Ecotoxicity of Nanoparticles Exemplified by Bacteria, Algae and Daphniad

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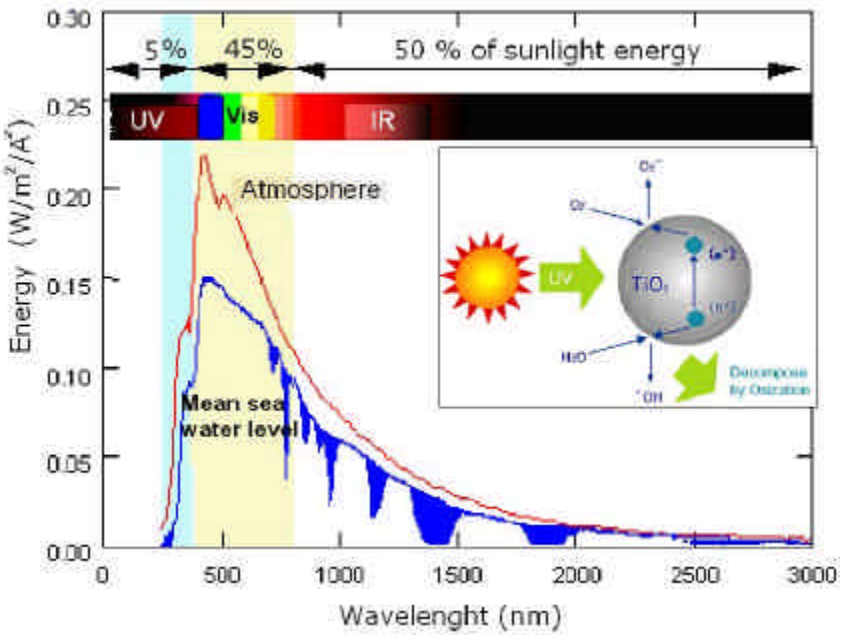
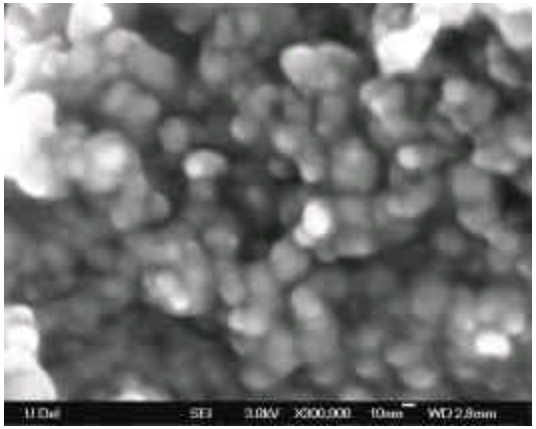
Objectives

- To determine the short-term chronic toxicity of photocatalytic nanoarticles to aquatic organisms, e.g.,*E. coli*, *Ceriodaphnia dubia*, *Selenastrum capricornutum*
- To assess factors that may affect the ecotoxicity of photocatalytic nanoparticles, e.g., TiO_2

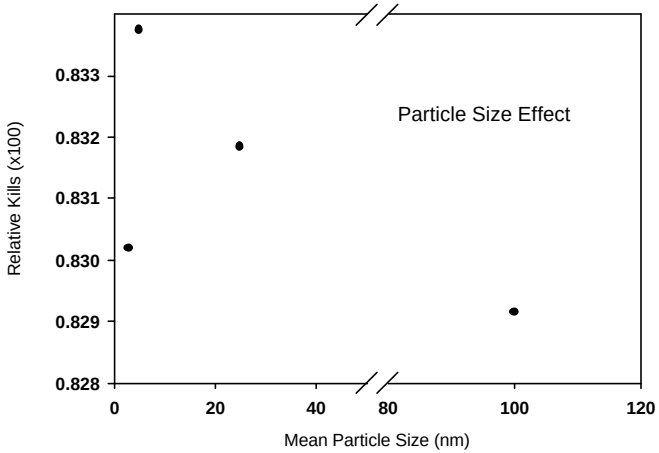
Nanoparticles as Environmental Toxicants



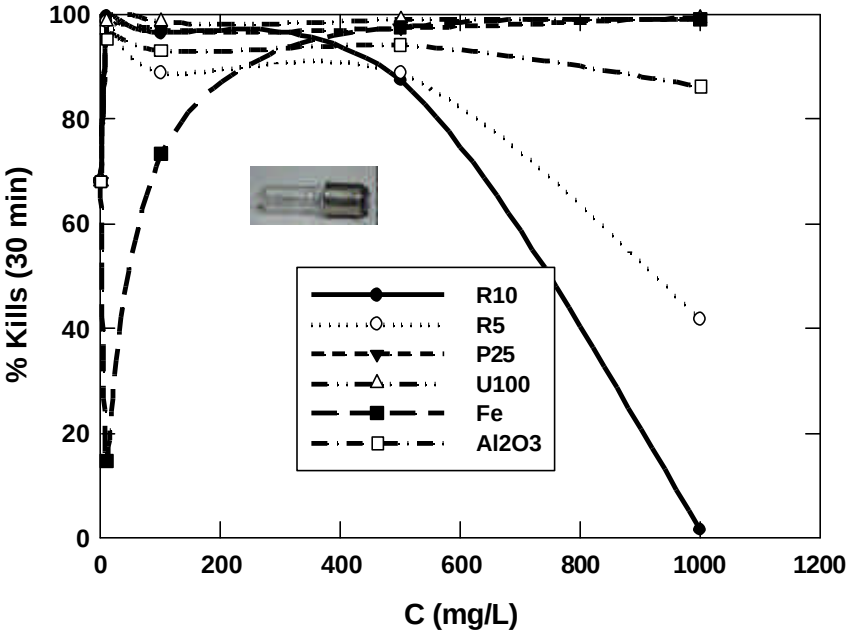


- **Small size**
  - procaryotic cells: 0.3 – 2 mm (or 300 – 2000 nm)
  - eucaryotic cells: 2 – 20 mm(or 2000 – 20000 nm)
  - nano-particles: 0.1 – 100 nm.
- **Surface charge**
- **Photocatalysis**
- **Chemical composition**

