# ABSTRACT

Nitrogen concentrations in aquatic ecosystems have increased because of human activities. Since nitrogen is an essential component in all organisms, its concentration is positively correlated with organic carbon. Therefore, excess nitrogen discharged into aquatic ecosystems can fuel rapid growth of primary producers like algae and result in subsequent eutrophication. Organic nitrogen in pelagic waters can be removed as $N_2$ by the anaerobic microbial processes denitrification and anammox (anaerobic ammonium oxidation). The understanding of pelagic $N_2$ production has almost exclusively been based on studies of free-living bacteria concluding that $N_2$ production is constrained to strongly oxygen depleted environments. However, this understanding is in recent years challenged by the discovery of anoxic microniches that develop in sinking particles such as phycodetrital aggregates and zooplankton carcasses due to high microbial aerobic respiration and limited replenishing of oxygen by diffusion. Thus, even in oxic waters these anoxic microniches can persist and mediate N-loss via anaerobic N-cycling. However, little is known about the magnitude and the relative contribution of these microniches to N-loss in pelagic waters. This thesis aimed at improving our knowledge about sinking particles as anaerobic microbial hotspots in hypoxic to oxic waters and their role in the biogeochemical cycling - with particular focus on their contribution to nitrogen cycling and N-loss from pelagic waters.

The thesis draws on three studies. Work described in **Manuscript I** explores sinking model diatom aggregates as they age under hypoxic or oxic conditions. The objective was to follow the succession in the microbial community and the anaerobic N-cycling simultaneously over a time frame that corresponds to that of natural aggregates descending through coastal pelagic water, an environment where they often are abundant. **Manuscript II** aimed at quantifying the contribution from mesozooplankton-associated anaerobic DNR-activity to the overall N-loss in a thermally stratified oxygen minimum zone (OMZ) in Golfo Dulce, Costa Rica. In **Manuscript III** carcasses of the copepods *Eudiaptomus* sp. and *Megacyclops gigas* from two freshwater lakes in NE Germany were investigated for potential anaerobic DNR-rates in an oxygen gradient.

These studies add novel aspects to the limited knowledge about the investigated particles (i.e. diatom aggregates, marine mesozooplankton (dead and alive) and limnic copepod carcasses) as unique hotspots for anaerobic activity. In all three we demonstrated anaerobic N-cycling and thus development of anoxic centers on the micrometer to millimeter scale, despite the presence of oxygen in the surrounding water. Due to the high abundances of these particles in nature they directly and indirectly contribute significantly to N-loss from pelagic waters via the dissimilatory nitrate reduction to (DNR)-processes. We found that as much as ~20% of the N-loss in an OMZ can be attributed to the mesozooplankton. The anaerobic DNR-activity was enhanced at low oxygen concentrations in the water and in diatom aggregates both the succession of microbial communities and the anaerobic N-cycling were under strong influence of the surrounding oxygen levels. Thus the occurrence of anoxic aggregate centers may be ephemeral at high ambient oxygen levels, but persistent at low levels, indicating that sinking phycodetrital particles can remain sinks for bioavailable N in the oceans for several days especially in oxygen depleted settings.