

RADIONUCLIDES PRESENT IN NORTH ADRIATIC SEA, IN FRONT OF THE PO DELTA
(1979-81)

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Abstract - Samples of marine water, plankton, organisms and sediment have been collected from 1979 to 1981 in the area facing the Po delta. The samples have been treated in order to determine the amount of artificial and natural radionuclides contained. The results concerning ^{137}Cs , ^{238}U , ^{232}Th are of some importance and are compared with those previously obtained in the same and in other marine areas of the Mediterranean Sea.

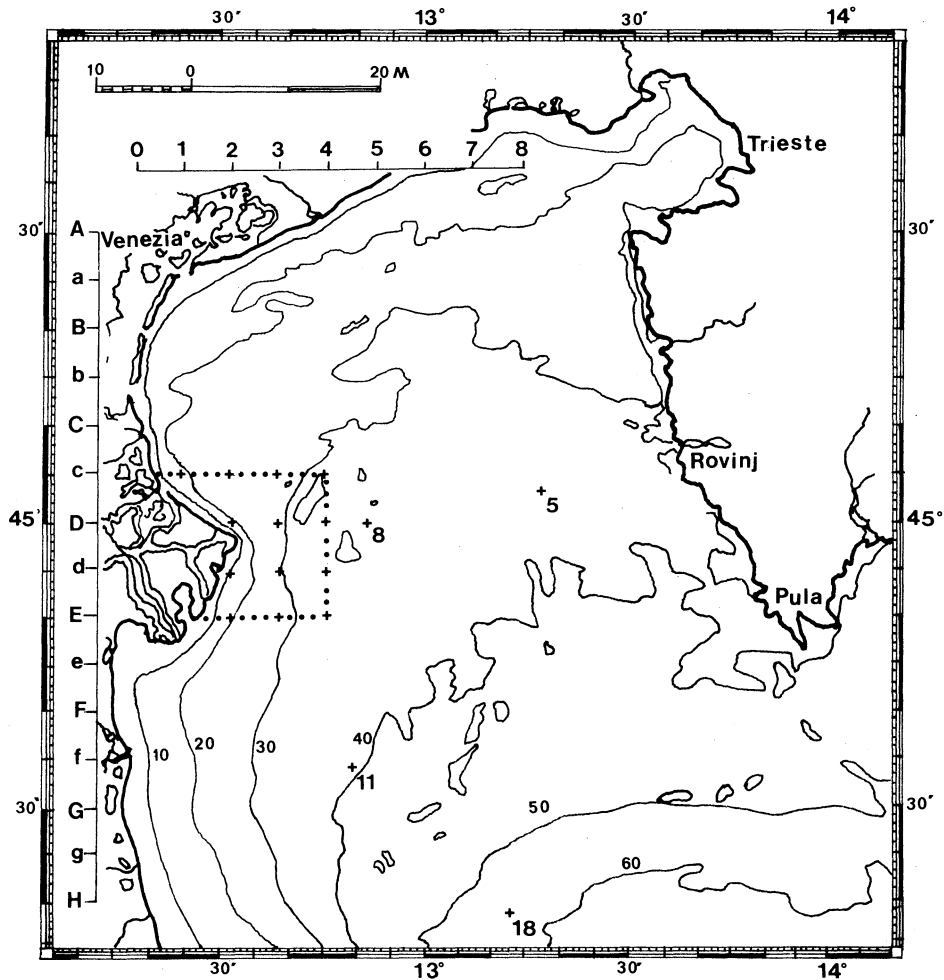
Résumé - De 1979 à 1981, nous avons effectué des échantillonnages d'eau marine, de plancton, d'organismes et de sédiment dans la zone du delta du Pô. Les étalons ont été analysés pour déterminer les radionucléides artificiels et naturels. Les résultats concernant ^{137}Cs , ^{238}U , ^{232}Th ont une certaine importance et sont comparés avec ceux obtenus précédemment dans la même zone et dans d'autres zones de la Méditerranée.

As in the past, the Radioecology Operative Unit of Parma University carries out researches to determine natural and artificial radioactivity in environmental matrices collected in different sea areas around the Italian coast. After Ligurian Sea, Tyrrhenian Sea and Taranto Gulf (Ionian Sea), attention has been paid again to the North Adriatic area: from 1979 to 1981 marine water, plankton, macroorganisms and sediment samples have been collected in the stations shown in Figure 1.

The sampling area of particular interest is a box in front of the Po river delta having different bathymetry values and complex hydro-bio-geomorphological characteristics.

