

## Age Determination of Sardine (*Sardina pilchardus*) through Otoliths along Albanian Adriatic Coast

SOKOL DURO<sup>1\*</sup>, JERINA KOLITARI<sup>2</sup>, NEIRA MEDJA<sup>3</sup>, ALFRED ÇAUSHI<sup>1</sup>

<sup>1</sup>Faculty of Veterinary Medicine, Agricultural University of Tirana, Albania

<sup>2</sup>Laboratory of Aquaculture and Fishing, Agricultural University of Tirana, Durrës, Albania

<sup>3</sup>Faculty of Natural Science, Shkodra University, Albania

### Abstract

Knowing the fish age allows fisheries managers to understand the dynamics of marine reserve. The purpose of this study was to define the age of sardines (*Sardina pilchardus*), based on sagittal otoliths, which found in the inner ear of fish. The study was conducted at the Research Institute of Fishery in Durres, in the period January 2008 - December 2009. During this time, 990 fish were analyzed monthly. The otoliths were removed from neurocranium, watched in stereomicroscope (40X) annual assessment circles around the otoliths opaque core. Age of fish is equal to the number of annual rings.

The study showed that the age average was 1.4 years (sd = 0.658), and 90% were 1+ and 2+ years. The average length was 13.27 cm and about 44% of sardines with length 12.5 - 14 cm.

The study will help determine the dynamics of populations of sardines accurately predicting the amount caught fish.

**Keywords:** *Sardina pilchardus*, otolith, age, length, coast.

### 1. Introduction

Sardine (*Sardina pilchardus*) belongs to the group of fish called "small pelagic", very popular in the Mediterranean, Adriatic and Ionian Sea waters.

This fish occupies a considerable share in the fishing industry of almost all Mediterranean countries, like Italia, Spain, Greece, Croatia, Albania, Turkey, etc. [2;7;9]. Previous studies data have shown that catches of sardines constituted somewhere between 40-50% of fish catches in Albania [8].

To contribute to a more effective fishing of sardines, in-depth knowledge about biology, geographical spread, the countries with the largest concentration of fishing stock, relative definition of fishing resources, etc. are required.

Among numerous knowledge on the biology and geographical area, age recognition allows fishery managers to assess fishery resources (fishing stocks). Age assessment is

one of the most important tools for studying biological aspects, such as growth, sexual maturation and longevity but also for understanding the dynamics of marine reserve versus stress environmental pollution, food supply, predators, etc., thus enabling a more effective long-term management [1;8].

In the recent years age assessment through otoliths is becoming a widespread method. Determination of the age is based on the sagittal otoliths structure assessment [3;5].

Otoliths are mainly non-cell calcium carbonate concentrations in a protein matrix, found in the sacculus of the fish inner ear. Otoliths consist of opaque bands formed by crystalline structures and hyaline bands formed by a protein matrix.

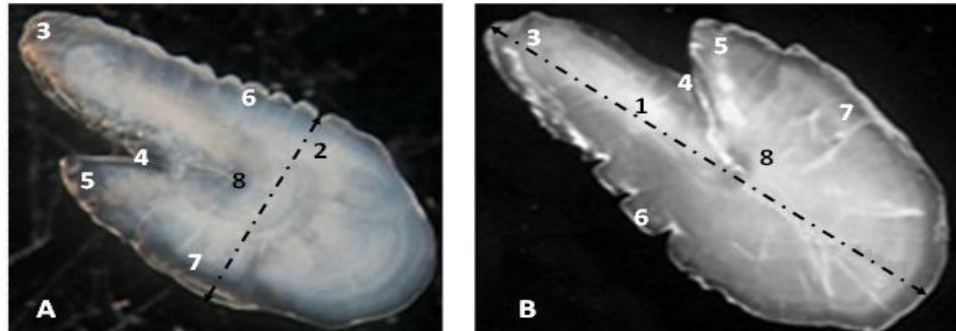
Each crystal is surrounded by proteinic matrix and this circle indicates the direction of crystal growth. This is an area with a not "continuous" growth. Studies have shown that the opaque

\*Corresponding author: Sokol Duro; E-mail: durosokol@ubt.edu.al  
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zones are associated with the summer period (May to November), while hyaline areas with the winter period (December to April) [1;5].

