Effects of Diatom Derived Oxylipins on Morphology and Gene Expression During Embryonic Development of Sea Urchin *Paracentrotus lividus*

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Abstract

Diatoms are a major class of unicellular algae that have traditionally been considered essential in sustaining the marine food chain. In the last decade diatoms have been shown to release a wide range of secondary metabolites, including polyunsaturated aldehydes (PUAs), hydroxyacids (HEPEs) and epoxy-alcohols (collectively termed oxylipins) through a wound-activated mechanism.

The present study focuses on the molecular mechanisms underlying the stress response to oxylipins, using the sea urchin *Paracentrotus lividus* as model organism. The impact of two classes of diatom-derived oxylipins, the PUAs (heptadienal and octadienal) and the HEPEs (5-, 9-, 11- and 15-HEPE) were examined on *P. lividus* embryos, comparing their biological activities with the better-studied PUA decadienal. Developing embryos were exposed to increasing concentrations of oxylipins, indicating that both PUAs and HEPEs induced dose-dependent teratogenesis. Moreover, the expression levels of several genes (having a key role in a broad range of functional responses, such as stress, development, differentiation, skeletogenesis and detoxification processes) were followed by Real Time qPCR in order to identify the targets affected by PUAs and HEPEs and their correlation with morphological abnormalities. Interactomic Ingenuity Pathway Analysis showed that the genes targeted by oxylipins were correlated with four HUB genes, *NF-κB*, *p53*, *δ-2-catenin* and *HIF1A*, describing for the first time hypothetical pathways potentially involved in the toxic stress response in sea urchins.

Finally, *P. lividus* embryos were also treated with higher concentrations of oxylipins, demonstrating that they were able to induce apoptosis in sea urchin embryos through the activation of caspase-3/7 and caspase-8.

In conclusion, these results assume considerable ecological relevance, considering the importance of diatom blooms in nutrient-rich aquatic environments. Future efforts in toxicological studies should therefore be directed to better clarify the negative effects of these molecules on grazers, because they are abundantly released during diatom bloom at sea.