SEASONAL DIFFERENCES IN THE GROWTH OF PILCHARD *SARDINA PILCHARDUS* LARVAE IN THE CATALAN SEA (NW MEDITERRANEAN).

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Abstract

The long- and short-term growth of 3.5 to 16 mm standard length *Sardina pilchardus* larvae was compared between two cruises conducted in autumn and winter in the Catalan Sea (NW Mediterranean). Growth was significantly higher in November than February, as assessed by muscle fibre recruitment and RNA/DNA ratios. Otolith age-length relationships suggested a similar trend. Sea temperature is regarded as a plausible explanatory factor for the differences in growth.

Keywords: Sardina pilchardus, larvae, growth, NW Mediterranean, temperature

Peak spawning of *Sardina pilchardus* in NW Mediterranean occurs in the unstable autumn-winter season (1). Although variations in environmental factors are known to affect both distribution and abundance of pilchard larvae in this area (2, 3), there is little information on the possible effects of environmental conditions on larval biological parameters and their possible relationship to survival.

The objective of the present study was to test the hypothesis that long- or short-term growth does not differ between two seasons (autumn and winter) characterised by marked differences in mean water temperature and comparable mean concentrations of potential food items.

Two cruises were conducted, in the Catalan Sea in November 1998 and February 1999. Long-term growth was estimated by (a) age-length relationships, and (b) the variation of fast muscle fibre numbers. The rationale for the latter method, seldom used in field studies, is that small differences in environmental variables (particularly temperature) during egg and early larval stages are known to alter muscle hyperplasia and/or hypertrophy, thus modifying larval growth (4, 5). Short-term growth was assessed through RNA/DNA ratios, based on the method described by Deniel (6).

Mean sea surface temperature in November 1998 (Mean=19.2°C, SE=0.007) was about 6°C higher than in February (Mean=12.9°C, SE=0.07)). The analysed larvae were collected from areas where the median values of copepod nauplii were between 4.4 nauplii l^{-1} (November) and 6.3 nauplii l^{-1} (February). The vertical profiles of mean temperature in the depth-range inhabited by pilchard larvae (2) showed a strong thermocline in November. It is believed that relative temperature differences between cruises were maintained during all developmental history of the larvae (based on AVHRR data: 7).

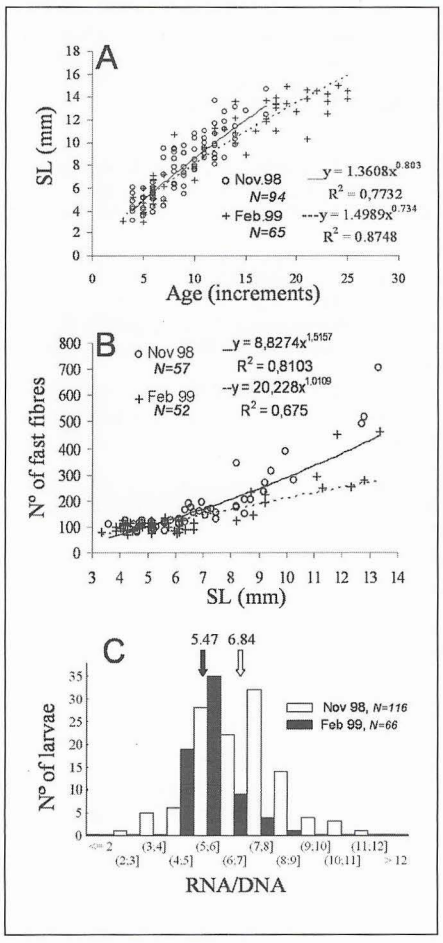

Fig. 1. Comparison of long and short-term growth of *Sardina pilchardus* larvae in November 1998 and February 1999. (A) Relationship between estimated age and standard length. (B) Relationship between standard length and total number of fast fibres, per transverse section of myotomal muscle. (C) Frequency distributions of RNA/DNA ratio values. Arrows indicate medians.

Long-term measures of growth indicated that pilchard larvae exhibited higher growth rates in November than in February. For both otolith and muscle-derived data, the slopes of the regression lines were compared between periods by testing the significance of the interaction term in a crossed two-way ANOVA with covariates (age or length) performed on appropriatedly standardised variables for GLM analysis. Although no significant difference in the slopes could be established between cruises for the age-length data at an α=0.05, the qualitative observation of the data (Fig 1A) suggest that November larvae tended to be younger (faster-growing) for a given length (Fig. 1 A). This hypothesis is strengthened by the significantly higher recruitment of fast muscle fibres in November respect to February (Fig. 1B), as shown by the significant interaction term in the ANOVA (interaction term: "year x total length" length used as a covariate, $F_{1,106}$=13.43, p<0.001).

The median RNA/DNA ratio in November was also significantly (Mann-Whitney W=4174, p<0.0001) higher than in February, which reinforces the results of the long-term growth analyses (Fig. 1C).

It is concluded that the 6°C difference in temperature between the two periods could account for the observed higher growth estimates in November than in February. However, the effect of changes in species composition of potential prey in February, related to the long persistence of a mesoscale eddy near the study area (7), cannot be ruled out. The slower growth of winter-spawned larvae could have negative consequences for survival to juvenile stages. Individuals would remain longer in the planktonic phase, which as noted elswhere (8) could increase the predator-induced accumulated mortality.

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