

Macroscopic study on some aspects of the reproductive biology of skipjack tuna (*Katsuwonus pelamis*) in the Western Indian Ocean.

by

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Abstract

A macroscopic study on some aspects of the reproductive biology of skipjack tuna (*Katsuwonus pelamis*) was carried out at Albion Fisheries Research Centre. The study aimed at determining seasonal sexual variations, length at first maturity, sex ratio and spawning seasons. Gonadal samples were collected from 758 fish. The different maturity stages of gonads assessed by gross visual examination indicated that whatever the month, there was always a majority of fish with gonads in terminal stage of maturation. The study showed that the reproduction of the species occurred throughout the year, with some periods of more intense sexual activity.

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1. Introduction

Skipjack tuna is a cosmopolitan, epipelagic species that inhabits worldwide in tropical and subtropical waters. This species is widely exploited in the Pacific, Atlantic and Indian Oceans. In 2010, the catch effected in the Indian Ocean of this resource amounted to about 440 600 tons.

In Mauritius skipjack tuna landed by purse seiners represents an important raw material for the canning factories. In 2010, a total of 49 000 tons of this species caught by licensed purse seiners was landed at Port Louis.

2. Aims and objectives

Macroscopic maturity evaluation is a rapid and inexpensive manner of determining the reproductive status and allows for many fish to be assessed in the field.(Tomkiewicz et al 2003

The main objective of this study is to improve our knowledge on some aspects of the biological parameters of skipjack tuna. The study is based on macroscopic analysis of the reproductive morphology and the reproductive parameters that have been taken into consideration are gonad stages, length at first maturity ($L_{50\%}$), Gonado Somatic Index (GSI) and sex ratio.

3. Materials and methods

Data were collected at the local canning factory. Biological samplings were done on skipjack tuna caught only by licensed purse seiners that unloaded their catch at Port Louis. The exact position and date of capture were also noted from fishing logbooks. The fish were caught between 08° N and 8° S and 47° E and 70° E in the Western Indian Ocean.

The data were collected during 2007 and 2008. During each sampling about 30-35 fishes were sampled at random. The study was carried out on a total of 758 skipjack tuna.

The fork lengths of the fish were measured to the nearest centimeters and weight data of each individual was recorded by a top loading balance.

Skipjack tunas were cut open on the ventral side starting from the genital aperture up to 10 cm from the operculum. Gonad stages were noted and sex of the individual determined. The samples were collected and placed inside labelled plastic bags and brought to the Albion Fisheries Research Centre laboratory for weighing and analysis. An electronic balance of high accuracy to the nearest 0.1 gramme was used for the measurement.

4. Visible changes observed in different gonadal stages

Visual examination of different gonadal stages was used to predict the time of spawning of fishes. The gonads of both males and females show some visible changes that can be identified macroscopically. The techniques of external observation of different stages of gonads were used for several years for skipjack tuna. Several characteristics were used to distinguish the different gonad stages and they were; size, coloration, consistency, and vascularisation.

Some authors in the past have carried out macroscopic analysis of gonads and they were; Stéquert (1976), Cayré and Farrugio (1986) and Stéquert and Ramcharrun (1995). All of them have proposed a method for staging. This constituted especially 5 (1-5) stages though they also agreed upon the stage 0 at which gonads could not be identified macroscopically.

