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Toxicity to meiobenthic copepods by polyvinylpyrrolidone coated silver nanoparticles (PVP-AgNPs)

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As commercial and industrial uses for silver nanoparticles (AgNPs) increase principally as biocides, environmental releases through sanitary waste discharge and degradation of Ag-nano containing products are growing. Most silver-induced toxicity in aquatic systems is from the release of Ag ions from AgNPs. This question of Ag-nano toxicity due to release of dissolved Ag species was addressed here using full-lifecycle comparative exposures of copepods to seawater-dissolved reference $AgNO_3$ (0, 20, 30, 45, 75 ug.L^{-1}) versus treatment PVP-AgNPs (0, 20, 30, 45, 75 ug.L^{-1}) using the meiobenthic copepod *Amphiascus tenuiremis* per ASTM E2317-04(2012) methods. Over the full lifecycle, $AgNO_3$ dissolved in 30S seawater at only 30 µg . L^{-1} was significantly lethal to copepods (45% of test population dead in 26 days) with mating success cut in half and fecundity reduced by 40%. In contrast, Ag-PVP at 30 µg.L^{-1} produced only 19% population death by 26 days with no negative effects on mating success or fecundity. Response data for stage-specific survival rates, sex ratios, mating success and fecundity were modeled via Leslie (Lefkovich) matrices to project an integrated population response model for these two forms of seawater Ag (i.e. $AgNO_3$ vs. PVP-AgNPs). PVP-AgNPs produced a population doubling time of 3-4 generations across all test concentrations except the control (i.e. 2 generations doubling time). $AgNO_3$ at 20 µg.L^{-1} pushed population doubling-time to 4 generations versus 2; and >30 µg.L^{-1} pushed copepod populations to extinction in 9-12 generations. PVP-AgNPs appears to confer population-relevant protection by modulating the release of Ag ions in seawater compared with $AgNO_3$ during exposure.

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