The Tolerance of Benthic Infauna to Organic Matter in the Indian River Lagoon

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Abstract

Organic-enriched sediments of anthropogenic origins are a growing concern in bays and estuaries around the world. This study examines infaunal communities in the Indian River Lagoon and the effects of fined-grained, organic-rich sediments. Infauna and sediments were collected monthly at 16 stations in the central Indian River Lagoon from October 2015 to February 2016. Results suggest that increasing organic matter in the sediments is correlated with decreasing species richness.

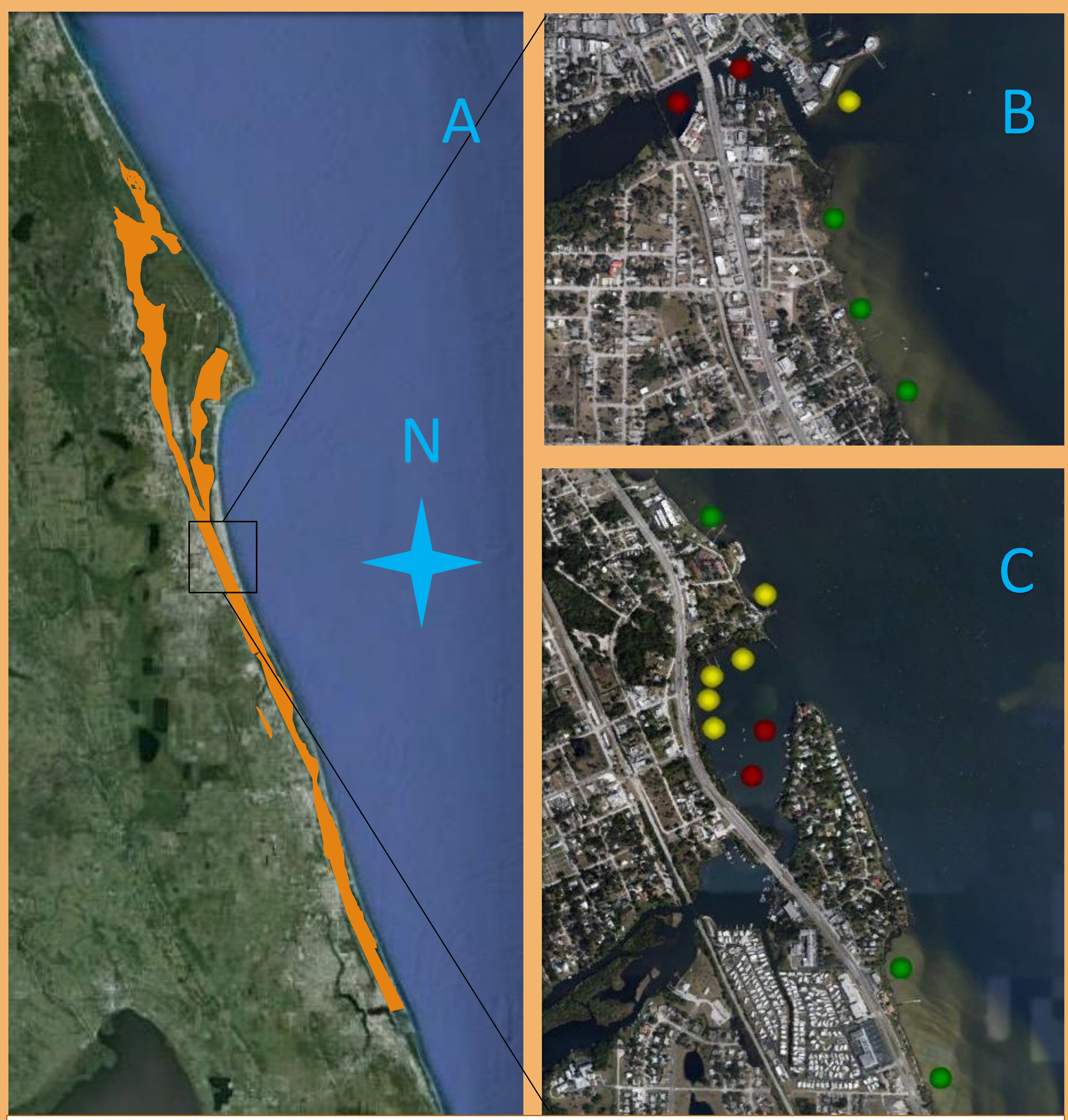

Figure 1. A. The Indian River Lagoon runs 156 miles along the east coast of Florida. **B.** Crane Creek Muck sampling stations (red) and IRL stations near Crane Creek (green and yellow). **C.** Turkey Creek Muck sampling stations (red), IRL stations near Turkey Creek (green and yellow), and Turkey Creek Intermediate stations (yellow). Green: Stations containing an average of 0.1 – 0.9% organic matter. Yellow: Stations containing 1 – 9.9% organic matter. Red: Stations containing > 10% organic matter.

Introduction

Estuaries throughout the world are accumulating high organic sediments from various sources such as runoff and sewage plants[1], terrestrial litter[2] and oil and industrial waste[3]. Sedimented organic matter, although a potential a food source for bottom