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PRELIMINARY STUDY OF THE GROWTH OF YELLOWFIN (Thunnus albacares) ESTIMATED FROM PURSE SEINE DATA IN THE WESTERN INDIAN OCEAN

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ABSTRACT

This analysis is based on length frequency samples from French and Ivory Coast purse seiners operating in the Western Indian Ocean. It seems that yellowfin grows relatively slowly (1.3 to 1.6cm/month), in its juvenile stages, from 35 to 57cm, followed by a phase of rapid growth attaining a maximum between 88 and 101cm (4.3cm/month). These individuals in the latter length group are not well represented in the catches and could well be the most migratory fraction of the stock.

The growth parameters Loo and K, of the Von Bertalanffy equation, calculated in the range of 88-143cm, have been estimated as 1.16 and 160.2cm respectively.

1. INTRODUCTION

Up till 1983 longlining was practically the only technique used on an industrial scale in the Indian Ocean. Apart from the pole and line fishery around Madagascar (1973-1975), the industrial surface fishery only started in 1983 in the Western Indian Ocean, with the arrival of the purse seine fleet from the Atlantic.

MARCILLE and STEQUERT (1976) made a preliminary study on the growth of juvenile yellowfin based on data from the fishery in Madagascar.

Length frequency samples collected from purse seine catches since 1983 have been used in this study to make a preliminary estimate of the growth of yellowfin. The samples used are for males and females combined.

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2. SOURCE OF DATA AND METHOD OF ANALYSIS

2.1 Source of Data

Since the beginning of 1983, length composition samples have been taken regularly on a random basis, by ORSTOM scientists based in Seychelles.

Catches from two fleets have been monitored, the French and the Ivory Coast fleet. The importance of these catches to the total fish captured by the surface purse seine fleet (85 percent in 1983, 75 percent in 1984), shows that the samples analysed are well representative of the population, vulnerable to the surface gears technique in this region.

Length measurements were either taken in fork length (FL) to the centimetre below for the young individuals, or in the first dorsal length (LDI) to the half-centimetre below, for older individuals. The results are given in FL for a better understanding.

Each sample consists of 100 to 120 individuals; the total number of yellowfin measured was:

- 1752 in 1983
- 13638 in 1984
- 8017 from January to June 1985

2.2 Method of Analysis

The length frequency samples were weighted to the quantity of the species in question in the fish tank. Data from all the zones covered by the seiners, have been merged for this analysis. It must be noted that the extent of the fishing grounds increased with the growing number of vessels from the beginning of 1984 and that the fishing grounds now lie in the belt of 5°N to 10°S and 48°E to 71°E.

The data have been analysed on a three month basis which gives a better picture of the progression of the modes, particularly for individuals greater than 100cm.

The separation of the modes from the length frequency data was carried out using the method of BHATTACHARYA (1967).

3. RESULTS

3.1 Progression of the modes

The evolution of the sizes class modes can be followed from the successive histograms for the nine quarters examined (fig 1).

The different modes identified in the analysis were joined, showing the growth of the different length groups, constituting the population (Fig 2). Several major observations can be made:

