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PRESENT STATUS OF EXPLOITATION OF FISH AND SHELLFISH RESOURCES : TUNAS AND BILLFISHES

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ABSTRACT

Despite the fact that several communications in the past have dealt with the trend of tuna fishery at different centres along the west coast of India, no directed attempt has been made till date to study the tuna fishery during the southwest monsoon period along this coast and to synthesise its problems and prospects. The present communication deals with their trend, general fishery, craft and gear employed in the fishing, fishing grounds, seasonal variation in catch, effort and catch rate and characteristics during *premonsoon, monsoon* and *postmonsoon* seasons. In addition, the species composition and length composition of major species during different seasons and available information of the spawning biology of tunas along the west coast of India are also dealt with. The effect of tuna fishing, demand and price structure during monsoon period as compared to other seasons and the management measures are also presented and discussed.

At present, monsoon fishery for tunas is confined to the Kerala Coast along the west coast of India. Continued operation of Pablo boats, motorisation of the traditional crafts and innovation in the gears gave a sudden fillip in tuna production in this State since 1984. Results of study indicate that in other maritime States also, the extended area of operation and diversified fishing through motorisation of country crafts, for high priced larger pelagics including tunas, have enhanced the revenue of the small scale fishery sector. However, in view of the dwindling catch rates observed at certain centres during the present study, caution has to be exercised in promoting indiscriminate motorisation programme in the tuna fishery in the artisanal sector, eventhough no conflict has been reported between the fishermen operating non-motorised and motorised crafts (7 to 24 HP) operating for tunas.

Suitable demarcation of the region between sub-sectors, installation of Fish Aggregating Devices (FADs), diversification of fishing operation by the introduction of multi-day boats for driftnetting, increasing the mobility of purse seiners and intensification of the troll line and handline fishery during monsoon season by sail power are the suggested management measures for augmenting production of tunas during the southwest monsoon period along the west coast of India.

INTRODUCTION

Several communications in the past have dealt with the fishery characteristics, biology and management strategies of tuna fishery from different centres along the west coast of India (Silas *et al.*, 1979, 1984, 1986a, 1986b, 1986c, 1986d; Dhulkhed and Annigeri, 1988; Dhulkhed *et al.*, 1982; Muthiah, 1982, 1986; Saxena, 1984; Silas and Pillai, 1982, 1986a, 1986b; Madan Mohan *et al.*, 1986; James and Pillai, 1986, 1988, 1991; James and Jayaprakash, 1988; Jayaprakash, 1989; James, 1991; James *et al.*, 1986a, 1986b; Gopakumar and Sharma, 1989; Gopakumar *et al.*, 1986; Kurup *et al.*, 1987; Nair *et al.*, 1988; Kumaran *et al.*, 1988; Rao and Alagaraja, 1988; Lipton *et al.*, 1988; Pillai, 1990a, 1990b, 1991; Pillai *et al.*, 1986; Kagwade *et al.*, 1989; Balan *et al.*, 1989; Sivadas and Balasubramanian, 1989; Yohannan and Balasubramanian, 1988, 1989).

The tunas and billfishes landed from the neritic waters of the east and west coasts of India and Lakshadweep by the artisanal sector increased from 20,350 t in 1984 to 31,170 t in 1988. Of these, about 85.6% has been contributed by the tuna fishery along the west coast of India and Lakshadweep.

While examining the motorisation of the country crafts in Kerala, Balan *et al.* (1989) opined that the total marine fish landings were highest during monsoon (July to September) and post-monsoon periods (October to December), followed by summer (January to March) and premonsoon seasons (April-June). Areawise, highest landings were recorded during the monsoon season from the south and central Kerala, while in the post-monsoon season, maximum catches were obtained from the northern Kerala. According to them, the total tuna catch in Kerala by mechanised vessels increased from 2376 t (1980) to 11,960 t (1986) while tuna production by non-mechanised crafts declined from 8235 t (1980) to 2824 t (1986). High catch rates

of tunas by mechanised vessels along the Karnataka and Goa Coasts have been reported (Kurup *et al.*, 1987). In general, it is observed that the motorisation of the country crafts, improvement and innovation of the gears and the implementation of effective operational techniques have paved the way for the enhancement of tuna production along the west coast of India and Lakshadweep, especially in Kerala where active tuna fishing by mechanised crafts and motorised country crafts employing drift gillnets and hooks and lines are in operation during monsoon season. In the present communication, the tuna fishery characteristics and certain aspects of the biology of major species during premonsoon, monsoon and postmonsoon period along the west coast of India and Lakshadweep are comprehensively presented, the effect of tuna fishing during monsoon season on the resource are discussed and management measures are suggested.

Data Base

The present study is based on the tuna fishery data available during the period 1984-88 from Vizhinjam, Cochin, Calicut (Kerala), Mangalore (Karnataka), Goa and Minicoy Island and Agatti Island (Lakshadweep). In order to make the report comprehensive, available published information on the tuna fishery from the maritime States of Maharashtra and Gujarat along the northwest coast of India has also been included.

Observations

Crafts, gears and fishing grounds

The details of major crafts and gears employed in the tuna fishery along the west coast of India are presented in Table 1. Recent improvements in the crafts and gears include the fibreglass coated plank built boats of 5.5 m OAL with OB engines, catamarans fitted with OB engines, capable of reaching the new fishing grounds at 60-80 m depth zone for drift gillnet and hooks and line operations off Vizhinjam (Gopakumar and Sharma, 1989); introduction of plank built boats ('Kettuvallams') of 9 m OAL, with trasorn sterns to accommodate the OB engines, usage of mariner's compass for tuna fishing operations in the offshore areas and increased use of ringnet, which surround tuna shoals both horizontally and vertically (Yohannan and Balasubramanian, 1989; Sivadas and Balasubramanian, 1989) at Calicut.

Traditional fishing ground for tuna fishery was upto 40 m depth zone. But with the introduction of mechanisation of country crafts and innovations in the gears the tuna fishing operations have extended upto 80 m depth zone.

Gearwise catch and effort at different centres

Vizhinjam : The monthwise average catch, effort and C/E of tunas and the average monthwise tuna catch in the total fish catch are given in Figs. 1 and 2. The effort ranged from 5896 units in June to 9548 units in October. The average catch varied between 100.8 t in January to 333.5 t in September. The lowest catch rate of 13.6 kg was in January and the highest (41.4 kg) in September. The productive months were observed to be May and September-October with regard to the tunas. The average catch of billfishes ranged from 0.3 kg in August to

Table 1. *Crafts and gears engaged in the tuna fishery in India*

Crafts				Gears			
Type	OAL (m)	Material	Power (HP)	Length (m)	Depth (m)	Mesh size (cm)	No. of crew
Pablo boats	7.6-9.1	Wood	Inboard engine (24-45)	Drift Gillnets (800-1200)	5-8	6.5-14.0	3-4
Plank built boats/Dugout Canoes	5.5-9.0	Wood	OB Engine (7-12)	-Do-	-Do-	-Do-	3-10
Purse seiners	13.0-14.0	Wood	105-120	Purse seine (400-600)	40-60	1.4	16-25
Pole & line Boats	7.9-9.1	Wood	10-40	Pole = 3-4	-	-	10-15
Troll line Boats	3.0-8.8	Wood	Sail/OB Engine (7-12)	Troll line = 3-5	-	-	4-10
Catamaranas	7.5-8.4	Wood	OB Engine (7-12)	Drift gillnets & Hooks and lines			Variable

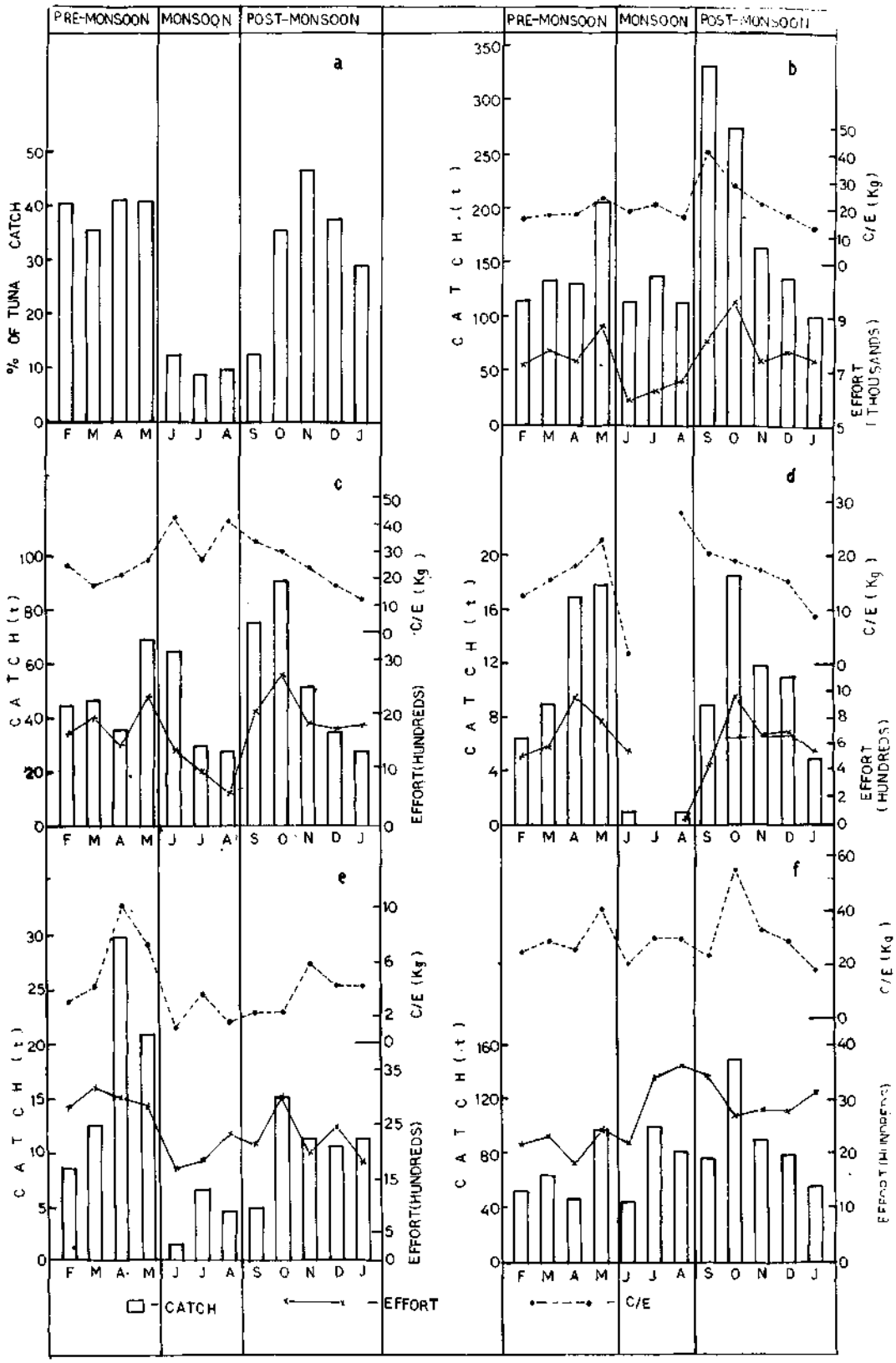


Fig. 1 a. The monthwise percentage of tuna catch in the total fish; b. Monthwise average catch, effort and C/E of tunas; c - f. Average monthly catch, effort and C/E of tunas in different gears (c = drift net, motorised; d = driftnet, non- motorised; e = Hooks and line, non-motorised; f = hooke and line, motorised) at Vizhinjam 1984-88.

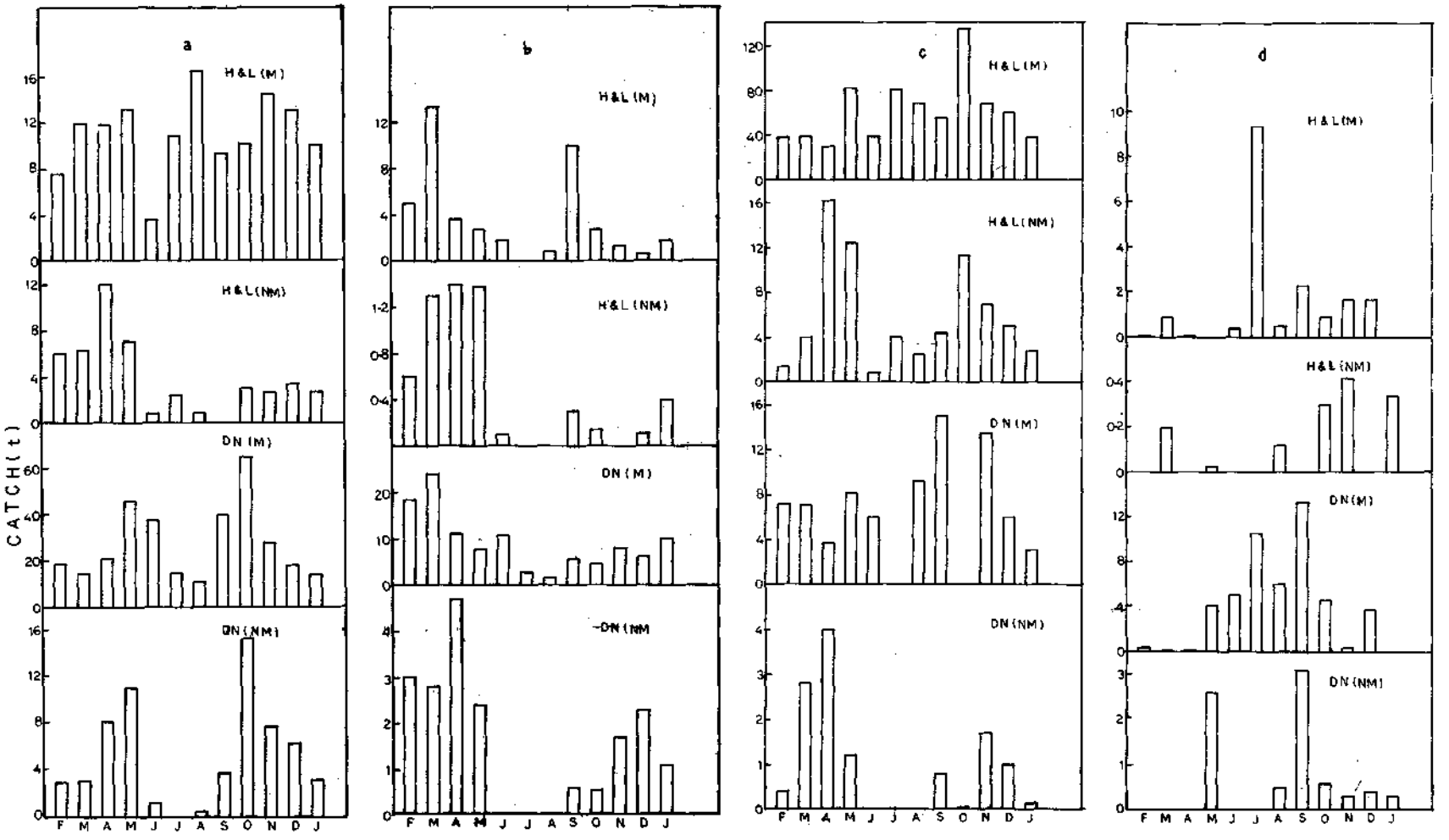


Fig. 2. The gearwise and monthwise catch of different species: a = *E. affinis;* b = *A. thazard;* c = *A. rochei;* d = *S. orientalis* at Vizhinjam.

