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Growth of the chub mackerel *Scomber japonicus* (Pisces: Scombridae) off the Canary Islands*

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SUMMARY: Growth of the chub mackerel off the Canary Islands was studied using a back-calculation method based on the relationship between the otolith radius and the length of the fish. Otoliths showed clear growth rings. Two rings, one opaque and one hyaline, were laid down each year on the otoliths. The opaque zone was formed from March to September and the hyaline one during the remaining months of the year. The otolith radius-total length of the fish relationship was described by the equation: $TL=83.333\ OR^{1.410}$. The back-calculated mean lengths ranged from 192 mm at the end of year 1 to 411 mm at the end of year 7. The parameters of the von Bertalanffy growth equation were: L_∞=492 mm, and K=0.21 yr^{-1}.

Key words: Chub mackerel, *Scomber japonicus*, growth, back-calculation, Canary Islands.

RESUMEN: CRECIMIENTO DE LA CABALLA *SCOMBER JAPONICUS* (PISCES: SCOMBRIDAE) EN LAS ISLAS CANARIAS. – Se estudió el crecimiento de la caballa de las Islas Canarias utilizando un método de retrocálculo basado en la relación que existe entre el radio del otolito y la talla del pez. Los anillos de crecimiento fueron observados con claridad en los otolitos. Cada año se forman dos anillos en los otolitos, uno opaco y otro hialino. El anillo opaco se forma entre marzo y septiembre, y el hialino durante los restantes meses del año. La relación entre el radio del otolito y la longitud total del pez está descrita por la ecuación: $TL=83.333\ OR^{1.410}$. Las longitudes medias retrocalculadas oscilaron entre los 192 mm del primer año y los 411 mm del séptimo. Los parámetros de la ecuación de crecimiento de von Bertalanffy obtenidos fueron: L_∞=492 mm y K=0.21 $año^{-1}$.

Palabras clave: Caballa, *Scomber japonicus*, crecimiento, retrocálculo, Islas Canarias.

INTRODUCTION

The chub mackerel (*Scomber japonicus* Houttuyn, 1782) is a cosmopolitan species, inhabiting the warm and temperate transition waters of the Atlantic, Indian, and Pacific oceans and adjacent seas. This fish is a primarily coastal pelagic species, and to a lesser extent epipelagic or mesopelagic over the continental slope, occurring from the surface to about 250 or 300 m depth (COLLETTE and NAUEN, 1983; COLLETTE, 1986).

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In the Canary Islands, the chub mackerel supports an important commercial fishery, but there is little information on its life-history in this area. LOZANO (1978) reported on taxonomy, anatomy and biometry; DELGADO de MOLINA *et al.* (1983) addressed length composition and reproduction; and CASTRO (1991) studied feeding habits.

The present paper deals with the growth of the chub mackerel caught off the Canary Islands using a back-calculation method based on the relationship between the otolith radius and the length of the fish, in an attempt to provide more information of this species in the area.

