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Research Article

Age Analysis on Different Bony Structures of Perch (*Perca fluviatilis* L. 1758) Inhabiting Derbent Dam Lake (Bafra, Samsun)

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Abstract: The age determination method and its accuracy are the most important subjects for the evaluation of age-length-weight relations in fisheries biology, since estimates of survival, growth and mortality rates, analysis of year-classes, and recruitment all depend on age structure. Thus, the aim of this study was to determine the most reliable bony structure for ageing *Perca fluviatilis* inhabiting Derbent Dam Lake. Scales, vertebrae, otoliths and opercles removed from each fish were examined by 2 readers 3 times, without referring to any information except for the date of capture and gonad state. The precision of the readers was estimated and ageing error was determined by analysis of variance. Due to their having the highest precision and the lowest ageing error, vertebrae were determined to be a reliable bony structure for ageing this species.

Key Words: *Perca fluviatilis*, bony structure, age.

Derbent Baraj Gölü (Bafra-Samsun)'nde Yaşayan Tatlısu Levreği (*Perca fluviatilis* L. 1758)'nin Farklı Kemiksi Yapılarında Yaş Analizi

Özet: Yaş tayini metodu ve doğruluğu balıkçılık biyolojisinde yaş-uzunluk-ağırlık ilişkilerinin belirlenmesinde en önemli konulardan biridir. Dolayısıyla, yaşama, büyüme ve ölüm oranları, yıl sınıfı analizleri ve katılım ile ilgili hesaplamalar yaş kompozisyonuna dayandırılır. Bu nedenle, Derbent Baraj Gölü'nde yaşayan *Perca fluviatilis*'in yaşının belirlenmesinde kullanılacak en uygun kemiksi yapının belirlenmesi amaçlanmıştır. İncelenen örneklerin her birinden alınan pul, omur, otolit ve operkül, balığın yakalandığı tarih ve gonad durumu dışında hiçbir bilgi kullanılmadan iki farklı okuyucu tarafından, üçer kez incelenmiştir. Okuyucu uyumu belirlenmiş ve yaş tayini hata payı değerleri varyans analiziyle hesaplanmıştır. İncelenen tüm kemiksi yapılar içinde en yüksek uyum ve en düşük yaş tayini hata payı değerleri nedeniyle omur bu tür için yaş tayininde kullanılacak güvenilir kemiksi yapı olarak belirlenmiştir.

Anahtar Sözcükler: *Perca fluviatilis*, kemiksi yapı, yaş.

Introduction

The age of fish is used in all studies concerning their biology. These studies involve age-length keys, rate of survival, growth and mortality, age composition and reproduction rate of stock. Age growth studies are important for solving problems related to the management of fisheries. The determination of age in fish helps us to know the age at first maturity, to study population dynamics, to estimate growth, and to optimise harvesting time (1). Therefore, knowledge on age is very valuable for studying population characteristics, and it is often required before more detailed studies on life history strategies and ecology are carried out (2).

There are different methods for the age determination of fish, such as mark-release-recapture, analysis of length-frequency data and anatomical research. Due to the disadvantages of the first and second methods, anatomical research has generally been used for ageing fish. In anatomical research, growth rings forming on bony structures such as scales, otoliths, vertebrae, opercles, and the cross-sections of dorsal and pectoral fin rays have been evaluated by readers.

The choice among the bony structures for age determination varies from species to species. While a bony structure may be particularly suitable for age determination in one species, it may be unsuitable for another as all the bony structures of the body generally do not record the marking with equal distinctness. In addition, bony structures used in age determination cannot be generalized for different species (1).

Age determination is not a procedure of counting rings on bony structures. When bony structures are examined under a microscope, it is possible that different rings are seen running concentrically around the centre. While some rings express yearly growth, some rings also reflect stress or periods of spawning, starvation or migration (1). The annual rings are the actual indicators of age. It is essential that the "true rings" be distinguished from other types of rings such as stock rings, false rings, larval rings and spawning rings through the repeated examination of samples to avoid confusion and inaccuracy in age determination.

In the past, the scale method was generally accepted as routine and accurate for ageing all fish in a population. Unfortunately, the method was seldom validated (3). Once it was realised by some investigators that scales underestimated the age of older fish, it was found that some species were considerably older than previously thought (4). Similarly, in Turkey, ages have been estimated using scales and the surfaces of otoliths. Other structures, such as fin rays, vertebrae and broken otoliths, have been used occasionally. Because ages from scales or otoliths have been considered accurate, few investigators have attempted to use other bony structures. However, it has been found that scales do not continue to grow as the fish ages (4). In addition, for some species such as *Solea lascaris*, otolith growth becomes allometric because deposition occurs predominantly on the inner surface (5). If the surfaces of otoliths are used ages will be underestimated due to lost rings stemming from central thickness or the losing of annuli on the edge. Pioneering work on broken and burnt otoliths concluded that this technique usually produces higher age estimates than other methods (6-10). Therefore, the broken-burnt otolith has been reported as a reliable bony structure for the age determination of species such as *Solea lascaris* (5), *Salvelinus alpinus* (9) and *Merlangius merlangius exunus* (11).

