ANCHOVY AND SARDINE JUVENILE GROWTH DETERMINED USING THE SARDONE PROTOCOL: THE CASE OF THE GULF OF LIONS

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Abstract
This contribution is a first attempt for sardina (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*) juveniles growth analysis in the Gulf of Lions. A first conclusion is that growth rates and increment widths are different depending on their hatching dates. Both clupeoid species growth is faster and higher when their hatch dates are closer to the warmer conditions, which is at the end of the spawning season for sardine and at the peak spawning for anchovy. In this period, environmental factors, such as SST, are more favorable for the early life stages growth.
Keywords: Growth, Life Cycles, Recruitment, Larvae

Introduction
In larval and early juvenile stages of fish, information on age structure can be used to clarify the effects of changes in the environment on growth and survival, and can result in an improved understanding of factors affecting recruitment success [1]. Rearing experiments under different environmental conditions provide valuable data on larvae growth but there is a limitation in rearing older individuals [1, 2, 3]. Long term series of data or different areas shall be used to determine the possible differences in growth determined by different environmental conditions in the wild. Sardone Project is aimed at developing a series of tools to better understand stock assessment and fishery management of small pelagic fish resources (anchovy and sardine) of the Mediterranean. The three major stocks and fisheries: the NW Mediterranean, the Adriatic and the Aegean have been chosen and a unique reading protocol and several calibration exercises were performed in order to minimize differences in interpretation between readers. All the differences in growth between the three areas will then be understood as induced by different environmental conditions. In this study we present the Gulf of Lions results, ready to compare with the other areas.

Material and Methods
Sardine and Anchovy juveniles from the different Sardone surveys were used to determine growth parameters. Sardine juveniles were caught at early August 2007, while anchovy juveniles were caught at early December 2007. Otolith preparation and interpretation were based on the protocols prepared by IMEDEA and AZTI for the SARDONE project [4]. The individual hatch date was calculated by subtracting its age (number of increments) from sampling date. According to [1] and [2], increment formation on anchovy and sardine otoliths starts from the hatching ring and the deposition is daily thereafter. The period in which all fish from each sampling period had hatched was divided into sub-periods and the evolution of increment widths was examined separately for each subperiod (subgroup).

Results and Discussion
a) Somatic growth
A total of 49 Sardine juvenile were analyzed, with TL ranging 65-97mm, the age interpreted range was between 101 and 120 days and the average growth rate was 1.01 mm day^{-1}. Based on the hatch dates, 3 groups were made and the evolution of increment widths was examined separately for each subgroup (Fig. 1). The three groups followed the same growth pattern but with differences in the slopes (JuvSp3 increments widths grew faster than JuvSp2 and JuvSp1), and differences in the maximum width reached.

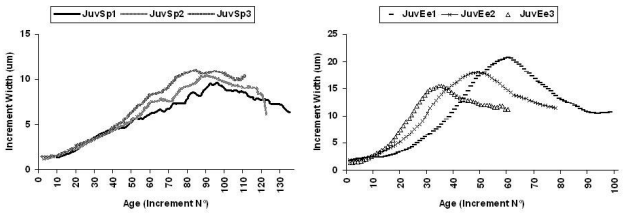

Fig. 1. Increment width (5-point running mean) by age (number of increments) for the different hatch-date grouped Sardine and Anchovy juveniles

Anchovy juvenile sample was bigger, 133 individuals were analyzed. Their TL ranged 48-95 mm, the age interpreted ranged between 42 and 101 days and the average growth rate 0.851 mm day^{-1}. Juveniles were grouped depending on their hatch date. The three groups had different growth rates, different maximum increment widths, and different period in life were the growth slows down (day 30, 45 and 60, figure 1)

b) *Environmental implications in growth*
For the sardine groups, as later they hatched in the season (Fig. 2), higher were their growth rates and higher the maximum increment width reached. The opposite occurs to the anchovy groups, where the higher growth rates and maximum increment widths reached belonged to the individuals hatched in September (JuvEe1). Around late November, the three groups growth patterns were synchronized.

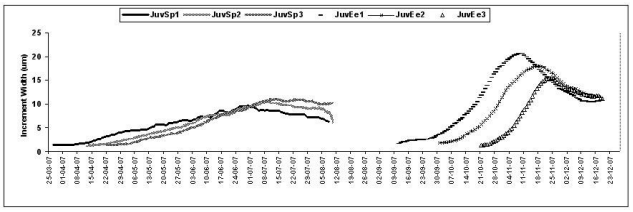

Fig. 2. Increment width (5-point running mean) for the hatch-date grouped *S. pilchardus* and *E. encrasicholus* juveniles

Environmental factors, such as sea surface temperature, which is higher in the central part of the year, might be responsible for those intra-area differences in growth. Growth plasticity in early life stages for both species depending on hatch date might also be present depending on the geographical area considered. Further comparisons between individuals hatched in different areas (different environments) will allow to identify key environmental factors affecting early life stages growth and will also allow to establish new growth patterns related to changes in those key factors.

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