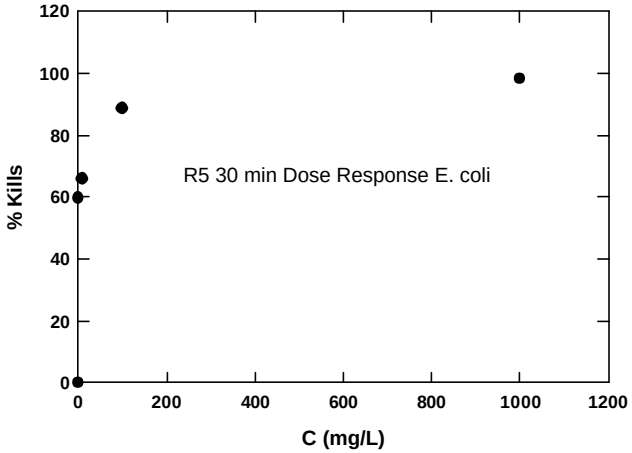
Effect of Particle Size (Dark)



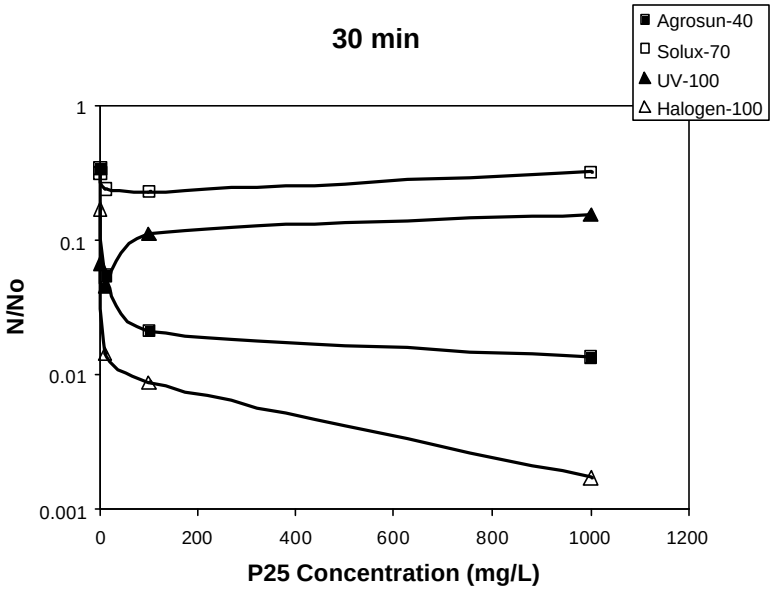
Effect of Particle Type

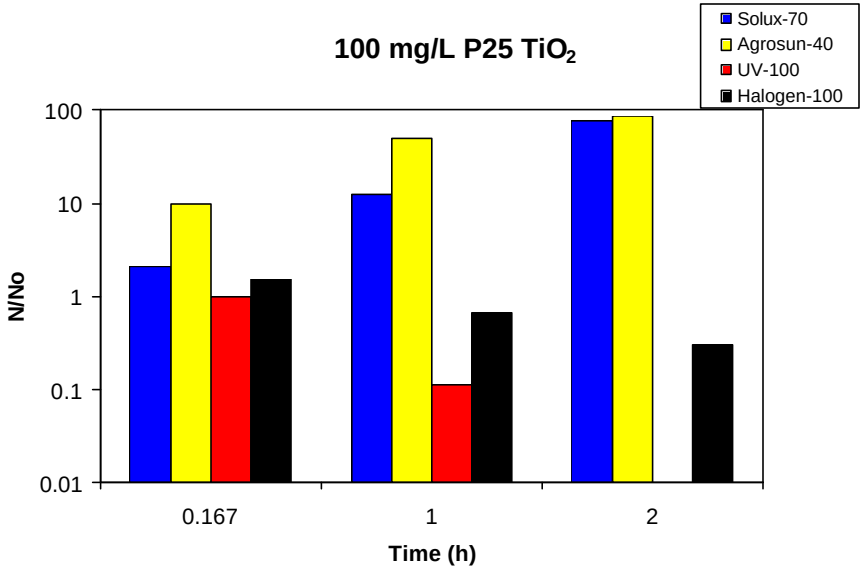


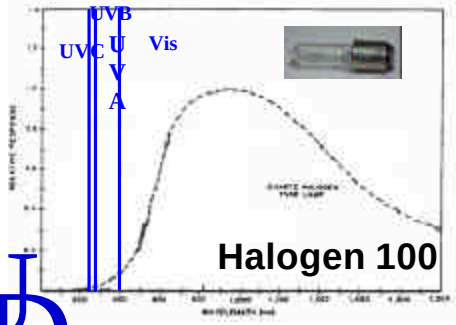
Dose-Response UV-100

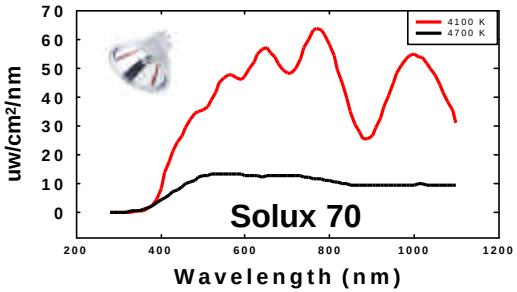