The sardine otoliths are approximately 2-5mm length, oval in shape with an outer concave face. Its major axis is oriented in anterior-posterior direction. Dorsal and ventral edges are joined cranially forming the rostrum.

In the dorsal edge more caudally of the rostrum is found another pinch (anti rostrum) less visible than rostrum, which is separated from it by a deep incisure (Figure 1). Dorsal edge is easily curved whereas ventral edge appears as a toothed saw that becomes more apparent with age.



**Figure 1.** The otoliths of sardine (*Sardina pilchardus*).

**A. Left otolith; B. Right otolith (medial side):** 1. Major axis, 2. Minor axis, 3. Rostrum, 4. Deep incisures, 5. Anti rostrum, 6. Ventral edge, 7. Dorsal edge, 8. Nucleus.

The core of otolith's nucleus appears diffused, corresponding to the larvae life period, and appears the same in the all analysed fish [1;5;6].

The purpose of this study was to determine the age of sardines (*Sardina pilchardus*) in Albanian catches during period January 2008 till December 2009, through otoliths as one of the most important indicators for fish growth pace assessment.

## 2. Material and Methods

The study was conducted at the Aquaculture and Fishery Laboratory, Durres, from January 2008 till December 2009. The samples of sardine (*Sardina pilchardus*) were taken randomly from the quantity of fish cached by fishing vessels, in Albanian Adriatic coast almost every month of the two years study period. During this time, 990 sardine fish (*Sardina pilchardus*) in total were analyzed.

Samples of fish are collected every month of the year by vessels that have carried the purse seine fishing method with 8-10mm eyepiece nets.

For each fish the exact weight (g) and total length (cm) (from the face tip to the dam tail tip) records were kept.

After a morphometric evaluation, dissection was made through the ventral head side for any fish. From the basis of a separate neurocranium, sagittal otoliths were removed with a forceps side, were cleaned with distilled water, were dried up with paper filter and then were put in matriculated plastic tubes.

The otoliths' reading was carried out through a high-quality stereomicroscope observation, with a 40X zooming. Originally the otolith is put on a concave surface from above, in a Petri plate containing alcohol 70°, on a black glass background in order that annual rings around the otoliths opaque core become more distinct.

Numbering of the rings was being launched from the centre towards the periphery. Age of fish is equal to the annual rings number. Age assessment was represented through the symbols **0+**, **1+**, **2+**, **3+**, etc. Thus, when around the central area there is a bright opaque circle, the fish is estimated to be one year old. Otoliths without hyaline circles are evaluated as **0+** year of age.

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To reduce possible errors, otoliths' assessment was carried out simultaneously by two readers [4].

### 3. Results and Discussions

The study showed that sardine is a fish that is found throughout the year, in the Albanian

coast waters of the Adriatic and Ionian Seas, information supported by other studies as well [1;5;8]. The data of length, weight and age of sardine by years, are given in Tables 1 and 2.

Data from two years of study showed that sardine average age was 1.4 years (sd = 0.658), (0 years min. and 4 years max.).

**Table 1.** Data of sardine samples for 2008

Sardine 2008										
Month	No. of samples	Length (cm)	Weight		Age (years)		Min	Max	Min	Max
			Min	Max	Min	Max				
January	38	14.93	13	17	22.68	14.1	34.4	2.02	1	3
February	65	13.76	10	17	18.42	7	34.8	1.83	1	4
March	49	12.22	10	15	12.3	6	21.9	1.51	1	2
April	39	14.25	12.5	17.5	22.17	14.7	42.2	1.71	1	3
May	35	13.6	12	16.5	17.96	11.8	30.3	1.71	1	3
June	57	11.97	8	15	13.07	3.4	25.8	0.96	0	2
August	36	12.61	10.5	17	15.28	7.3	37.6	1.58	1	2
September	41	14.23	12	16.5	22.13	12.4	34.3	1.68	1	2
October	54	14.15	10	17.5	20.59	5.5	36.1	1.85	0	3
November	58	12.46	9.5	17.5	13.95	5.7	34.6	1.55	0	3
December	42	13.16	11	16	16.28	8.3	29.4	1.85	1	3
<b>Sum</b>	<b>514</b>	<b>13.39</b>			<b>17.71</b>			<b>1.65</b>		

