

Changes in Nutrient Content, C and N Stable Isotope Ratios and Molecular Composition During Decomposition of Seagrasses and Mangrove Leaves in Florida Bay

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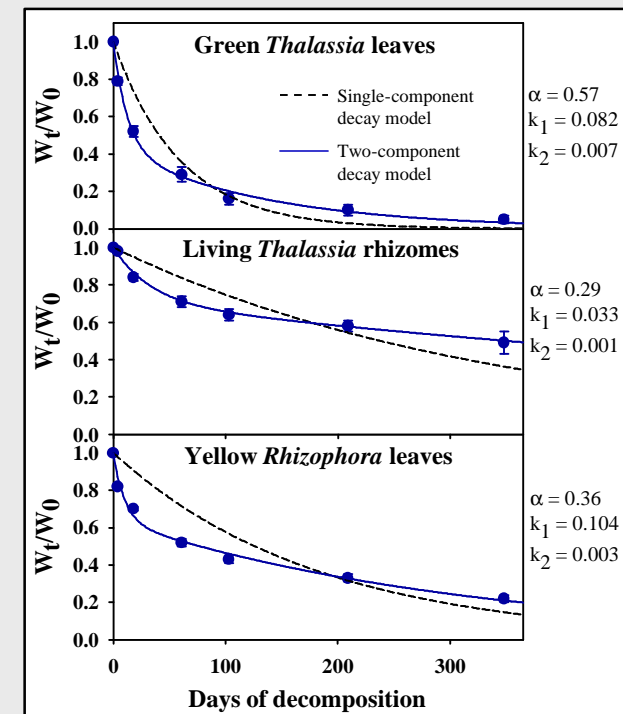


Decomposition Rates

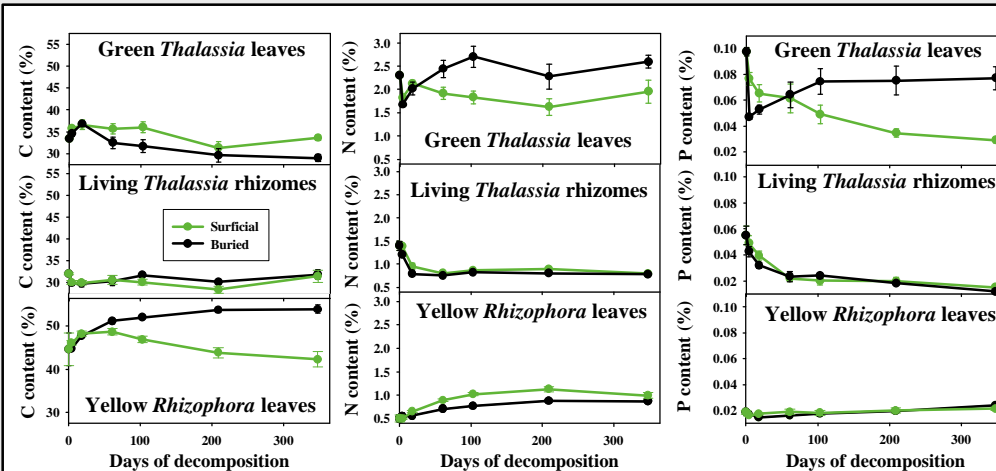
There were large differences in the decay rates of tissue types, but there were no consistent differences in the decay rates among sites or burial condition. The loss of mass over time for the detritus samples was best described by a two-component exponential decay model, which accounted for the initial rapid loss of easily degraded compounds (sugars, starches, proteins) as well as the slow decomposition of the refractory portion of the initial material (cellulose, fats, waxes, tannins, lignin). This can be represented as:

$$W_t/W_0 = \alpha e^{-k_1 t} + (1 - \alpha) e^{-k_2 t}$$

Where: W_0 = initial dry mass, W_t = mass remaining at time t , α = the fast decay component, $1 - \alpha$ = the slow decay component, k_1 = decay constant for labile component (per day), and k_2 = decay constant for the refractory component (per day).



