

SIZE DISTRIBUTION, LENGTH-WEIGHT RELATIONSHIPS, AGE AND SEX
OF ALBACORE, THUNNUS ALALUNGA BONN., IN THE AEGEAN SEA

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ABSTRACT

The Sporades basin of the Aegean Sea presents a suitable trophic area of concentration for albacore, Thunnus alalunga Bonn. The size frequency distribution of the catches from 1986 to 1989 showed that the albacore stock is mostly made up of small specimens with fork lengths between 54 and 89 cm and estimated ages from 1 to 6 years. Length-weight relationships for males and females showed no appreciable difference between the sexes. Gonads examination indicated the presence of both immature and adults individuals. Males were more numerous and the sex ratio of females to males was 1:2.1.

INTRODUCTION

Albacore, Thunnus alalunga Bonn., is one of the large pelagic fish species exploited in Greece. Its distribution in the Aegean Sea is discontinuous, with a higher concentration mainly in the north between the Sporades islands and the peninsula of Chalkidiki where the most important Greek albacore fishing fleet has been operating for several years.

The albacore stock is mostly formed by small individuals which arrive in the above-mentioned area usually at the end of August and remain there in surface waters until the end of November.

Preliminary data on fishing grounds, fishing period, total catch and size distribution are reported by DE METRIO et al. (1988), but there are no data on the age structure or other characteristics of the stock in this area. Age estimates have been made for albacore in the central Mediterranean using the scales (CEFALI et al., 1982). Some other estimates were performed in the Atlantic using different methods (BEARDSLEY, 1971; BARD, 1974; GONZALEZ-GARCES and FARINA-PEREZ, 1983).

The present study is a first approach to evaluating the age and the growth of albacore caught in the Aegean Sea using the scales and to provide information on size-frequency distribution, age distribution, sex and growth in weight. Data on the albacore landings from 1982 to 1989 are also reported.

MATERIALS AND METHODS

Data on the catches and the number of vessels are derived from the data archives of the Alonisos fishermen's cooperative.

A total of 1886 albacore, caught by the fishing fleet of Alonisos island, were measured during the autumn in 1986, 1987 and 1989. Measurements of fork length (FL), to the nearest centimetre, and total weight to the nearest tenth of a kilogramme were taken at the port of Alonisos. Length-weight relationships were established using regression analysis.

The fresh gonads of 363 specimens were examined in order to estimate the sex and sexual maturity.

Scales were collected from 219 fish. Date of capture and fork length (FL) were recorded for each specimen. For the age estimation, reading of the scales was performed using an optical microscope. The average fork lengths at age were calculated.

RESULTS

Catches and Size-Frequency Distribution

Numerous small size boats are involved in the albacore fishery every year, which is mainly carried out by troll-line. Surface longline is also used by some vessels. Although the number of vessels is stable since 1982, landings have decreased in the last four years (Table I).

A study of the size-frequency distribution was made on 867, 379 and 639 fish in 1986, 1987 and 1989, respectively. The length-frequency distributions are shown in Figure 1, and the weight-frequency distributions are shown in Figure 2. The average lengths and weights as well as the standard deviations, the minimum and maximum values are calculated for each year (Table II).

Maturity of Gonads, Sex-Ratio

A total of 363 albacore were examined for gonad maturity and the sex ratio. No individuals with ripe gonads were found. A lot of spent gonads were found.

A prevalence of males (67.8%) was observed. The prevalence of males is evident in the size range from 68 to 87 cm. Females are more numerous for lengths less than 68 cm. No female longer than 77 cm was found (Fig.3). The calculated ratio of females to males was 1:2.1.

Length-Weight Relationship

Length-weight relationships, which are essential for the purpose of raising size data, were developed for each year. Relationships were also developed for males and females separately. The range of fork lengths, on which these are based, the sample size and the a, b and r values are presented in Table III.

Length-weight relationships for males and females show no appreciable difference over the range of the fish sampled (males 58.7-87 cm and females 61.5-77 cm). Furthermore, when the fitted curves are extrapolated beyond the sampled lengths (Fig.4), the relationships do not differ. No appreciable difference were observed between the other length-weight relationships (Table IV.)