7.9 kg in January. The peak fishing months were January to April. Maximum tuna catch was landed by hooks and lines (52.7%) operated from motorised crafts followed by drift nets operated from motorised crafts (33.6%) Hooks and lines and drift nets operated from non motorised crafts yielded only 7.7% and 6.0% respectively of the total tuna catch. Motorised hooks and lines landed 41.3% of the billfishes and motorised drift nets landed 23% of the total billfish catch.

The annual effort by non-motorised drift gillnetters varied from 1961 units in 1987-88 to 10,722 units in 1984-85. A reduction in the effort was seen from 1984-85 onwards. Maximum catch was in 1985-86 (175.9 t) and minimum catch was during 1987-88 (32.6 t). However, the C/E ranged from 13.9 kg per unit in 1984-85 to 21.3 kg per unit in 1985-86. May was the productive month in tuna fishery by these crafts. An increasing trend in the effort of motorised drift netters was observed from 1985-86. The annual effort ranged from 6677 units in 1984-85 to 26,515 units in 1987- 88. The annual catch ranged from 242.5 t in 1984-85 to 764.3 t in 1987-88 and the catch rate varied from 21.4 kg in 1986-87 to 36.3 kg in 1984-85. The peak catch and catch rates by motorised drift gillnetters were during May-June and September-October. The annual effort of hooks and line operated from non-motorised crafts ranged from 71,575 units in 1984-85 to 7746 units in 1987- 88. The tuna catch ranged from 201.9 t in 1984-85 to 41.0 t in 1987-88. The C/E showed a marginal increase from 2.8 kg (1984-85) to 14.1 kg (1987-88). The annual effort of motorised hooks and line ranged from 12,734 units (1984-85) to 37,940 units (1987-88). Range of catch and catch rates during these years were 236.3 t to 1154.5 t and 18.6 kg to 32.8 kg respectively.

TABLE 2. *Catch, effort expended and C/E of tunas in the purse seine fishery at Cochin 1984 - 88*

	Season	Catch (t)	Effort (units)	C/E (kg)
1984-85	PRM	-	4203	-
	PTM	-	4428	-
1985-86	PRM	16.4	3851	4.3
	PTM	265.1	2315	114.5
1986-87	PRM	261.2	1286	203.4
	PTM	1085.9	690	1573.0
1987-88	PRM	73.5	1018	72.2
	PTM	-	643	-

(PRM = Premonsoon season; PTM = Postmonsoon season)

Cochin : Monthwise total landings of tunas and billfishes by the drift gillnet fishery and purse seine fishery, effort expended and C/E are presented in Figs. 3, 4 and 5. The total catch and catch rate were relatively high during April-June period. In all the years considered, the C/E was maximum in June, except in 1985-86 when peak catch rate was recorded in April. Relationship between the monthwise effort and trend of monthly catch rate in the drift gillnet fishery indicated that the effort expended and catch rates were relatively high during April-August. Purse seine operations were confined during premonsoon and postmonsoon months only. The average effort expended during the premonsoon season was realtively high when compared to that of the postmonsoon months (Table 2). The catch and catch rate during the postmonsoon season were 280% and 390% respectively higher than that of the premonsoon season.

Calicut : The monthly catch of tunas and effort expended during different years are presented in Fig. 6. Peak catch was recorded in October during the years 1984-86 when the effort was also high. Minor peaks were observed in March-April period also. In 1987- 88, peak catch and effort was in July. Only drift gillnetters were employed in the tuna fishery.

Mangalore : The catch, effort and C/E in the drift gillnet fishery and purse seine fishery are presented in Fig. 7. Both the gears were operated during the premonsoon and postmonsoon months. October was found to be the productive period which accounted for 71% of the total catch followed by November. In the purse seine fishery, September and October during the postmonsoon season and March during the premonsoon period recorded high catch and catch rate.

Goa : The drift gillnet operations were confined to the months of Sepetmber to January. As in the case at Mangalore, maximum catch and catch rate were recorded during October followed by November (Table 3).

Minicoy and Agatti Islands (Lakshadweep) : Monthwise total tuna landings and the effort expended by the pole and line fishery and troll line fishery along with the C/E realised are presented in Figs. 8, 9 and 10. In the pole and line fishery at Minicoy, the catch and catch rate were relatively

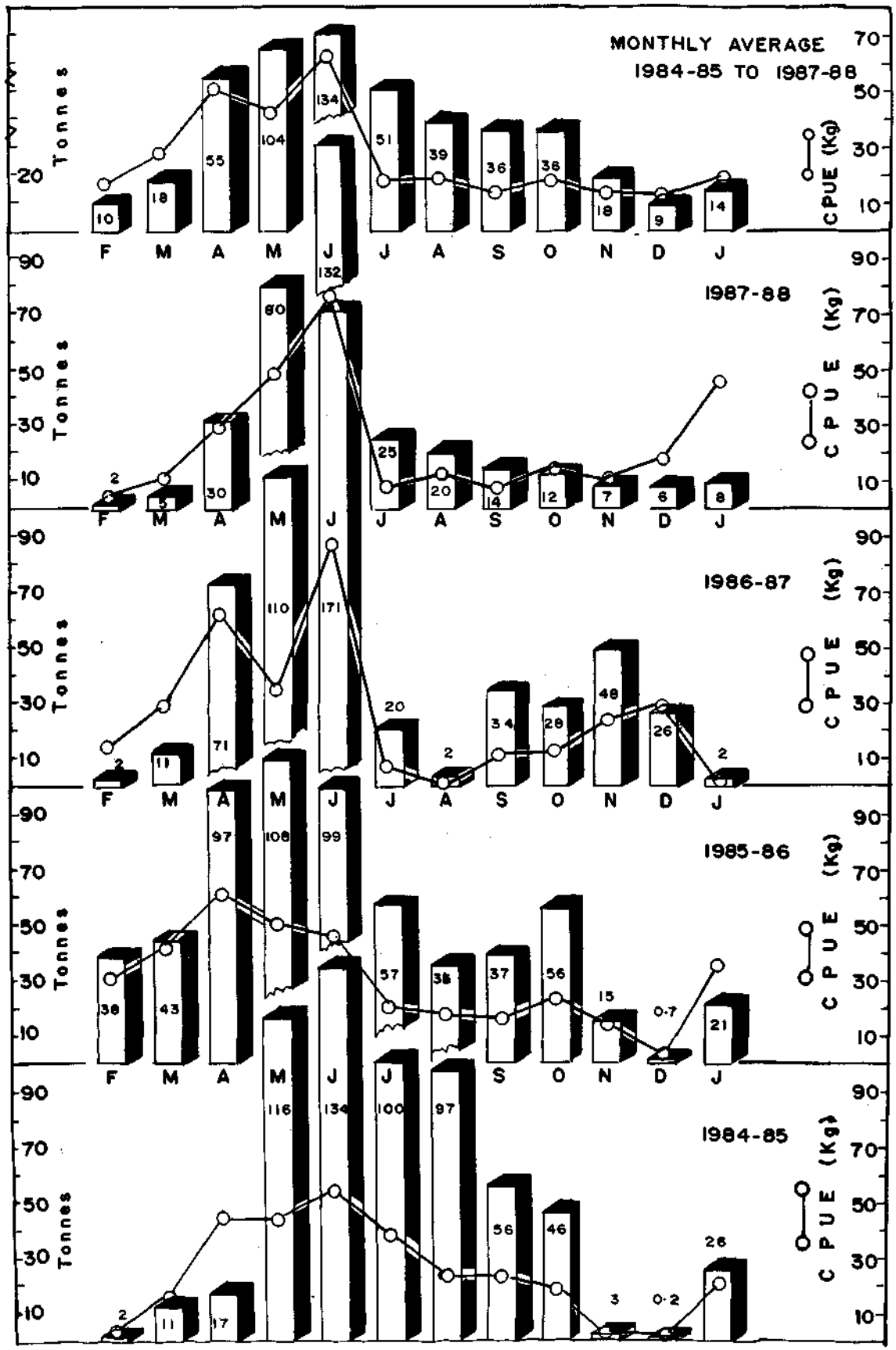


Fig. 3. a - d : monthwise catch and C/E of tunas and billfishes in the drift gillnet fishery off Cochin, 1984-88; e : average monthly variation of these parameters during the same period.

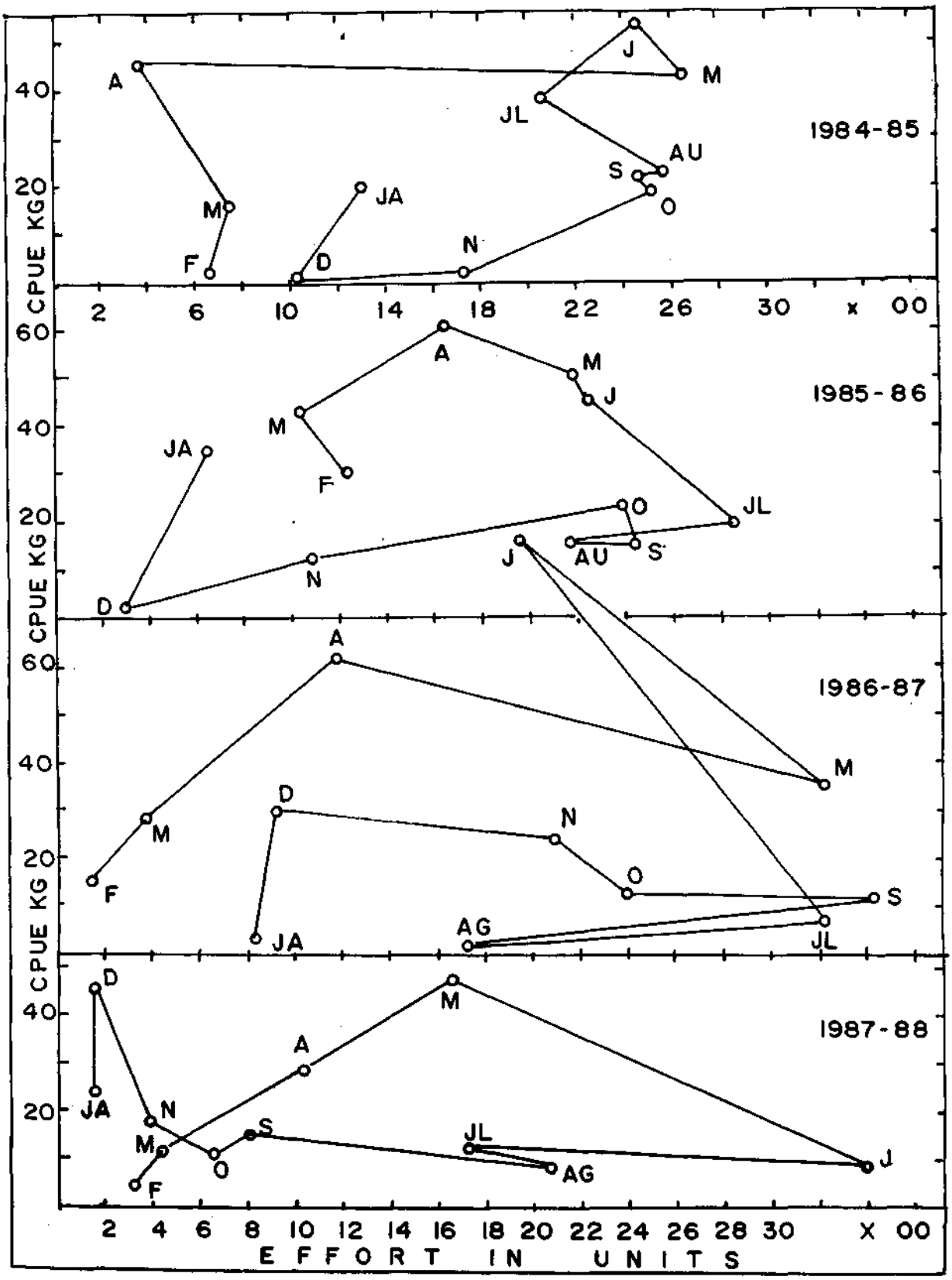


Fig. 4. Relationship between monthwise trend of effort expended and C/E of tunas in the drift gillnet fishery off Cochin 1984-88.

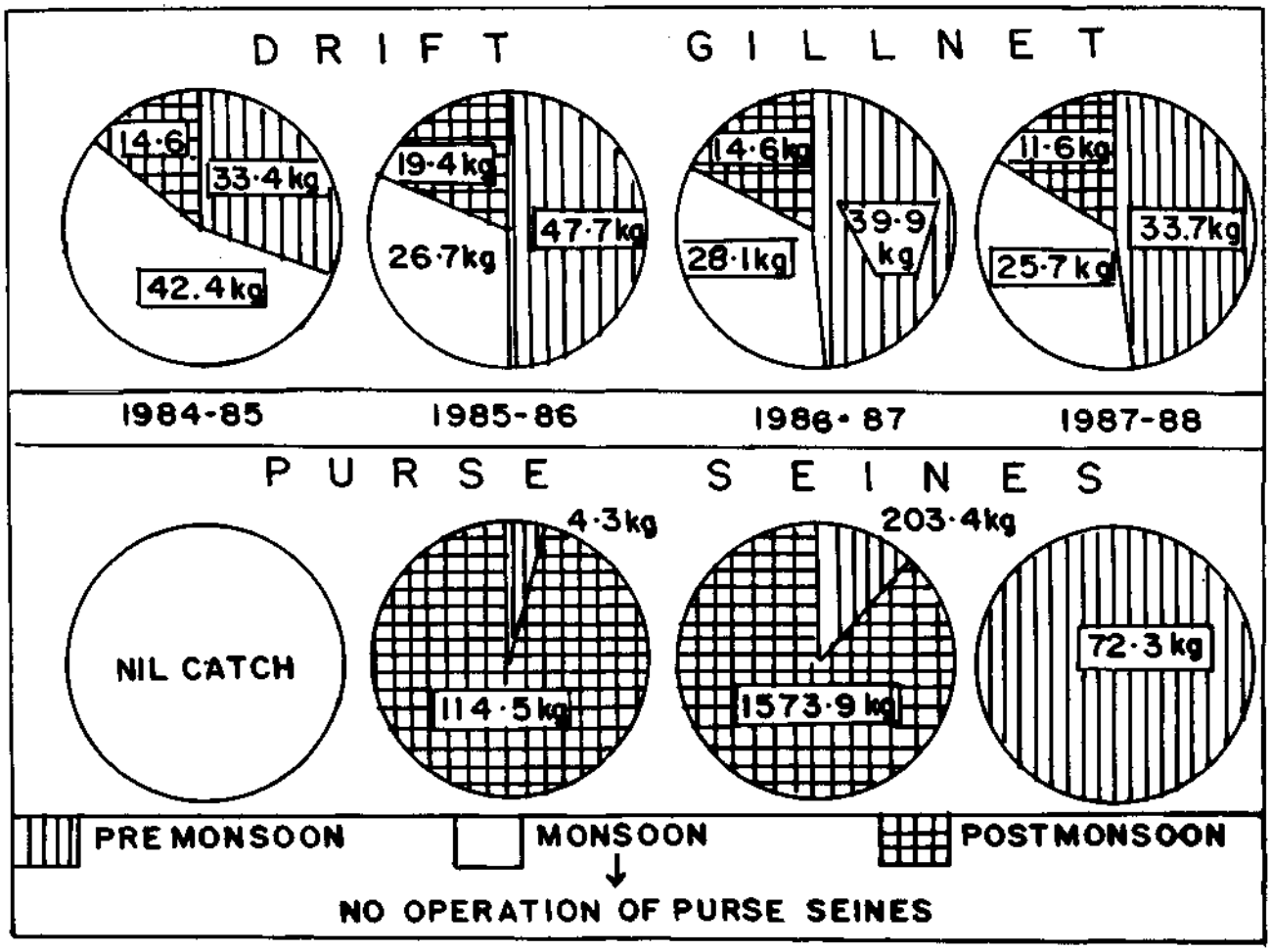


Fig. 5. Seasonal average values of C/E of tunas in the drift net fishery and purse seine fishery off Cochin, 1984-88.

high during January to April period of every year. During monsoon season, operation of pole and lines are suspended. In the troll line fishery, effort expended was high during monsoon months in all the years and the catch and catch rates were also high during the monsoon months. At Agatti, in the pole and line fishery, the catch, effort expended and C/E were relatively high during January-April.

