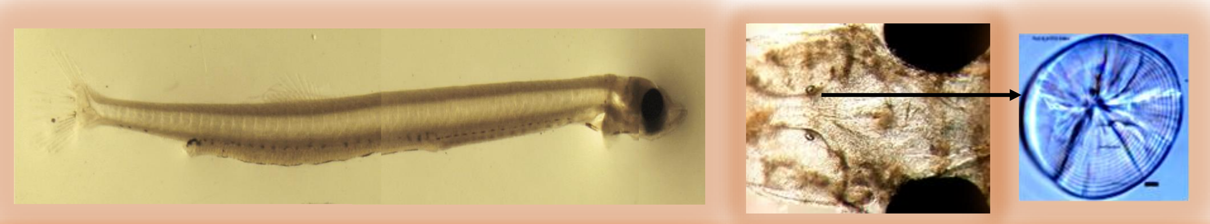
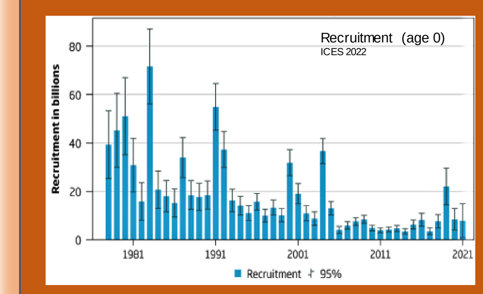
Otolith daily growth of sardine (***Sardina pilchardus***, Walbaum 1792) larvae off western **Iberia**: Effect of environmental variables

Isabel Meneses, Ana Moreno, João Pastor, Sónia Antunes, Susana Garrido

Instituto Português do Mar e da Atmosfera (IPMA)