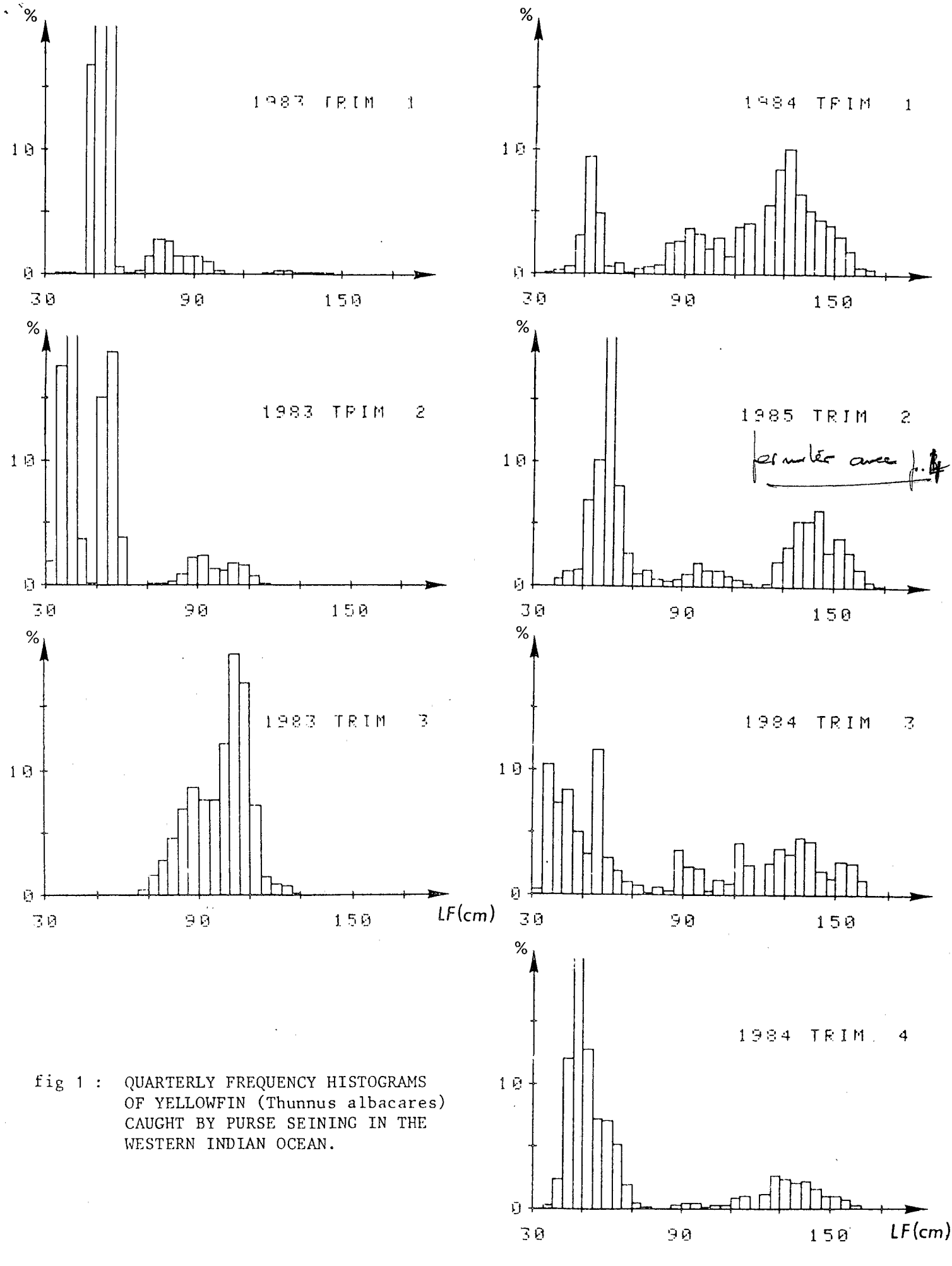
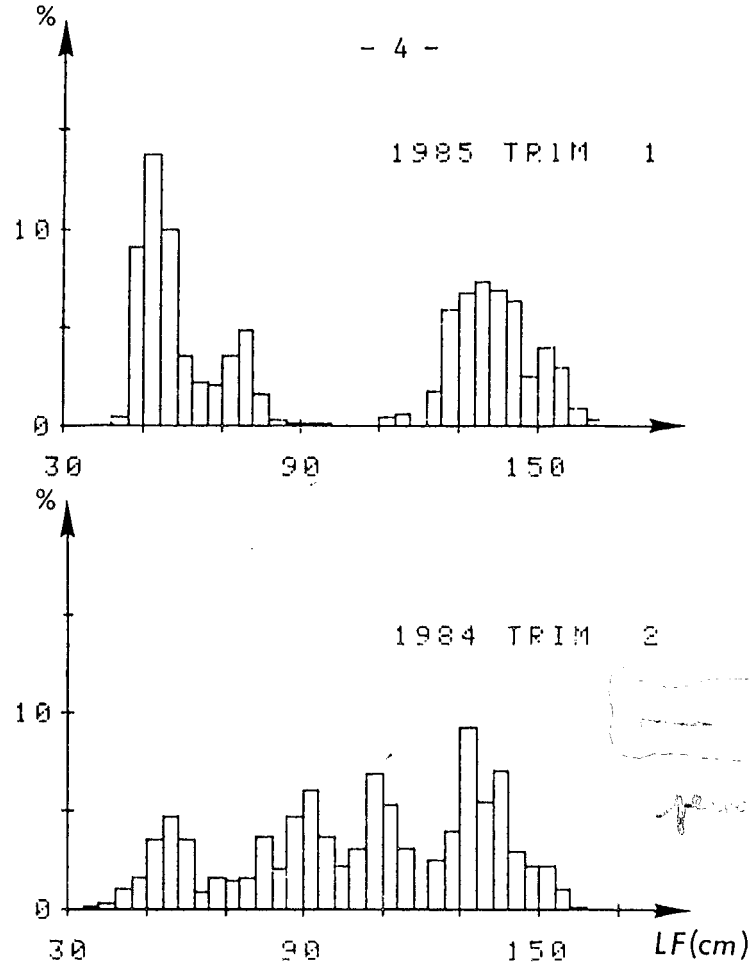


