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A STUDY OF THE LIFE HISTORY OF BRAZILIAN SARDINE, *Sardinella brasiliensis*. II. SPAWNING IN 1970 and 1971*

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SYNOPSIS

Distribution and abundance of eggs of *Sardinella brasiliensis* (=*S. aurita*), are presented for the years 1970 and 1971 and compared with that of the previous year (1969). The spawning size of three spawning seasons was calculated using Tanaka's method. Incubation time of sardine eggs was estimated using the method of Ahlstrom. During three spawning seasons a considerable change in the relative spawning size was observed. The spawning season (during spring and summer in the southern hemisphere) of 1970-71 was poor when compared with those of 1969-70 and 1971-72. A slight change in the average diameter of eggs in different spawning seasons was also observed. The relation between oceanographic conditions and spawning size was analysed. It is suggested that the warm water covering the spawning ground during the 1970-71 spawning season may have caused an unsuccessful spawning in this year.

INTRODUCTION

In a previous paper (Matsuura, 1971*a*), the description of the eggs of Brazilian sardine and their distribution and abundance in the region of Ilha Grande were presented. The spawning season of the Brazilian sardine occurs during spring and summer (from September to March) in this region. The spawning area is localized in the region of Ilha Grande between 50 and 100 m contour lines. Because the survey area was limited to the region between Cabo Frio and São Sebastião, it has not been determined whether there are other important spawning areas.

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This report presents the results obtained during the spawning seasons of 1970-71 and 1971-72 which had extended survey area. Since the spawning is observed during the period from September to March with concentration in December-January, we used the term "1970-71 spawning season" as indicating the period from September 1970 to March 1971 and so on.

Because the survey cruises were conducted by only two research vessels covering large areas, the number of sampling stations was not sufficient and the results obtained from year to year cannot be used for comparative purpose. Neverthless a notable annual variation is spawning size was recognized from the results. The present enlarged survey cruises showed further spawning areas in southern Brazil.

MATERIAL AND METHODS

The area covered by the cruises made during the period from October 1970 to December 1971 is shown in Figure 1. The survey area was divided into six subareas:

subarea I= region of Cabo de São Tomé; II= region of Rio de Janeiro, III= region of Ilha Grande; IV= region of Santos; V= region of Paranaguá and VI= region of Ilha de Santa Catarina.

During the cruises which covered the region from Cabo de São Tomé (Lat. 22° S) to Cabo de Santa Marta Grande (Lat. 28°40' S) in May and August 1970, no sardine eggs appeared. Therefore they are not discussed in this paper.

Plankton hauls were made vertically from the depth of 80 m up to the surface or in inshore stations from near the bottom to the surface. The amount of water strained was calculated from flow meter readings.

Plankton samples were fixed and preserved in a solution of 10 percent formalin. After measuring the plankton volume, all eggs and larvae of fishes were sorted out using a stereoscopic binocular microscope. The sardine eggs were identified according to Matsuura (1971*a*).

For a computation of spawning size, it is necessary to estimate the incubation time of sardine eggs at different temperatures. There are two ways to obtain it: 1) to rear artificially fertilized eggs at different temperatures in the laboratory (e.g. Nakai, 1962); 2) using plankton eggs to analyse the relation between developmental stage, temperature, and estimated developmental time (e.g. Ahlstrom, 1943). In this paper the author used the method of Ahlstrom to estimate incubation time.

One of the purposes of the quantitative study of fish eggs is to evaluate the size of the spawning stock. Many methods have been described but we can summarize them in one principle, i. e. to calculate the egg density per standard area, accumulate them and then estimate total egg number in the spawning area during the season.

The method described by Sette & Ahlstrom (1948) is very useful for data collected with fixed station pattern but it was not appropriate for present data. The method of Tanaka (1955*a*, *b*; 1973) is useful for many cases of plankton samples collected vertically with different types of sampling gear and arbitrarily arranged sampling stations. The advantage of Tanaka's method is that the sampling stations can be stratified according to data presented. Therefore we followed Tanaka's method (1973).

He showed the total spawning quantity with following formula:

$$E_{st} = \sum_{st}\sum \frac{A_s \cdot T_t}{K_{st} \cdot b_{\theta_{st}} \cdot n_{st}} \sum_i Y_{sti}$$

where A is area of the spawning ground, T is the period of spawning season, b_θ is incubation period (time with days) at water temperature θ, and K is the correction factor, or $k=\frac{d_\theta \cdot M}{b_\theta}=\frac{1}{M.b_\theta}(1-e^{-Mb_\theta})$. Here M is the mortality coeficient and d= corrected b_θ value when mortality is operating, n is the number of sampling stations in the area A, and Y is the egg number per standard area (m^2) at i station. But $Y_i=d \cdot X$: d=depth sampled, X=egg concentration.

Using plankton samples, Ahlstrom (1943) expressed the incubation time of the eggs of California sardine as $\log b_\theta=\alpha-\beta\theta$, but in this paper we used a fixed value, b_θ=24 hours, which was estimated from the developmental stage of plankton samples, to be applied for all of our samples, because we have no data available to estimate a variation of incubation time at different water temperature.

Stratification of sampling stations was planned based on the number of stations and period. It is shown in Figure 1. The area from Cabo de São Tomé (22°00' S) to the south of Cabo de Santa Marta Grande (29°20' S) was separated for six subareas and each subarea was divided into three different depth zones, i. e. 1st depth zone=15-50 m, 2nd depth zone=51-100 m, and 3rd depth zone=101-200 m. To measure the area of each subarea a planimeter was used. The period of spawning season was divided into bimonthly period.

RESULTS

SIZE FREQUENCY OF EGG DIAMETER - It is generally accepted that the egg diameter of a given species shows a considerable variation depending on size of the spawner or the spawning period.

