TWS/91/17

WORKSHOP ON STOCK ASSESSMENT OF YELLOWFIN TUNA IN THE INDIAN OCEAN, 7-12 OCTOBER, 1991

GROWTH OF INDIAN OCEAN YELLOWFIN TUNA ESTIMATED FROM SIZE FREQUENCIES DATA COLLECTED ON FRENCH PURSE SEINERS

INDO-PACIFIC TUNA DEVELOPMENT AND MANAGEMENT PROGRAMME (IPTP)

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GROWTH OF INDIAN OCEAN YELLOWFIN TUNA ESTIMATED FROM SIZE FREQUENCIES DATA COLLECTED ON FRENCH PURSE SEINERS

by Francis MARSAC *

INTRODUCTION

The current status of research on Yellowfin tuna growth is open to debate. Two main hypotheses are proposed. The first one suggests a high growth rate during the first ages, as commonly observed in most of the species of fish. It is supported by observations of Wang and Tanaka (1986) and Huang *et al.* (1973). These authors found growth rates as high as 3.32 to 3.39 cm/month for yellowfin ranging between 35 and 92 cm. Marcille and Stequert (1976) got a 3 cm/month rate between 45 and 70 cm; Anderson (1988) estimated a rate of 2.9 cm/month between 30 and 70 cm. Similar values were observed in the Eastern Pacific (Wild, 1986), Central Pacific (Uchiyama and Struhsaker, 1981) and Western Pacific (Yamanaka, 1988).

The second hypothesis is a two step growth pattern, with a low rate in the young ages and a sudden increase in the intermediate ages, leading to a common growth trend that can be described by the Von Bertalanffy growth curve (VBGF). This was observed in the Atlantic through tagging techniques: 1.4 cm/month for fish measuring less than 65 cm FL (Fonteneau, 1980; Bard, 1984; Miyabe, 1984). An analysis carried out from size frequencies data in Vanuatu (SW Pacific) resulted in 1.3 cm/month rates between 30 and 50 cm FL (Brouard *et al.* 1984). A preliminary study (Marsac and Lablache, 1985) suggested this growth pattern in the Indian Ocean. A longer data series allows now a revision of this analysis.

SOURCE OF DATA AND METHOD

The basic data are the size frequencies samples of the catch made by the French purse seiners between 1984 and 1989. The size spectra extends from 30 to 170 cm. It comprises a part of the size range exploited by the artisanal fishery (smaller fish) and by the longline fishery (bigger fish). Therefore, these samples represent the bulk of yellowfin sizes exploited in the Indian Ocean.

We used the Bhattacharya method to analyse the modal distribution.

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RESULTS

Through these data, the population appears as composed of three major groups (fig.1) :

- juveniles (size < 70 cm FL) caracterized by well pronounced modes. Though they are caught all the year round, the maximum occurence is found during the 3rd quarter, in relation with purse seine fishing on logs.

- fish from 80 to 120 cm FL: poorly represented in the catch from 1984 to 1987, they become more abundant in 1988 and 1989. However, they remain in low proportion in the catch compared with juveniles and adults.

- adults (size > 120 cm): well represented but the distinction between the modes is tricklish due to the combined effects of a slow growth rate, a different growth pattern between males and females and different individual history.

A first view of the connection between modes is given on a quarterly basis in figure 2.

More detailed information is obtained on a monthly basis. During the first 21 months of the life cycle, the modal progression suggests a recruitment in the surface fishery in May and June (size between 40 and 42 cm FL). In the yellowfin population, the gonad index reaches peak values from December to March (fig.3) and larvae should appear during the first quarter (Hassani and Stequert, 1991). The recruits found in May and June would represent a cohort born in the very beginning of the year.

Five cohorts with clear modal progression were selected and their growth pattern compared on the basis of a birth in December or January. A graphic representation (fig. 4) points out a good coherence between all of these. The growth is linear from 6 to 18 months, with an average rate of 1.5 cm/month. Then the growth rate increases up to 4 cm/month between 20 and 24 months. This growth curve cannot be modelized along the whole size range. The Von Bertalanffy Growth Function was calculated from 24 months and produced the following estimators :

L_∞ = 173.1 cm
K = 0.65
t_0 = 1.03 year

According to the specific processing applied there, no biological meaning can be given to the parameter t_0.

An additional analysis focusing on largest sizes gives a slightly higher L_∞, estimated at 174 cm, with K = 0.66 (Sabadach, manuscript).

The growth in weight is calculated using the length-weight relationship proposed by Hallier (manuscript, this meeting). The curves are presented in figure 5 and a key between age, size and weight in Table 1.