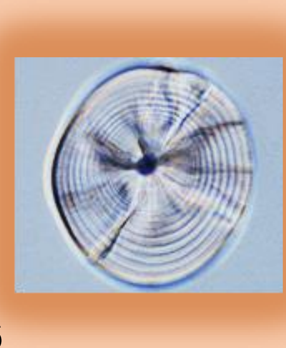


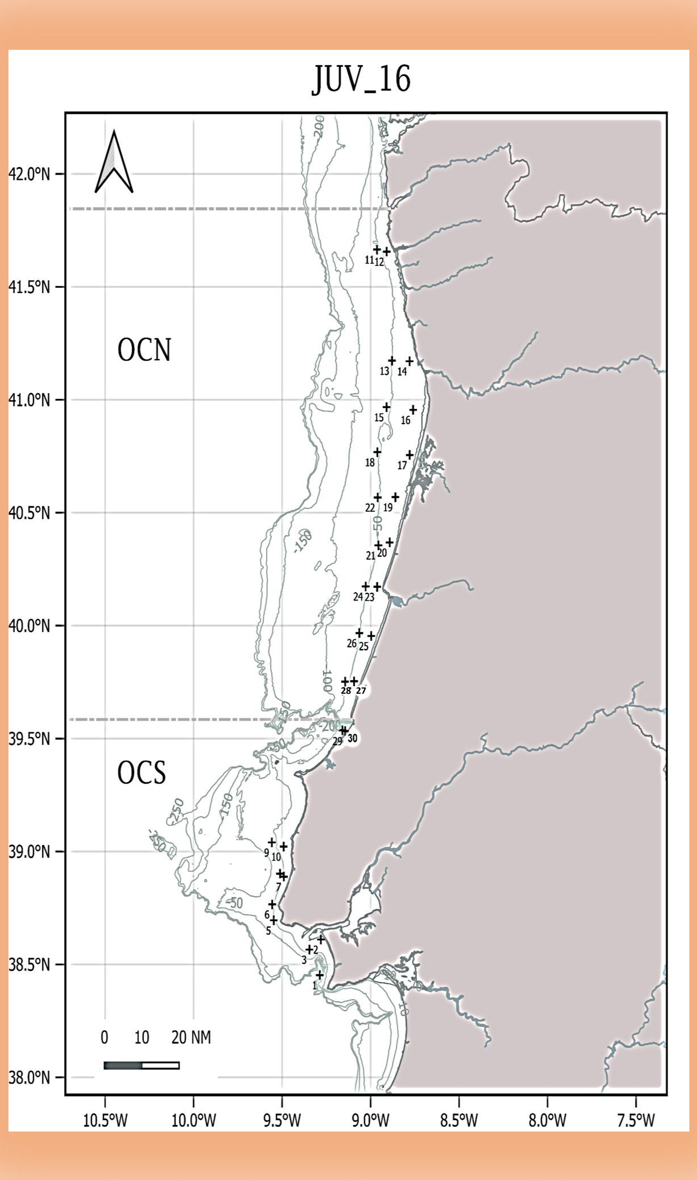
Problem



- Sardine recruitment variability off Atlantic Iberian waters has declined significantly in the last decade (Malta et al 2016, ICES 2018, ICES 2021)
- It is difficult to identify the main drivers of recruitment strength amongst all those responsible for fish larval mortality (Houde 1987, Cury et al, 2008, Greer et al 2014).
- There is a need to improve our knowledge of the factors involved in early stages growth because as fast as they grow the better will survive (Takasuka et al, 2003) to next stages/juveniles/recruitment

Data collection





Sampling locations of fish larvae off the NW Portuguese coast using Bongo net (780µm) during the Juvesar16 acoustic survey

***Sardina pilchardus* larvae** sampled during the night. Survey from 30 of November till 9 of December of **2016** off the occidental part of the Portuguese continental coast (subdivision 9a-Central North and part of Central South of ICES Divisions)

Temperature (SST), salinity (SSS) and chlorophyll-a (Chla) data from in situ CTD profiles (integration 1-10m depth)

Otoliths sagittae (N=265) and lapilli (N=213) were dissected

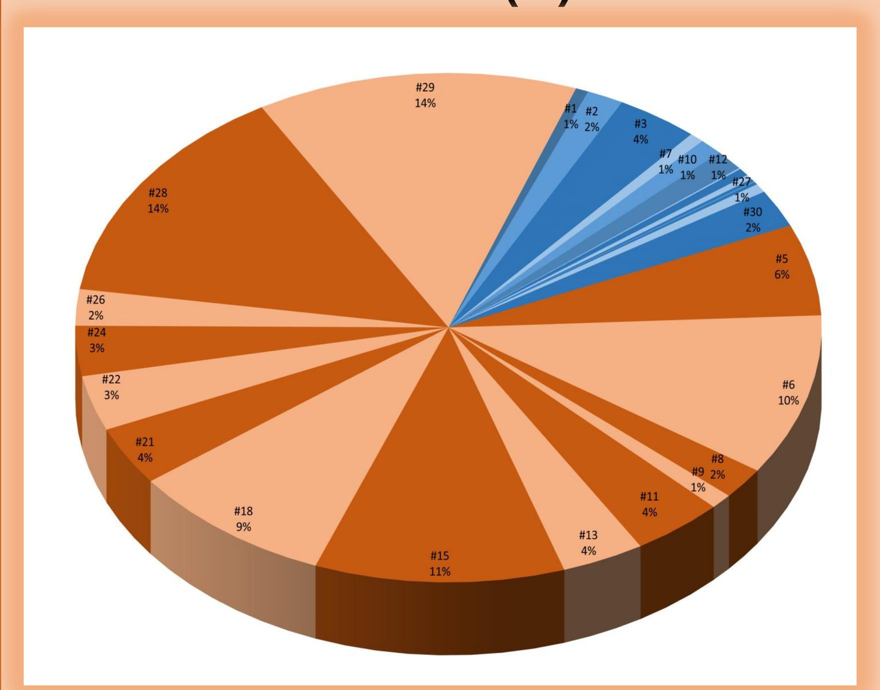
Ages estimated counting daily increments

Growth estimated by relationship of daily increments to standard length of larvae and radius of the otoliths

The **three last increments widths** were considered to investigate hypothetical environmental influence in accretion rates in the three days before sampling

Environmental conditions and abundances

Relative abundances (%)