dwellers[4], is harmful to natural ecosystems in large amounts[5]. Anaerobic bacterial processes can further degrade a system via mass decomposition of organic matter, resulting in hypoxia or anoxia[6]. This is exacerbated when the water is static and warm[7]. These conditions foster sulfur reducing bacteria which release hydrogen sulfide (H_2S). This toxic dissolved gas can saturate the benthic environment, making hypoxic habitats even more hostile[8]. Benthic infauna may struggle to survive in such polluted sediments.

Methods and Materials

Infauna were collected monthly at 16 sampling stations (3 replicate grabs per station per sampling date) in Florida's central Indian River Lagoon (IRL) from October 2015 to February 2016. Turkey Creek, Crane Creek, and nearby stations were sampled.

A Petite Ponar grab was used for infaunal grabs which were then sifted through a 0.5 mm sieve. Counting and identification was done via stereomicroscopy. On each sampling date, one sediment grab at each sampling station was collected for organic content analysis. This was done using the loss-on-ignition method[9].

Results

At least 76 different infaunal species have been identified and occur in sampled sediments. Benthic macroinfaunal species richness decreases as organic matter increases (Figure 2, $R^2 = 0.82$, $p<0.001$) and this is an inverse logarithmic relationship. Species richness was highest when organic matter was lowest.

