Age and Growth of the Marbled sole, *pleuronectes yokohamae*, in Approaches to Kyongyolbiyolto of the Yellow Sea, Korea

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한국서해안 격열비열도 근해산 문치가자미의 년령과 성장

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요 약

한국서해안 격열비열도 근해산 문치가자미의 년령과 성장을 조사하기 위하여 1992년 9월부터 1993년 8월까지 매월 정기채집한 256개체의 이석을 년령형질로서 사용하여 조사분석한 결과를 보면, 이석의 투명대와 불투명대는 년 1회 형성되었으며 투명대 형성시기는 7월이고 불투명대 형성 시기는 2월에서 4월로 이는 산란종기(2월)와 일치함을 보였다. 년령별 체장(Lt)과 년령(t)을 von Bertalanffy 성장식에 적용하여 숫컷은 $Lt=313.7[1-\exp\{-0.4342(t+0.9017)\}]$, 암컷은 $Lt=458.1[1-\exp\{-0.2368(t+0.1934)\}]$과 같은 관계식을 구하였다. 또한 암컷과 숫컷의 성장속는 2세까지는 별다른 차이를 보이지 않았으나, 3세어 이상에서는 암컷이 숫컷보다 월등이 빠름을 나타내었다. 본 연구에서의 최고령어는 암수 각각 5세와 6세였다.

Introduction

The mabled sole, *pleuronectes yokohamae*, is distributed in Korea from south coast to west coast, the northern part of the East China Sea, and in Japan from southern Hokkaido to Oita Prefecture in Kyushu. It inhabits sandy - mud bottoms less than 100 m depth[1] It is fished mainly by bottom trawl and gillnets and is an important commercial fish in several parts of Korea. The mabled sole, *pleuronectes yokohamae*, is one of the most important target species of small bottom trawl fishery in the Yellow Sea and a comprehensive study of the fisheries biology of this species will be conducted in near future. The age and growth of mabled sole, *pleuronectes yokohamae*, have been studied in some portions of Korea and Japan[2-6], but no studies have been conducted in the Yellow Sea, Korea. Here, the otoliths of mabled sole,*pleuronectes yokohamae*, which have been collected during the investigation of the fisheries biology in the Yellow Sea, were utilized to examine the age and growth of this species. Although the number of samples is not large enough and the collection period is rather long, some useful information of age determination and growth was obtained.

Materials and Methods

Otoliths of mabled sole, *pleuronectes yokohamae*, collected from small commercial fishing boats in approaches to Kyongyolbiyolto, the Yellow sea from September 1992 to August 1993 were used for age determination. A total of 271 specimens was examined and 256 of them had readable otoliths. The specimens were measured to the nearest mm body length and weighted to the nearest g. The body lengths were from 150 to 384 mm and 150 to 450 mm for male and female fish, respectively.

All otoliths removed from the fish were kept in glass vials. Some of the otoliths, especially the larger ones were ground until the opaque and hyaline zones could be seen clearly. Smaller otoliths did not require grinding. The otoliths were placed in a watch glass with black background containing glycerine to facilitate reading. They were examined using a Meiji techo Model 1 microscope with reflected light and measured to 0.01 mm with a built- in measuring device. Of each otolith pair, those from the blind side of the fish were found suitable for reading and used for measurement. The radius and the ring radii were measured from the center of the nucleus to the distal margin of the otolith and to the outer margins of the hyaline zones, respectively.

Monthly changes in percentage occurrence of otoliths with opaque and hyaline margins were examined. Observations were made using 256 otoliths from fish less than 6 years old out of the 271 otoliths used for age determination and 15 additional otoliths from fish of unknown sexes.

Results and Discussion

Monthly changes in percentage occurrence of the otolith with opaque and hyaline margine are shown Fig. 1. The opaque zone begins forming from February to April and ends in June. From July to January only the hyaline zone appeared. Therefore, the hyaline zone formation is completed in the period from February to April. This period coincides with the end of the spawning season(December to February) in approaches to Kyongyolbiyolto of the Yellow Sea, Korea(Park, unpublished). These data indicate that the hyaline zone can be used as annulus for age determination.

The relationship between otolith radius and body length is shown in Figs. 2 and 3 as a straight line. The corresponding equations are ;

Male : $BL=87.664R-2.6053(r^2=0.790)$

Female : $BL=86.589R-19.338(r^2=0.843)$

where BL is body length in mm and R is otolith radius in mm. Analysis of covariance showed no significant difference in slopes between males and females. Therefore, the data were treated separately for each sex.

The relationship between body length and total length is shown in Fig.4.