It can be pointed out that since 1977 determination of radioactive fallout collected in Parma about 160 km far in the west has been performed (1,2). Normally monthly samples are analyzed for the ^7Be , ^{95}Zr , ^{103}Ru , ^{106}Rh , ^{137}Cs , $^{141,144}\text{Ce}$ contents whereas are considered, after atmospheric nuclear

Fig.1 - Sample collection area in the North Adriatic Sea



explosions, also weekly collections for the determination of short-life radionuclides ($^{131,132}\text{I}$, ^{140}Ba - ^{140}La , ^{239}Np etc.). This data set and their trends have been and are still useful as references in environmental studies.

Unfiltered sea water samples collected at a 5 m depth have been processed to isolate ^{137}Cs using ^{134}Cs spike to determine the radiochemical separation yield.

The results are reported in Table 1; some samples derive from the mixing of different station collections.

Table 1 - ^{137}Cs contents in sea water samples collected in the zone facing the Po delta

year	collection stations	pCi/m ³
SW 79	c3	185
SW 79	E4	195
SW 80	c(3-4) D(3-4)	180
SW 80	d(3-4) E(3-4)	163
SW 81	c1 - D2 - d2 - E2	139
SW 81	c(3-4) D(3-4)	191
SW 81	d(3-4) E(3-4)	153

Details on collection, conservation and treatment are reported in other publications (3-6). It can be noticed that the ^{137}Cs value (1981) of 139 pCi/m³ refers to an integrated collection near the coast. These data are in the range of those recently obtained by other Authors in other zones of the Mediterranean Sea (5, 7-9).

Plankton samples have been collected by a 200 um mesh net at surface and at a 10 m depth. The data obtained are reported in Table 2. Other information on these samples are published elsewhere (6,10).

The presence of gamma emitters in the 1981 samples is scarce or below the detection limits. The radionuclide presence in the November 1980 zooplankton samples is comparable with that observed in the gamma spectrum of fallout collected in the same month: in fact the last Chinese atomic explosion occurred on 16th October 1980.

Table 2 - Radionuclide content in zooplankton samples from the North Adriatic Sea (pCi/g dry_{±2} at the date of collection)

	st.5	st.8	st.11	st.18	st.c ₁	st.c ₂	st.c ₃	st.D ₄
⁴⁰ K	13.10 _{±1.12}	11.80 _{±1.21}	12.00 _{±1.17}	11.90 _{±1.37}	9.21 _{±1.73}	10.40 _{±1.50}	10.50 _{±1.41}	8.06 _{±1.37}
⁷ Be	8.93 _{±0.22}	4.60 _{±0.18}	6.00 _{±0.12}	5.33 _{±1.39}	5.43 _{±1.09}	2.84 _{±0.71}	3.03 _{±0.61}	N.D.
⁹⁵ Zr	0.93 _{±0.17}	0.36 _{±0.24}	0.37 _{±0.15}	0.71 _{±0.29}	0.54 _{±0.16}	N.D.	0.56 _{±0.15}	0.73 _{±0.20}
⁹⁵ Nb	1.90 _{±0.27}	0.70 _{±0.17}	0.47 _{±0.27}	1.45 _{±0.30}	0.67 _{±0.10}	0.24 _{±0.10}	0.78 _{±0.14}	1.05 _{±0.16}
¹⁰³ Ru	0.53 _{±0.11}	0.36 _{±0.03}	0.30 _{±0.08}	0.36 _{±0.26}	N.D.	N.D.	N.D.	N.D.
¹³⁷ Cs	0.13 _{±0.06}	0.07 _{±0.03}	0.11 _{±0.05}	N.D.	N.D.	N.D.	N.D.	N.D.
¹⁴¹ Ce	1.28 _{±0.23}	1.46 _{±0.12}	1.07 _{±0.11}	0.77 _{±0.17}	0.67 _{±0.14}	N.D.	0.74 _{±0.08}	0.46 _{±0.09}
¹⁴⁴ Ce	0.78 _{±0.23}	0.38 _{±0.18}	0.34 _{±0.12}	0.57 _{±0.21}	1.77 _{±0.37}	0.76 _{±0.18}	0.13 _{±0.10}	N.D.
gross Beta*	25.84 _{±1.67}	28.82 _{±2.05}	28.07 _{±2.97}	65.07 _{±4.46}	19.15 _{±1.66}	20.82 _{±2.42}	23.05 _{±1.86}	21.19 _{±2.05}

* measured 1 month after the collection

N.D. = not detectable

Macroorganisms samples like those listed in Table 3 have been analyzed by gamma spectrometry, but the values have shown to be under the detection limits of our instruments. Therefore the table only reports the beta radioactivity values with reference to ⁴⁰K.

