Correlation between 2,3,7,8-tetrachlorodibenzofuran levels in sediments and clams (Tapes sp.) from the Venice lagoon

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Introduction

In the '90s many research programs dealing with the chemical contamination of the Venice lagoon were carried out. Among the chemicals considered in these programs, there were many persistent toxic substances (PTSs) including selected polycyclic aromatic hydrocarbons, polychlorobiphenyls, polychlorinated dibenzo-*p*-dioxins (PCDDs) and dibenzofurans (PCDFs), and chlorinated pesticides. Matrices of interest were biological (e.g., bivalves) and abiotical (e.g., sediments). The predictive power of the relationships between clams — a traditional Venetian cultivated organisms — and congruent bottom sediments was recently studied for the TEQ sum estimates.[1] In this study, a clear trend was observed where an increase of sediment contamination levels corresponded to a clam body burden increase. The relationship showed a non-linear behaviour, indicating that the bioaccumulation process rate is greater at lower environmental concentrations than at higher ones. Some differences among the congener behaviours can be expected on the basis of their chemical-physical characteristics.[2] A congener bearing a remarkable interest for its bioaccumulation behaviour is 2,3,7,8-T_4CDF ("TCDF").[3] In this paper, the results of a field correlation study on TCDF levels detected in clams and sediments from the Venice lagoon is presented.

Experimental and modelling

Data were derived from unpublished and published material.[1,4,5,7] The 26 pairs of PCDD+PCDF concentration values selected — X, in dry sediments; Y, in whole clams — were obtained from lagoon sites/zones with different contamination levels (see table; Figure 1). The relationship between clams and sediments was studied upon the following conditions: (1) biological and abiotical samples were selected when sampling sites/zones were under a fairly even and well-defined local impact; (2) clam size was considered of low priority; (3) organisms physiological state was disregarded;[6] (4) a dynamic exposure condition was assumed, as a large seabed movement occurs in the shallow lagoon waters (average depth, ≈0.7 m). Linear regression was carried out with the canonical form $y = w x + q$ (Eqn. 1) on the set of 26 ln-transformed analytical X-Y values, so that: y = ln(Y); x = ln(X); $q = \ln(m)$. In a linear field, Eqn. 1 reverts to the power function $Y = m X^{w}$ (Eqn. 2). For $w = 1$, Eqn. 2 formally coincides with the simplest bioaccumulation model $C_{TSS} = BAF\ C_S$ (Eqn. 3), where: C_{TSS}, tissue concentration at steady state; BAF, bioaccumulation factor; C_S, sediment concentration. In Eqn. 2, these quantities correspond to Y, m, and X, respectively.[1]

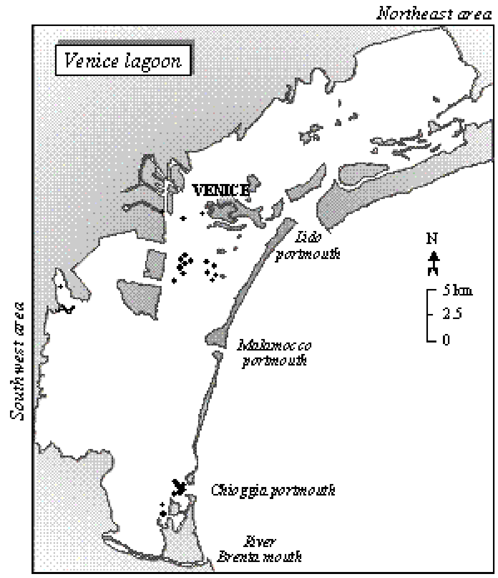

Figure 1. Layout of paired clams and sediment sampling sites/zones.

TCDF levels (pg g^{-1}) in clam and sediment samples collected in the Venice lagoon. Values rounded off to three figures.

	Clam [a]	Sediment[b]		**Clam**	Sediment
1	0.171	0.290	*14*	0.780	1.06
2	0.176	0.290	*15*	0.977	4.78
3	0.239	0.290	*16*	0.984	9.18
4	0.250	1.03	*17*	1.10	2.22
5	0.290	0.770	*18*	1.19	0.910
6	0.294	0.290	*19*	1.20	8.42
7	0.336	0.290	*20*	1.20	0.780
8	0.360	0.820	*21*	1.22	1.50
9	0.412	0.290	*22*	1.30	7.69
10	0.433	0.290	*23*	1.50	5.81
11	0.450	0.550	*24*	1.66	1.50
12	0.660	6.31	*25*	2.77	9.30
13	0.760	2.20	*26*	3.23	7.98

(a) On the whole (fresh) weight (*ww*).
(b) On the dry weight (*dw*).

Results and discussion

Figure 2a exhibits the ln-transformed analytical data scattergraph, Eqn. 1 best fit line, and the related regression equation. Based on Eqn. 1 regression coefficients and their standard errors, the power form $Y = (0.577 \pm 0.061)\,X^{(0.497 \pm 0.080)}$ (Eqn. 2a) may be derived. This is clearly a non-linear relationship ($w \neq 1$) where; in particular, the rate of Y increase diminishes with increasing X ($w < 1$). Figure 2b shows the scattergraph of analytical data in the X-Y linear field and the best fit curve $Y = (0.69 \pm 0.13)\,X^{(0.44 \pm 0.11)}$ (Eqn. 2b) obtained from the direct non-linear regression with Eqn. 2: it may be seen that Eqns. 2a and 2b are in good agreement. Eqns. 2a and/or 2b confirm what was previously observed with PCDD+PCDF cumulative estimates[1] and are in agreement with other observations.[6] By multiplying the estimated BAF for the ratio $f_{LIP} \times f_{OC}^{-1}$ — average extracted organic fractions for clams and sediments,[7] respectively 1.0 and 0.31 % — an indicative mean value in the order of 2 is obtained for the AF based on the equilibrium partitioning theory. This value is in the range of AF estimates found for PCBs and infaunal organisms.[6] The dispersion around the curve can be attributed essentially to the different organism sizes and their physiological state, [6] and to the exposure characteristics that appear to be linked to sediment contamination levels.

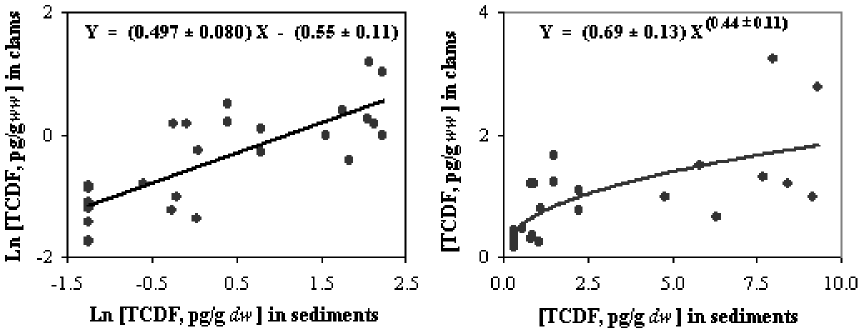

Figure 2. Correlations between TCDF concentrations in clams and bottom sediments from the Venice lagoon. Regressions were carried out on the original analytical values (pg g^{-1}) ($F_{2,24}$ = 47.6, P_F << 0.001; R = 0.701, P_R < 0.001) or their log-transformations ($F_{2,24}$ = 38.5, P_F << 0.001; R = 0.785, P_R << 0.001).

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