TABLE 3. *Gearwise percentage composition of different species of tunas at different centres*

Centre	Gear*	*E. affinis*	*A. thazard*	*A. rochei*	*S. orientalis*	*T. albacares*	*T. tonggol*	*K. pelamis*
Vizhinjam	DGN (M)	54.2	18.9	13.1	8.1	1.1	4.2	0.4
	DGN (NM)	58.3	18.3	11.8	7.1	1.4	3.1	-
	HL (M)	14.2	4.8	77.0	1.9	0.8	1.0	0.3
	HL (NM)	35.9	4.5	52.6	0.9	2.4	3.1	0.6
Cochin	DGN (M)	72.1	19.1	0.8	0.8	4.0	2.9	0.3
	PS (M)	50.5	43.2	6.3	-	-	-	-
Calicut	DGN (M)	72.1	5.3	-	0.1	8.8	2.2	-
Mangalore	DGN (M&NM)	39.9	3.0	0.7	0.3	2.4	53.7	-
	PS (M)	72.0	24.1	3.7	0.1	-	-	0.1
Goa	DGN (M&NM)	36.7	13.5	-	3.9	-	45.9	-
Minicoy & Agatti	PL & TRL	4.0	1.8	-	18.0	-	-	76.2

* DGN (M) = Drift gillnet, mechanised; DGN (NM) = Drift gillnet, non-mechanised; HL (M) = Hooks and line, mechanised; HL (NM) = Hooks and line, non-mechanised; PS (M) = Purse seine, mechanised; PL = Pole and line; TRL = Troll line.

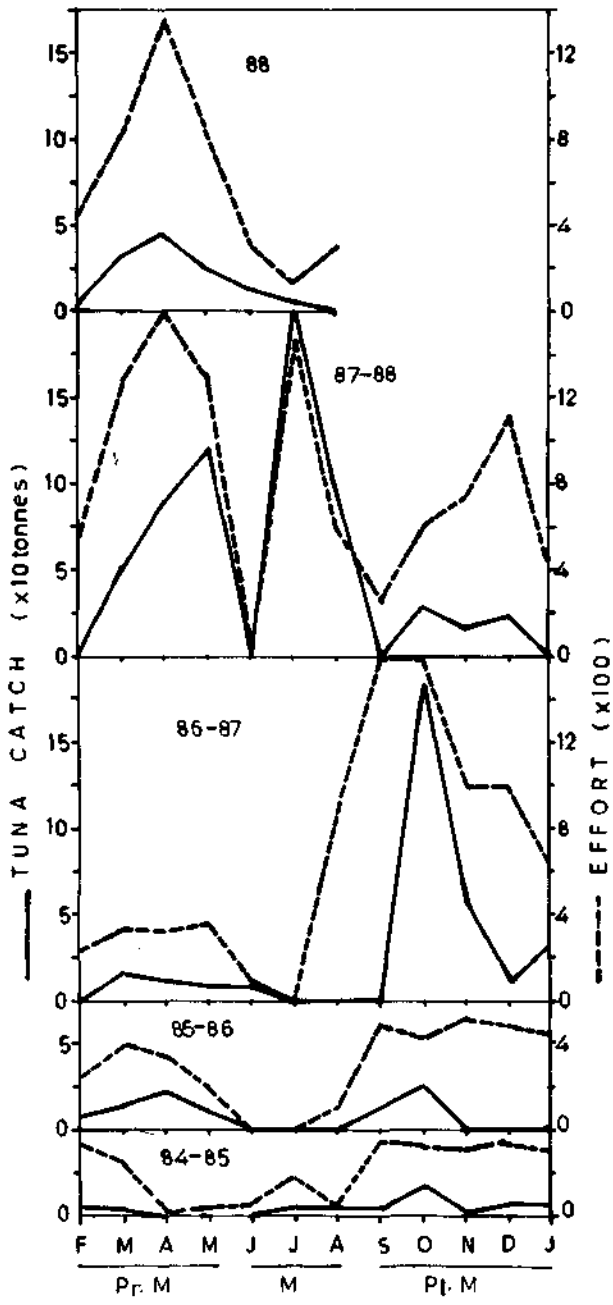


Fig. 6. Monthly total tuna catch and effort during 1984-88 at Calicut.

Seasonal Variation in Effort, Catch and Catch Rates (Gearwise)

Average gearwise catch rates of tunas for the three seasons for the period 1984-88 at the five centres are presented in Fig. 11. The tuna fishery during monsoon is found active at Vizhinjam (fibreglass coated plywood boats and catamarans with OB engine - Drift gillnets and hooks and line), Cochin (Pablo boats - Drift gillnets), Calicut (Plank-built boats with OB engine - Ring nets) and at Minicoy (Surface troll line fishery).

At Vizhinjam, maximum catch was landed during the postmonsoon period (41.6%), followed by premonsoon period (35.9%). Eventhough the tuna catch during the monsoon period was low, the C/E was higher (19.5 kg) than that in the premonsoon period (18.9 kg), with the maximum of 22.0 kg in July. Billfish catch was maximum during premonsoon period (54.9%). Gearwise catch indicated that maximum catch in the non-motorised drift net was in the premonsoon season (51.8%) followed by postmonsoon (46.0%). In the motorised drift net fishery, postmonsoon period contributed to the bulk of the catch (41.3%), followed by the premonsoon period (36.2%). The catch contribution during the monsoon period by the drift gillnetters was relatively low. Subsequent to the lift of ban on fishing operations in 1987, the catch rate of non-motorised drift gillnetters were 17.8 kg, 3.7 kg and 16.7 kg during the premonsoon, monsoon and postmonsoon seasons. On the other hand the catch rate of motorised gillnetters were 25.6 kg, 39.0 kg and 26.4 kg during the above three seasons.

The highest catch of non-motorised hooks and lines was obtained during the premonsoon period (57%) followed by postmonsoon period (33.6%). In motorised hooks and lines, the post-monsoon period contributed the maximum tuna catch (42.6%), followed by the premonsoon period (30.8%). The catch rates of non-motorised hooks and lines were 6.1 kg, 2.0 kg and 4.7 kg respectively for the premonsoon, monsoon and postmonsoon periods; the same for the motorised hooks and line units were 30.1 kg, 24.7 kg and 30.8 kg respectively for the above three seasons (Figs. 1, 2, 11).

At Cochin, drift gillnetters were in operation throughout the year, while purse seine operations were confined to the pre and post monsoon seasons only. Hence, detailed analysis of seasonal trend in catch, effort and C/E in this study pertains to drift gillnet fishery. The average C/E value for tunas during the premonsoon, monsoon and postmonsoon periods in this fishery were 39 kg, 31 kg and 15 kg, indicating the productive period to be from February to May (Figs. 11, 12). However, in the purse seine fishery, the average C/E value as high as 845 kg was recorded during the postmonsoon season (September-January).

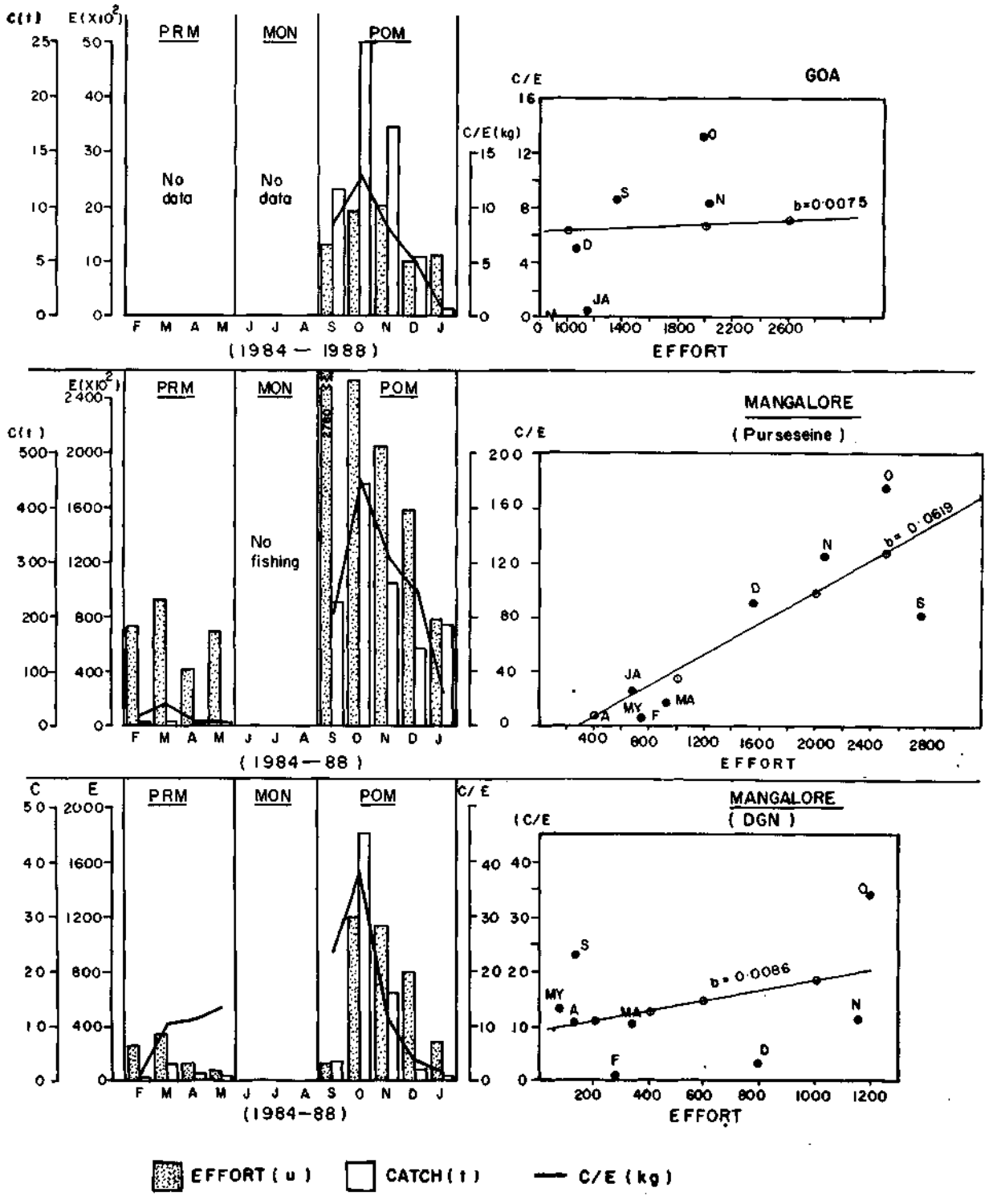


Fig. 7. Monthly catch and C/E of tunas and relationship between C/E and effort in tuna fishery at Mangalore and Goa, 1984-88.

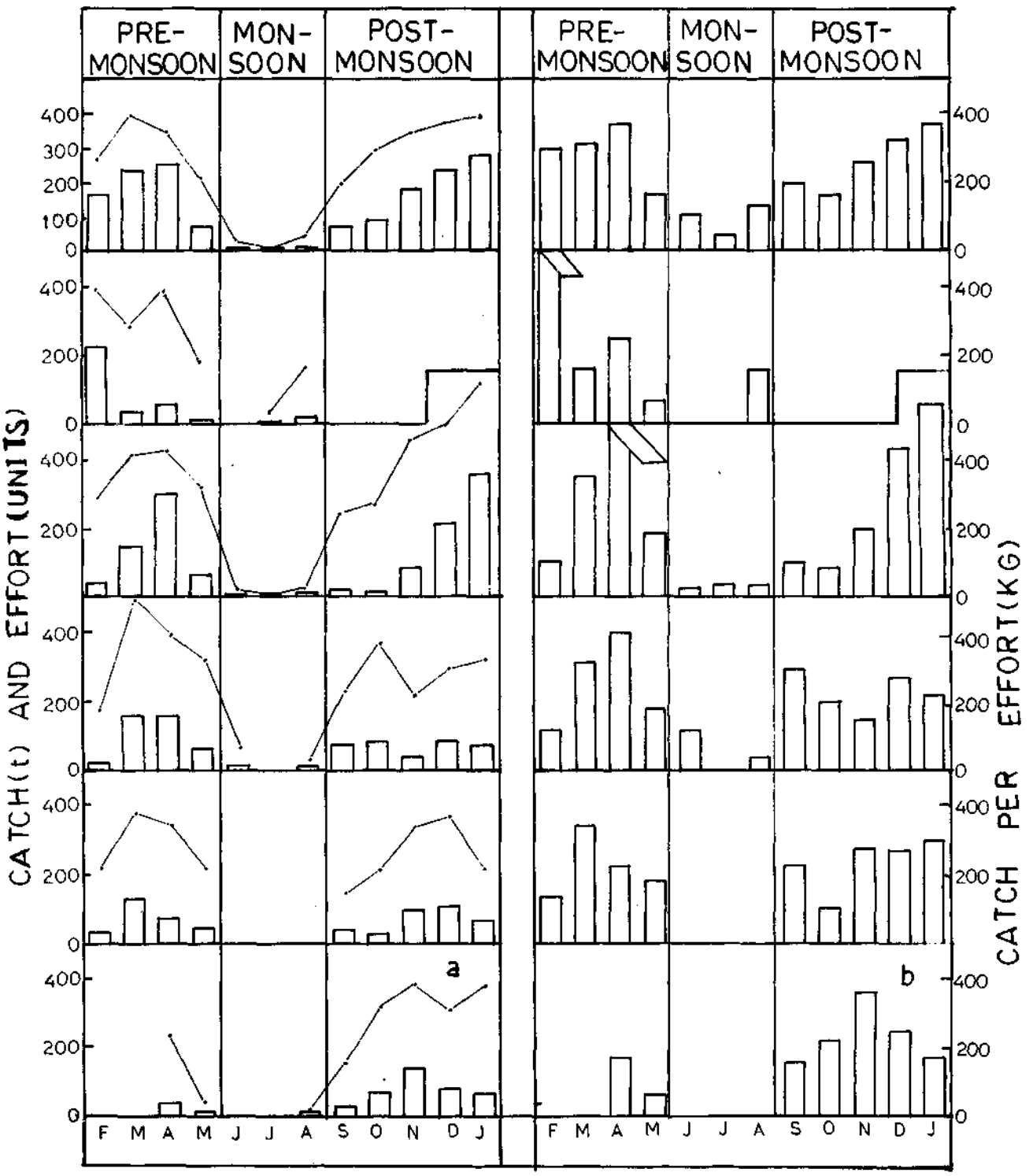


Fig. 8 a & b : Monthwise catch, effort and C/E in the tuna pole and line fishery, Minicoy 1984-88. Monthly averages are shown in the upper panel.