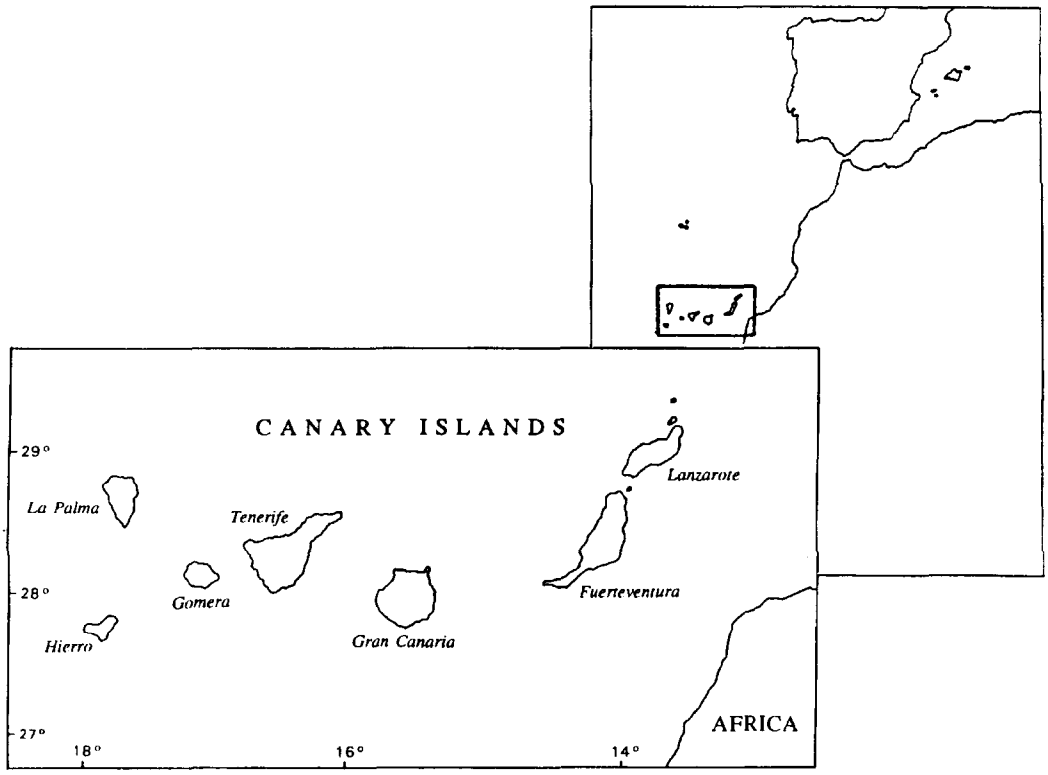

Fig. 1. – Map of the Canary Islands.

MATERIAL AND METHODS

Samples of chub mackerel, totalling 658 specimens, were obtained fortnightly from commercial catches of the artisanal fleet at different fishing ports of the Canary Islands (Fig. 1) between March 1988 and July 1990. All fish were caught by purse-seine nets around the islands.

Analysis of the samples was always done immediately after landing. The total length of the fish was measured to the nearest mm and the otoliths (*sagittae*) were removed, cleaned and stored in labelled vials.

Whole otoliths were placed in a blackened-bottom watch glass containing water and were viewed, concave side up, under the reflected light of a stereoscopic microscope (18X). After counting the number of rings, the otolith radius (the distance from the focus to the posterior edge) and the distance from the focus to the distal edge of each annulus along the radius were recorded. The measurements were determined using a micrometric ocular (1 micrometric unit = 0.0645 mm).

In order to determine if one hyaline and one opaque ring were formed each year, the edges of the otoliths, collected on a monthly basis during the sampling period, were examined (MORALES-NIN, 1987). Thereafter, the relationship between the otolith radius (OR) and the total length of the fish (TL) was established. Various equations (linear, power, exponential and logarithmic) were examined to choose the one which best fitted the data. For this choice the criterion of the smaller mean square error (MSE) between observed and calculated length was used. The relationship obtained was used to back-calculate total lengths at earlier ages using the methods recommended by BAGENAL and TESCH (1978) and FRANCIS (1990). The von Bertalanffy growth curve was determined by means of a Marquardt's algorithm for non linear least squares parameter estimation (PRAGER *et al.*, 1987) from the back-calculated mean length at age.

RESULTS

Chub mackerel otoliths are thin and show clear growth rings. Of the total otoliths examined, 83.3% were readable and used in the growth study. Under the reading conditions, hyaline zones appeared as dark bands whereas opaque zones were white. Both were concentric to the outer edge of the otolith and

were more clearly visible in the region posterior to the otolith centre. No significant difference in otolith radius was found between left and right otoliths (*t*-test, P>0.05).

The otoliths showed a seasonal variation in the formation of hyaline and opaque zones in all years examined (Fig. 2). Opaque and hyaline edges were noted in all the months, but the general pattern indicated that two rings, one opaque and one hyaline, were deposited during the period of one year. The opaque zone was formed between March and September and the hyaline one during the remaining months of the year.

