Treatment of nitrogen-polluted sediment using marine anammox bacteria

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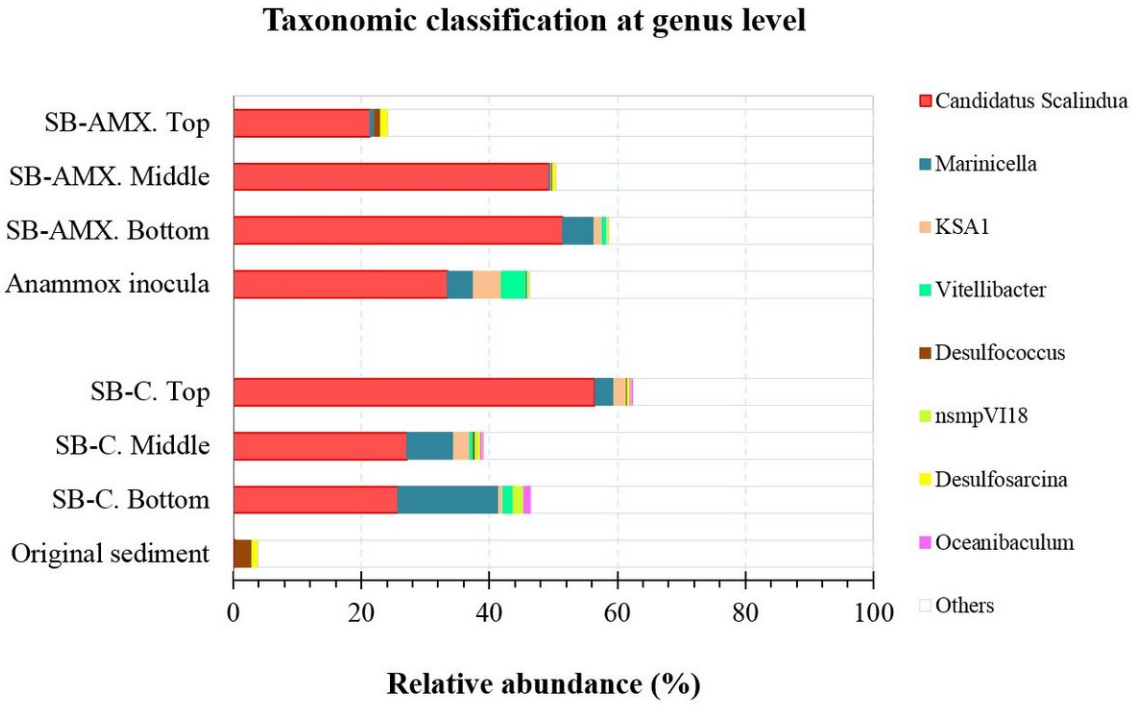

Genus-level taxonomic classifications of microbe colonies having more than 1% of the total in any sediment sample. Note the abundance of the sulfur-oxidizing bacteria (SOB) Marinicella in the lower layers of SB-C and the sulfate-reducing bacteria (SRB) *Desulfococcus* & *Desulfosarcina* in all layers of SB-AMX. It is thought that SOB works in concert with anammox bacteria to reduce excess nitrogen in sediment samples.[Reprinted from Chemosphere, 196, Van Duc, L., Song, B., Ito, H., Hama, T., Otani, M., & Kawagoshi, Y., High growth potential and nitrogen removal performance of marine anammox bacteria in shrimp-aquaculture sediment, 69-77, 2018, with permission from Elsevier.] Credit: Dr. Yasunori Kawagoshi

Working on a way to alleviate eutrophication in coastal waters, a research collaboration between Kumamoto University in Japan and the Virginia Institute of Marine Science (VIMS) in the U.S. reports a combination of bacteria with the potential to lighten the impact of excess nitrogen found in many coastal water systems.

Water enrichment through excessive amounts of nutrients in coastal environments, a phenomenon known as eutrophication, is a major issue for many coastal areas around the world. The extra nutrients, typically from anthropological changes to the nitrogen cycle (e.g., agricultural runoff), are deposited into the seabed causing an unbalanced system and having detrimental effects on the aquatic environment. These effects often manifest as algal blooms that can be harmful to both humans and aquatic animals in the area. As eutrophication increases in coastal areas around the world, methods of counteracting its consequences are highly sought after.

Researchers have had limited success with different nitrogen removal techniques. Flushing is often ineffective at removing contaminants because it doesn't reach sources deep in sediment. Evacuation can produce new environmental risks when sediment is transferred away from the area. And recirculation with denitrification can have low contaminant removal efficiency. Anaerobic ammonium oxidation (anammox) with bacteria is thought to be a cost-effective alternative that could be performed "on-site," but its effectiveness and interaction with other microbes was unclear. This is what the collaboration between Kumamoto University and VIMS worked to illuminate.

The researchers used sediment from a shrimp pond in southern Japan and compared the nitrogen removal between an unmodified sample (SB-C) and one with an increased amount of indigenous marine anammox

bacteria (MAB) (SB-AMX). The sediment samples went through four different phases over 285 days. By the end of the experiments, the researchers found that a bicarbonate supplement and high nitrogen content was necessary for anammox bacteria to thrive.

The researchers also assessed the makeup of other microbial colonies in the sediment samples to reveal any symbiotic or disadvantageous relationships. They discovered that the microbial communities between the two samples were very different. A relatively large amount of sulfur-oxidizing bacteria (SOB) was found at the bottom of SB-C, and higher amounts of sulfate-reducing bacteria (SRB) were found in SB-AMX. As compounds produced by SRB are toxic to anammox bacteria, it is thought that SRB is the cause for the low nitrogen reduction performance of both samples at various times in the experiment. SOB, on the other hand, is beneficial because it removes the sulfur compounds that are toxic to anammox bacteria. Furthermore, other researchers have noted that SOB can be stimulated by the addition of bicarbonates, like that which was added to phase three of this experiment.

"Our study shows that a synergistic effect can be had between SOB and anammox bacteria by simply adding bicarbonate," said project leader Dr. Yasunori Kawagoshi of Kumamoto University. "There is still much work to be done before we can try this technique in nature but we believe it shows a lot of promise to lessen the damage caused in areas of high eutrophication."

More information: Luong Van Duc et al, High growth potential and nitrogen removal performance of marine anammox bacteria in shrimp-aquaculture sediment, *Chemosphere* (2017). DOI: 10.1016/j.chemosphere.2017.12.159

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