Abiotic Aggregation of Organic Matter in Aquatic Systems: Alteration of Chemical Characteristics and Implications

Tzong-Yueh Chen, Ph.D.
Postdoctoral Fellow,
Institute of Oceanography, National Taiwan University

Organic aggregates in aquatic systems play an important role in microbial food webs and the sinking carbon flux. In addition to the aggregates formed by biological growth, abiotic processes also form organic aggregates. Experiments employing two major collision mechanisms (shear and differential sedimentation) were carried out to access the effect of aggregation on composition of newly formed aggregates and dissolved organic matter (DOM).

Experimental treatments employed Couette flocculator, where shear is the major collision mechanism, and glass bottles on a roller table, where initial shear is followed by differential sedimentation. An important result from the Couette flocculator experiments was significant contamination by release of uncharacterized C-rich DOM from the device. Blanks have not been included in previous studies and our results indicate that great care must be taken when using and evaluating data from Couette devices.

In general, experimental treatments using both Couette flocculators and roller tables increased formation of particulate organic carbon (POC) compared to control groups. However, the net aggregation was not always positive. Bacterial abundance in treatments did not change, but community respiration (CR) increased. Aggregation increased CR less in samples where salinity was manipulated, indicating that salinity increases along an estuarine continuum may temporarily decrease microbial activity. The combination of aggregation and bacterial respiration in treatments decreased the abundance of biologically labile organic matter (OM) in the particulate phase. The decease of C-yields of labile organic components resulted in an increase of uncharacterized OM, indicating that aggregation processes tend to accumulate particulate uncharacterized OM. Neutral aldoses and amino acids in aggregates were selectively degraded compared with less labile OM. Degradation of amino acids were higher in samples in N-limited environments.

The salinity increase in the river-estuary-sea continuum has been considered a major driver for aggregate formation. Experiments using two salinities and two different salt compositions indicated that divalent cations (Ca^{2+} and Mg^{2+}) enhance aggregation, possibly result of these ions acting as bridging agents for DOM and transparent exopolymer particles (TEP). However, our experiments indicated that salinity induced flocculation plays a minor role in aggregate dynamics. Instead, the initial POC concentration is strongly correlated with aggregation formation.