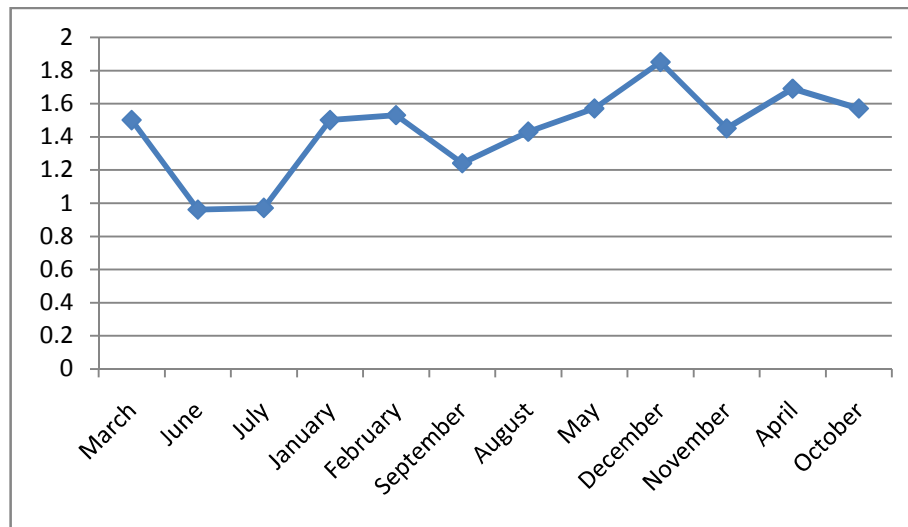
**Table 2.** Data of sardine samples for 2009

Sardine 2009										
Month	No. of samples	Length (cm)	Weight		Age (years)		Min	Max	Min	Max
			Min	Max	Min	Max				
January	57	11.48	8.5	15	10.18	3.8	22.3	1.15	0	2
February	62	12.44	9.5	17	13.63	5.4	30.4	1.2	0	2
April	42	13.92	12	16	19.55	12.6	31.1	1.69	1	3
May	38	12.65	11	14.5	16.98	9.7	27	1.36	0	3
June	42	12.89	11	15	17.22	10.3	27.5	0.97	0	2
July	35	12.54	10.5	14.5	15.65	8.3	23.2	0.97	0	2
August	57	13.33	10.5	17	20.18	8.1	40.1	1.33	0	2
September	59	13	10	16	17.62	5.9	32.1	0.93	0	2
October	31	14.33	12.5	16	21.67	12.7	35.5	1.096	1	2
November	54	14.76	11.5	18	23.72	9.5	44.3	1.35	1	3
<b>Sum</b>	<b>477</b>	<b>13.13</b>			<b>17.64</b>			<b>1.2</b>		

The data showed that 890 fish or 90% were 1 to 2 years old and only 63 or 6.3% were aged 0-1 years. The rest, or 3.7% resulted

between 3 and 4 years old, but that is entirely negligible.

Younger ages (average 0.96 years) were found in the summer period (June, July) and those of a higher average age (1.85 years) were found mainly in December (Fig. 2).



**Figure 2.** Average age about months for both years 2008 and 2009

The assessment of 990 sardine fish samples (514 in 2008 and 476 in 2009) showed that the fish average length was 13.27cm with a minimum length of only 8cm (month of June) and a maximum length of 18cm (month of November).

The sardine average weight was 17.67g (3.4g minimum weight and 44.3g maximum weight in June and November, respectively).

The lowest average fish length, respectively 12.36 cm and 12.54cm was found in the summer months (June, July) of the two years of the study (Table 1 and 2).

Sardine is a fish that grows very fast, and this is supported by this study data which shows that there is a highly expressed correlation between weight and height values of 0.96. Meanwhile the age/length correlation resulted in 0.64, and age/weight correlation resulted in only 0.56.

This is explained by the fact that sardine being a fish that grows up mainly until the second year of age, when reaches a certain size. After two years of age notwithstanding, the growth pace slows. [1; 5; 8].

#### 4. Conclusions

This study showed that average age of sardine catches in Adriatic Albanian coast were 1.4 years.

Such data can be used for a better assessment of small pelagic stock in order to continue to guarantee a responsible fishing.

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