Determination of age and growth of the striped seabream *Lithognathus mormyrus* (Sparidae) in the Canarian archipelago by otolith readings and backcalculation*

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SUMMARY: The age and growth of the striped seabream *Lithognathus mormyrus* caught off the Canary Islands (central-east Atlantic) from January to December 1999 were studied. A total of 496 individuals, ranging in size between 113 and 350 mm total length, were examined. Otoliths clearly showed the ring pattern common to teleost fishes. One year’s growth was made up of one opaque and one translucent ring. The opaque ring was deposited during the summer months and the translucent one during the winter months. Fish aged 0-8 years old were found. The von Bertalanffy growth parameters for all fish were: $L_\infty=427$ mm, $k=0.19$ year$^{-1}$, and $t_0=1.46$ year. The otolith readings for estimating age and growth were confirmed by using the backcalculation method.

Key words: *Lithognathus mormyrus*, age, growth, otolith readings, backcalculation, Canary Islands.

INTRODUCTION

The striped seabream *Lithognathus mormyrus* (Linnaeus, 1758) is a marine fish belonging to the Sparidae family. It is a demersal species living in groups over various types of sea bottoms, especially rocky, sand and seagrass beds, at depths ranging from 0 to 150 m. This species is distributed in the eastern Atlantic and in the western Indian Ocean. In the eastern Atlantic, it occurs from the Bay of Biscay to the Cape of Good Hope, and around the Canaries and Cape Verde. It is also present in the Mediterranean, Black, Azov and Red seas. In the western Indian Ocean, it occurs on the Natal coast (Smith and Smith, 1986; Bauchot and Hureau, 1990; Harmelin-Vivien *et al.*, 1995).

In the Canary Islands, the striped seabream is one of the main target species of the demersal small-scale fishery (Pajuelo, 1997). This species is caught at depths ranging between 10 and 100 m with traps. It is captured all year round with seasonal differences in landings. Catches of striped seabream have been declining in this area during the last few years.

Despite its fishing importance, the striped seabream has never been the object of investigation in the Canary Islands. The present work investigated
the age and growth of the striped seabream off the Canary Islands to obtain growth estimates, which are important input parameters for stock assessment techniques and will provide an insight into the life-history of this species. The importance of this study is enhanced by the fact that only three articles on the age and growth of the species have been published (Suau, 1970; Kraljević et al., 1995, 1996).

MATERIALS AND METHODS

A total of 496 individuals of striped seabream were collected from commercial catches of the artisanal fleet from January to December 1999. Fish were caught with traps deployed on the bottom at depths of 10-90 m off Gran Canaria (Canary Islands).

For each fish, the total length (TL, mm) was measured, the sex was determined (male, female or intersexual), and the sagittal otoliths were removed. Age was determined by counting the annual growth rings on the otoliths. Whole otoliths were placed in glycerin and examined under a compound microscope (15 x) with reflected light against a dark background. Counts for each otolith were performed three times. Readings for given otoliths were accepted only when two agreed. An index of average percent error was used to compare the accuracy of the determination (Beamish and Fournier, 1981). Ageing was validated indirectly by means of the analysis of the evolution of the mean monthly marginal increments. The marginal increment (MI, 0.01 mm) was measured as the distance from the outer margin of the outermost translucent ring to the periphery of the otolith. Measurements were always made along the longest axis of the piece. Once the annual periodicity of the rings was confirmed, individuals were assigned to the corresponding age classes beginning with the date of capture and considering 1 September as the birthdate. The von Bertalanffy growth curve was fitted to the data of the resulting age-length key by means of Marquardt’s algorithm for non-linear least squares parameter estimation (Saila et al., 1988).

The backcalculation method was applied as an independent means of validating the otolith-based age determinations (Morales-Nin, 1989). Backcalculation analysis was undertaken using a method described by Francis (1990). The radius of the otolith at capture (R, 0.01 mm), i.e. the distance from the centre of the otolith to the periphery, were measured. Measurements were always made along the longest axis of the otolith. The size of an individual when the ith band was laid down (SI, mm) was calculated as SI=(RI/R)bTL, where b is a constant derived from the power function which describes the relationship between the radius of the otolith and the total length of the fish (Francis, 1990). The von Bertalanffy growth curve was fitted to the backcalculated mean length at age by means of Marquardt’s algorithm for non-linear least squares parameter estimation (Saila et al., 1988). The growth parameters obtained for males, females and all individuals were compared statistically by means of Hotelling’s T²-test (Bernard, 1981).

RESULTS

Of the 496 individuals examined, 235 (47.4%) were males, 229 (46.2%) females, and 24 (4.8%) intersexuels. The sex of the remaining 8 (1.6%) individuals could not be identified macroscopically because they were immature and had very thin, translucent gonads.

The size range of the individuals was between 113 and 350 mm total length. Males ranged in size from 201 to 350 mm, females from 199 to 350 mm, and intersexuels from 217 to 323 mm. The length of immature fish was comprised between 113 and 230 mm.

A concentric pattern of translucent and opaque zones was readily distinguishable in the otoliths, and easily interpreted. Of the 496 otoliths examined, 17 (3.4%) were considered unreadable and therefore no age estimates were obtained from them. Of these otoliths, 6 were broken, and 11 had poorly defined growth zones. Of the remaining 479 otoliths, the readings were coincident at least twice in 452 (94.5%) but yielded conflicting ages in 27 (5.5%). The value of the index of average percent error was only 3.1%. Annual marks were equal in both the anterior and lateral otolith fields. Readings were equal in both left and right otoliths.
The evolution of the mean monthly marginal increments in otoliths with one and two translucent zones, three and four translucent zones, and more than four translucent zones is shown in Figure 1. The same temporal variation pattern was recorded for the three cases. The highest values occurred between May and October, peaking during July-August. From November to April the values were low. Based on this, it was assumed that an opaque zone and its adjacent translucent zone were deposited on the otoliths each year. The values of increments on the otoliths decreased with the age of the fish.