Blaxter & Hempel (1963) reported that larger larvae derived from large eggs of the herring have better survival and they observed some variation in

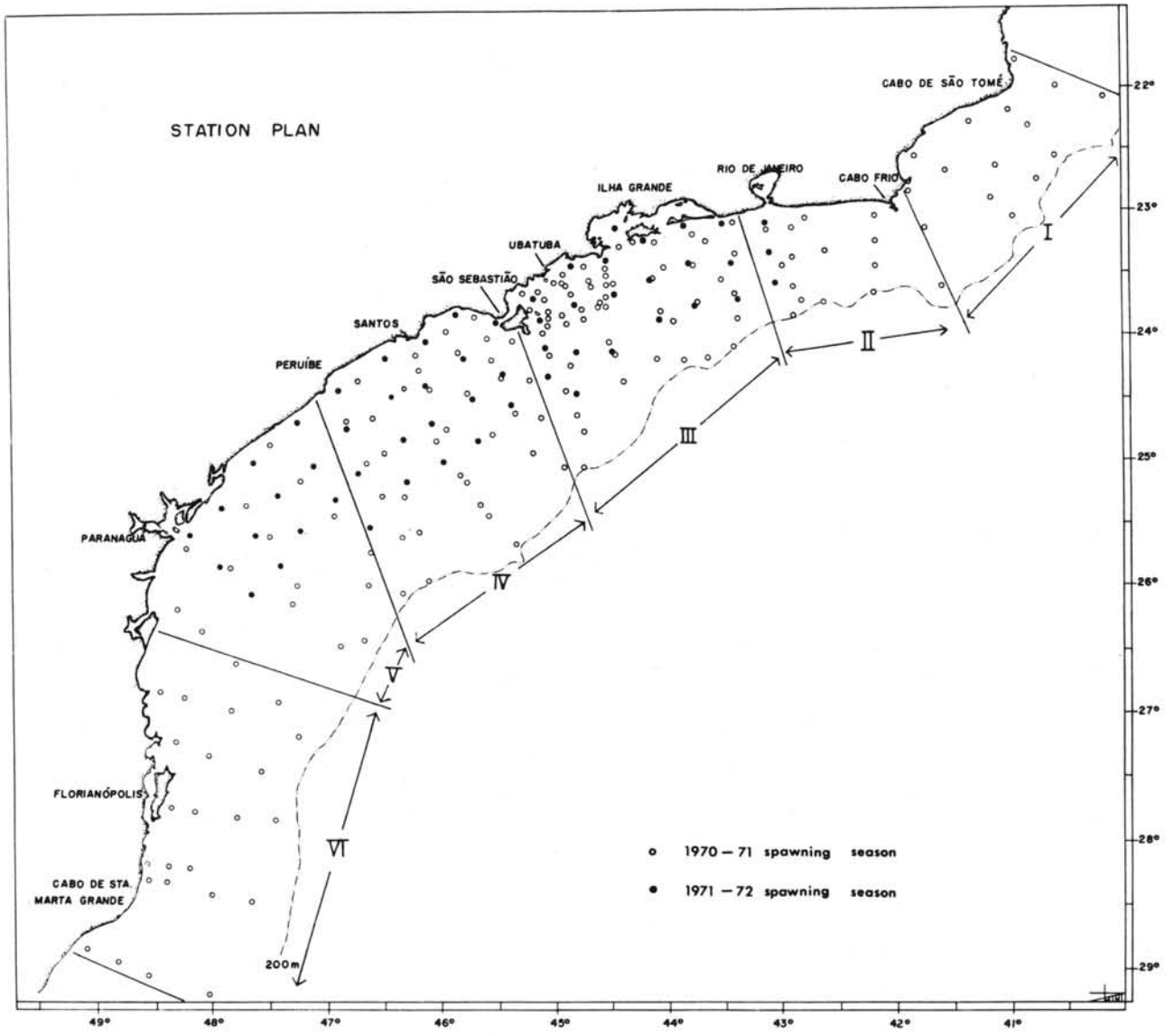

Fig. 1 – Location of stations occupied during survey cruises made in 1970 and 1971.

egg size depending on spawning area and size of spawners. They also found that the difference among spawning groups was larger than variation within a group. The recruit spawners tend to have somewhat smaller eggs.

Ciechomski (1966) working with *Engraulis anchoita*, showed a positive correlation between egg diameter and the size of females. She concluded that larger females spawn larger eggs.

Size frequency of egg diameter during three spawning seasons showed some variation among seasons. No significant differences were found in the eggs resulting from the 1969-70 and 1970-71 spawning seasons, but those from the 1971-72 spawning season showed somewhat larger diameters. The difference was significant at the 1% level.

Size frequency of total eggs measured from three years is shown in Figure 2. The average diameter for a total of 1052 eggs measured was 1.20 mm. Egg

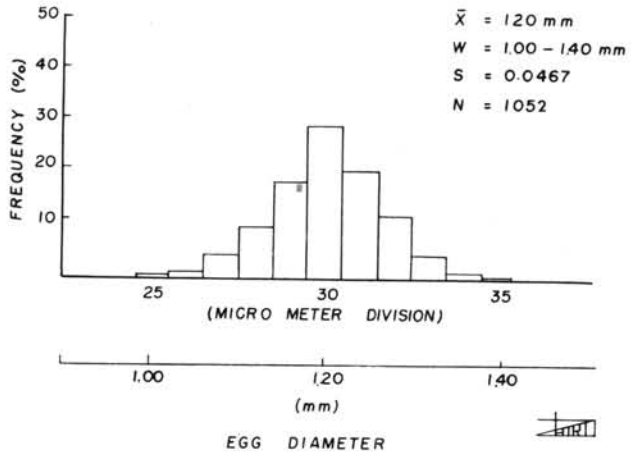

Fig. 2 - Distribution of the diameter of the sardine eggs for the three spawning seasons. (1 micrometer division: 0.040 mm). $\bar{x}$: mean egg diameter, w: range of distribution, s: standard deviation, n: total number of eggs measured.

diameter of this Figure is higher than that of the 1969-70 season, since this includes the larger eggs of 1971-72 spawning season.

