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Fish biology

**SARDINELLA MADERENSIS LOWE, 1841 IN POLISH COMMERCIAL CATCHES
FROM THE SENEGALESE SHELF IN 1979–1980**

**EBA (SARDINELLA MADERENSIS LOWE, 1841) W POLSKICH POŁOWACH
PRZEMYSŁOWYCH NA SZELFIE SENEGALU W LATACH 1979–1980**

Based on data collected in 1979–1980 from the southern part of the Senegalese shelf, the paper discusses results of biological observations on *Sardinella maderensis* seasonal feeding rhythm, varying condition, reproduction, and growth rate. The length and age distributions of Polish commercial catches of *S. maderensis* are presented as well.

INTRODUCTION

The Senegalese shelf houses two *Sardinella* species, namely *S. aurita* and *S. maderensis*, both species making up an important catch component of coastal fisheries and long-range commercial fleets. To quote but one example, the data collected by the Sea Fisheries Institute's Świnoujście Branch showed *Sardinella* to contribute 77.7, 87.4, and 74.0% of the Polish commercial catches from the area in 1977, 1978, and 1979, respectively, *S. maderensis* contribution ranging from about 30 to 35%.

Inasmuch as the *S. aurita* biology and resources have been treated in a number of publications, much fewer data exist on *S. maderensis*. Of the currently available works, that by Boely (1978) is particularly worth mentioning as the author treats comprehensively the fundamental problems of the species biology and fisheries. Among other papers, those by Conand and Fagetti (1971) and Conand and Cremoux (1972) on *S. maderensis* spawning and by Nieland (1980) on its food and feeding deserve referring to. It should be stressed that the papers mentioned have been based on data collected

directly of Dakar and on a fishing ground located close to the Senegalese-Mauritanian borderline.

In order to enrich the existing information on this poorly known species it seems purposeful to present the results of biological studies on *S. maderensis* carried out mainly in the southern part of the Senegalese shelf (Cap Roxo, Casamance), a region differing markedly in its hydrography from that off northern coast.

MATERIALS AND METHODS

The paper is based on data collected during cruises of the following B-29 trawlers: MT Luzytanka: February – May 1979; MT Kanaryjka: September 1979 – January 1980; MT Kanaryjka: March – August 1980; MT Kanaryjka: August – November 1980.

A total of 42,093 individuals were measured, 4057 specimens being examined for a biological analysis. Mass measurements involved measuring the fork length (LF) to the nearest cm below.

Stomach filling and intestinal fat cover were determined by means of a 5-score (0 to 4) scale.

Sexual maturity was determined with the 6-score Fontana scale used commonly in studies on African *Sardinella* species.

Scales for age readings were taken from above the lateral line anteriorly to the dorsal fin.

The *S. maderensis* growth rate was determined from back readings by means of the Rosa Lee formula:

$$l_n = c + \frac{r_n}{R} (L - c)$$

where: c = correction factor,
 L = fish length,
 R = scale radius,
 l_n = fish length at the age n ,
 r_n = scale radius at the age n .

The Petersen curves were additionally used when considering problems related to fish growth and age, particularly with reference to juveniles.

Theoretical growth parameters were determined from the von Bertalanffy equation.

LENGTH AND AGE DISTRIBUTION OF *S. MADERENSIS* IN POLISH CATCHES

Based on observations gathered in 1979 and 1980, Polish commercial catches were found to contain the *S. maderensis* measuring 10–25 cm and belonging to age groups

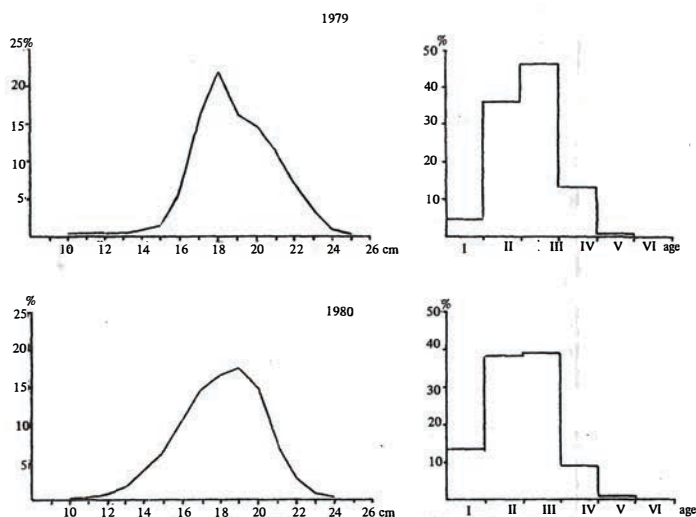


Fig. 1. Composition of Polish *Sardinella maderensis* catches in the Senegalese shelf in 1979–1980 in terms of length and age distribution

