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AN ANALYSIS OF LENGTH FREQUENCY DATA OF SKIPJACK TUNA (*KATSUWONUS PELAMIS*) FROM THE GILLNET FISHERY USING ELEFAN PROGRAMS

by

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ABSTRACT

ELEFAN computer programs were used to analyse the length frequency distribution of Skipjack tuna from the gillnet fishery in Sri Lanka. Values of 0.62 and 85 cm. obtained for K and L_{∞} are well within the values obtained for skipjack tuna elsewhere, but higher than those reported earlier for Sri Lanka. The high exploitation rate (0.68) obtained for skipjack tuna indicate limited opportunities of expansion of the fishery in the presently exploited range.

INTRODUCTION

Skipjack tuna, *Katsuwonus pelamis*, is the dominant variety in the tuna fishery in the coastal waters of Sri Lanka. This species made up 36 to 50% per annum of all tuna landed in the country in recent years (Joseph, 1984). A considerable amount of information is available on the fishery and biology of skipjack tuna from Sri Lanka. Age and growth studies, however, have been limited. These include a graphical analysis of length frequency distribution using probability paper (Sivasubramanium, 1972) and use of ELEFAN (Electronic Length Frequency Analysis) computer programs on the length frequency distribution of skipjack tuna from the pole and line fishery in 1974/1975 (Sivasubramanium, 1983).

This paper analyses the length frequency distribution of skipjack tuna from the gillnet fishery (drift gillnet) along the western coastal waters of Sri Lanka, using ELEFAN computer programs. These programs were used for length frequency distributions available for sixteen months, from June 1982 to December 1983. The catch rates of skipjack tuna in the fishery are also analysed and Selection and Recruitment patterns obtained from the ELEFAN programs.

MATERIALS AND METHODS

Length frequency data of skipjack tuna for this study has been obtained from the gillnet fishery. 67% of the effort on tuna fishery in Sri Lanka is applied through gillnets and skipjack tuna accounts for 56% of all tuna caught by this gear (Sivasubramaniam, 1970). In the study area, North-West, West, South-West and South coasts of Sri Lanka, the 3.5 GT, 9 meter boats which constitute the main fishing fleet in the tuna fishery number one thousand six hundred and forty three. These boats carry 20 to 34 pieces of gillnets, ranging from 4" to 6½" stretched mesh (Joseph et al 1985).

