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Age Determination of *Trachinotus ovatus* (L.) based on Otolith Weight

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ABSTRACT. Age determination of fish, from a population having a considerable variation in size at age, has been investigated using the relationship between otolith weight (W_o) and fish length (L_f), which has been described by many authors to be influenced by growth rate. In such a population of *Trachinotus ovatus* (L.), an index of age can be obtained for individual fish by estimating the equivalent otolith weight (W_e) at a particular fish length (L_f) and the appropriate value of modal length (Lm), using the otolith weight-fish length relationship determined for each age group. This index of age can be calculated from the formula:

$$W_e = 0.29\ (L_m - L_f) + W_o$$

It is concluded that this model not only permits a much greater proportion of fish to be assigned ages than is possible with otolith alone, but also enables these age groups to be verified as year classes.

Introduction

The ability to tell the age of a fish accurately from its otoliths, scales, fin rays or other structures is one of the most useful features available in fish biology and fishery sciences. Consequently, it has become a routine to use the observation of periodic changes occur in the growth or structure of hard permanent parts of the fish, which appear to be related to seasonal cycles in the fishes metabolism. However, this type of age determination is usually based on subjective criteria and an independent verification of its accuracy is often lacking.

Investigations of the time-keeping properties of fish otoliths have indicated that age is explained principally in term of otolith weight and fish length (Boehlert, 1985). On the other hand, Gauldie (1988) has postulated that otolith size is highly correlated with fish size since they are both controlled by the same metabolic process. Nevertheless, experimental studies using a fish of known age (Reznick *et al.*, 1989; Secor and Dean, 1989) have shown that the relationship between otolith size and fish size is strongly influenced by the growth rate of the fish and suggested that otolith growth of the fish itself, but has an additional time-dependent rate which results in slow-growing individuals having relatively heavy otoliths for their body size.

A study of the *Trachinotus ovatus* (L.) population from the Mediterranean Sea off Alexandria, Egypt (Allam, 1996) revealed growth patterns determined by otolith reading that appeared to change considerably through the year (means lengths at-age of adult fish varied by up to 6.6 cm over a period of 5 months compared to annual growth increment of 2.3-4.8 cm). It was considered to be important to find an independent means of ageing this fish.

The aim of this study is to examine the relationship between otolith weight and fish length in samples of *Trachinotus ovatus* (L.) collected from the commercial catch landed at Alexandria from the Mediterranean Sea and tests the hypothesis that this strictly objective measurement can be used to determine age of fish.

Materials & Methods

Monthly samples of *Trachinotus ovatus* (L.) were collected from the commercial catch of purse-seine and trammel nets, landed at Alexandria from the Egyptian Mediterranean Sea. Total length and gutted weight of each specimen were recorded. Sagittal otoliths were collected, cleaned, dried, weighed to nearest 0.1 mg and then stored dry in labelled envelopes for further study. Age was determined from whole otolith against black background, using reflected light and viewed with a low power binocular microscope. Counts of zones used to determine age refer to number of complete opaque zones. A t-test was used for statistical evaluation. Significance was accepted at $P < 0.01$. The relationship between otolith weight and fish length was determined by linear regression analysis.

Results and Discussion

Basically, there was no consistent bias in the weight of left or right otoliths taken from the same fish. Also, it is feasible that the weight of otoliths of several fish having the same total length were ranked in the same order as the ages determined for the fish by examination of the structure of the otoliths as shown in Table (1). The obtained results is in accordance with Reznick *et al.*, (1989) who concluded that although age-related differences in otolith size were small in magnitude, they were still statistically significant.

As shown in Fig. (1), the relationship between otolith weight and total fish length, for all *Trachinotus ovatus* sampled is a non-linear, logarithmic relationship. This result is in agreement with Gauldie (1988). However, it was noticed that for two identically-sized fish of different ages, the older and therefore slower-growing individual, will have a heavier otolith than that of the younger fish presumably, because the deposition of otolith materials has continued for a longer time. Moreover, for any one year class, the small, slow-growing fish will have heavy otolith relative to their body length, whilst the otoliths of bigger, faster-growing fish will be relatively light of their body length. These results support the observations and hypotheses proposed by Wilson (1984); Secor and Dean (1986), Pawson (1990).

TABLE 1. The relationship between mean total length and mean otolith weight of *Trachinotus ovatus* for each age group.

Age group	N	Total length (cm)	Otolith weight (mg)
I	57	16.3 ± 1.9	2.5 ± 0.3
II	148	21.1 ± 1.2	4.2 ± 0.4*
III	101	22.8 ± 1.2	5.7 ± 5*
IV	17	24.3 ± 1.1	6.3 ± 0.4*

Average ± standard deviation.

