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Variation and temporal patterns in the composition of the surface ichthyoplankton in the southern Bay of Biscay (W. Atlantic)

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ABSTRACT

From September 2000 to December 2006, surface plankton samples were collected on a monthly basis, from a station located in the southern Bay of Biscay (43°37N; 1°43W France), near the deep Capbreton canyon. In this paper, the results for the ichthyoplankton assemblage are presented. Among the 62 taxa recorded, only 35 were present in the larval stage whilst only 10 were represented by their eggs. Taxa represented by both stages (eggs+larvae; $N = 17$) had the highest abundance. The presence in the surface plankton assemblage of species, at either or both stage, is interpreted within the context of the bathymetric distribution of species. The maxima in abundance and diversity occurred in February–March, for eggs, and May–June, for larvae. This 3-month time-lag between the stages is proposed to be related to the timing of egg spawning and larval recruitment to the pelagic environment. Mean egg abundances (82.4 ± 29.8 eggs/10 m^2) were 10-fold higher than the larval abundances (7.1 ± 1.8 larvae/10 m^2). Despite pronounced monthly variability, no statistically significant decrease in either egg or larvae abundance was observed during this 6-year study period. Compared with previous published studies, this study shows that the peak in ichthyoplankton diversity occurred two months earlier. In addition, the spawning period occurred over the whole year, even during autumn and winter. Using ordination techniques, the annual sequence appearance of taxa are described at the study site: Gadiforms, Ammodytidae and Pleuronectiforms were present during the winter whilst Sparidae, Blennidae, Labridae and Gobiidae, formed the summer group. Only three species, European anchovy *Engraulis encrasicolus*, European pilchard *Sardina pilchardus* and Atlantic horse mackerel *Trachurus trachurus* were recorded throughout the year.

1. Introduction

Ichthyoplankton in the Bay of Biscay (SW Atlantic) is well-documented, although most published studies encompass only a few, especially commercially important, species such as the European hake, European anchovy, European pilchard and Atlantic horse mackerel or Atlantic mackerel (Sola et al., 1990; Motos et al., 1996; Alvarez et al., 2001; Coombs et al., 2001, 2004 and Planque et al., 2007). Some studies have described the entire species assemblage, but sampling was restricted to an annual cycle, or sparsely distributed in time (Suau and Vives, 1979; Dicenta, 1984; Acevedo et al, 2002; Ibaibarriaga et al., 2007). Other studies from the Galician (Ferreiro and Labarta, 1988) or Cantabrian coasts (Valencia et al., 1988), have sampled over 2 or 3 years only.

The objective of the present study in the Bay of Biscay was to describe seasonal and inter-annual variation in species diversity, as well as species abundance for the whole surface ichthyoplankton assemblage on a long-term basis (>10 years). The sampling strategy was based upon monthly collection to strengthen the temporal dimension of the long-term pattern. Data collection was restricted to horizontal surface samples, at a single station. This study is part of a larger research programme, on the whole at the zooplankton community (Elbée (d') and Castel, 1991; Elbée (d') and Prouzet, 2001) and the seabird and mammal communities (Hémery et al., 2002; Castège et al., 2004) of the southern Bay of Biscay. These studies together are aimed at quantifying the impacts of global oceano-climatic changes (Hays et al., 2005; Poulard and Blanchard, 2005 and Costello et al., 2006).

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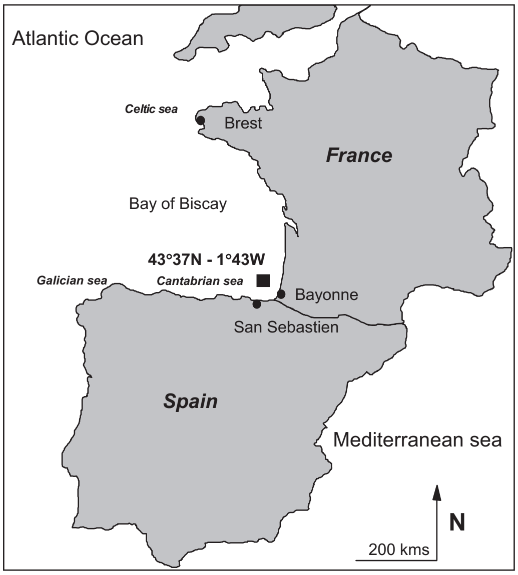

Fig. 1. Location of the sampling station (dark square) in the southern Bay of Biscay.