At present, samples are under radiochemical separation to determine the ¹³⁷Cs and ²³⁹Pu contents.

Sediment collections have been obtained using a grab sampler or a corer or a box-corer (3,4). Determinations have been carried out by gamma spectrometry with Ge-Li devices and the results mainly concern ¹³⁷Cs, ²³²Th, ²³⁸U and ⁴⁰K; thorium and uranium have been evaluated by the gamma emission of ²⁰⁸Tl and ²¹⁴Bi, respectively under the assumption that the natural radioactive chains are in equilibrium.

Table 4 report the results for the upper layer sediments and those for some vertical distributions.

Table 3 - Gross beta radioactivity values (^{40}K ref.) of some organisms collected in the zone facing the Po delta

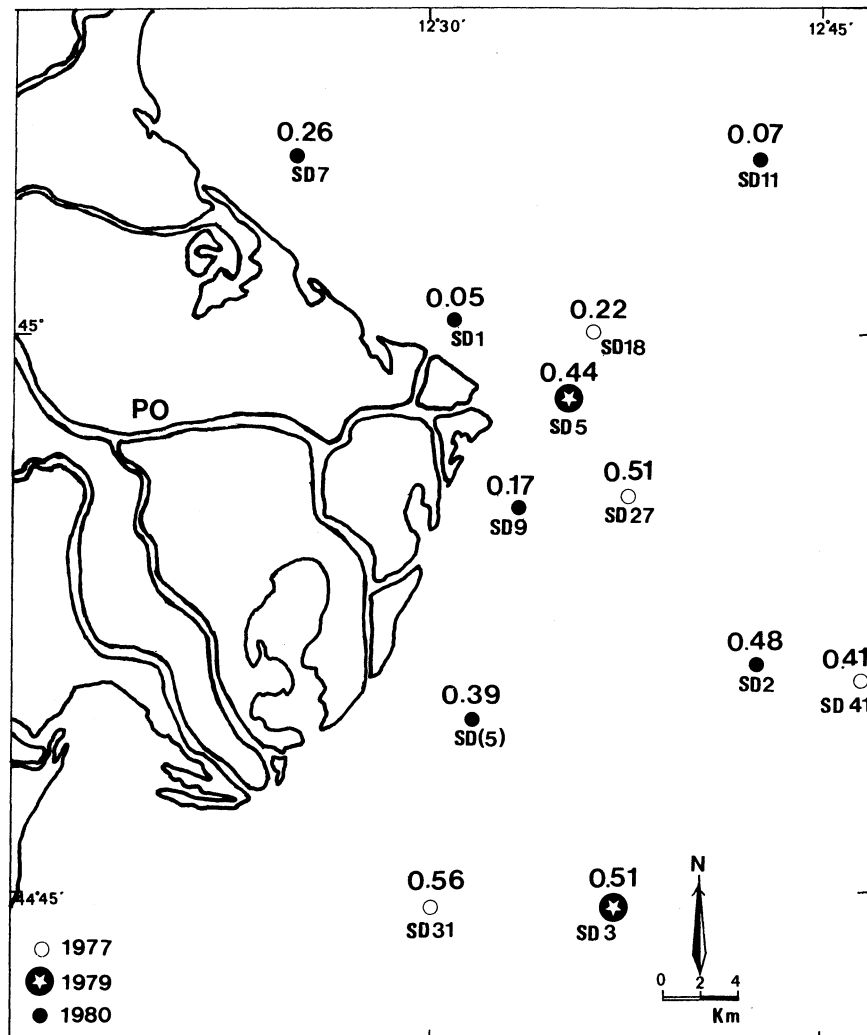
organisms	year of collection	pCi/g dry
<u>Sepia officinalis</u>	1980	12.8
<u>Sepia officinalis</u>	1981	11.6
<u>Gobius niger yozo</u>	1981	11.9
<u>Ophiura sp.</u>	1981	3.9
<u>Astropecten sp.</u>	1981	13.8
<u>Portunus sp.</u>	1981	8.9
Plankton	1979	10.0
	1980	8.2
	1981	12.7