4.1 Characteristics of male and female gonads at different stages.

Table 1: Characteristics of male and female gonads

Stages	Females	Males
Stage 1 (Immature)	Gonads appeared pale pink in colour, cylindrical and elongated.	The size of the gonads were very small and plain with pale pink in colour
Stage 2 (Start of maturation)	Initial stage of primary oocyte development. The texture slightly changed and became pale yellow and a slight change in the size could be observed. Vascularisation appeared on the surface lining.	Gonads had undergone a major change in colour and appeared whitish. The size was increased and the testicular arteries became apparent.
Stage 3 (Maturation)	Gonads had undergone more changes and became prominent in colour and their size increased further. Blood vessels started to appear on the surface. The ovocytes present were still invisible behind the lining	The gonads appeared plump and increased in size. There was very little change in colouration. The blood vessels appeared more prominent.
Stage 4 (End of maturation)	An orange colour appeared on the outer surface with granules and eggs.	Size was much bigger and looked very plump. Gonads fully matured and testicles were well developed. The colour was pink and whitish creamy.
Stage 5 (After spawning)	The ovaries became flaccid and reddish in colour. Small number of eggs appeared on the inner lining. Probably the eggs were released.	Gonads looked flaccid with a reduction in size. The colour was dark pink. No further development of blood vessels.

5. Results

5.1 Size at first maturity ($L_{50\%}$)

According to Cayré and Farrugio (1986), the size at first maturity is defined as the length (fork length) at which 50% of the individuals are capable to reproduce. In this study, only sexually matured gonads stages (III-IV) were taken into consideration. For both males and females, the proportion was calculated for each size.

The females thus reach first sexual maturity at the size 43 cm. The males on the other hand reach first sexual maturity at 44 cm.