1970-1971 SPAWNING SEASON - During this season four cruises were carried out. The cruise of October 1970 was made by R/V "Emília" on the survey area located between 44°28' W and 45°12' W within the 100 m contour line. The cruises of November-December 1970 and February-March 1971 covered a larger area from Cabo de São Tomé (22° S) to south of Cabo de Santa Marta Grande (29°20' S). The cruise of January 1971 covered the area between Rio de Janeiro (43° W) and Peruíbe (47° W). The last three cruises were conducted by R/V "Prof. W. Besnard". The occurrence of eggs is shown in Figure 3.

In the cruise of February-March 1971, a conical-cylinder plankton net was used during the initial stations, but it was lost by accident at the 12th station. Most part of sampling then was made with Hensen plankton net. Therefore the calculation of number of eggs per square meter was not applied for the data of this cruise. The occurrence of eggs during this cruise is represented by a large circle in Figure 3.

The spawning during this season was very poor in both senses, i.e. in number of eggs per station and in number of samples in which sardine eggs appeared (Table I). The total number of sampling stations in this season was 162 (119 with conical-cylinder net and 43 with Hensen net). Eggs appeared only in eleven samples.

For comparison with the results of other seasons, the average number of eggs per station was calculated using only eight samples collected with the conical-cylinder net during the cruises of November-December 1970 and January 1971 (Table II).

Three spawning areas can be visualized in this season: the northern area off Cabo Frio, Ilha Grande, and Paranaguá. It is interesting to note that during this spawning season the eggs occurred mainly at depths other than 51-100 m depth zone, the zone in which the main spawning was observed in the previous year. Only four samples out of eleven in which sardine eggs were observed, appeared in this zone.

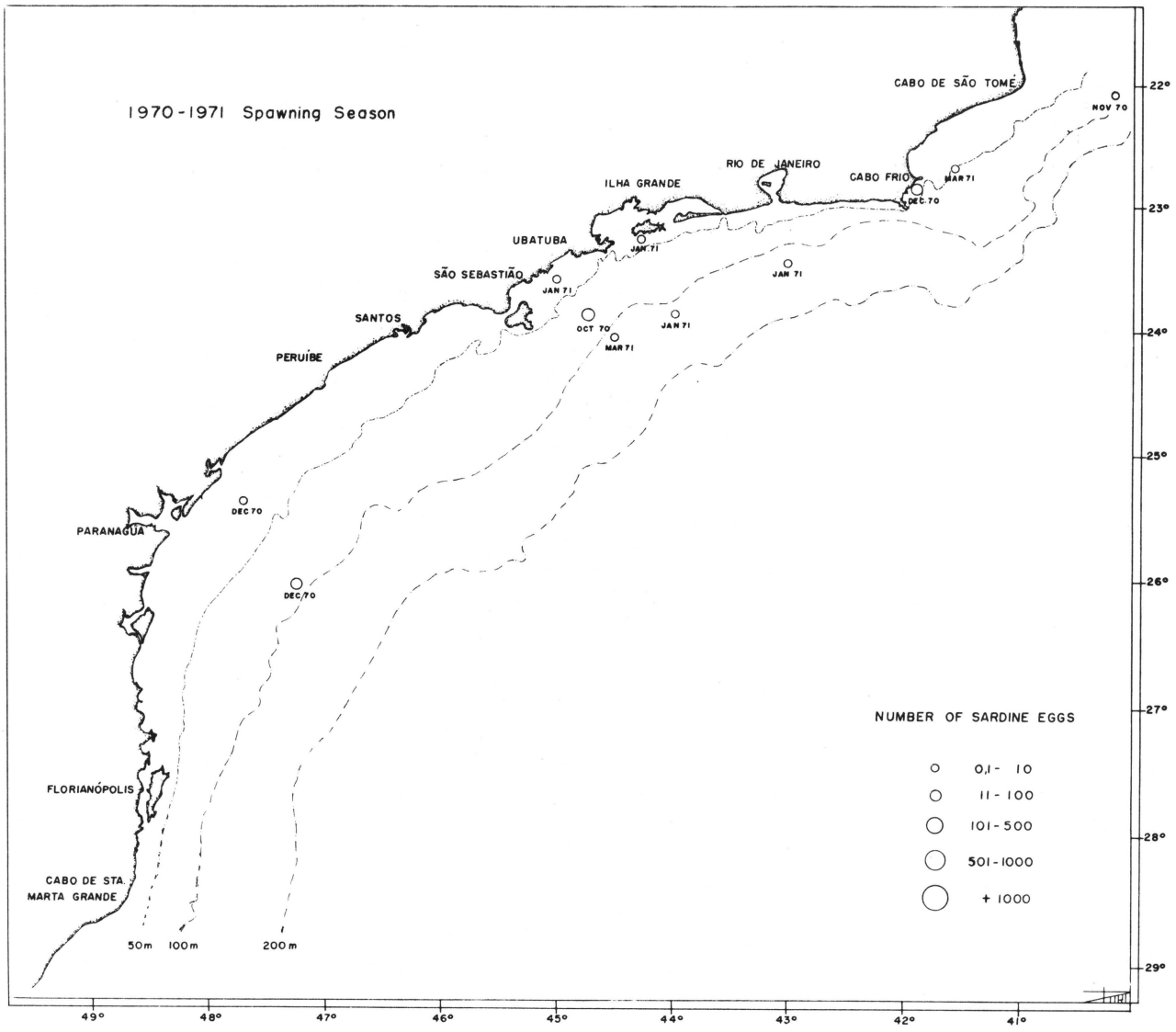

Fig. 3 - Distribution and abundance of sardine eggs in the 1970-71 spawning season.