DISCUSSION

The estimation of size at age 1 is in accordance with the size found in the Indian Ocean by Yabuta *et al.* (1960), based on scale readings. The differences appear later and bigger sizes are estimated by the present growth equation.

This particular two step growth pattern seems consistent between size frequencies analysis and tagging techniques, while different figures are given by otoliths, scales or vertebrae rings readings. For most of the otoliths readings, small size fish are in concern and no comprehensive growth equation can be proposed. In the other hand, selectivity is often invocated as a restriction to modal analysis an tagging based results. Since no results on the whole size range are available through direct methods, the growth equation given in this study could be considered as a reasonable hypothesis for this working group.

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Table 1 - Key between age (month), fork length (cm) and weight (Kg) for the Indian Ocean yellowfin tuna.

Age	Length (cm)	Weight (Kg)
6	44	1.8
9	48	2.3
12	53	3.0
18	62	4.6
20	66	5.5
24	81	10.3
30	106	23.3
36	125	38.5
42	138	52.0
48	148	64.3
60	160	81.5
72	166	91.2
84	170	98.1

- the birth date is set to January 15 th;
- the growth from 6 to 20 months is estimated by the apparent progression of the modes;
- the growth from 21 months is calculated by the VBGF with the following parameters :

L_∞ = 173.1 cm K = 0.65 t_0 = 1.03 an (i.e. 12,40 months)

- the length-weight relationships is from Hallier (manuscript).

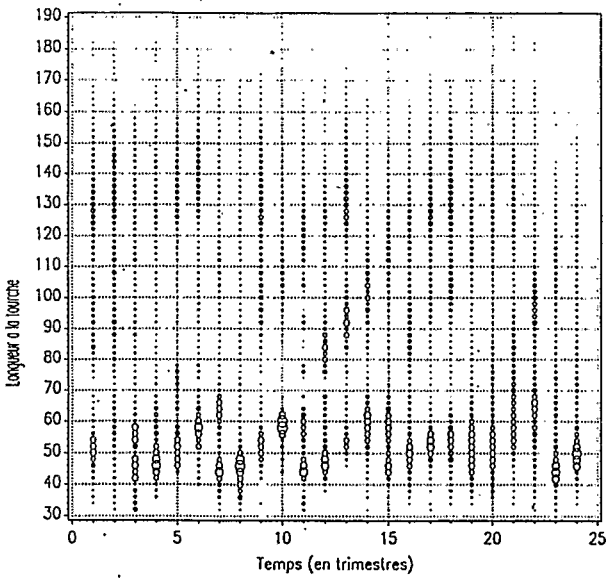


Fig. 1 – Quarterly distribution of the size frequencies of yellowfin tuna caught by the French purse seiners in the Western Indian Ocean.
The frequency of each size class is proportionnal to the area of the circles (from Sabadach, manuscript)

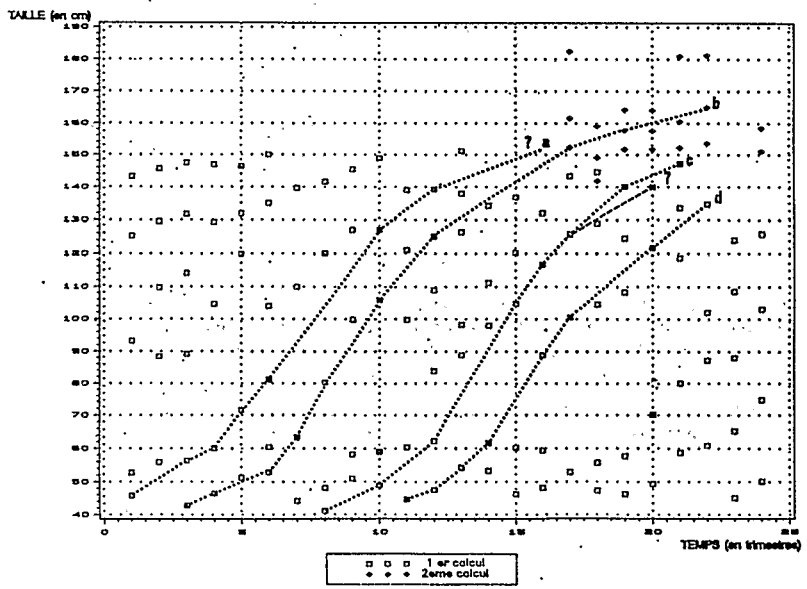


Fig. 2 – Quaterly distribution of modes estimated by SAS package from 1985 to 1989 and connection of some cohorts (from Sabadach, manuscript).