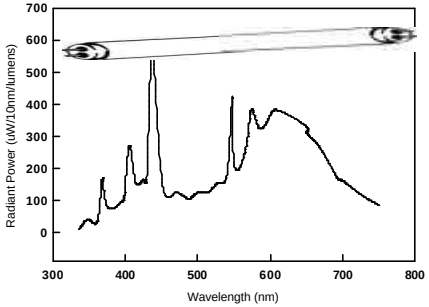
Effect of Light Source: *E. coli*



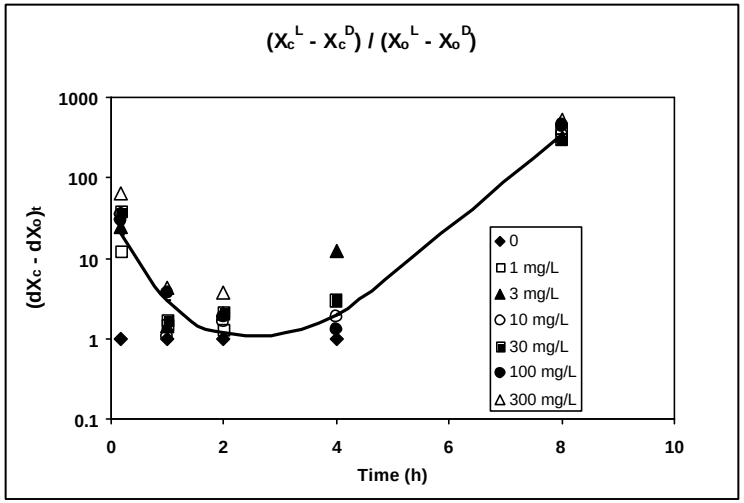


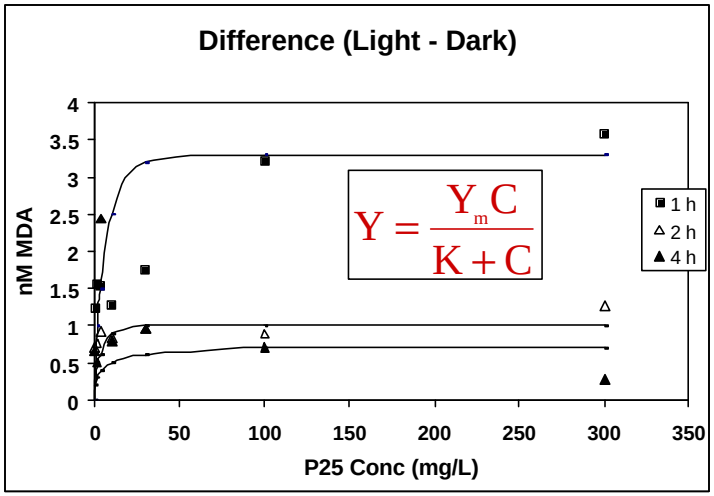




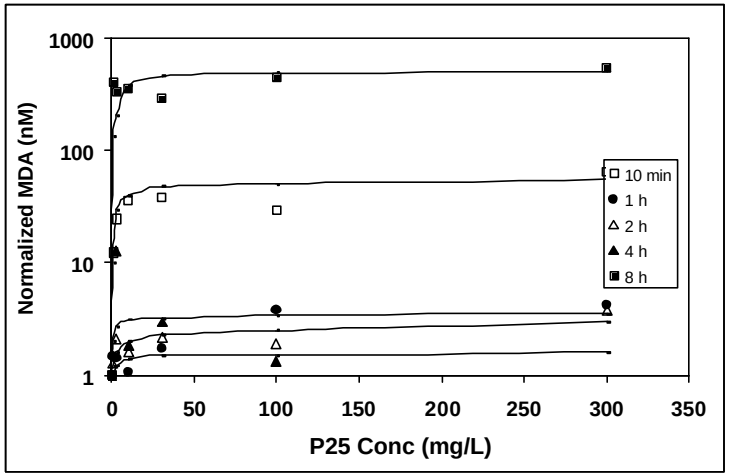


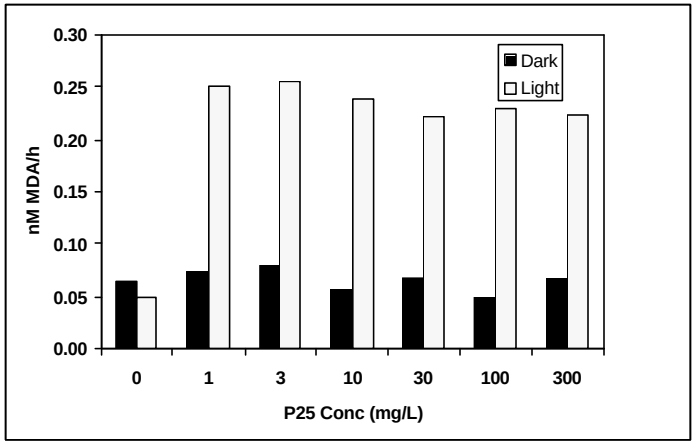
Enzynamatic response: MDA





