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REPRODUCTIVE BIOLOGY OF SPANISH MACKEREL, SCOMBEROMORUS BRASILIENSIS COLLETTE, RUSSO & ZAVALA-CAMIN, 1978 (PISCES: FAM: SCOMBRIDAE) IN EASTERN VENEZUELA.

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ABSTRACT: A total of 357 specimens of Spanish mackerel, *Scomberomorus brasiliensis* were analyzed between November, 1983to October, 1984 at the Esmeralda Beach, Sucre State, Venezuela. The females to male sex ratio was 1: 1.7. Gonadosomatic indices for female varied between 0.1 and 3.37. The mean fecundity was 1.821.210 eggs per female and 499 ova per gm of body weight of female fish. The relationship between fecundity and fork length was $F = -5.6 \times 10^6 + 10986L$. Diameter of oocytes ranged between 28 and 585 µm, developing asynchronously. This and other evidences indicated that Spanish mackerel spawn repeatedly throughout a prolonged season, with peak from October to January.

RESUMEN: En playa Esmeralda (estado Sucre, Venezuela), durante un año (Nov, 1983 - Oct, 1984) fueron estudiados 357 ejemplares de carite pintado, *Scomberomorus brasiliensis* Collette, Russo & Zavala-Camin, 1978. La proporción sexual fue de 1: 1,7 (hembra a macho). En la hembra, el Indice Gonadosomatico varió entre 0,1 y 3,37 y su mayor valor es durante los meses de octubre a enero. La fecundidad media es de 1.821.210 óvulos y 499 óvulos por g de peso corporal; y tiene una relación lineal con la longitud, expresada por la ecuación $F = -5{,}6 \times 10^6 + 10986L$. El diámetro de los óvulos varia entre 28 y 585 micras. Se infiere que el carite *S. brasiliensis* desova durante todo el año, pero con mayor intensidad durante los meses de Octubre a Enero.

INTRODUCTION

COLLETTE and RUSSO (1978) recognized 18 species of the genus *Scomberomorus*. These are all epipelagic marine fishes of commercial and recreational importance all over the world. The species *Scomberomorus maculatus* in the Caribbean and Western Atlantic is being replaced by the new species *S. brasiliensis* COLLETTE, RUSSO & ZAVALA-CAMIN, 1978. The range of this species, according to the authors, in the Atlantic and Caribbean coasts of Central and South America are from Belize to Rio Grande do Sul, Brazil.

Mackerel fishery in Venezuela is composed of three species of *Scomberomorus: S. brasiliensis. S. cavalla* and *S. regalis* of which S. regalis is not common in the catch of the artisanal fisheries.

Due to commercial importance of *S. brasiliensis,* Brazilian investigators studied the different aspects of biology and fisheries (NOMURA & COSTA, 1966; 1968; MOTA ALVES, 1969; MOTA ALVES & TOME, 1970 and GESTEIRA, 1972). Little has been studied on the biology of this species in Venezuelan waters though it is one of the very important species in the artisanal as well as trawl fisheries in the country. GRIFFITHS (1971) evaluated and observed the importance of mackerel fishery in Venezuela. GINES (1972) stated that over 58 % of catch of spanish mackerel landed in the eastern part of the country. TORRES (1986) and BASHIRULLAH & ACUÑA (1991) studied some aspects of biology of spanish mackerel in the venezuelan waters.