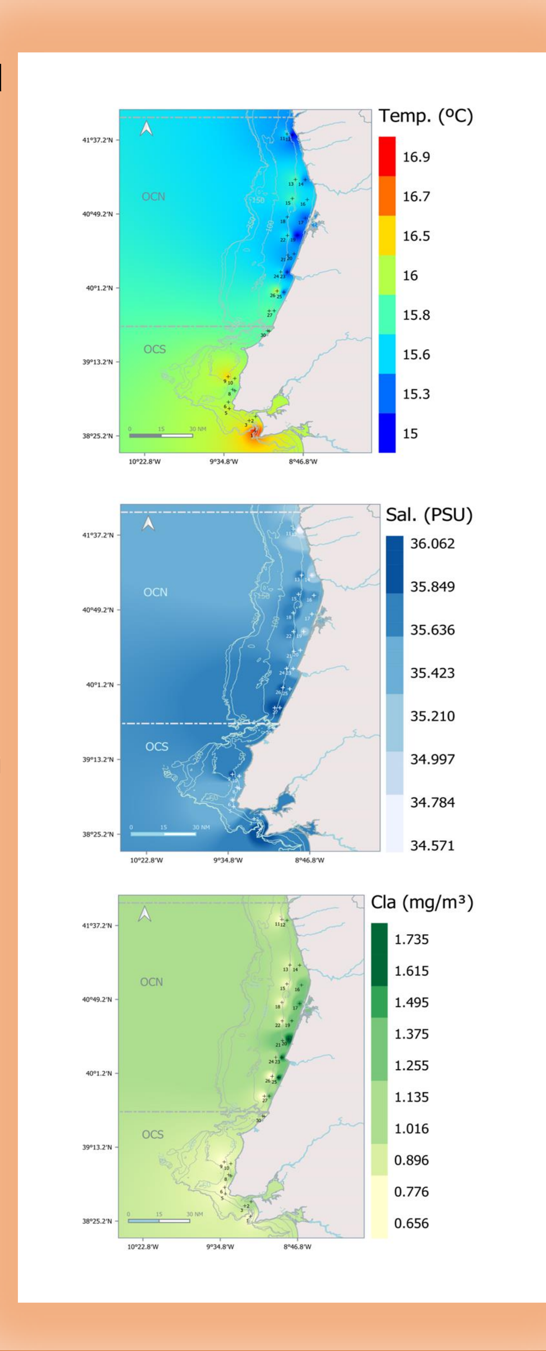
Offshore stations

Inshore stations

Higher abundances preferably on offshore locations with:

- **Temperatures** 15.4 – 16.2ºC
- **Salinities** 35.1 – 35.8PSU
- ***Clorophyll-a*** 0.6 – 1.2mg.m^{-3}

Environmental variables



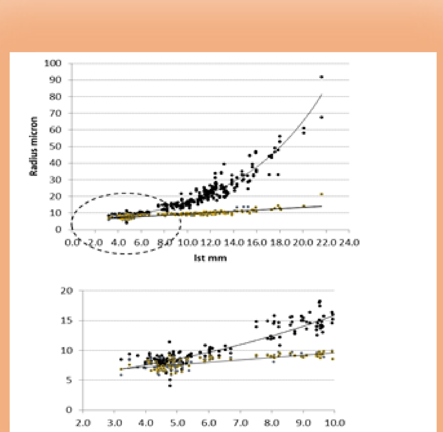
Temperature varied between 15.2 – 16.9ºC beeing lower in locations close to the coast except in the southernmost locations of OCS region

Salinity varied between 34.6 – 36.1PSU exprecing the influence of rivers in inshore locations

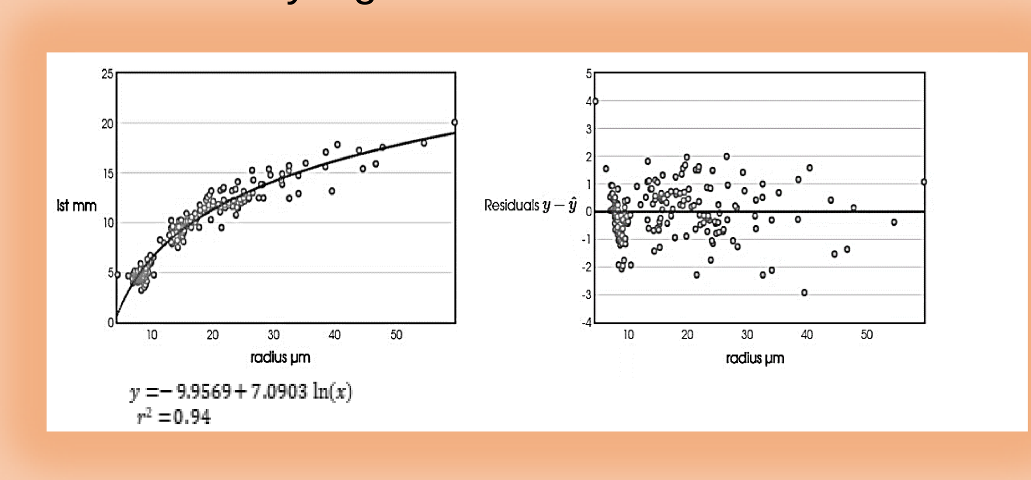
Chorophyll-a varied between 0.6 – 1.7 mg.m^{-3} showing higher productivity influenced by river runoff