I–V (Fig. 1). In terms of length the bulk of catches was made up by the individuals measuring 17–20 cm, the age groups II and III predominating numerically. No large differences were found between the results obtained in the two years of study. A slight decrease in the age group III contribution, seen in the 1980 catches, might have been caused by both a growing fisheries pressure and an altered abundance of generations. The relatively short period of observations makes an unambiguous explanation of the fact impossible.

SARDINELLA MADERENSIS – AGE AND GROWTH RATE

Fish length (LF) – scale radius relationship

The relationship was determined from measurements on scales taken from 558 individuals measuring 13–24 cm; the results are presented in Fig. 2 as partial mean points. The pattern shows the relationship between length (LF) and scale radius of *S. maderensis* to be linear, the appropriate equation with calculated coefficients being $LF = 5.4692 R - 3.9190$.

A high determination coefficient, $r^2 = 97.4\%$ points to a very close correlation between the scale radius and fish length.

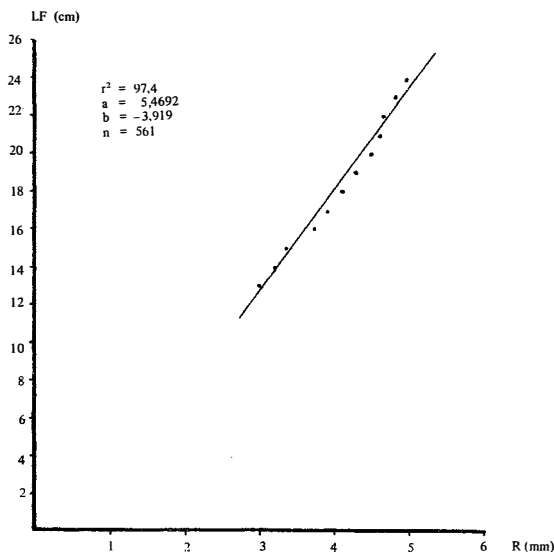


Fig. 2. *S. maderensis* length (LF)–scale radius relationship

Length growth

Lengths of *S. maderensis* males and females (Tables 1 and 2) were calculated from back readings by means of the Rosa Lee formula. The data obtained show the mean lengths in younger age groups to be higher than the corresponding ones in older fishes (the Rosa Lee phenomenon).

The von Bertalanffy equation parameters calculated are presented below:

Growth equation parameters	Males	Females	Males + females
L	259	246	249
t_0	-0.3131	-0.2826	-0.2742
k	0.3848	0.4353	0.4252

Fig. 3 presents theoretical growth curves for both sexes of *S. maderensis*. It is seen that the fish growth proceeds in a similar way in males and females, the slight differences observed in age group V resulting presumably from a small number of individuals examined. When speaking about the *S. maderensis* growth rate in general terms, it should be stressed that the highest increments are obtained in the first year of life. In later years the annual increments tend to decline successively.

Table 1

Sardinella maderensis females length growth rate as calculated from back readings (cm)

Age group	n	Mean length (direct measurement)	l_1	l_2	l_3	l_4	l_5
I+	17	15.3	11.7				
II+	108	18.3	11.0	16.4			
III+	131	19.5	9.7	15.0	18.2		
IV+	38	21.5	9.3	14.5	18.2	20.8	
V+	5	23.6	9.8	14.8	19.1	21.7	22.0
Total 299		\bar{x} (mean)	10.3	15.2	18.5	21.3	22.0
		S (standard deviation)	1.007	0.842	0.493	0.636	
		(coefficient of variation)	0.109	0.064	0.033	0.042	
		$l_n - l_{n-1}$	10.3	4.9	3.3	2.8	0.7
		n	299	282	174	43	5