The equations are as follows :

$BL=1.1598\ TL+5.8317(r^2=0.9966)$

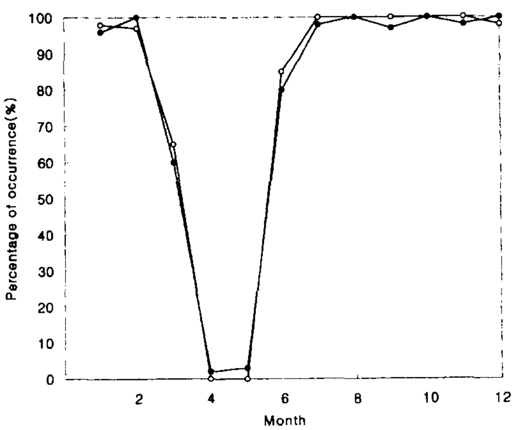

Fig.1. Monthly changes in percentages of occurrence of otoliths with hyaline margine for mabled sole, *pleuronectes yokohamae*, from Kyongyolbiyolto(○ : male, ● : female)

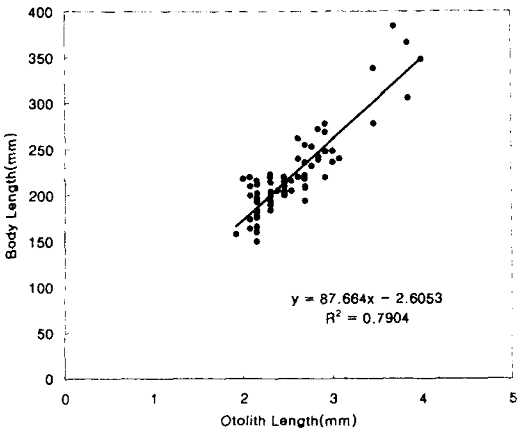

Fig.2. Relationship between otolith radius and body length for male mabled sole, *pleuronectes yokohamae*, from Kyongyolbiyolto.

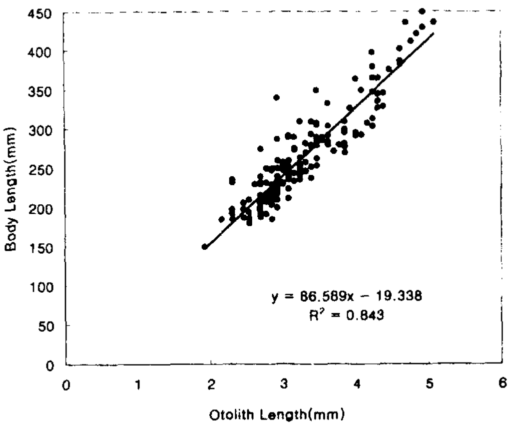

Fig.3. Relationship between otolith radius and body length for female mabled sole, *pleuronectes yokohamae*, from Kyongyolbiyolto.

Covariance analysis showed no significant difference between male and female fish in either slopes or adjusted means.

Most of fish examined were found to be not more than three years old, although the oldest fish were 5 years old for males and 6 years old for females. The mean radius of each successive otolith ring at each estimated age for males and females is shown in Table 1 for male and Table 2 for female.

From this result it is known that Lee' s phe-

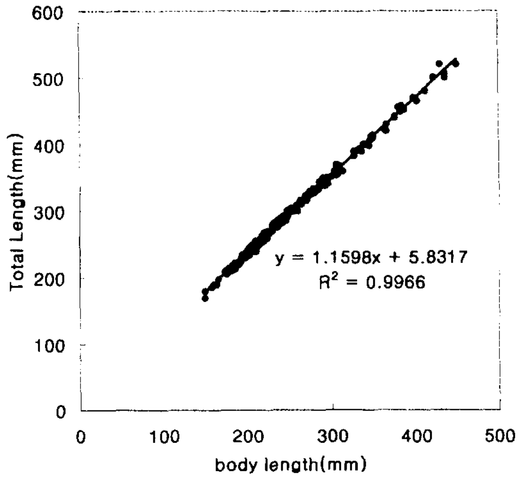

Fig.4. Relationship between body length and total length for mabled sole, *pleuronectes yokohamae*, from Kyongyolbiyolto.

nomenon is not present and therefore the weighed mean radius of each ring was calculated and used to back calcalate fish length. The mean body length back - calculated from otolith measurements at each annulus is shown in Table 3.Von bertalanffy growth equations calculated using back - calculated lengths are :

Male $L_t=313.7[1-\exp\{-0.4342(t+0.0971)\}]$

Female $L_t=458.7[1-\exp\{-0.2368(t+0.1934)\}]$

The body lengths at each estimated age calculated from the above equations are also shown in table 3. It was found that there is a difference in growth between males and females, where the female fish show a higher growth than the male fish for fish greater than 2 years old.(Fig.4)

The relationship between the body length and body weight is shown in Fig.6. Covariance analysis showed no significant difference between male and female fish in either slopes and adjusted means. therefore, the data were pooled and the relationship between the body length(L, mm) and body weight(W, g) estimated as follows :

$W=2L^{3.0163}\times 10^{-5}$ $(r^2=0.9473)$

Table 1. Mean otolith ring radii(±SD) at estimated age for male mabled sole, *pleuronectes yokohamae* in Kyongyolbiyolto, Korea

Estim ated age	N*	Mean otolith ring radii in mm				
		r_1	r_2	r_3	r_4	r_5
1	33	1.35±0.23				
2	33	1.40±0.70	2.19±0.22			
3	3	1.40±0.36	2.10±0.24	2.82±0.09		
4	2	1.50±0.30	2.20±0.12	2.70±0.11	3.01±0.10	
5	1	1.45	2.08	2.62	3.0	3.21
weighted		1.38±0.20	2.14±0.22	2.71±0.12	3.01±0.09	3.21
mean N*		72	39	6	3	1

N*, number of fish examined.