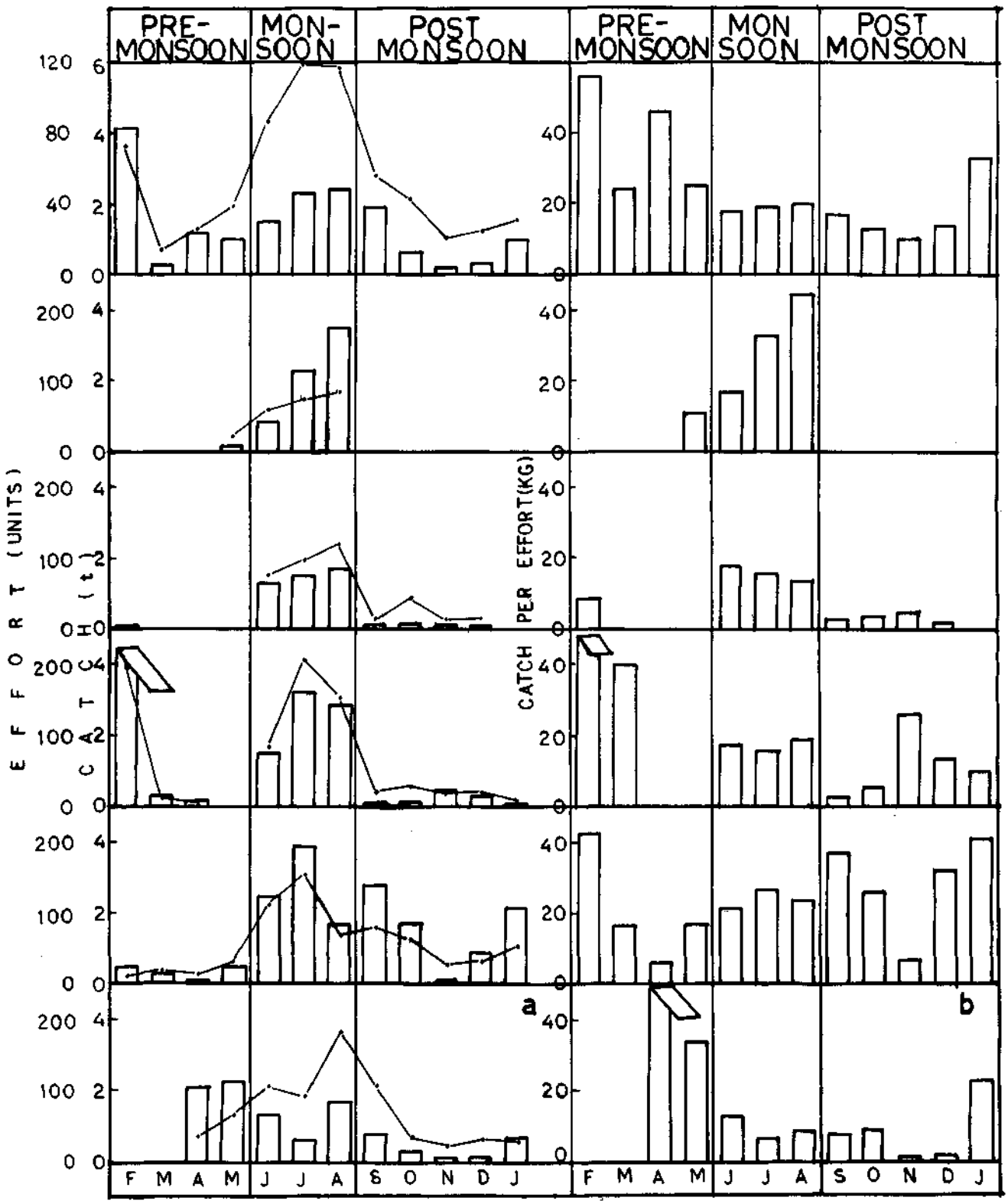
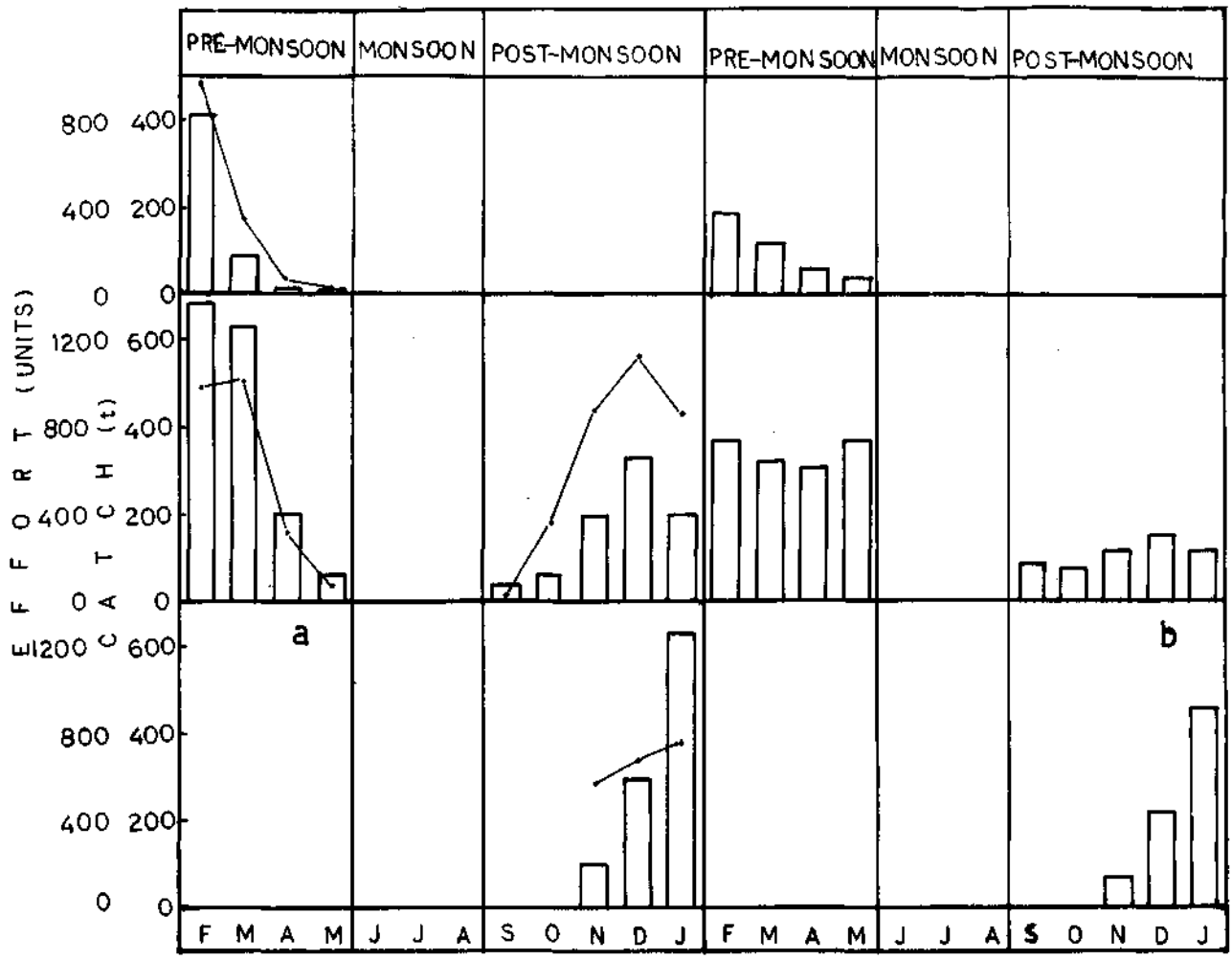


Fig. 9 a & b : Monthwise catch, effort and C/E in the troll line fishery, Minicoy 1984-88. Monthwise averages are shown in the upper panel.



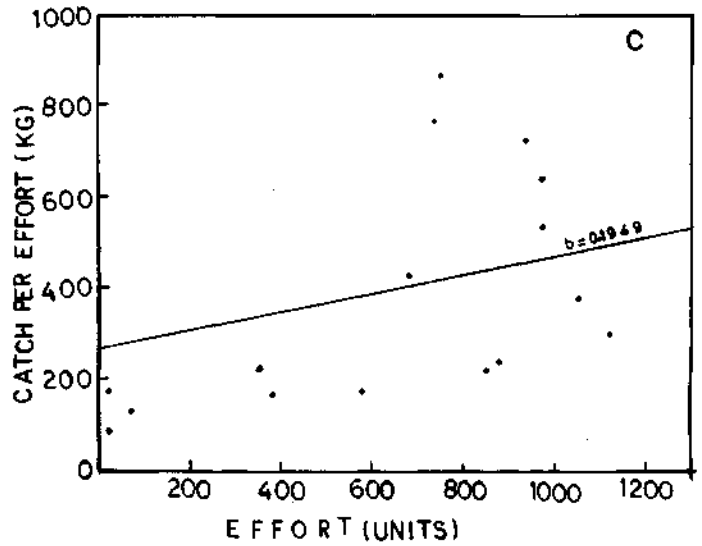


Fig. 10 a & b : Monthwise catch, effort and C/E in the pole and line fishery, Agatti 1984-88; c. Effort - C/E relationship in the pole and line fishery.

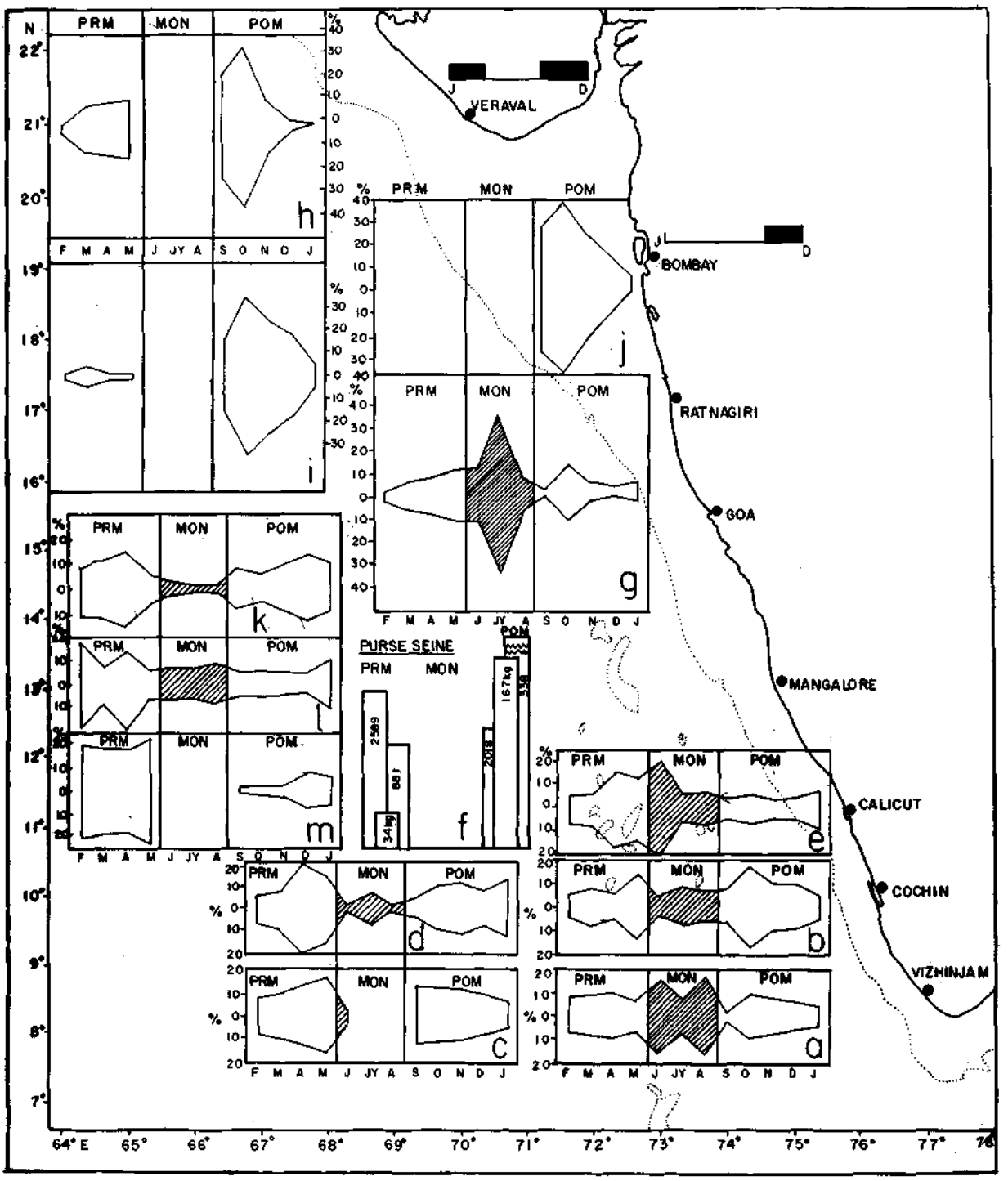


Fig. 11. Average C/E of tunas observed at different centres during the premonsoon, monsoon and postmonsoon seasons, 1984-88.