For obtaining correct age data, the ages of fish are estimated by comparing readings from various bony structures and different readers (12). As the most reliable ageing method may vary among species, the precision of bony structures by readers should be studied for each species (13,14). Furthermore, ageing errors must be considered before deciding on the most reliable bony structure for the ageing of fish (15-19). By establishing the rate of agreement and ageing error, bony structures which have the highest agreements and minimal ageing error should be determined. Thus, among different bony structures reliable ones can be distinguished from other bony structures.

We have attempted to age *Perca fluviatilis*, since no study on this subject has been carried out before.

Materials and Methods

The study material consisted of 130 *Perca fluviatilis* specimens collected from different parts of Derbent Dam Lake between November 1998 and June 1999. Otoliths, scales, vertebrae and opercles from each sample were removed after fork length and weight were recorded. Otoliths, vertebrae and opercles were prepared procedures (12,20) and examined under a binocular microscope with 1.5x magnification and top lighting. Scales were also examined under a binocular microscope with 1x magnification and transmitted light.

Each bony structure was examined by 2 readers 3 times. A total of 3120 readings were made (130 samples x 4 structures x 2 readers x 3 replicates). Two readers did not refer to information such as fish length, weight and sex, but only to the collection date and gonad stage of the sample. The readers examined each bony structure independently. Mean ages (21) were estimated for each of 4 bony structures and the precision (14,16) of the age estimated from multiple readings was evaluated. Additionally, the ageing error (standard deviation) was calculated by variance analysis (22,23) (one-way ANOVA).

Results

Age composition derived from scale, vertebra and otolith counts indicated 4 year classes. The use of opercle counts extended this to 5 (Figure 1).

Mean age estimates were compared for each structure. The mean age for all structures was 1 year. There was no significant difference between the mean age of each bony structure (ANOVA, $F(3,511) = 1.05$, $P > 0.05$). This shows that the criteria for age interpretation were appropriate for structures. The

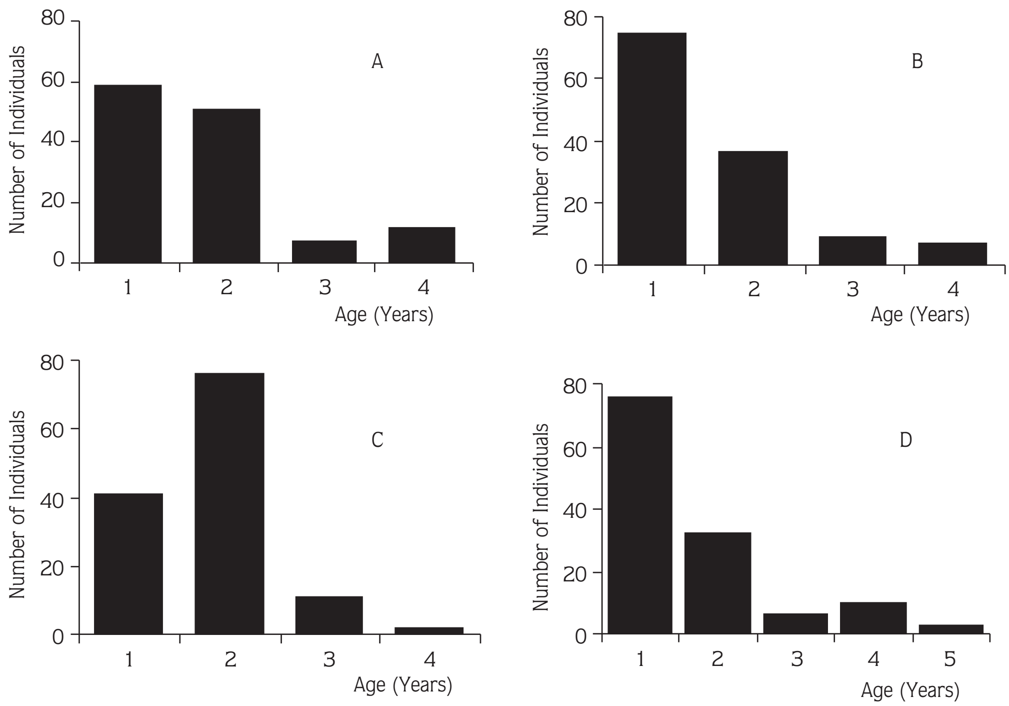

Figure 1. Age composition derived from 4 bony structure readings. (A. Scale, B. Vertebra, C. Otolith, D. Opercle)

ageing error for the bony structure-reader combination was calculated (Table 1).

Precision of readers has been estimated from the percentage agreement of six readings (2 readers x 3 times) (Table 2).

Table 1. Mean ages, and standard and ageing errors for 130 perch samples.

