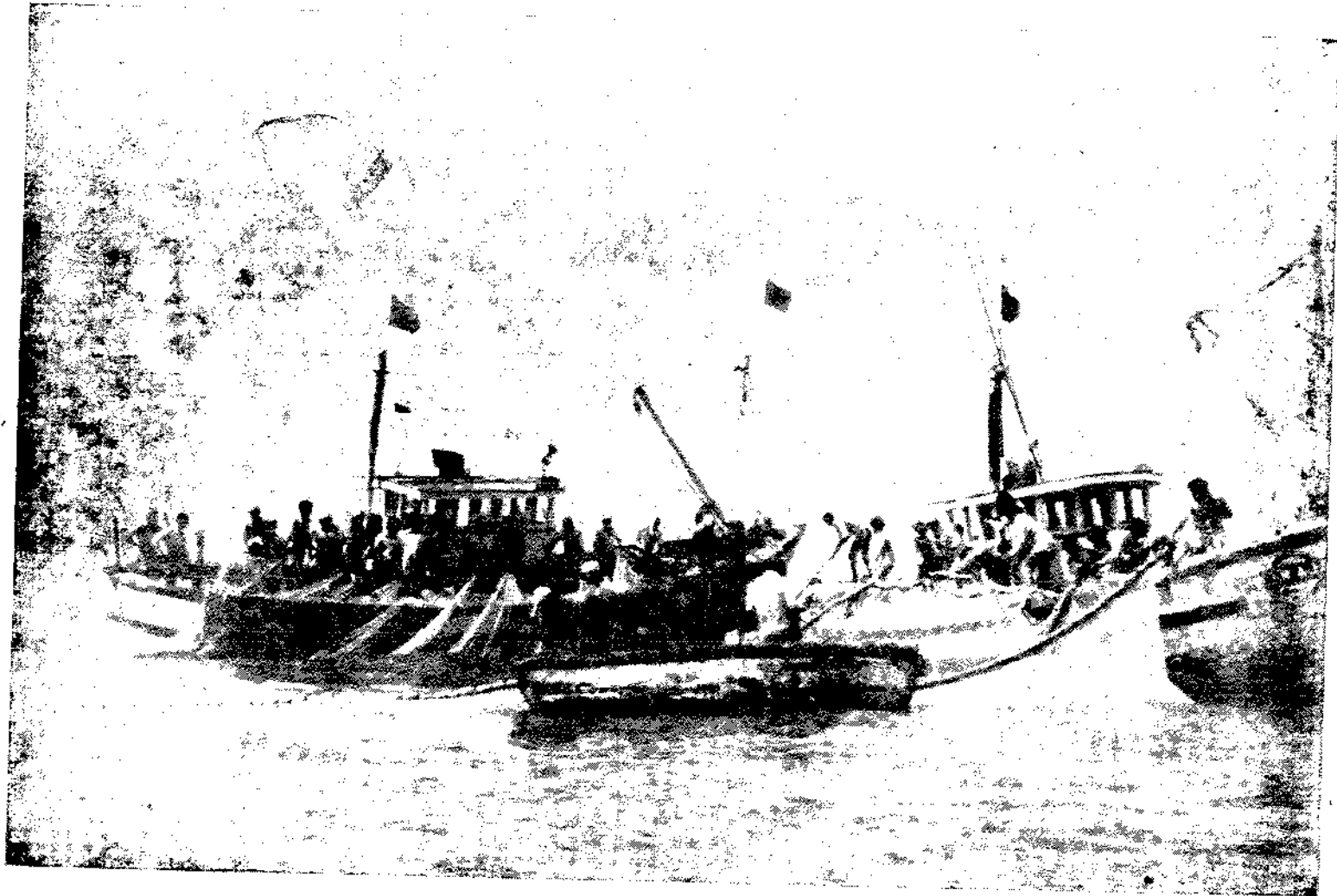


PLATE IV. Operation of purse seine, off Mangalore, Karnataka State.



PLATE V. Tunas taken by purse seine boats from off Mangalore, Karnataka State.



PLATE VI. Little tuna (*Euthynnus affinis*) landed by purse seine boats from off Magalore, Karnataka State.



PLATE VII. Little tuna (*Euthynnus affinis*) catch by purse seine boats, another view.

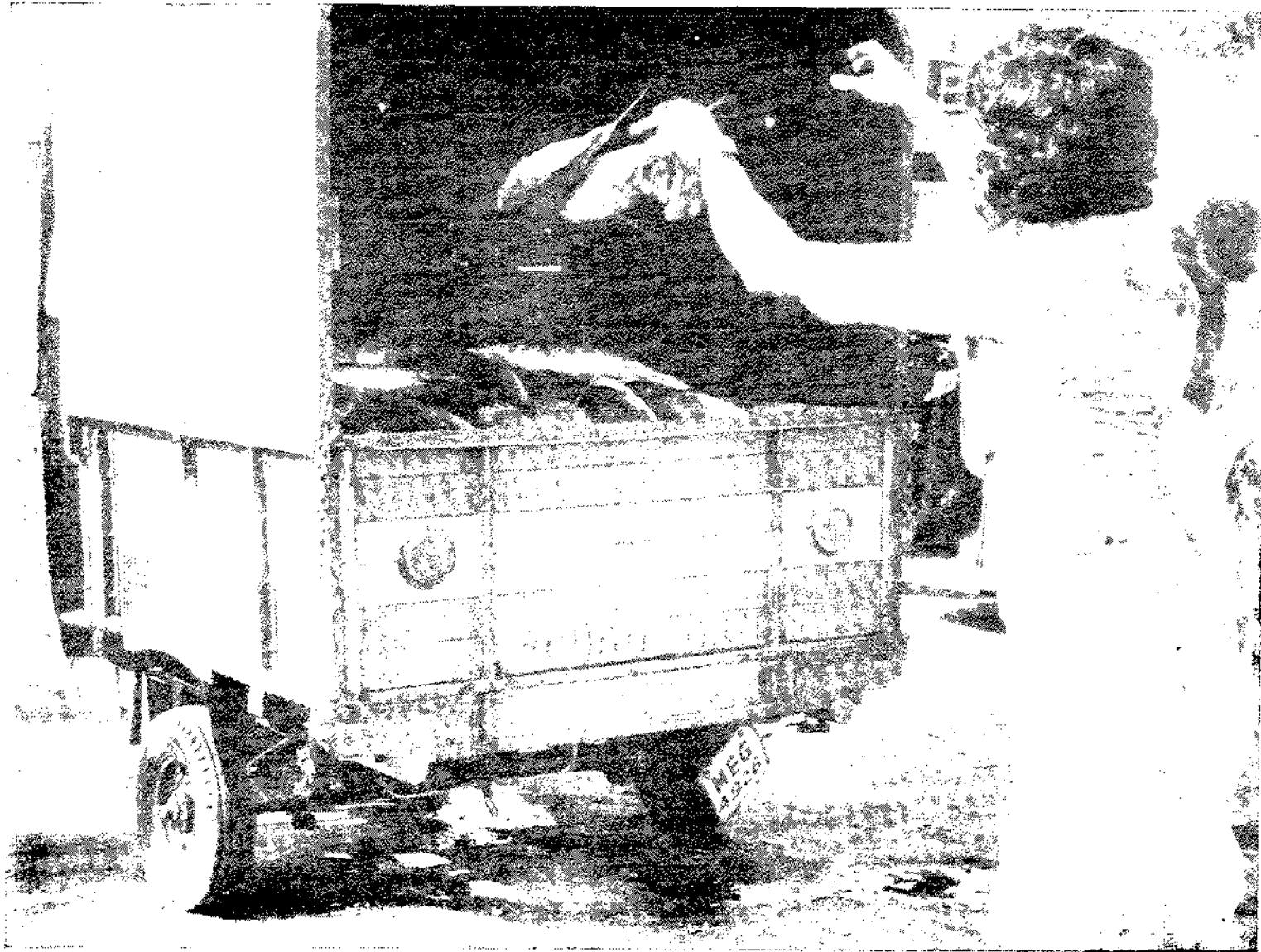


PLATE VIII. Tuna being loaded for distribution at Mangalore (*Photos 5-12 by C. Muthiah*).

'Odubale' operations are restricted to inshore waters. With the advent of mechanisation/motorisation of canoes and boats and the introduction of purse seine in the mid-seventies landings of tunas from the coastal Karnataka have gone up. The annual average catch of tunas and billfishes for the five-year period 1970-'75 (prior to the introduction of purse seine) was 230.5 tonnes, forming 0.2% of the total fish catch of the state, which was increased to 1,166 tonnes in the next five-year period (1976-'81) forming 0.9% in the state's total marine fish catch. About 300 purse seiners and 400 drift gillnetters are engaged in exploiting the pelagics in the state, of which about 250 purse seiners and an equal number of drift gillnetters are under operation in the South Kanara Coast.

Purse seine fishing on a commercial scale was introduced in the Karnataka Coast during 1975-76 and expansion of the purse seine fleet was rapid through the years.

The purse seine unit consists of a main boat made of timber having length from 13 to 14m with diesel engine of 105/120 HP and a 'skiff.' The gear is made up of synthetic nylon of 450 m in length and 33 m height of depth with a mesh size of 14 mm. The upper line of the net is attached with plastic floats and the lower edge to sinker line (lead) and this in turn with purse rings made of brass. The number of crew varies from 18-25. During the season at times of bumper catches, carrier boats, usually trawlers of 8 to 11m length are employed to transport the catch from the fishing area to the landing site. The method of operations of purse seiners has been dealt with earlier (Dhulkhed *et al.*, 1982).

The drift gill net fishing along the South Kanara Coast has been practised with dugout or plank built canoes of 5 to 6 m length propelled by oars or sails and mechanised vessels of 9.7 m length made of timber. Recently the canoes are fitted with Yamaha outboard engine. The net is made of synthetic nylon mostly of pink colour and varying in length from 450 m to 700 m and the height from 6 to 7 m. Usually mechanised vessels use comparatively longer nets in the distant waters. About 20 pieces having 65 to 135 mm mesh size are plied together to make a single net. Wooden floats are attached to the head rope at regular intervals and the foot rope is not weighted during September-December period. From December onwards the foot rope is attached with sinkers of smaller stones.

During September-November, the nets are attached to one end of the canoe or boat. The net is set in the surface waters. After December till the end of the season (March-April) the nets are used as bottom set

gill nets with one end attached to the boat which is anchored. The nets are set either against the wind direction or water current so that the fish that swim across get gilled or entangled.