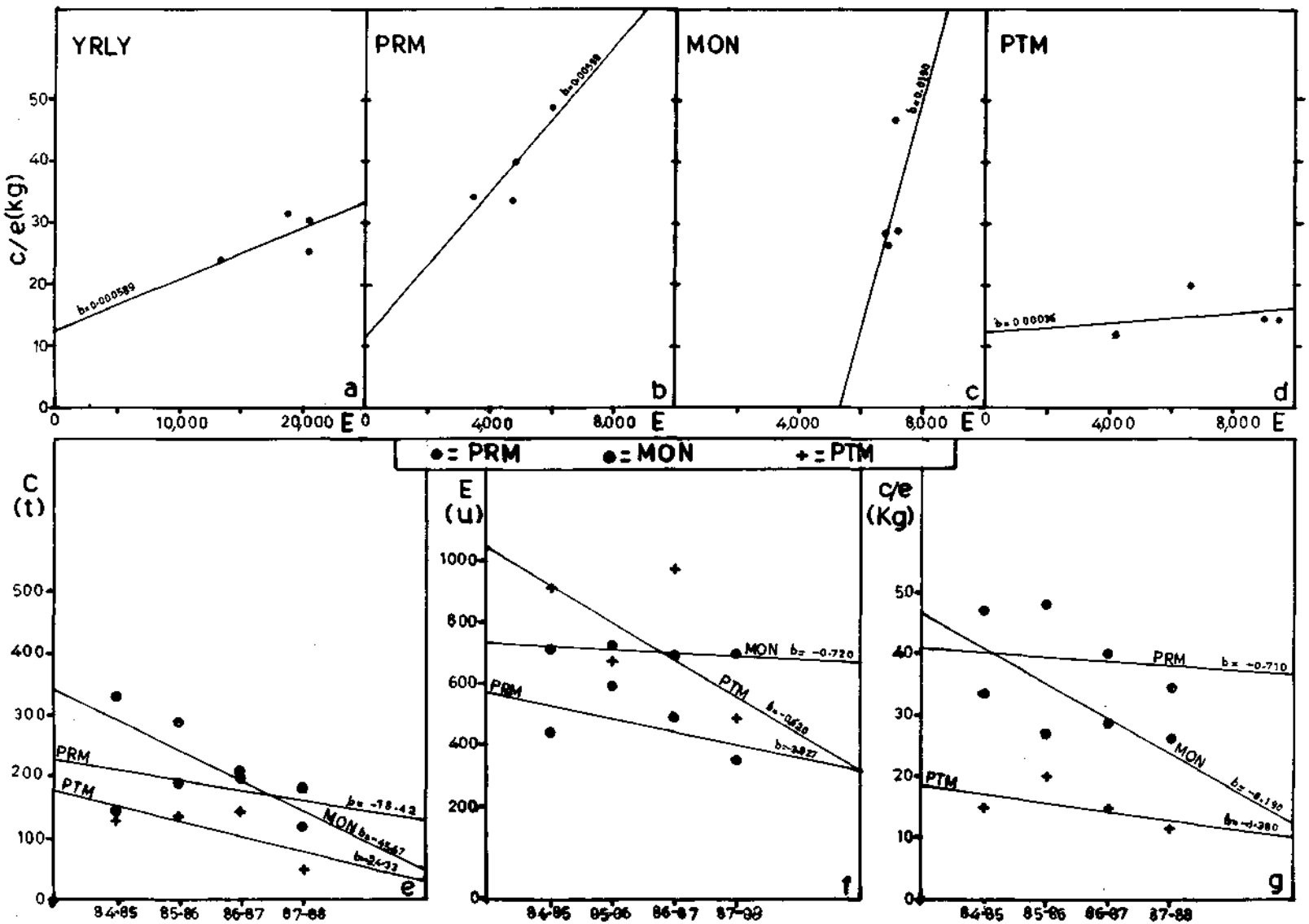


Fig. 12 a - d : Relationship between the annual and seasonal trend of C/E and Effort distribution in the drift gillnet fishery at Cochin 1984-88; e - g : seasonal trend of catch, effort and C/E of tunas in the drift gillnet fishery over time at Cochin.

Regression analysis was carried out to study the trend of fishery during different years and three seasons. Although the relationship between the catch, effort and C/E indicated a downward trend, the relationship between the effort and C/E was positive for all the periods considered. Total annual C/E values tended to increase with increase in fishing effort and during monsoon both the C/E and effort expended were relatively high.

The data on the tuna catch at Calicut during different periods of all the years are given in Fig. 13. It is evident that maximum catch was recorded during the premonsoon period and minimum during the postmonsoon period. The maximum C/E was observed during the monsoon period and the minimum in the postmonsoon months. The trend of changes in the catches in different periods over the years was studied using regression of catch on time. A definite increasing trend in all the periods was observed, with only slight variation in the tuna catch rate. Increase was fast in the premonsoon period, followed by postmonsoon and monsoon seasons. The trend of increase in effort during different seasons also evinced the same pattern. During monsoon season, the rate of increase was relatively less.

At Mangalore, in the drift net fishery, postmonsoon period was observed to be the most productive season for tunas, accounting for about 92% of the annual catch. The catch rate ranged from 7.9 kg in 1984-85 to 43.7 kg in 1986-87, the average value being 17.8 kg. Billfishes contributed to 0.3% of the drift gillnet catch during the premonsoon period and 0.32% during the postmonsoon period. In the purse seine fishery, during the premonsoon period, the catch rate of tunas ranged from 28.4 kg (1984-85) to nil (1986-87), with an average value of 8 kg. Postmonsoon period accounted for about 98% of the tuna landings. The catch rate varied from 11.1 kg (1984-85) to 191.7 kg in 1985-86, with an average value of 113.3 kg (Fig. 7).

At Goa, tuna fishery was totally absent during the monsoon period and during the postmonsoon season, the productive period was observed during October and November (Fig. 7).

At Minicoy and Agatti, tuna pole and line fishery operations were in vogue during the premonsoon and postmonsoon periods and at Minicoy, troll line fishery was conducted during monsoon period. Regression analyses carried out between C/E and effort on the tuna pole and line fishery data over three seasons and during different years indicated that the relationship was positive at Minicoy. C/E increased with the increase in effort. Eventhough only a few units were operated during the beginning of monsoon, the relationship between C/E and effort was observed to be high. In the troll line fishery, the relationship was positive during all the seasons except in monsoon, when catch rate decreased with increased effort. Annual trend also indicated that the pole and line fishery was in the developing stage. At Agatti, the regression analysis between annual effort and catch and also on the relationship between effort and catch rate indicated that the former was positively correlated while the latter evinced negative trend, with declining catch rate with increasing effort. However, the gross pattern of fishery indicated that the catch rate of tunas was relatively high during the premonsoon periods (Figs. 14-18).

Species Composition

Available information on the species composition of tunas during different years from six centres are summarised and presented in Table 3 and in Figs. 19-21. It is discernible that seasonal variation in species composition is not pronounced and *Euthynnus affinis* constituted the major species, followed by *Katsuwonus pelamis, Auxis thazard, Thunnus tonggol, Auxis rochei, Thunnus albacares* and *Sarda orientalis*. However, at Vizhinjam, *A. rochei* constituted about 57% of the total tuna catch.

Length Composition

Length composition of *E. affinis, K. pelamis, A. rochei, A. thazard* and *T. tonggol* at different centres are presented in Figs. 22-28. The size range of the important species during different seasons is as follows:

Species	Size range in the fishery (cm)		
	Premonsoon	Monsoon	Postmonsoon
E. affinis	20-72	16-72	18-80
A. thazard	20-46	20-48	20-48
T. tonggol	42-48	38-62	22-82
A. rochei	20-26	16-28	20-28
K. pelamis	20-72	45-65	20-72

It was observed that small-sized specimens of *E. affinis* and *A. rochei* were recorded in the fishery during monsoon season in fewer numbers.

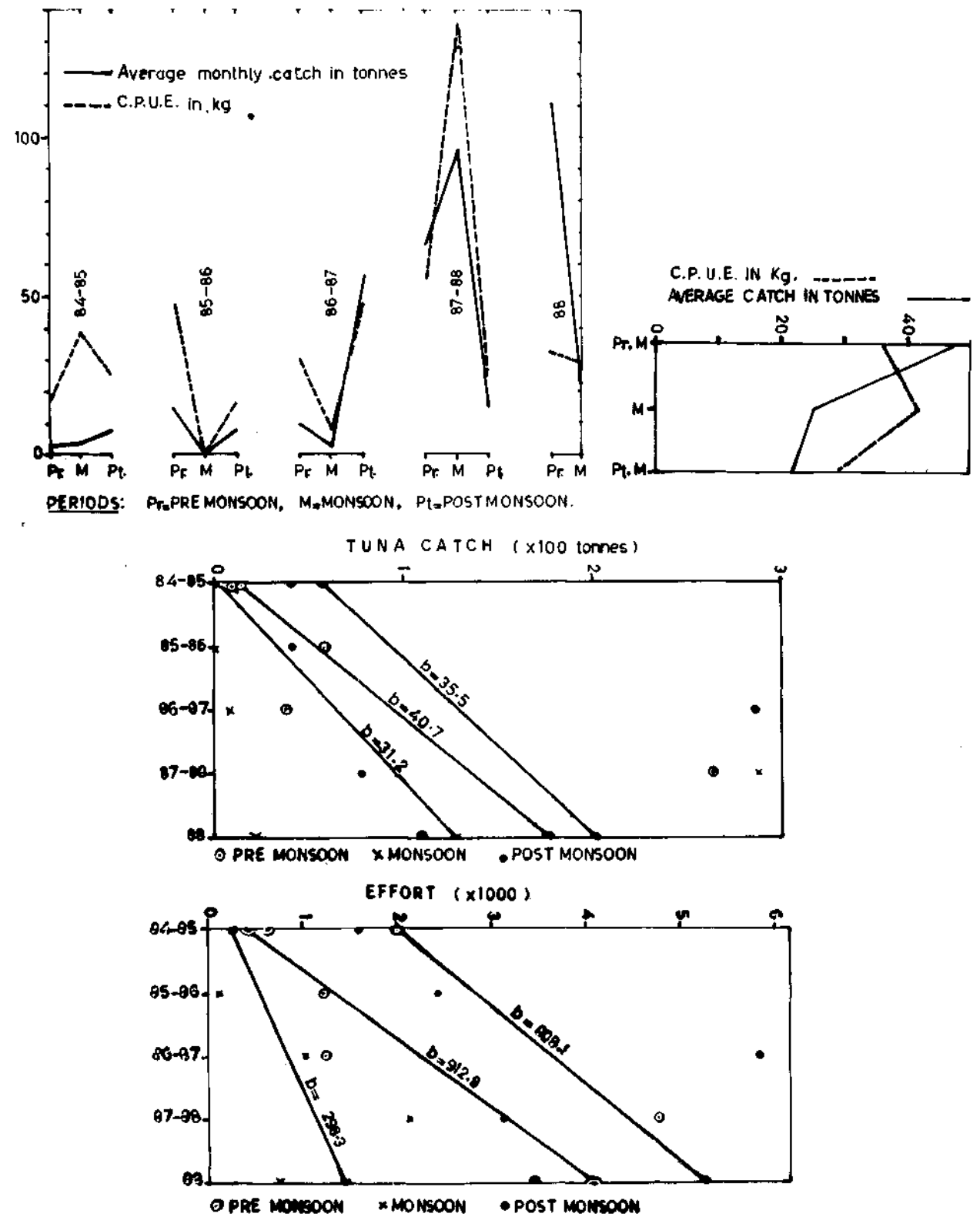


Fig. 13. Monthly average catch of tunas and C/E in different periods during different years (upper panel); Monthly average catch of tunas and C/E for all the years during different periods (upper panel); Regression of catch of tunas during different periods of time (middle panel); Regression of effort during different periods on time (Calicut 1984-88).

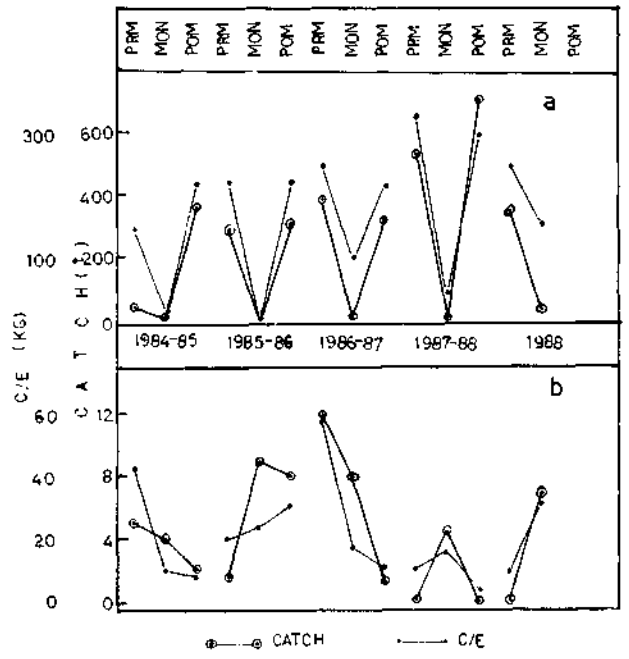


Fig. 14. Seasonal average values of catch and C/E for tunas in the pole and line fishery (a) and troll line fishery (b), Minicoy 1984-88.

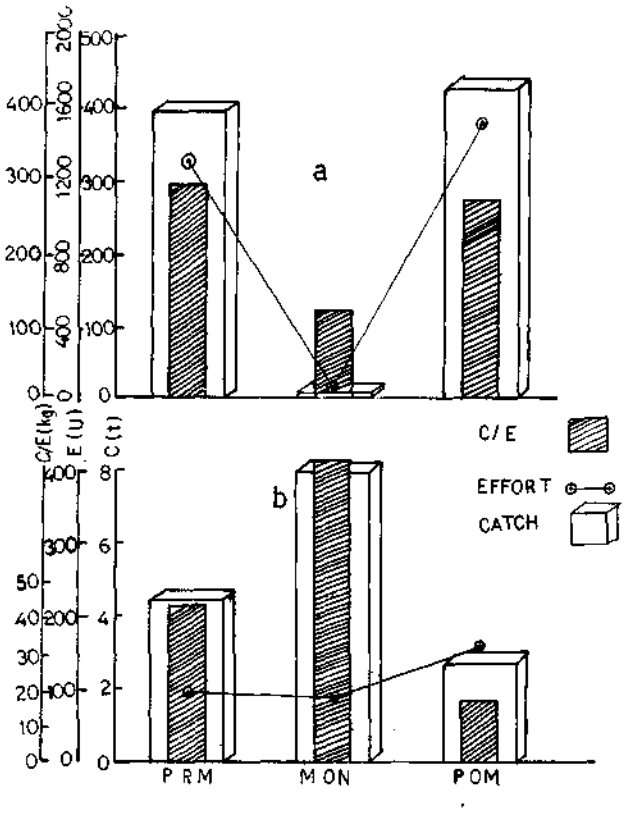


Fig. 15. Average seasonal pattern of fishery parameters for tunas in the pole and line fishery (a) and troll line fishery (b), Minicoy 1984-88.

Spawning

Based on the available published information, the spawning season of tunas along the west coast of India and in Lakshadweep is considered as during April-September. As the recruitment to the fishery is regular over the period of study, the tuna fishery during the monsoon period appears to be not affecting the spawning stock.

