Uptake of sediment-derived ^{14}C into freshwater benthic organisms in a controlled microcosm experiment

Sayed Tariq Uzzaman[1], Tung Pham[1], Victor Carrasco-Navarro[1], Zahra Shirani[1,*], Tatiana Trubnikova[1], Jarkko Akkanen[2], Christina Biasi[1,3], Soroush Majlesi[1,4]

[1]Department of Environmental and Biological Sciences, University of Eastern Finland, P.O. Box 1627, FI-70211, Kuopio, Finland

[2]Department of Environmental and Biological Sciences, University of Eastern Finland, PO Box 111, FI-80101 Joensuu, Finland

[3]Department of Ecology, University of Innsbruck, Sternwartstrasse 15, 6020 Innsbruck, Austria

[4]Department of Chemistry, Radiochemistry, P.O. Box 55 (A. I. Virtasen aukio 1), 00014 University of Helsinki, Helsinki, Finland

** e-mail: zahra.shirani@uef.fi*

Radiocarbon (^{14}C) is a significant radionuclide that can enter the biosphere through nuclear fuel cycles and radioactive waste repositories, making it easily absorbed by organisms. With a long half-life of 5,730 years, it can disperse globally in both dissolved and gaseous forms. In this work, we investigated the proportion of sediment-derived C (from a field-collected peat) in benthic animals, chironomid larvae (*Chironomus riparius*) and blackworm (*Lumbriculus variegatus*), in a microcosm study. There was a large difference in ^{14}C/total C ratio between the atmosphere and up to 8000-year leftover peat, providing a unique opportunity to track the fraction of C from different sources. Two-pool isotope mixing model was used to estimate the contribution of C from each source in the selected animals. The results revealed a significant incorporation of sediment-derived C in chironomids (40%), while smaller contribution was observed from sediment to feeding (2.6%) and non-feeding blackworm (2%). Despite a notable contribution of C from sediment, fish food remained the dominant C source in chironomids. Lower uptake of sediment-derived C in worms may be attributed to C storage in their tissues from fish food and previous diet with more enriched ^{14}C contents (e.g., fish food and towel papers used as the culture materials) as well as their slower C turnover rates. Additionally, feeding worms showed slightly higher sediment-derived C contribution than non-feeding ones, likely due to sediment ingestion alongside fish food particles. In contrast, non-feeding worms may have mostly avoided sediment consumption during the 10-day experiment in the absence of fish food. Overall, the findings highlight the role of sediment in transferring ^{14}C to chironomids, even in food-rich environments. This suggests potential ^{14}C transfer to higher trophic levels, as these benthic organisms serve as a food source for various species, including fish, which are regularly consumed by humans.