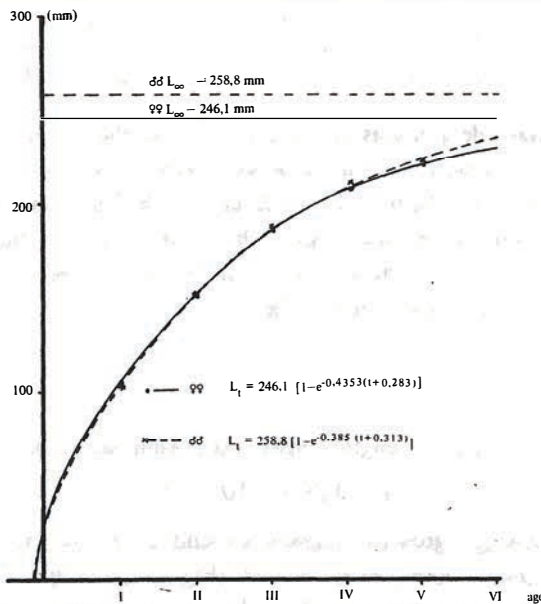


Fig. 3. Von Bertalanffy length growth curves of *S. maderensis* males and females

Table 2

S. maderensis males growth rate as calculated from back readings (cm)

Age group	n	Mean length (direct measurement)	l_1	l_2	l_3	l_4	l_5
I+	12	15.3	12.1				
II+	112	17.4	10.3	15.6			
III+	103	19.3	9.4	14.7	18.6		
IV+	29	22.6	10.0	15.7	19.9	21.6	
V+	3	23.3	8.4	13.5	17.7	21.0	22.4
Total 259		\bar{x} (mean)	10.1	14.9	18.7	21.3	22.4
		(standard deviation)	1.361	1.021	1.106	0.424	
		(coefficient of variation)	0.152	0.079	0.072	0.028	
		$l_n - l_{n-1}$	10.1	4.8	3.8	2.6	1.1
		n	259	247	135	32	3

The literature available contains no detailed data on the growth rate of the species in question. Some information is given by Boely (1978) only who shows *S. maderensis* to reach the length of 18–19 cm and 21–22 cm in the first and second year of life, respectively. These values are much higher than those found in the present study. The differences observed make it necessary to undertake supplementary studies with a particular reference to the growth of juveniles.

Weight growth

Based on the *S. maderensis* length-weight relationship determined by Boely (1978) as

$$W = 0.3895 \cdot 10^{-5} l^{3.274}$$

and considering the length growth parameters found in the present study, weight growth curves for males and females were plotted (Fig. 4) according to the modified von Bertalanffy equation. The weight growth of the species is seen to be typical, i.e., after a

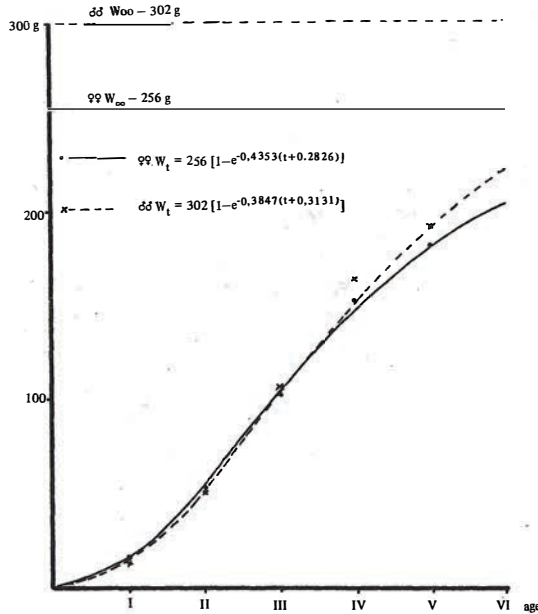


Fig. 4. Weight growth curves of *S. maderensis* males and females as plotted according to modified von Bertalanffy equation (points determined from length-weight relationship)

period of rapid increments there occurs, starting from the fourth year of life, a gradual decline in the growth rate.