Discussion

The motorisation of the country crafts and targeted operation of mechanised boats (with inboard engine) for tunas along the southwest coast of the mainland of India and Lakshadweep, witnessed significant increase of tuna catch in the artisanal sector. This region at present contribute to about 67% of the All-India total tuna production estimated at 63,600 tonnes of tunas. On account of the increased mobility and accessibility to deeper fishing grounds, the total tuna catch increased from 7280 tonnes (1984) to 25,990 tonnes (1988) along the west coast and Lakshadweep. The impact of motorisation of the country crafts traditionally operating drift gillnets and hooks and line on the increase in the tuna production at Vizhinjam Coast (SW coast of India) has been reported by Gopakumar and Sharma (1989). According to them, the significant advantages due to this development and introduction of fibre-glass coated plywood boats (5.5 m OAL) with OB engine are the accessibility to offshore fishing grounds at a depth zone of 60 - 80 m, increase in the catch rate of *Auxis rochei* and the ability for operation during monsoon season. The catch rate of tunas by these crafts increased considerably in comparison with the non-mechanised crafts. At Calicut, the motorisation of the country crafts, introduction of improvised canoes and gears have been reported by Yohannan and Balasubramanian (1988, 1989) and Sivadas and Balasubramanian (1989). During 1986-87 period, all the country crafts and plank built boats were motorised and tunas and seerfishes became their target species. The use of mariner's compass has also facilitated the fishermen to operate the boats during monsoon season.

Jayaprakash (1989) evaluated the effort inputs and returns in the drift gillnet fishery at Cochin during the period 1981-82 and 1986-87 seasons and opined that the effort by mechanised Pablo boats during the SW monsoon months (May

to September) was the maximum and it was mainly directed to tap the tuna resources. During monsoon months, the income realised was 42% to 62% of the total annual income. According to him, during 1982 and 1987 the monsoon period realised the highest catch rate of tunas by the Pablo boat operations and the percentage contribution of tunas varied between 60 and 77% of the total tuna catch in the drift gillnet fishery.

At Cochin, the decrease of catch and catch per unit effort during 1984-88 in the drift gillnet fishery and increase of these parameters in the purse seine fishery during this period was observed. The operational area of both the gears is in the depth zone 25-40 m. It requires further detailed study whether the operation of these two gears would result in the overfishing of the inshore tuna population.

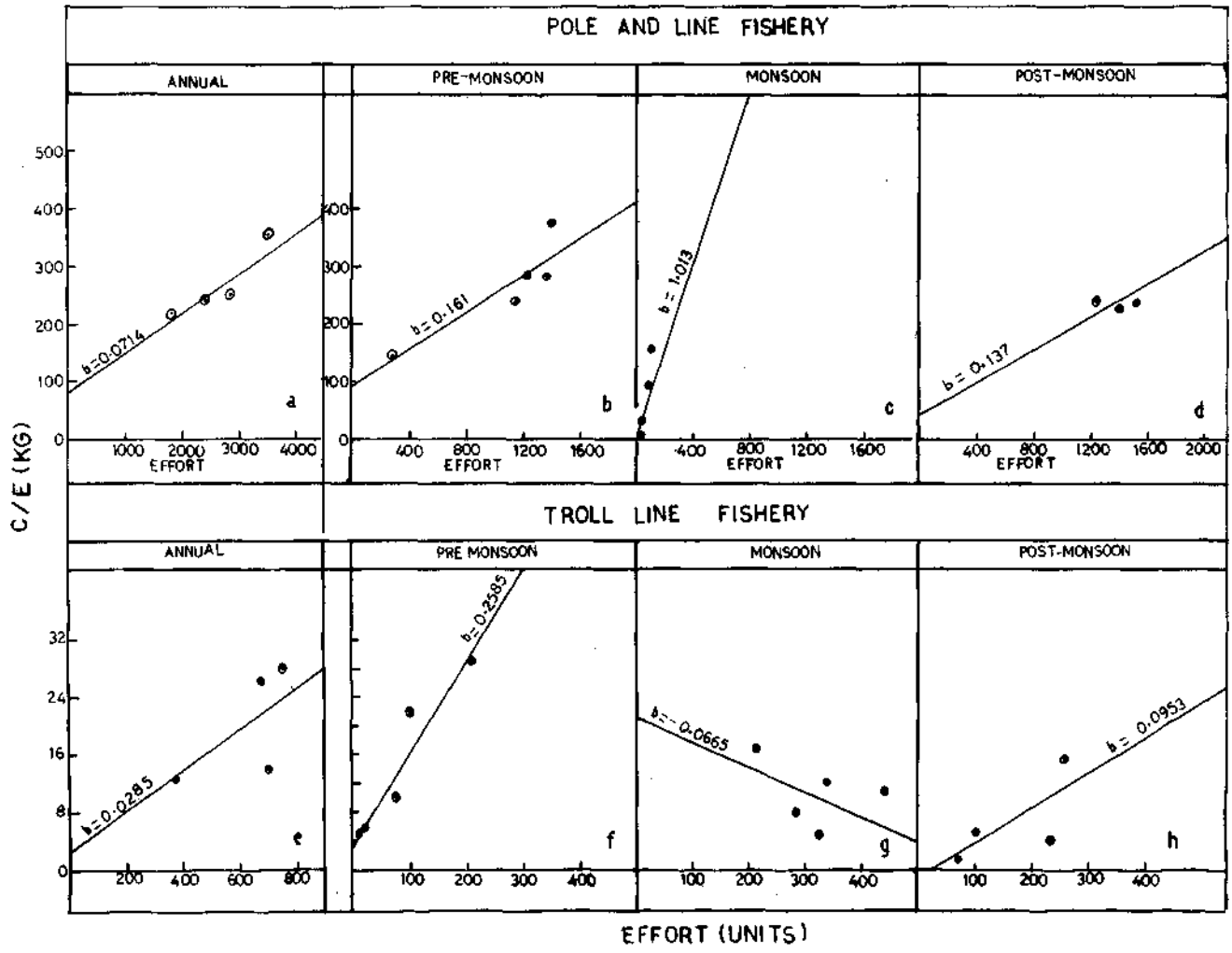


Fig. 16. Relationship between annual and seasonal trend of effort and C/E in the pole and line fishery (a - c) and troll line fishery (d - f), Minicoy 1984-88.

The size composition of major species indicates that *E. affinis* and *A. rochei* belonging to smaller size groups are caught during the monsoon period. However, it is felt that detailed size composition analyses for few more years are necessary before any regulation is recommended.

At Calicut, the tuna catch is bound to increase with the increase in effort. However, the present level of fishing is found not affecting the stock. *E. affinis* is not having at present local consumer demand. If better marketing facilities are provided, there appears to be considerable scope to develop the tuna fishery at Calicut.

Further, this diversification of fishing may also help to divert the fishing pressure now exerted on mackerel and oilsardine.

the troll line fishery the trend of increase was passive. At Agatti, eventhough effort was increased substantially during 1984-88 period, the

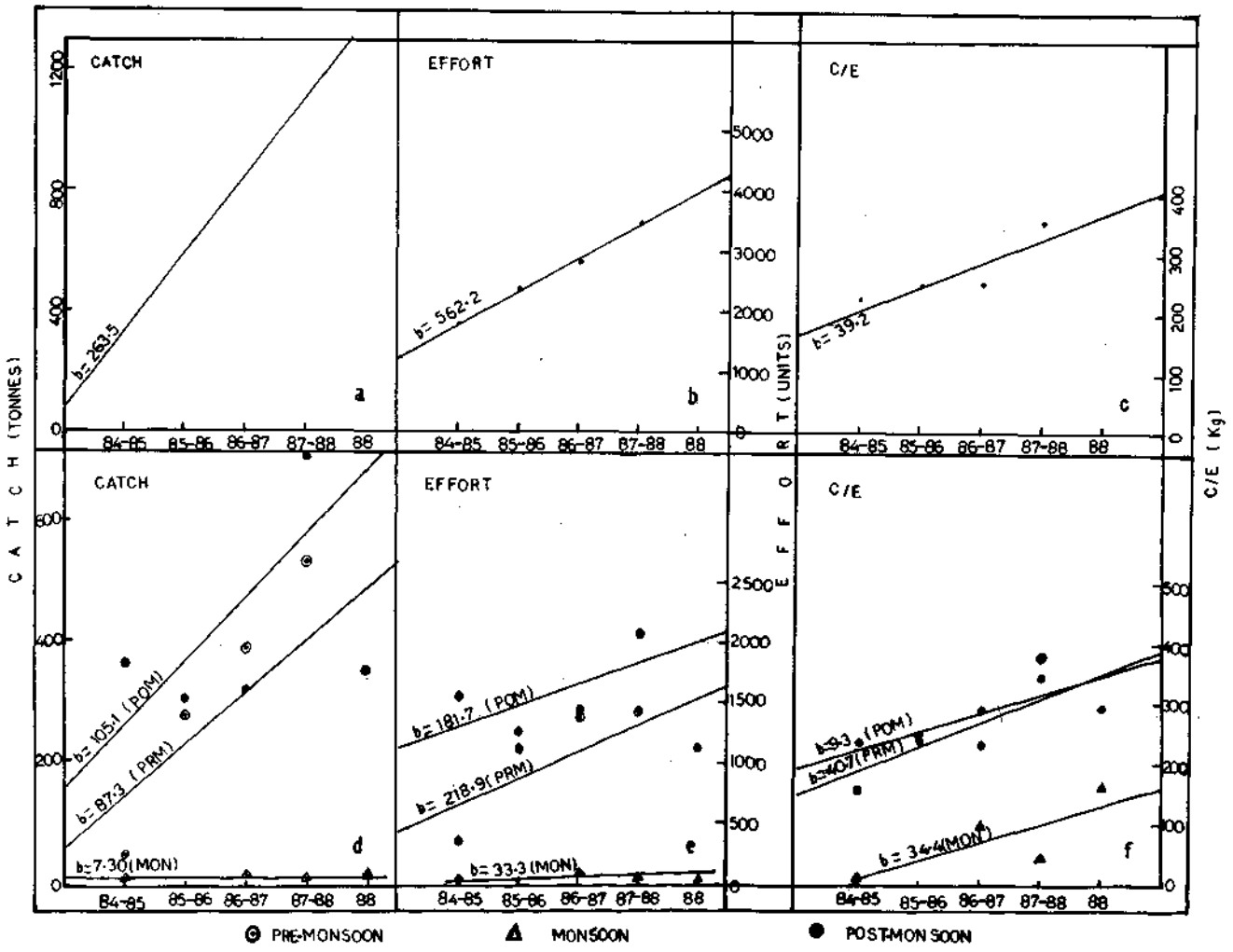


Fig. 17. Annual and seasonal trend of catch of tunas, effort and C/E in the pole and line fishery for tunas over time in Minicoy 1984-88.

As observed from the published information (Lipton *et al.*, 1988; Dhulkhed and Annigeri, 1988; Kagwade *et al.*, 1988; Rao and Alagaraja, 1988), the monsoon fishing operations are suspended in Karnataka, Goa, Bombay and Veraval and the peak period of occurrence of tunas are during post-monsoon months. It is recommended that the country crafts fitted with OB engines be encouraged for operation during monsoon season also, which would fetch good returns in the artisanal sector.

In Minicoy, the trend of tuna fishery by pole and line gear recorded an increasing trend, but in catch and catch rate recorded a declining trend, which might be due to the non-availability of tuna shoals for fishing or the negative biting response. In the small scale mechanised and non-mechanised fishery sector in Lakshadweep, controversies or clashes have not been reported.

As opined by James and Pillai (1990) and Pillai (1991), installation of Fish Aggregating Devices, diversification of fishing operations by the introduction of multi-day boats and intensification of troll line and handline fisheries during the monsoon months using sail power would contribute to the enhancement of tuna production in the artisanal sector in India.

It is customary on the part of the fishermen to increase or decrease the fishing effort depending upon the net economic returns. In view of this, estimation of economic parameters such as cost

fishing industry for continued operation of crafts and gears during monsoon season also and aim at larger pelagics such as tunas and seerfishes beyond the traditional fishing grounds, which in turn

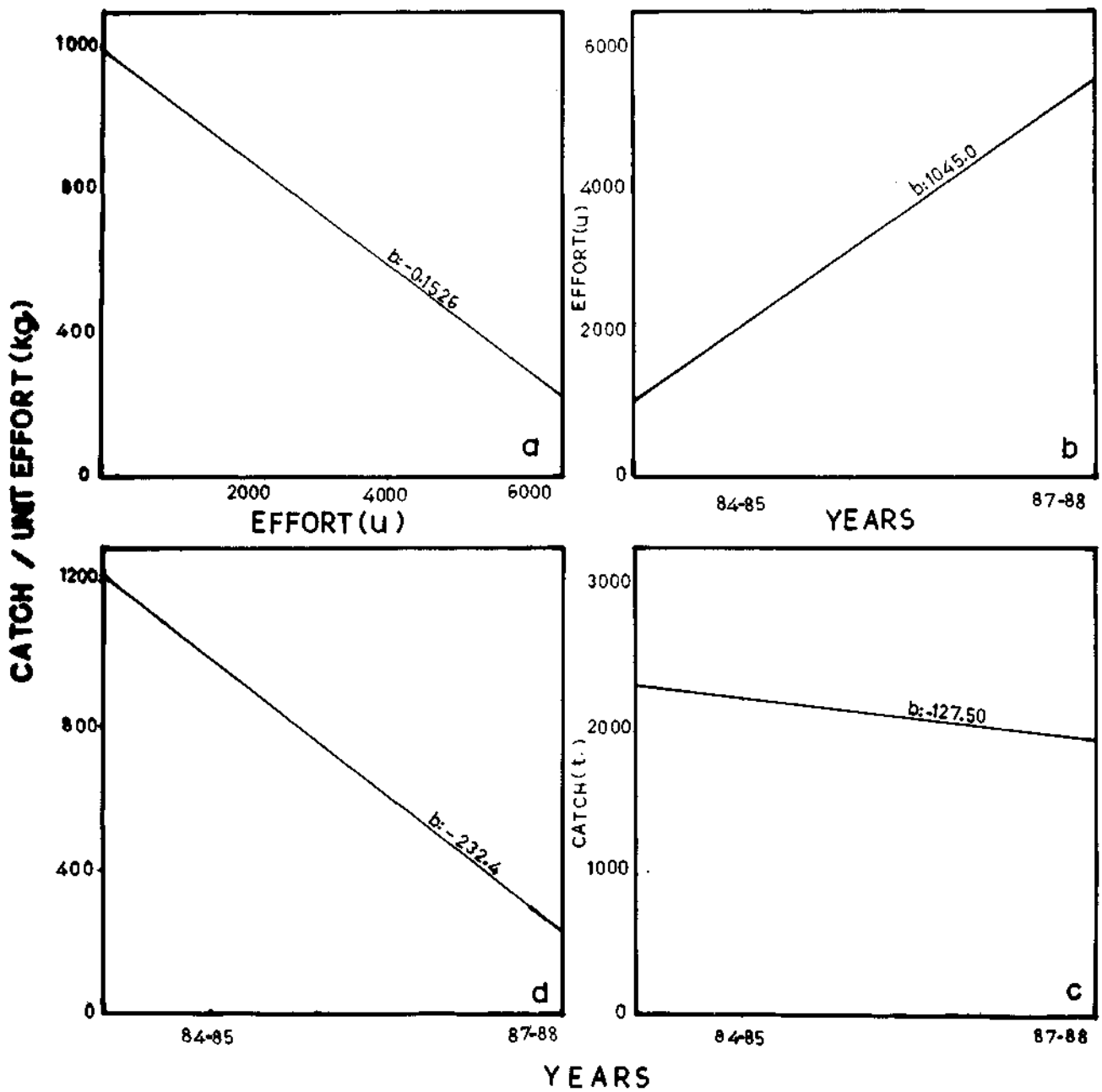


Fig. 18. Annual and seasonal trend of catch, effort and C/E in the pole and line fishery for tunas, Agatti 1984-88.

benefit ratio and maximum economic yield of the tuna fishery operation during the monsoon season would be relevant in taking effective management decisions. It would also prompt the artisanal

would enhance the production of tunas especially the longtail and yellowfin tunas and also contribute to the economic betterment of the fishing community in the artisanal sector.

