ROLE OF SOLID PHASE AND POREWATER IN EVALUATING MARINE SEDIMENT TOXICITY BY SEA URCHIN BIOASSAYS

G. Pagano [1], M. Guida [1], A. De Biase [1], R. Oral [2], M. Warnau [3] *

[1] Federico II Naples University, Department of Biological Sciences, Section of Hygiene and Microbiology, I-80134 Naples, Italy

[2] Ege University, Faculty of Fisheries, TK-35100 Bornova, Izmir, Turkey

[3] International Atomic Energy Agency, Marine Environment Laboratory, MC-98012 Monaco - m.warnau@iaea.org

Abstract

Coastal sediment samples were tested from a series of sites (Mediterranean, North Sea and Baltic Sea), for the induction of toxicity endpoints in sea urchins. The major goals of this study consisted of: a) defining the localisation of toxic sediment sites, and b) comparing the toxicities of sediment components (solid phase, SP *vs*. porewater, PW). The results showed that: a) toxicity outcomes were consistent with the data of pollutant analyses, and b) SP- and PW-associated toxicity was exerted to different extents.

Keywords : Echinodermata, Bio-indicators, Ecotoxicology, Sediments.

When evaluating sediment toxicity, most of the literature reports on PW, elutriates, or extracts, whereas only a few authors [1] have recognised the relevance of whole sediment bioassays in providing a realistic evaluation of sediment toxicity. This study was to evaluate the toxicity to sea urchin embryos and sperm by whole sediment (WS) samples with the following goals: 1. providing a topographic characterisation of sediment toxicity, and 2. comparing PW to SP toxicity from sediment samples from various sites.

Sea urchin bioassays were utilised in toxicity testing of environmental contaminants, pharmaceutical drugs, as well as complex mixtures with good agreement between bioassay and analytical data [2].

Two species of sea urchins were utilised (*Sphaerechinus granularis* and *Paracentrotus lividus*); the gametes and embryo cultures were obtained as described previously [2,3]. Sediment was collected from a set of sites in Italy, Germany, and the Netherlands. The samples were tested within two weeks as WS, or SP or PW (0.1 to 1%, dry w/v). Sediment aliquots were laid in 10-ml wells of cultures plates, suspended in filtered seawater (FSW) and stirred. Fertilised eggs were laid on sediment, whereas sperm were suspended (0.1%) in stirred sediment and untreated eggs were fertilised by the supernatant sperm suspension (0.5%).

Tab. 1. Percent developmental defects in *S. granularis* larvae exposed to sediment samples from Kiel Fiord tested as solid phase (SP) or pore water (PW). *Abbreviations: W = Warnemünde; K = Kiel Fjord; R = % retarded larvae; P1 = % malformed larvae; P2 = % arrested embryos (e.g. gastrulae); D = % dead embryos/larvae.*

#Site	R	P1	P2
Blank	3.5 ± 1.0	3.3 ± 0.6	3.3 ± 0.8
SP			
K1	0.0 ± 0.0	0.0 ± 0.0	100.0 ± 0.0
K2	15.5 ± 2.1	6.7 ± 1.6	40.7 ± 7.2
K3	24.5 ± 1.8	3.2 ± 1.4	63.0 ± 5.1
K4	48.3 ± 10.7	4.7 ± 2.0	40.8 ± 12.5
PW			
K1	6.8 ± 1.7	6.5 ± 1.1	4.5 ± 0.9
K2	26.7 ± 17.0	7.5 ± 3.9	65.8 ± 18.5
K3	27.5 ± 13.7	10.7 ± 5 .1	61.8 ± 17.6
K4	10.8 ± 4.7	13.7 ± 10.6	3.5 ± 1.8

Toxicity of Italian coastal sediment was exerted to a varied extent according to the different sampling sites. The sediment-associated developmental toxicity ranked as follows: Pula (14) >Sarno River estuary (21) >Palermo (15) ≅ Palmas (13) ≅ Capri (20). When sperm were exposed to 0.2% sediment samples, site 21 (Sarno River estuary), showed a significant mitotoxic effect ($p<0.01$). Mitotic aberrations ranked as follows: 21 >14 ≅ 22a >15 ≅ 17 ≅ 19. The Pula site has been affected by a coal-fueled power plant; the other sites were Palermo harbour, and at the mouth of the Sarno River, affected by a number of pollution sources [4].

Toxicity of Baltic Sea sediment (Germany) was evaluated from four sites in the Kiel Fjord (K) and five sites offshore Warnemünde (W). As shown in Table 1, the highest toxicity to *S. granularis* embryos was exerted by K1, and was confined to the SP component, whereas PW was found to be non-toxic. The K4 site also displayed toxicity for the SP component only. The other two sites (K2 and K3) were effective in inducing developmental arrest for both SP and PW. Mitotic activity and fertilisation success were significantly decreased by the K1 sample.

The other values observed for the K1 site suggested an overall depression of the mitotic activity, as well as an increase in morphologic aberrations. The other sediment samples displayed non-significant changes, with the exception of a decreased MPE for site W1. By exposing *P. lividus* sperm to Baltic Sea sediment, fertilisation success was significantly decreased by the K1 sample and, to a lesser extent, by K2 and K5 samples. The resulting offspring quality was affected, to the highest extent by the K2 sediment sample, as 100% of embryos were either malformed or developmentally arrested.

Offspring quality was affected, to the highest extent by the K2 sediment sample. Toxicity of North Sea sediment showed that PW resulted in stronger toxic effects than SP.

Conclusions

The relative toxicities of the two sediment components cannot be assessed a priori, thus both SP and PW should be tested for a reliable assessment of sediment toxicity. For practical purposes, WS toxicity testing may provide realistic information both encompassing SP- and PW-associated toxicities.

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