In the subarea III (region of Ilha Grande) a continous spawning was observed from October to March. Five of eleven samples were collected in this region. This fact shows that this area was probably the main spawning ground in this season.

1971-1972 SPAWNING SEASON - During this season only one cruise was carried out from Rio de Janeiro to Paranaguá (48°30' W) on December 1971 with the R/V "Prof. W. Besnard". The conical-cylinder plankton net was used and vertical and horizontal hauls were conducted in all stations. No flow meter was used, therefore the number of sardine eggs was represented by next calculation for comparative purposes;

Estimated water volume = (mouth area) x (towing distance) x (filtration coefficient)

TABLE I — Estimated number of sardine eggs by station (1970-1971 spawning season)

Sample no.	Date	Time	Position	Local depth (m)	10 m depth		Egg developm. stage *	Total no. of eggs/sample	Volume of filtered water (m^3)	Depth of haul (m)	Number of eggs per square meter ▲
					T (°C)	S (°/oo)					
Cruise October 26 - 29, 1970											
465	27/10	09:45	23°52' S 44°45' W	85	21.36	—	Aa	64	(30)**	30	(64)
Cruise November 28 - December 10, 1970											
483	28/11	16:00	22°04' S 40°09' W	105	23.80	—	Ca	7	147	80	3.8
487	01/12	05:25	22°51' S 41°52' W	48	21.76	—	Aa	33	44	45	34
518	07/12	17:15	25°59' S 47°15' W	81	21.82	—	Ca	22	66	75	25
520	08/12	01:35	25°20' S 47°42' W	25	23.15	—	Ac	2	20	20	2
Cruise January 16 - 22, 1971											
532	16/01	08:35	23°26' S 43°00' W	108	23.98	—	Aa	1	34	80	2.3
537	17/01	04:55	23°13' S 44°17' W	43	27.22	—	Bb	1	27	38	1.4
539	17/01	13:45	23°51' S 43°59' W	122	24.99	—	Bb	1	72	80	1.1
546	18/01	09:15	23°33' S 45°00' W	36	24.95	—	Ca	2	27	30	2.2
Cruise February 27 - March 11, 1971 ***											
651	07/03	18:10	24°01' S 44°30' W	114	26.10	—	Ca	10	—	60	(+)
667	10/03	20:05	22°39' S 41°33' W	52	23.70	—	Aa	5	—	45	(+)

* Refer to Nakai, 1962

** Not used flow meter

*** Collected with Hensen plankton net

▲ $Y = \frac{d.X}{V}$ d = depth of haul; X = egg count; V = water volume

TABLE II — Number of sardine eggs taken during three spawning seasons

Spawning season	A	B	$\frac{B}{A}$ x 100	C	$\frac{C}{A}$	$\frac{C}{B}$	Cruise	Survey area
	Number of routine stations*	Stations with sardine eggs		Total number of sardine eggs				
1969-70	54 **	7	13.0%	6.100	113	871	Nov. 1969 Jan. 1970	From Cabo Frio to São Sebastião
1970-71	84	8	9.5%	69	0.8	8.6	Nov-Dec. 70 Jan. 1971	From Cabo São Tomé to Santa Marta Grande
1971-72	55	14	25.4%	461	8.4	33	Dec. 1971	From Rio de Janeiro to Paranaguá

* Fixed station not included

** Five extra stations near São Sebastião not included

Note: This table contains only data obtained on the cruises conducted during the main spawning season (November, December and January). All the samples were collected vertically with the conical-cylinder plankton net.

The occurrence of sardine eggs is shown in Figures 4*a* and *b*. The spawning during this season may be considered good when compared with that of the previous season. The abundance of eggs per station is given in Table III*a* and *b*.

