Recent threats on coastal ecosystems by new pollutants: a multiple trace elements study

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Introduction and objectives:

Some previously poorly studied trace elements can now be considered as chemical pollutants further to the recent modification of their production and industrial uses (fig. 1). In this project, we investigate:

- the potential use of the purple sea urchin (grazer), the posidonia (primary producer) and the Mediterranean mussel (filter feeder) as bioindicators (fig. 2) ;
- bioconcentration and biomagnification processes in the Mediterranean coastal environment ;
- dynamics of absorption and excretion of selected elements in experimental mesocosms ;
- the cartography of the seagrass bed health status of PACA area (Provence-Alpes-Côte d'Azur) and Corsica coast (trace element measures associated to biometry, stable isotopes and C:N:P ; in collaboration with the IFREMER) (fig. 3) ;
- the past evolution of Mediterranean coastal trace element pollutions by lepidochronological analyses(1).

Figure 1. Periodic table with classic and newly studied trace elements.

Group 1	Group 2	Group: 3	4	5	6	7	8	9	10	11	12	Group 13	Group 14	Group 15	Group 16
		← d transition elements →													
3 0.98 Li 6.941	4 1.57 Be 9.012											5 2.04 B 10.811	6 2.55 C 12.011	7 3.04 N 14.007	8 3.44 O 15.999
11 0.93 Na 22.990	12 1.31 Mg 24.305											13 1.61 Al 26.98	14 1.90 Si 28.086	15 2.19 P 30.974	16 2.58 S 32.064
19 0.82 K 39.102	20 1.00 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.941	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.71	29 Cu 63.546	30 Zn 65.37	31 1.81 Ga 69.72	32 2.01 Ge 72.59	33 2.18 As 74.922	34 2.55 Se 78.96
37 0.82 Rb 85.47	38 0.95 Sr 87.62	39 Y 88.906	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.91	46 Pd 108.4	47 Ag 107.87	48 Cd 112.40	49 1.78 In 114.82	50 1.96 Sn 118.69	51 2.05 Sb 121.75	52 2.10 Te 127.60
55 0.79 Cs 132.91	56 0.89 Ba 137.34	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 2.04 Tl 204.37	82 2.32 Pb 207.19	83 2.02 Bi 208.98	84 Po (210)
87 Fr (223)	88 Ra 226.025	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Unb				