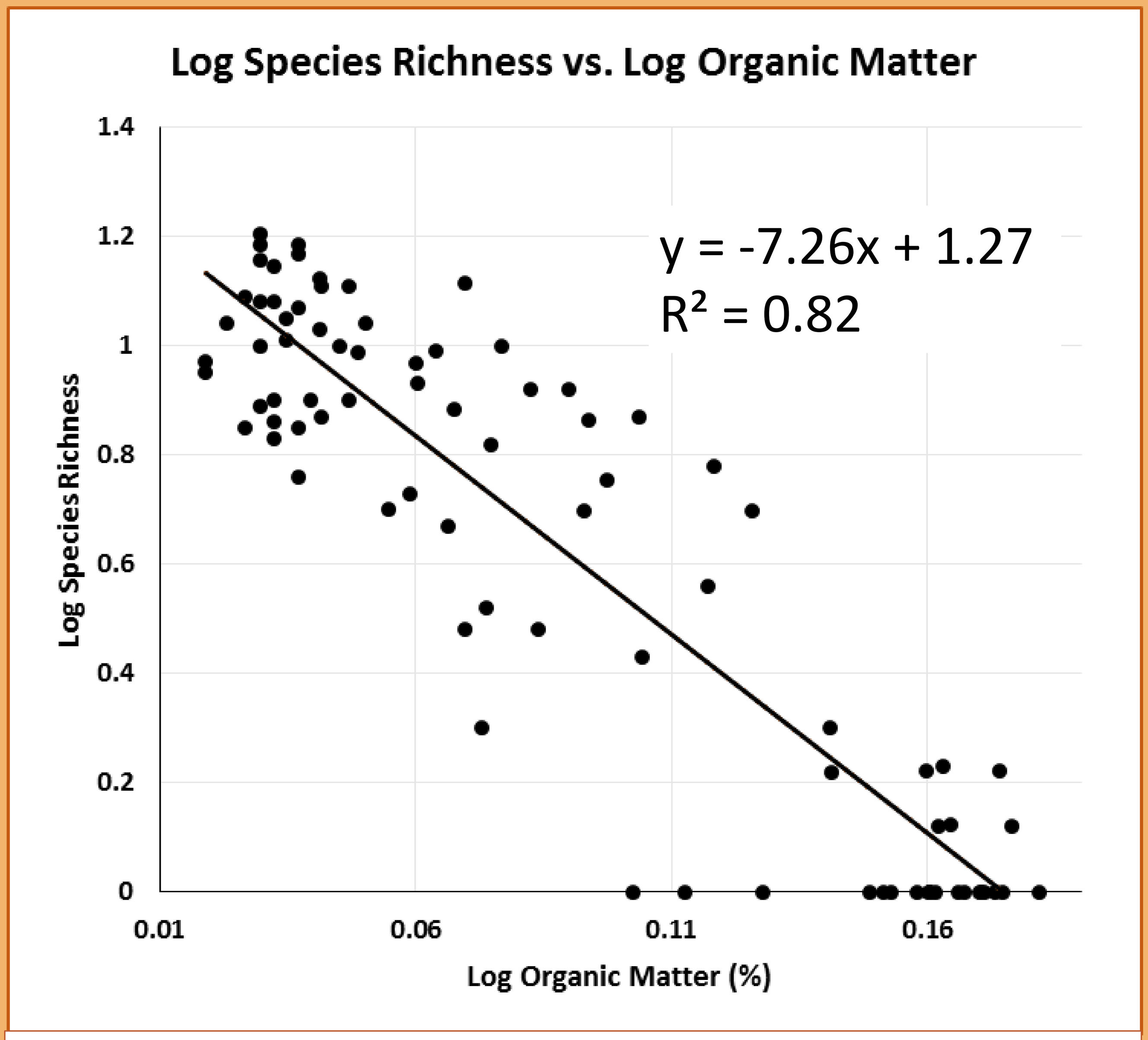

Figure 2. Species Richness vs. % Organic Matter (transformed data). Richness decreases dramatically with the accumulation of organic matter.

Discussion

Studying the accumulation of organic-rich sediments can help identify critically impacted benthic habitats. In the IRL, organic sediment buildup drives down infaunal species diversity and richness. Notably, a drop-off in species occurs between 2 - 12% organic matter (Figure 3). Infaunal species' tolerances are variable, but each species has a threshold of organic content above which they do not survive. Sediments with greater than 11 – 13% organic content are devoid of metazoan life (Figure 3). For mitigation, a target organic content of 5% or less might improve species diversity and richness.