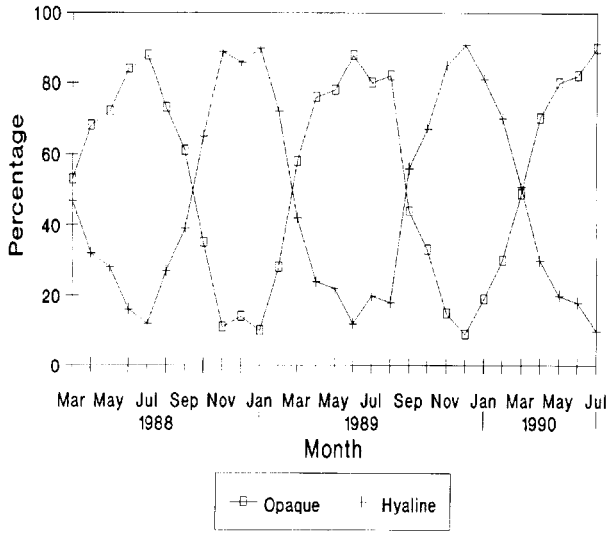

Fig. 2. – Mean monthly percentage of otoliths of *S. japonicus* off the Canary Islands with opaque and hyaline edges.

Having established the fact that formation of the rings was regular and the otoliths could, therefore, be used to determine growth, the relationship between otolith radius and fish length was established. The regressions were estimated separately for males and females. Coefficient of correlation, regression coefficient and mean square error indicated that the power function was the one which best fitted the data. The slopes of the total length and otolith radius regressions did not differ between sexes (ANCOVA, P>0.05), so data were pooled. The relation is given by the equation (Fig. 3):

$$TL = 83.333\ OR^{1.410}$$

Fish length and otolith size were closely correlated (r^2= 0.98). The proportionality between fish growth and otolith size increase allowed use of back-calculation for determining the growth.

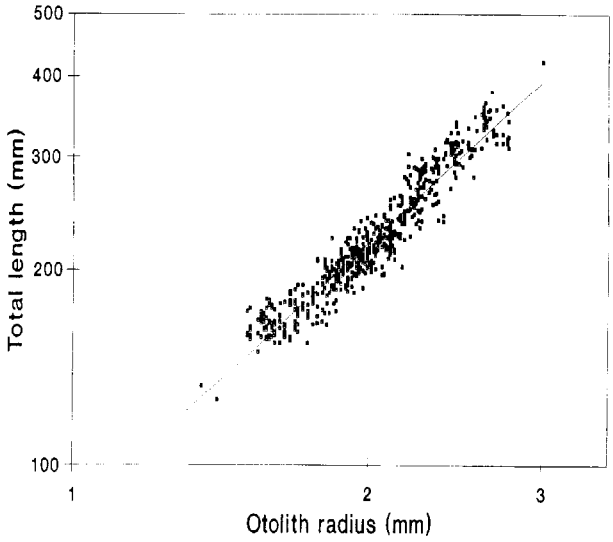

Fig. 3. – Relationship between the otolith radius and the total body length (both in logarithms) of *S. japonicus* off the Canary Islands.

The back-calculated total lengths at the end of each year of life by age group are given for all fish in Table 1. There was no indication of Rosa Lee's phenomenon. Chub mackerels aged 1 to 7 years were present in the samples. Age-1 fish averaged 192 mm, age-2 fish 252 mm, age-3 fish 298 mm, age-4 fish 338 mm, age-5 fish 358, age-6 fish 391 mm, and age-7 fish 411 mm. The annual growth average increments tended to decrease for age groups 1 to 5. From this age group on, it was less evident, probably due to small number of chub mackerels in older age groups.