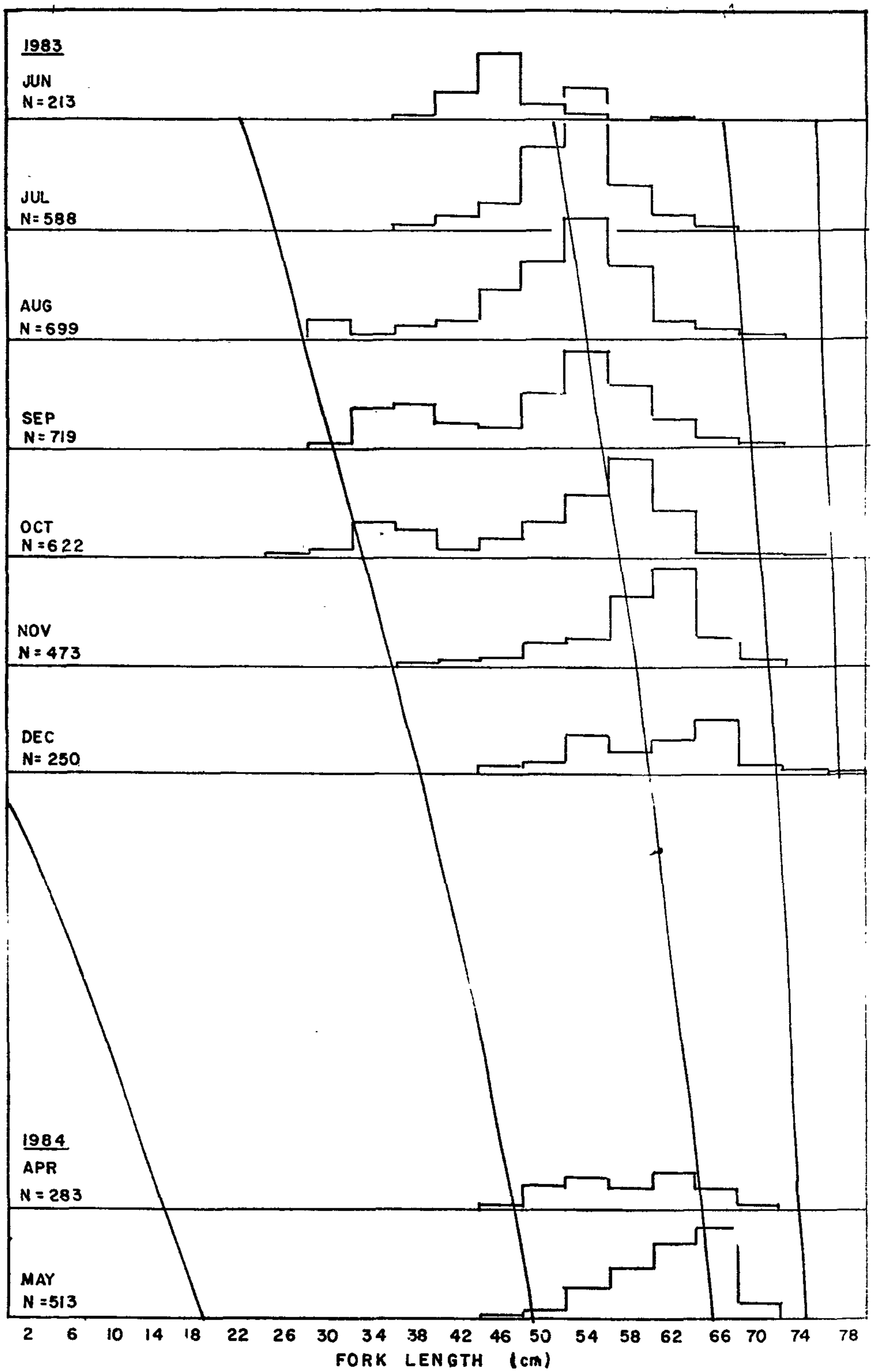


Fig. 1 (a) : Length frequency distribution of skipjack tuna with growth curves fitted by ELEFAN I (June 1982 to May 1983).

