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Research Note

Age Determination of Shad (*Alosa pontica* Eichwald,1838) Inhabiting the Black Sea

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Abstract: The most reliable bony structure and method were investigated for age determination of shad (*Alosa pontica* Eichwald, 1838) inhabiting the Black Sea. Therefore, five bony structures such as scale, vertebra, otolith, opercle and subopercle were removed from 240 individuals collected from April 1998 to April 1999. Each bony structure was prepared for age determination by different techniques, and examined by binocular microscope. Mean ages were estimated for each bony structure-reader combination and the precision of age estimated from multiple readings was evaluated. Furthermore, the error of ageing was calculated. Vertebra was the most reliable bony structure for ageing this species as it had the highest agreement and the lowest ageing error. Therefore, it is emphasized that the vertebra is the most accurate and reliable source of information in studies that require reliable age data about shad.

Key Words: *Alosa pontica*, Age Determination, Bony Structure, Black Sea

Karadeniz'de Yaşayan Tirsi Balığı (*Alosa pontica* Eichwald, 1838)'nda Yaş Belirleme

Özet: Bu çalışmada, Karadeniz'de yaşayan Tirsi Balığı (*Alosa pontica* Eichwald, 1838)'nın yaş tayininde kullanılabilecek en güvenilir kemiksi yapı ve metot araştırılmıştır. Bu amaçla, Nisan 1998-Nisan 1999 tarihleri arasında 240 örnek yakalanarak pul, omur, otolit, operkül ve suboperkül olmak üzere beş kemiksi yapı çıkarılmıştır. Her bir kemiksi yapı farklı tekniklerle yaş tayinine hazırlanmış ve binoküler mikroskopta incelenmiştir. Her bir kemiksi yapı-okuyucu kombinasyonu için ortalama yaş bulunmuş ve tekrarlı okumalardan elde edilen yaş verilerinin uyumu değerlendirilmiştir. Ayrıca yaş tayini hata payı değeri hesaplanmıştır. En yüksek uyum ve en düşük yaş tayini hata payı değerinden dolayı, bu türün yaş tayini için kullanılabilecek en ideal kemiksi yapının omur olduğuna karar verilmiştir. Bu sebeple, bundan sonra Tirsi Balığı ile ilgili olarak yaş bilgilerinin gerekli olduğu bütün çalışmalarda doğru ve güvenilir sonuçlar için omur metodunun tercih edilmesinin gerektiği vurgulanmıştır.

Anahtar Sözcükler: *Alosa pontica*, Yaş Tayini, Kemiksi Oluşum, Karadeniz

Introduction

Studies on the age and growth of fish are important for solving common problems in fishery management. The knowledge obtained as a result of an examination of age can establish a basis for studies on fish biology (1,2). Errors in age data may cause misleading results and mismanagement (3).

One of the significant aspects for getting accurate data on fish biology and population dynamics is to determine age with the lowest error (4). The most reliable method of age determination in fish is to mark them in their natural environment (1,2). Age data estimated by this method is definite and reliable; furthermore, it generally establishes a basis for validation studies (5). The marking method is limited in use due to its being costly and time-consuming. The other method in age determination is length-frequency analysis. However, it is considered a reliable method when the samples are representative of a fish population which has a short life, fast growth and reproduction once in a year (6,7). The third method used in the ageing of fish is the examination of bony structures at least three times by multiple readers. The most reliable bony structure can be established by estimating the precision (8,9) of the multiple readings and calculating ageing error by variance analysis. The reliable bony structure in determining the age of fish varies from species to species. The reliable method for age determination varies in different populations of the same species as well as the age differentation in the same stock (10).

The shad (*Alosa pontica* Eichw., 1838) has obtained commercial importance due to decreasing stocks of other economically important species inhabiting the Black Sea after the mid-80s. Some 76% of the shad production of Turkey is provided from the Black Sea. The shad has the lowest fishing rate among the other commercial species with a rate of production of 0.4% in the Black Sea. An organization for shad fishing has not been established yet. In the future, research on the determination of the stock and bio-ecological characteristics of the shad must be started in order to profit from the optimum level of stocks and to provide continuity of stocks. It is necessary to establish a fishing organization according to the information which will be obtained from detailed research (11).

There have been no studies concerning the estimation of the reliable bony structure used for the age determination of *Alosa pontica*. Therefore, our aim was to investigate the most reliable bony structure for the age determination of shad.