Table 4 - Natural and artificial radioactivity contents in sediments collected in the zone facing Po delta

year and collection stations	pCi/g dry				year and collection stations	pCi/g dry			
	^{232}Th	^{238}U	^{137}Cs	^{40}K		^{232}Th	^{238}U	^{137}Cs	^{40}K
<u>SD-77-18</u>	0.60	0.68	0.22	12.56	<u>SD-77-27</u>	0.58	0.73	0.51	16.34
<u>SD-77-31</u>	0.60	0.66	0.56	16.97	<u>SD-77-41</u>	0.63	0.60	0.41	16.17
<u>SD-79-5</u>					<u>SD-79-3</u>				
cm 0-3	0.71	0.52	0.37	10.98	cm 0-3	0.59	0.63	0.42	12.13
" 3-6	0.91	0.63	0.50	16.46	" 3-6	0.59	0.32	0.59	10.69
" 6-9	0.24	0.69	0.45	14.44	" 6-9	0.99	0.66	0.59	20.22
" 9-12	0.59	0.72	0.34	16.46	" 9-12	0.52	0.40	0.38	15.89
" 12-15	0.24	0.69	0.43	15.89	" 12-15	0.63	0.43	-	16.46
<u>SD-80-1</u>					<u>SD-80-2</u>				
cm 0-5	0.87	0.65	0.05	16.00	cm 0-5	1.03	0.64	0.48	19.04
" 5-10	0.92	0.68	0.07	17.26	" 5-10	0.67	0.56	0.50	22.05
					" 10-15	0.67	0.80	0.51	18.64
<u>SD-80-(5)</u>					<u>SD-80-7</u>				
cm 0-5	0.98	0.64	0.39	29.07	cm 0-5	0.53	0.72	0.24	23.19
" 5-10	0.78	0.89	0.42	19.05	" 5-10	0.79	0.77	0.19	28.24
" 10-15	0.78	0.65	0.24	17.31	" 10-16	0.68	0.84	0.16	13.18
<u>SD-80-9</u>					<u>SD-80-11</u>				
cm 0-5	0.85	0.87	0.17	20.63	cm 0-5	0.56	0.51	0.07	17.22
" 5-10	0.50	0.56	0.08	12.56	" 5-10	0.50	0.60	0.13	
" 10-15	0.89	0.65	-	22.65	" 10-15	0.49	0.56	0.04	22.35

As for ^{137}Cs , in particular, surface distribution data concerning the 0-6 cm sediment layer are reported in the map of Figure 2.

Figure 2 - ^{137}Cs distribution in the upper layer sediment near the Po delta



Finally Table 5 reports a comparison of ^{238}U , ^{232}Th , and ^{137}Cs concentrations in the upper layer sediments collected at different times in different zones along the Italian coast (4, 5, 11-14).

Table 5 - Radionuclide contents in the upper layer sediments from different seas (pCi/g dry)

	North Adriatic Sea		Ionian Sea		Ligurian Sea
	Po Delta	other zones	mouth Sinni	other zones	La Spezia Gulf
^{238}U	0.43-0.87	0.64-0.69	0.66-1.09	0.66-1.49	0.83-1.02
^{232}Th	0.53-1.03	0.61-0.86	0.36-0.48	0.57-0.83	1.11-1.16
^{137}Cs					
1966	- -	0.17-0.66	- -	- -	0.02-0.52
1069	- -	- -	0.25	0.28-0.47	- -
1977-80	0.05-0.56	0.08-0.27	- -	- -	- -

A complete study on sediment ^{137}Cs distribution and granulometric-petrographic characterization is in progress together with a study on the vertical radioactivity distribution, and will be the subject of a further paper.

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"Radionuclides present in North Adriatic Sea, in front of the Po delta (1979-81)"

Paper presented by C. Triulzi (Italy)

Discussion

H. FLOROU-GAZI: How much time after the Chinese nuclear explosion did you collect the plankton samples?

C. TRIULZI: We collected the plankton samples at stations 5,8,11,

18 during the period 7-9 November; the nuclear explosion occurred on the 16 October. Samples were analyzed by gamma spectrometry between the 20-30 November.

C. PAPADOPOULOU: Do you have values for the radionuclides analyzed in sea water, Po river water and sediments?

C. TRIULZI: I have some data for river samples. These data, not directly comparable with those from the marine samples, are derived from samples collected near the Trino and Caorso nuclear power plants, 300-400 km upstream from the delta.

S. FOWLER: What is the principal goal of your research?

C. TRIULZI: The aim of our research is to obtain an overall picture of the distribution of ^{137}Cs and $^{239,240}\text{Pu}$ in abiotic and biotic compartments of the immediate environment of the Po delta and, more extensively, in the North Adriatic Sea.

