Evaluation of carbon export from blue carbon ecosystems and allochthonous sequestration using eDNA techniques

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Blue carbon ecosystems such as mangroves and seagrass meadows (coastal marine ecosystems dominated by halophytic vascular plants) are regarded as a global carbon dioxide (CO_2) sink supported by high net community production. A part of the excess organic carbon (OC) production by these ecosystems is stored for a long term as persistent OC in underlying sediments, while the rest is exported to outside the system (open ocean) without being remineralized. In order to properly assess the role of blue carbon ecosystems in the global carbon cycle, the fate of exported OC must be elucidated. A part of the OC exported to the open ocean may be decomposed and remineralized quickly while in the ocean surface and return to the atmosphere as CO_2. In such a case, the export production cannot be regarded as a long-term carbon sink. On the other hand, the exported OC may either be (1) stored for a long term in the offshore sediment as detrital OC, (2) stored as refractory dissolved organic carbon (RDOC) in seawater, or (3) settled down in the bathypelagic layer and subsequently remineralized into CO_2 there. In these cases, carbon does not return to the atmosphere in the short term and can be included in net CO_2 sequestration. It is obvious that carbon pools corresponding to these three processes exits in the ocean. However, it is technically extremely difficult to clarify whether and to what extent carbon derived from the blue carbon ecosystems is contained in these pools.

The purpose of this study is to demonstrate by using environmental DNA techniques that OC derived from the blue carbon ecosystems can be transported to and stored in open ocean sediments. As a case study, coastal area off the west coast of Busuanga Island, Philippines, was set as study site, where natural coral reefs, seagrass beds, and mangroves are relatively well preserved. DNA probes for MatK sequences (part of chloroplast DNA) of two mangrove species (*Rhizophora mucronata*, *Sonneratia alba*) and two seagrass species (*Enhalus acoroides*, *Thalassia hemprichii*) as well as ITS sequence (part of nuclear DNA) of *R. mucronata* were designed. Then, the DNA copy numbers of respective sequences contained in extracts from surface sediment samples were quantified by the qPCR method. In addition, the organic and inorganic carbon concentrations and the specific surface area of the surface sediment samples were determined, and the origin of the sediment OC was assessed using a carbon stable isotope mixing model. During sample collection, seismic profiling with a sub-bottom profiler was also conducted to evaluate thickness of sediment accumulated in the studied area.

In this presentation, we summarize the results of these surveys to evaluate the areal extent to which seagrass- and mangrove-derived OC is transported and stored in relatively intact state, and identify environmental conditions that influence the accumulation in open ocean sediments of OC derived from blue carbon ecosystems. Difficulties in converting the data of DNA copy numbers into the amount of OC derived from specific plant species in the sediment will be also discussed.

Keywords: Carbon sequestration, Seagrass meadow, Mangrove, Sediment, Environmental DNA, Blue carbon