EFFORT, CATCH AND CPUE

Purse seine

The estimated total tuna catch by purse seiners of Mangalore during 1979-'82 was 3,007 t, the annual average being 752 t. The tunas formed 0.4%, 1.73%, 4.65% and 1% respectively of the total fish catch during the above years. The catch showed progressive trends through the years with large fluctuations. In 1979 the catch was 112 t which increased to 508 t in 1980 and leaped to 1,966 t in 1981 and in 1982 it declined to 420 t despite increased effort. The total effort expended also increased progressively from 13,109 units in 1979 to 13,177 in 1980, 16,713 in 1981 and 19,173 in 1982. It may be mentioned here that in Karnataka waters the purse seine effort either decreases or increases in relation to the availability of pelagic fish stocks of mackerel or oil sardine.

The annual catch per unit effort (CPUE) showed an upward trend during 1979, '80 and '81 and a fall in 1982, the values being 8.54 kg, 38.5 kg, 117.69 kg and 21.92 kg respectively with an average annual value of 46.67 kg.

Month-wise effort expended and catch of tunas by the purse-seiners of Mangalore are presented in Fig. 2. It will be seen that in January-April, 1979 there were no tuna landings though the average monthly effort during these months was well above 1,000 units. The maximum effort was in October (2,403 units) and the catch realised was only 7 t. The highest catch of 63 t came in December whereas the effort fell to 1,333 units.

The CPUE of 11.8 kg in May 1979 rose to a maximum of 87.9 kg in June (Fig. 2) and decreased to a minimum in September (1.6 kg) and October (2.9 kg) and again increased to 47.3 kg in December.

In 1980, tunas were caught in almost all months except in December (Fig. 2). March recorded the peak catch (239 t) for the year inspite of a heavy reduction in the effort (510 units). April witnessed a steep fall in the production (6 t). During this year March recorded the highest catches in the pre-monsoon period and October in the post-monsoon period.

In January 1980, the CPUE was about 46 kg which declined to 6.67 kg in February. It attained a maximum

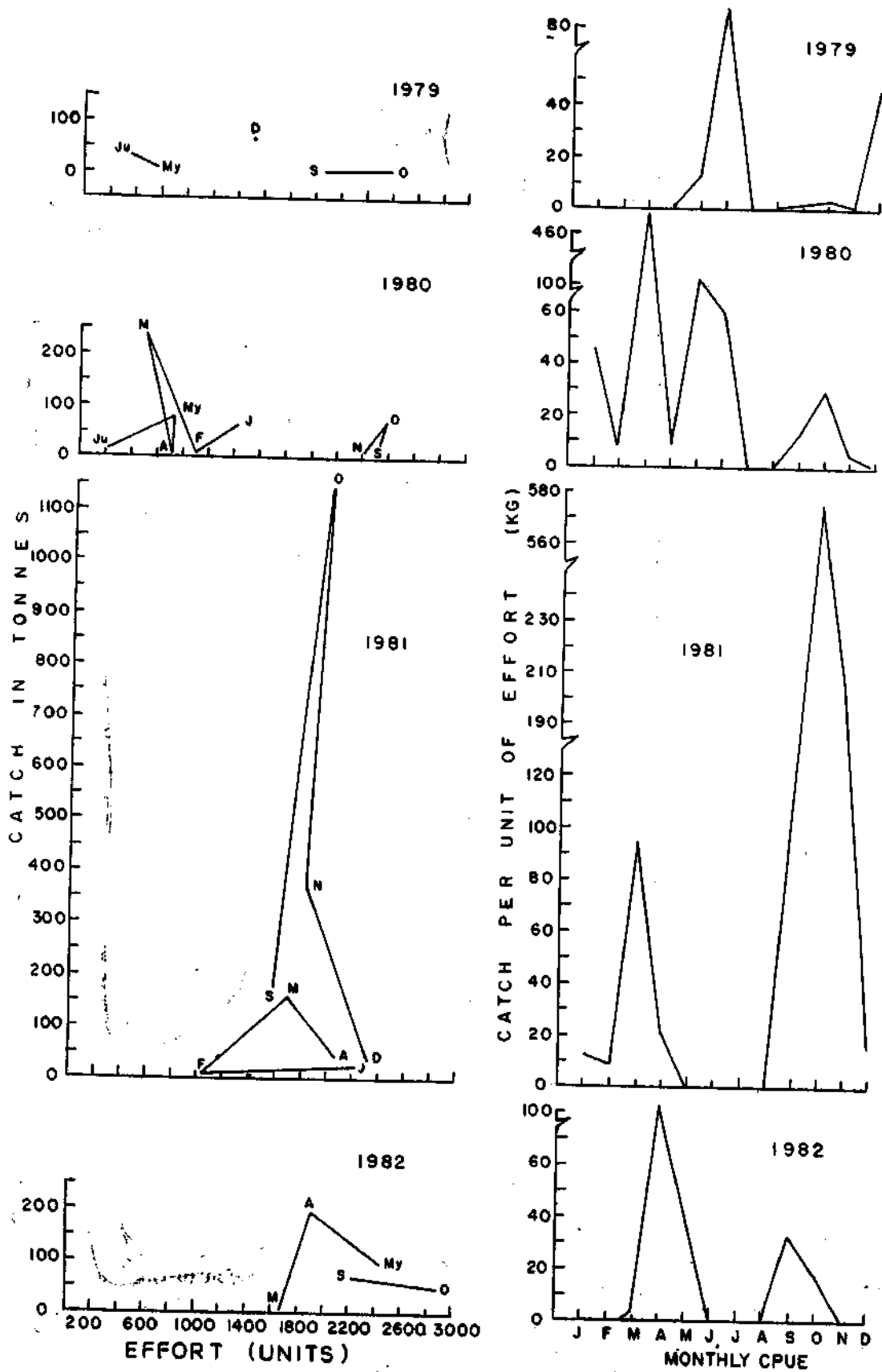


Fig. 2. Catch effort relationship and catch per unit effort of tunas taken by purse seiners at Mangalore, 1979-'82.

in March (468.6 kg) and fell to 8.4 kg in April. It recovered to some extent in May (103.5 kg) followed by a reduction in June (60 kg). In September the CPUE was 11.5 kg which increased to 29.6 kg in October and reduced to a minimum of 4.5 kg in November.

During 1981 tunas were obtained in all months except in May and June (Fig. 2). The trend of catch followed the same pattern as that in the previous year.

During 1981, the CPUE was 11.7 kg in January which showed a marginal decline in February (8.9 kg) followed by a steep increase (95.2 kg) in March and fall (21.2 kg) in April. In September it was higher than in the previous months (110.7 kg) and shot up to an all time record of 566.3 kg in October and then decreasing to 200 kg in November and 16 kg in December.

In 1982, tunas formed a fishery only during March-May and September-October periods though considerable amount of effort was expended during other months. Unlike the previous two years, this year April in the pre-monsoon period and September in the post-monsoon period were productive.

In 1982 the CPUE was 3.5 kg in March which increased to 103.5 kg in April but declined to 38.5 kg in May. September recorded 33 kg which decreased to 17.5 kg in October.

In general post-monsoon period (September-December) seems more productive the catch accounting for 68% of the annual catch with about 53% of the total annual effort and the pre-monsoon period (January-June) recording the rest of the catch and effort.

Drift gillnet

The catch and effort of tunas and billfishes by the drift gillnet units along the South Kanara Coast showed an increasing trend from 1979 to 1981 and a decline in 1982. The catch during 1979 was 107.3 t (for the four month period September-December) for a total effort of 11,342 units, the average monthly catch and effort being 26.8 t and 2,836 units. The total catch was 143.2 t for a total effort of 28,235 units with a monthly average of 20.46 t and 4,034 units in 1980. The catch and effort reached a maximum of 166.2 t (seven months) and 40,314 units in 1981 with an average monthly catch of 23.7 t and effort 5,719 units. In 1982, the catch and effort declined to 119.8 t and 33,958 units respectively the monthly average was 17 t and 4,851 units.

Monthly trend of catch and effort of tunas and billfishes by drift gillnets of South Kanara Coast is given in Fig. 3. It can be seen that during the beginning

of the season in September, 1979, the catch was about 24 t for a total effort of 420 units. It reached a peak (37 t) in November with a slightly decreased effort over October and decreased to 21.1 t in December, though the maximum effort of the year was expended in this month (3,855 units).

During January to March period, the fag end of drift gillnet fishery registered very low catch (9.32 t) and effort forming 6.5% and 31.3% of the annual catch and effort respectively and September-December period accounted the rest (Fig. 3). Tunas and billfishes were absent in March when the effort decreased to 1,495 units. This decrease in effort was due to poor catches of high priced fishes such as seerfishes, pomfrets and sharks. The landings in September were at its peak (65.5 t) with a total effort of 2,448 units.

In 1981 very little catches were taken in February, March and April and the effort expended in these months was far less than that in January (7,548 units). A maximum catch of 86.1 t was obtained in October, due to good landings of *E. affinis* and *T. tonggol*. The effort level showed increasing trends from 7,719 units in November to 8,579 units in December.

As in the previous years, the catches were very low in January-March period of 1982 accounting to 1.2 t with 34% of annual effort. The catch was about 15 t for a total effort of 2,043 units which increased to 71.2 t (6,996 units) in October.

Post-monsoon period (September-December) appears the best season when as high as 98% of the annual tuna and billfish catches are caught with about 68% of the annual effort. October forms the peak month with 41% of the annual catch followed by November (25%), September (21%), December (11%) and January-April period, the rest of the catch (2%). It is seen that the drift gillnet fishery commences from September and maximum tuna and billfish catches are obtained in the months of September-December, especially in October, and after December the tuna and billfish landings decreased and reached the minimum at the end of the fishing season March/April.

The annual catch rates during 1979-'82 were 9.5 kg, 5.07 kg, 4.12 kg and 3.53 kg respectively. The average annual catch rate was 4.24 kg (1980-'82 values; the value for 1979 is not included because during this year data is available for only 4 months).