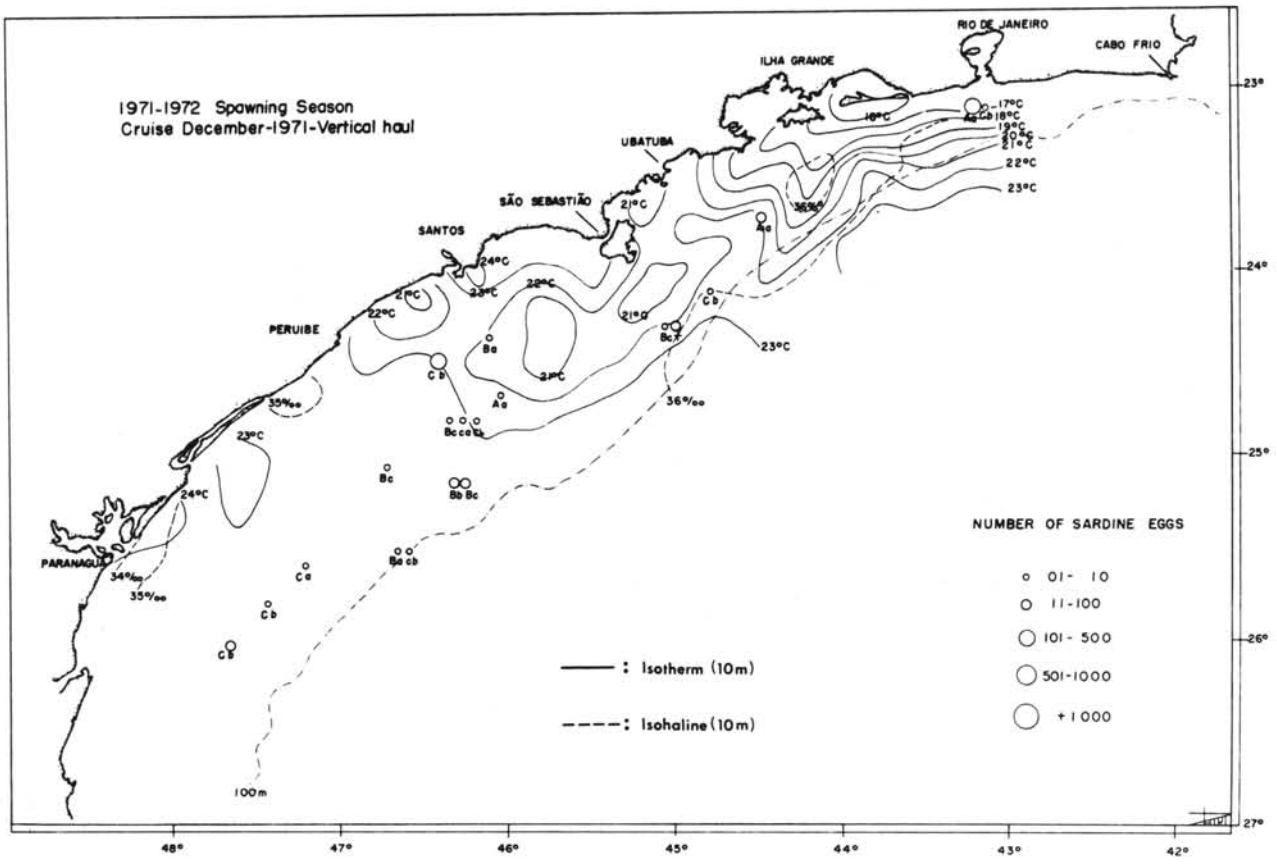

Fig. 4a - Distribution and abundance of sardine eggs on the cruise of December 1971. (Vertical haul). (Letters under each circle shows developmental stage of eggs).

The occurrence of sardine eggs in vertical and horizontal hauls were similar having fourteen stations in which sardine eggs were collected in both, horizontal and vertical hauls, but two extra stations showed sardine eggs only in horizontal haul.

All eggs were collected in the depth zone of 51-100 m except for one sample which was collected at the station of 21 m depth near Cananéia (25° S).

Three spawning areas can be distinguished: near Rio de Janeiro, off Ubatuba and Santos-Paranaguá. The last group may be divided into two subareas: off Santos and off Paranaguá. The distribution pattern of the sardine eggs in this season seems to be continuous. Based on the observation of developmental stages we can find eggs of two different stages, originating from different spawning days. It means that there occurred two successive spawnings at the same station.

The spawning ground off Ilha Grande and São Sebastião which was considered the main spawning ground for two previous seasons was confirmed in this season also, but it moved to a somewhat off-shore position near the 100 m depth contour.