$$Y = \frac{Y_m C}{K + C}$$

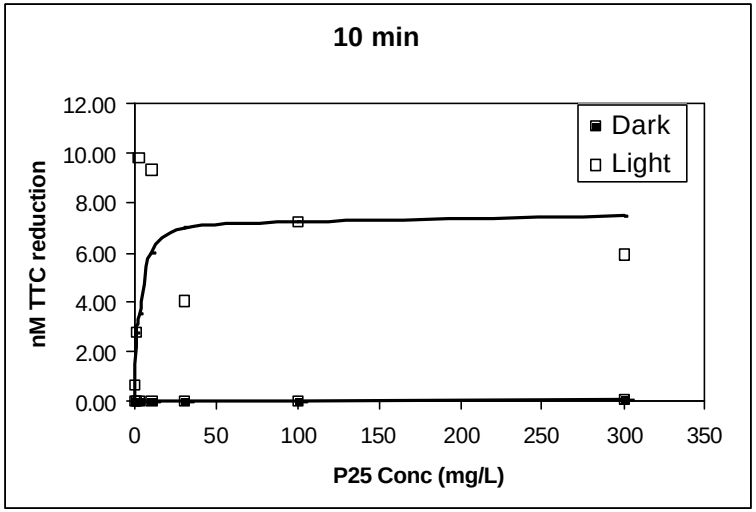


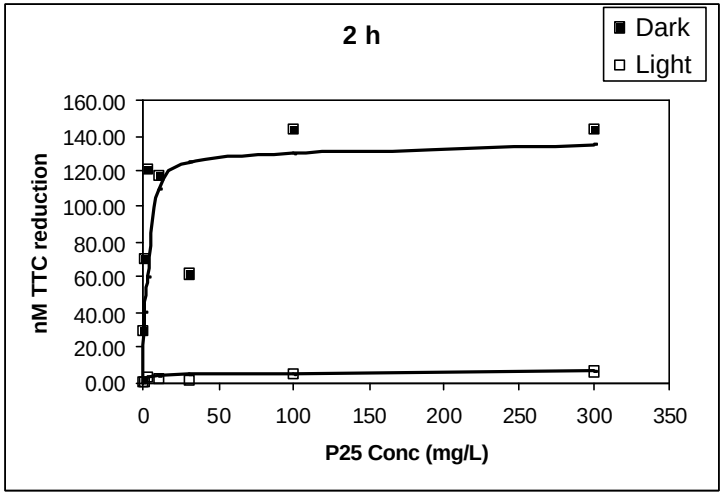


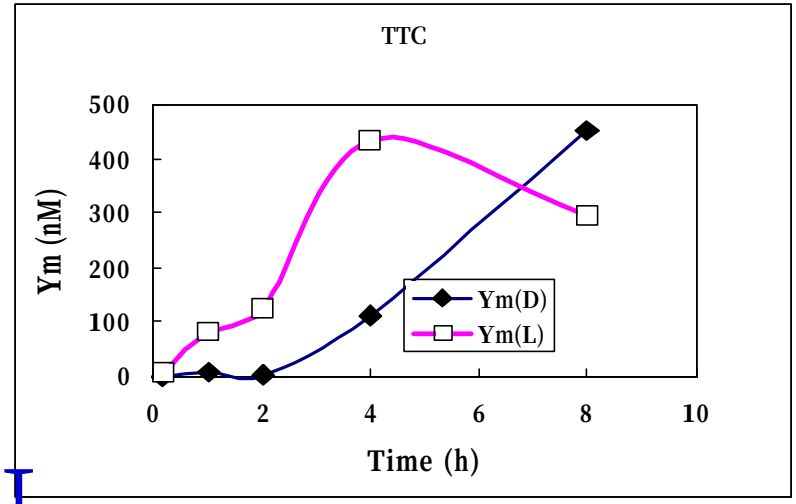
UV-100

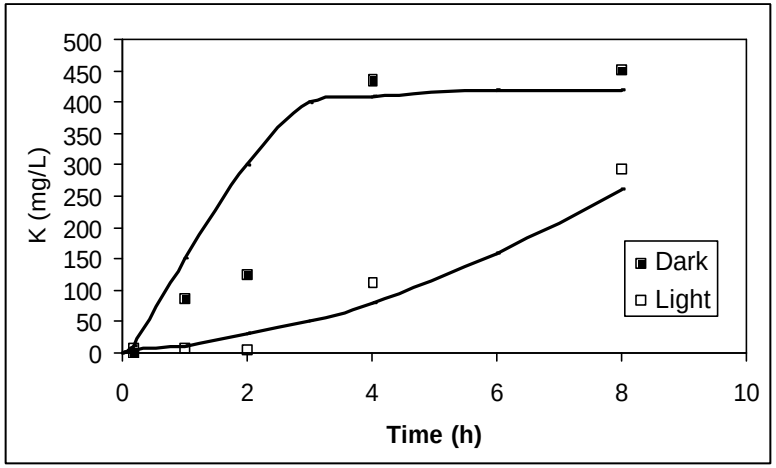
$$\frac{Y_c^L - Y_{\cdot c}^D}{Y_{\cdot c=o}^L - Y_{c=o}^D}$$

