CELLULAR AND SUBCELLULAR DISTRIBUTION OF URANIUM AND TRANSURANIC RADIONUCLIDES IN MARINE ORGANISMS.

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Since radionuclides have been introduced in the marine environment by several ways (nuclear weapons tests, nuclear fuel cycle operations, accidental releases), it is a topic of interest to assess radionuclides bioavailability to marine organisms, in particular to those of economic interest such as shellfish.

Cellular and subcellular distribution of ^{238}U, ^{239}Pu and ^{241}Am was examined by means of microanalytical techniques in several organisms: oysters, mussels, shrimps, crabs and sea spiders collected from the French coastal waters (Channel, Mediterranean Sea and Atlantic Ocean). Secondary Ion Mass Spectrometry (Ion Microscope and Ion Microprobe) made possible to obtain isotopic measurements and cellular images of the radionuclides distribution. A post-acquisition image processing system was used in association with SIMS for multi-image correlation. X Ray Spectrometry (Camebax: Castaing Microprobe associated with a Transmission Electron Microscope) enabled investigations at the subcellular level.

Using both of these techniques, we were able to detect in every species, target organs (Fig.1 to 5), cells and organelles (Fig.6,7 and table) of radionuclides bioaccumulation and to elucidate some of the physiological strategies involved in the uptake, storage and elimination of these radioactive elements, concentration factors ranging from 10 to 2×10^3.

Compared to other analytical techniques (histoautoradiography, radiochemistry etc...), microanalysis, for which not much biological material is needed, provides accurate advantages such as a high sensitivity and very short term investigations, for the ecotoxicological control and watch of radionuclide pollution in the marine environment.

REFERENCES:

D.Calmet, S.Charmasson, J.M.Willemot, M.Verry, C.Chassard-Bouchaud, R.L.Inglebert, M.Outrequin and P.Galle, 1987, 239-240 Pu levels in Mussels Mytilus sp. collected from the French coasts: a radiochemical and microanalytical study. C.R.Acad. Sc. Paris, 304, série III, 9, p.199-206.

C.Chassard-Bouchaud, 1983, Cellular and subcellular localization of uranium in the Crab Carcinus maenas: a microanalytical study. Marine Pollution Bull., 14, 4, p.133-136.

C.Chassard-Bouchaud, 1987, Ion Mocroscopes and Microprobes in Marine Pollution Research, Analytica Chimica Acta, 195, p.307-315.

P.Galle and R.Masse, 1982, Radionuclides: metabolism and toxicity, Masson ed., Paris, 321 p.

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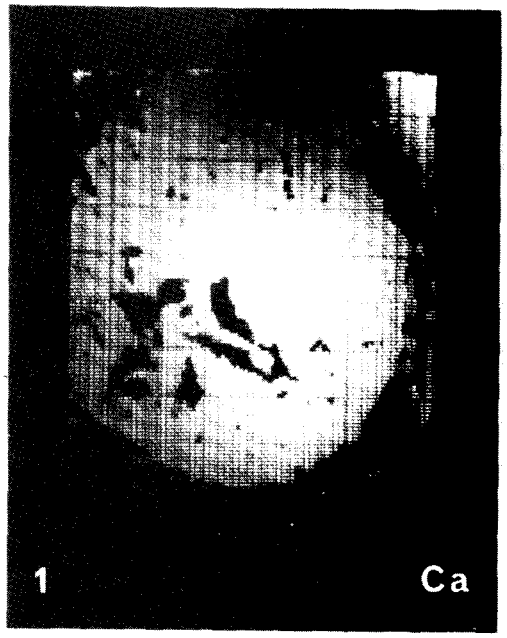
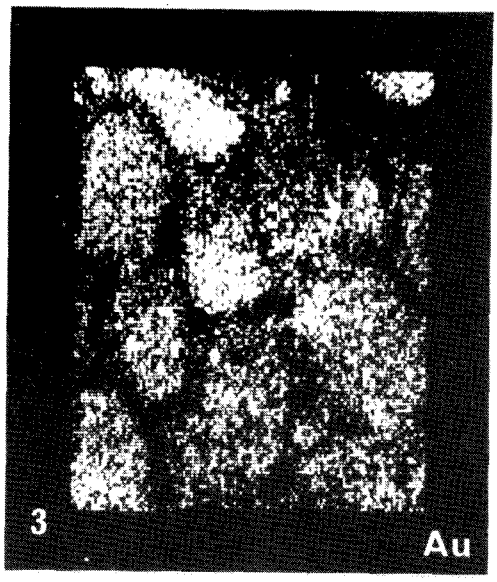


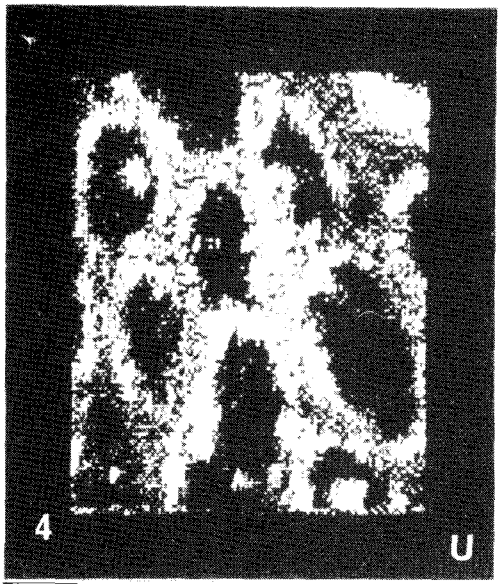
Sea Spider *Maia squinado* (Channel), Digestive gland.(200 µm full horizontal scale)
Ion probe images obtained from the same area (RIBER MIQ 156), 1: $^{40}Ca^{+}$,2:$^{239}Pu^{+}$
Elements appear as bright points in the biological section.