MATERIALS AND METHODS

Specimens were collected from the commercial artisanal fishermen (gillnetters) at the Esmeralda Beach, Carúpano on the northern coast of Sucre state, Venezuela. Sampling was conducted at monthly intervals from November 1983 to October 1984. A total of 357 fish were measured for fork length to the nearest millimetre and whole weight to the nearest 10 g. Sex and gonadal development were determined macroscopically from all fish sampled. The stages of gonadal development were classified as per NIKOLSKY (1963). Gonads were removed, weighed and preserved in 10% buffered formalin. Preserved

gonads were weighed after removing liquid to the nearest 0.01 g. and the gonadosomatic index (expressed as percentage) was derived for each specimen using the relationship, GSI = Wg x 100/W, where Wg is gonad weight and W is body weight. Fecundity of 19 mature female fish with stage IV and V ovaries was determined by direct count of the ripening eggs. A sub-sample of 1g was taken from anterior, posterior and mid-region of 5 ovaries to study the existence of any differences between the region of the same ovaries. Oocyte diameters were measured using a binocular microscope fitted with a micrometer eye-piece. The linear regressions of fecundity- length and weight were calculated, and in addition, 3000 oocytes were measured from three ovary and plotted.

RESULTS

Sex Ratio:

Sex of 357 *S. brasiliensis* was grouped by months and data revealed males to be more abundant than females in the sample. The overall ratio of male to female was 1.7: 1. There was a significant departure from the expected 1:1 sex ratio with the exception of the month of August when data were stratified by months as well as total. There was wide variaton in monthly sex ratio. Mean monthly values for females and males are given in Table - 1.

Size at first maturity:

The shortest male and female measured in the sample were 35 cm for male and 38 cm for female and both were classified at reproductive stage I. It was not possible to establish minimum size of mature fish in the present study as the fish were collected from the catch by pre-selected gill nets.

Gonadal Cycle:

The mean monthly gonadosomatic indices (GSI) of male and female (Table I and Fig. 1A), indicate that gonadal development of both sexes of *S. brasiliensis* fluctuate, with higher GSI from October to January. The reproductive stage IV (Table-II) of female fish were found almost throughout the year and some spent fish in the months of January, March and April.

Fecundity:

Eggs counts from anterior, posterior and middle regions of the ovary showed no significant difference. The fecundity of 19 mature *S. brasiliensis* ranged from 658.000 (FL 55 cm, wt 2.2 Kg) to 4.360.000 (FL 88 cm, wt. 5.4 Kg), with an average number of 499 ova/g of body weight and 1.821.210 eggs per, female. The relationship between fecundity (F) and lenght (L) was linear (Fig. 2), but the same was not rue for fish weight.

$$F = -5.6 \times 10^6 + 109866L \quad (r = 0.947, P\ 0.01)$$

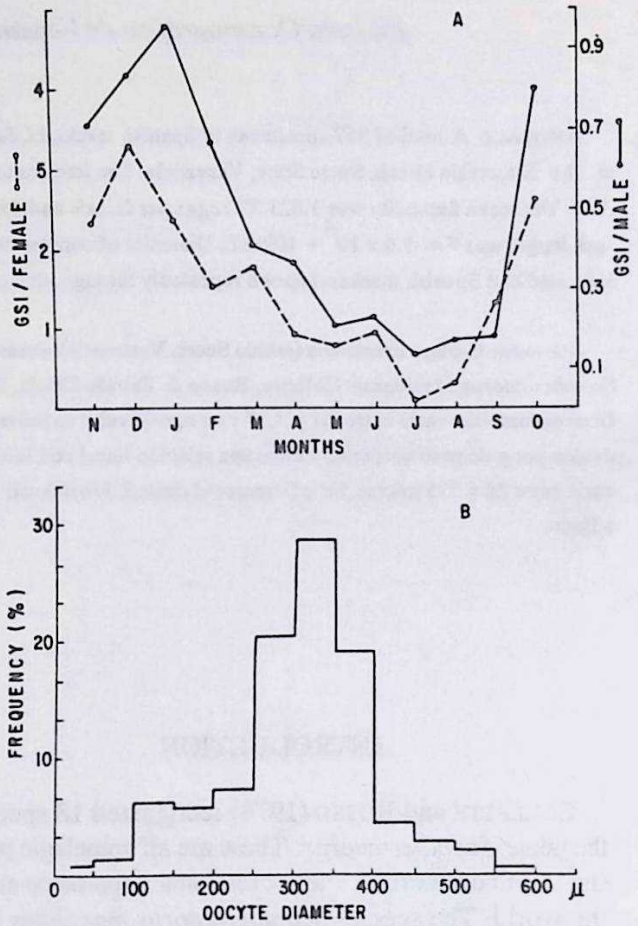


FIG. 1. A. Mean Gonadosomatic Indices of male and female *Scomberomorus brasiliensis* from November, 1983 to October, 1984.