Changes in Nutrient Content

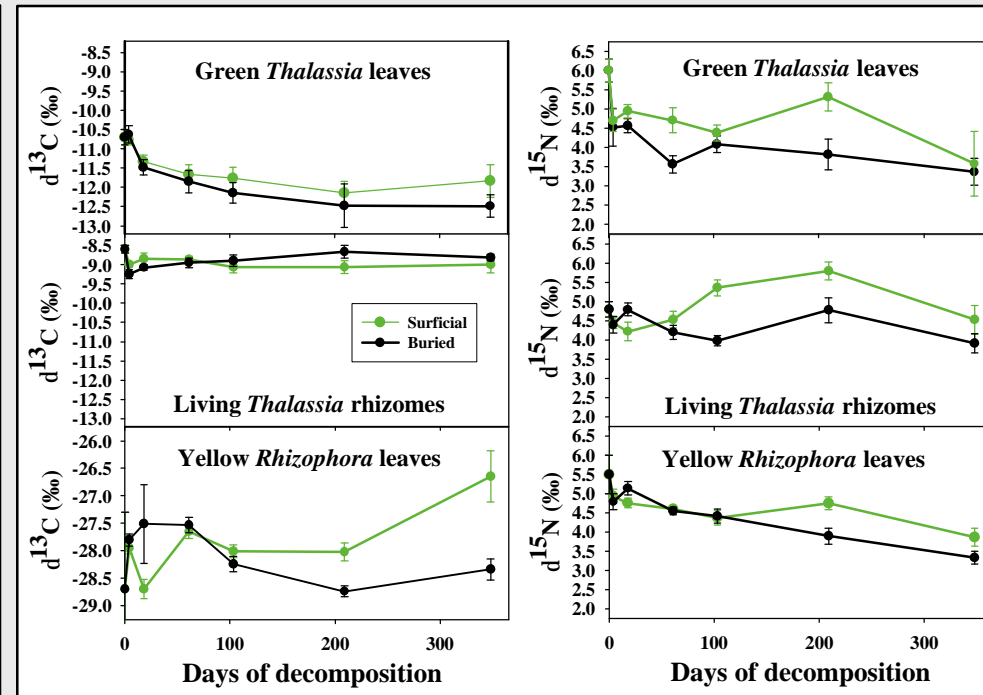


The C, N, and P dynamics of the litterbag samples were different for each of the tissue types, and the patterns of change were dependent on both the starting material and the burial condition. Interestingly, there was no influence of the nutrient availability between sites on the elemental dynamics. There was a marked divergence of C content of *R. mangle* leaves between surface and buried incubations,

and the leaves also slowly accumulated N in both conditions. In buried *Thalassia testudinum* leaves, there was an initial loss of over 50% of the P content in the first week of the incubation, but subsequently P content increased until it reached about 75% of the initial content. In contrast, P content continued to decrease in the surficial litterbags throughout the year.

Stable Isotope Ratios

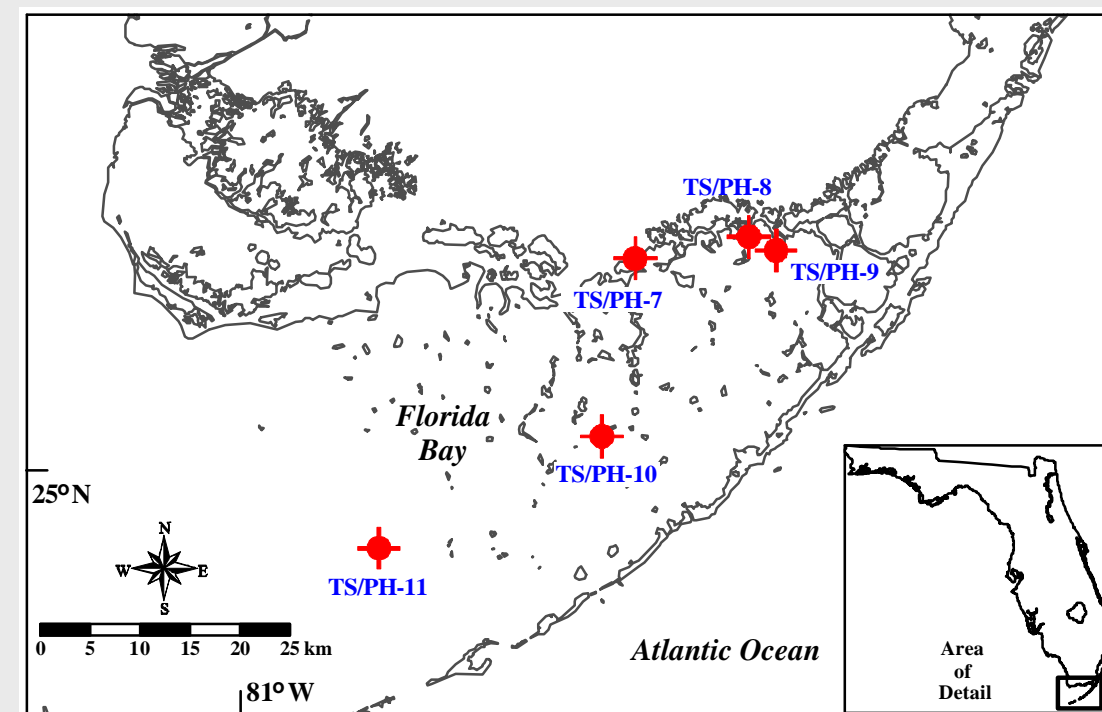
Throughout the experiment, small changes in the C stable isotope content of the decomposing material did not obscure the initial differences in $\delta^{13}\text{C}$ of the starting materials. Changes in the $\delta^{13}\text{C}$ of mangrove leaves were most pronounced, and there was a difference in buried and surficial treatments. The patterns in stable N isotope ratios through time were more complicated than for stable C isotopes. In general, detritus became depleted of ^{15}N during decomposition. *Thalassia testudinum* leaves showed an initial loss of ^{15}N , with a decrease in $\delta^{15}\text{N}$ of over 2‰ in the first week of decomposition, while seagrass rhizomes showed little change.



