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Chronological structure of stream food webs in Lake Biwa watersheds approached by carbon-14 natural abundance

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In this presentation, we show the relationship between landscape properties and carbon-14 of stream organisms to understand chronological structure of stream food webs in Lake Biwa watersheds. The cycling of carbon in stream ecosystems represents an interface between the atmosphere, terrestrial, and aquatic ecosystems, and as such plays a central role in global carbon cycle. Several studies have successfully used natural carbon-14 abundance to identify carbon turnover time in stream and river ecosystems (e.g., Raymond et al. 2004; Mayorga et al. 2005).

Carbon-14 shows beta decay with 5730-half-life and can be used as a natural tracer of carbon transfer pathway in the watershed, which consists of; (1) transfers between the terrestrial and stream environment; (2) incorporation into organismal biomass; and (3) mineralization by metabolism of stream organisms. In general pathways 2 and 3 remain more poorly resolved because few studies have measured carbon-14 signature within stream food webs.

We show, for the first time, the potential use of carbon-14 signature in the study of food webs in stream ecosystems (Ishikawa et al. in press). The main sources of carbon in stream ecosystems are old carbon weathered from underground and new carbon form atmospheric CO_2(Raymond et al. 2004). We applied carbon-14 signature to discriminate the two major carbon sources; (a) inorganic carbon fixed by stream autotrophs (autochthonous source); and (b) particulate organic carbon originated from terrestrial leaf detritus (allochthonous source). The result suggested that carbon-14 signature can elucidate not only carbon source contribution to organisms, but also chronological structure of stream food webs.

Furthermore, we show a study conducted in the upper and lower parts of six streams that have different landscape properties in Lake Biwa watersheds. We measured carbon-14 signature of stream organisms and evaluated watershed landscape properties such as land use, bedrock, riparian vegetation types, and watershed area by using GIS. The change of carbon-14 signature within food webs between upper and lower parts of streams should estimate in-stream carbon dynamics as a natural tracer. Additionally, organisms are expected to integrate long-term fluctuation in carbon-14 signature. We will also discuss future development of carbon-14 studies on stream ecology.

References

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Ishikawa, N. F., M. Uchida, Y. Shibata, and I. Tayasu. 2009. A new application of radiocarbon (^{14}C) concentrations to stream food web analysis. Nuclear Instruments and Methods in Physics Research B. doi:10.1016/j.nimb.2009.10.127. In press.

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