Copper-Tolerant Hull-Borne Invasive Species: Further Analysis

Some marine organisms, such as the fouling alga *Ectocarpus siliculosus*, have developed resistance to copper-based antifouling paints.[1,2] This adaptation may be evidence of an evolutionary process among ship fouling organisms.[3] Resistance to heavy metals is a potentially important trait for invasive marine species, facilitating their success in invading disturbed, natural communities. For example, the invasive bryozoans *Bugula neritina* and *Watersipora subtorquata* can settle, survive and grow in elevated concentrations of copper.[4,5] The invasive bryozoans *Schizoporella errata* and *Tricellaria occidentalis* also have a wide range of copper tolerance.[6] In addition, copper contamination has contributed to lowering the numbers of some ascidians, or sea-squirts, that are less copper-tolerant and increasing the density of some polychaetes, or marine worms, that would otherwise be limited for space by the ascidians.[7]

Watersipora subtorquata
Luis A. Solorzano, Californiabiota.com

Scientists have also investigated how biodiversity, or a variety of different species, affects the ability of a native ecosystem to resist invasions. Decreasing native diversity increases the survival of invaders both in the field and in experimentally assembled communities.[8] For example, communities with increased diversity more completely and efficiently use available space which decreases the chance for successful invasions.[9]

New research in San Francisco Bay suggests that invasive species tolerate copper better than native species do. Scientists compared the diversity of invasive and native fouling species when exposed to varying concentrations of copper contamination. The diversity of natives declined with increasing contamination while the diversity of invasive species did not.[10] These results suggest that improving coastal water quality by reducing pollution

Crowded Marina
Cesar Alvarez, UC SGEP

from antifouling paints and other sources could help native species that are less tolerant of heavy metal and other pollutants to resist invasions.[11]

Research in Australia indicates that certain invasive species benefit from highly polluted environments and that human disturbance can help invasive species to become established and spread in marine systems.[12] Two sites in each of two harbors in New South Wales, Australia, were treated by increasing heavy metal pollution. As pollution levels increased, native species diversity decreased, while there was no significant change in numbers of invasive species.[13] Scientists also found that, despite the use of copper-based antifouling paints, several invasive species, such as the bryozoans *Bugula neritina* and *Watersipora subtorquata*, were able to colonize boat hulls.[14]

An accumulation of heavy metals from antifouling paints has the potential to enhance the success of invaders. Copper tolerance and abundance of the tubeworm, *Hydroides elegans*, in recreational harbors may be related to its transportation on hulls of recreational vessels.[15] In other words, those that survived voyages on copper treated hulls may have passed along their ability to tolerate copper to their descendents.

3 Months Growth of Tubeworms and Sea Squirts
Cesar Alvarez, UC SGEP

Scientists also found that copper-tolerant species may provide a foundation for others to colonize. As a result, less-tolerant species can become more abundant on hulls and thus be transported to new areas more readily than would otherwise be possible.[16]

Since this is a new area of research, a comprehensive survey for copper tolerance among fouling species remains to be done. However, early indications suggest that at least some invasive fouling species are tolerant of copper, as some weeds and insects are less susceptible to agricultural pesticides and some bacteria are resistant to antibiotics. Since most recreational vessels travel infrequently[17] and remain in marinas for longer periods of time than commercial vessels, this provides opportunities for invasive species to settle and eventually be transported on recreational boat hulls. Boat owners may wish to consider using a variety of fouling control methods to deal with this new challenge and to slow development of resistance to new methods.

Please see our publications on protecting water quality and preventing the hull transport of invasive species on our website http://seagrant.ucdavis.edu

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