fig 1 : QUARTERLY FREQUENCY HISTOGRAMS OF YELLOWFIN (Thunnus albacares) CAUGHT BY PURSE SEINING IN THE WESTERN INDIAN OCEAN.

fig. 1 (continued)



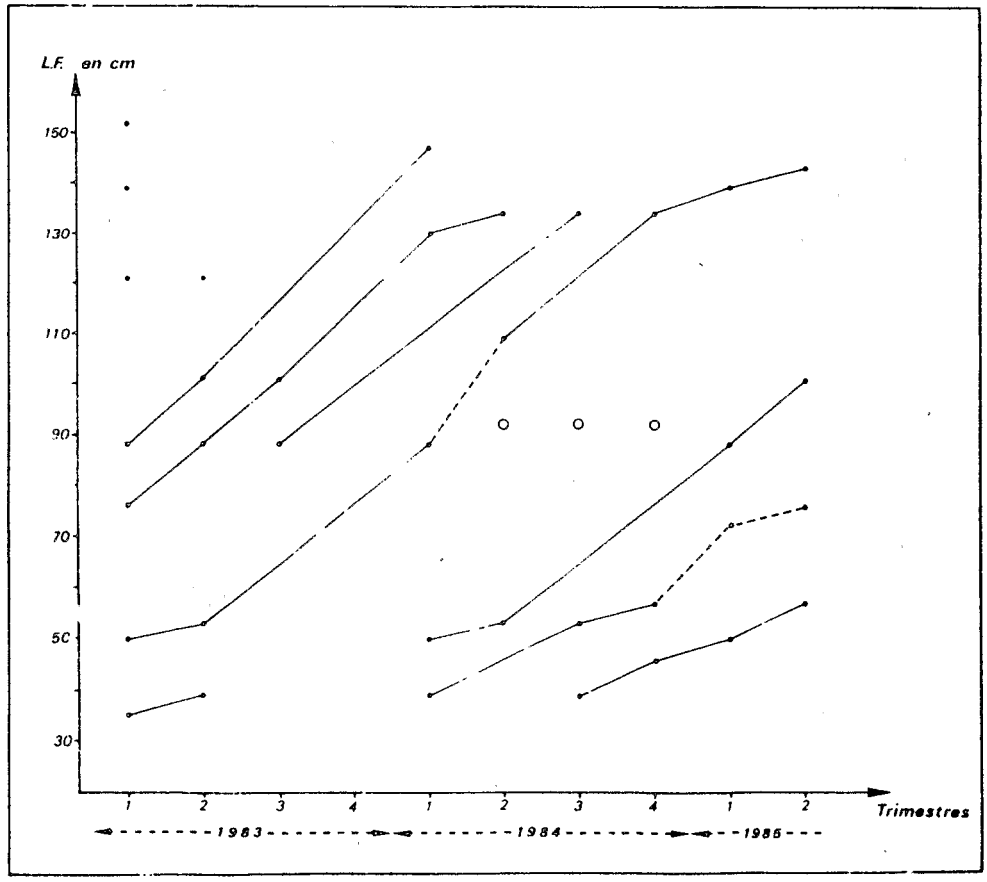


Fig 2. QUARTERLY SIZE CLASS MODES IDENTIFIED FROM YELLOWFIN SAMPLES AND MODAL PROGRESSIONS.