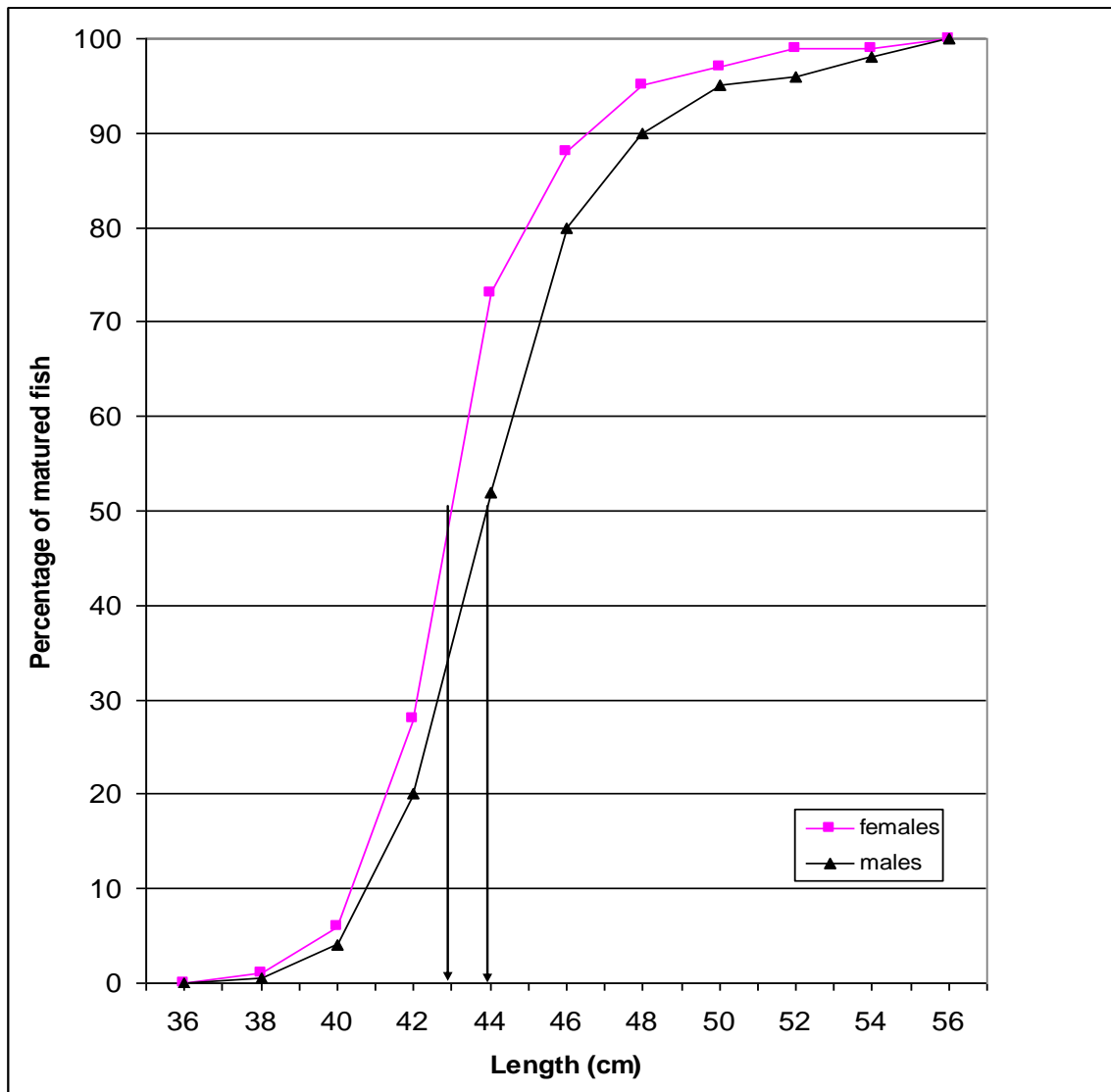


Figure 1: Size at first maturity ($L_{50\%}$) of males and females skipjack tuna

5.2 Gonado Somatic Index (GSI)

Gonads undergo regular cyclical changes in weight, particularly in females such cyclical changes are indications of spawning.

For both males and females the GSI were calculated for matured skipjack tuna and the results obtained were as follows:

The GSI was high in January, April, July and December and minimum during June and August.

Moreover, the results obtained for both males and females of the monthly variation of GSI were synchronous.

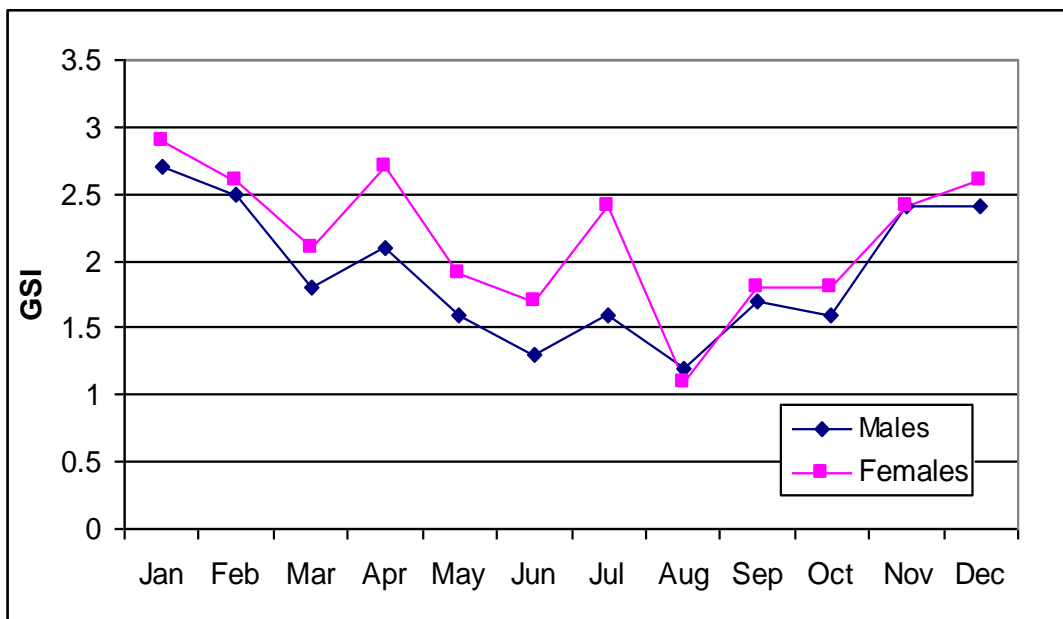


Figure 2: Monthly average GSI of males and females skipjack tuna

Table 2: Monthly average variations of GSI

Months	GSI
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	Females	Males
January	2.9	2.7
February	2.6	2.5
March	2.1	1.8
April	2.7	2.1
May	1.9	1.6
June	1.7	1.3
July	2.4	1.6
August	1.1	1.2
September	1.8	1.7
October	1.8	1.6
November	2.4	2.4
December	2.6	2.4

5.3 Sex ratio

In this study it was observed that male individuals were predominant over female individuals. From a total of 758 individuals studied, 409 males and 342 females were observed. The sex ratio was 1,19. It was also noted that only in the months of January and August, the number of females was slightly higher than males.