Materials and Methods

The study material consisted of 240 samples provided by fishermen in Çarşamba-Dereköy (Samsun, Turkey) from April 1998 through April 1999. Five bony structures, scale, vertebra, otolith, opercle, subopercle, were removed for age determination. Scale (12), vertebra (13), otolith (14), opercle and subopercle (13) were prepared for age determination by different techniques and examined under a binocular microscope.

Five readings were made for each bony structure. No reference was made to any information concerning each sample except for the data of capture and the shape of a gonad. The last annulus which was completed was used in ageing. All ages were interpreted by considering January 1st to be the birthdate (10). Mean ages (15) were estimated for each of five bony structures and the precision (8,9) of age estimated from multiple readings was evaluated. Additionally, the ageing error was calculated (16,17).

Results

Age was determinated by evaluating five bony structures, scale, vertebra, otolith, opercle and subopercle, in a population consisting of 240 individuals of shad inhabiting the Black Sea.

Ages between 1 and 6 were observed on five bony structures as a result of multiple readings. The age composition of bony structures derived from scale and vertebra counts indicated 6 year-classes and 5 year-classes in otolith, opercle and subopercle counts (Figures 1-5). All the bony structures were photographed (Figures 6-10).

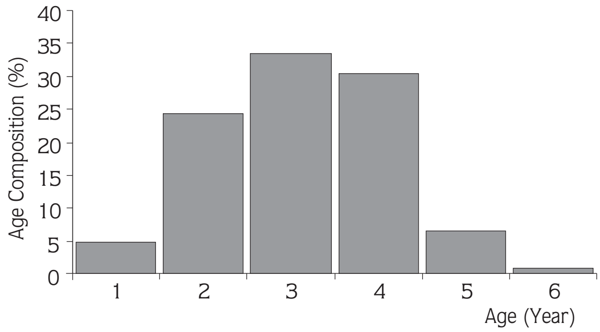

Figure 1. Age composition derived from scale readings

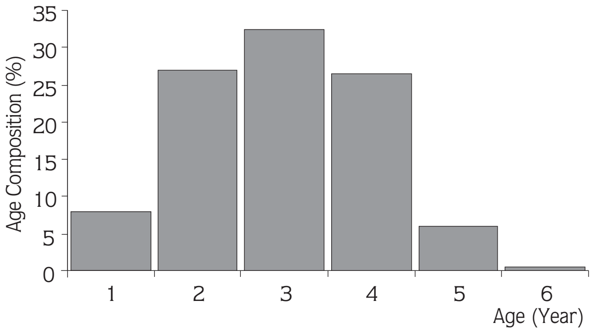

Figure 2. Age composition derived from vertebra readings

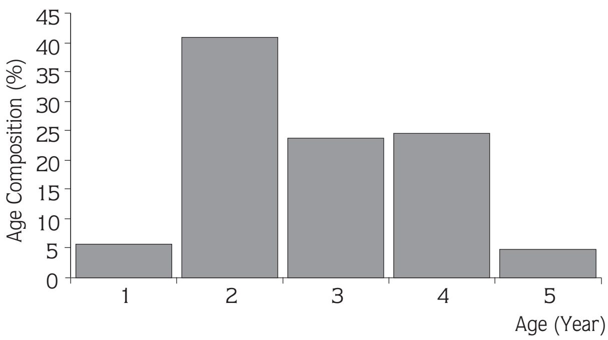

Figure 3. Age composition derived from otolith readings

In relation to mean ages, the highest value was obtained for scale, 3.15 (Table 1). The lowest mean age was recorded for otolith, 2.82. There was no significant difference between mean ages of each bony structure (P