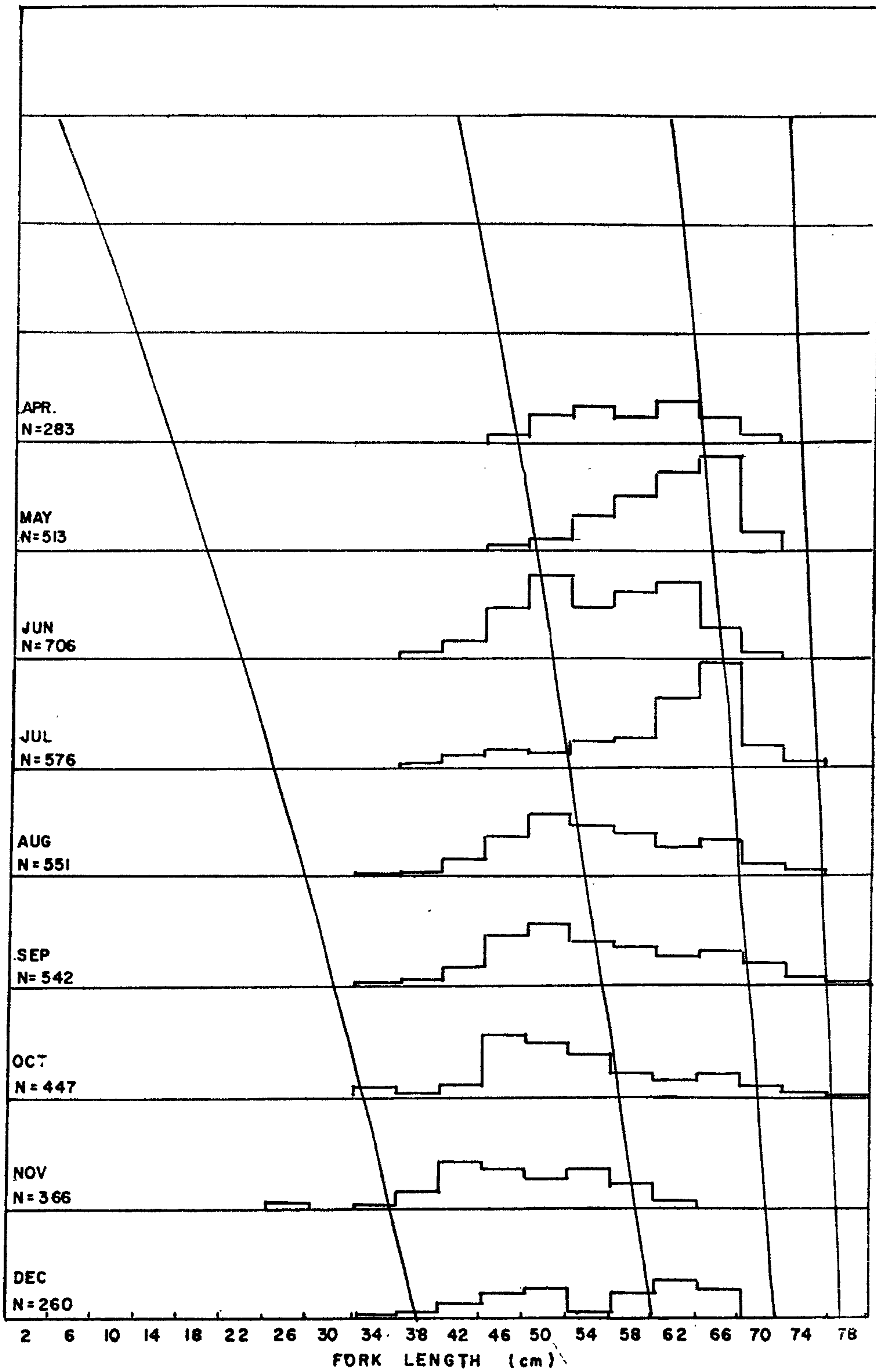


Fig. 1(b) : Length frequency distribution of skipjack tuna with growth curves fitted by ELEFAN I (April to Dec. 1983.)

