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A coupled biomass spectrum-stable isotope approach to estimating zooplankton trophic transfer efficiency

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Zooplankton are the essential intermediate step between phytoplankton primary producers and higher trophic levels in pelagic food webs. A key factor in the energy available to pelagic food webs is the transfer efficiency (TE) between phytoplankton and the zooplankton size classes accessible to higher trophic levels as prey. Phytoplankton size structure is considered an important variable determining TE, through its effect on food chain length. Inefficient grazing of small (pico) sized phytoplankton in oligotrophic systems (OS) is expected to favour longer food webs with intermediary trophic levels required to make these phytoplankton available to zooplankton. Conversely, large phytoplankton (micro), which dominate in eutrophic systems (ES), are expect to favour short food webs with direct transfer to zooplankton grazers. Normalized Biomass Spectra (NBS) describe the transfer of biomass between organism size classes. A global mean, time averaged NBS slope of -1.05 has been combined with food chain length, inferred from stable nitrogen isotope size spectra (SIS), to estimate predator prey mass ratios (PPMR) and transfer efficiencies (TE) in food webs. Both PPMR and TE are positively correlated with the NBS and SIS slope, highlighting the importance of regionally specific measures to derive food web parameters. Here we present empirically measured NBS and SIS across an oligotrophic-eutrophic food web gradient spanning: Temperate British Columbia – ES; Mediterranean – OS; sub–tropical South Pacific - OS; the south Atlantic Polar Front – ES. Estimates of PPMR and TE are used to assess the role of nutrient availability / phytoplankton size structure in zooplankton transfer efficiency in the global ocean.

Keywords: trophic transfer efficiency, predator prey mass ration, biomass spectra, stable isotopes

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