

Changes in the sediment and water column due to fish farming in a Mediterranean Bay
(Fornells, Balearic Islands)

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The Bay of Fornells is a restricted bay in the North of Menorca Island. Its area is 4.1 km² and its maximum dimensions are 4.73 km north-south and 1.5 km east-west. The average depth is 5.5 m with a maximum of 20 m near the outlet. Strong and frequent north winds determine the hydrodynamics of the bay as evidenced by the sediment distribution (FORNOS *et al.*, 1992).

The activity of fish-farms produces an input of organic waste from the uneaten food and faeces, a concentration of animal life in the zone and a reduction in solar radiation. This activity causes changes in water quality mainly in closed bays. In Fornells Bay fish culture started in 1985 and has been increasing ever since. During the study period, 32 cages were installed, each of 100 m³ containing *Sparus auratus* (L.) with an input of 77 Tm of dry fodder per year. This implies the beginning of a eutrophication process.

Three hydrological sample stations were placed in the axis N-S and monitored every two months from January 1991 to January 1992: E-1, (5 m depth) in the interior of the bay; E-2, (7 m depth) in the middle of the fish farm; E-3, (20 m depth) near the outlet. The sedimentological study was made by means of four transects extending from the centre of the cages to the unaltered zone. Sediment traps (FORNOS *et al.*, 1989-90) were also installed under the cages and beyond the fish farm (control traps) to estimate the discharge of particulate matter. These two studies were monitored during the summers from 1988-92.

The hydrological study shows few changes for the first 5 metres among the sample stations. Average values of the year are:

	E-1	E-2	E-3
Oxygen. %:	93.35	92.45	95.80
Temp. °C:	18.01	18.14	18.46
Chl-a. mg.m ⁻³	0.376	0.445	0.377
Light ext. %	32.63	37.93	46.63

The physico-chemistry of the sediments under the cages shows the following values: 40-60% carbonate (CO₂ gasometry), 7-18% volatile solids (calcination at 450°C for 2h), 1.5-5% organic carbon (GAUDETTE *et al.*, 1974) and 0.2-0.4% nitrogen (Kjeldahl), 33.5-60% sand, 11.8% fine sand, 23.7% silt, 17.1% clay (HEAD, 1984).

There is an increase in the average particle size under the cages. This explains the increase in carbonate composition of the sediment, as the sand fraction is principally composed of bioclastic remains, mainly *Halimeda tuna* (Ellis & Solander) Lamouroux segments. At the same time benthic communities disappear (ZABALA *et al.*, 1992) and so can no longer trap and bind the fine material. Thus current and wave action clean the area surrounding the cages.

The effects of the fish farm to the sediments are not confined to the area around the cages but also affect the whole bay. They are particularly noticeable in the shallow interior area where the hydrodynamics are low with a consequent accumulation of fine materials (FORNOS *et al.*, 1992) and only there is a located increase of phytoplankton biomass surrounding the cages.

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