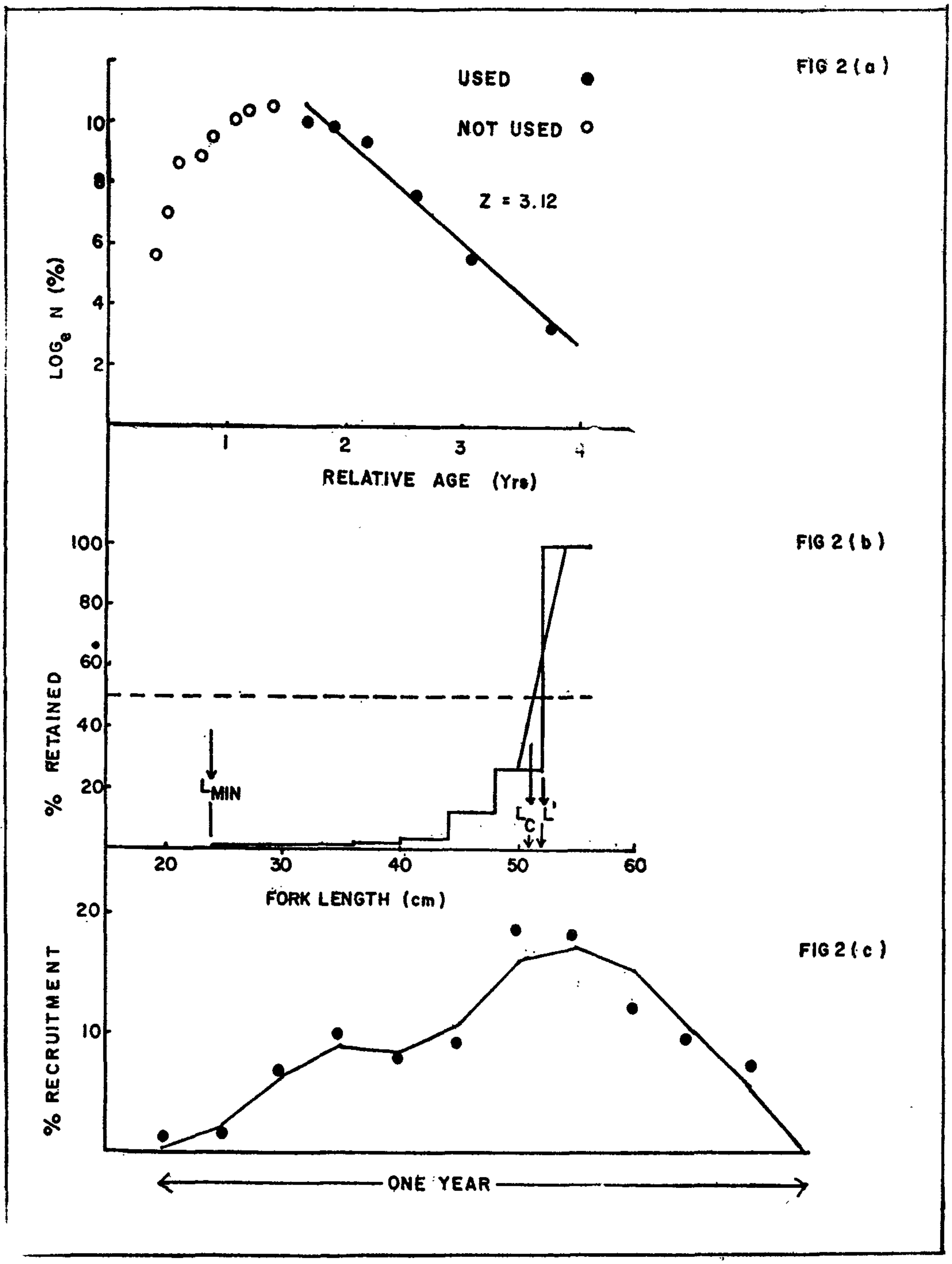
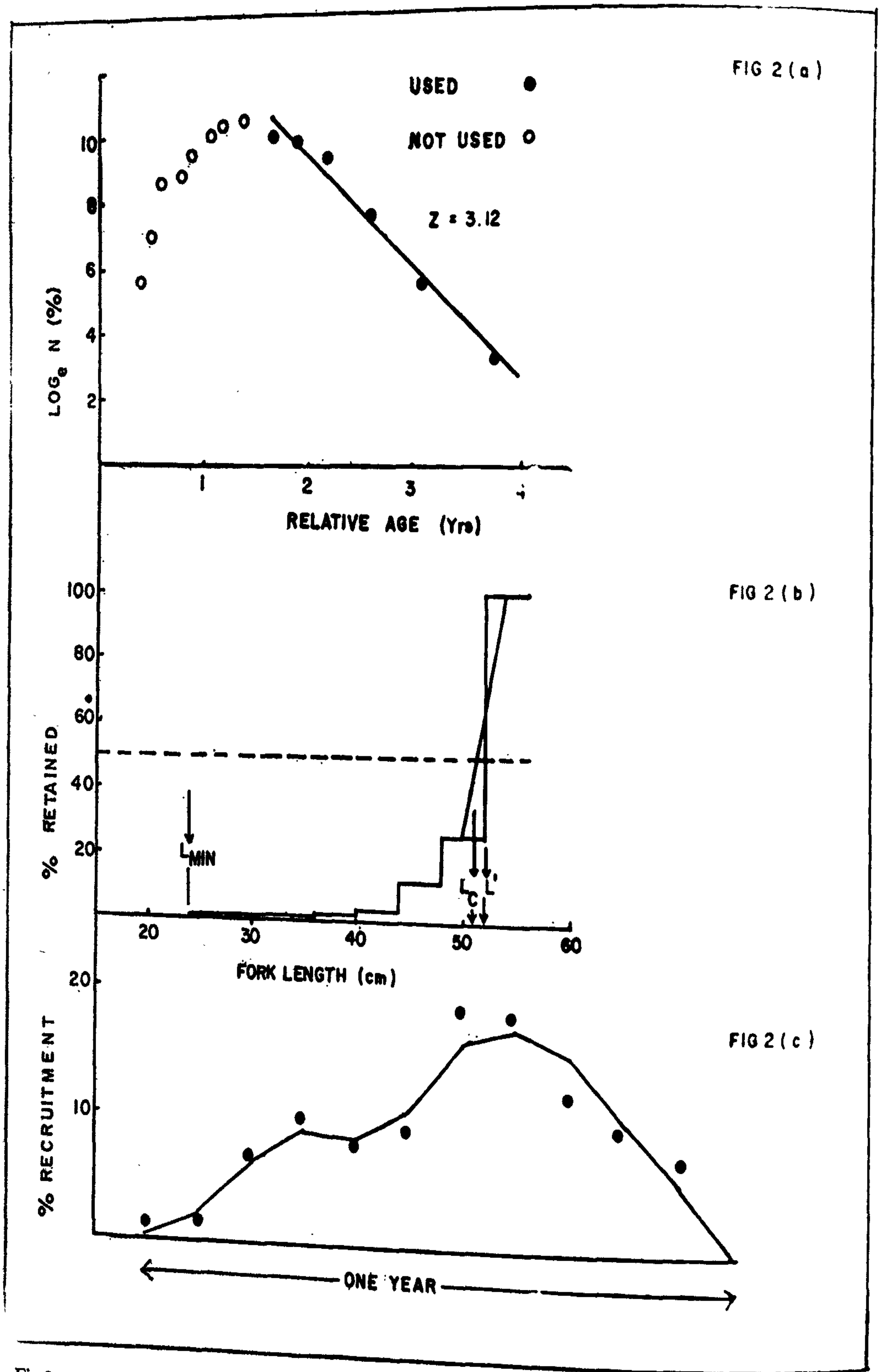


