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Larval distribution of *Ophiothrix fragilis* (Echinodermata: Ophiuroidea) in a macrotidal area, the Dover Strait (eastern English Channel, France)

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Seasonal and spatial variations in the distribution and abundance of *Ophiothrix fragilis* larvae (2-arm to 8-arm stages) were determined from a series of plankton net tows in the Dover Strait in 1995 and 1996. Ophioplutei appeared in the plankton between June and September. Larval population was constituted by ophioplutei from different spatio–temporal origins. A major fraction of the ophioplutei observed in the Dover Strait might come from a population localized southward.

Reproduction of *Ophiothrix fragilis* (Abildgaard) in the Dover Strait is cyclical with a higher gonad index in June and July leading to a main benthic recruitment in September and a resting phase between September and February (Davoult et al., 1990; Lefebvre et al., 1999). Due to peculiar hydrodynamic conditions of the Dover Strait, eggs then planktonic larvae are scattered in the water mass mainly by advection and diffusion (Thorson, 1950; Mileikovsky, 1971). Nevertheless, the low variability of recruitment and abundance of the population contrasts with the environmental variability, with the fluctuation of abundance and the switch of dominant species in neighbouring communities (Dewarumez et al., 1986; Dauvin et al., 1993). To understand and predict abundances, population growth rate and population structure of a species with a bentho–pelagic life cycle, it is necessary to understand the importance of the physical, chemical and biological properties and processes that affect individuals within both planktonic and benthic phases. A first approach on the pelagic stage was composed of the study of the seasonal and spatial variations in the distribution and abundance of *O. fragilis* larvae (2- to 8-arm stages) determined from a series of plankton net tows in the Dover Strait in 1995 and 1996.

Along the French coast of the eastern English Channel, a macrotidal area governed by tidal currents alternating and parallel to the coast, fluvial supplies, distributed from the Bay of Seine to Cape Gris-Nez, generate a frontal area (Brylinski & Lagadeuc, 1990). In the Dover Strait, gravels and pebbles are colonized by a sessile epifaunal community, where the brittle-star *Ophiothrix fragilis* is dominant. This species has a density of 1500–2000 ind m^{-2} (Davoult, 1990) and accounts for approximately 63% of the total biomass of the community (281 g ash-free dry weight m^{-2}) (Migné & Davoult, 1997).

The different plankton samples were taken with vertical tows (200-μm mesh net) from the bottom to the surface off Cape Gris-Nez at station B (50°55′80″N 01°34′72″E) located in the area of maximum adult population of *O. fragilis* (Davoult et al., 1990) and at an inshore and an offshore station (outside the area of the adult population), respectively, stations A (50°55′N 17°36′19″E) and C (50°56′58″N 01°33′28″E). Sampling was carried out from February to July 1995 at the three stations and from February to December 1996 at station B and from June to October 1996 at stations A and C. In 1996, plankton tows were made near the end of the flood tide in order to sample a new water mass. The mean sample volume was approximately 5.5 m^3 at station A, 8 m^3 at station B and 11 m^3 at station C (mean depth of 22, 32 and 44 m, respectively). After sampling, the zooplankton was immediately fixed in 5% formaldehyde. Representative aliquots of 20% were taken from samples after homogenization according to Frontier's method (1972) and were observed under a binocular microscope. The different larval stages (2-, 4-, 6- and 8-arm stages) of *O. fragilis* were isolated using the identification keys of McBride (1907). For most dates, water masses were characterized by probe profile using pressure, temperature, density and salinity data.

Temporal variations in the temperature of the water column followed a typical bell curve, with temperature approximately 12°C at the beginning of June, rising to 18°C at the end of August before the lower winter values. On an annual scale, the water column was homogeneous with salinity differences which did not exceed 0.1 psu. Salinity ranged from 33 to 34.9 psu inshore to offshore. Adult populations of *O. fragilis* were then in typical coastal or intermediate waters (Brylinski et al., 1984). From June to September, anticyclonic conditions (wind from the north-east sector) occurred during a period of several days (up to 18 consecutive days in 1995, 14 in 1996). Consequently, water transport was reduced or even reversed (Belgrano et al., 1990), thus favouring larval retention of larvae near the releasing area, allowing self-recruitment.