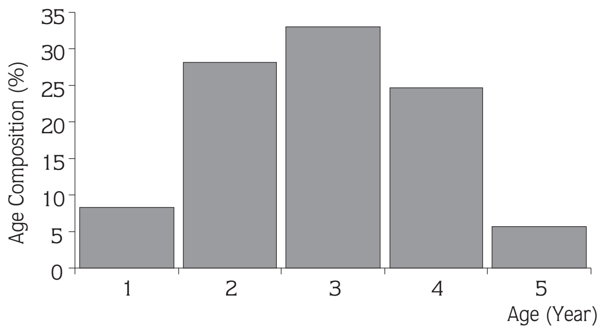

Figure 4. Age composition derived from opercle readings

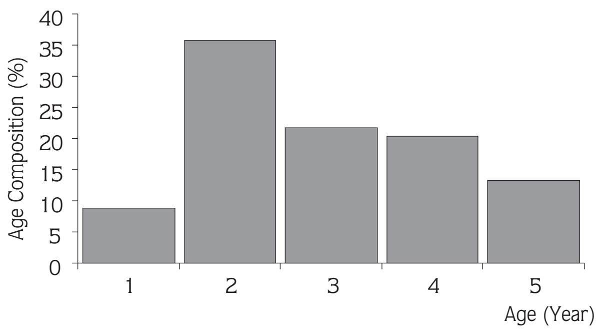

Figure 5. Age composition derived from subopercle readings

> 0.05). This means that the criteria for age interpretation were appropriate for the structures. The ageing error for the bony structure-reader combination was calculated (Table 1).

The agreement rate showed differences in the five readings for each bony structure (Table 2).

According to Table 2, in the 5/5 group where all five readings were the same, the rate of agreement was highest for vertebra as 42.01%. This rate was followed by otolith (37.68%), subopercle (26.99%), opercle (25.55%) and scale (19.91%). However, 34.46% of samples of vertebrae were evaluated by a yearly difference. On the other hand, 2/5 and 1/5 agreement, which were obtained from vertebra as 0.42%, was higher in otolith (5.80%), opercle (6.18%), subopercle (9.30%) and scale (10.41%).

Among the five bony structures, the ageing error was determined for vertebra to be 0.44. These results for vertebra were followed by otolith with 0.50, subopercle with 0.56, opercle with 0.56 and scale with 0.60.

Discussion

There are differences in the length of immersion in 3% NaOH during the preparation for age determination of scales due to the fact that the types and characteristics of each fish' scale are different. The most suitable period can only be estimated from the results of tests. It is determined that the appropriate waiting period in 3% NaOH for *Alosa pontica*'s scale is 10-12 hours.

Generally, the selected vertebra is used since not all vertebrae of fish show similar ring features. For instance, Das (2) reported that the 5th vertebra of *Tachysurus thalassinus* and *Tachysurus platystomus*, and the prehaemal and first three haemal vertebrae of *Otolithoides brunneus* have different ring characteristics.

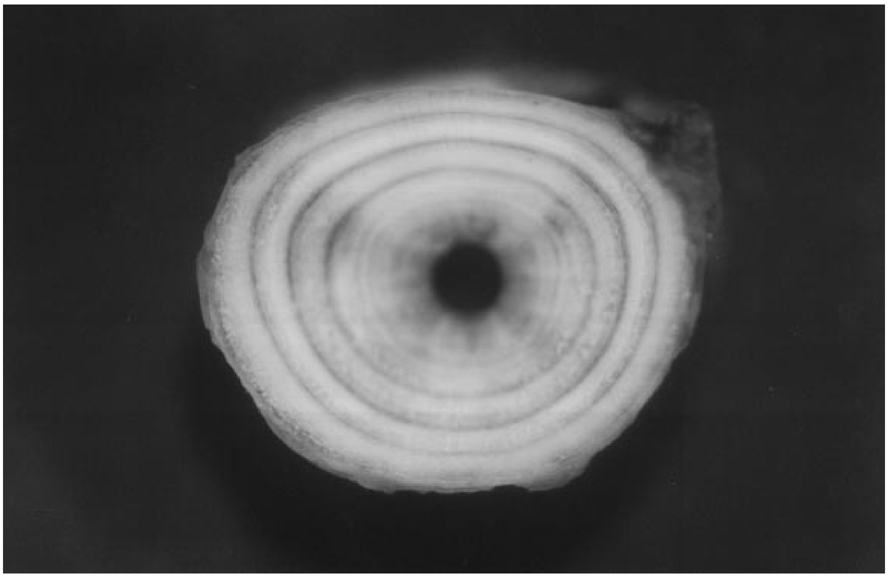

Figure 6. Vertebra of male shad, age 4, fork length 201 mm (x 2.5)