Fig.2 (a) : Length converted catch curve for skipjack based on growth parameters obtained by ELEFAN I.
(b) : 'Selection Pattern' of skipjack tuna pbtained by ELEFAN II.
(c) : 'Recruitment Pattern' of skipjack tuna obtained by ELEFAN II.



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Ten to twelve days sampling per month has been attempted at fifteen landing centres scattered along the study area. The south-west monsoon period of May to October is the peak fishing season for the tuna gillnet fishery in the study area, with possible extenticns to March/April and November/December months. Random samples of skipjack tuna were selected at each landing site and the fork lengths (from tip of snout to base of fork in the caudal fin) were measured to the nearest centimetre using measuring tapes. Monthly length frequency distributions were prepared by pooling data from each month and grouping them into 2 mm. length classes. The ELEFAN computer programs have been used in this study to extract growth parameters, mortality rates, recrutiment and selection patterns, using an Apple II e microcomputer. The programs are described in David et al (1982), Pauly et al (1981) and Pauly and David (1981).

Since the boats are day-boats, leaving port at mid-day and returning early next morning the effort is estimated in terms of boat days. Each boat is considered to average twenty boat-days of fishing per month. The monthly catch and effort values are estimated from the catch and effort data obtained during sampling days in the respective months.

RESULTS AND ANALYSIS

The values obtained for K and L_∞ of the von Bertlanffy growth equation from ELEFAN I, using length data obtained for the period June 1982 to Dec. 1983 were 0.62 and 85.0 cm respectively, with a ESP/ASP ratio of 0.332. The maximum length of skipjack tuna measured during this study was 82.0 cm. The growth curve fitted, using the estimated K and L_∞ values, to the length frequency distribution cf skipjack tuna is shown in figuresl(1) (a) and 1(b) for the periods June 1982 to May 1983 and Jan. to Dec. 1983 respectively.

The length at age values calculated, using K and L_∞ values computed as well as the t_0 (approximate) obtained from ELEFAN I, are 38.5 cm, 60.0 cm, 71.6 cm. and 77.8 cm for ages one, two, three and four years respectively. From the length frequency distributions shown it appears that the majcr contribution to the gillnet catehes is made by fisL between the ages 1 and 3 years.

The length converted catch curve obtained from ELEFAN II is shown in fig. 2(a). The values of Z, M, F and E obtained from the same program are as follows :

Total Mortality	(Z)	—	3.12
Natural Mortality	(M)	—	0.98
Fishing Mortality	(F)	—	2.14
Exploitation Rate	(E=F/Z)	—	0.68

The 'Selection Pattern' shown in fig. 2(b) indicate that the length at first capture, L_{min}, length at 50% probability of capture, L_c and the length at full recruitment, L' are 26.0 cm. 51,2 cm. and 54.0 cm. respectively.

The 'Recruitment Pattern' shown in fig. 2(c) indicate two recruitment pulses over a period of one year. The peaks of the two pulses are five months apart and are of unequal strength, 20.7% and 29.3%. The two recruitment pulses observed in the 'Recruitment Pattern' is considered common for most tropical fish (Pauly, 1984).