SPECIES COMPOSITION

In general, *Euthynnus affinis* predominated the tuna catches by purse seine (86.88%) followed by *Auxis*

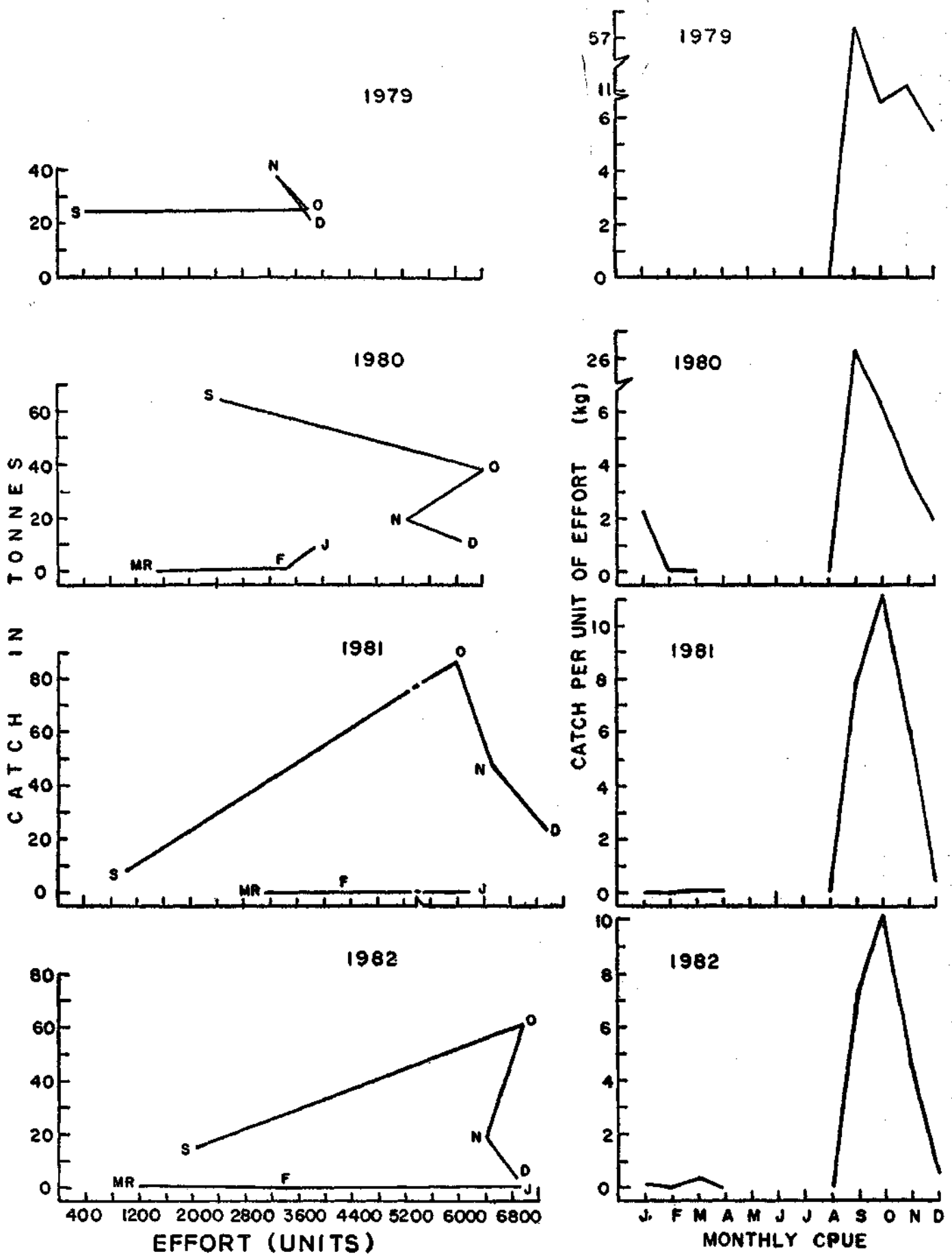


Fig. 3. Catch and effort relationship and catch per unit effort of tunas taken by drift gillnetters at Mangalore area, 1979-'82.

thazard (9.71%); *A. rochei* (3.38%) and *S. orientalis* (0.03%) (Fig. 4).

Yearwise estimates indicate that during 1979, *E. affinis* was the chief species contributing as high as 99% of the tuna catches. They were caught during May, June, September, October and December. Best

While *E. affinis* continued to dominate the catches in 1980 forming 89%, *A. thazard* and *A. rochei* made their appearances in the fishery contributing to 4% and 6% respectively. *E. affinis* was caught in all months except in November and December, their landings were at its peak in March, 237 t (with high catch rates 465 kg) and lowest in September (4 t). *A. thazard*

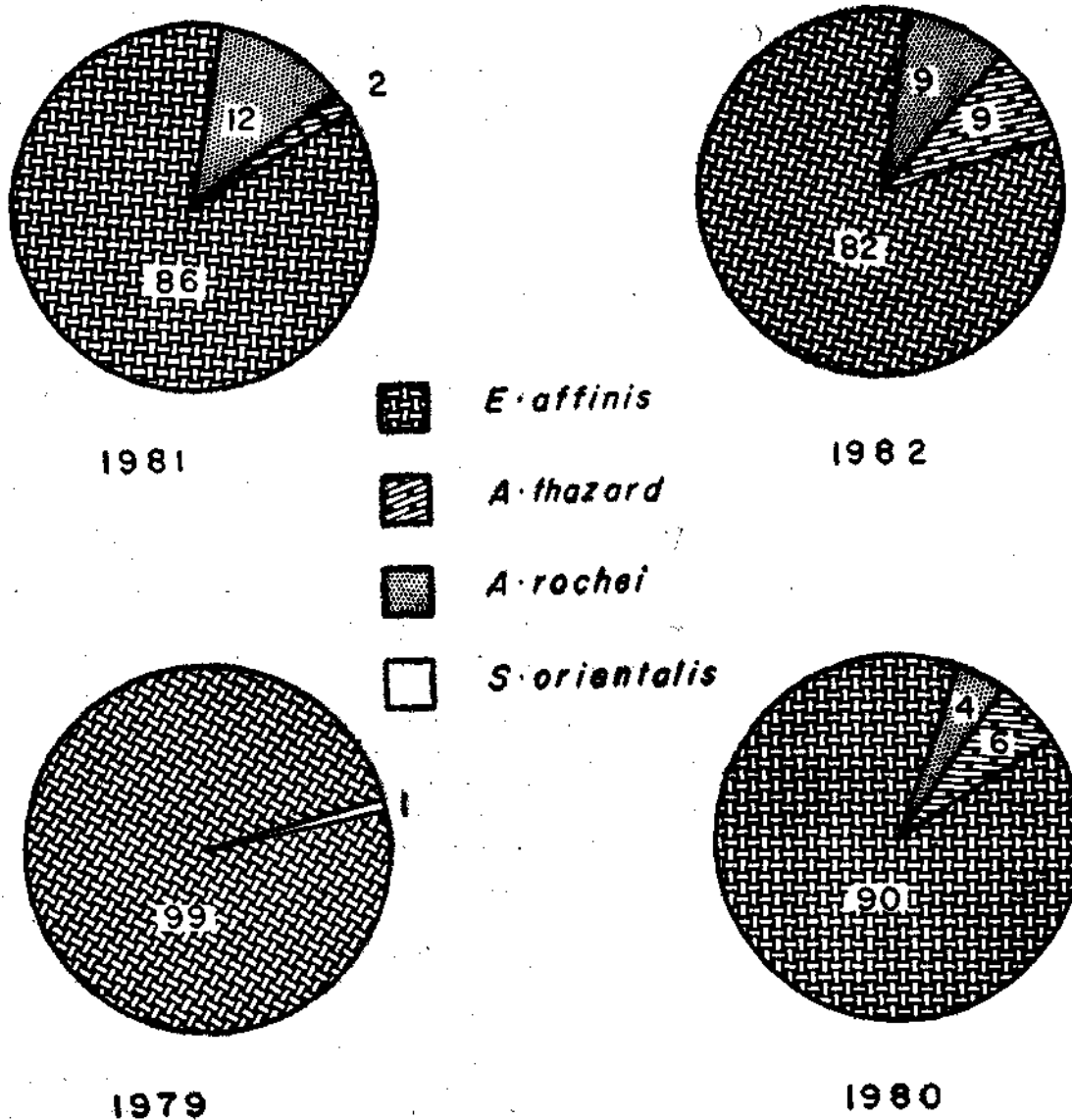


Fig. 4. Percentage composition of different species of tunas in the purse seine catch at Mangalore, 1979-'82.

catches were obtained in December (63 t) at a CPUE of 47 kg and in June 32 t with a cpue of 88 kg. *S. orientalis* was the only other species of tuna taken in small numbers during September-October period.

was landed in March-May and October; *A. rochei* in September and November. The maximum catch of *A. thazard* was in October (18 t) and *A. rochei* in September (22.7 t).

In 1981 *E. affinis* dominated the landings although their percentage had decreased to 86% and that of *A. thazard* had increased to 12% and *A. rochei* had decreased to 2%. *E. affinis* was obtained in all months except in May-June. October witnessed bumper landings (1,038 t) with cpue of 515 kg. *A. thazard* catches were better in October-November and *A. rochei* in September.

During 1982 the percentage of *E. affinis* had further dropped to 82%, and *A. thazard* and *A. rochei* contributed each 9% to the total catch of tunas. *E. affinis* was caught during March-May and September-October. Higher landings were in March (196 t).

In the drift gillnet catches *E. affinis* was the single major species. It contributed 53.38% to the tuna and allied fish landings followed by *T. tonggol* (16.05%), *M. indica* (13.05%), *A. thazard* (9.52%), *I. platypterus* (6.15%), *A. rochei* (1.47%) and *S. orientalis* (0.39%), mainly during the September-December period. Relatively high catches of *E. affinis* and *A. thazard* were in October, *T. tonggol*, *M. indica* and *I. platypterus* in November, *A. rochei* and *S. orientalis* in December.

During 1979 *E. affinis* was the major species contributing 57.71% followed by *M. indica* 13.30%, *I. platypterus* 10.65%, *T. tonggol* 9.03% and *A. rochei* 6.85%. *S. orientalis* and *A. thazard* were of very minor importance (Fig. 5). In 1980 the catches were dominated by *E. affinis* (67.38%), *M. indica* (17.05%) and *I. platypterus* (9.73%) compared to 1979, the percentage of *E. affinis* and *M. indica* had shown an increase whereas *T. tonggol* a decrease and *I. platypterus* remained the same. The landings of *S. orientalis*, *A. thazard* and *A. rochei* were very meagre. In 1981 the catches were constituted by *E. affinis* (49.05%), *T. tonggol* (25.05%), *M. indica* (11.19%), *A. thazard* (10.13%) and *I. platypterus* (4.16%) in the order of abundance. When compared to the previous year, a decrease was noticeable in the catches of *E. affinis*, *M. indica* and *I. platypterus* whereas there was an increase in the case of *T. tonggol* and *A. thazard*. In 1982 the catches were predominated by *E. affinis* (38.79%), *A. thazard* (26.44%), *T. tonggol* (21.84%) and *M. indica* (11.12%) in the order of abundance. During this year the percentage of *E. affinis*, *I. platypterus* had shown a decrease while the catches of *A. thazard* and *T. tonggol* were better than in 1981.