Temporal and spatial changes of abundances or relative frequencies of the different larval stages of *O. fragilis* showed high variations during the periods sampled (Figure 1). In 1995 and 1996, *O. fragilis* ophioplutei appeared in the plankton at the beginning of June to the end of September. This was in agreement with the reproductive period of the local adult population and confirmed that gamete release was spread out over several months (Davoult et al., 1990).

The input of 2-arm larval stage at the end of July 1995 or at the beginning of August 1996 and the change in the relative abundance of the different larval stages: preponderance of older larval stage with competent larvae able to settle at the end of August and at the beginning of September (100% of 6- and 8-arm stages, with up to 620 8-arm larvae m^{-2} on 2 September

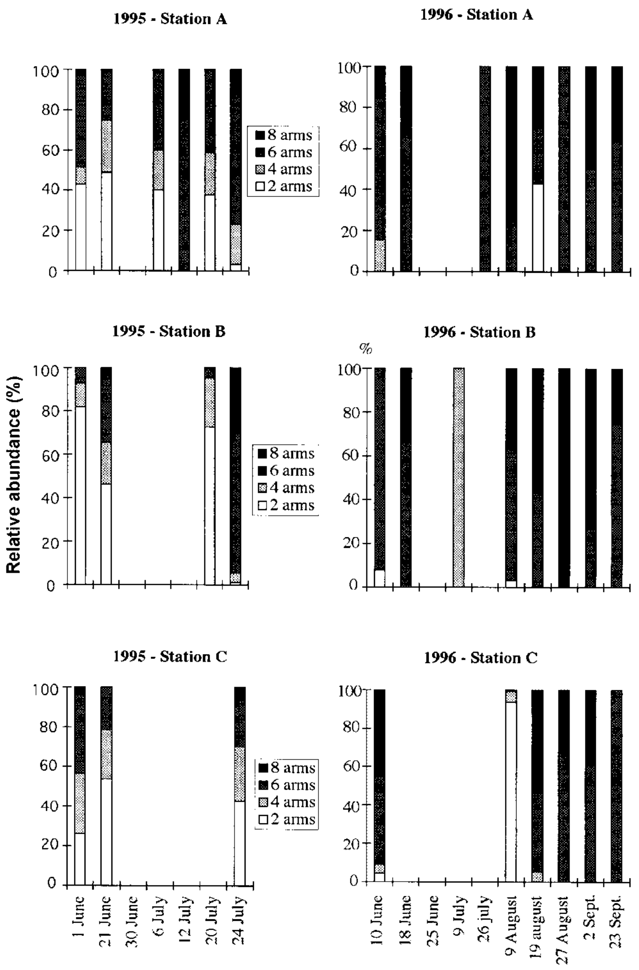

Figure 1. Spatio–temporal changes in the relative abundance of the different larval stages in *Ophiothrix fragilis* in 1995 and 1996.

1996), confirmed the demographic observations of Davoult et al. (1990) who found the major benthic recruitment to be at the beginning of September. All 2-arm larval stage input (1.5-d old according to McBride, 1907) corresponded to an autochthonous spawning, whereas older larvae might have an allochthonous origin. This latter hypothesis was confirmed by the Salomon simulation in the English Channel (1990) and by Lagadeuc & Brylinski (1987) who concluded that settled individuals of the annelid *Polydora ciliata* observed in the Dover Strait were of allochthonous origin. It seemed that ophioplutei observed in the area between June and September were constituted by cohorts from different spatial and temporal origins. As gamete release was more important around station B (due to the concentration of adults), this distribution revealed that larvae were dispersed in the water mass. The frontal area could limit or allow the offshore expansion of ophioplutei according to the tidal cycle, whereas the Cape Gris-Nez could favour the projection of inshore water. This phenomenon was certainly dependent upon the intensity, direction and variability of the local hydrodynamism. Further investigations will be needed to achieve informations on the vertical and horizontal distribution of the ophioplutei in different tidal conditions (neap tide and spring tide) and during a tidal cycle (ebb tide and flood tide).

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