Seagrass biomass as a controlling factor of organic carbon stocks in subtropical seagrass meadows

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Carbon sequestrated in marine ecosystems has been termed “blue carbon”, and seagrass meadows are one of the most dominant blue carbon stocks. Globally, one of the major distribution sites of seagrass meadows is coral reef flat. Recent studies have revealed that the amount of sedimentary organic matter in tropical and subtropical coasts is comparable to that in temperate coasts. However, these estimations are based on a few data and have wide range. Since quantifying organic carbon in the carbonate sediment is technically difficult and costly, easier methods for estimating the amount of organic carbon in seagrass meadows are strongly needed to assess the global blue carbon stocks for mitigation of global warming. Seagrass biomass is suggested to have responsible for the variability of seagrass carbon sink capacity, but the models have not been presented yet. To identify the relationship between seagrass biomass and blue carbon stocks, we developed a new box corer which can facilitate to obtain the intact cores structured by both sediments and seagrass bodies. Using the core samples taken in subtropical seagrass meadows and adjacent unvagetated areas, located around Ishigaki Island, Japan, we measured total organic carbon mass (TOC_{mass}) and the stable isotope ratios ($\delta^{13}C$) of total sedimentary organic matter and then conducted regression analyses between organic carbon stock and seagrass biomass. The averaged TOC_{mass} of the top 15 cm sediment including live seagrass biomass was 876 ±408 g C m^{-2} (n = 28). The live seagrass biomass accounted for 17 ±15 wt%, whereas the dead plant structures (>2 mm), coarse sediments (>1 mm except for dead plant structures >2 mm) and fine sediments (<1 mm) accounted for 4 ±4 wt%, 21 ±14 wt%, and 58 ±15 wt%, respectively. TOC_{mass} increased with increasing the above seagrass biomass (A_b [g DW m^{-2}]) ($TOC_{mass} = 5.92 A_b + 502$, $R^2 = 0.72$, n = 28, $p < 0.01$). The above seagrass biomass was one of the controlling factors of blue carbon stocks at the sites.
Sedimentary organic carbon mass (mixture of the dead plant structures, coarse sediments and fine sediments) was also positively correlated with the above seagrass biomass ($R^2 = 0.45$, n = 28, $p < 0.01$). Using a Bayesian isotopic mixing model, we estimated that the contribution of seagrass-derived carbon to total sedimentary organic carbon was about 70%. The median values of seagrass-derived carbon mass estimated by the model was positively correlated with the above seagrass biomass ($R^2 = 0.46$, n = 28, $p < 0.01$), whereas those derived from terrestrial POM or suspended POM had no correlation with the above seagrass biomass. Consequently, the enrichment of sedimentary organic carbon with increasing the live seagrass biomass was mainly due to accumulation of seagrass-derived organic carbon at the sites. These results suggest that blue carbon stocks can be increased by the conservation and restoration of seagrass meadows in subtropical coasts.

Keywords: carbon stock, blue carbon, seagrass meadow, isotopic analyses, coral reef