Fish aged 0 to 8 year old were recorded (Table 1). Individuals attained over 50% of their maximum observed size during the second year of life. Growth parameters determined for males, females, and all individuals (males, females, immatures and intersexuels) are shown in Table 2. Significant differences in the growth parameters were found between males and females (Hotelling’s $T^2$-test, $T^2=41.13 > T_{0.05,3,425}^2=7.89$). The mean size of males was slightly smaller than the mean size of females at the same age.

Fish total length and otolith radius were closely correlated (Fig. 2). The total length and otolith radius were also estimated for males (LT=

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37.216R^{1.3842}$ and females ($LT=38.022R^{1.397}$) separately. Backcalculated total lengths at the end of each year of life by age group for all individuals are shown in Table 3. There was no indication of Rosa Lee’s phenomenon in which computed sizes at a given age tend to be smaller when derived from measurements on older fish (Francis, 1990). Observed lengths were slightly higher than backcalculated lengths for individual age groups. Growth parameters estimated from the mean backcalculated sizes at age for males, females, and all individuals are presented in Table 2. Significant differences in the growth parameters were found between males and females (Hotelling’s $T^2$-test, $T^2=508.03>T^2_{0.05,3,12}=9.76$).

No significant differences between the growth parameters estimated by reading otoliths and using the backcalculation method were found in males (Hotelling’s $T^2$-test, $T^2=7.08<T^2_{0.05,3,223}=7.93$), females ($T^2=6.97<T^2_{0.05,3,214}=7.93$), and all individuals ($T^2=6.03<T^2_{0.05,3,373}=7.89$).

**DISCUSSION**

In sparid species, age determination has often proved difficult as a consequence of the phenomenon of stacking of growth zones towards the otolith edge, especially in older fish (Buxton and Clarke, 1991, 1992; Smale and Punt, 1991; van der Walt and Beckley, 1997). However, in the striped seabream off the Canary Islands, the translucency of the otoliths allowed age to be determined with...
relative ease. The oldest age estimated in this study
is 8 years and the phenomenon of stacking is not
evident.

Otoliths of the striped seabream of the Canarian
archipelago show the ring pattern common to teleost
fishes. One opaque and one translucent ring are
deposited each year on the otoliths. These rings are
formed owing to alternating periods of fast and slow
growth (Williams and Bedford, 1974). Seasonal
growth cycles might be related to physiological
changes produced by factors such as the temperature
or the food availability (Morales-Nin, 1989). In the
otoliths of the striped seabream off the Canaries, the
opaque rings are formed when the sea temperature
reaches the highest values (24°C, August) and the
food is more abundant, and the translucent ones
when the temperature reaches the lowest values
(18°C, February). The evidence presently available
suggests that a seasonal temperature difference of
6°C might be sufficient to cause ring formation
(Morales-Nin and Ralston, 1990). Similar findings
have been recorded in other studies carried out in the
Canarian archipelago on other sparids, such as
Descabosus, Pagellus acarne, Pagellus erythrinus,
Pagrus pagrus and Spondylisoma cantharus (Pajuelo

The proportionality between fish growth and
otolith size increase allows backcalculation to be
used to determine the growth. The results obtained
by backcalculation were very satisfactory and con-
firmed the estimations of the age and growth of the
striped seabream of the Canary Islands by otolith
readings. Because the ring formation is regular and
therefore the otoliths can be used for age determina-
tion, and because the fish length and otolith size are
closely correlated, it is judged valid to permit the use
of measurements to previously formed marks to
backcalculate the growth history (Bagenal and
Tesch, 1978; Bartlett et al., 1984; Campana, 1990;
Francis, 1990).

The striped seabream off the Canary Islands has
a relatively short life (8 years). Kraljević et al.
(1995, 1996) also found that this species may attain
an age of 8 years in the Adriatic Sea, and Suau
(1970) examined 7-year-old specimens from the
Spanish Mediterranean coast.

In the Canarian archipelago, the striped seabream
grows relatively fast during the first few years of
life, attaining approximately fifty percent of its max-
imum length during the second year. After the sec-
ond year, the annual growth rate drops rapidly, relat-
ed to sexual maturity, since in the studied area indi-
viduals are mature by the second year of life (unpub-
lished data). Hence, energy seems to be diverted to
reproduction (June-December), with less energy
available for somatic growth. The difference in
growth between sexes, with females reaching a
slightly larger length than males at the same age, is
a characteristic of the protandric species such as the
striped seabream (Besseau and Bruslé-Sicard, 1991,
out that the mean size of sex-reversed fish is slight-
ly greater than that of males of the same age. There-
fore, the difference in size between males and
females of the same age cannot be considered as evi-
dence of an intersexual difference in growth rates
because males and females are the same specimens
at different stages of sexual succession and the
largest males in an age group may be the first to
revert.

The growth parameters of the striped seabream
off the Canary Islands are very similar to those
obtained by Suau (1970) and Kraljević et al. (1995,
1996) for L. mormyrus on the Spanish Mediterranean
coast (L∞=332 mm, k=0.275 yr⁻¹) and in the
Adriatic sea (L∞=362 cm, k=0.297 yr⁻¹) respec-
tively. The growth performance index obtained for
the striped seabream of the Canary Islands (θ=4.53)
is very similar to that estimated from the growth para-
eters given by Suau (1970) on the Spanish Mediterranean coast (θ=4.48) and Kraljević et al.

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