Abstract

The decomposition of the mangrove *Rhizophora mangle* and the seagrass *Thalassia testudinum* was examined using litterbags along a natural gradient in nutrient availability. Seagrass leaves had a higher fraction of their biomass in the labile pool (57%), compared to mangrove leaves (36%) and seagrass rhizomes (29%); the overall decomposition rates of the starting material reflected the fractionation into labile and refractory components. There was no relationship between the N or P content of the starting material and the decomposition rate. Nutrient availability had no influence over decomposition rate, and mass was lost at the same rate from litterbags that were buried in the sediment and litterbags that were left on the sediment surface. The dynamics of N and P content during decomposition varied as a function of starting material and burial state. N content of decomposing mangrove leaves increased, but seagrass rhizomes decreased in N content during decomposition while there was no change in seagrass leaf N content. These same general patterns held for P content, but buried seagrass leaves increased in P content while surficial leaves decreased. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ changed by as much as 2‰ during decomposition. Changes in the chemical composition of these litterbag samples is also being investigated through ^{13}C CP-MAS Nuclear Magnetic Resonance and GC/MS lipid biomarker analysis, while changes in the lignin-phenol content will be examined by TMAH Thermochemistry. Preliminary results from the NMR data are presented.

Figure 1

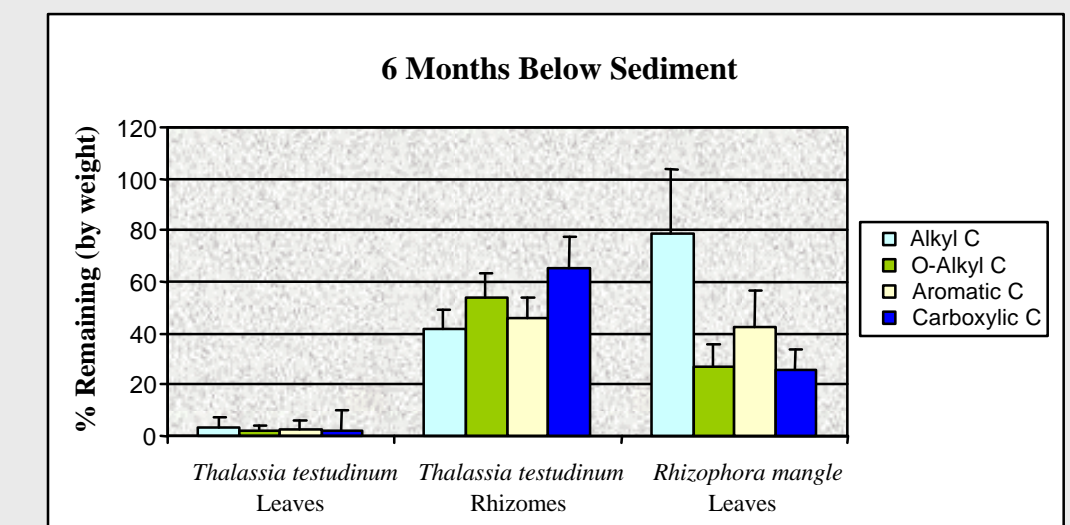
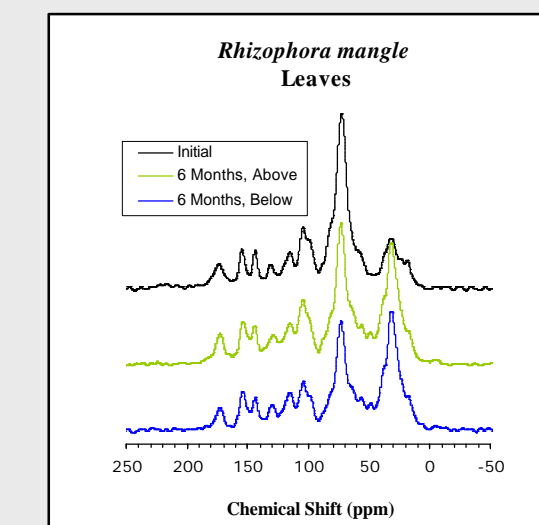
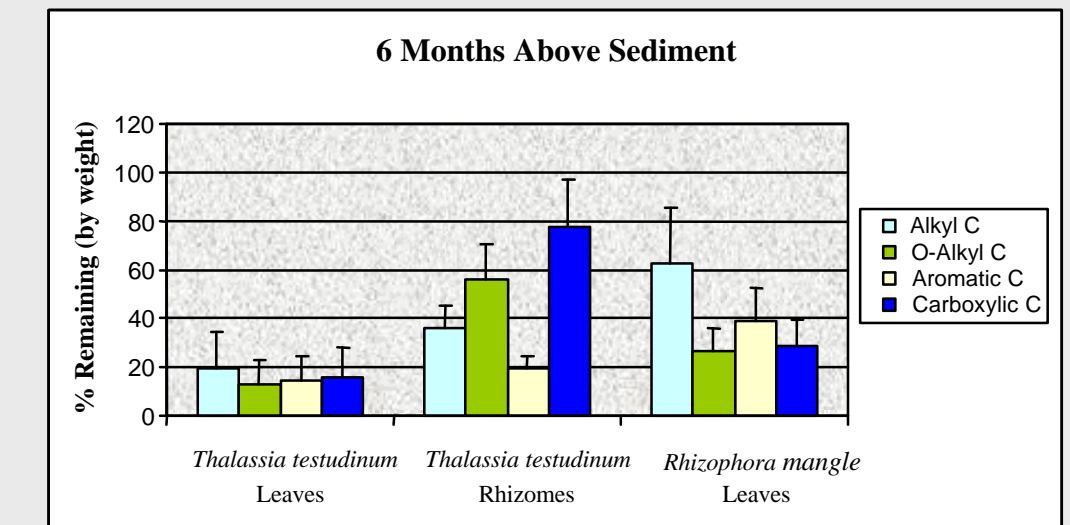
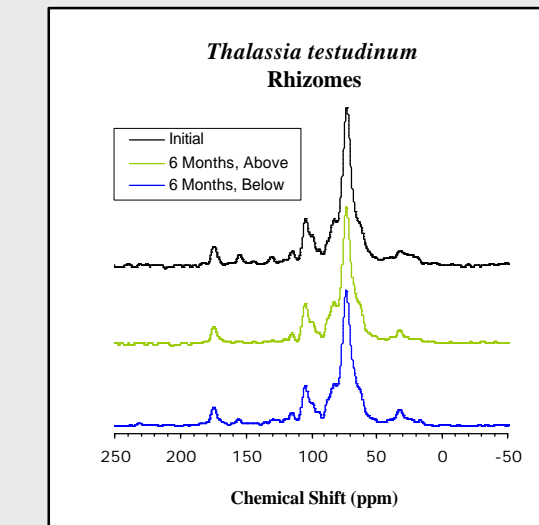
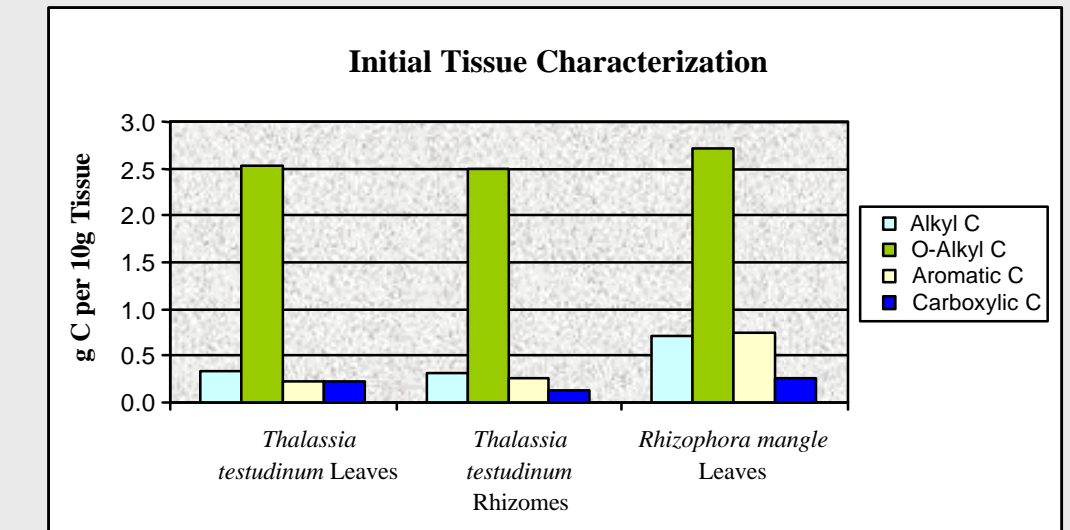
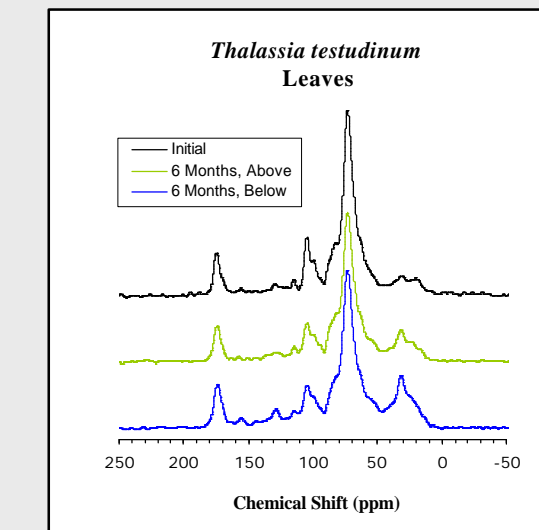