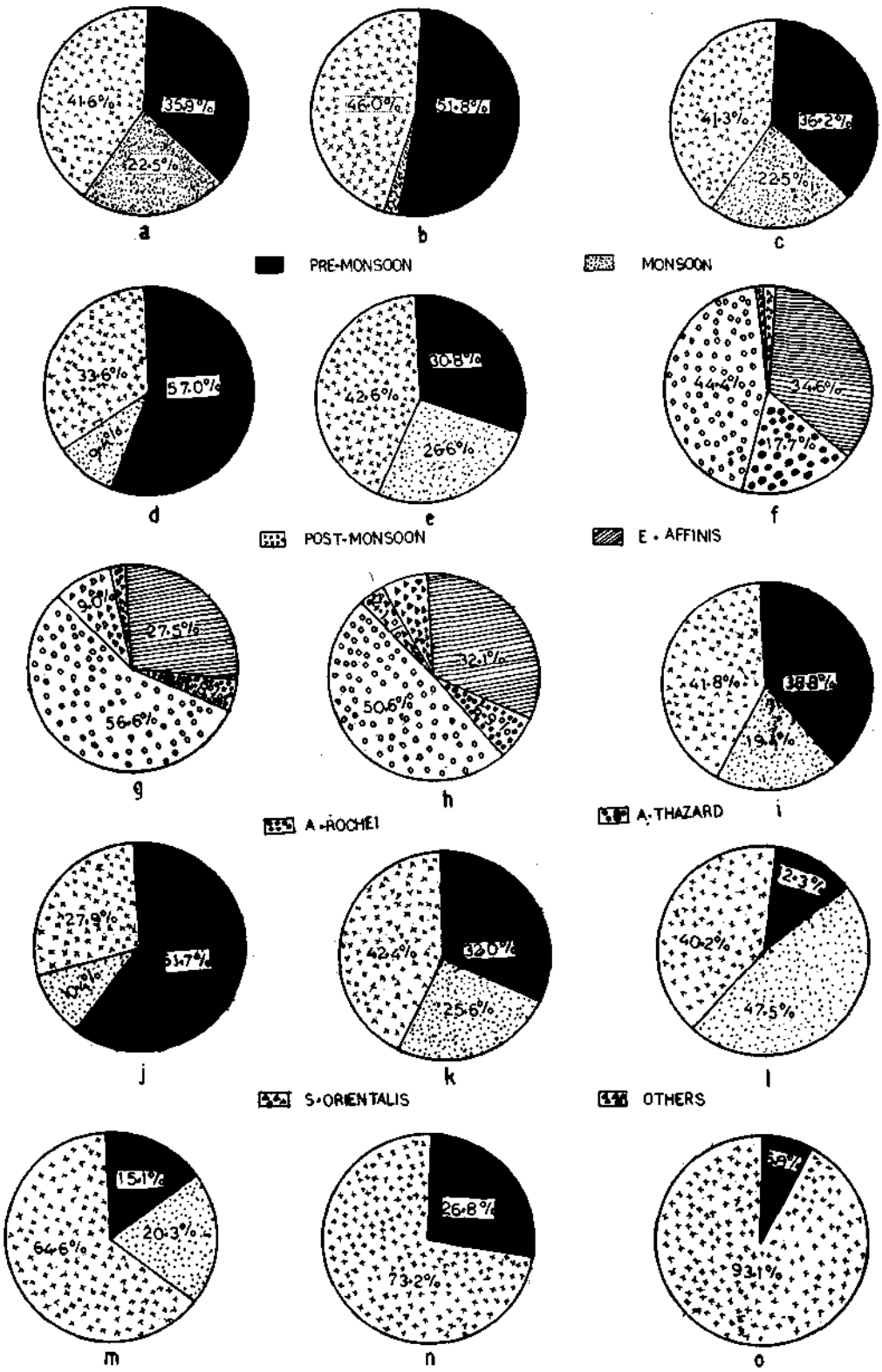


Fig. 19 a. Percentage composition of tuna catch during the premonsoon, monsoon and postmonsoon periods. b - e : Gearwise tuna catch in relation to monsoon b = Drift gillnet, non-motorised crafts; c = Drift gillnet, motorised crafts; d = hooks and line, non-mechanised crafts; e = hooks and line, mechanised crafts; f - h : Species composition of tunas during the premonsoon, monsoon and postmonsoon months (f = Premonsoon period; g = Monsoon period; h = Postmonsoon period).

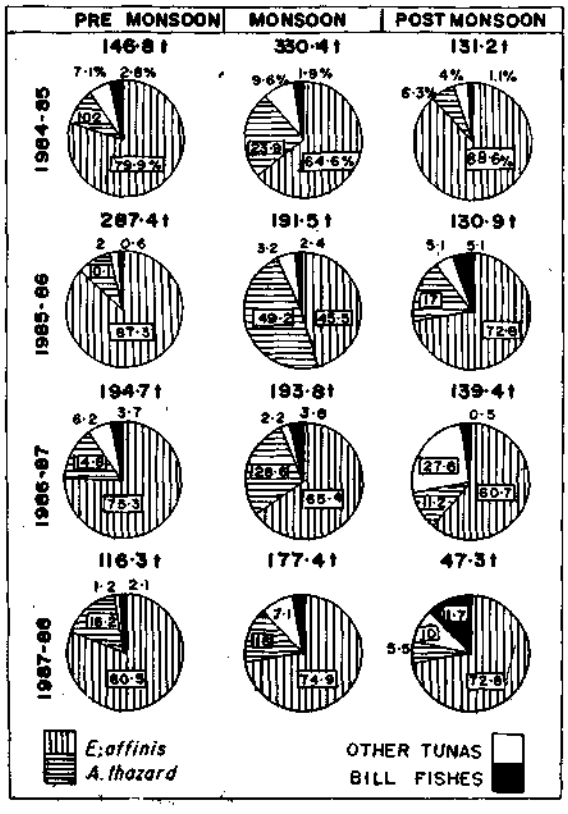


Fig. 20. Species composition of tunas in the drift gillnet fishery off Cochin 1984-88.

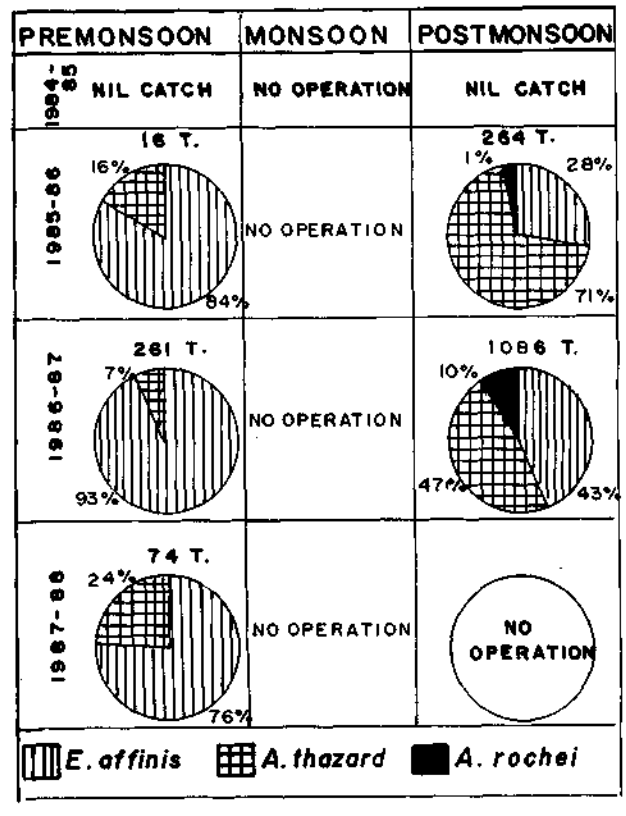


Fig. 21. Species composition of tunas in the purse seine fishery off Cochin 1984-88.

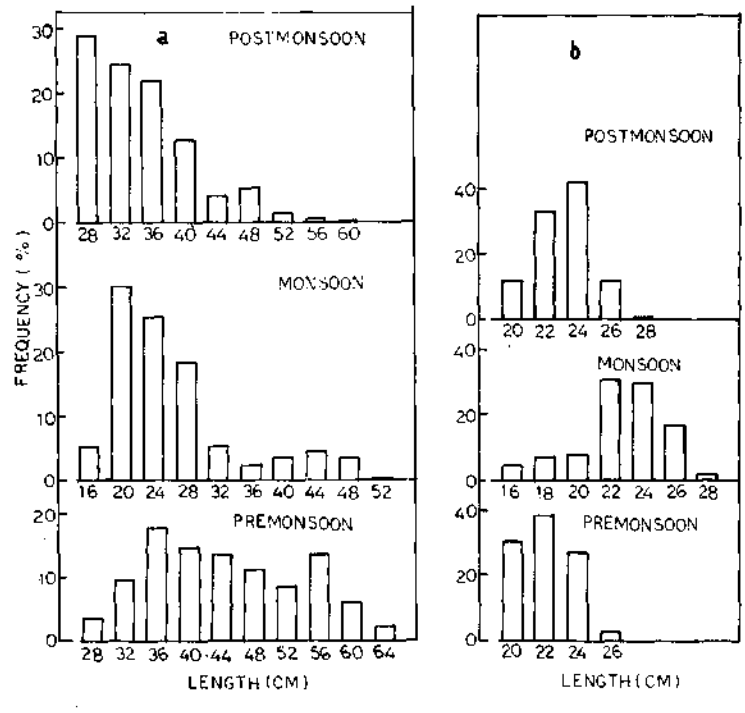


Fig. 22. Size composition of *E. affinis* and *A. rochei* at Vizhinjam 1984-88.

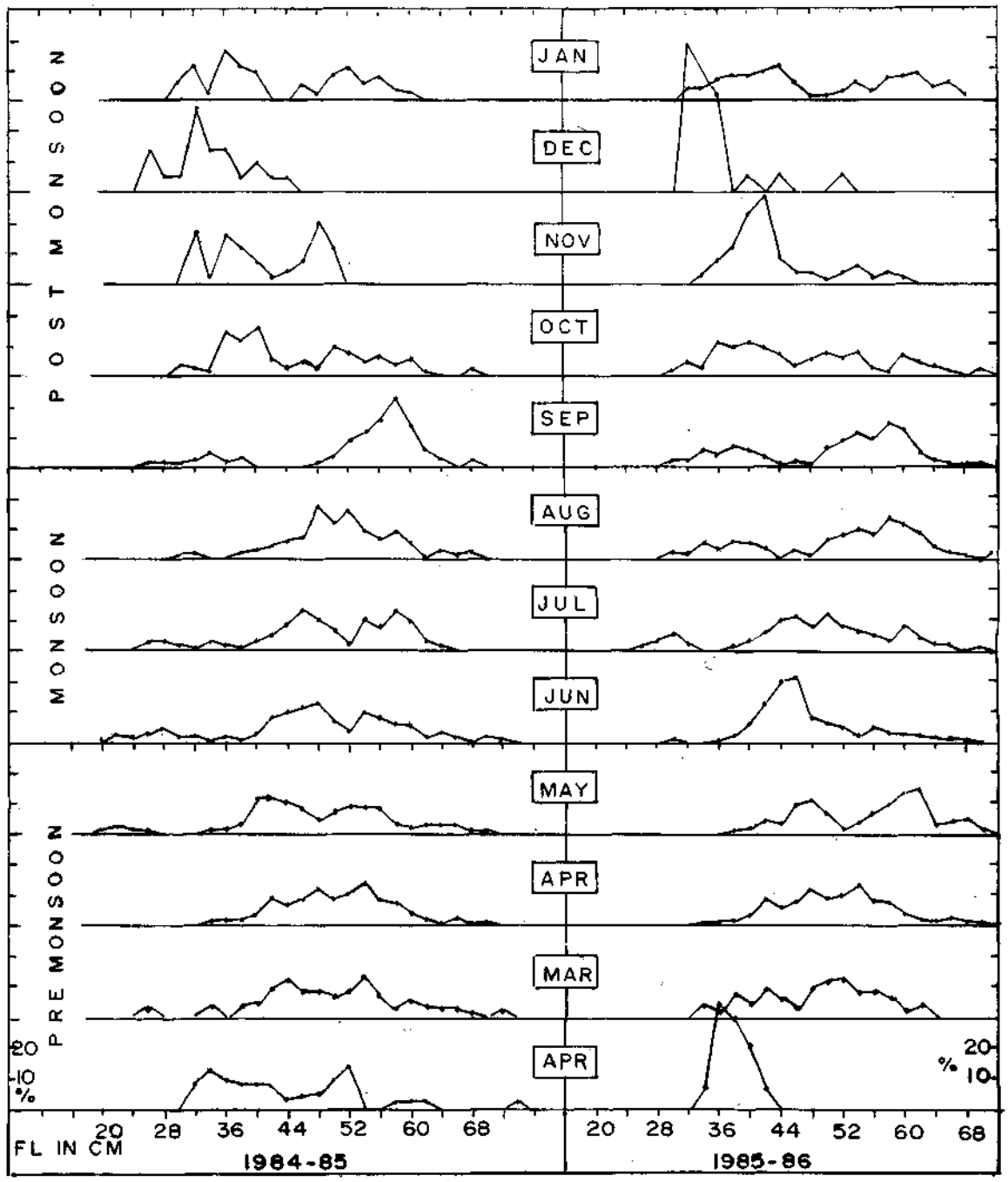


Fig. 23. Monthwise size distribution of *E. affinis* in the drift net fishery and purse seine fishery off Cochin 1984-86.