i) A regular displacement of the modes is apparent.

ii) A certain inter-annual variability in the position of the modes is shown. The modes are located at the same positions only during the first quarter of 1983 , 1984 and 1985.

iii) A constant inter-annual range in the lengths corresponding to the modes of the juveniles (coefficient of variation = 0.4 to 0.5 percent within modes inferior than 40cm), whereas for the higher modes this range can differ considerably within the same mode (coefficient of variation =0.3 to 6 percent for the modes 50-53cm; 4.1 to 7.7 percent for the mode at 88cm)

iv) Transitory appearance of modes inferior to 40cm corresponding to individuals aged less than six months (first and second quarter 1983, first and third quarter 1984) were noted.

v) Presence of a stationary mode at 92cm (second and fourth quarter 1984) is apparent which cannot be affiliated to any particular cohort.

A similar observation was made by MARCILLE and STEQUERT (1976), for individuals of 60 to 61cm. This stagnation could be explained by a continuous recruitment - growth - migration pattern. We can well imagine such a case for the older individuals where this apparent mode gives the impression that the population's growth remains stagnant.

3.2 Growth Rate

Taking into account the above mentioned modal progressions, monthly growth rates have been estimated in several size intervals, from 35 to 143cm. (Table 1)

Table 1. MONTHLY GROWTH RATE OF YELLOWFIN IN THE WESTERN INDIAN OCEAN

Length Interval (cm)	average growth rate (cm/month)	
35 - 39	1.3	
39 - 57	1.6	2.0
57 - 76	3.1	
76 - 88	4.0	
88 - 101	4.3	
101 - 134	3.9	3.0
134 - 139	1.7	
139 - 143	1.3	

These show an abrupt acceleration of growth in the length interval 57-76cm (mid class : 66.5cm), which reaches a maximum around 95cm (4.3cm/month). Above 139cm, a growth rate of 1.3cm/month similar to that found in the juveniles (35 to 39cm can be identified.

This growth pattern comforms perfectly to those obtained by FONTENEAU (1980) in the Eastern Atlantic, which was confirmed through tagging by BARD (1984).

Growth rates obtained here for the young stages, are much higher than those for the Atlantic, but are similar for the older fish : FONTENEAU obtained 1.4cm/month for the interval 40 to 70cm and 3.1cm/month between 76 and 140cm. (2.0cm/month between 35 and 76cm, 3.0cm/month for 76 to 143cm , in this study). MARCILLE and STEQUERT (1976) estimated a growth rate of 3cm/month for 45 to 70cm fish in Madagascar.

This reduced growth rate in young yellowfin has also been observed in the Pacific Ocean, by various authors, e.g. through tagging (SCHAEFFER et al, 1961; BAYLIFF, 1973), and through analysis of length frequencies (SUZUKI, 1971). Growth studies on young yellowfin (30-50cm) in Vanuatu (BROUARD et al, 1984) gave similar growth rates of 1.3cm/month.

3.3 Estimation of the VON BERTALANFFY growth parameters, Loo and K

It will be improper to fit a growth curve using the VON BERTALANFFY model on all the length range, bearing in mind that the growth of the yellowfin is in two phases. Loo and K will therefore be estimated from the length groups having a decreasing growth rate with size.

Firstly, the average growth of a cohort has been reconstructed by following the different modal components over the time series (Table 2). The estimates of Loo and K were obtained by a GULLAND and HOLT plot (1959), on the last five length intervals$\Delta L/\Delta t$ (76 to 143cm). The results obtained are as follows:

$$Loo = 160.2cm$$
$$K = 1.16 \text{ (per year)}$$

Table 2. GROWTH OF A YELLOWFIN COHORT IN THE INDIAN OCEAN

Quarter	Fork length	ΔL/ Δt	[L(t+Δt)+L(t)]/2
1	35		
		4	37.0
2	39		
		7	42.5
3	46		
		4	48.0
4	50		
		7	53.5
1	57		
		15	64.5
2	72 (?)		
		4	74.0
3	76		
		12	82.0
4	88		
		17	96.5
1	105		
		14.5	112.3
2	-		
		14.5	126.7
3	134		
		5	136.5
4	139		
		4	141.0
1	143		

Table 3 compares the parameters obtained for the Atlantic and Pacific oceans for the regions of Pointe Noire (Congo) Dakar (Senegal), Vanuatu (W. Pacific) and the Eastern Pacific.