Growth

Somatic and otolith growth relationship well described by logarithmic model *Lst=lnb+a*

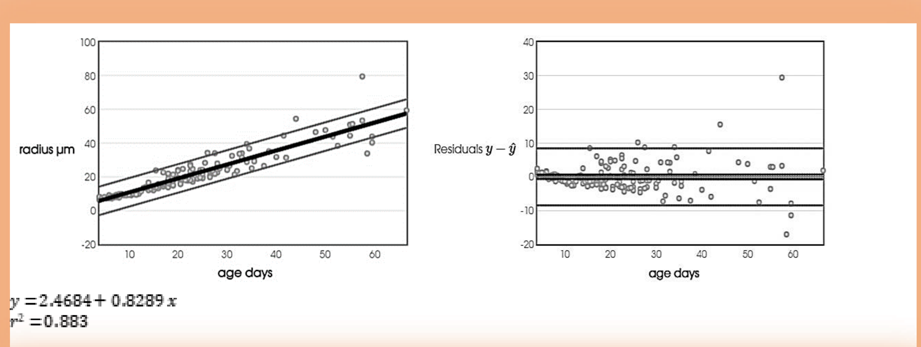


Sagittae and lapilli follow different growth trajectories after 7mm standard length

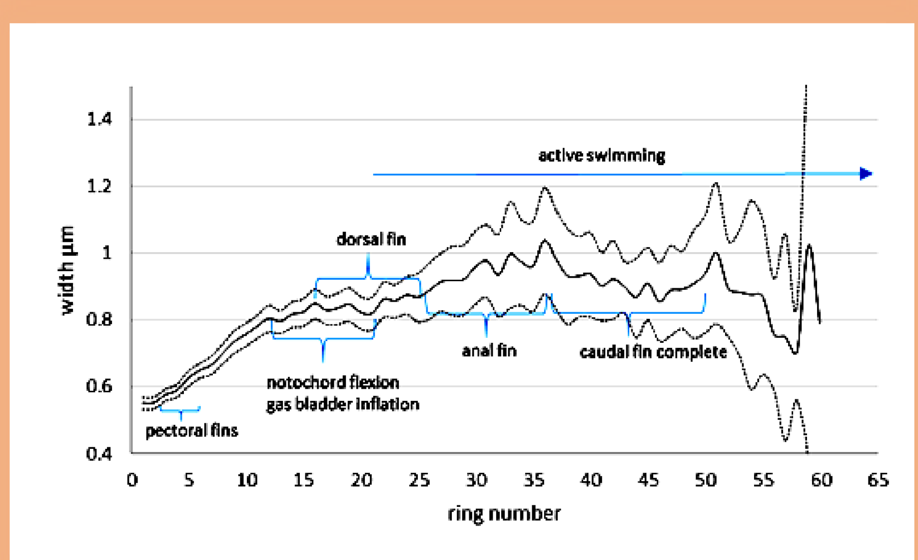


Average **somatic growth** rate (N=333, r^2=0.94), as a function of otolith radius (between 10µm and 60µm), was estimated as g=0.19mm.µm^{-1}

Sagittae radii and age relationship well described by linear model *Radius= b age+a*



Average **otolith growth** rate was estimated as the slope of the linear model g=0.83µm.day^{-1} (N=172, r^2=0.88)



Increment width chronology (N=2718) Data are sequential increments counted from first feeding check to the edge of the otolith, average width ±95% confidence level, standard deviation of the mean

