# ON THE SEASONAL GROWTH OF COMMON SARDINE (*Strangomera bentincki*) AND ANCHOVY (*Engraulis ringens*) OFF TALCAHUANO, CHILE.

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ABSTRACT: Luis Cubillos[1] and Hugo Arancibia[1]. On the seasonal growth of common sardine (*Strangomera bentincki*) and anchovy (*Engraulis ringens*) off Talcahuano, Chile.

The seasonal growth of common sardine (*Strangomera bentincki* Norman, 1936) and anchovy (*Engraulis ringens* Jenyns, 1842) off Talcahuano (37°S-73°W), Chile, is analized. The growth parameters of the von Bertalanffy growth function, modified for seasonal oscillation in the growth rate, were estimated for both species using the ELEFAN software, from length-frequency data including the period July 1990 to January 1992. The growth parameters estimated for both clupeoid, compare well to those reported by several authors. However, the differences are in the amplitude of growth oscillation, were the growth rate for both species diminishes by 50% during that part of the year when growth is most strongly reduced, which occurs in May for common sardine and in mid-June for anchovy. It is postuled that the reduced growth rate during the winter time of this species, could be related to the spawning time, particularly for the adults, and also to the downwelling period that tends to occur between early April to late August in the area off Talcahuano.

Key words: Clupeoid, length-frequency analysis, somatic growth, Talcahuano (Chile).

RESUMEN: Luis Cubillos[1] y Hugo Arancibia[1]. Crecimiento estacional de sardina común (*Strangomera bentincki*) y anchoveta (*Engraulis ringens*) del área de Talcahuano, Chile.

Se analiza el crecimiento estacional de sardina común (*Strangomera bentincki*) y de anchoveta (*Engraulis ringens*) del área de Talcahuano (37°S-73°W), Chile. Los parámetros del modelo de von Bertalanffy, modificado para describir el crecimiento estacional, fueron estimados para ambas especies a partir de datos de frecuencia de longitudes que cubren el período julio de 1990 a enero de 1992, utilizando el programa ELEFAN. Se obtuvo una alta concordancia en la estimación de los parámetros de ambos clupeiformes con aquellos comunicados por otros autores. Sin embargo, la diferencia está en la amplitud de la oscilación del crecimiento estacional, donde la tasa de crecimiento de ambas especies disminuye en 50%; en mayo, para la sardina común, y mediados de junio, para la anchoveta. Se postula que el reducido crecimiento invernal de estas especies podría estar relacionado con la época de desove, particularmente para los adultos, y también al período de relajación de los eventos de surgencia, que tiende a ocurrir entre abril y agosto en el área de estudio.

Palabras claves: Clupeiformes, análisis de frecuencia de longitudes, crecimiento corporal, Talcahuano (Chile).

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## INTRODUCTION

Polar and temperate fishes, and to a lesser extent subtropical and tropical fishes, generally display seasonal growth. This is also true for tropical fishes, since winter-summer temperature differences as small as 2°C are sufficient to include detectable seasonal growth oscillations (Pauly & Davis 1981). In fact, growth of fishes is faster in summer time when temperatures are higher, and lower in winter time when temperature are lower (Pauly 1991).

However, it must be mentioned that another causes, for instance other than temperature might be causing the seasonal growth oscillation of fishes. This paper analyses the seasonal growth of two clupeoid species: the common sardine (*Strangomera bentincki* Norman, 1936) and the anchovy (*Engraulis ringens* Jenyns, 1842), which are commercially important fishes in the area off Talcahuano (37°S-73°W), Chile. The objectives are: 1) to estimate the seasonal growth parameters, 2) to compare this results with previously growth data found in the literature, and 3) to identify possible causes related to the seasonal growth of this species in the area off Talcahuano.

## MATERIALS AND METHODS

Biological data, such as total length (TL in cm), total and eviscerated weigth (g), weigth of gonads (g), and others are daily sampled from the fishery, for both the common sardine and the anchovy, by personnel of the Instituto de Investigación Pesquera Octava Región (Fisheries Research Institut of the 8th Region, Chile). Monthly length-frequency data from the fishery were used in this study, which cover the period between July 1990 to January 1992.