Though the Loo is quite similar to that observed in the region of Pointe-Noire, the K value is on the other hand much higher for the Indian Ocean. However, these results have been calculated for lengths greater than 88cm whereas the studies made in other oceans were studies based on lengths starting from 60 to 80cm.

However, it must be borne in mind that these estimates are only valid in the length range examined and that any extrapolation below or over this range, has no biological significance.

These first results are only preliminary and should be revised, once further data is obtained.

An estimate of to has not been attempted due to limitations of the data .

Table 3. ESTIMATES OF LOO AND K FOR VARIOUS SIZE INTERVALS AND REGIONS.

Source of data	Interval (FL, in cm)	Zone	Loo (cm)	K (annual)
LE GUEN AND SAKAGAWA (1973)	61 to 70	PN	175.2	.528
	70 to 170	PN	180.0	.528
data from 1966 to 1970	70 to 147	PN	161.0	.756
	61 to 142	PN	161.8	.660
FONTENEAU (1980)	70 to 152	PN	166.4	.864
data from 1969 to 1977	70 to 140	PN	161.2	.936
	70 to 156	DK	189.0	.600
BROUARD ET AL (1984)	30 to 50	VA	-	.55 to .70
DAVIDOFF (1963)	80 to 140	EP	167.0	.600
Present study	88 to 143	IO	160.2	1.160

PN= Pointe Noire
DK= Dakar
VA= Vanuatu
EP= East Pacific Ocean
IO= Indian Ocean

3.4 Proportion of different length groups in the catch.

The separation of the modes using the BHATTACHARYA method also gives the theoretical number of individuals in each of the modes identified. This indicates the relative importance of different modes with time.

The range of sizes present in the samples (see Fig 1) has been separated into seven length groups (FL) as follows:

Group 1 : 35 to 39cm
2 : 50 to 57cm
3 : 72 to 76cm
4 : 88 to 101cm
5 : 109cm
6 : 120 to 143 cm
7 : 147 to 152 cm

Figure 3 shows the evolution of these length groups for the nine quarters sampled. There is a great difference in distribution between 1983 and 1984/1985. The only point in common could be the arrival of young recruits of about 6 months old, in the second and third quarters. Younger age groups were generally present in the catch in 1983 (groups 2 and 4).

In 1984 and 1985, it can be observed that the catch is essentially composed of two groups; individuals of less than 57cm and those greater than 120cm. Intermediate classes (groups 3, 4 and 5) are not well represented; some of the fish belonging to this apparent mode were identified earlier. (cf section 3.1). It therefore seems that these individuals constitute the most migratory fraction of the population. Their large displacement motivated by their active search for rich feeding grounds, out range of the actual fishery, renders them less vulnerable. These groups of yellowfin, aged two to three years, reach stages of first maturity during this time, and it seems that they can reproduce at least once before being again fully vulnerable to the fishery.

This finding and the fact that the catches are composed of roughly the same proportion of juveniles (immatures) and spawners throughout the year, could suggest for the moment, a healthy exploitation of yellowfin by purse seining in the Western Indian Ocean.

The big difference in the size distribution between 1983 and 1984-85 (cf Fig 3) is probably due to the fact that the fishery was initially localised during the first year of study. This could have limited the exploitation to a proportion of the population, those preferentially associated to the sectors prospected. Furthermore, a major proportion of the fishing activity was concentrated on drifting objects which aggregate small individuals. This explains the high proportion of young age groups in the catches. This fishing effort on drifting objects substantially decreased in 1984 and 1985 (HALLIER 1985).