SIZE COMPOSITION

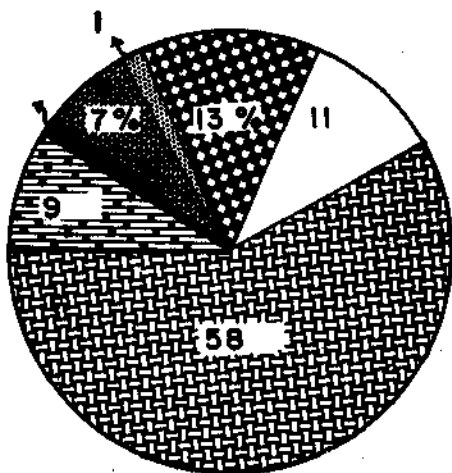
E. affinis

In the purse seine catches in 1979, *E. affinis* was composed of fish from 20 to 66 cm with modal sizes at 24, 44 and 56 cm (Fig. 6). In June there were two modes at 44 and 56 cm and a minor mode at 50 cm.

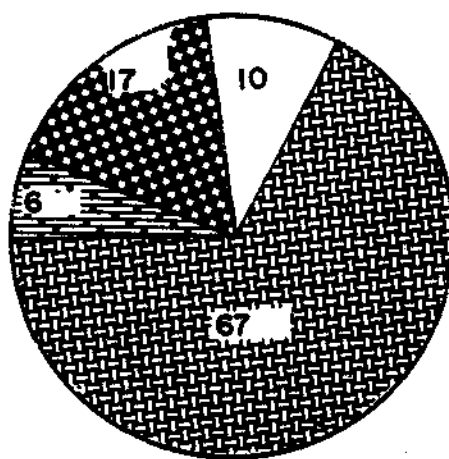
In September small fish (24-26 cm) formed the bulk of the catches besides a few big fish (50-54 cm). Modal groups at 54-56 cm dominated the catches in December. In 1980 the catches were supported mainly by fish ranging from 42 to 62 cm and stray occurrence of small fish (24 cm) in October and older fish (70 cm) in March and April. The length frequency of catches exhibited bimodal distribution with modal sizes at 44 and 54 cm in March and April, at 42 and 56 cm in May and at 52 and 56 cm in June whereas it was trimodal in September with modes at 46, 56 and 62 cm. In October once again catches showed two modes at 46 and 56 cm. During 1981 catches comprised of fish with size range of 30-72 cm. During January-April period catches were constituted by 46-62 cm with modal size between 52 and 54 cm. A few individuals of 36 and 66 cm of size occurred during this period. September and October catches showed multimodes of which the chief one was at 44 cm in September and at 56 cm in October. Small fish (30-38 cm) exclusively supported the fishery in November. Catches in 1982 were represented by fish ranging in size from 42 to 72 cm. In March it showed two modes, the major one at 58 cm and a minor one at 48 cm. In April in addition to a mode at 58 cm, older fish (70 cm) were noticed in small numbers. Catches in May had modes at 48, 56 and 60 cm.

In the drift gill net catches in 1979 the length of *E. affinis* varied from 24 to 64 cm (Fig. 7). The catches in September were dominated by fish with modal lengths at 26, 46 and 58 cm. Small fish (26-40 cm) continued to appear in the catches till November and these fish were the mainstay of the fishery during this period (September-November) except stray occurrence of medium sized fish (56-64 cm). In December in addition to small fish with modal length at 36 cm medium sized fish with modal length at 58 cm formed the bulk of the catches.

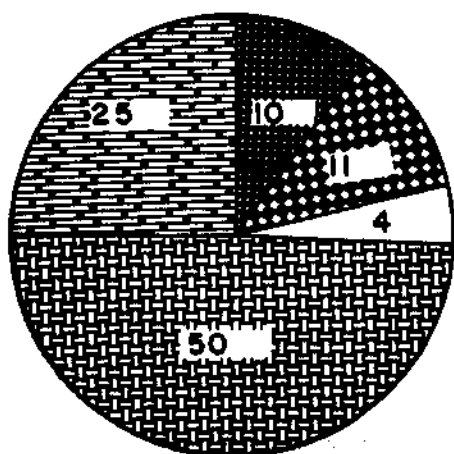
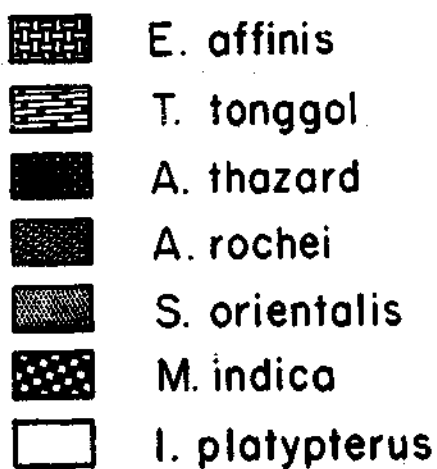
The catches during 1980 had size range from 20 to 70 cm. In January the catches were in the size between 50 and 68 cm with the mode at 58 cm. The catches were very poor in February and were formed of 62-64 cm size groups. In September the catches were good and the predominant sizes were between 50 and 56 cm. In October the catches were dominated by fish with modal lengths at 48 and 54 cm followed by younger fish (20-38 cm) with modal sizes at 28 and 38 cm. The catches in November were constituted by fish with modal lengths at 32, 46, 50 and 54 cm whereas younger fish in the modal sizes at 24 and 30 cm comprised the catches in December. In 1981 the fish were in 22-70 cm size range. The catches in September were represented by multimodal size groups with the major modes at 24, 34, 46, 54 and 60 cm. October had prominent



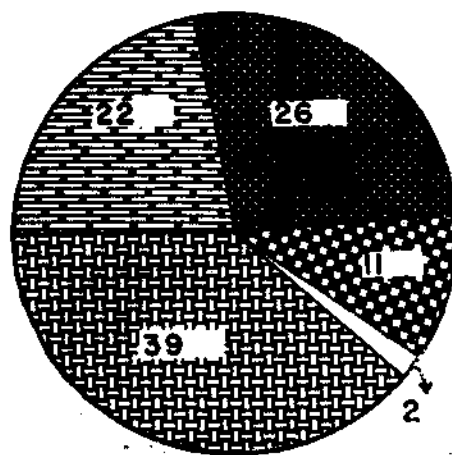
1979



1980



1981



1982

Fig. 5. Percentage composition of different species of tunas in the drift gillnet catch at Mangalore 1979-'82.

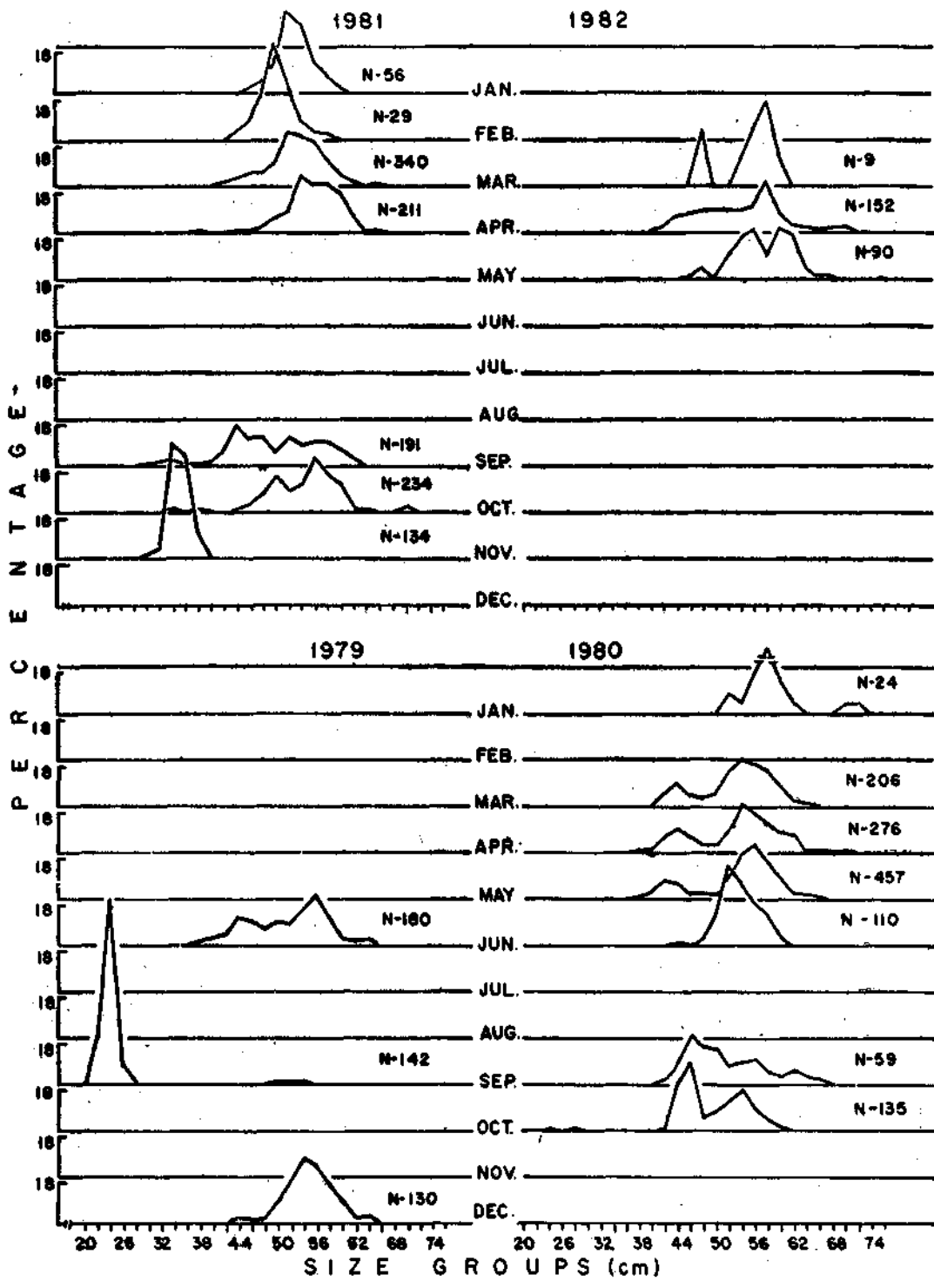


Fig. 6. Monthly length frequency distribution of *E. affinis* taken by purse seiners at Mangalore, 1979-'82.