2. Study site

The sampling location for plankton was located in the southern Bay of Biscay (43°37N; 1°43W), on the southern border of a deep oceanic canyon (the so-called Gouf of Capbreton) (Fig. 1). Selection of this sampling site was based on logistical (practical) and biological reasons; at 20 km of the coast (the city of Bayonne) it was close enough to minimize travel costs, but remote enough to minimize anthropic and continental influences. Water depth at the sampling site was around 540 m. The planktonic community at this site is highly diversified and well-balanced between surface and deep influences (Elbée (d'), 1993, 2001).

3. Material and methods

Plankton was sampled at the same time of day (ca 0900–1000 a.m.), using a WP2-type tronconic net with 200 μm mesh size, from the vessel "*Haize Hegoa*" (30 m length), from the Douanes Françaises and the Affaires Maritimes (Coast Guard ship). Horizontal hauls were collected at 1 m below the surface and the net was towed at a speed of 0.5 m s^{-1}. The volume of water filtered through the net was estimated with a General Oceanics flowmeter. Plankton was preserved in 5% seawater formalin and then stored for further analysis. Samples were sorted in the laboratory, under a WILD M10 stereomicroscope provided with epi- and dia-scopique light. When concentrations (especially for eggs) were high, sub-sampling was carried out, using a Motoda box.

Identification of taxonomic units (TUs) was carried out using specialized literature and reference textbooks (Marinaro, 1971; Russel, 1976; Fahay, 1983; Halbeisen, 1988; Aboussouan, 1990; Olivar and Fortuño, 1991; Ré, 1996; Munk and Nielsen, 2005 and Richards, 2006), and from the following websites: http://www.larvalbase.org/; and http://access.afsc.noaa.gov/ichthyo/index.cfm. An original database of eggs and oil globule diameters, for ca 200 fish species, developed by one of the authors (J. d'E) at the LAPHY laboratory, was also used. Confirmation of the identification of some doubtful eggs/larvae was facilitated greatly by information on the presence/absence of adult fish, derived from annual bottom trawl surveys EVHOE and carried out by IFREMER over the area (Souissi et al., 2001; http://www.ifremer.fr/drvlorient/programmes/posterevhoe.htm).

Abundances were expressed as number of individuals per m^3. The total abundance for each TU was calculated, by summing the monthly abundances estimated during the study ($n = 57$ months). The relative abundance was defined as the ratio between total abundance of each TU, over the total abundance of all TUs collected.

4. Statistical analysis

Statistical analysis of the data was undertaken using StatBox v. 6.0® and SAS® (SAS Institute, V. 8) softwares. Time-series were analysed using the method of moving averages, with a window width equal to two and plotted accordingly (Spiegel, 1983). Sampling fluctuations around the mean were described by their standard error $SE = SD \div \sqrt{n}$(with SD: standard deviation and n: sample size). Correspondence analysis was performed on a contingency table of the 62 taxa (whatever their life cycle stage) and 12 months i.e. over the whole of the study period. Occurrence frequency was incremented each time a new taxon was found in the sample. Mean monthly frequencies ("MONTH"), as well as unidentified taxa ("INDETE"), were treated as supplementary elements in the analysis. Both the correlation analyses between time and the variation in the means of eggs or larval abundance means and correlation between variation in eggs and larval abundance means were performed using the non-parametric Kendall test, with the CORR procedure of SAS.

5. Results

5.1. Plankton sampling

Between October 2000 and December 2006, 57 plankton samples were collected (Table 1). The average annual sampling frequency was high (mean: 9.16 months/12) and relatively stable (coefficient of variation: 0.13), with a maximum of 11 months in 2006 and a minimum of 2 months in 2000. In contrast, the sampling frequency for the different months of the year was rather variable (3–7; mean: 4.17; CV = 0.22).

5.2. Taxon richness

A total of 62 TUs (eggs and larvae combined) were collected, over the 6 years of the study (Fig. 2). The increase in occurrence of

Table 1
Sampling effort (monthly and annual frequency) at the single station (43°37N; 1°43W) during the study period (October 2000–December 2006).

	2000	2001	2002	2003	2004	2005	2006	Total
January			11	20		39	47	4
February		3	12	21	30		48	5
March			13	22	31	40	49	5
April				23	32	41	50	4
May		4	14	24	33		51	5
June		5	15	25			52	4
July		6	16	26	34		53	5
August		7			35	42		3
September		8	17	27	36	43	54	6
October	1			28		44	55	4
November		9	18		37	45	56	5
December	2	10	19	29	38	46	57	7
Total	2	8	9	10	9	8	11	57