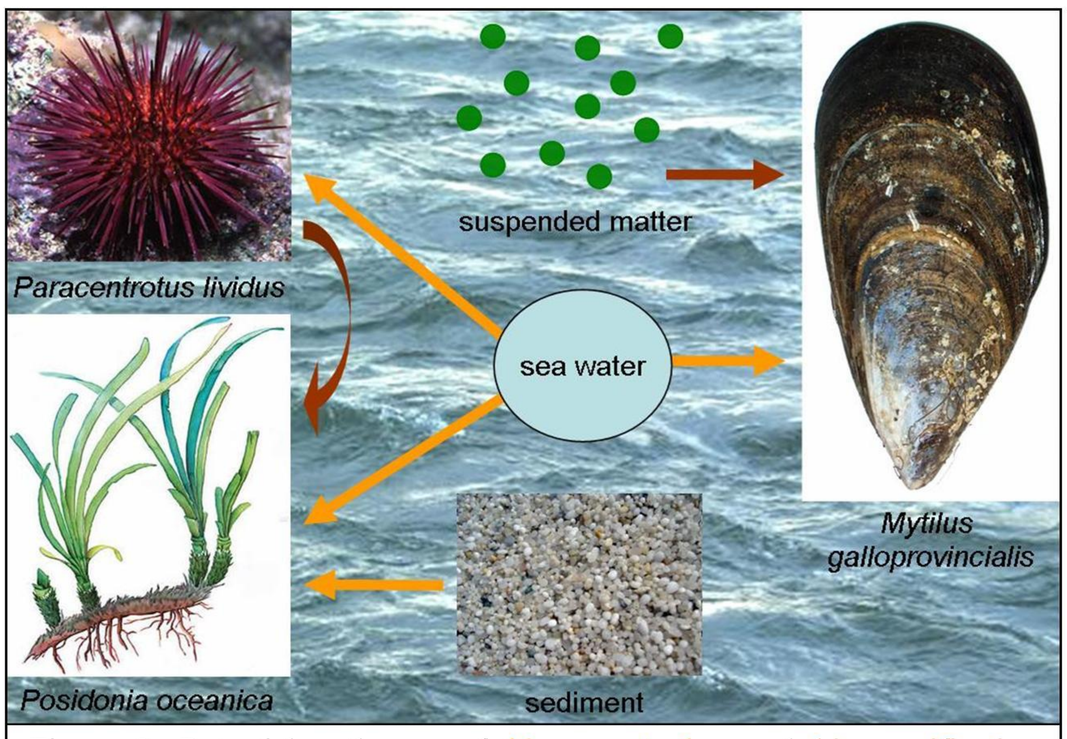

Figure 2. Potential pathways of bioconcentration and biomagnification studied in this project.

Sampling strategy:

Sampling of sea urchins and posidonia, and mussel caging, in reference and polluted sites (fig. 3):

- spatial variability (Marseille, Calvi, Naples ; French coasts) ;
- seasonal (march, june, november) and interannual variability ;
- trace element distribution in organism tissues.

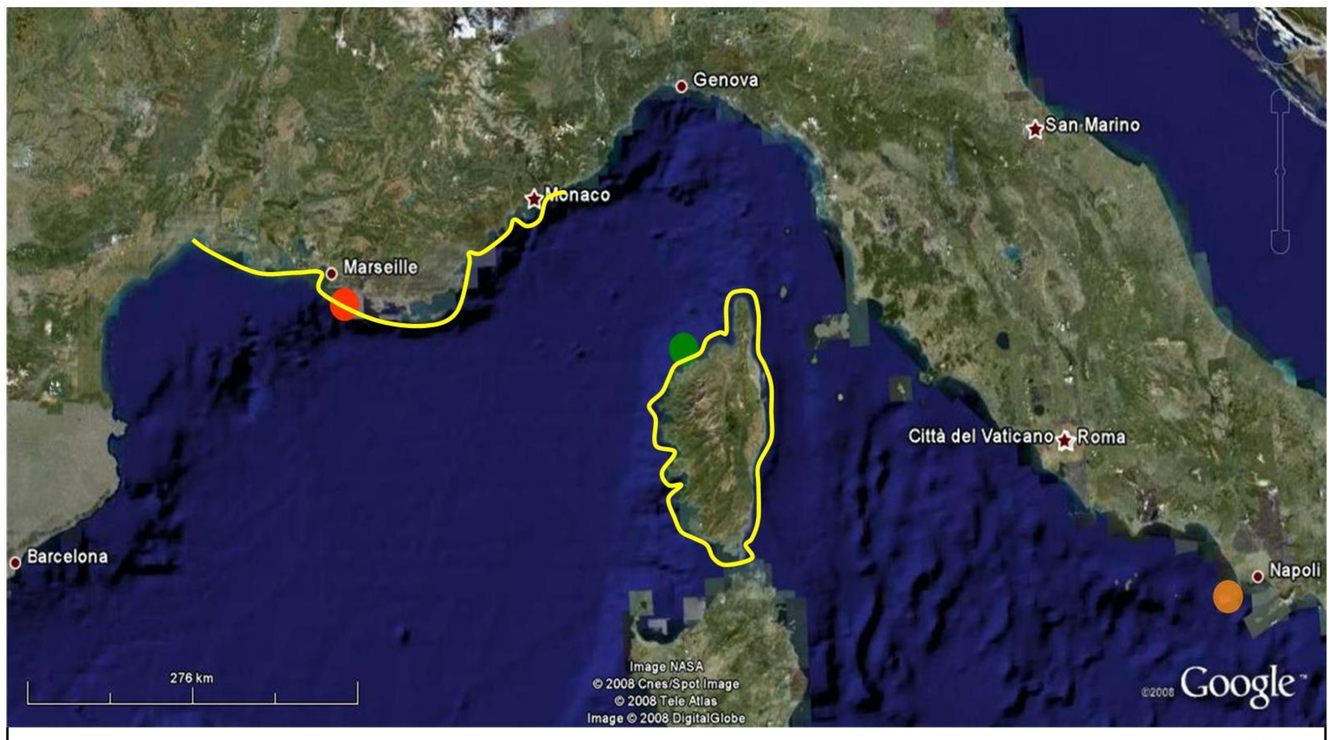

Figure 3. Northwestern Mediterranean bassin showing seasonal sampling sites (Marseille, Calvi, Naples) and Corsica and Paca coasts (highlited in yellow).