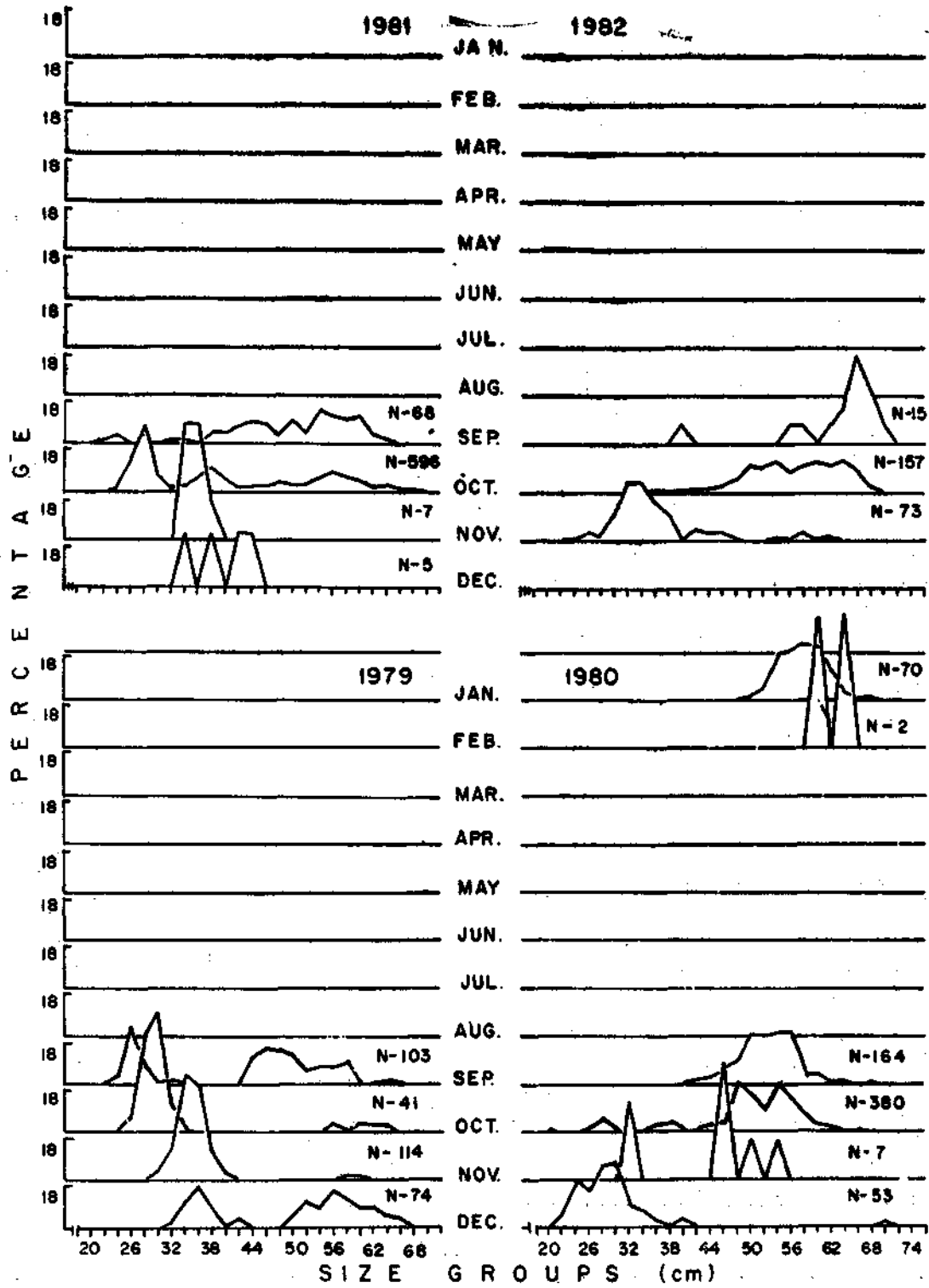


Fig. 7. Monthly length frequency distribution of *E. affinis* taken by drift gillnetters at Mangalore, 1979-'82.

modes at 28, 38 and 56 cm. Catches in November were composed of fish in the range of 34-38 cm. In December the catches were very poor and were represented by fish of 34-56 cm. In 1982 the size range was 24-70 cm. Modes were seen at 40, 56 and 66 cm in September and at 54 and 64 cm in October. Younger fish (24-38 cm) with modal groups at 32-34 cm formed the major portion of the catches in November followed by 40-48 cm and 54-58 cm size groups.

T. tonggol

During 1979 the catches of *T. tonggol* in the drift gill net were very poor and had size range of 36-72 cm (Fig. 8). The sizes were at 62 and 66 cm in September and 54 and 66 cm in October. Five modes at 36, 42, 50, 54 and 60 cm were recorded in November. In December the fish were mostly of medium size (54-60 cm). In 1980 the size range was from 34-74 cm. During January-February the fishery was poor and the sizes were at 60 cm in January and 68 cm in February. In October the catches were good and consisted of fish from 34-66 cm with modal lengths at 48 and 54 cm. The fishery was poor in November and the lengths were at 46, 52 and 70 cm. Fishery in October was mainly supported by modal groups at 58 and 70 cm. Small fish with modal length at 40 cm were also caught in small quantities during this month. In 1981 the size ranged from 26 to 78 cm. Younger fish (26-36 cm) with modal size at 30 and 34 cm entered the fishery in large numbers during October. The other prominent modal groups in other months were at 46, 56 and 64 cm. Medium size (58-66 cm) and large size (68-78 cm) with modal lengths at 60 and 72 cm dominated the catches in November and small fish (34-38 cm) with a mode at 34 cm were also noticed during the month. The catches in December showed multimodes at 42, 52, 56, 66, 72 and 76 cm.

During 1982 the size range was from 28-80 cm. In January catches consisted of fish (38 to 56 cm) with modal length at 42 cm. In September the fishery was poor and the sizes were at 44, 52, 62 and 66 cm. The fishery in October was good and had modal groups at 28, 40, 54, 58 and 66 cm. In November the fishery was fairly good and the catches showed wide ranges from 32 to 80 cm with modal groups at 40, 48, 60 and 70 cm. Sizes in December were at 44, 70 and 76 cm.

A. thazard

In 1980 the size composition of catches of *A. thazard* in the purse seines showed a range of 34-48 cm (Fig. 9). In March sizes were at 44-46 cm. Catches in April had size range of 36-46 cm with modes at 38 and 46 cm and 40-48 cm in May with a single mode at 46 cm.

In October the catches were dominated by modal group at 38 cm. During 1981 the fishery showed a range of 20-40 cm. The catches were represented by bimodal groups at 34 and 42 cm in September and 36 and 40 cm in October. During November small fish with modal length at 26 cm predominated the catches followed by 30 and 38 cm modal groups. In 1982 the size range was from 28-36 cm in October and the dominant mode was at 36 cm.

In the drift gill net landings, during 1979, the size of *A. thazard* varied from 32-42 cm (Fig. 10). In October the catches were very poor and the size was at 40 cm. Modal groups at 40 cm dominated the catches in November and 38 cm in December. In 1980 the size range was from 20-42 cm. Small fish of 20-28 cm formed the major component of the fishery during September-December period. During 1981 sizes were from 22 to 44 cm. Catches in September were constituted by fish with a modal group at 34 cm. In October fish of 40 and 36 cm sizes formed major portion of the catches followed by young fish (22 cm). During 1982 the size range was from 20-46 cm. In September catches had size range of 38-46 cm and showed a major mode at 40 cm. The size range in October was wide from 20-44 cm with two modes at 28 and 36 cm.

A. rochei

During 1980, purse seine catches of *A. rochei* in September had a size range of 20-28 cm with a dominant mode at 24 cm. In October the fish were small (20-26 cm) and had showed a prominent mode at 22 cm. During September-October period of 1981 the catches comprised of fish ranging in size from 24-32 cm with a single mode at 26 cm. In 1982 catches of September showed a size range of 24-30 cm with a mode concentration at 26 cm as in the previous year. In October the fish were of small size (18-20 cm) with a mode at 18 cm (Fig. 11).

In the drift gill nets, in December 1979 the catch of *A. rochei* consisted of fish with a size range of 20-26 cm and a single mode occurred at 22 cm (Fig. 12). During 1982 the catch in September had the size range 26 to 30 cm with a single mode at 26 cm. In October the catches were constituted by small fish (18-28 cm) with mode around 22 cm.

S. orientalis

In the purse seine catch in 1979 this species had a size range of 26-30 cm with a mode at 28 cm (Fig. 13). In the drift gill-net catches in September 1979 this species showed a size of 26-32 cm with a modal group at 38 cm (Fig. 14). This modal group continued to

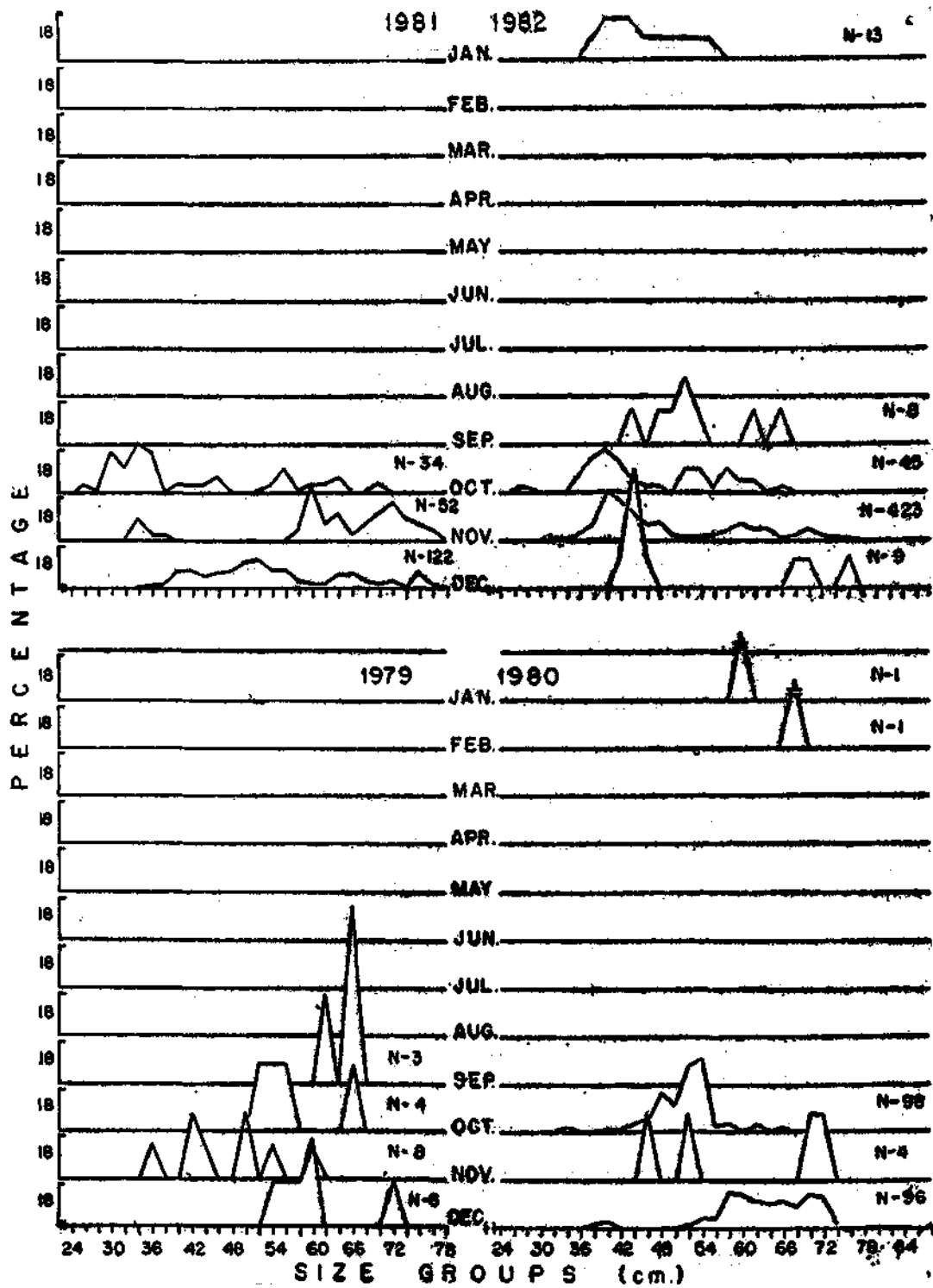


Fig. 8. Monthly length frequency distribution of *T. tonggol* taken by drift gillnetters at Mangalore, 1979-'82.