Enzymatic Response: TTC



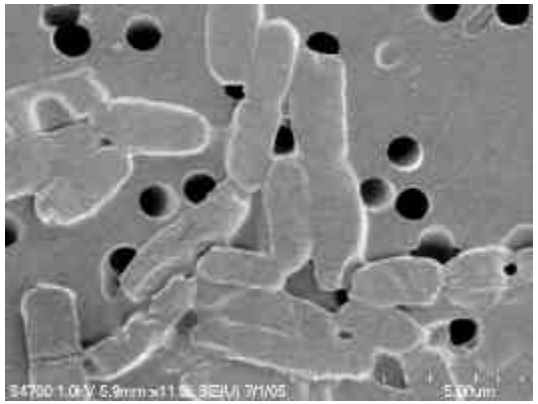


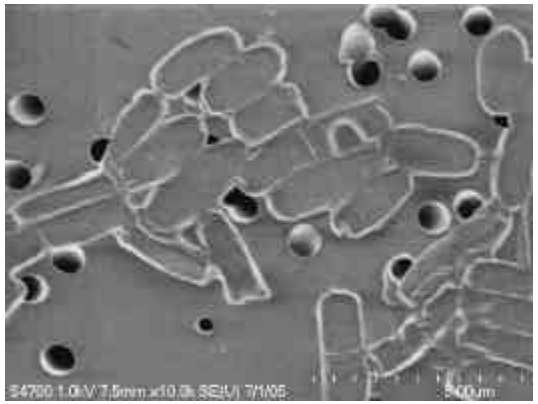


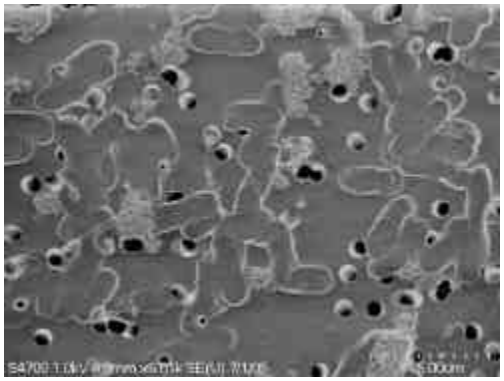


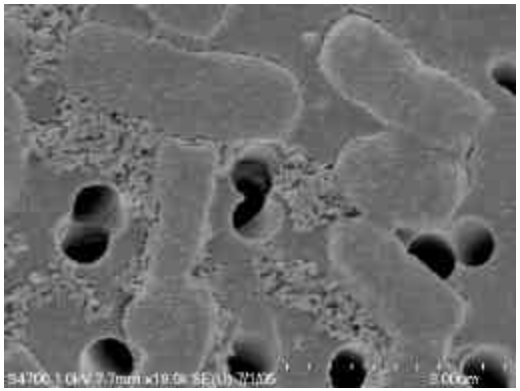
UV-100

SEM Observation: *E. coli*

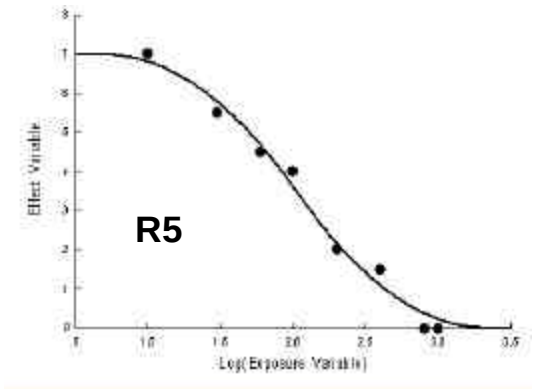


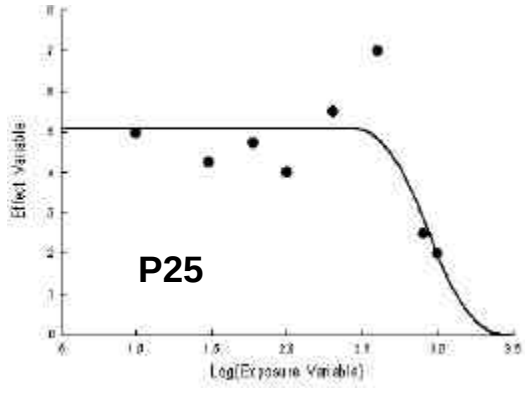


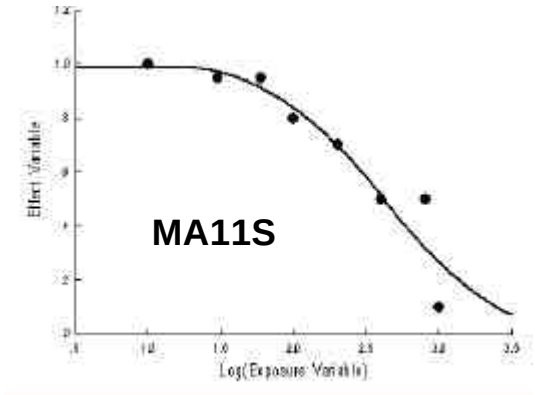




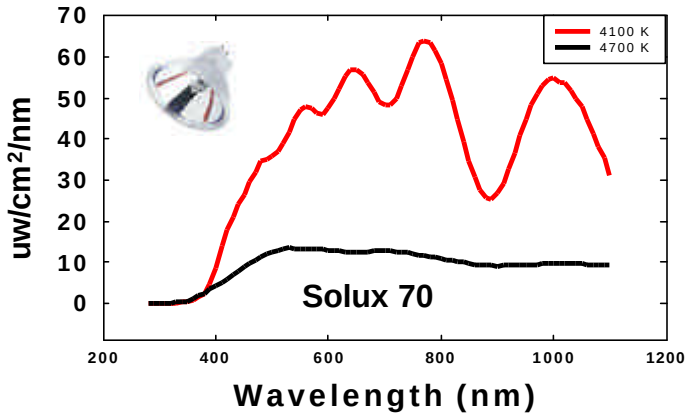
Acute Test (24-h Survival): *C. dubia*





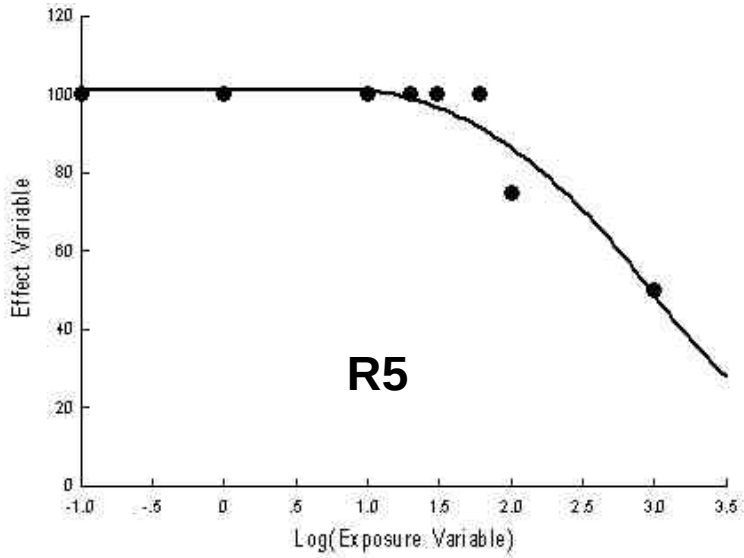


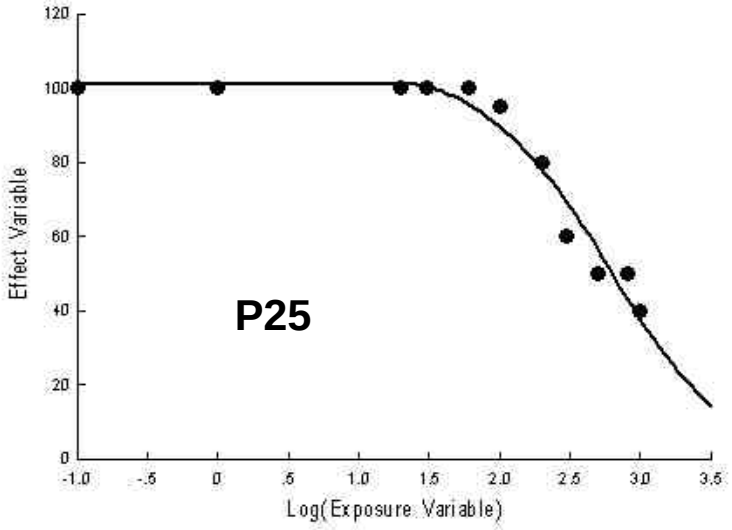
		95% Confidence Limits			
	LC 50	Lower	Upper	NOEC	LOEC
R5	98.3	37.0	165.3	10	30
P25	38.1	7.8	90.1	＜10	10
MA11S	433.4	293.5	653.0	60	100