The von Bertalanffy growth curve fitted to back-calculated mean length at age is shown in Fig. 4. The

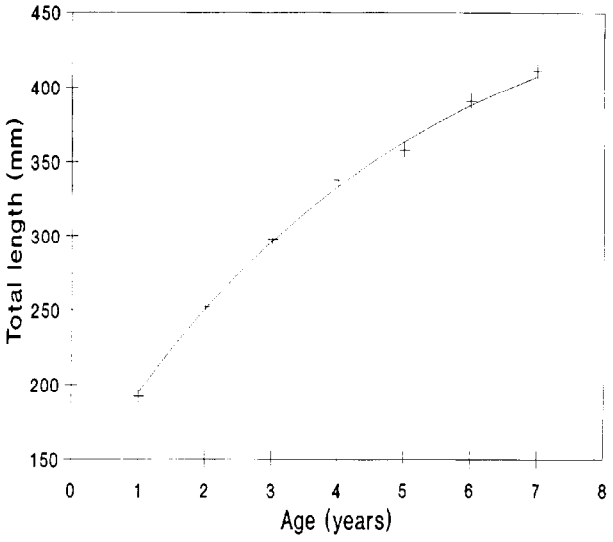

Fig. 4. – The von Bertalanffy growth curve of *S. japonicus* off the Canary Islands obtained from back-calculated mean length at age.

TABLE 1. – Back-calculated total lengths at the end of each year of life by age group for *S. japonicus* off the Canary Islands.

Age	Number	Mean length at capture	Mean back-calculated lengths at the end of year						
			1	2	3	4	5	6	7
1	345	212	189						
2	107	268	196	250					
3	55	312	197	254	297				
4	24	349	201	257	301	340			
5	11	362	199	254	299	334	357		
6	4	398	198	253	298	337	358	391	
7	2	421	210	266	305	338	366	392	411
Mean			192	252	298	338	358	391	411
Average increments			192	60	45	40	20	33	20
Number			548	203	96	41	17	005	2

growth parameters were: L_∞=492 mm, K=0.21 yr^{-1}, and t_0=-1.40 yr (r^2=0.97). Differences between the observed and the estimated mean length at age values were negligible.

DISCUSSION

The alternative pattern of hyaline and opaque rings was easily distinguishable on the otoliths of the chub mackerel off the Canary Islands. Two rings, one opaque and one hyaline, were laid down each year on the otoliths. The opaque zone was mainly formed during the spring and summer months, when the temperature of the sea is higher and the food is more abundant, and the hyaline one was formed during the autumn and winter months, when the spawning of this species occurs (LORENZO, 1992).

It was judged valid to permit the use of measurements to previously formed marks to back-calculate the growth history (BAGENAL and TESCH, 1978; BARTLETT *et al.*, 1984; CAMPANA, 1990; FRANCIS, 1990), both because the rings formation was regular and, therefore, the otoliths could be used for age determination and because the fish length and otolith size were closely correlated. Furthermore, there was no indication of Rosa Lee's phenomenon in which computed lengths at a given age tend to be smaller when derived from measurements on older fish.

The chub mackerel off the Canary Islands is a moderately long-lived species. The oldest fish was estimated to be 7 years old. Growth is relatively rapid during the first year of life, attaining approximately 40% of their maximum length. After the completion of the first year, the annual growth rate drops rapidly, a phenomenon which could be related to sexual maturity. In this area, all chub mackerels are mature at a length of approximately 250 mm total length (LORENZO, 1992), that is when they are in their second year of life. Hence, energy is probably diverted to reproduction, resulting in less energy available for somatic growth.

The growth parameters obtained from the back-calculated mean length at age were reasonable. The theoretical maximum length value (492 mm) was close to the size of the largest fish sampled (470 mm) and the growth coefficient value (0.21) indicated relatively rapid attainment of maximum size.

The values of the growth parameters of the chub mackerel off the Canary Islands were very similar to those reported for the same species in Mauritania, L_∞=488 mm and k=0.20 yr^{-1} (FAO, 1983), and Morocco, L_∞=512 mm and k=0.20 yr^{-1} (MARTINS and SERRANO GORDO, 1984). Undoubtedly, these three localities of Norhwest Africa are very close and have similar oceanographic conditions (MOLINA and LAATZEN, 1986, 1989) and, therefore, the growth activity of the stocks could be similar. It is even possible that genetic relationships among stocks of those neighbouring localities exist.