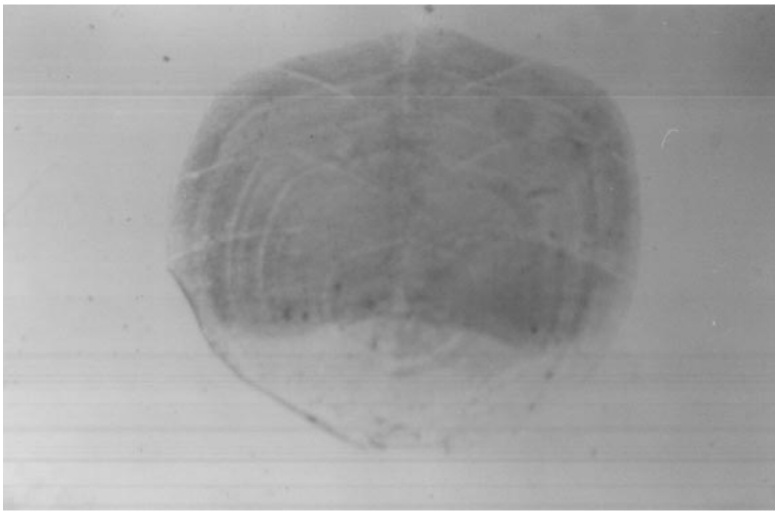

Figure 7. Scale of male shad, age 4, fork length 159 mm (x 1.7)

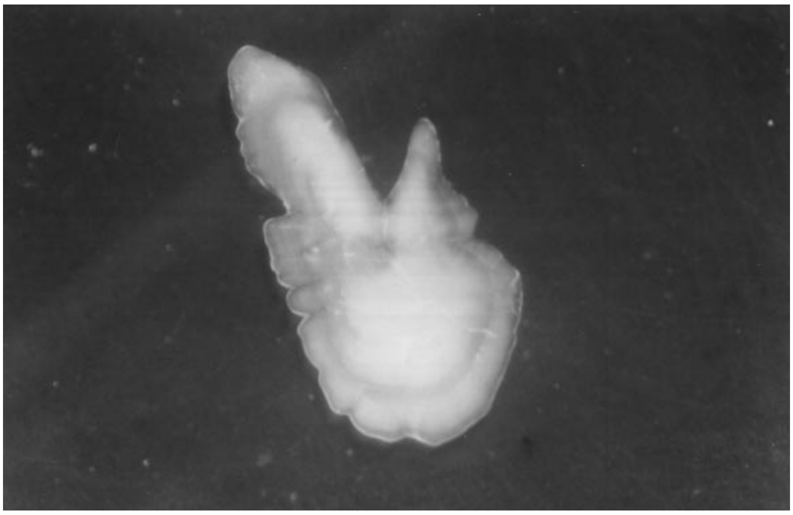

Figure 8. Otolith of female shad, age 2, fork length 199 mm (x 3)

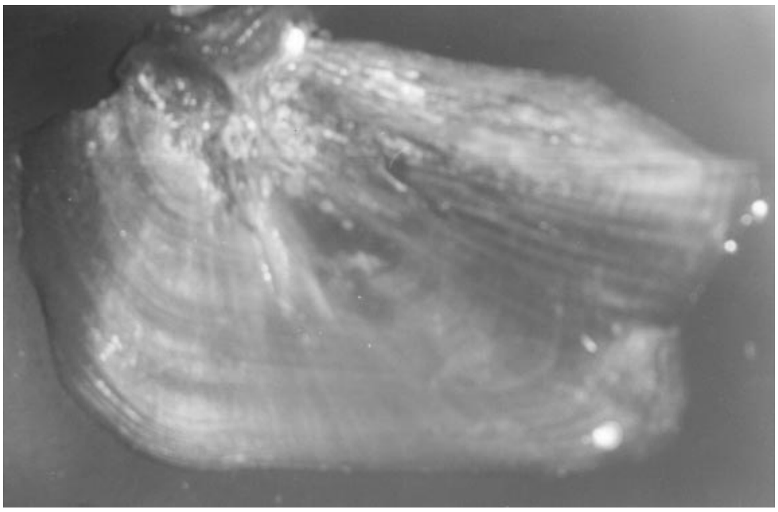

Figure 9. Opercle of female shad, age 5, fork length 268 mm (x 0.5)