*Significant differences (P < 0.01) from first age group.

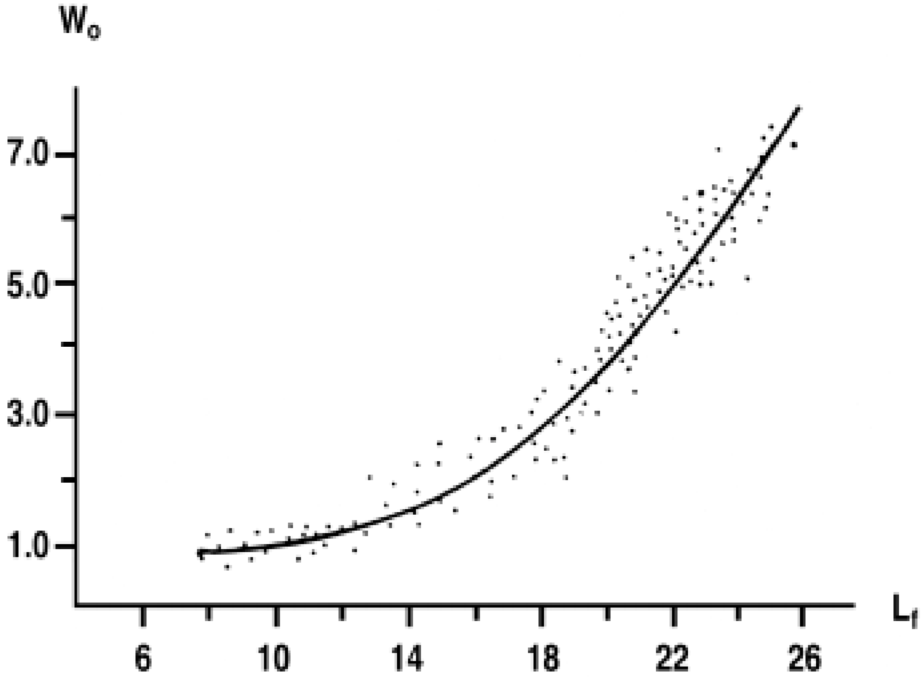

FIG. 1. The relationship between otolith weight (W_o) and total fish length (L_f) for *Trachinotus ovatus* (L.) caught near Alexandria.

The variability of the relationship between otolith weight (Wo) and total fish length (L_f) was investigated by fitting linear regressions for each age group (as attributed by otolith reading) in all monthly fish samples at Alexandria for which adequate data were available. The regression coefficients are given in Table (2). It is suggested that the seasonal variations in this relationship (b) are principally due to sampling bias, since *Trachinotus ovatus* catches at Alexandria do not at any time represent the population as a whole.

In order to determine the relationship between otolith weight, fish length and age in the population as a whole, the regression equations were used to calculate the otolith weight at the modal length of 2- and 3-group fish each month (Table 2).

TABLE 2. Otolith weight (Wo) – fish length (L_f) regression parameters for *Trachinotus ovatus* (L.) sampled at Alexandria, using $Wo = bL_f + a$ and estimated We at modal Lm (ages assigned by otolith structure interpretation).

Month	Age group	N	b	a	r	Lm (cm)	We (mg)
January	2+	8	1.57	– 1.47	0.98	20.0	3.76
February	2+	9	1.60	– 1.67	0.99	20.5	3.86
June	2+	10	1.22	– 0.96	0.94	21.0	4.42
July	2+	8	1.35	– 1.18	0.95	23.0	4.60
August	2+	31	1.37	– 1.22	0.91	21.0	3.98
September	2+	21	1.18	– 0.09	0.93	21.0	4.37
October	2+	49	1.09	– 0.80	0.94	22.0	4.50
November	2+	12	0.80	– 0.44	0.98	21.0	4.09
January	3+	9	0.88	– 0.44	0.99	21.0	5.19
April	3+	17	0.66	– 0.17	0.89	23.0	5.77
May	3+	8	1.02	– 0.64	0.95	23.0	5.75
June	3+	10	1.24	– 0.91	0.97	22.0	5.41
July	3+	13	1.40	– 1.16	0.99	23.0	5.68
August	3+	8	1.30	– 0.18	0.92	23.5	5.83
September	3+	12	0.82	– 0.34	0.97	23.0	6.06
October	3+	11	0.88	– 0.46	0.99	22.0	5.36
November	3+	12	1.40	– 1.17	0.86	23.0	5.54
All year	2+	8	0.29	– 1.89	0.84		
All year (using Lm and We)	3+	9	0.29	– 1.03	0.85		

These data, therefore, represent individuals from among the slowest-growing fish to the fastest growing of their respective age groups. The relationship between these mean otolith weights and fish lengths is probably the best estimate possible of that for the whole population: b = 0.28712 for 2-group and 0.29432 for 3-group.

