

## SPAWNING HABITAT OF IBERIAN SARDINE (*SARDINA PILCHARDUS*, W.) OFF THE NORTH SPANISH COAST

Miguel Bernal<sup>1</sup>, Carmela Porteiro<sup>2</sup> and Pablo Carrera<sup>3</sup>

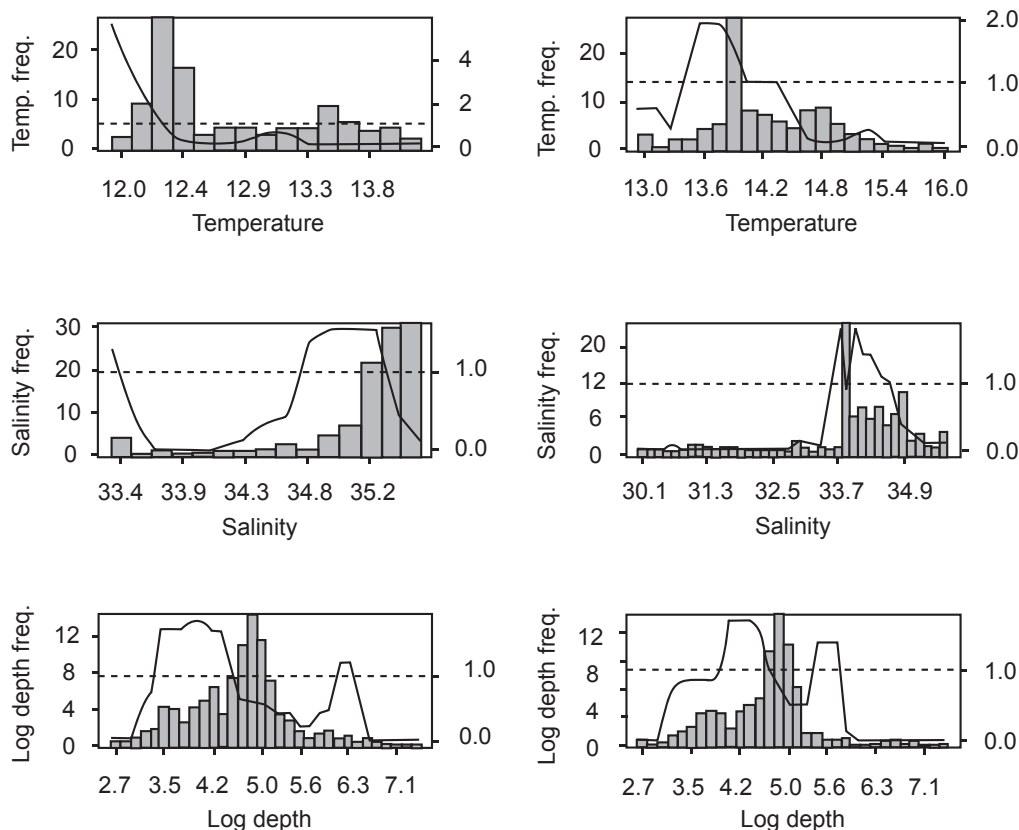
<sup>1</sup>Instituto Español de Oceanografía, Centro costero de Málaga. Puerto pesquero s/n, Fuengirola, Málaga, Spain (miguel.bernal@ma.ieo.es).

<sup>2</sup>Instituto Español de Oceanografía, Centro costero de Vigo, Aptdo 1552 36200 Vigo, Spain.

<sup>3</sup>Museo del Mar de Vigo, Alcabre, Vigo, Spain.

*Sardina pilchardus* Walbaum is an indeterminate multiple batch spawner, with a protracted spawning season that lasts from autumn to spring (October to May). This species is found in North East Atlantic (NEA) waters and in the Mediterranean Sea and the main spawning grounds in the NEA include the Atlantic coasts of Morocco, Portugal, Spain and France. Here, a brief characterization of the spawning grounds off the north Spanish coast using two recent CUFES surveys is carried out. Table 1 summarises the years, number of stations and environmental variables used in the analysis, while Figure 1 and Plate 6 show the main results from the analysis.

Quotient analysis (Fig. 1) was carried out using temperature, salinity and depth as environmental and geographic covariates, the latter transformed to logarithm scale. Quotients of sardine egg density (eggs / m<sup>3</sup>) are smoothed using a running median. For the 2001 survey, the salinity range



**Figure 1.** Quotient analysis of *S. pilchardus* egg density (eggs / m<sup>3</sup>) in relation to temperature (top) salinity (middle) and logarithm of the bottom depth (bottom) off the north Spanish coast. Left panels represent the year 2000, right panels the year 2001. The right y-axis and the line represent quotient values, the left y-axis and histograms represent the frequency distribution values for each class of environmental variable examined, and the class values are given on the x-axis. The horizontal dashed line indicates a quotient value of 1.

used in the quotient analysis ([30 – 36]) is a subset of the one observed in the survey ([23 – 36]), excluding around 10% of the stations, and 5% of the positive stations, most of them off the northern Portuguese coast. Results from the quotient analysis show different environmental characteristics, and no clear preference for a fixed salinity or temperature range, between years. Temperature preferences are in the lower part of the range of survey temperatures in both years, while salinity follows the salinity range observed for the 2001 survey, but quotient values are higher in the lower part of the salinity range for the 2000 survey. As for depth, most of the positive stations and the classes with quotients larger than one are on the shelf ( $\text{Log}(\text{Depth}) < 5.3$ ) but there is a second peak in the quotient related to a few positive stations in deeper waters, associated with a deep cannon located in the inner Bay of Biscay (Cap Breton Cannon).

The T-S plots (Plate 6) indicate quite different situations in 2000 and 2001. In 2000, most stations are located along a density isoline and only stations with lower salinity, associated with river inflows, depart from this isoline. Most of these low salinity stations show a sardine egg presence, which corresponds also with the hydrographical conditions of the northern Spanish coast, where river inflows affect only coastal areas. Stations with larger abundance of eggs are aggregated near the lower salinity and lower temperature values of the 27 pycnocline. In 2001, T-S pairs are more scattered and do not follow any pycnocline. The low salinities in 2001 are associated with large river discharges off the north Portuguese coast during this year. In both T-S plots, higher temperatures are associated with the Portuguese coast, due to spring SST warming. Following this first implementation of quotient analysis and T-S plots to study Spanish sardine, both methods are regarded as interesting tools to analyse the characteristics of the spawning areas in this area, but due to the large interannual and small scale spatial variability, longer time series and of broader coverage are desirable to perform a more complete analysis.

**Table 1. Summary of data used in the analysis**

Region	Species	Year/season of sampling	Method of egg collection and number of samples	Environmental parameters
North Spanish coast	<i>Sardina pilchardus</i>	March-April, 2000, 2001	CUFES 332 (2000) 360 (2001)	SST, surface salinity, bottom depth