Table 3: Sex ratio of male and female skipjack tuna

Months	Number of Males	Number of Females	Number of Immature fish	Total	Sex Ratio
January	35	38	-	73	0,92
February	39	28	-	67	1,39
March	32	25	1	58	1,28
April	35	28	-	63	1,25
May	39	32	-	71	1,21
June	33	25	1	59	1,32
July	30	23	2	55	1,30
August	29	38	-	67	0,76
September	33	27	-	60	1,22
October	35	24	2	61	1,45
November	34	28	-	62	1,21
December	35	26	1	62	1,34
Total	409	342	7	758	1,19

6.0 Discussion

6.1 Size at first maturity

It was observed that size at first maturity of females was 43 cm and males 44 cm in this area of study. Moreover, the results are in conformity with some authors who have also studied on this parameter in the Indian Ocean.

A study on size at first maturity in the Indian Ocean was carried out by Raju in the region of Laccadives island in 1964. According to him $L_{50\%}$ of skipjack tuna in this area ranged from 40-45cm. However, he had indicated that the smallest female to have reach maturity measured 39.6 cm. Later in 1976, Stéquert estimated size at first maturity of this species caught along North-West coast of Madagascar and it ranged from 41-43 cm. Study based on macroscopic and histological analysis was effected by Stéquert and Ramcharrun (1995) in the Western Indian Ocean and they estimated size at first maturity of females and males to be 42 cm and 43.5 cm respectively

6.2 Spawning periods

An analysis of the Gonado Somatic Index (GSI) shows that majority of spawning seemed to occur during warmer months from December to January and April. Sexual activity was more intense during January and April as observed in corresponding peaks in GSI.

Moreover, it appeared that there was minimal reproductive activity at certain period of the year (June and August). Spawning activity could be observed in the cold season as well, that is in the month July. This indicated that spawning might occur throughout the year in this zone of study.

In the Northern part of the Mozambique channel, Stéquert (1976) pointed out that though spawning activity occurred all round the year, it seemed that there were four periods of intense spawning, that is in December-January, February-March, June-July and September-October.

Study carried out by Marcille and Suzuki in 1974 showed that in the Central Indian Ocean, skipjack tuna spawn from September to April, whereas for the eastern part of the Indian Ocean, they found that spawning occurred throughout the year, but the main spawning period corresponded to warmer months that is from October to April.

According to Matsumoto *et al.* (1984), skipjack tuna spawns in the three oceans namely (Indian, Pacific and Atlantic) throughout the year in the tropical waters near the equator and from summer to autumn in subtropical waters

6.3 Sex Ratio

Sex ratio indicates the proportion of males and females in the population. For most pelagic species, when all the size classes are present in the fishery, the sex ratio is almost 1

In the Indian Ocean, Marcille and Suzuki (1974) had observed that the sex ratio of male and female skipjack tuna from the longline fishery was 1,02. However, they were of the view that detail study on a zonal basis showed significant differences. Around Minicoy island, Raju (1964) had observed a sex ratio of 1, 88 with a predominance of males especially during September to May. Around Maldives, Hafiz (1988) had also found an abundance of males over females in a study on the landing of pole and line fishery. However, Stéquert (1976) had observed a dominance of females over males in the Western Indian Ocean especially in the North of Mozambique Channel. Moreover, Stéquert and Ramcharrun (1995) found that sex ratio of males and females was 1, 23 in a zone of study in the Western Indian Ocean.