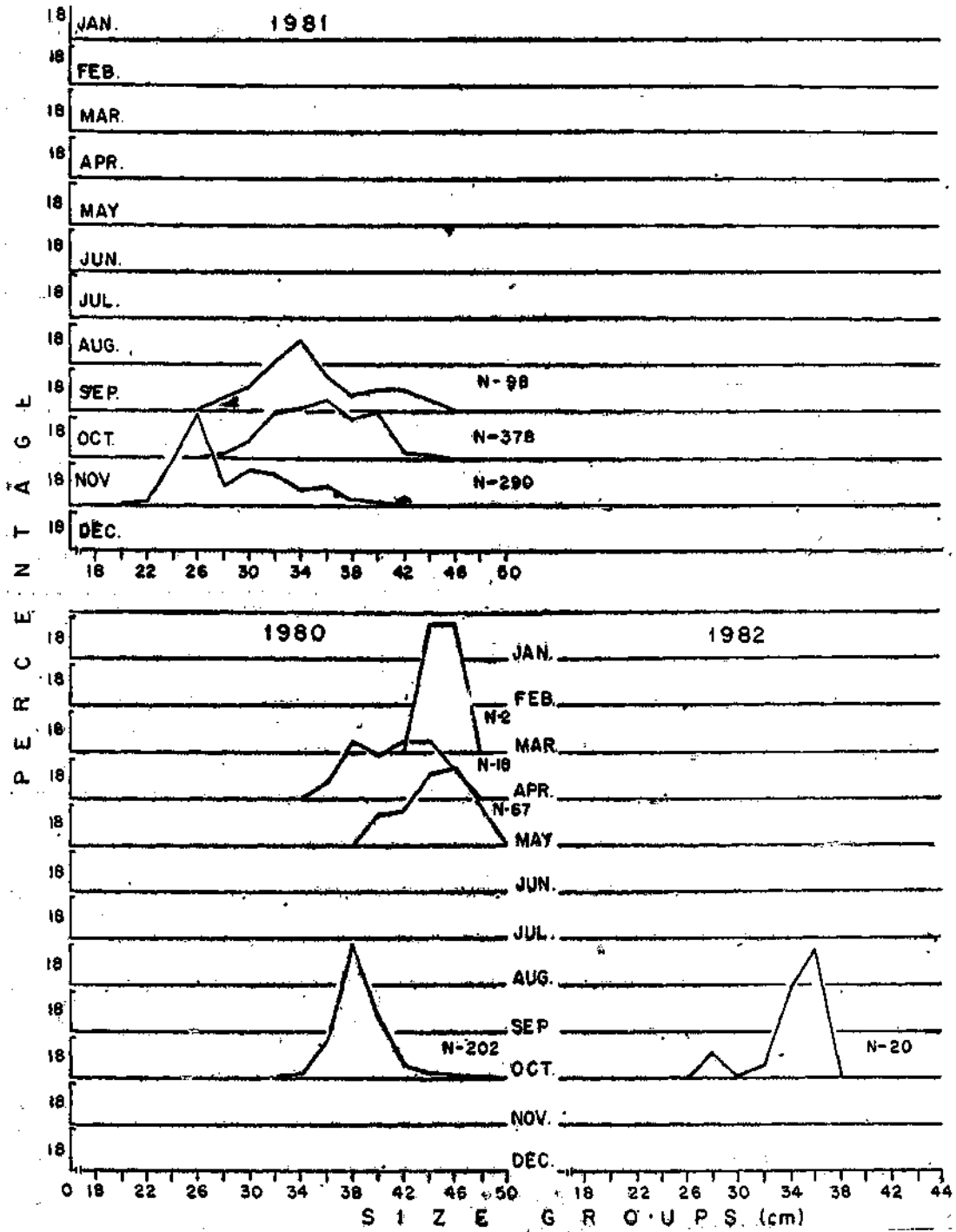


Fig. 9. Monthly length frequency distribution of *A. thazard* taken by purse seiners at Mangalore, 1980-'82.

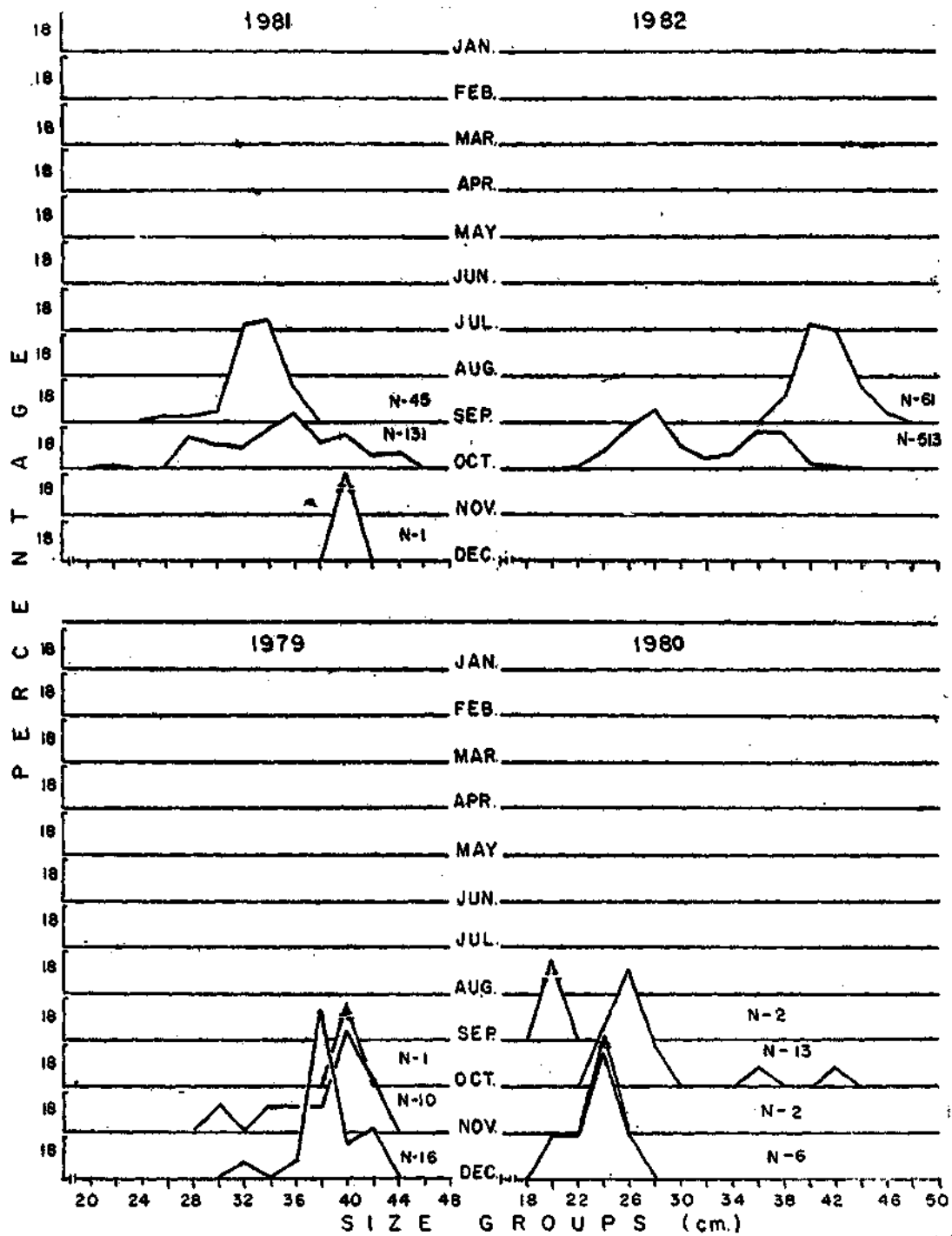


Fig. 10 Monthly length frequency distribution of *A. thazard* taken by drift gillnetters at Mangalore, 1979-'82.

