

TRANSURANIC ACCUMULATION IN PLANKTON FROM THE SPANISH MEDITERRANEAN COASTAL ENVIRONMENT

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Broadly speaking, zooplankton and phytoplankton include mobile and immobile microbial marine species, respectively. From a classical point of view, phytoplankton are photosynthetic organisms and zooplankton are phytoplankton consumers, therefore representing the first and second levels of the marine trophic chain. However, real food-chains may be very complex depending on the species involved (FENCHEL, 1988). In regard to size classification, a widely accepted cut-off between "classical" phytoplankton and adult zooplankton is 200 μm (SIEBURTH, 1972), though some zooplankton species may have smaller sizes (microzooplankton). Furthermore, though most phytoplankton species have dimensions larger than 20 μm , some species may also be smaller (picoplankton). For practical reasons, 20 μm and 200 μm are the adopted plankton cut-off sizes in our work. As transuranic concentrations in the Mediterranean Sea are low, zooplankton was collected by towing through surface waters, for 30-60 minutes, a large 200 μm mesh conical net (diameter: 1 m, length: 5 m) provided with a flow-meter. It should be noted that when the net saturates, some phytoplankton species may also be collected. Phytoplankton was collected by filtering large volumes of water through 20 μm depth cellulose filters (SCHLEICHER and SCHUELL, #520B). Other size fractions filtered were 8 μm (Schleicher and Schuell, #AE99) and 0.2 μm (Gelman Sciences, Suporcap-100). The smaller fractions include increasingly larger proportions of suspended detrital particles. Samples reported in this work were collected during the MED'92 research expedition on board the N.O. Urania.

Phytoplankton and suspended particles. Large volume (c. 1000 liter) water samples were sequentially passed through 20 μm , 8 μm and 0.2 μm filters, and analysed for plutonium (Table 1). The phytoplankton fractions (microplankton: > 20 μm) showed activities ranging from 59-364 $\mu\text{Bq}\cdot\text{m}^{-3}$. The concentrations observed in the medium sized particles (nanoplankton: 8-20 μm), mostly constituted by small phytoplankton species, were low (28-119 $\mu\text{Bq}\cdot\text{m}^{-3}$) though smallest particles (picoplankton and suspended detritic and inorganic particles: 0.2-8 μm) showed concentrations of the same order as phytoplankton (43-218 $\mu\text{Bq}\cdot\text{m}^{-3}$). Therefore, about 50% of the particulate plutonium observed in the N.W. Mediterranean Sea appeared to be associated with the phytoplankton fraction (> 20 μm).

Station	Pu-239,240 ($\mu\text{Bq}\cdot\text{m}^{-3}$)		
	> 20 μm	8-20 μm	0.2-8 μm
Barcelona	168 \pm 23	28 \pm 24	144 \pm 56
Golf de St. Jordi	364 \pm 158	119 \pm 63	218 \pm 84
Garrucha	59 \pm 20		43 \pm 27 *

* 0.2-20 μm

Table 1. Plutonium concentrations in suspended particles (phytoplankton: > 20 μm) from the NW Mediterranean Sea, August 1992 (uncertainties = $\pm 1\sigma$). * 0.2-20 μm

Zooplankton. Zooplankton biomass was larger in the northern stations (Barcelona and Golf de St. Jordi, mean 18 ± 2 mg dw/m³) indicating higher productivity related to higher nutrients input. The mean specific biomass in the Palomares area was only 5 ± 2 mg dw/m³. The wet to dry ratio ranged from 6 to 12. The transuranic concentrations and isotopic ratios in 4 zooplankton samples from the N.W. Mediterranean Sea are shown in Table 2. Concentrations ranged from 3.13-9.45 $\mu\text{Bq}(^{239,240}\text{Pu})\cdot\text{m}^{-3}$ and 0.54-0.90 $\mu\text{Bq}(^{241}\text{Am})\cdot\text{m}^{-3}$ corresponding to concentration factors (CF), computed as indicated in IAEA (1985), ranging from $(2.90-9.5)\cdot 10^3$ for Pu and $(2.9-14)\cdot 10^3$ for Am.

Location	Pu-239,240		Pu-238	Am-241		Am-241
	$\mu\text{Bq}\cdot\text{m}^{-3}$	CF $\cdot 10^3$	Pu-239,240	$\mu\text{Bq}\cdot\text{m}^{-3}$	CF $\cdot 10^3$	Pu-239,240
Barcelona	8.4 \pm 0.6	4.7 \pm 0.3	0.065 \pm 0.014	0.54 \pm 0.11	2.9 \pm 0.7	0.064 \pm 0.013
Golf St. Jordi	9.5 \pm 0.4	8.2 \pm 0.8	0.099 \pm 0.011	0.9 \pm 0.3	3.8 \pm 1.5	0.095 \pm 0.034
Palomares	3.13 \pm 0.14	3.9 \pm 0.2	0.026 \pm 0.007	0.61 \pm 0.06	7.9 \pm 1.5	0.194 \pm 0.021
P. Macenas	2.90 \pm 0.12	4.8 \pm 0.4	0.024 \pm 0.008	0.80 \pm 0.08	14 \pm 3	0.274 \pm 0.030

Table 2. Transuranic concentrations in zooplankton (> 200 μm) from the N.W. Mediterranean Sea, August 1992 (uncertainties = $\pm 1\sigma$).

K_d 's, concentration factors and isotopic ratios. The particulate (> 0.2 μm) Pu amounted from 0.8% to 10% of the overall sea water activity, with K_d ranging from $(0.1-1.2)\cdot 10^5$ l·Kg⁻¹. This is only slightly smaller (but within the range) than the phytoplankton CF recommended by IAEA (1985) and that reported in the literature (FISHER *et al.*, 1983). The phytoplankton (> 20 μm) CF for plutonium could not be derived as the sample mass was too low to be determined by standard methods on the filtered material.

The mean CF's for zooplankton were $4.4\cdot 10^3$ for plutonium and $4.2\cdot 10^3$ for americium, slightly higher (but within the range) than the values recommended by the IAEA (1985). The plutonium isotopic ratios showed the presence of bomb plutonium in the Palomares area samples (Palomares and P. Macenas), though activities were not higher. The distortion observed in the Golf de St. Jordi sample confirms the presence of plutonium from a nearby nuclear power plant (Vandellós I). The americium to plutonium ratio indicates a varying degree of sediment-originated radionuclides in the samples, going from a predominately water origin (Barcelona) to a largely sediment origin (P. Macenas).

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