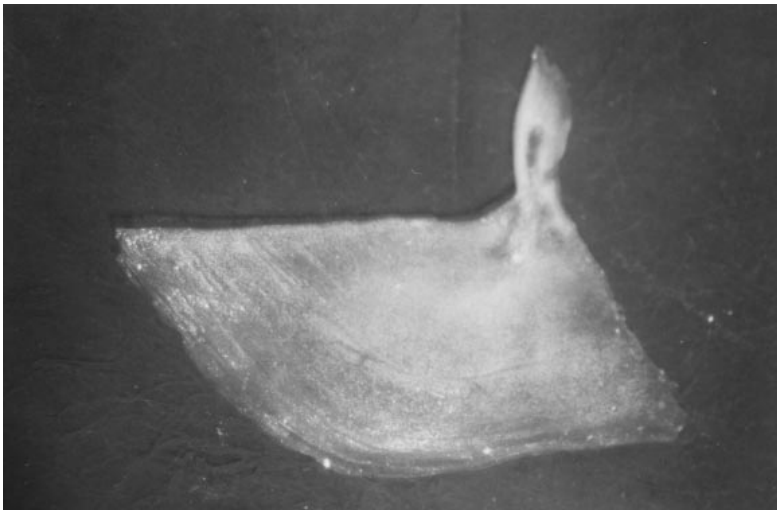

Figure 10. Subopercle of female shad, age 2, fork lenght 196 mm (x 1)

Table 1. Mean ages, and standard and ageing errors for each bony structures

Bony structures	Scale	Vertebra	Otolith	Opercle	Subopercle
Mean ages	3.15	2.95	2.82	2.89	2.93
Standard errors	1.22	0.90	1.01	1.13	1.14
Ageing errors	0.60	0.44	0.50	0.56	0.56

Table 2. Percentage agreement on bony structures

Bony structures	Agreement groups (Agreement of reader / Total reading)					Total
	5/5	4/5	3/5	2/5	1/5	
Vertebra	42.01	34.46	23.11	0.42	-	100
Otolith	37.68	31.88	24.63	4.35	1.45	100
Subopercle	26.99	26.10	37.61	6.65	2.65	100
Opercle	25.55	36.12	32.15	4.85	1.33	100
Scale	19.91	29.43	40.25	5.65	4.76	100

Moreover, Prince at al. (18) have used the 35^{th} vertebra on the pedincule in the age determination of *Thunnus thynnus*. In this research, the 4^{th}-10^{th} vertebrae were removed from *Alosa pontica*, and the vertebra with the best annulus characteristic was evaluated for ageing. It was cleaned by the method reported by Polat and Beamish (13), and annuli were seen more clearly on the vertebra which was left for 15 minutes at 103 °C.

Both right and left otoliths were examined, and age readings were done by whole otolith regarding isometric growth. The annuli were easily read by clean rubbing in 96% ethyl alcohol after otoliths were kept for 15 minutes at 103 °C. On the other hand, the otolith cleaning techniques proposed by Limburg (19) and Liew (20) were not used, since these methods caused erosion on the otoliths.

The age annuli appeared clearly when opercular and subopercular bones, which were immersed in boiling water for a few minutes, were cleaned with cheese cloth. However, immersion for longer than one or two minutes in boiling water of opercle and subopercle caused erosion and deformation, especially on the side of them.

Precision refers to the degree of reproducibility and thus relates to the variability between readings or readers (10). Although the precision of the estimated ages cannot be a unique measure of accuracy (5,21), selection of the most reliable bony structure for the ageing of fish can be achieved. In our study, the highest agreement, 42.01%, was obtained for vertebra among the five bony structures. The other criterion for estimation of the most suitable bony structures in age determination is ageing error. The bony structure which has the lowest ageing error is more appropriate than other bony structures for age determination (5,17,21,22). In this research, the lowest ageing error (0.44) was calculated for vertebra. In addition, the smaller false ring coincided in the samples of vertebra. Therefore, it was concluded that vertebra is the most suitable method for the age determination of this species.

Consequently, vertebra is the most accurate and reliable source in studies which require age data about shad, *Alosa pontica*.