Reproduction and gonad maturity

S. maderensis, as most fish species inhabiting the subtropical zone, has a portional spawning. Thus the catches throughout the year are found to contain individuals with gonads maturing, mature, semispent, and spent. Fig. 5 presents the results of gonad maturity analysis for the *S. maderensis* males and females in 1979–1980. The data presented show almost no overlap of intensified spawning activity in the two years; a regular feature is, however, observed whereby from November through April the highest numbers of fishes with resting and maturing gonads (stages I–III) are encountered. An intensive spawning proceeds within the remaining months as evidenced by a considerable contribution of mature (stages IV–VI) individuals. A short hold-up in the spawning observed on the onset of the warm season (July, August) should be mentioned. In some cases, as for instance in 1978 (Krzeptowski, 1978) the spawning can be stopped for several months.

Boely (1978) found *S. maderensis* to spawn from April through October as evidenced by changes in sexual maturity index (IGS), some alterations in the duration of

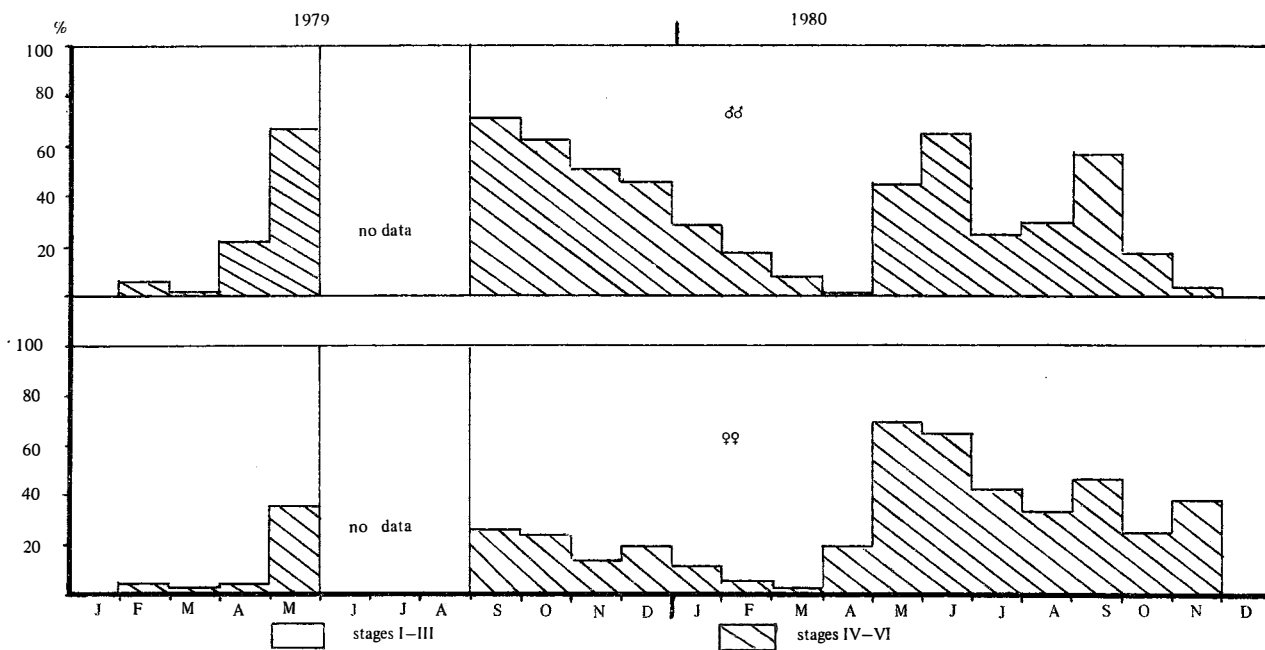


Fig. 5. Seasonal changes in gonad maturity of *S. maderensis* males and females in 1979-1980

reproductive activity being possible in different years. Thus, according to that author, there are two spawning peaks observed within a year (April–May and August–September) or a single one strongly extended in time (May – October).

Seasonal changes in feeding intensity and condition

The Senegalese shelf hydrography undergoes serious changes throughout a year. From December (January) until June (July) the area is affected by cold, less saline Canary Current waters, intensified upwellings being observed during this time. In the remaining part of the year the shelf is influenced by the warm, more saline, Guinea Current, upwellings being weaker and finally disappearing altogether.

The changing environmental conditions leading, i.a., to changes in trophic relationships, markedly affect fish feeding and condition.

