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Controls of marine pelagic food webs on biogeochemical carbon cycles: Do we grasp the fundamental processes?

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Although our understanding of marine biogeochemistry and food-web processes has progressed considerably during the last decades, some fundamental controls exerted by pelagic food webs on key carbon fluxes remain poorly constrained due to methodological or conceptual limitations. Many conceptual studies and models of planktonic food webs consider the flows of chemical elements (e.g. for carbon: consumption, production, respiration, excretion) as either interchangeable or proportional. This assumption ignores the non-additive nature of heterotrophic consumption (C), i.e. part of the organic carbon that is consumed by one heterotrophic component (Cc) can be passed to other components where it contributes to their Cc. In other words, the various Cc are not mutually exclusive. Hence, community C can exceed net primary production (PP), whereas heterotrophic community respiration cannot. Consequently the trophic status of a heterotrophic component can be defined from the ratio of its respiration (Rc) to PP (Rc:PP), and not from Cc:PP. However characterization of trophic conditions of the upper ocean is often hampered by incomplete quantification of total PP (dissolved + particulate, PPT) over large spatial and temporal scales. The underestimation of PPT may lead to overestimating Rc:PPT.