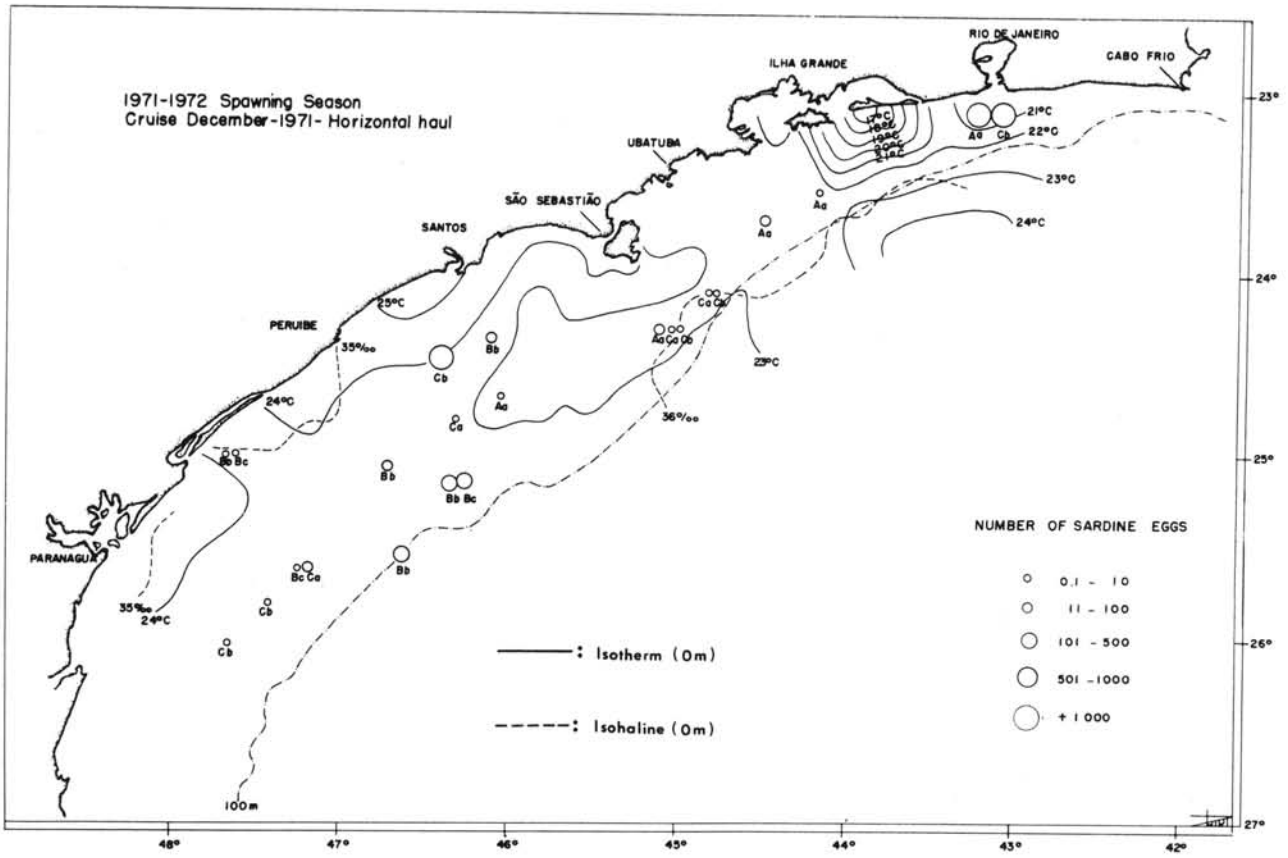

Fig. 4b – Distribution and abundance of sardine eggs on the cruise of December 1971. (Horizontal haul).

During this season the north-eastern region (off Cabo Frio) and the southern region (off Santa Catarina) were not studied. In the region of the State of Rio Grande do Sul some sardine eggs and larvae were collected in January 1972 (Phonlor, 1973). This indicates that the spawning ground in this season extended far to southern region. On the other hand, collections made in the same area in December 1968 revealed no sardine spawning in the State of Rio Grande do Sul (Matsuura, 1971*b*).

The data presented in the previous section, indicate that the spawning pattern of 1970-1971 season was somewhat different from the others and that the spawning was poor. The spawning area in this season was not only observed in the 51-100 m depth zone, but was also out of it. In order to know what happened in this region, we calculated the average temperature for each depth zone. In this paper we used "depth zone" instead of "distance from coastal line" to separate a region studied, because the continental shelf of this region demonstrates complicated contour near Cabo Frio and so the distance from the coast seems not to represent a characteristics of the physical and chemical conditions of the station.

The average temperatures at the depth of 10 m for all stations occupied during spawning seasons are shown in Figure 5.

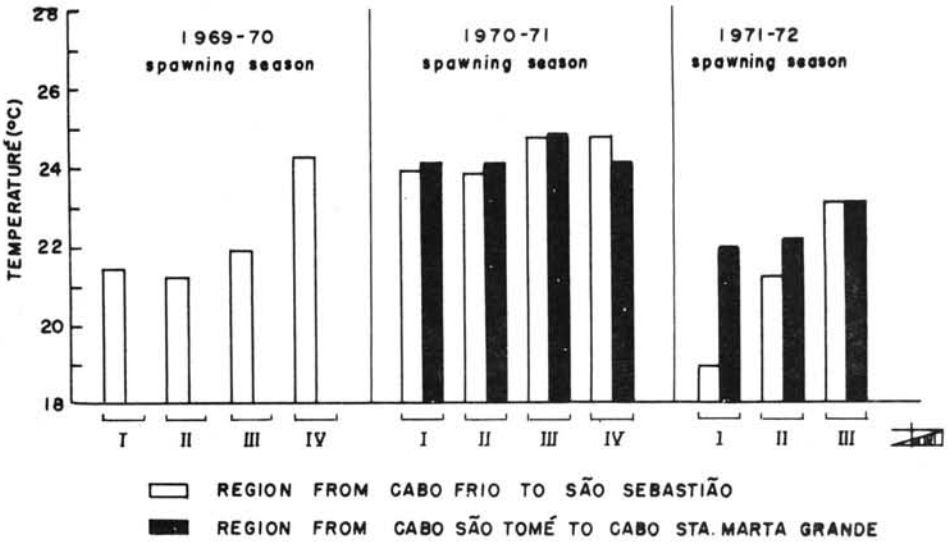

Fig. 5 - Average water temperature at the depth of 10 m in southern Brazil based on all stations occupied. The data of the cruises of September 1969, March 1970 and October 1970 is not included, because they covered only the area inside the 100 contour line. I: 15-50 m depth zone, II: 51-100 m depth zone, III: 101-200 m depth zone, IV: over 200 m.

The average temperature in the 51-100 m depth zone of the 1970-71 spawning season is higher than those of the other two seasons. The average temperature of this zone for the region from Cabo Frio to São Sebastião was 23.8° C and that of 1969-70 and 1971-72 seasons was 21.2° C. The average temperature of this zone for the region from Cabo de São Tomé to Cabo de Santa Marta Grande which includes the total area studied, was 24.1° C for 1970-71 season and 22.1° C for 1971-72 season.

The average temperature for the other depth zones in 1970-71 season was also higher than the others.

Therefore we may hypothesize that the water with higher temperature which covered the continental shelf, especially on the spawning ground of 51-100 m depth zone, may have caused the poor spawning in this period. Further investigation is required to confirm this hypothesis.

TEMPERATURE AND SALINITY ON THE SPAWNING GROUND - Since the distribution of the sardine eggs was assumed to be in the upper mixed layer of the thermocline, the temperature and salinity of the 10 m depth were used as representative of the station and are given in Tables I and III.

In the 1970-71 spawning season, no salinity data was taken. The temperature of the spawning ground ranged from 21.4 to 27.2° C and the average temperature was 23.4° C.

In the 1971-72 spawning season, the temperature ranged from 16.8 to 23.6° C and the average temperature was 22.4° C. The salinity range was from 35.33 to 36.04°/oo and the average salinity was 35.55°/oo.

