

Rising Concern about a Household Chemical on Marine Health

The industrially produced chemical nonylphenol, an endocrine disruptor, is known to harm aquatic life. Marine toxicologists at NOAA want to learn more about its impacts on marine invertebrates to better guide future policies and regulations associated with the chemical.

Nonylphenol (often referred to as NP) is one of a number of surfactants classified as alkylphenols that have been extensively manufactured since the 1940s. NPs have been used in a broad spectrum of industrial applications and consumer products. They are produced as a stabilizer for plastics, and have been shown to leach out of FDA food-grade plastic containers and bags. NPs are also found in household paints, surface cleaners, laundry and dish soaps as well as some personal care products. Unfortunately, most of these products are washed down the drain and released into the natural environment. Since the 1980's studies have shown that NPs are toxic to aquatic life, can bioaccumulate and can function as an endocrine disruptor in organisms. In the 2000s the US EPA encouraged a phase-out of NPs from industrial laundry detergents, although it is still widely used in other products.

Meagan Currie, a NSF Research Experience for Undergraduates (REU) intern has been working to increase the growing pool of knowledge about NP's impact to aquatic life and its effects on the health of a critical marine organism: the staghorn coral, *Acropora cervicornis*.

Dr. Cheryl Woodley, the project lead from NOAA says, "There are currently 22 coral species protected under the Endangered Species Act. 7 are Caribbean species, including staghorn coral. Poor water quality and pollutants pose significant threats to the recovery of these species. There are few, if any, studies to ensure that current water quality standards are protective for coral adults or larvae. Our laboratory is interested in providing information on various water quality parameters and pollutant concentrations that are harmful to coral and their larvae. A water quality standard for nonylphenol of 1.7ug/L in seawater recently has been proposed, but the unknown factor is whether corals can tolerate these levels. We hope to provide insights on tolerances of staghorn coral for this group of compounds. Meagan's work is the first step."

Staghorn coral is of particular interest because it is a shallow water coral that hugs the coast throughout the Caribbean and as far north as the Florida Keys. Given its proximity to shore, it is likely to be exposed to chemical runoff. Staghorn coral is also classified as threatened under the Endangered Species Act of 1973.

Currie exposed corals in a laboratory setting to different concentrations of NP. She evaluated the tissue regeneration (wound healing), polyp activity and color of coral fragments to assess the coral's physical health. Additionally, she monitored the health of the zooxanthellae (single celled algae) living in the coral tissue using a technique called Pulse Amplitude Fluorometry (PAM). This involves saturating the coral with a short pulse of UV light, which causes algae that live symbiotically in the coral's tissue fluoresce. By measuring the intensity of the fluorescence it is possible to measure how well the symbiotic algae (zooxanthellae) are able to photosynthesize and produce energy for their coral host.



Pulse Amplitude Fluorometry (PAM)

Top Row: Heat map of control fragments that have been lacerated at the top, and normal image (matching letter and number). No exposure to NP. (blue and green are healthy).

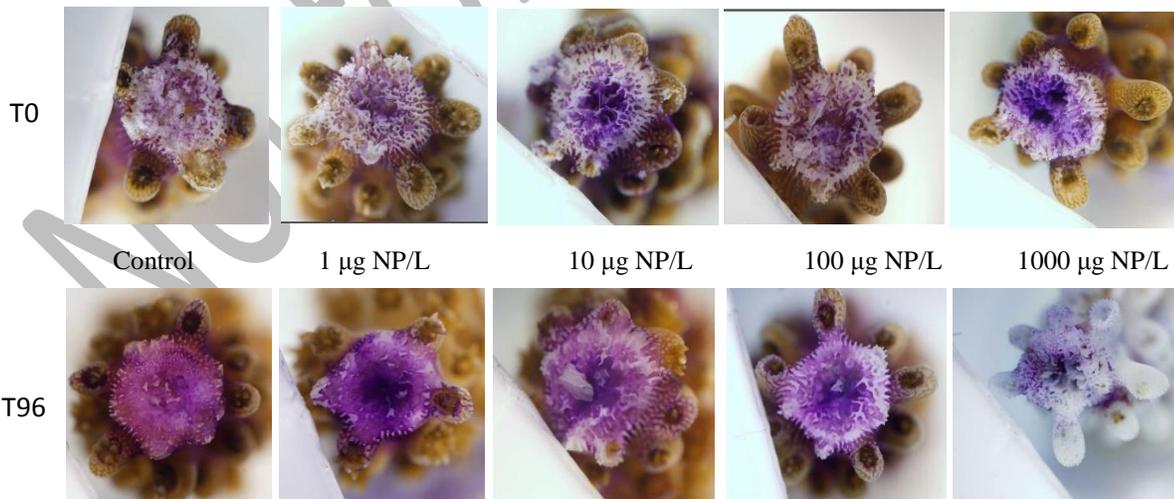


Bottom Row: Heat map of injured fragments exposed to 1000 µg/L nonylphenol (highest test concentration). The injured fragments were more susceptible to nonylphenol, and experienced bleaching, tissue loss and decrease in

Findings indicate that nonylphenol significantly affects the overall physical health of exposed coral and negatively impacts tissue regeneration over time. Interestingly, this study indicates that the coral and their algal symbionts may respond differently to nonylphenol; while the physical health of the coral decreases during exposure, fluorescence of algae in the tissue is not significantly impacted over a short exposure period in uninjured coral, regardless of nonylphenol concentration.

The results of this study will help inform marine water quality standards and the public about its impacts on marine invertebrates and complex organisms like staghorn coral. Ultimately, the hope is to ensure that the water quality standards are sufficiently stringent to protect the marine environment from such pollutants. This work was supported by the Fort Johnson REU Program, National Science Foundation award No.

Acropora cervicornis fragments, 0 hours (pre-exposure)



Acropora cervicornis fragments, 96 hours of exposure

Tissue regeneration over time

Images taken before exposure (*top row*) and after 96 hours of exposure to NP (*bottom row*). Percent change of tissue coverage was calculated for each fragment within the five test groups. Wound healing is an important feature for all coral species, as they are often injured by boats and natural forces, and rely on regrowth to remain healthy. During the test, a laceration was made before exposure to the chemical, and then the tissue over wound lacerations was monitored over time to see whether NP impacts healing.