Age Estimation

The fork length (FL) of the albacore samples used for age estimates ranged from 54.8 to 82 cm and the estimated ages were from 1+ to 6+ years. The smallest specimen of the sample was 1+ year old, while the largest was 4+ years old. A size-age key for 219 albacore grouped in size classes of 2 cm is given in Table V.

The age classes most frequent in the sample were classes II, III and IV with a percentage of 37.9%, 39.7% and 17.8%, respectively. Very few individuals, practically 4.6% of the sample, were estimated as belonging to the age classes I, V, and VI.

The lengths at age were estimated and the results are given in Table VI. Length frequencies by estimated age classes are illustrated in Figure 5.

DISCUSSION

The albacore fleet of Alonisos has operated in the Sporades basin for several years and is directed at different species according to the season of the year. Catches of albacore varied within a range of 10943 -73920 kg, with an annual average of 49023 kg during the 1982-1989 period. Since 1986 landings were greatly reduced and stabilized at approximately 40000 kg in the following years.

The size distributions in 1986, 1987 and 1989 shown in Figure 1 show that the bulk of the catches in the Sporades basin of the Aegean Sea is made up of small specimens. The average FL and weight values for 1986 and 1987 coincide (68 and 67.6 cm; 5.8 and 5.7 kg) whereas in 1989 the comparable values are higher (72.6 cm, 7.2 kg). Most of the fork lengths ranged from 62 to 72 cm in the first two years whereas in the last year, they ranged from 66 to 78 cm. The presence of larger individuals is evident in the catches of the last year.

A review of the Italian albacore catches in the Gulf of Taranto and in the Adriatic Sea in recent years (De Metrio *et al.*, 1987; Marano *et al.*, 1987) indicates that the size composition of the catches in the Aegean Sea and in some other areas of the Mediterranean Sea are more or less similar. However, the catches in the Atlantic comprise larger specimens compared with those of the Aegean. Annual mean length of albacore sampled by ICCAT in different Atlantic ports in 1975-1986 ranged from 84.9 cm to 105 cm (ICCAT, 1990).

These considerations indicate that the populations exploited in different areas of the central and eastern Mediterranean are made up of smaller specimens.

In spite of the clear prevalence of males in the catches, most of the small individuals are females. The prevalence of males is remarkable, especially among the larger specimens while the females are more numerous among the smaller ones. There is no information on the albacore sex composition in other areas of the Mediterranean Sea; however, the dominance of males over females has also been verified for the Atlantic albacore. In 1970 Lam Hoai, using histological observations of the gonads, found the sex ratio to be 1 female for 2 males in the N.E. Atlantic; Nepgen found a numerical dominance of males (64.1%) over females in the S.E. Atlantic (LE GALL, 1974). In 1971 BEARDSLEY examined 598 albacore in Porto Rico and found that the 61% of the specimens were males; in addition, he observed a complete absence of females with lengths over 105 cm. As regards the albacore of the surface waters, BARD reported a light prevalence of females (52%) over males (LE GALL, 1974).

The examination of the gonads showed that the population of the albacore in the Sporades basin comprises immature and adult individuals which have already spawned probably during the summer in an- other spawning area. The Sporades basin, because of its favourable hydrological and ecological conditions and the abundance of the food, presents a suitable trophic area of concentration for the albacore.

Length-weight relationships for males and females show no appreciable difference between the sexes even when the fitted curves are extrapolated beyond the sampled lengths. It is evident (Table III) that, for a given length, males and females have the same weight so the length-weight relationships established for the Aegean albacore cannot demonstrate the existence of a dimorphism. Bard's (1971) relationships for males and females show no appreciable difference over the range of 85-115 cm, whereas concerning larger fish, females are heavier than males. In addition, a comparison between our relationships and those of Bard demonstrates a remarkable difference, especially for the large individuals (at a given length, Atlantic albacore are heavier than the Aegean ones). The same fact was also verified for the other relationships established for the Atlantic albacore using different samples (Table III). However, our length-weight relationships are very similar to those found in the Pacific -by Liu and Hsu in 1989- and Indian Oceans -by Lee and Kuo in 1988 (ICCAT, 1990).