TABLE III-a — Estimated number of sardine eggs by station (1971 - 1972 spawning season)**

Sample no.	Date	Time	Position	Local depth (m)	10 m depth		Egg developm. stage *	Total no. of eggs/sample	Depth of haul (m)	Number of eggs per square meter
					T (°C)	S (°/oo)				
Cruise December 11 - 19, 1971 (Vertical haul)										
682	11/12	20:00	26°02' S 47°41' W	58	23.34	35.63	Cb	20	50	22
684	11/12	22:15	25°49' S 47°26' W	61	23.33	35.67	Cb	8	56	9
694	12/12	16:45	25°32' S 47°14' W	62	23.52	35.64	Ca	7	55	8
706	13/12	11:00	25°04' S 46°44' W	60	22.97	35.57	Bc	2	60	2
708	13/12	14:15	25°32' S 46°38' W	100	23.19	35.74	Ba	6	95	7
							Cb	1		1
710	13/12	17:25	25°09' S 46°19' W	76	23.61	35.43	Bb	26	80	29
							Bc	50		56
712	13/12	20:05	24°49' S 46°20' W	62	23.17	35.47	Bc	6	55	7
							Ca	2		2
							Cb	1		1
714	13/12	22:30	24°29' S 46°26' W	47	23.07	35.44	Cb	129	42	143
720	14/12	09:20	24°22' S 46°08' W	45	21.99	35.36	Ba	8	40	9
722	14/12	12:15	24°41' S 46°04' W	63	22.53	35.33	Aa	1	60	1
761	16/12	09:15	24°18' S 45°05' W	82	22.29	35.74	Bc	4	77	4
							+	31		34
773	17/12	01:50	24°07' S 44°49' W	92	22.52	36.04	Cb	5	80	6
							+	2		2
779	17/12	10:25	23°42' S 44°30' W	72	22.05	35.51	Aa	50	70	56
807	19/12	00:25	23°06' S 43°11' W	56	16.82	—	Aa	101	53	112
							Cb	1		1

* Refer to Nakai, 1962

** VERTICAL HAULS

During three spawning seasons the temperature on the spawning area ranged from 16.8 to 27.2° C and the average temperature was 22.3° C. Approximately 87% of the occurrences were taken at the temperature between 19.0 and 24.9° C. The frequency of occurrences of eggs at different temperatures is given in Table IV.

For the purpose of obtaining a correlation between the physical conditions prevailing on continental shelf in which spawning was observed, and the spawning ground in successive seasons, the vertical distribution of temperature was analysed. The results showed us that there was no upwelling in the spawning area for the season of 1970-71. In the spawning season of 1971-72, one upwelling was observed near the coast of Restinga da Marambáia (43°45' W) in December 1971. In this station the thermocline was nearly up to 10 m depth.

TABLE III-b — Estimated number of sardine eggs by station (1971 - 1972 spawning season)***

Sample no.	Date	Time	Position	Local depth (m)	10 m depth		Egg developm. stage *	Total no. of eggs/sample	Volume of filtered water (m^3)**	Number of eggs/100 m^3
					T (°C)	S (°/oo)				
Cruise December 11 - 19, 1971 (Horizontal haul)										
683	11/12	20:17	26°02' S 47°41' W	58	23.34	35.63	Cb	9	(232)	(4)
685	11/12	22:45	25°49' S 47°26' W	61	23.33	35.67	Cb	11	(232)	(5)
691	12/12	07:45	25°00' S 47°39' W	21	22.74	35.27	Bb	8	(232)	(3)
							Bc	8		(3)
695	12/12	16:55	25°32' S 47°14' W	62	23.52	35.64	Bc	11	(232)	(5)
							Ca	102		(44)
707	13/12	11:10	25°04' S 46°44' W	60	22.97	35.57	Bb	28	(232)	(12)
709	13/12	14:25	25°32' S 46°38' W	100	23.19	35.74	Bb	469	(232)	(202)
711	13/12	17:45	25°09' S 46°19' W	76	23.61	35.43	Bb	535	(232)	(231)
							Bc	892		(384)
713	13/12	20:12	24°49' S 46°20' W	62	23.17	35.47	Ca	18	(232)	(8)
715	13/12	22:45	24°29' S 46°26' W	47	23.07	35.44	Cb	3,171	(232)	(1367)
721	14/12	09:37	24°22' S 46°08' W	45	21.99	35.36	Bb	198	(232)	(85)
723	14/12	12:40	24°41' S 46°04' W	63	22.53	35.33	Aa	8	(232)	(3)
762	16/12	09:31	24°18' S 45°05' W	82	22.29	35.74	Aa	57	(232)	(25)
							Ca	4		(2)
							Cb	2		(2)
							+	62		(27)
774	17/12	01:55	24°07' S 44°49' W	92	22.52	36.04	Ca	6	(232)	(3)
							Cb	4		(2)
780	17/12	10:40	23°42' S 44°30' W	72	22.05	35.51	Aa	106	(232)	(46)
788	17/12	21:05	23°33' S 44°11' W	72	18.54	36.27	Aa	1	(232)	(0.4)
808	19/12	00:39	23°06' S 43°11' W	56	16.82	–	Aa	6,120	(232)	(2635)
							Cb	3,150		(1357)
							+	3,230		(1392)

* Refer to Nakai, 1962

** Estimated volume of water filtered = (towing distance) x (mouth area) x (filtration coefficient)

*** HORIZONTAL HAULS

TIME OF INCUBATION OF THE SARDINE EGGS - Based on the time interval of occurrences of eggs in stage *Aa*, (for developmental stages refer to Nakai, 1962) the spawning time for the Brazilian sardine was supposed to be between 20:00 and 24:00 (Matsuura, 1971*a*).

In the spawning seasons of 1970-71 and 1971-72, some eggs in the stage *Aa* were collected during day time (08:00-12:00), but the main spawning time was concentrated in the four hours period prior to midnight.

