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Vertical Fluxes and Food Web Interactions

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Although pelagic systems are potentially capable of retaining and recycling all autochtonous organic material, losses due to sinking particles inevitably do occur. The upper limit for the annual pelagic export in terms of essential biogenic elements is set by the availability of new nutrients and hence controlled by physical transport. The time pattern, composition and origin of settling particles, however, is under biological control by pelagic food web interactions. Sediment trap deployments revealed significant spatial and temporal variations of vertical fluxes that reflect imbalances of pelagic particle formation and degradation. Seasonal patterns, often consisting of flux maxima during spring and reduced losses thereafter during summer are the best documented ones. In the concept of new and regenerated production the spring vertical flux maximum is commonly regarded as characteristic for temperate to polar latitudes. Trap deployments have since shown, however, that seasonal patterns may substantially deviate from this paradigm and considerable interannual variations have come to light as well. This holds true in particular for different types of settling particles (various types of faeces, aggregates of varying origin, different organisms).

The presentation highlights the impact of selected planktonic organisms and their seasonal food web interactions on pelagic sedimentation. It concludes that further differentiations beyond the categories of new and regenerated production are needed for understanding observed vertical flux patterns. Herbivores with different feeding and life cycle strategies (including copepods, euphausiids, salps, pteropods) are grouped according to their role of either accelerating losses or counterworking sedimentation. The possible roles of copepods and pteropods are discussed in particular.

Based on sediment trap and water column data from the northern Northeast Atlantic, copepod grazing is proposed as a general retaining mechanism for suspended matter. For the spring period it is concluded that the timing between the onset of phytoplankton growth and copepod grazing controls the vertical flux. The coastal (fjords) and shelf systems (Norwegian Coastal Current, Barents Sea) as well as the marginal ice zones are characterized by spring blooms prior to the onset of intense copepod grazing. Thus, they have in common a spring sedimentation maximum of autotrophic origin that is triggered by the exhaustion of winter accumulated new nutrients. In the Norwegian Atlantic Current, however, that houses large overwintering copepod populations, a closer coupling of spring autotrophs and copepods is typical. The retention efficiency for essential elements in the pelagic food web therefore is more efficient and seems to be related to copepod population dynamics (with coprorhexy and coprophagy as important processes).

In the Norwegian Atlantic Current the seasonal vertical flux maximum accordingly is shifted towards late summer/autumn and consists of matter with heterotrophic origin. Omnivorous pteropods play a major role during this period and their abundance is highest after copepod hibernation has commenced. Their abandoned feeding webs and discharged pseudofaeces of pteropods scavenge smaller particles into aggregates. Discarded pteropod webs provide microhabitats and serve as transport vehicles accelerating the vertical export of particles. Their shells, in addition, contribute significantly to the carbonate flux during autumn in the Norwegian Sea. Little is known about the factors triggering pteropod mass sedimentation in autumn, be it may be starvation or old age mortality. The impact of the succession from copepods to pteropods as important grazers on the pelagic food web and on sedimentation can as yet only be speculated upon.

Other plankters such as salps and euphausiids can entirely dominate the vertical flux regionally and temporarily due to their rapidly sinking faeces. Krill faeces dominate trap collections during summer on the Norwegian Shelf and have been found of paramount importance in antarctic waters. Being rapidly exported from the layers of production, however, they are commonly not collected by deep moored traps, indicative of their easy fragmentation and, hence, deceleration. Salps, notoriously unpredictable in appearance and being patchily distributed, could contribute significantly to the interannual vertical flux variability at a given place.

Knowledge of the propagation, seasonal appearance and regulatory mechanisms of the biomass of all these plankters, as well as their specific functions in the pelagic food web, is of paramount importance in understanding the biological control of vertical fluxes in the oceans.

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