Taking into account the very limited number of the individuals in the sample, smaller than 60 cm and bigger than 76 cm, we do not consider the estimates of the length at age for the classes I, V and VI as being representative. It is

obvious that a sample including more individuals in the extreme length classes should be studied. Furthermore, results obtained by various authors using the same or different methods differ; so, given the importance of a correct age estimation for the stock assessment, the method used must be validated. However, according the estimated size-age key, we suppose that the age structure of the albacore catch in the Sporades basin could be as follows:

AGE CLASS	1986	1987	1989
II	39.3%	37.5%	14.2%
III	41.8%	39.9%	33.6%
IV	12.8%	12.2%	40.3%

Most of the catch consists of individuals of the second, third and fourth age classes.

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Table I. Albacore catches by the fishing fleet of Alonisos from 1982 to 1989

Year	Number of vessells	Catches in kg	Catches in number
1982	52	73249	12629
1983	53	73920	12745
1984	52	10943	1887
1985	57	71624	12349
1986	48	41350	7129
1987	54	35791	6279
1988	42	41486	7153
1989	51	43820	6086

Table II. Fork length and weight data for albacore in the Aegean sea.

YEAR	FORK LENGTH				WEIGHT			
	Mean	Min	Max	St.Dev.	Mean	Min	Max	St.Dev
1986	68.0	54.5	81.8	4.21	5.8	3.0	9.8	1.04
1987	67.6	58.2	81.7	3.77	5.7	3.7	10.0	0.99
1989	72.6	58.7	89.0	4.56	7.2	4.2	14.5	1.86

TABLE III. Length-weight relationships for albacore in the Aegean Sea

	No samples	size range	a	b	r
1986	501	55.5-81.8	3.561xE-5	2.84	0.97
1987	379	58.2-81.7	3.317xE-5	2.86	0.94
1989	496	58.7-89.0	5.618xE-5	2.74	0.94
males	164	58.7-87.0	4.344xE-5	2.80	0.96
females	87	61.5-77.0	4.178xE-5	2.81	0.95
total	1742	55.5-89.0	3.119xE-5	2.88	0.96

Table IV. Fork lengths (cm) and weights (kg) calculated from the five equations in Table II. The sixth relationship (SCRS/84/64) is for Atlantic albacore (ICCAT, 1990)

FL	WEIGHT						
	Females	Males	1986	1987	1989	TOTAL	SCRS/84/64
40	1.31	1.32	1.26	1.27	1.38	1.28	1.48
42	1.50	1.51	1.45	1.46	1.57	1.48	1.71
44	1.71	1.72	1.66	1.66	1.79	1.69	1.96
46	1.94	1.95	1.88	1.89	2.02	1.92	2.23
48	2.19	2.20	2.12	2.13	2.27	2.17	2.52
50	2.45	2.46	2.38	2.40	2.54	2.44	2.84
52	2.74	2.75	2.66	2.68	2.83	2.73	3.18
54	3.05	3.06	2.96	2.99	3.14	3.04	3.55
56	3.37	3.38	3.28	3.32	3.46	3.38	3.95
58	3.72	3.73	3.63	3.67	3.81	3.74	4.38
60	4.09	4.10	3.99	4.04	4.18	4.12	4.83
62	4.49	4.50	4.38	4.44	4.58	4.53	5.32
64	4.91	4.92	4.80	4.86	4.99	4.96	5.84
66	5.35	5.36	5.24	5.30	5.43	5.42	6.38
68	5.82	5.82	5.70	5.78	5.90	5.91	6.97
70	6.31	6.32	6.19	6.28	6.38	6.43	7.58
72	6.83	6.83	6.70	6.80	6.90	6.97	8.23
74	7.38	7.38	7.25	7.36	7.43	7.54	8.92
76	7.95	7.95	7.82	7.94	8.00	8.14	9.64
78	8.55	8.55	8.42	8.55	8.59	8.77	10.40
80	9.18	9.18	9.04	9.20	9.20	9.44	11.19
82	9.84	9.83	9.70	9.87	9.85	10.13	12.03
84	10.53	10.52	10.39	10.57	10.52	10.86	12.91
86	11.25	11.24	11.11	11.31	11.22	11.62	13.82
88	12.00	11.98	11.86	12.08	11.95	12.42	14.78
90	12.78	12.76	12.64	12.88	12.71	13.25	15.79
92	13.59	13.57	13.45	13.71	13.50	14.12	16.83
94	14.44	14.41	14.30	14.58	14.32	15.02	17.92
96	15.32	15.29	15.18	15.49	15.17	15.96	19.06
98	16.23	16.19	16.09	16.43	16.05	16.93	20.24
100	17.18	17.13	17.04	17.41	16.97	17.95	21.47
102	18.16	18.11	18.03	18.42	17.91	19.00	22.75
104	19.18	19.12	19.05	19.47	18.89	20.01	24.07
106	20.23	20.17	20.11	20.56	19.90	21.23	25.45
108	21.32	21.25	21.21	21.69	20.95	22.40	26.88
110	22.44	22.37	22.34	22.86	22.03	23.61	28.36
112	23.61	23.53	23.51	24.07	23.14	24.87	29.89
114	24.81	24.72	24.73	25.32	24.29	26.18	31.47
116	26.06	25.96	25.98	26.61	25.48	27.52	33.11
118	27.34	27.23	27.27	27.95	26.70	28.91	34.80
120	28.66	28.54	28.60	29.32	27.96	30.34	36.55