B. Frequency distribution of diameters of oocytes of a *S. brasiliensis* female (FL= 58: 8 cm) in November 1982.

Oocyte Diameter:

Measurements of the size of oocytes from 3 mature females from the sample of the month of November showed a wide range of sizes from 28 to 585 μm. An example of size frequency distribution of oocytes is given in Fig. 1B, based on measurement of 3000 oocytes. This demonstrated an asynchronous development of ripening oocytes in the sample. This type of frequency distribution is typical of prolonged spawners which release small batches of eggs over a long spawning period (HISLOP & HALL, 1974).

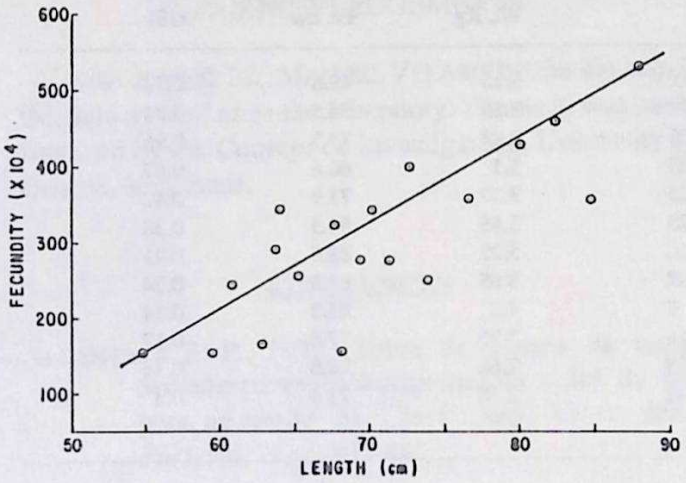


FIG. 2. Relationship between fecundity and fish for length in S. brasiliensis (based on 19 ovaries of Stages IV and V).

DISCUSSION

Scomberomorus brasiliensis is the dominant species in the national as well as in regional catch. The fish size in the present study ranged from 35 to 110 cm in male and 38 to 118 cm in female. COLLETTE *et al.* (1978) reported size from 26.7 to 125 cm. NOMURA and COSTA (1968) observed a maximum fork length of 75.5 cm for female but, ALCANTARA (1972) recorded a mean size (FL) of 92.8 cm for female and 96.6 cm for male.

The overall sex ratio of male to female in *S. brasiliensis* was 1.7 : 1 in the present study, while MENEZES (1976) observed 3.3: 1 in the same species in Brasil. It was not possible to examine the variation in sex ratio between age groups because the fish could not be aged. STURM (1978) observed also dissimilar proportion of sexes in the same species in Trinidad. KLIMA (1959) found a sex ratio of 1: 3.9 of *S. maculatus* in Florida.

KLIMA (1959) observed that the smallest mature spanish mackerel from Florida water was 25 cm for female and 28 cm FL for male. GESTEIRA (1972) observed the shortest mature female at 46 cm FL while, MOTA ALVES & TOME' (1968) found matured female at 40.5 cm FL in Brazilian waters. STURM (1978) measured the shortest mature male at 38 cm and female at 45 cm FL. The shortest male and female in the present study were found at 35 and 38 cm FL respectively.

The mean fecundity of *S. brasiliensis* was found to be 1.821.210 oocytes per female, based on 19 matured female and an average of 499 ova/g of body weight of fish. GESTEIRA (1972) reported a mean fecundity of 2.204.000 in Brazil, while STURM (1978) observed a mean fecundity of 63.375 oocytes per female in the Trinidad for the same species. The fecundity of this study is more close to the data given by GESTEIRA than STURM.