Unit: mg/L

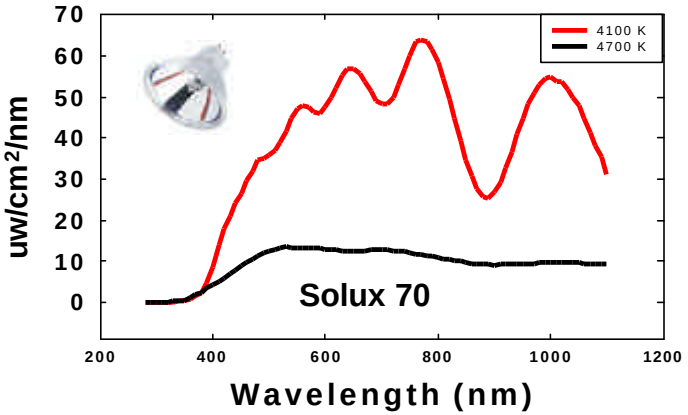
Chronic Test (24-h Survival): *C. dubia*





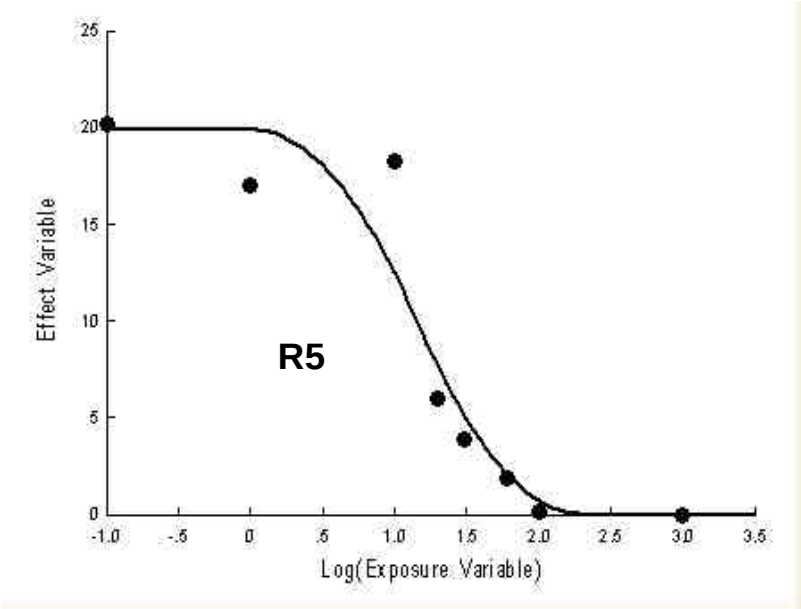
		95% Confidence Limits			
	LC 50	Lower	Upper	NOEC	LOEC
R5	683.38	298.76	4774.69	60	100
P25	810.93	429.90	2780.88	100	200

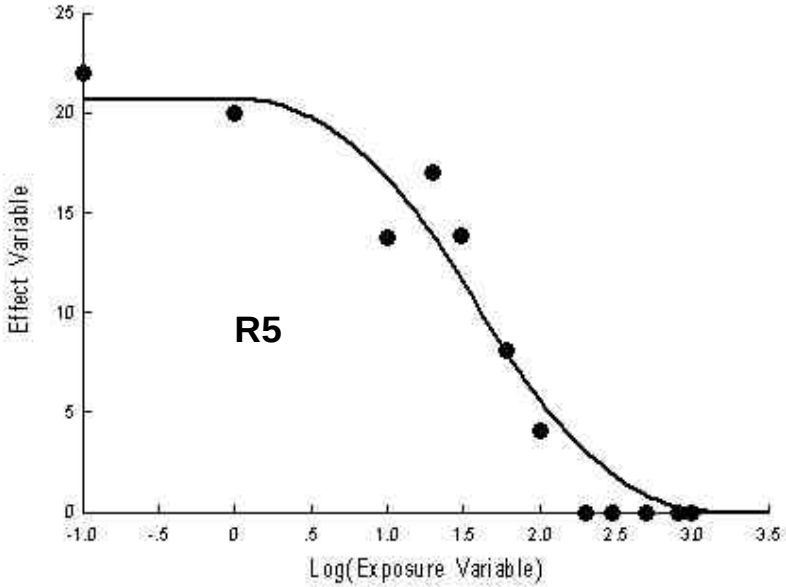
Unit: mg/L



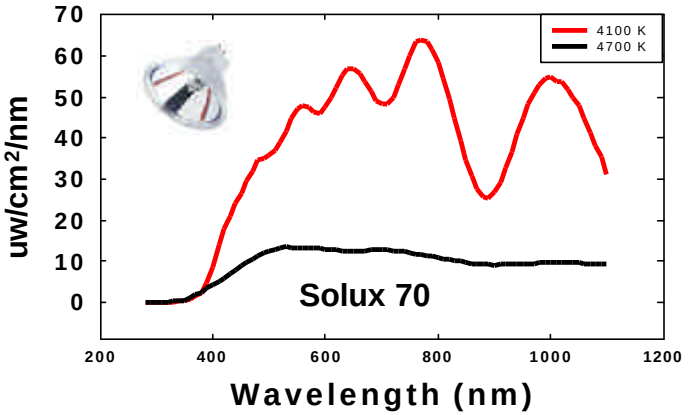
Chronic Test (7-day Reproduction): *C. dubia*