CONCLUSION

It seems that yellowfin in the Indian Ocean, has a slow rate of growth (1.3 to 1.6cm/month) up to around 57cm, followed by more rapid growth, reaching values in excess of 4cm/month for fish from lengths of 76 to 134cm. This phenomenon of growth in two phases in fishes has already been demonstrated in the Pacific Ocean and Atlantic Ocean and was observed by MARCILLE and STEQUERT in Madagascar. The growth conforms to the VON BERTALANFFY equation, only for sizes greater than 88cm : the K value obtained is much higher than those estimated in Dakar by FONTENEAU (1980) and in the Pacific Ocean by DAVIDOFF, (1963) and BROUARD et al, (1984).

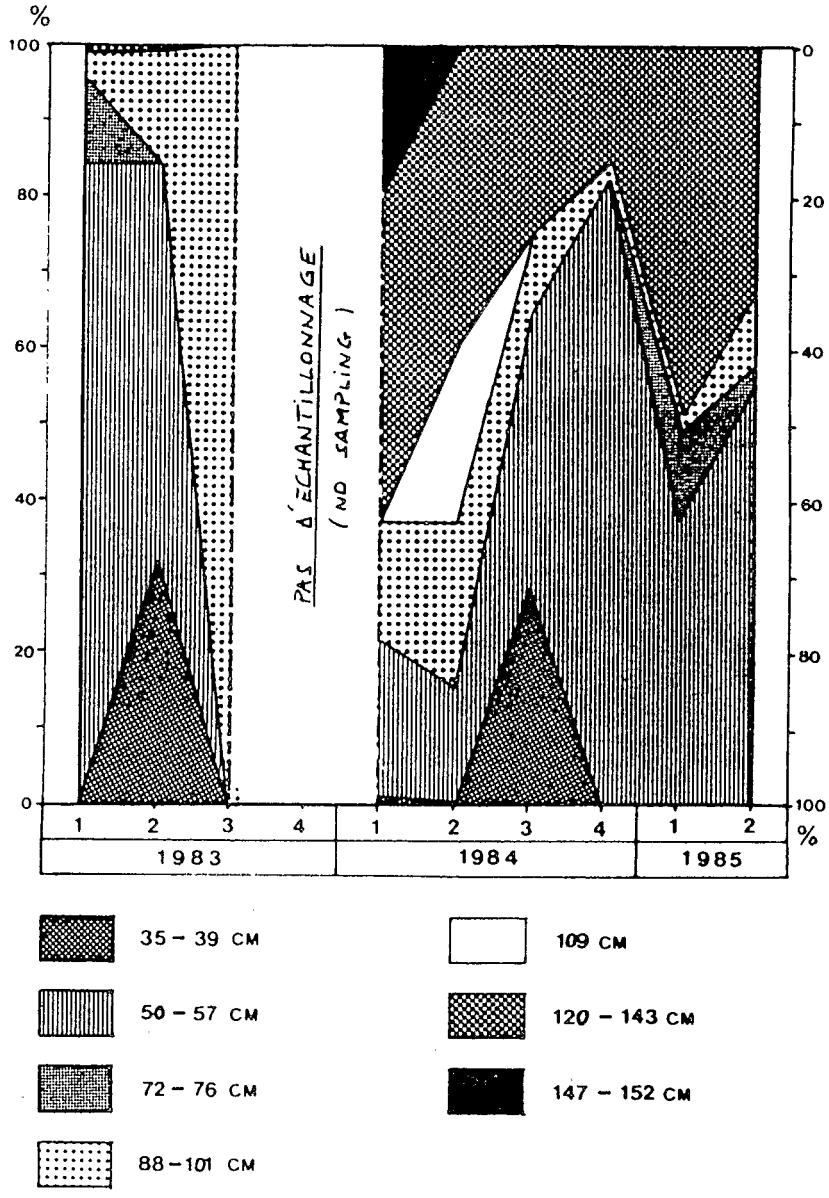


Fig 3. QUARTERLY EVOLUTION OF THE SIZE GROUP DISTRIBUTION OF YELLOWFIN PRESENT IN THE CATCH FROM JANUARY 1983 TO JUNE 1984.

The use of only length frequency data for growth studies in itself poses some uncertainty . In the larger length groups, the spread of modes observed, may sometimes be due to differing growth rates between males and females. Other techniques such as tagging, reading of otoliths, spines , vertebrae and scales in particular, according to SUZUKI (1974) can give accurate estimates for young yellowfin. This technique should be developped to complete and to give more precision to these estimates.

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