Experimental Design

The decomposition experiments were conducted at 5 FCE-LTER focal sites within Florida Bay (Figure 1). These sites differed in salinity characteristics, as well as water column N and P concentrations. Three different plant tissue types were collected: green leaves and living rhizomes of *Thalassia testudinum* and senescent yellow leaves of *Rhizophora mangle*. Litterbags (15 cm x 15 cm) were sewn from 1 mm mesh, plastic-coated window screen material. At each of the five sites 21 litterbags of each tissue type were deployed underwater both at the sediment surface and buried approximately 20 cm deep on August 6, 2001. Litterbags (2 or 3 bags of each tissue type from both above and below the sediment surface) were collected on August 10, August 24, October 6, November 17 2001, February 25 and July 20, 2002.

Powdered samples were analyzed in duplicate for carbon and nitrogen content using a CHN analyzer (Fisons NA1500). Phosphorous content was determined by a dry-oxidation, acid hydrolysis extraction followed by a calorimetric analysis of phosphate concentration of the extract. Elemental content was calculated on a dry weight basis; elemental ratios were calculated on a mole:mole basis. All isotopic analyses were measured at the Southeast Environmental Research Center Stable Isotope Laboratory using standard elemental analyzer isotope ratio mass spectrometry (EA-IRMS) procedures. The EA was used to combust the organic material and to reduce the formed gases into N_2 and CO_2 , which were measured on a Finnigan MAT Delta C IRMS in a continuous flow mode.

^{13}C CP-MAS NMR Analysis



The major C species contained in the initial plant tissues was O-alkyl C, representing mainly carbohydrates. These compounds composed more than 75% of *T. testudinum* tissues and over 60% of *R. mangle* leaves. No appreciable differences between the composition of leaves and rhizomes of *T. testudinum* were observed. Two peaks (145-157ppm) derived from tannin/lignin components were present in *R. mangle*, but not in *T. testudinum*.

After 6 months of incubation, there were no significant differences observed in the organic C composition incubated above or below sediment. Significant depletion of the %O-alkyl C and enrichment of the %alkyl C were observed for *R. mangle*. This suggests selective preservation of long chain alkyl C biomolecules such as cutin and suberin. The high value of the decay constant k_1 (labile component) for *Rhizophora* leaves suggests selective leaching of soluble compounds.

Though the %O-alkyl C in *T. testudinum* leaves and rhizomes was initially similar, it was shown that the leaves ($\alpha = 0.57$) had a higher fraction of their biomass in the labile pool than *Thalassia* rhizomes ($\alpha = 0.29$). Hence, a selective preservation of alkyl C in the *Thalassia* leaves may be reflecting a difference in the quality of initial O-alkyl C species. Since *T. testudinum* may not contain many rigid structural components, its decomposition might proceed rather homogeneously compared to *R. mangle*. This is especially the case for *Thalassia* leaves, which are physically fragile.