Fig. 6 presents *S. maderensis* mean stomach filling and intestinal fat cover indices in 1979–1980. As seen from the data presented, particularly in 1980, the first and fourth quarter of the year are the periods of the weakest feeding, the stomachs being filled to a considerable degree in the second and third quarters.

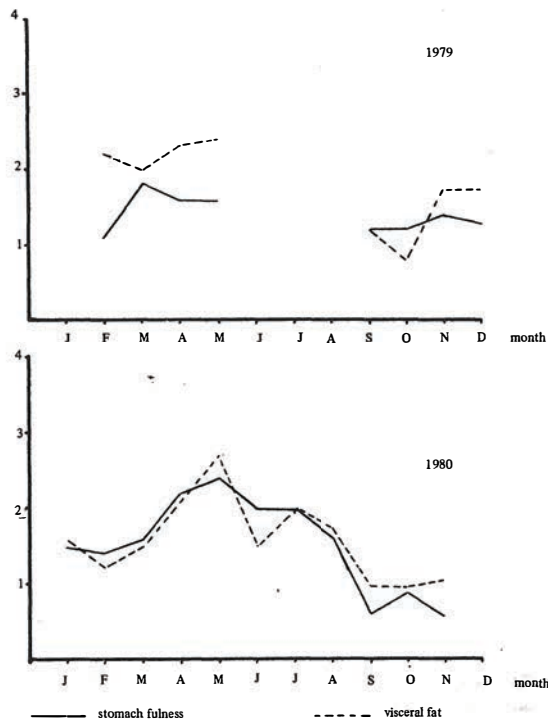


Fig. 6. Mean stomach filling and intestinal fat cover indices of *S. maderensis* in 1979–1980

Seasonal changes in feeding intensity are closely correlated with intestinal fat cover indices evidencing the fish condition. The indices are at their highest in the second and third quarters of the year, thus pointing out the highest technological utility of the *S. maderensis* caught during that time.

ACKNOWLEDGEMENT

The author wishes to express his sincere gratitude to Messrs R. Majchrzyk, K. Chłapowski and R. Długosz for their assistance in collecting the study materials.

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EBA (*SARDINELLA MADERENSIS* LOWE, 1841)
W POLSKICH POŁOWACH PRZEMYSŁOWYCH
NA SZELFIE SENEGALU W LATACH 1979–1980

STRESZCZENIE

Na podstawie materiałów zebranych w latach 1979 i 1980 na szelfie Senegalu w czasie czterech rejsów statków przemysłowych stwierdzono, że podstawową część analizowanych połowów eby (*S. maderensis*) stanowiły ryby o długości od 17 do 20 cm z II i III grupy wieku. W oparciu o odczyty wsteczne z łusek, stosując wzór Rosa-Lee, określono tempo wzrostu badanego gatunku.

Stwierdzono, że eba w omawianym rejonie odbywa tarło w ciągu całego roku, przy czym szczyt aktywności rozrodczej występuje tu niej od kwietnia do listopada.

W okresie od kwietnia do sierpnia badany gatunek żeruje z największą intensywnością, w tym czasie posiada on również najwyższą kondycję.

Кржептовски М.

МАДЕЙРСКАЯ САРДИНЕЛЛА *Sardinella maderensis* Lowe, 1841
В ПОЛЬСКИХ ПРОМЫШЛЕННЫХ УЛОВАХ НА ШЕЛЬФЕ СЕНЕГАЛА В 1979-80 гг.

Р е з ю м е

На основе материалов собранных в 1979 гг. на шельфе Сенегала в течение 4 рейсов промысловых судов обнаружили, что основную часть анализируемых уловов мадейской сардинеллы (*S. Maderensis*) составляли рыбы длиной (17 до 20 см, II и III возрастных групп.

Принимая во внимание возвратные отсчёты отолитов и применяя формулу Rosa-Lee, определили темп роста исследуемого вида.

Обнаружили, что мадейская сардинелла в рассматриваемый период нерестится на протяжении всего года. Вместе с тем пик её половой активности приходится на период апрель - ноябрь.

В промежуток времени с апреля по ноябрь исследуемый вид кормится с наибольшей интенсивностью и в тоже время имеет он наивысший коэффициент упитанности.

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Received: 23-th Apr. 1982