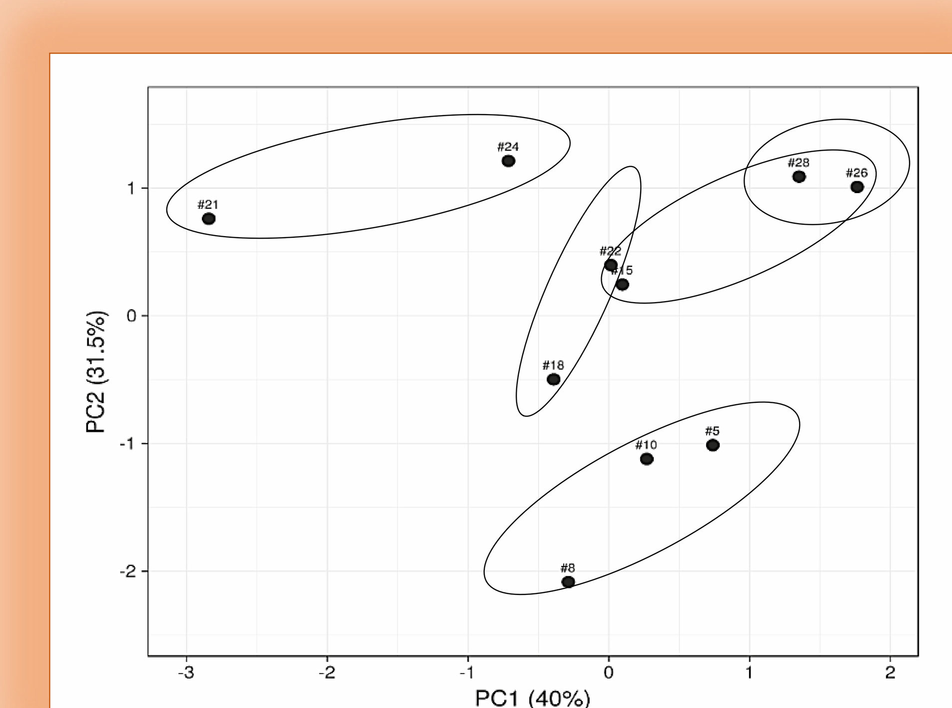
Increments widths ranged from 0.53-1.04µm

Significant levels were set at α=0.05

Relationship with environmental variables

The **3 last increments widths** ranged from 0.61-1.27µm

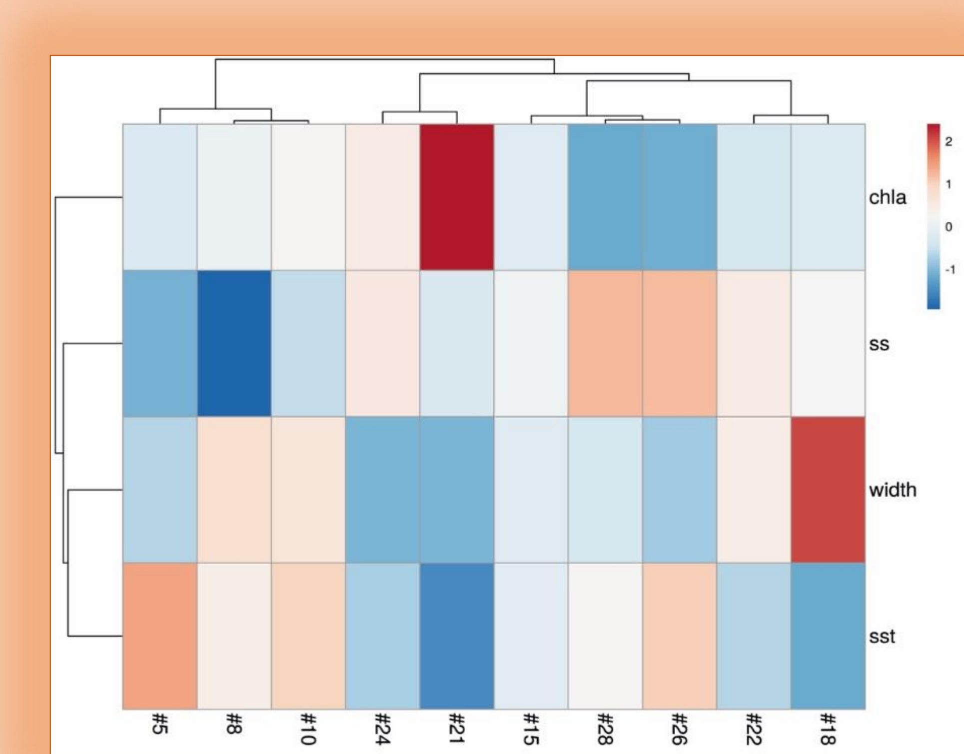
Explained variability of the three last **increment widths** by the effect of environmental parameters **temperature** (SST), **salinity** (SSS) and **chlorophyll-*a*** (Chla) using Principal Component Analysis (**PCA**)