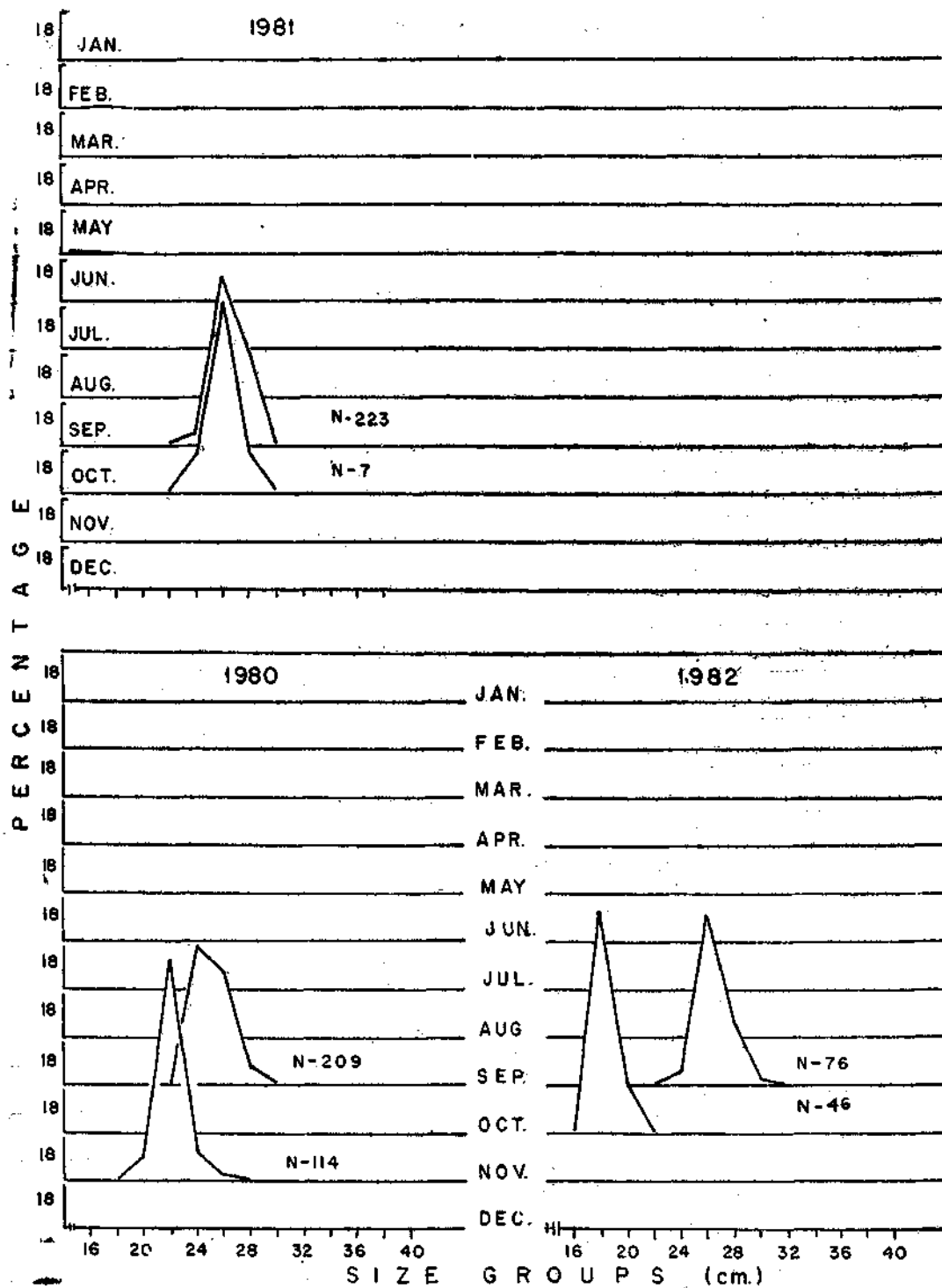


Fig. 11. Monthly length frequency distribution of *A. rochei* taken by purse seiners at Mangalore, 1980-82.

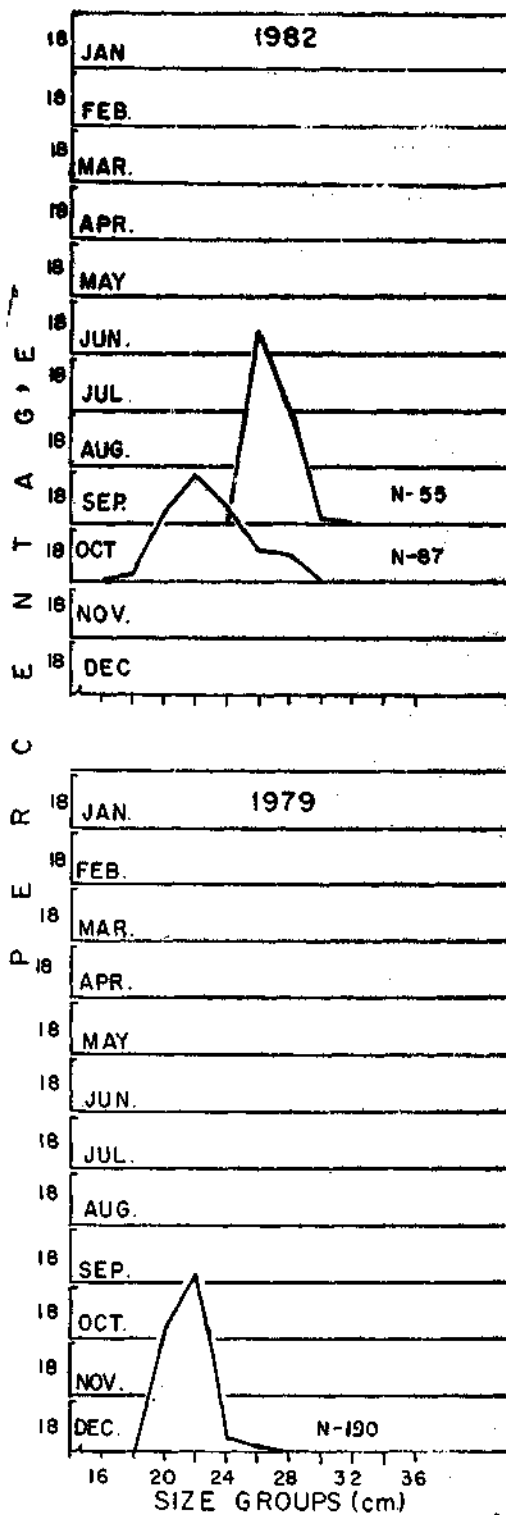


Fig. 12. Monthly length frequency distribution of *A. rochei* taken by drift gillnetters at Mangalore, 1979 and '82.

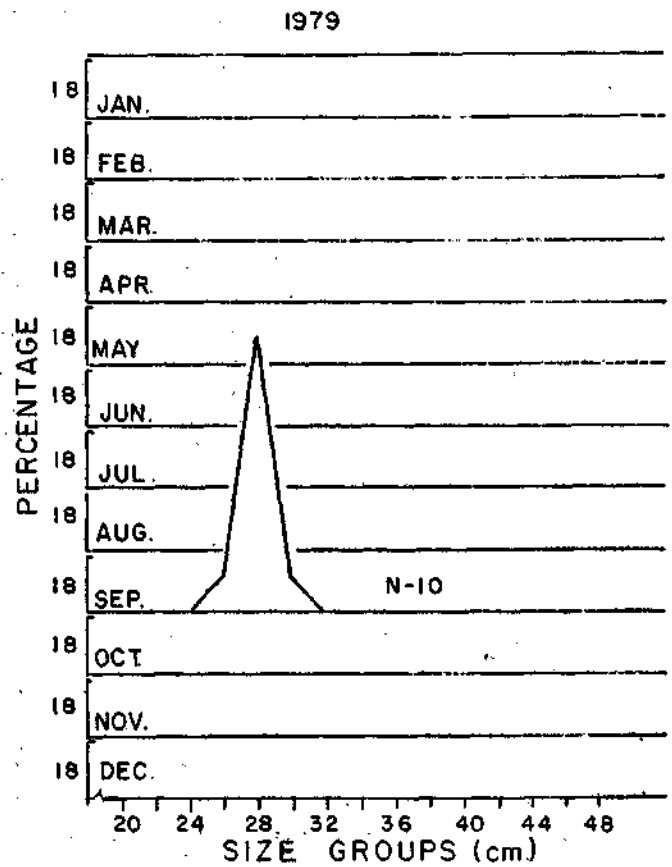


Fig. 13. Monthly length frequency distribution of *S. orientalis* taken by purse seiners at Mangalore, 1979.

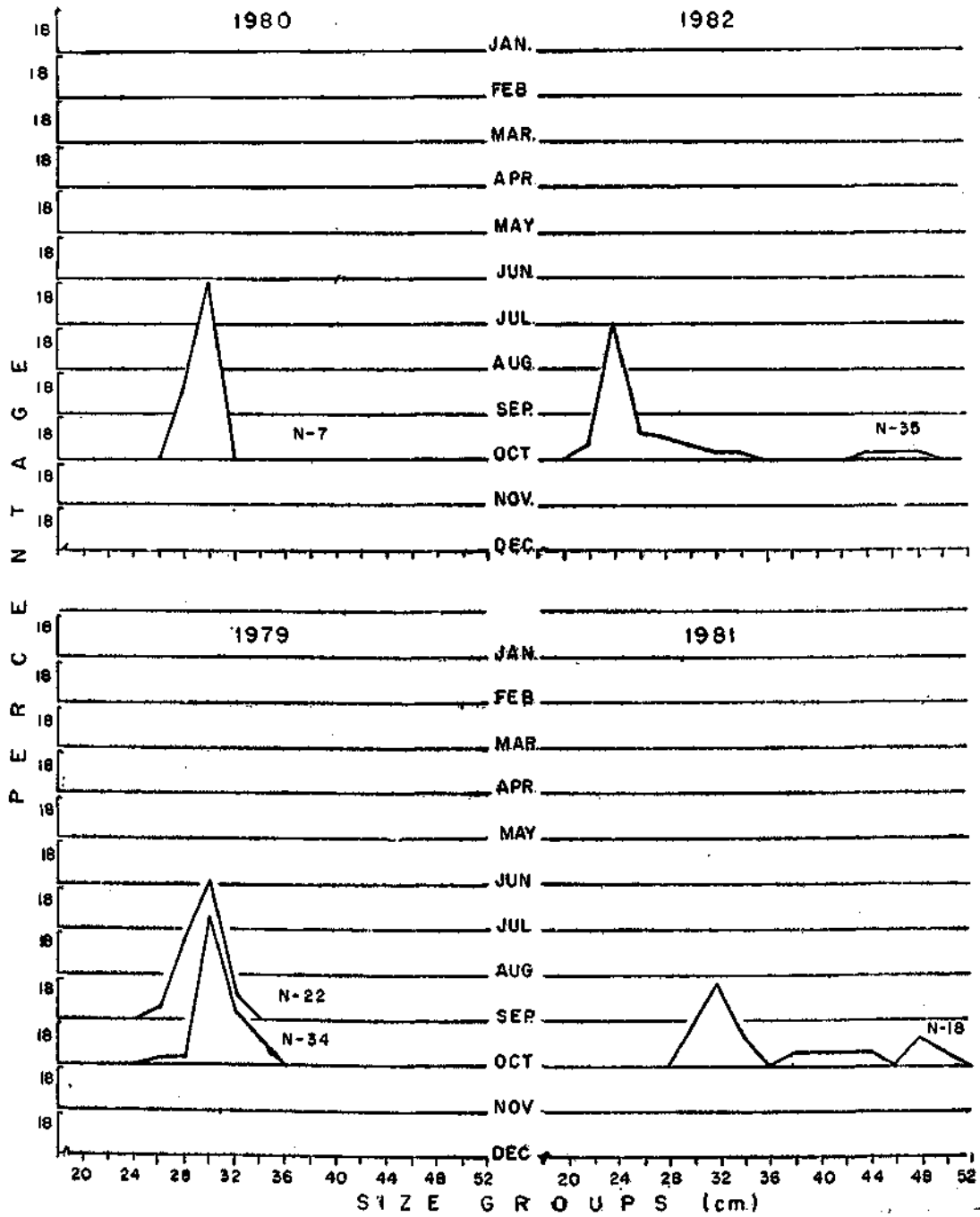


Fig. 14. Monthly length frequency distribution of *S. orientalis* taken by drift gillnetters at Mangalore, 1979-'82.