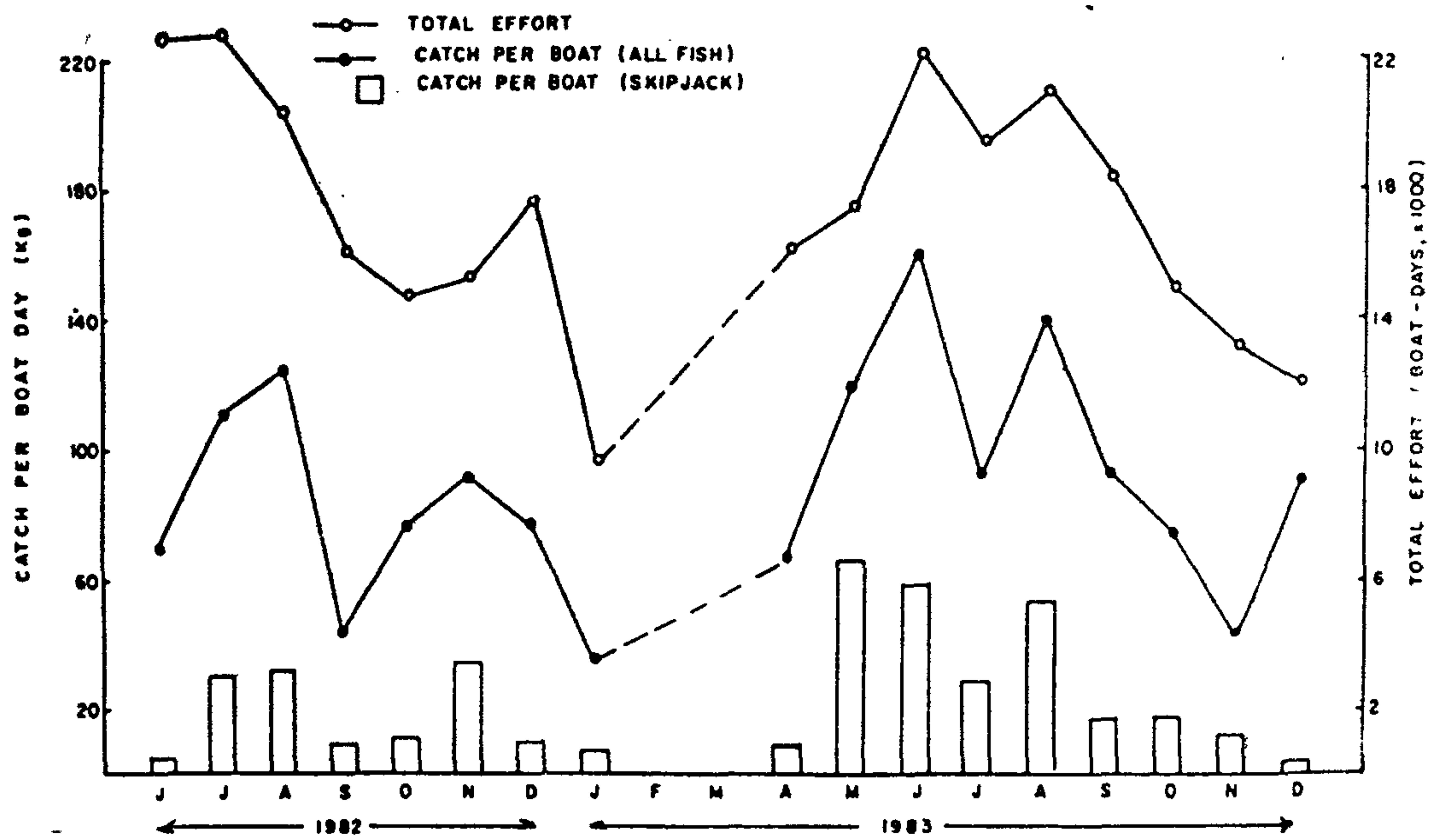
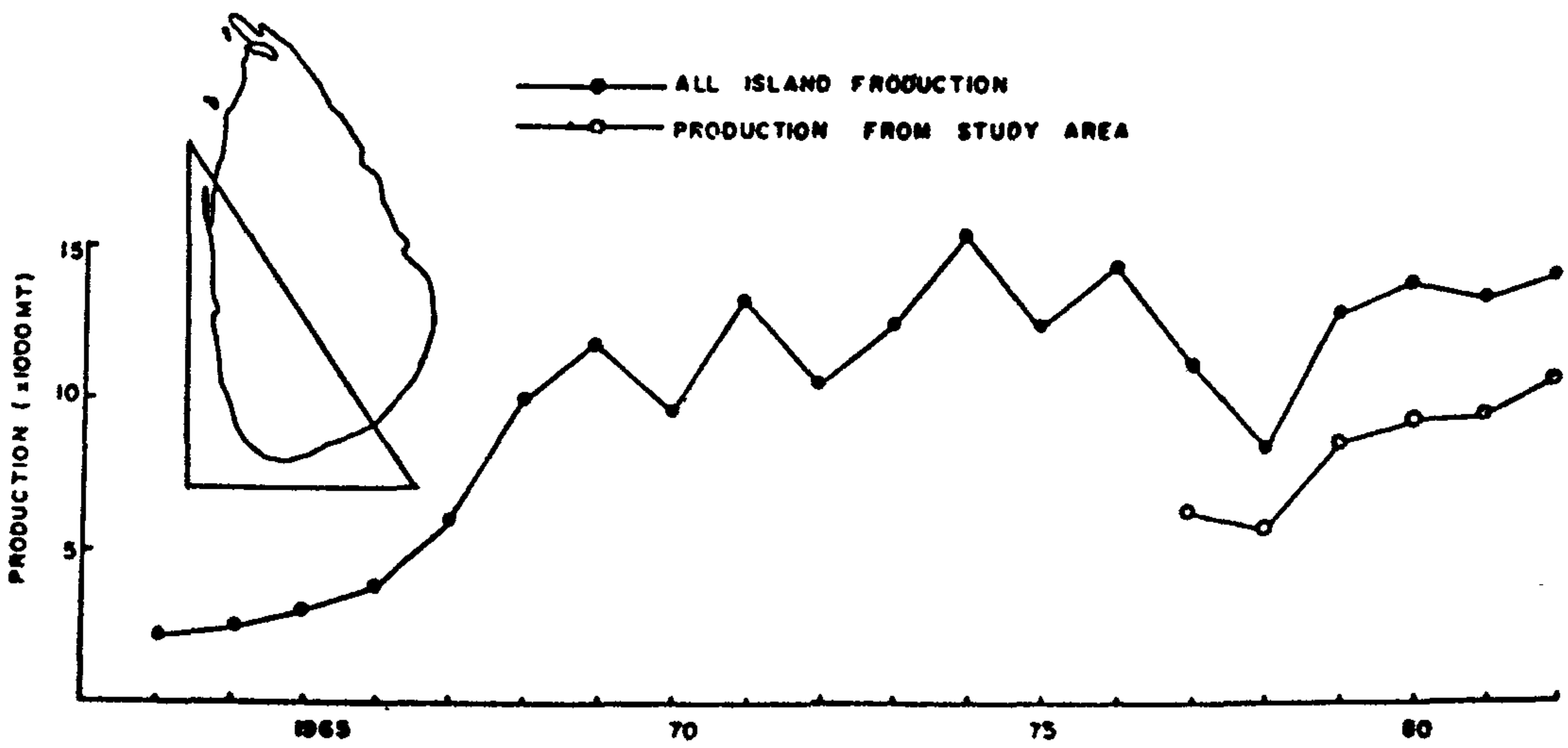


