Tracing Nitrogen Pathways in Coastal Wetlands: The Role of MAOM in a Changing Landscape

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Coastal wetlands play a critical role in carbon sequestration and water quality improvements, capturing 20–30% of the total carbon as soil organic matter (SOM). However, in Florida, these vital functions face threats from two major environmental changes: nitrogen (N) enrichment and the conversion of marsh grass to mangroves. Nutrient eutrophication has significantly impacted Florida's coasts, exacerbating public health issues such as harmful algal blooms and marine fauna die-offs. While N addition can both stimulate and hinder plant growth — affecting wetland subsidence and elevation — the shift from herbaceous marshes to woody mangroves adds further complexity to SOM dynamics.

This study explores the relationship between SOM composition and these environmental changes, focusing on particulate organic matter (POM) and mineral-associated organic matter (MAOM). POM is more labile and responsive to environmental shifts, while MAOM, bound to fine soil particles like silt and clay, is more stable and serves as a long-term carbon and nitrogen reservoir. Although carbon has consistently been shown to be stable when incorporated into MAOM, the persistence of nitrogen remains less understood. Therefore, this research aims to investigate the fate and stability of nitrogen within the MAOM pool, examining how nitrogen addition and the marsh-to-mangrove shift impact microbial substrate lability and MAOM formation.

Field sampling will be conducted at the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR), where marsh and mangrove ecosystems coexist, offering a unique comparative landscape. A 15N pulse experiment will trace short- and long-term nitrogen incorporation into MAOM. The study design involves two vegetation types (mangrove vs. marsh) and two nutrient treatments (N-fertilized vs. control), with five replicates per category, resulting in four plot types: fertilized marsh, control marsh, fertilized mangrove, and control mangrove. The plots will be enriched with a 15N tracer, and 5 cm diameter x 30 cm deep soil cores will be taken from treated plots at 0, 3, 6, 9, 12, and 24 months post-15N addition. These cores will be sectioned into 15-cm increments and analyzed for MAOM content and 15N composition. Short-term data will reveal immediate N demand under various conditions, while long-term data will provide insights into N retention, turnover, and the impacts of N enrichment and mangrove dominance on nutrient cycling.

We hypothesize that mangroves will sequester more added N than marshes due to greater plant N demand, leading to higher MAOM incorporation in marsh plots. Broader impacts of this research include informing wetland management strategies aimed at enhancing carbon sequestration and mitigating eutrophication through targeted conservation of ecotonal wetlands. Understanding these processes will support the development of adaptive policies that optimize the ecological services provided by Florida's dynamic coastal systems.