On the assumption that b is constant for all age groups at any one time, the equivalent otolith weight (We) at the modal length (Lm) of a monthly sample can be calculated for individual fish using b = 0.29 and the appropriate value of Lm to give an index of age.

$$We = b\,(Lm - L_f) + Wo$$

Figure (2) shows the distribution of We against L_f for *Trachinotus ovatus* aged as 1-, 2-,3- and 4- group according to otolith structure in the October samples.

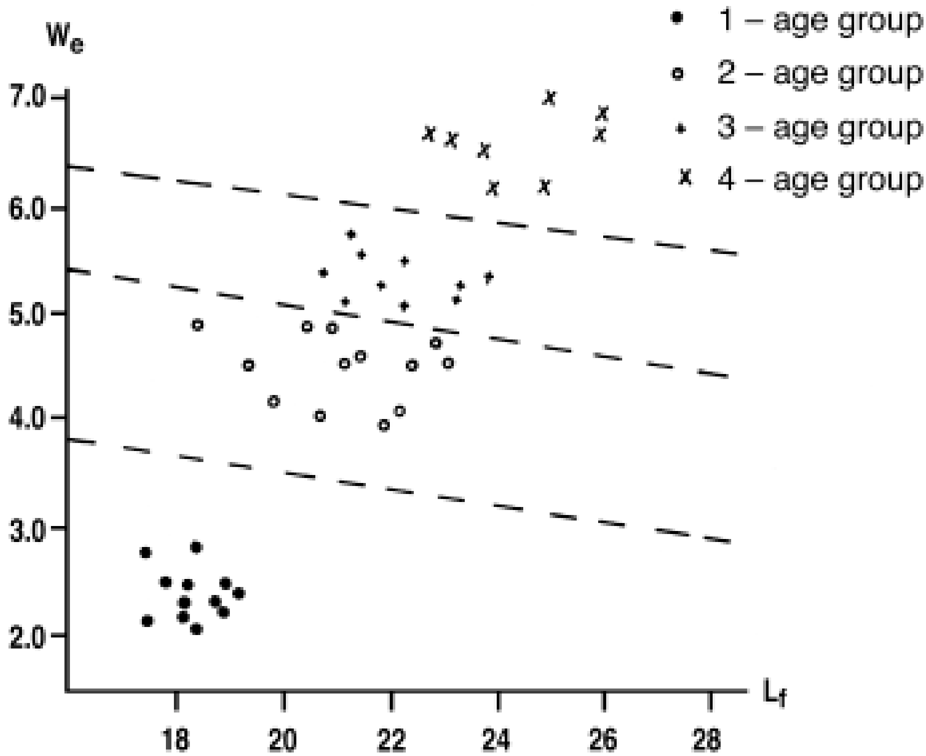

FIG. 2. The distribution of We against fish length for four age groups of *Trachinotus ovatus* (L.) caught near Alexandria in October using We = 0.29 (22 - L_f) + W_o. Dashed line indicates tentative boundaries between age groups.

It has been clear that this technique segregates the majority of fish in these four age groups and permits a greater resolution of the age structure, with respect to the fish lengths, than a conventional age-length key. Also, it may has advantages over traditional age reading including an amenability to data processing, standardization of ageing criteria and avoidance of subjective judgement by the personnel involved. Finally, this technique may be particularly relevant to age determination of fish, which otolith structures can be difficult to interpret.

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تقدير عمر سمكة الغلنفيش بواسطة وزن عظمة الأذن

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المستخلص . تهدف هذه الدراسة إلى استخدام طريقة جديدة لتحديد عمر الأسماك بواسطة وزن عظمة الأذن وذلك بدلاً من الطرق التقليدية وتتلخص فكرة هذه الطريقة باستخدام العلاقة بين طول السمكة ووزن عظمة الأذن وذلك عن طريق هذه المعادلة :

$$W_e = b\,(L_m - L_f) + W_0$$

حيث أن :

الوزن المكافيء لعظمة الأذن	=	W_e
معامل الارتداد	=	b
طول السمكة التكراري	=	L_m
طول السمكة	=	L_f
وزن عظمة الأذن	=	W_0

وقد أوضحت نتائج هذه الدراسة على سمكة الغلنفيش نجاح هذه الطريقة في حساب عمر الأسماك .