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REFERENCES

BAGENAL, T.B. and F.W. TESCH. – 1978. Age and growth. In: T.B. Bagenal (ed.): *Methods for Assessment of Fish Population in Fresh Waters*, pp. 101-136. Blackwell Scientific Publications, Oxford.

BARTLETT, J.R., P.F. RANDERSON, R. WILLIAMS and D.M. ELLIS. – 1984. The use of analysis of covariance in the back-calculation of growth in fish. *J. Fish Biol.*, 24: 201-213.

CAMPANA, S.E. – 1990. How reliable are growth back-calculations based on otoliths?. *Can. J. Fish. Aquat. Sci.*, 47: 2219-2227.

CASTRO, J.J. – 1991. *Ecología trófica de la caballa* (Scomber japonicus *Houttuyn, 1782*) *en aguas del Archipiélago Canario*. Ph. D. thesis, Univ. Las Palmas de Gran Canaria, 313 pp.

COLLETTE, B.B. – 1986. Scombridae. In: P.J.P. Whitehead, M.-L.Bauchot, J.-C. HUREAU, J. NIELSEN and E. TORTONESE (eds.): *Fishes of the North-eastern Atlantic and the Mediterranean*, pp. 981-997. UNESCO, Paris.

COLLETTE, B.B. and C. NAUEN. – 1983. FAO species catalogue. Scombrids of the world. An annotated and illustrated catalogue of tunas, mackerels, bonitos, and related species known to date. *FAO Fish. Synop.*, 125 (2), 137 pp.

DELGADO DE MOLINA, A., M.T.G. SANTAMARÍA, E. RODRÍGUEZ and L.J. LÓPEZ. – 1983. *Plan regional de evaluación de recursos pesqueros. Provincia de Santa Cruz de Tenerife. Pelágicos costeros*. Rep., Gobierno de Canarias, 148 pp.

FAO. – 1983. Rapport du groupe de travail *ad hoc* sur les chinchards et les maquereaux de la zone nord du COPACE. *COPACE/PACE Séries*, 83/27, 191 pp.

FRANCIS, R.I. – 1990. Back-calculation of fish length: a critical review. *J. Fish Biol.*, 36: 883-902.

LORENZO, J.M. – 1992. *Crecimiento de la caballa* Scomber japonicus *Houttuyn, 1782 en aguas del Archipiélago Canario*. Ph. D. thesis, Univ. Las Palmas de Gran Canaria, 199 pp.

LOZANO, G. – 1978. *Estudio biométrico, morfológico, anatómico e inmunotaxonómico del estornino* (S. colias *Gmelin, 1789*) *del Banco Pesquero Sahariano y del Archipiélago Canario*. Ph. D. thesis, Univ. La Laguna, 554 pp.

MARTINS, M.M. and L. SERRANO GORDO. – 1984. On the comparison of spanish mackerel (*Scomber japonicus* Houttuyn, 1782) from Gorringe Bank and Peniche. *ICES C.M.*, 1984/H:50, 14 pp.

MOLINA, R. and F.L. LAATZEN. – 1986. Hidrología en la región comprendida entre las Islas Canarias orientales, Marruecos y las Islas Madeira. Campaña 'Norcanarias I'. *Bol. Inst. Esp. Oceanogr.*, 3(3): 1-16.

MOLINA, R. and F.L. LAATZEN. – 1989. Hidrografía en la región canaria. Campaña 'Canarias I'. *Bol. Inst. Esp. Oceanogr.*, 5(2): 71-86.

MORALES-NIN, B. – 1987. Métodos de determinación de la edad en los osteíctios en base a estructuras de crecimiento. *Inf. Téc. Inst. Inv. Pesq.*, 143, 30 pp.

PRAGER, M.H., S.B. SAILA and C.W. RECKSIEK. – 1987. FISHPARM: A microcomputer program for parameter estimation of nonlinear models in fishery science. *Old Dominion University Tech. Rep.*, 87-10: 1-37.