Table 2. Mean otolith ring radii(±SD) at estimated age for female mabled sole, *pleuronectes yokohamae*, in Kyongyolbiyolto, Korea

Estim ated age	N*	Mean otolith ring radii in mm					
		r_1	r_2	r_3	r_4	r_5	r_6
1	33	1.65±0.29					
2	72	1.54±0.25	2.29±0.32				
3	50	1.53±0.16	2.33±0.30	3.10±0.29			
4	13	1.70±0.20	2.48±0.25	3.07±0.25	3.55±0.32		
5	10	1.65±0.26	2.46±0.25	3.13±0.28	3.71±0.36	4.15±0.41	
6	6	1.55±0.18	2.35±0.23	2.95±0.26	3.41±0.31	3.79±0.33	4.23±0.34
weighted		1.60±0.26	2.33±0.31	3.09±0.29	3.58±0.35	4.00±0.43	4.23±0.34
mean N*		184	151	79	29	16	6

N*, number of fish examined.

table 3. Mean back calculated body lengths(mm) at estimated age and these predicted using von Bertaranffy equation for mabled sole, *pleuronectes yokohamae* in Kyongyolbiyolto.

Estimated age	back-calculated from radius of otolith ring		Predicted using von bertalanffy growth equation	
	Male	Female	Male	Female
1	118.4	119.2	118.9	112.9
2	185.0	182.4	187.5	185.8
3	235.0	248.3	231.9	243.4
4	261.3	290.7	260.7	288.8
5	278.8	327.0	279.4	324.6
6	346.9	352.9		

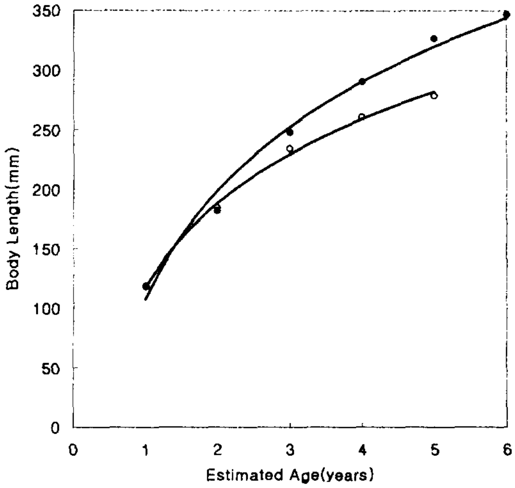

Fig.5. von bertalanffy growth curve for male and female mabled sole, *pleuronectes yokohamae*, from Kyongyolbiyolto.The data points(○ : male, ● : female) are back calculated body length at estimated age.

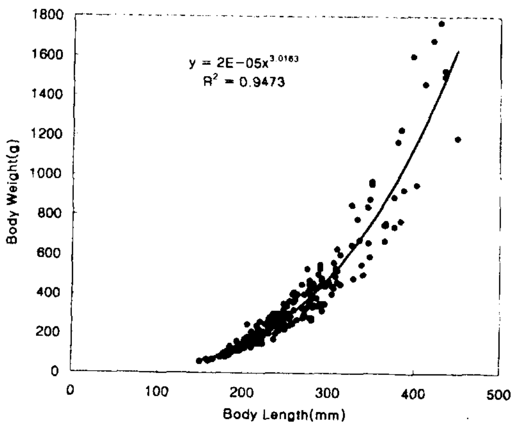

Fig.6. Relationship between body length and body weight of mabled sole, pleuronectes yokohamae, from Kyongyolbiyolto.

The von Bertalanffy growth equations for body weight are as follows :

Male

Wt=678[1 − exp{ − 0.4342(t+0.0971)}]3.0163

Female

Wt=2133[1 − exp{ − 0.2368(t+0.1934)}]3.0163

The age and growth of the fish were estimated precisely using well known procedures. However, the author believe it is important to undertake further validation studies to assess the accuracy of age determination.

Fish in approaches to Kyongyolbiyolto of the Yellow sea, Korea have a larger L_∞ and a larger length at each age for both male and female fish than those in Tokyo Bay[3,4] and Suo − nada of Seto Inland sea[2] In Kyongyolbiyolto L_∞ was 313.7 mm and 458.7 mm for male and female fish, respectively, while corresponding values for Tokyo bay were 255.7 mm and 376.9 mm. In Ise bay[7], the oldest age for male and female fish was 5 and 6, respectively, as in Kyongyolbiyolto.

The author found it difficult to compare my results with those from Ise Bay[7] due to the difference in the procedure of the growth estimation.

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