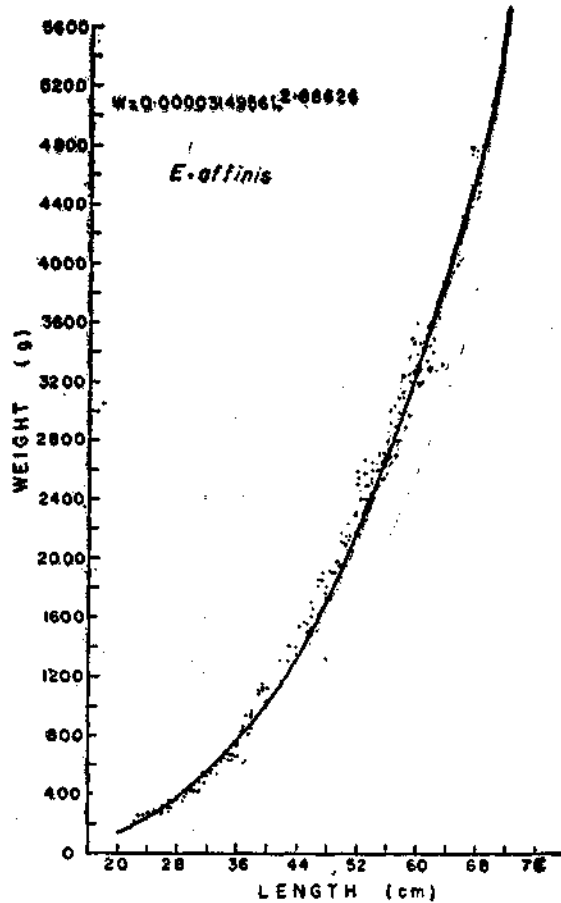
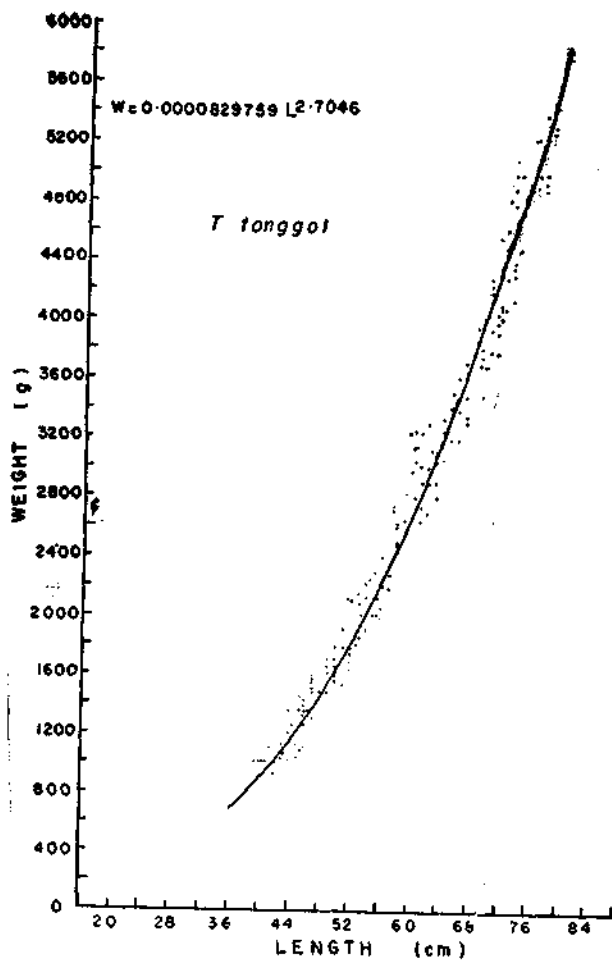


Fig. 15. Length-weight relationship of *T. tonggol* and *E. affinis* at Mangalore, 1979-'82.

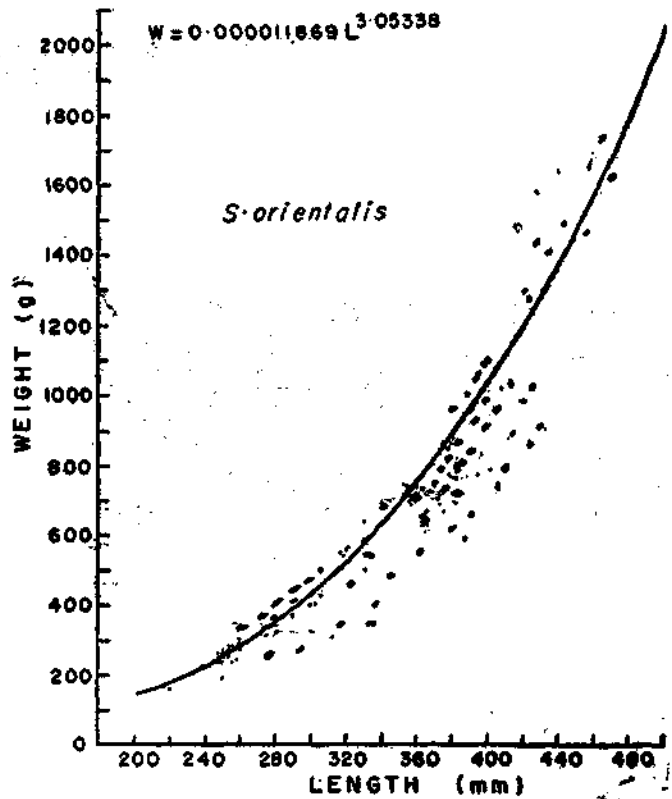
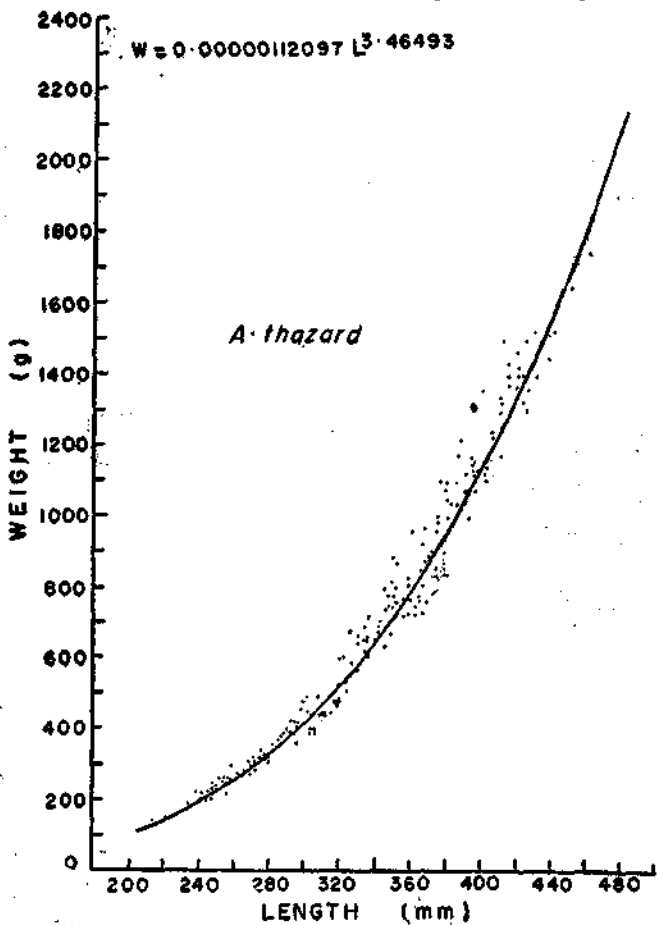


Fig. 16. Length-weight relationship of *A. thazard* and *S. orientalis* at Mangalore, 1979-'82.

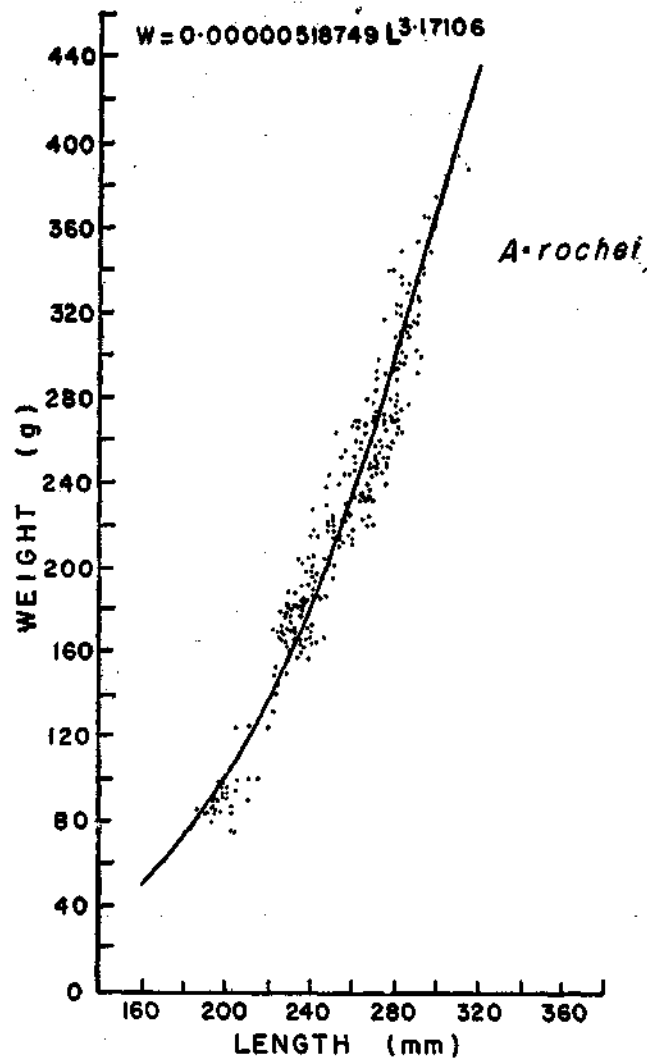


Fig. 17. Length-weight relationship of *A. rochei* at Mangalore, 1979-'82.

dominate during October also when the overall size ranged from 26 to 38 cm. In 1980 the catches in September were composed of small fish (28-30 cm) with a mode at 30 cm. During October, 1981 wide size-range was noticed (30-50 cm) and the modes were at 32, 44 and 48 cm. In 1982 the catches had the size range from 22 to 46 cm of which young fish with mode at 24 cm predominated the catches.

The length-weight relationships of the different species of tunas landed at Mangalore area (Fig. 15-17) are as follows :

<i>E. affinis</i>	$W = 0.0000314956 L^{2.88626}$
<i>A. thazard</i>	$W = 0.00000112097 L^{3.46493}$
<i>A. rochei</i>	$W = 0.00000518749 L^{3.17106}$
<i>S. orientalis</i>	$W = 0.000011869 L^{3.05338}$
<i>T. tonggol</i>	$W = 0.0000829759 L^{2.7046}$

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