Trap Regression –Piecewise Tailed



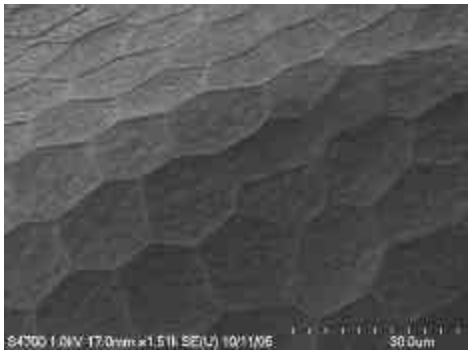


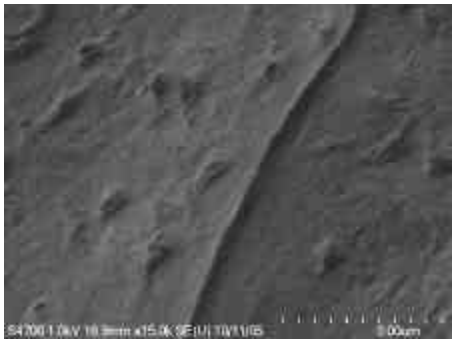
		95% Confidence Limits			
	EC50	Lower	Upper	NOEC	LOEC
R5	14.4	5.8	35.6	10	20
P25	39.1	21.8	7.0	<0.1	0.1

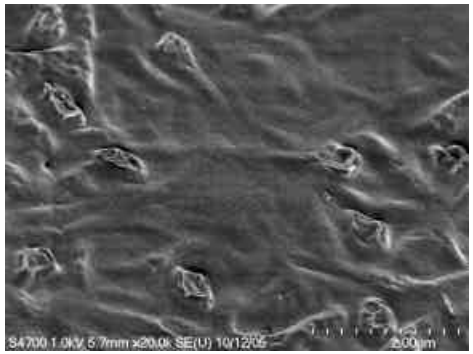


Unit: mg/L

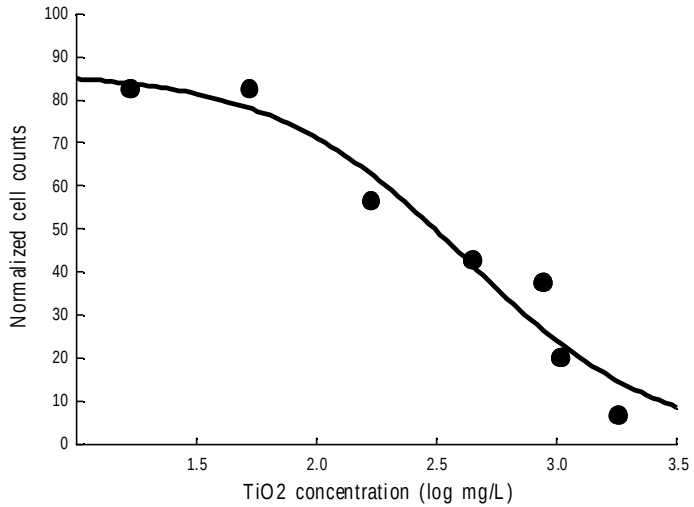
SEM Observation: Daphniad

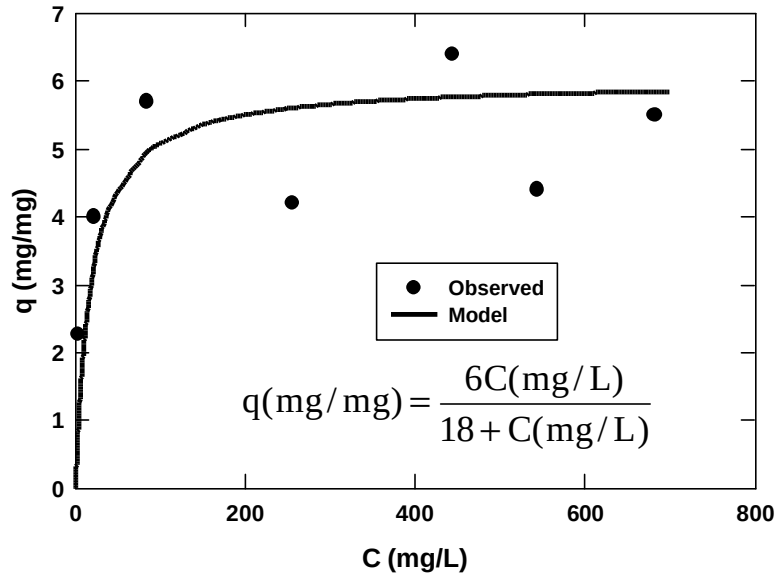






Chronic Tests: *S. capricornutum*



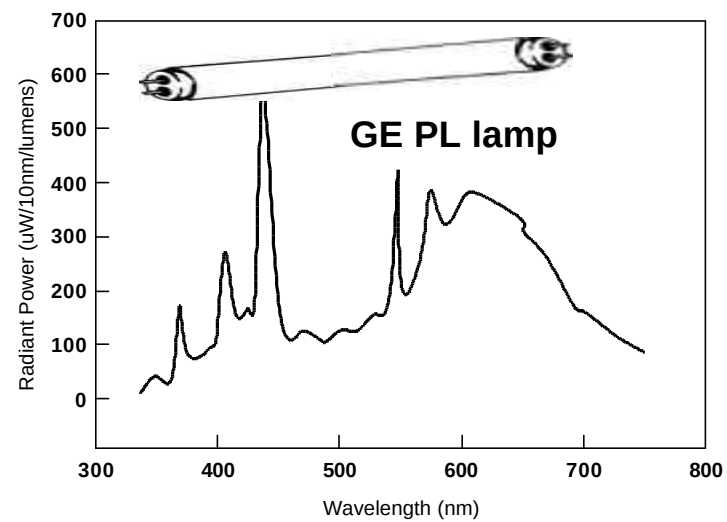


$$\left(\frac{N_C}{N_{C=0}}\right) = \frac{\left(\frac{K}{N_{C=0}}\right)}{\left(\frac{K}{N_{C=0}}\right) e^{-\left(\frac{(C-2.6}{}\right)}}$$