Discussion Continued

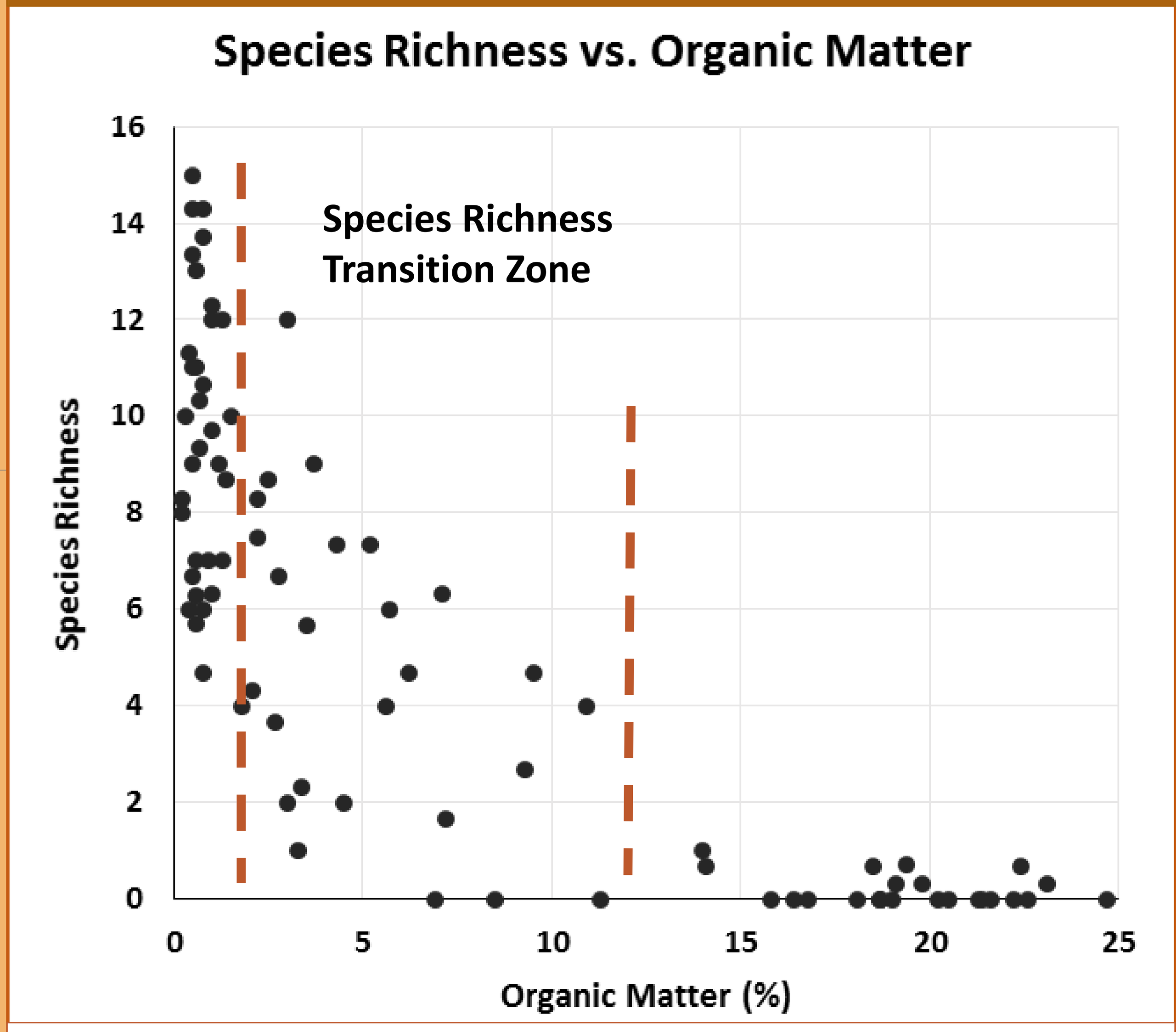

Figure 3. Species richness vs. organic matter (untransformed data) displaying the inverse logarithmic relationship and highlighting the critical zone of species richness transition.

