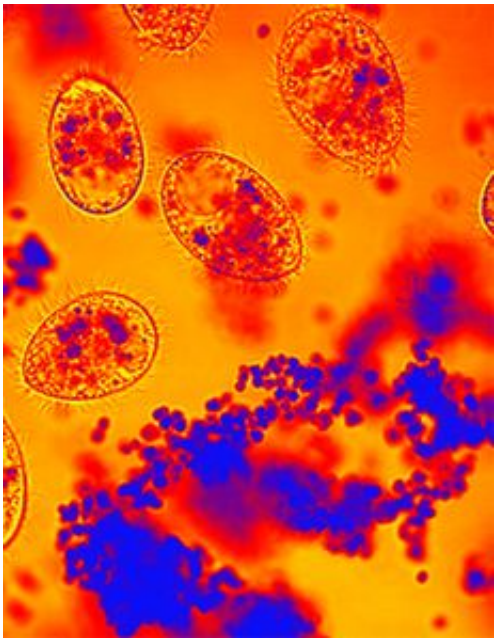
Carbon Nanotubes Compromise the Functions of Certain Protozoa, Study Shows

June 18 2008, By Laura Mgrdichian



A Tetrahymena thermophila culture exposed to a moderate concentration of single-walled carbon nanotubes. The image shows the nanotubes (blue) both outside and within the protozoa.

A new study by researchers from the University of Waterloo in Ontario, Canada, hints that carbon nanotubes may be toxic to microorganisms. When cultures of a certain key protozoan, a single-cell organism, were exposed to the nanotubes their ability to ingest and digest bacteria was hindered.

The protozoan studied, *Tetrahymena thermophila*, lives in water, propelling itself using many arm-like cilia. The group it belongs to, the "grazing protists," are ecologically important because they are active in water ecology at many levels.

Tetrahymena thermophila helps regulate microbial populations by ingesting and digesting bacteria. It is also an important organism in wastewater treatment and is an indicator of the quality of treated wastewater. For these reasons, it is often studied by ecotoxicologists.

When the University of Waterloo group exposed *Tetrahymena thermophila* to single-walled carbon nanotubes (SWNTs), the researchers found that the protozoa unnaturally clumped together initially and then ingested SWNTs and bacteria alike. One troubling effect of this, if such exposure ever occurred in the wild, is that the nanotubes could move up the food chain. In addition, because the protozoa's ability to ingest and digest their prey bacteria species is compromised, certain bacteria populations could balloon. This could have untold ecological effects.

"There is a pressing need for research into the health and environmental impact of nanoparticles," said Xiaowu (Shirley) Tang, the study's corresponding researcher, to *PhysOrg.com*. Tang is an assistant professor in the University of Waterloo Department of Chemistry. "But although the importance of grazing protists to the environment and public health is well known, few reports can be found on exposure of such organisms to carbon nanotubes."

Part of the reason for the lack of studied on carbon nanotubes effects on microorganisms is that scientists generally believe that the nanotubes are insoluble in water. However, at least one recent study challenges this belief.

With that study in mind, Tang and her colleagues exposed *Tetrahymena*

thermophila cultures to different concentrations of nanotubes in solution and monitored them for three days using video microscopy. Besides clearly showing that the protozoa ingested the nanotubes, the video revealed that the control cultures remained healthy while the nanotube-exposed cultures exhibited various negative responses depending on the concentration. These ranged from diminished mobility to death, with the most prevalent effect being cell clumping.

“We hope that our work will stimulate a line of research towards better understanding of the effects of nanomaterials on diverse organisms, especially on single-cell organisms that are ecological important,” says Tang.

The researchers do note one potential positive effect of *Tetrahymena thermophila* nanotube uptake that could make controlled exposure useful in wastewater treatment: The protozoa released extra “exudates,” fluids rich in proteins and cellular debris, which help solidify impurities in the wastewater. This, in turn, could make the protozoa more efficient water-cleaners.

Citation: Parnian Ghafari, Christine H. St-Denis, Mary E. Power, Xu Jin, Veronica Tsou, Himadri S. Mandal, Niels C. Bols and Xiaowu (Shirley) Tang *Nature Nanotechnology* advance online publication 11 May 2008, DOI:10.1038/nnano.2008.109