The first version of the ELEFAN software (Gayanilo *et al.* 1988) was used to estimate the growth parameters of the von Bertalanffy growth formula, modified for seasonal oscillation in the growth rate by Pauly & Gaschütz (1979), which has the form

$$L_t = L_\infty [1 - \exp\{-K(t - t_0) + \frac{CK}{2\pi} \sin(2\pi(t-t_s))\}] \quad ...1)$$

where $L_t$ is the length at age t, $L_\infty$ the asymptotic length, K a growth coefficient, $t_0$ the (hypothetical) age at which length would be zero if the adult fish growth curve could be extrapoled back to the origin, C is a dimensionless constant expressing the amplitude of the growth oscillations and $t_s$ is the time (with respect to t = 0) at the beginning of a growth oscillation of one year period. For practical purposes the estimation of $t_s$ is replaced by the estimation of a winter point (WP), defined as

$$WP = t_s + 0.5 \quad ...2)$$

which expresses the time during which growth is slowest (as a fraction of the year). It must be mentioned that when the C constant reaches C = 0, equation (1) reverts to the standard von Bertalanffy growth formula, i.e.,

$$L_t = L_\infty[1 - \exp(-K(t-t_0))] \quad ...3)$$

On the other hand, it must be mentioned that the ELEFAN programs, are based on length-frequency data (rather than length-at-age data), hence for the estimation non require estimates of $t_0$ ; all "ages" used by the program are relative ages (relative to $t_0$).

In order to compare the estimates of growth parameters with results of other authors, the empirical equation of Pauly & Munro (1984) was used:

$$\Phi' = \log_{10} K + 2\log_{10} L\infty \qquad ...4)$$

where K is the growth coefficient ($yr^{-1}$) and $L\infty$ is the asymptotic length (TL, cm). The $\Phi'$ is an index of "growth performance" which for a family, a genus or a species, is normally distributed, with the coefficient of variation decreasing from the family to the species level (Pauly & Munro 1984).

Additional data used are the mean gonadosomatic index (GSI) for females of common sardine and anchovy to determine the season of the spawning. The GSI was calculated by

$$GSI = \{GW/(TW - W)\} 100$$

where GW is the gonad weigth, TW and W represents total weigth and the eviscerated weigth of fishes, respectively.

RESULTS AND DISCUSSION

The growth for both clupeoid species in the area off Talcahuano, is described by the following parameters: $L\infty$ = 19.7 cm, K = 0.69 $yr^{-1}$, C = 0.50, and WP = 0.44 for the common sardine; and $L\infty$ = 20.5 cm, K = 0.75 $yr^{-1}$, C = 0.48, and WP = 0.55 for the anchovy (Fig. 1 and 2).

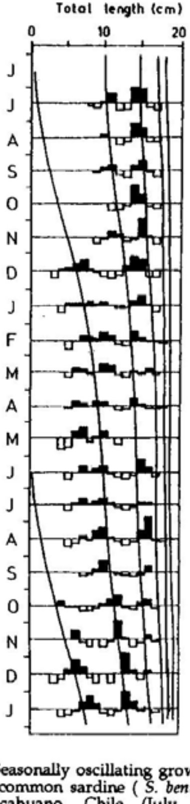


Figure 1. Seasonally oscillating growth curve of common sardine ( *S. bentincki*) off Talcahuano, Chile (July 1990 to January 1992). "Restructured" length-frequency data, as computed and used internally by ELEFAN I program, were black histograms represent frequencies that are part of "peaks" (modes), and white histograms represent "troughs" separating peaks.

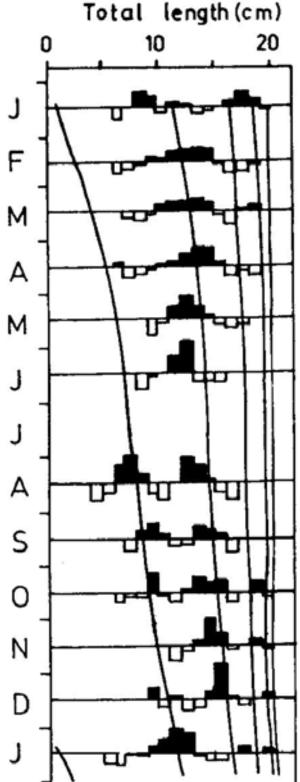


Figure 2. Seasonally oscillating growth curve of anchovy (*E. ringens*) off Talcahuano, Chile (January 1991 to January 1992; see Fig. 1 for details).

Our estimated values of L∞ and K compare well to those reported by several authors (Table 1), especially Arrizaga (1981) for common sardine, and Aguayo (1976) and Peña (1991) for anchovy off northern Chile. Moreover, the anchovy growth parameters reported in this study are closely related to that of Palomares *et al*. (1987) and Pauly & Palomares (1989).

In general, the growth performance index (Φ') of Pauly & Munro (1984), shows that the differences in the growth parameters estimated here are small by comparing several sources of information (see Table 1). However, the differences are not in the standard growth parameters, L∞ and K, rather are in the amplitude of growth oscillation expressed by the parameter C. In fact, Pauly & Tsukayama (1983) and subsequently Palomares *et al*. (1987), estimated for the Peruvian anchovy a mean value of C close to 0.3, which implies that the growth rate diminishes by 30% during that part of the year when growth is most strongly reduced (around September in Peruvian waters).