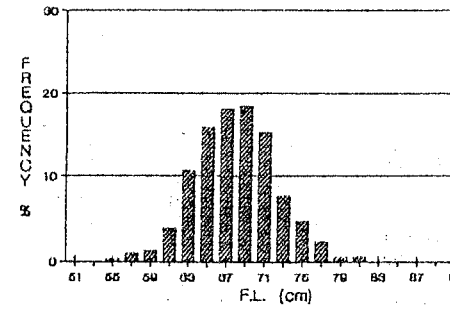
Table V. Size-age (estimated) key of the 219 albacore studied. The fork length (FL) is regrouped in classes of 2 cm.

FL (cm)	Estimated age						TOT	
	0+	1+	2+	3+	4+	5+		6+
54-56		1	1					2
56-58		3						3
58-60			2					2
60-62			8	1				9
62-64			20		1			21
64-66			31	10				41
66-68			16	23	1			40
68-70			5	32	1			38
70-72				15	11			26
72-74				4	12			16
74-76				1	10	2		13
76-78					1	1		2
78-80				1	1	2	1	5
80-82					1			1

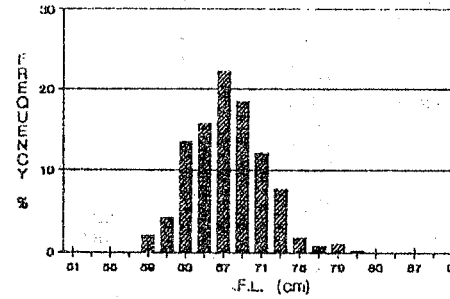
Table VI. Average fork length by age class and standard deviation.

AGE CLASSES	samples	FL (cm)	st.deviation
I	4	56.5	0.8
II	83	64.5	2.5
III	87	68.8	2.6
IV	39	73.0	2.9
V	5	77.0	1.5
VI	1	79	-

alonisos 1986



alonisos 1987



alonisos 1989

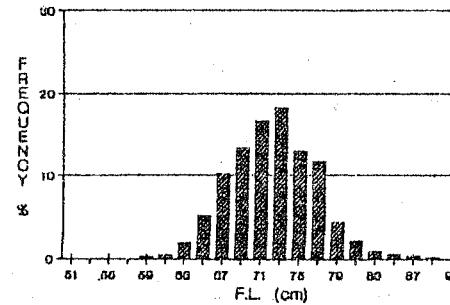


Fig. 1 Length frequency (FL) distribution of albacore in the Aegean Sea in 1986 - 1987 - 1989.