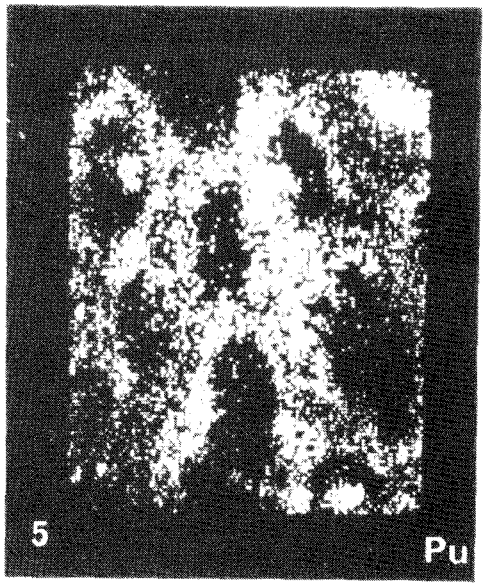
ORGANELLES	LYSOSOME (*DIGESTIVE GLAND*)	SPHEROCRYSTAL (*KIDNEY*)
ELEMENTS		
U	2750 ± 221	1820 ± 217
P	3020 ± 247	1937 ± 215

TABLE

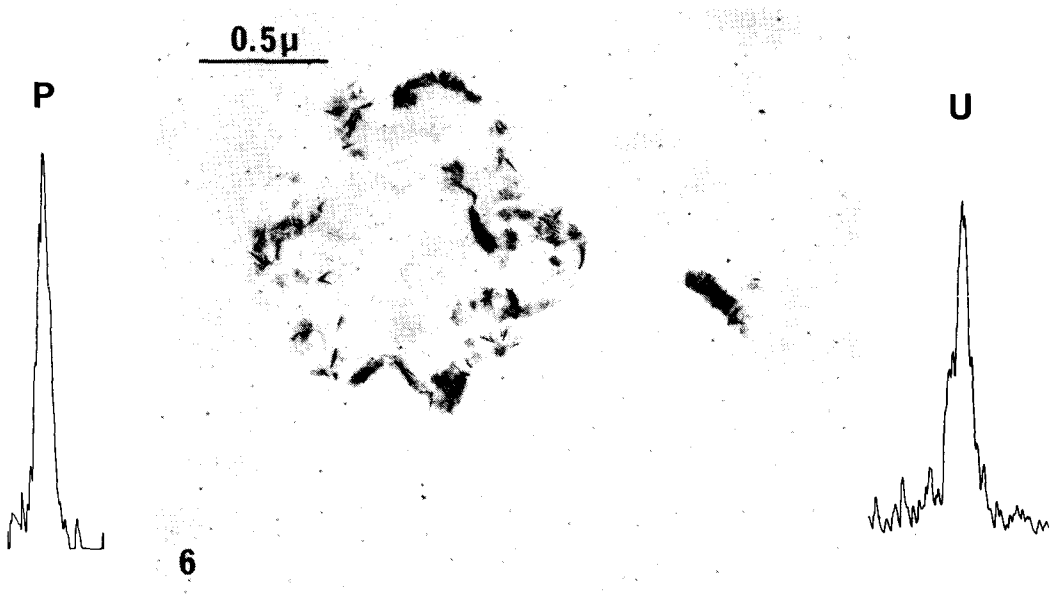
Mytilus edulis
*Electron probe X Ray microanalysis (CAMEBAX) of the organelles shown in Figures 6 and 7 (counting time : 100 sec.).*In these organelles,uranium is associated with phosphorus in the form of an unsoluble phosphate.

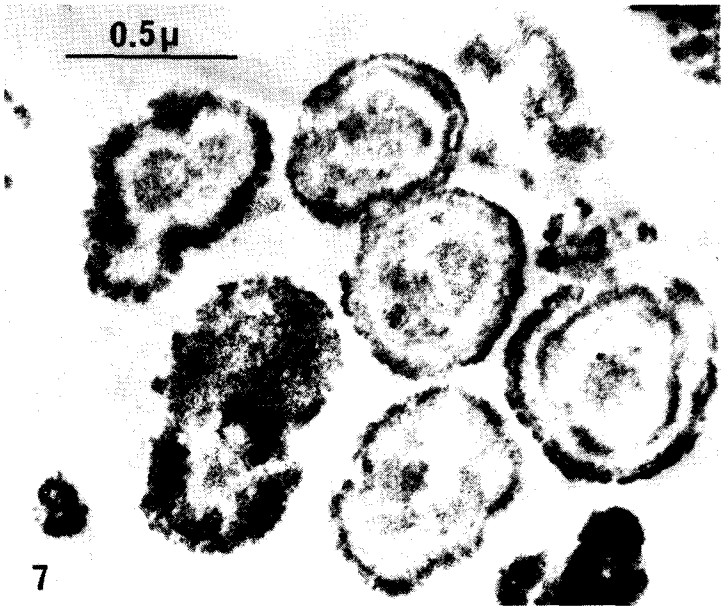






Mussel *Mytilus edulis* (Channel),Digestive gland.(200 μm full horizontal scale)
Ion probe images obtained from the same area (RIBER MIQ 156),3: $^{197}Au^{+}$, 4: $^{238}U^{+}$, 5: $^{239}Pu^{+}$. On the Au image,biological section appears dark and the gold of the specimen holder appears as bright points.On the U and Pu images,the elements appear as bright points in the biological section.





Mussel *Mytilus edulis* (Channel).

6:Electron image showing a lysosome with microneedles of uranium phosphate(unstained and non osmicated section).X Ray emission spectra of P and U,obtained from this lysosome are shown on each side.

7.Electron image showing spherocrystals where uranium phosphate is concentrated.