

Time-course analysis of gene expression of a benthic protist during exposure to titanium dioxide nanoscale particles.

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The engineered nanomaterials have caused serious environmental pollution in the ocean. Marine environmental pollution represents nowadays an international issue, because they potentially destruct the marine ecosystem. Especially along the coast, the inflow and sedimentation from rivers and the convection by tides concentrate such pollutants, leading lethal exposure to the benthic organisms. The accumulation of artificial materials has been reported from many marine vertebrates (fish, turtles, whales, etc.), however few from benthic organisms. Moreover, we have still not known the effect of those materials to life *in vitro*. Benthic foraminifers, a group of benthic protists play important roles for supporting food web and carbon cycles. They have three unique features: (1) wide distribution in marine and transitional marine environments including polluted area, (2) large-sized cell ($> 200 \mu\text{m}$), and (3) uptake of external materials into the cell through the pseudopodia. These characters provide us an excellent condition for exposure experiments to test physiological reactions (i.e., stress) of foraminifera to the engineered nanoparticles additive sea-water (Ciacci et al., 2019). This study presents “*in vitro*” exposure experiments in time-series with foraminiferal culture in titanium dioxide nanoscale particle (TNP) additive sea-water to understand molecular metabolisms against the pollutant. At each of 1, 6, and 24 hours, we observed the time change in biological response with confocal laser scanning microscopy and inspected the expressed gene differences, among the foraminiferal cells. Cell observation indicates high productions of lipids and reactive oxygen species (ROS) in the foraminiferal cell. Our time-course analysis of gene expression also suggests high activity of the biosynthesis of unsaturated fatty acid and ROS quenching. Both experiments show these processes as the key to survive in the polluted area. Ciacci, C., et al., 2019. Scientific Reports 19(9),19441.

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