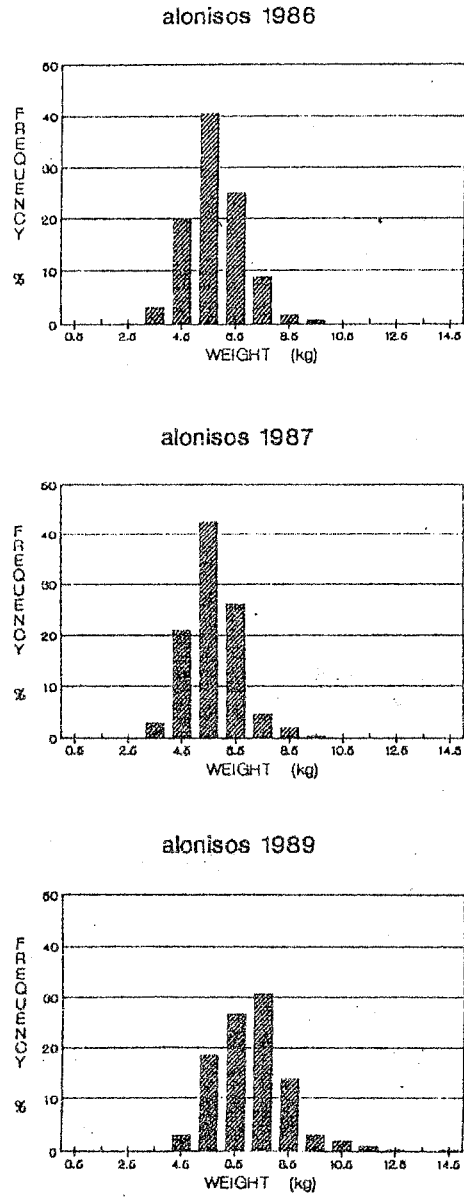


Fig. 2 Weight frequency distribution of albacore in the Aegean Sea in 1986 - 1987 - 1989.

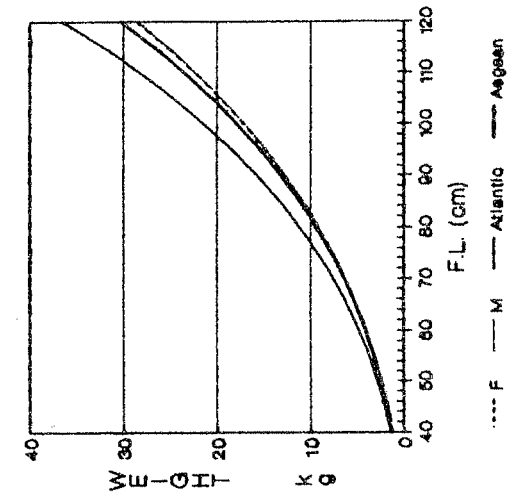


Fig.4 Comparison of length-weight relationships for males and females and for Aegean and Atlantic albacore

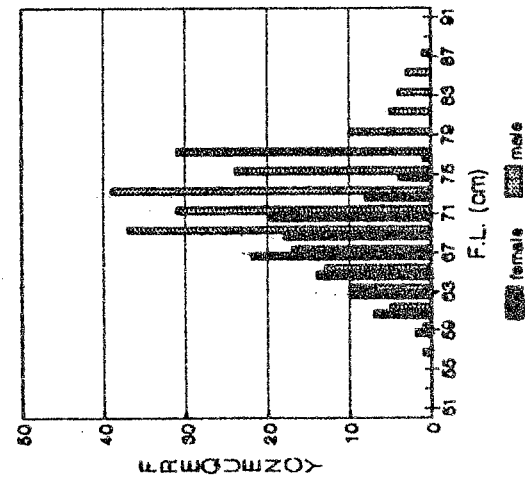


Fig.3 Length frequencies of male and female albacore.

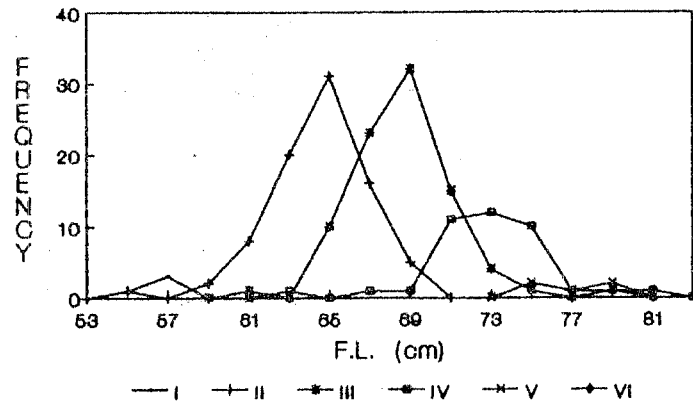


Fig.5 Length frequencies of albacore by estimated age groups