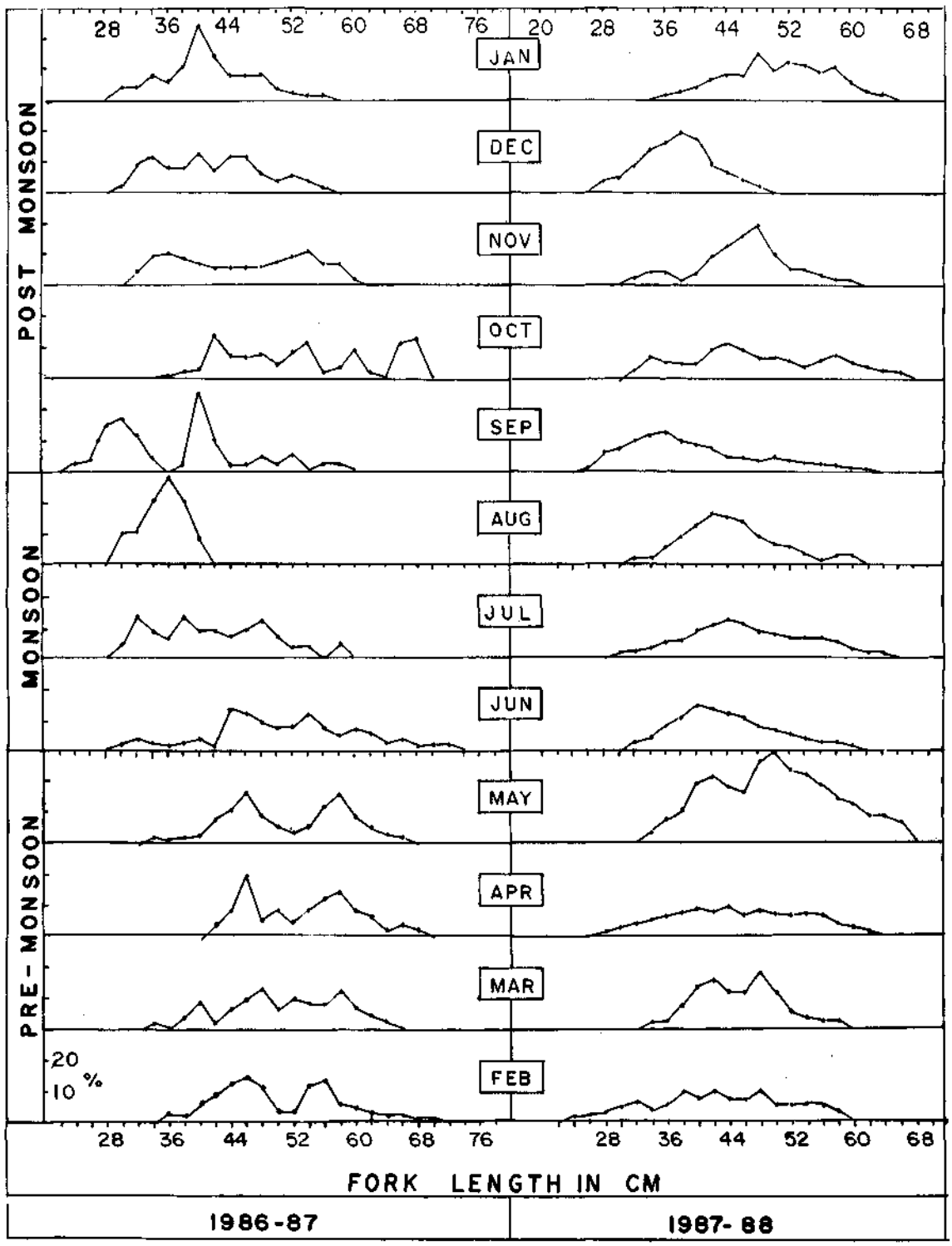


Fig. 24. Monthwise size distribution of *E. affinis* in the driftnet fishery and purse seine fishery off Cochin 1986-88.

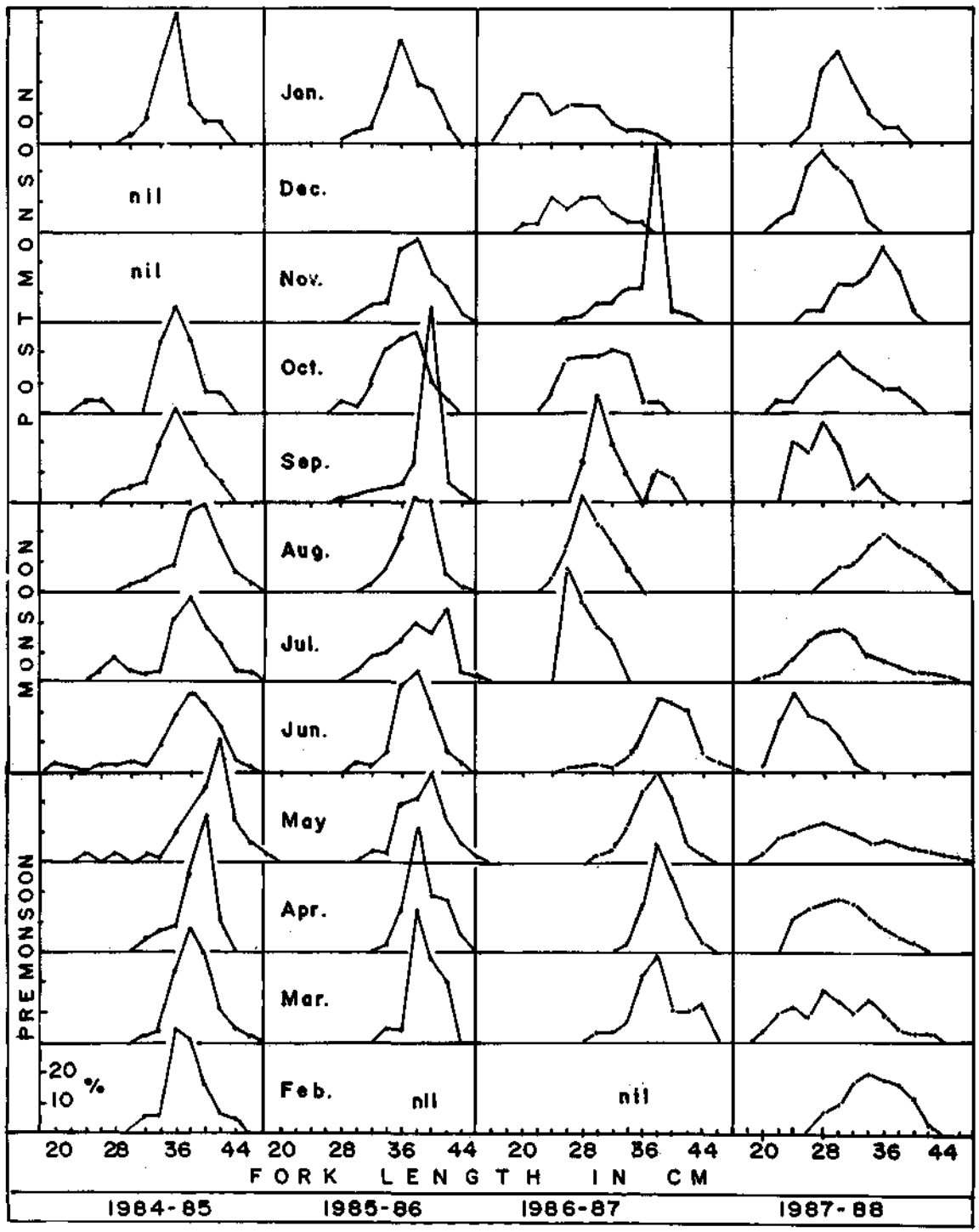


Fig. 25. Monthwise size distribution of *Auxis thazard* in the drift net fishery and purse seine fishery off Cochin.

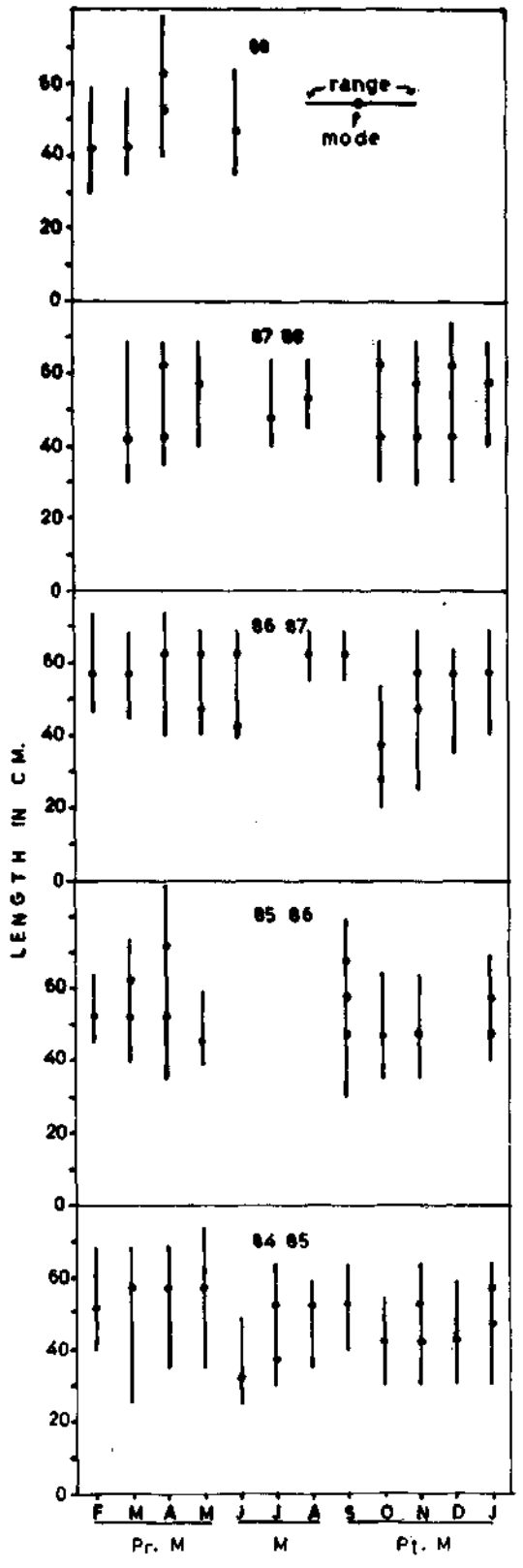


Fig. 26. Size range and modal values of tuna caught during different months at Calicut 1984-88.

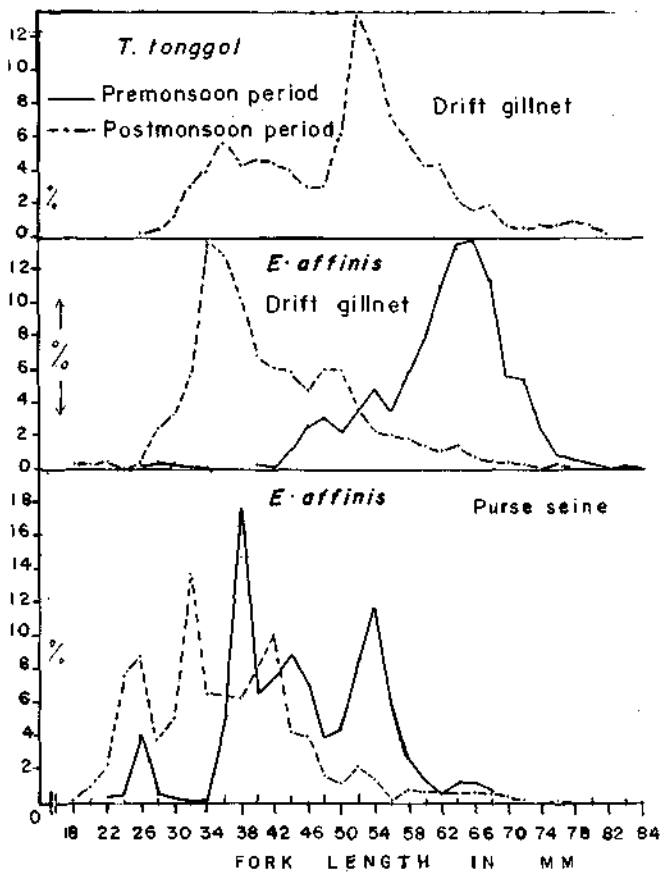


Fig. 27. Pooled size composition of *E. affinis* and *T. tonggol* at Mangalore 1984-88.

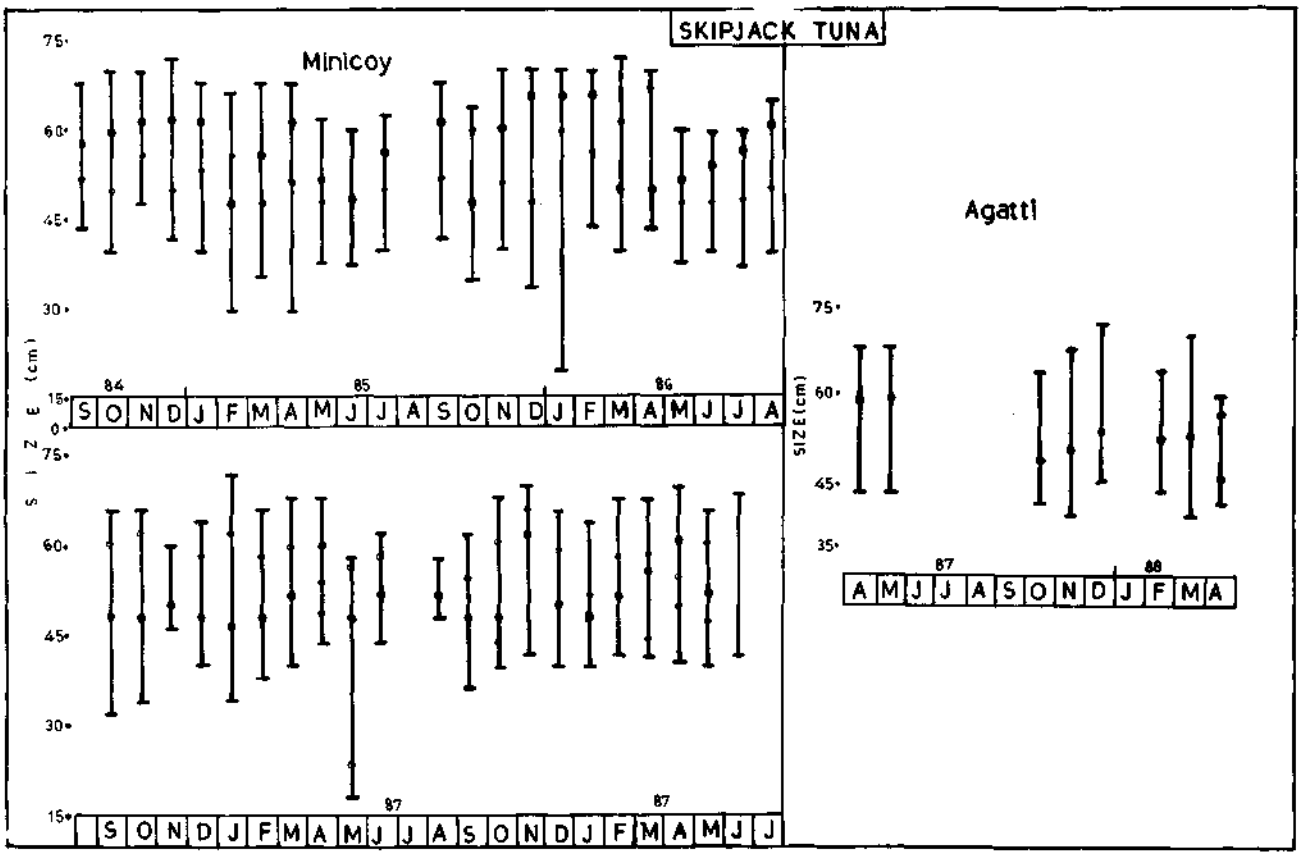


Fig. 28. Observed size distribution (monthly range and modes) of skipjack tuna at Minicoy and Agatti Islands, Lakshadweep 1984- 88.

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