In this study, the sex ratio of males and females skipjack tuna was 1,19. It was observed that in almost every month male predominated over female. The monthly analysis of sex ratio showed that the value was slightly different to 1 especially during summer months and when compared to peaks observed during spawning periods.

7.0 Conclusion

A total of individuals (409 males to 342 females) were studied for fish caught in the Western Indian Ocean. The sex ratio was 1,19 with a slight predominance of males over females. The males were predominant mostly during the spawning season.

In this zone of study it could be noted that females became sexually matured at the length of 43 cm and males at 44 cm. Skipjack tuna usually spawn in the summer months when the sea temperature is high and plenty of food is available.

As this study was based on macroscopic analysis, exact information on the period of spawning could not be determined. It is recommended that for the validation of such type of studies, histological examination be carried out. At the Albion Fisheries Research Centre, histological study of gonads is being planned.

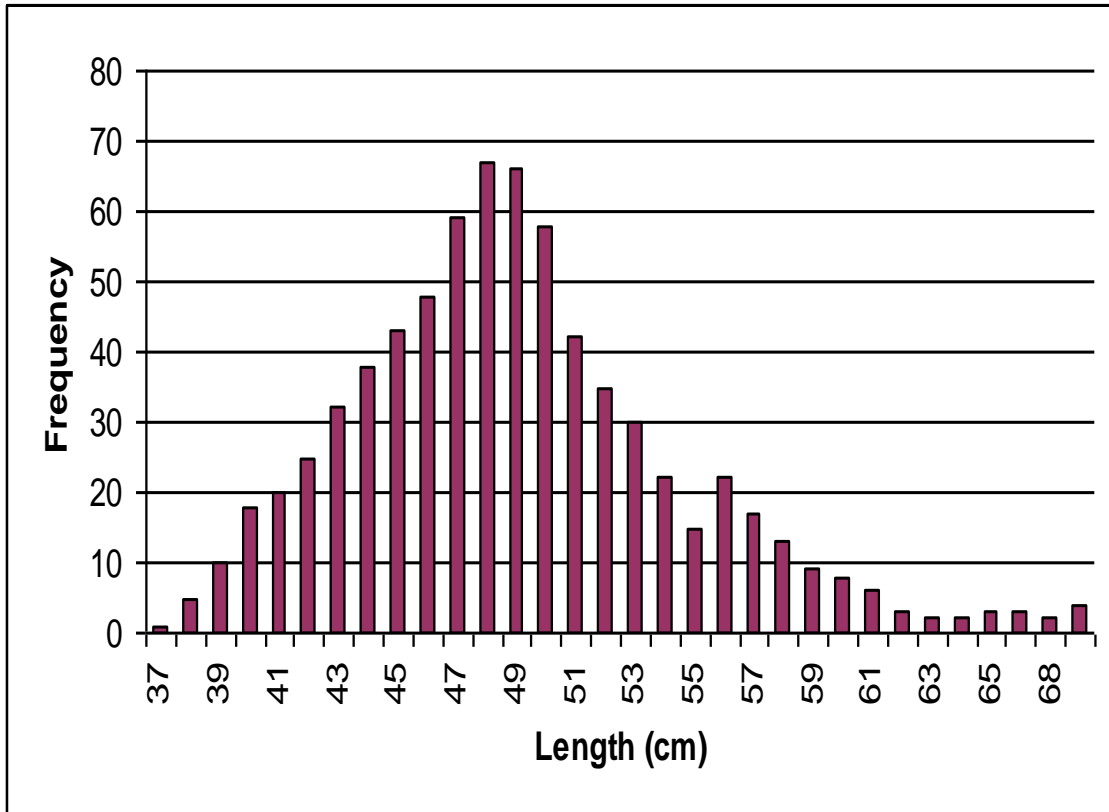


Figure 3: Length frequency distribution of skipjack tuna sampled

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