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Trophic fractionation of carbon and nitrogen isotope ratios along food chains in marine, lake and grassland ecosystems

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Evidence suggests that analysis of Stable Isotopes (SI) have the potential to reveal complex interactions, including trophic interactions and energy or mass flow through ecological communities. However, the magnitude of trophic fractionation of carbon isotopes in natural ecosystems remains unclear and requires further study with emphasis on kinetic isotope fractionation during feeding processes on food chains. To examine the relationship between carbon and nitrogen stable isotope ratios ($d^{13}C$ and $d^{15}N$) along food chains, we analyzed data collected from both from marine and terrestrial ecosystems.

For marine ecosystems, we analized data from four oceanic regions: the Oyashio waters at the western North Pacific (samples collected from March to October 2009), the warm-core ring 86-B derived from the Kuroshio extension region (preserved samples), and previously published data from the Gulf of Alaska, Antarctic Ocean. The statistical analysis suggested a strong similarity in slopes of d15N versus d13C ($d^{15}N/d^{13}C$) among regions: $d^{15}N = 1.53[+/-0.25]\ d^{13}C$ + [ecosystem specific constant] ($p < 0.001$). For terrestrial ecosystems, we conducted statistical analysis for previously published data from Lake Biwa, Lake Baikal and Mongolian grassland, which showed similar slope value of 1.61[+/-0.41] as the marine ecosystems. We attribute this similarity to common physiological aspects of feeding processes (*e.g.*, 'kinetic isotope effects' inherent in the processes of amino acid synthesis). We also compared seasonal differences seasonal in $d^{15}N/d^{13}C$ for the euphotic layers of the Oyashio waters. The $d^{15}N/d^{13}C$ slope of the food chain during the spring bloom differs from its common value in other seasons. We suspect that the $d^{15}N/d^{13}C$ slope of food chain may reflect 'ecologocal factors' due to strong seasonal factors such as spring bloom, and appearance of various zooplankton with different life history.

If we could better understand both carbon and nitrogen trophic fractionation within ecosystems, the stable isotope ratios may help to elucidate migratory behavior of higher trophic levels such as fishes in marine ecosystems as well as frame work of biogeochemical cycles in question.

Keywords: d15N-d13C relationship, food chain, isotopic fractionation