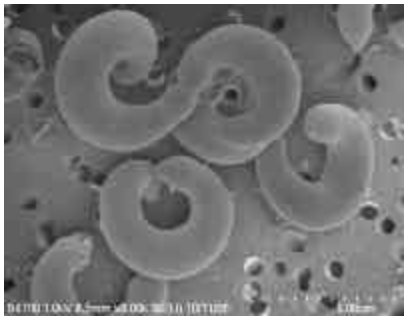
LC50 (log) = 2.6 (396 mg/L)

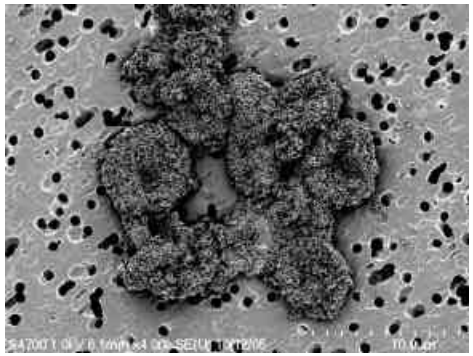
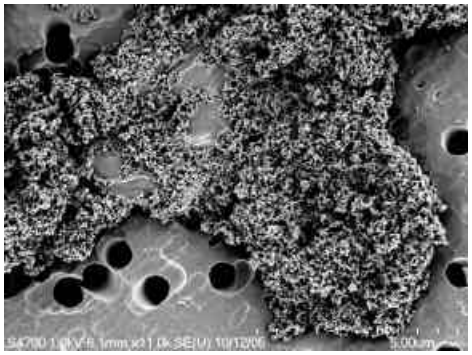
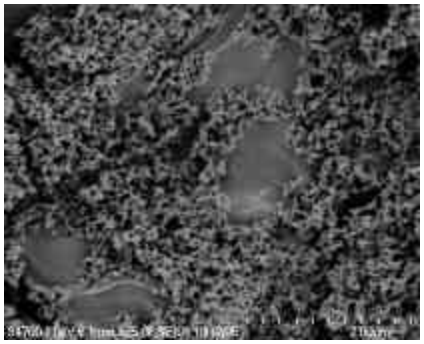
95% LCL (log) = 2.1 (125.8 mg/L)

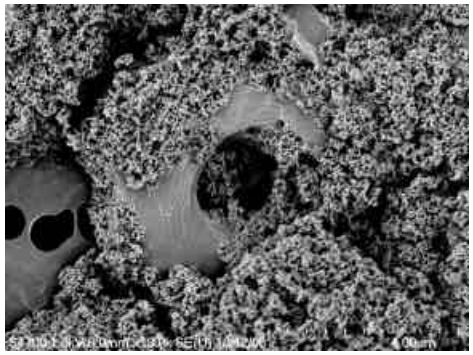
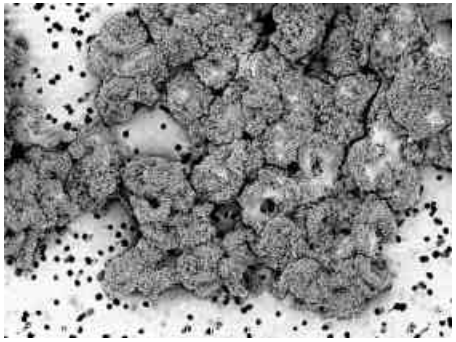
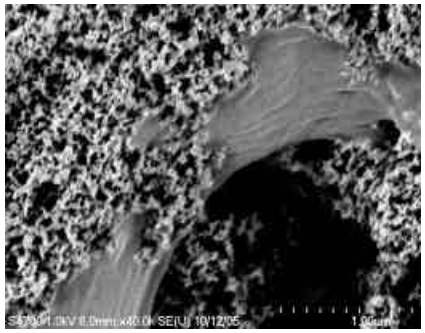
95% UCL (log) = 3.0 (1000 mg/L)



SEM Observation: *S. capriocornutum*



Expected Benefits

- Dose-response of photocatalytic nanoparticles is useful to the evaluation of ecological risk imposing by nanoparticles.
- Exposure experiments reveal mechanistic information on the effects of nanoparticles to aquatic community.
- Toxicity studies will lead to increased understanding of the potential effects of nano-particles on trophically important aquatic organisms.

Acknowledgement

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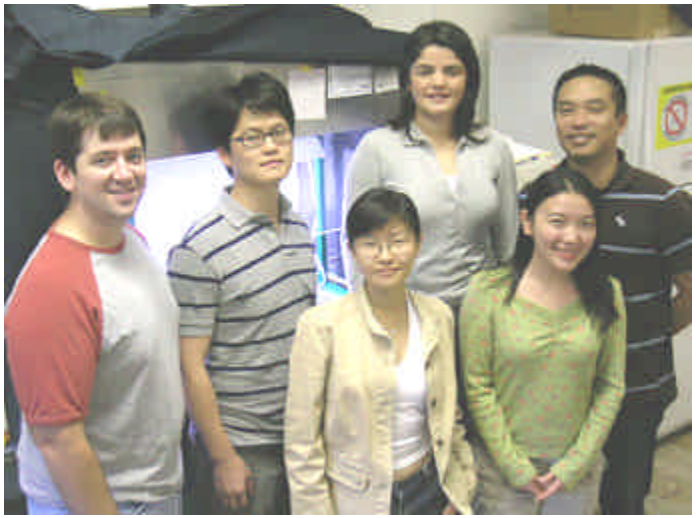
"Short-term Chronic Toxicity of Photocatalytic Nanoparticles to Bacteria, Algae, and Zooplankton"

PI: C. P. Huang
Co-PI: Dan Cha
Co-PI: Ismat Shah