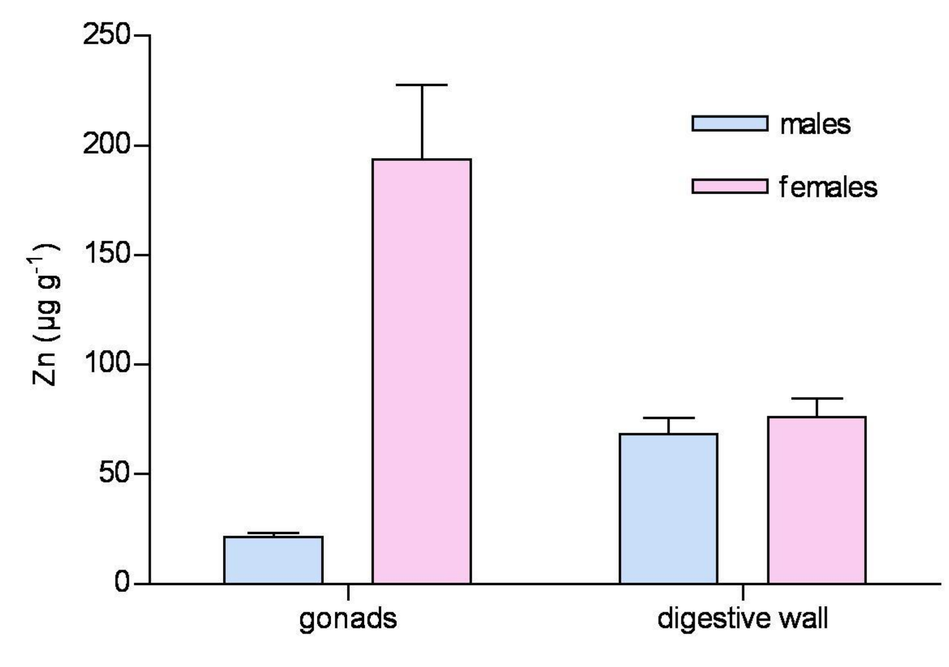

Figure 4. Zn concentrations (µg g^{-1} of dry weight) in gonads (G.) and in the digestive wall (D.W.) of female (n=3) and male (n=3) sea urchins.

First results for urchins sampled in march 2008 in Calvi:

Investigated elements are all measurable in sea urchin soft tissues. They show higher concentrations in the digestive wall than in gonads (e.g. table 1). These data can be considered as reference values for comparisons with polluted sites. All trace elements present similar concentrations in female and male soft organs, excepted for gonadal Zn content (fig. 4). Indeed, oogenesis requires larger amounts of Zn than spermatogenesis(2). *P. lividus* is an interesting candidate to monitor recent trace element pollution of the coastal ecosystem.

Trace element	Al	V	Cr	Fe	Mn	Co	Ni	Cu	Zn	Se	Mo	Ag	Cd	Pb
G. average	27.15	0.61	0.17	33.20	1.45	0.12	1.99	3.19	193.67	1.97	0.21	0.08	0.13	0.10
SD	18.85	0.30	0.06	11.52	0.31	0.02	0.64	0.36	58.76	0.43	0.10	0.01	0.10	0.03
D.W. average	276.67	2.95	0.54	172.67	4.66	0.36	7.78	16.10	76.10	2.79	4.43	0.98	3.64	0.88
SD	146.03	0.76	0.12	65.74	1.19	0.10	4.27	4.91	14.90	0.73	0.68	0.46	1.07	0.21
max. / min. ratio	10.19	4.87	3.20	5.20	3.22	3.04	3.90	5.04	2.54	1.41	21.38	12.46	27.36	9.09

Table 1. Trace element concentrations (µg g^{-1} of dry weight) in gonads (G.) and in the digestive wall (D.W.) of female sea urchins (n=3). Red averages are significantly different ($p<0.5$) between tissues.

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Bibliography: (1) Pergent-Martine and Pergent (1994). Oceanologica Acta. 17 (6): 673-681 ; (2) Unuma *et al.* (2007). FEBS Journal. 274: 4985-4998..

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