Structures	Scales	Vertebrae	Otoliths	Opercles
Mean ages	1.71	1.57	1.73	1.62
Standard errors	0.05	0.03	0.06	0.05
Ageing errors	0.55	0.38	0.69	0.54

Table 2. Precision of readers on different bony structures (Agreement of readers/Number of total readings).

Bony Structures	6/6	5/6	4/6	3/6	Total
Scales	41.08	17.82	27.13	13.97	100
Vertebrae	68.75	17.18	11.71	2.36	100
Otoliths	41.73	28.27	20.0	10.0	100
Opercles	59.05	10.23	18.89	11.83	100

The highest agreement between 2 readers is 68.75% in vertebrae and the lowest is 41.08% in scales. While the lowest ageing error was 0.38 in vertebrae, the highest was 0.69 in otoliths (Table 1).

Discussion

Mean age cannot indicate which bony structure is reliable for age determination, but may give reasonable information about a structure which may be over - or underestimated age. Mean age facilitates the elimination of the structure when an over - or underestimation exists. However, Table 1 shows that neither over- nor underestimation occured in the 4 bony structures.

Precision may be used to compare the age estimation of different bony structures of a species. Therefore, the bony structures aged with the highest agreement must be preferred to others. In addition to a reliable age determination, the structure with the lowest ageing error must be preferred. When the bony structures are arranged according to precision and ageing error the following arrangement was formed for this species:

for precision vertebra > opercle > otolith > scale

for ageing error vertebra < opercle < scale < otolith

In this case, it is obvious that the vertebra has the highest precision and the lowest ageing error. Thus, the vertebra is the most reliable bony structure for the age determination of perch (Figure 2).

When scale ages are compared with vertebra ages for this species, it is seen that scale ages deviated from vertebra ages. The distribution of mean scale age deviation from vertebra age is represented in Figure 3.

The scale method overestimated the age from the vertebra method on 24, 2 and 5 specimens for 1, 2 and 3 ages, respectively. In contrast, the scale method underestimated the age from the vertebrae method on 5 specimens for 2 age. In 36 specimens, scale ages deviated from vertebra ages (Figure 3).

We recommend that in studies involving the rates of survival, growth and mortality, age composition and reproduction rate of stock of *Perca fluviatilis*, the vertebra be used as the most reliable structure for the age determination.

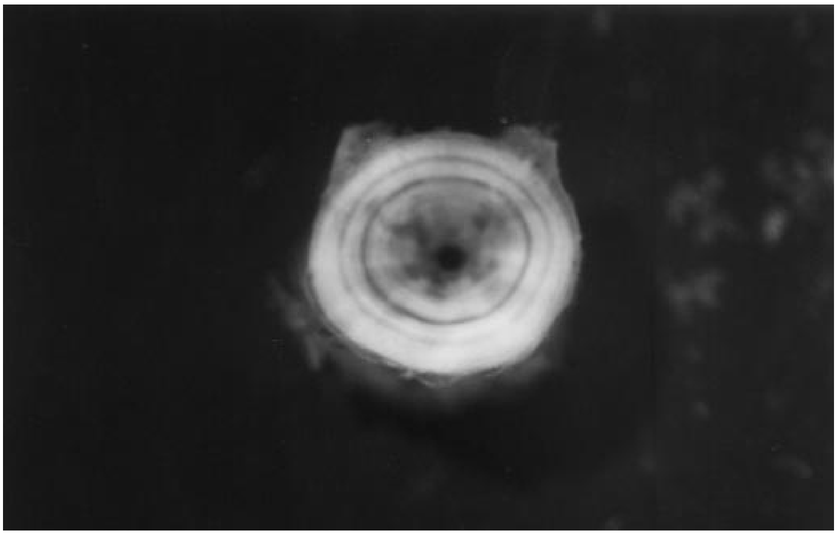

Figure 2. Vertebra from *Perca fluviatilis* age 2(3). (X15)

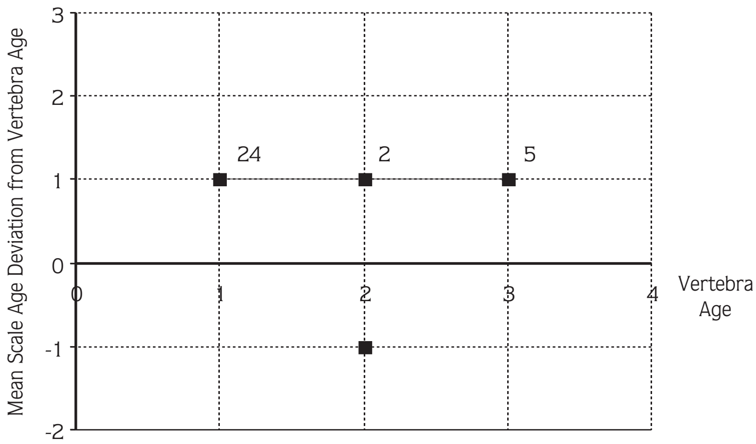

Figure 3. Deviation of mean age determined by the scale method from age determined by the vertebra method for *Perca fluviatilis*.

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