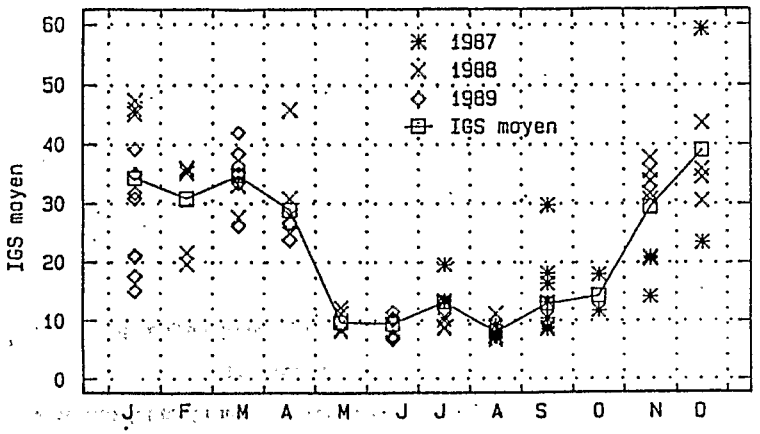


Fig. 3 – Monthly means of the gonad index for female yellowfin measuring less than 113 cm (from Hassani and Stequert, 1991).

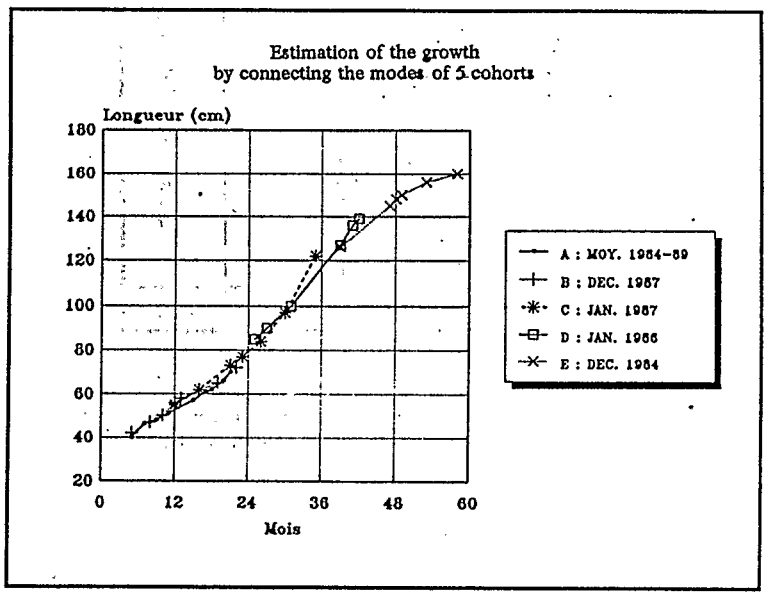
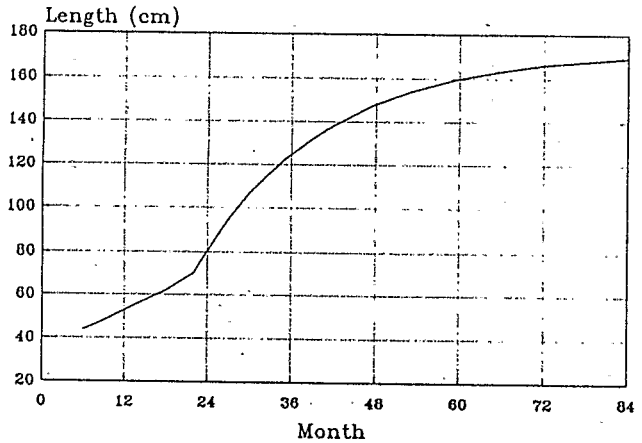


Fig. 4

The cohort A is a pseudo-cohort obtained by combining the yars 1984 to 1989, for ages less than 21 months.

Growth in length



Growth in weight

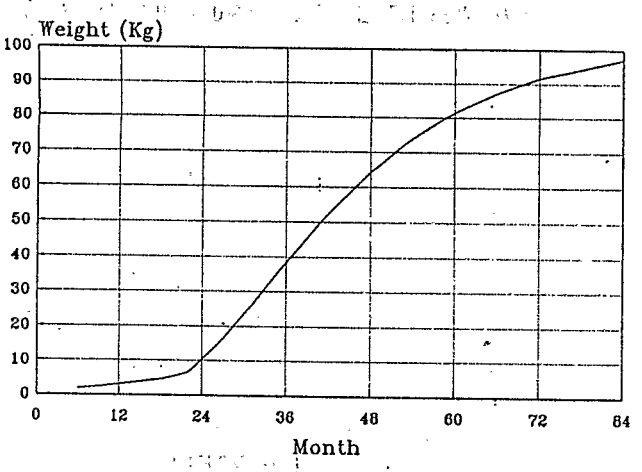


Fig-5

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