References

1. Morales-Nin, B., Determination of Growth in Bony Fishes from Otolith Microstructure. FAO, Fisheries Technical Paper, 1992.
2. Das, M., Age Determination and Longevity in Fishes. Gerontology, 40, 70-96, 1994.
3. Crawford, S., Coleman, W.S., Porak, W.S., Time of Annulus Formation in Otoliths of Florida Largemouth Bass. N. Amer. J. Fish. Man., 9, 231-233, 1989.
4. Chalanchuk, S.M., Ageing a Population of the White Sucker, *Catostomus commersoni* by the Fin-Ray Method. Can. Tech. Rep. Fish. Aquat. Sci., 1321, IV, 16 p., 1984.
5. Beamish, R.J., McFarlane, G.A., The Forgetten Requirement for Age Validation in Fisheries Biology. Trans. Amer. Fish. Soci., 112 (6), 735-743, 1983.
6. Casselman, J.M., The Biology of Fish Growth (Chapter 7) Academic Press, Canada, 209-242, 1987.
7. Baker, T.T., Timmons, L.S., Precision of Ages Estimated from Five Bony Structure of Arctic Char (*Salvelinus alpinus*) from the Wood River System. Alaska. Can. J: Fish. Aquat. Sci. 48, 1007-1014, 1991.
8. Polat, N., Işık, K., Kukul, A., Bıyıklı Balık (*Barbus plebejus escherichi*, Steindacheri 1897)' ın Yaş Tayininde Kemiksi Yapı-Okuyucu Uyum Değerlendirmesi. Doğa, Turk J. Zool., 17, 503-509, 1993.
9. Polat, N., Gümüş, A., Age Determination and Evaluation Precision Using Five Bony Structures of the Bround-Snout (*Chondrostoma regium* Heckel, 1843). Turk J. Zool., 19, 331-335, 1995.
10. Chilton, D.E., Beamish, R.J., Age Determination Methods for Fishes Studies by the Groundfish Program at the Pacific Biological Station. Can. Spe. Pub. Fish. And Aquat. Sci., 60 s., 1982.
11. Zengin, M., Genç, Y., Tabak, İ., Karadeniz'de 1990-1995 Yılları Arasında Avlanan Önemli Ticari Balık Türlerinin Av verileri Üzerine Araştırmalar (Sonuç Raporu). Tarım ve Köyişleri Bakanlığı, Tarımsal Araştırmalar Genel Müdürlüğü, Trabzon Su Ürünleri Araştırma Enstitüsü Müdürlüğü, Trabzon, 1998.
12. Chugunova, N., Age and Growth Studies in Fish. Nat. Sci. Found., Washington, 132 s., 1963.
13. Polat, N., Beamish, R.J., Annulus Formation on Anatomical Structures of Siraz (*Capoeta capoeta*) in Altınkaya Dam Lake. Ondokuz Mayıs Üniversitesi Fen Dergisi, 4 (1), 70-88, 1992.
14. Polat, N., Age Determination of *Capoeta trutta* (Heckel, 1843) in Keban Dam Lake, Doga, Turk., J. Zool., Vol. 11, Num. 3, 155-160, 1987.
15. Campana, S.E., How Reliable are Growth Back Calculations Based on Otoliths? Can. J. Fish. Aquat. Sci., 47: 2219-2227, 1990.
16. Fowler, J.A., Validation of Annual Growth Increments in the Otoliths of a Small, Tropical Coral Reef Fish, Mar. Ecol. Prog. Ser., 64: 25-38, 1990.
17. Trojnar, J.R., Marking Rainbow Trout Fry with Tetracycline, The Progressive Fish Culturist, 35 (1) : 52-54, 1973.
18. Prince, E.D., Lee, D.W., Javech, J.C., Internal Zonations in Sections of Vertebra from Atlantic Bluefin Tuna, *Thunnus thynnus*, and Their Potential Use in Age Determination. Can. J. Fish. Aquat. Sci., 42: 938-946, 1985.
19. Limburg, K.E., Growth and Migration of 0-year American Shad (*Alosa sapidissima*) in the Hudson River Estuary: Otolith Microstructural Analysis. Can. J. Fish. Aquat. Sci. 53: 220-238, 1996.
20. Liew, P.K.L., Age Determination of American Eels Based on the Structure of Their Otoliths. The Proceeding of an International Symposium on the Aging of Fish. Page 124-136, 1973.
21. Campana, S.E., Accuracy, Precision and Quality Control in Age Determination, Including a Review of the Use and Abuse of Age Validation Methods. Journal of Fish Biology, 59, 197-242, 2001.
22. Polat, N., Bostancı, D., Yılmaz, S., Comparable Age Determination in Different Bony Structures of *Pleuronectes flesus luscus* Pallas, 1811, Inhabiting the Black Sea. Turk. J. Zool. 25, 441-446, 2001.