As migth be seen, the amplitude of growth oscillation expressed by C = 0.5 for both the common sardine and the anchovy off Talcahuano corresponds to a 50% reduction of the growth rate. Furthermore, in the area off Talcahuano, the sea temperature shows a seasonal variation (Fonseca 1987) where the "summer-winter" differences reach 3 to 4°C, which could be sufficient to generate the observed value of C = 0.5. In fact, Pauly (1985) found a close relationship between the amplitude of seasonal growth oscillation (C) in fishes,

Table 1. Growth parameters of *S. bentincki* and *E. ringens*, as reported from various authors.

| AREA | METHOD | L∞ (TL,cm) | K ($yr^{-1}$) | Φ'[a] | SOURCE |
|---|---|---|---|---|---|
| a) *S. bentincki*: | | | | | |
| Chile: | | | | | |
| Coquimbo | otoliths | 16.9 | 0.52 | 2.17 | Aguayo & Soto (1978) |
| Talcahuano | otoliths | 17.9 | 0.45 | 2.16 | Aguayo & Soto (1978) |
| Talcahuano | MPA[b] | 19.2 | 0.71 | 2.42 | Arrizaga (1981) |
| Talcahuano | ELEFAN I | 19.7 | 0.68 | 2.42 | This study |
| b) *E. ringens*: | | | | | |
| Peru : | | | | | |
| Chimbote, Callao | MPA | 15.0 | 1.70 | 2.58 | Saetersdal & Valdivia (1964) |
| Northern Peru | ELEFAN I | 20.6 | 1.26 | 2.70 | Pauly & Tsukayama (1983)[c] |
| Northern Peru | ELEFAN I | 20.5 | 0.88 | 2.57 | Palomares *et al*. (1987)[c] |
| Northern Peru | ELEFAN I | 20.3 | 0.80 | 2.52 | Pauly & Palomares (1989) |
| Southern Peru | otoliths | 16.7 | 1.82 | 2.70 | Morales-Nin (1989) |
| Chile: | | | | | |
| Arica, Iquique | otoliths | 16.9 | 1.60 | 2.66 | Simpson & Buzeta (1967) |
| Arica, Iquique | otoliths | 19.0 | 1.11 | 2.60 | Simpson & Buzeta (1967) |
| Arica, Iquique | otoliths | 19.0 | 0.73 | 2.42 | Aguayo (1976) |
| Iquique | ELEFAN I | 20.0 | 0.78 | 2.49 | Peña (1991) |
| Talcahuano | ELEFAN I | 20.5 | 0.75 | 2.50 | This study |

a $\Phi' = \log_{10} K + 2\log_{10} L_\infty$ (Pauly & Munro 1984).
b = Modal Progression Analysis
c = Parameters presented here are means of various values in original papers.

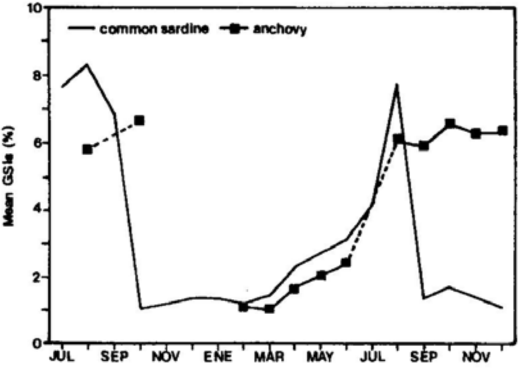


Figure 3. Mean monthly gonadosomatic indices for females of common sardine (*S. bentincki*) and for females of anchovy (*E. ringens*) off Talcahuano, Chile.

crustaceans and molluscs and the differences between the mean monthly summer and the mean monthly winter temperature of their habitats.

The winter point (WP = 0.44) refers to a season of lowest growth around May for common sardine, while, the season of lowest growth occurs in mid-June (WP = 0.55) for anchovy. This is a small diference and it could be related to the spawning season, which is located between July to September for the common sardine and between August to December for the anchovy (Fig. 3). Likely, in the spawning condition the fishes would send more energy to gamets production than to somatic growth, though this argument is not valid for the young fishes less to 11 cm TL, which are not sexually mature.

However, the existence of seasonal growth oscillations in common sardine and anchovy can also be related to the major upwelling period, and hence to increased food availability. In fact, monthly mean upwelling index off Talcahuano shows that the main upwelling season occur between early September to late March, while that downwelling occurs between early April to late August (Arcos & Navarro 1986).

From that point of view, it sounds reasonable to assume that the clupeoid fishes migth grow in length rapidly during the major upwelling period when there is sufficient food for feeders such as small clupeids.

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