Abundant Species Found in Sediments

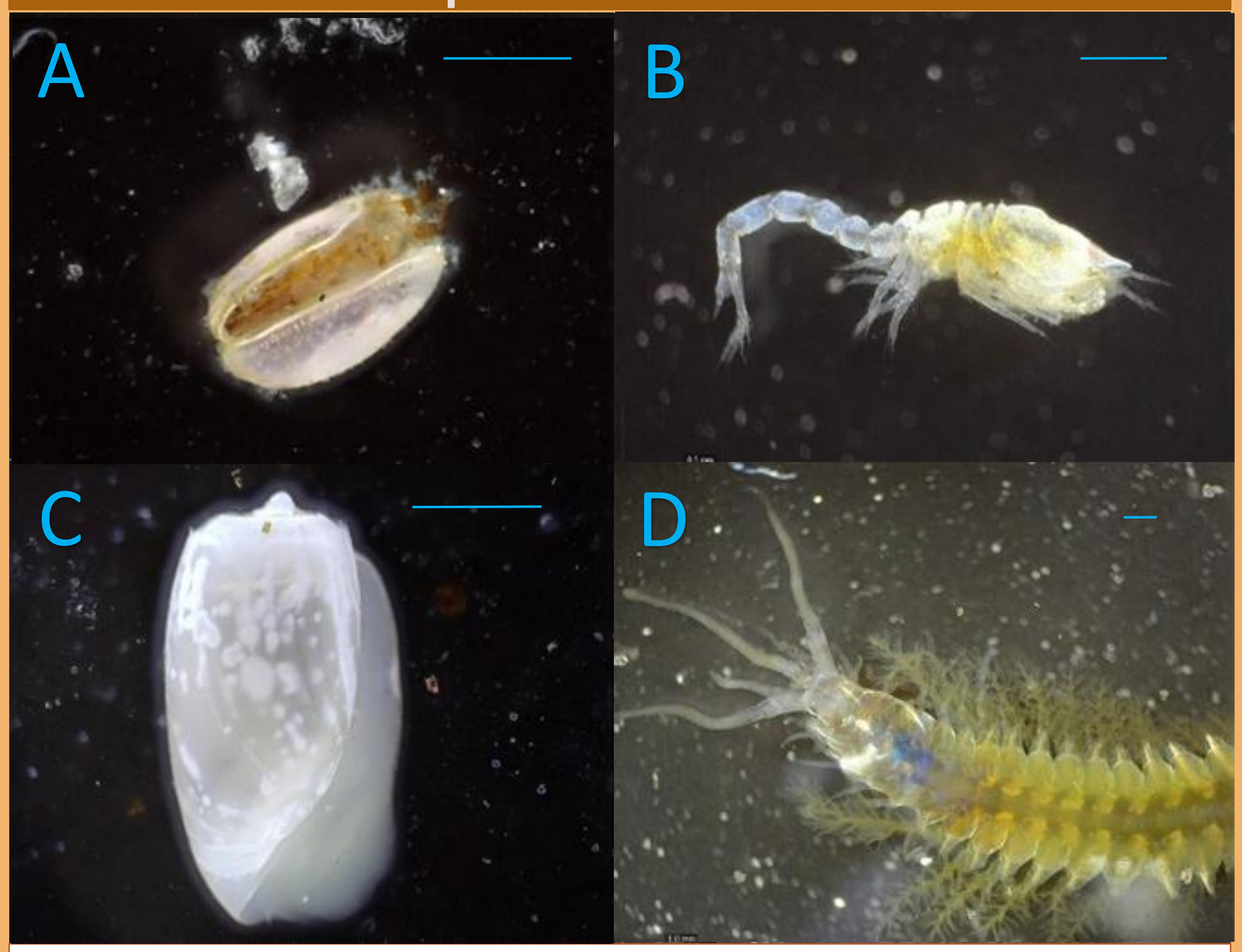

Figure 4. Common benthic infauna species found in this study **A.** The ostracod *Peratocytheridea setipunctata* **B.** The cumacean *Cyclaspis* sp. **C.** The mollusc *Acteocina canaliculata* **D.** The polychaete worm *Diopatra* sp. The Snail *Acteocina canaliculata* was the most abundant overall and reached densities of $3.9x10^3$ m^{-2} in October 2015. Scale bars = 0.5 mm.

Conclusion

Benthic accumulations of organic matter from fertilizer, runoff, sewage plants, and other anthropogenic sources are threatening the diversity and survival of coastal and estuarine benthic ecosystems. Sediment organic content of 2-3% represents the lower threshold of a rapid transition zone where species richness and diversity collapses. This correlation might be used to evaluate benthic ecosystem health based upon sediment characteristics.

Acknowledgment

References

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