Fig. 3 Effort and catch per unit effort of skipjack tuna in gillnet fishery, June 1982 to December 1983.



Fiy. 4 Annual production of skipjack tuna, in whole island and study area (inset - study area).

The total monthly effort in terms of total number of boat-days and the mean catch per boat-day for all fish, all tuna as well as for skipjack are shown in fig. 3. The total effort in the gillnet fishery is high during the south-west monsoon months of May to October and then declines during the rest of the year. The effort reaches a peak during the months June, July and August. The catch per boat-day of all fish in the gillnet fishery also show a gradual increase with the onset of south-west monsoon and then declining with the end of the monsoon period in October, with the exception of low catch rates in September 1982 and July 1983. The catch per boat-day values obtained for skipjack show higher catch rates during most months in 1983 compared to 1982. In 1982, it ranged from a low 6.1 kg. in June to a high 34.9 kg. in November, while in 1983, the range was from 2.5 kg. in December to 65.9 kg. in May.

DISCUSSION

Even though gillnets are considered highly selective, the wide range of mesh sizes used in the fishery sample a fairly wide size range of the population; 28 cm. to 84 cm. in the present study. This range has been considered adequate to give meaningful estimates from ELEFAN programs.

Relatively less information is available on age and growth of skipjack tuna in Indian Ocean compared to the other two Oceans. Examination of the literature reveals a wide range of values for skipjack growth parameters, 0.19 to 1.01 for K and 72.9 cm. to 141.8 cm. for L_∞. For skipjack in Indian Ocean, Yesaki (1981) has obtained values of 0.51 and 75.0 cm. for K and L_∞ from length frequency studies off west coast of Thailand while Sivasubramanium (1985), obtained values of 0.52 and 77.0 cm. for K and L_∞, using ELEFAN programs on length frequency distribution of skipjack from the pole and line fishery around Sri Lanka.