Variability of **3 last increments** widths explained primarily by temperature (40%), salinity (31.5%) and finally by Chla (26.5%)

The more evident were stations #21 (40.38ºN) and #24 (40.19ºN) that stand out of all the others.

Here the three last increments were **thinner (0.61µm)**, sea surface temperatures were **lower** (15.4-15.7ºC), salinities (35.62-35.76PSU) were in the middle of the range of the other locations and chlorophyll-*a* was **higher** (0.92-1.28mg.m^{-3}) than in the other stations



Conclusions

Sardine larval otolith growth was within the range of values presented by other authors (Alemany *et al*, 2006, Garrido *et al* 2021)

Increment width increased until ~15 days old and after that stabilized. We found correspondence to chronology of larval development (Garrido *et al* 2021)

Thinner increments were found in locations with lower temperatures which is the principal parameter we suggest to influence growth, followed by salinity.

Spawning takes place at temperatures 13-17ºC (Stratoudakis *et al*, 2007) which were the temperatures registered in sampled locations

Ackowledgments

Research team and crew of survey JUVESAR16

-References-

- Cury, P., Yunne-Jai, S., Planque, B., Durant, J.M., Fromentin, J.-M., Kramer-Schadt, S., Stenseth, N.C., Travers, M. and Grimm, V. (2008). Ecosystem oceanography for global change in fisheries. Trends in Ecology and Evolution, 23 (6): 338-346
- Greer, A. T., Cowen, R. K., Guigand, C. M., Hare, J. A. and Tang, D. (2014) The role of internal waves in larval fish interactions with potential predators and prey. Progress in Oceanography 127: 47-61
- Houde. E. D. (1987) Fish early life dynamics and recruitment variability. Am. Fish. Soc. Symp. 2: 17-29
- ICES (2022): Working Group on Southern Horse Mackerel, Anchovy and Sardine (WGHANSA). Draft Report. ICES Scientific Reports 4:51 354 pp http://doi.org/10.17895/ices.pub.19982720
- Malta, T. Santos, P., Santos, M., Rufino, M. and Silva, A. (2016) Long-term variations in Ibero-Atlantic sardine (*Sardina pilchardus*) population dynamics: Relation to environmental conditions and exploitation history. Fish. Res. 179: 47-56
- Takasuka, A., Aoki, I., Mitani, I. (2003) Evidence of growth-selective predation on larval Japanese anchovy Engraulis japonicus in Sagami Bay. Mar. Ecol. Prog. Ser., 252: 223-238
- Alemany, F., Álvarez, I., Garcia, A. Cortés, D., Ramirez, T., Quintanilla, J., Álvarez, F., Rodríguez, J. (2006). Postflexion larvae and juvenile daily growth patterns of the Álboran sea sardine (*Sardina pilchardus*, Walb.): influence of wind. Sci. Mar.: 93-104
- Garrido,S., Ferreira, S., Soares, C., Meneses, I., Baylina, N., Batista, H., Chicharo, M.A., Santos, M. and Ré, P.(2021) Effect of food availability on the growth and age determination of European sardine (Sardina pilchardus Walbaum, 1792) larvae. J. Mar Biol Ass UK 101(3):609-619
- Stratoudakis, Y., Coombs, S.H., Halliday, N., Conway, D., Smyth, T., Costas, G., Franco, C., Lago de Lanzo´s, A., Bernal, M., Silva, A., Santos, M.B., Alvarez, P., Santos, M., (2007) Sardine (*Sardina pilchardus*) spawning seasonality in European waters of the northeast Atlantic. Mar Biol 152:201–212