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Variability of ammonia-oxidizing bacteria and archaea in the lower Columbia River Estuary

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Nitrification, with ammonia oxidation as the first and rate limiting step, is an important metabolic process in aquatic environments, particularly in riverine, estuarine, and marine ecosystems. Recent studies have demonstrated the ubiquity, high abundance and diversity of ammonia-oxidizing archaea (AOA) in aquatic environments and postulated that their ability to oxidize ammonia compared to ammonia-oxidizing bacteria (AOB) is significant. In this study, we examined the abundance of ammonia-oxidizing archaea and betaproteobacteria (β-AOB) across physicochemical gradients in the water column of the Columbia River Estuary. The Columbia River system, encompassing its plume, estuarine mixing zone, and fluvial reaches, is the largest source of freshwater to the northeastern Pacific Ocean and thus can exert a major influence on regional biogeochemical processes. Estimates by quantitative PCR indicated that AOA amoA (encoding ammonia monooxygenase subunit A) copy numbers were greater than β-AOB amoA in all collected samples, with differences up to 100-fold observed at higher salinities. Furthermore, 15N tracer incubations carried out in both freshwater and stratified portions of the estuary produced values ranging from 1.46 – 2.97 μmol N oxidized liter^{-1} day^{-1}. These results suggest that AOA may play a significant and active role in riverine and estuarine water column nitrogen cycling. This research is part of a time-series study of biogeochemical fluxes in the Columbia River Estuary to investigate variability within the context of the nitrogen cycle and the functional genes involved in its transformations.

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