The K and L_∞ values of 0.62 and 85 cm. obtained in the present study are higher than those obtained by Sivasubramanium (1985). The high value of L_∞ could probably be due to the fact that the gillnets have sampled more fish of large size compared to the pole and line fishery. Sivasubramanium (1972), in a length frequency analysis of skipjack tuna has shown that the fish of the large model groups of 63.0 and 71.5 cm. have entered the commercial catches since the introduction of gillnets and that fish of these model groups are present more in gillnet fishery compared to troll and pole and line fisheries. Therefore, the ELEFAN program has yielded a high L_∞ with length data from gillnet fishery as it has sampled fish at larger lengths compared to pole and line fishery. The L_c value obtained in the present study is also slightly higher than the value of 47.2 cm. obtained by Sivasubramanium (1983) for skipjack tuna from pole and line fishery.

The values of M and F obtained in this study were 0.98 and 2.14 while Sivasubramanium (1985) obtained values of 0.87 and 1.01 for M and F of skipjack tuna in the pole and line fishery of 1974/75. The exploitation rate obtained by Sivasubramanium (1985) using length data from pole and line fishery in 1974/75 was 0.54 while it is 0.68 in the present study which used length data from the gillnet fishery. Since the gillnet fishery has also been shown to sample a wide size range of the population as the pole and line fishery and is the dominant gear exploitating skipjack tuna to-day, these values may indicate a 23% increase in exploitation of skipjack tuna during the last eight to nine years.

The mean catch per boat-day of skipjack tuna in the gillnet fishery in sub areas North-West, West, South-West and South in 1982 and 1983 are lower than those estimated by Sivasubramanium (1972) for gillnet fishery by the same type of boats in the same areas for the period 1967 to 1971 (Table 1). While the decrease is very significant in West, the higher catch

TABLE 1.

CATCH PER BOAT - DAY (Kg) OF SKIPJACK TUNA IN GILLNET FISHERY

Area	1982 *Jan. - Nov.*	1983 *Jan. - Dec.*	1967 - 1971
North - West	22.8	10.7	26.8
West	23.3	13.0	65.2
South - West	26.2	54.8	40.5
South	21.5	47.2	52.6

rate obtained for South-West in 1983 is mainly due to large catches of skipjack made in May. In a fishery that is at or close to a high level exploitation, it is customary to observe a decrease in the size of fish caught (length at 50% capture), compared to the size of fish caught when the exploitation is comparatively at a lower level but the L_c values obtained in this study and that by Sivasubramanium (1985) were 51.2 cm and 47.2 respectively. The two values may not be strictly comparable as they were derived from length data obtained from two different fisheries, the one sampling more of the large fish yielding the high L_c value compared to the other.

The annual production of skipjack tuna from the coastal waters around Sri Lanka (Fig. 4) showed a rapid increase in 1969 and 1970 compared to previous years. Sivasubramanium (1972) attributed this increase to the introduction and subsequent popularity of gillnets as a method of fishing for tuna. Although the fishing fleet had increased considerably since 1970, the annual production has been fluctuating between 10,000 to 13,000 metric tons per annum, except for a peak of 15,243 metric tons in 1975.

The higher exploitation rate obtained in the present study, the lower catch rates estimated compared to 1967-1971 period as well as the more or less stabilized annual production trend observed in recent years, inspite of increased effort, suggest that this species is being exploited at a high level and that further increase in effort may only bring about marginal increases in production from the presently exploited range, a range extending up to about 50 kilometers from the shore. Emphasis should therefore be placed on expansion of tuna fisheries to the off-shore areas in future.

According to Sivasubramanium (1972), the fishery is mainly based on migrating populations of skipjack tuna (from the Indian Ocean stock) moving into the coastal waters around Sri Lanka, mainly during the south-west monsoon period and again during November to March. Differences in catch rates between years therefore may also be influenced by the annua differences in the degree of availability of the resources within the exploited area brought abou various factors-fishing activities inside and outside the area under discussion, biological and or environmental. Assessment of the status of the fishery vis-a-vis the effort therefore require time series of data on catch and effort of the local fishery as well as information on the level af exploitation and general biology of the stock from its whole area of distribution in the Indian Ocean.

In the absence of such data, preliminary estimates were made with the help of ELEFAN programs. Application of ELEFAN programs to derive population parameters and mortality rates of skipjack tuna need to be considered with certain very important assumptions and limitations. While population parameters such as age and growth need to be verified by other methods or approaches, they may not necessarily be representative of the whole population of skipjack tuna in the Indian Ocean. Mortality and exploitation rates obtained may reflect only the condition of that component of the stock available to and exploited by the local fisheries assuming that the composition of the fully recruited size groups in the exploited range represents that of the whole stock.

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