The relationship between egg stage and the time of preservation revealed the following: 1) at three stations, the stage *Aa* and the stage *Cb* were collected simultaneously (the samples 334, 335 and 336 were considered as the

TABLE IV — Relationship between water temperature and occurrence of sardine eggs

Temperature (°C) (10 m depth)	1969 - 70	1970 - 71	1971 - 72	Total
16.0-16.9	—	—	1	1
17.0-17.9	1	—	—	1
18.0-18.9	1	—	—	1
19.0-19.9	2	—	—	2
20.0-20.9	1	—	—	1
21.0-21.9	2	3	1	6
22.0-22.9	—	—	5	5
23.0-23.9	4	4	7	15
24.0-24.9	1	2	—	3
25.0-25.9	—	—	—	0
26.0-26.9	—	1	—	1
27.0-27.9	—	1	—	1
Total frequency	12	11	14	37
Average temp.	21.4° C	23.4° C	22.4° C	22.3° C

same spawning group, therefore it was counted as one station), 2) the eggs of stage *B* were collected almost exclusively during day-time, and 3) the samples, 707, 709, 711 and 715, considered to belong to the same spawning group, show that the eggs needed about eleven hours to develop from the stage *Bb* to the stage *Cb* at the water temperature of about 23° C.

In considering these facts, the incubation time of the eggs was supposed to be about 24 hours. This conclusion agreed with the values given by Nair (1959), for *Sardinella longiceps*, which has a similar habitat and occurs in tropical waters (Rosa & Laevastu, 1960).

Here we do not consider differences in developmental temperatures. More data is needed to calculate a correlation coefficient of temperature and a incubation time for the Brazilian sardine eggs.

ESTIMATION OF THE SPAWNING SIZE - The mortality rate of the eggs of Brazilian sardine was not yet studied. To facilitate, k=1.0 was used for computation. The estimation of eggs was made to each subarea. The results are shown in Table V.

TABLE V — Tentative estimation of eggs spawned by the Brazilian sardine (k=1.0)

Spawning seasons \ Subareas	I	II	III	IV	V	VI	Total
1969-70	—	0.054	260.5	—	—	—	260.6
1970-71	4.373	0.656	7.812	0	17.473	0	30.3
1971-72	—	18.504	7.276	14.408	5.488	—	45.7

unit: 10^{12} eggs

Note: The samples which contain eggs spawned in two successive days were treated as of one-day spawning

The estimated number of sardine eggs in 1969-70 spawning season was 261 x 10^{12} in the region from Cabo Frio to São Sebastião. Most eggs were spawned in the 2nd depth zone of the subarea III (region of Ilha Grande). It is assumed that the spawning size in this season was overestimated on account of the occurrence of an extraordinarily high number of eggs in sample no. 271 (November 1969).

In the 1970-71 spawning season the total egg number was 30 x 10^{12}. A decrease in the spawning size was observed in spite of the enlarged survey area. The curious thing is that the 2nd depth zone which was considered to be the main spawning ground for the previous year, had a smaller spawning. As shown in the previous section, the reason for this failure in the 2nd depth zone and also in the other zones, may be due to the higher temperature of the water which covered the survey area during the season. The main spawning was observed in subareas V, IV, and I in this sequence. Perhaps we can suppose that there were additional spawnings that we failed to sample in regions out of survey area or at other seasons of the year.

In the 1971-72 spawning season, the quantity of eggs spawned in just one cruise was larger than that of the previous year. The total number of eggs was estimated as 46 x 10^{12} for the period of November-December in the region from Rio de Janeiro to Paranaguá. The main spawning was observed in the subareas II and IV in the 2nd depth zone. The average water temperature in the survey area was similar to that of the 1969-70 season in the region from Cabo Frio to São Sebastião.

The incubation period of the eggs (about one day) may be considered short when compared with the time of incubation of the eggs of sardines from temperate zone of the world (several days). Therefore this shortness of the incubation time may cause a larger sampling error. In order to increase the accuracy of the estimation it is necessary to have a denser station plan. Further-

more the time interval between successive cruises would have to be short enough to sample all of the spawning groups.

RESUMO

O presente trabalho apresenta a distribuição e abundância de ovos de sardinha verdadeira, *Sardinella brasiliensis* (=*S. aurita*), na costa sul do Brasil nos anos de 1970 e 1971. Um dos principais objetivos do estudo quantitativo de ovos e larvas de peixes é estimar o tamanho do estoque, através da abundância de ovos desovados. Com essa finalidade, a computação da abundância de ovos de sardinha verdadeira foi feita usando o método apresentado por Tanaka (1955). O tempo de incubação dos ovos de sardinha foi estimado com base no método da Ahlstrom (1943).

A quantidade de ovos desovados variou durante os três anos (1969 a 1971). Foi feita uma comparação entre a abundância total de ovos desovados e a freqüência de ocorrência de ovos nas estações da região estudada. Os índices de abundância mostram que a desova na época de 1970-71 foi muito fraca, comparada com as de 1969-70 e de 1971-72.

Para esclarecer a relação entre a variação anual de tamanho da desova e a condição ambiental, foi analisada a temperatura e salinidade da água na área de desova. Os resultados indicam que, por ocasião da desova realizada em 1970-71, a temperatura da água era maior do que a dos outros dois anos. Esta água quente que cobriu o centro da área de desova (na faixa de 51 a 100 m de isóbata), foi considerado o motivo fundamental do fracasso da desova nesta época.

O diâmetro dos ovos de sardinha foi comparado com os de outros anos. A média de diâmetro dos ovos desovados em 1971-72, foi um pouco maior do que a das outras épocas.

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