MOTA ALVES & TOME (1968) recognized 5 stages for ovaries of Brazilian Spanish mackerel, while TORRES (1986) classified six stages for ovaries of *S. cavalla* in Venezuela and NIKOLSKY (1963) was followed to classify the gonadal stages of *S. brasiliensis*. Five spent female (stage VI) were found in the months of January, March and April and matured fish were observed in most of the months of the year.

Because eggs do not ripen synchronously in an individual ovary and because mature fish are found at different times of the year, it is assumed that spawning of *S. brasiliensis* is prolonged. This is in concordance with EARLL (1883); SMITH (1907); POWELL (1975) and STURM (1978). BERRIEN and FINAN (1977) reported that the onset of spawning varies with the latitudes being earlier in the south than in the north. EARLL (1883) stated that the gonads do not ripen very rapidly until a temperature of about 72 F has been reached and BEAUMARIAGE (1973) claimed spawning is probably limited to water where the temperature is above 78 F. The water temperature in the eastern region of Venezuela is between 78.8 F and 82.4 F throughout the year (BONILLA, *personal comm.*) which indicates that *S. brasiliensis* encounters a suitable temperature all the year round to maintain a prolonged spawning.

TABLA 1.- Mean monthly weight, Length and Gonadosomatic Indices (GSI) of *Scomberomorus brasiliensis.*

	FEMALE			MALE			
Month	Nº	Mean Wt. Kg	Mean Lt. cm	Mean GSI	Nº	Mean Wt. Kg	Mean Lt. cm	Mean GSI
Nov.	12	1.5	59.2	2.31	15	3.15	49.6	0.72
Dec.	9	1.96	62.7	3.37	27	2.19	54.5	0.84
Jan.	11	2.95	79.8	2.4	25	3.48	73.5	0.96
Feb.	3	3.42	79.8	1.51	23	3.1	60.6	0.67
Mar.	10	2.93	64.6	1.82	25	3.29	71.9	0.42
Apr.	14	3.25	77.8	0.96	23	3.45	84.5	0.38
May.	17	3.88	82.8	0.8	10	5.25	88.8	0.21
Jun.	5	2.45	75.0	0.95	22	3.65	83.2	0.24
Jul.	12	1.5	57.3	0.18	8	4.2	85.2	0.14
Aug.	16	3.8	79.3	0.31	16	3.25	77.4	0.17
Sep.	8	2.81	69.7	1.4	19	2.66	70.8	0.18
Oct.	15	3.2	83.5	2.65	12	2.38	71.4	0.8

TABLA 2.- Monthy occurrence of *Scomberomorus brasiliensis* with different maturity stages.

	MATURITY STAGES						
MONTH	I	II	III	IV	V	VI	TOTAL
Nov.	-	2	9	1	-	-	12
Dec.	-	3	4	2	-	-	9
Jan.	-	1	2	3	2	3	11
Feb.	-	-	2	1	-	-	3
Mar.	1	-	3	2	1	3	10
Apr.	5	3	3	1	-	2	14
May.	6	5	6	-	-	-	17
Jun.	3	2	-	-	-	-	5
Jul.	6	5	5	1	-	-	16
Sep.	1	2	4	1	-	-	8
Oct.	4	2	5	3	1	-	15
TOTAL	31	30	44	15	4	8	132

CONCLUSION

The overall ratio of male to female of 357 specimens of *S. brasiliensis* was 1.7: 1. There was wide variation in monthly sex ratio and fluctuation in gonadal development. Mature female fish were found throughout the year. The fecundity varied between 658.000 to 4.360.000, with an mean of 499 ova per gm of body weight. The relationship

between fecundity (F) and length (L) was lineal. The diameter of oocytes of matured female ranged from 28 to 585 /μm, which showed asynchronous development of ripening oocytes.

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