Absorption of radiocesium by fungi -estimation of soil hyphal distribution using stable isotopes-

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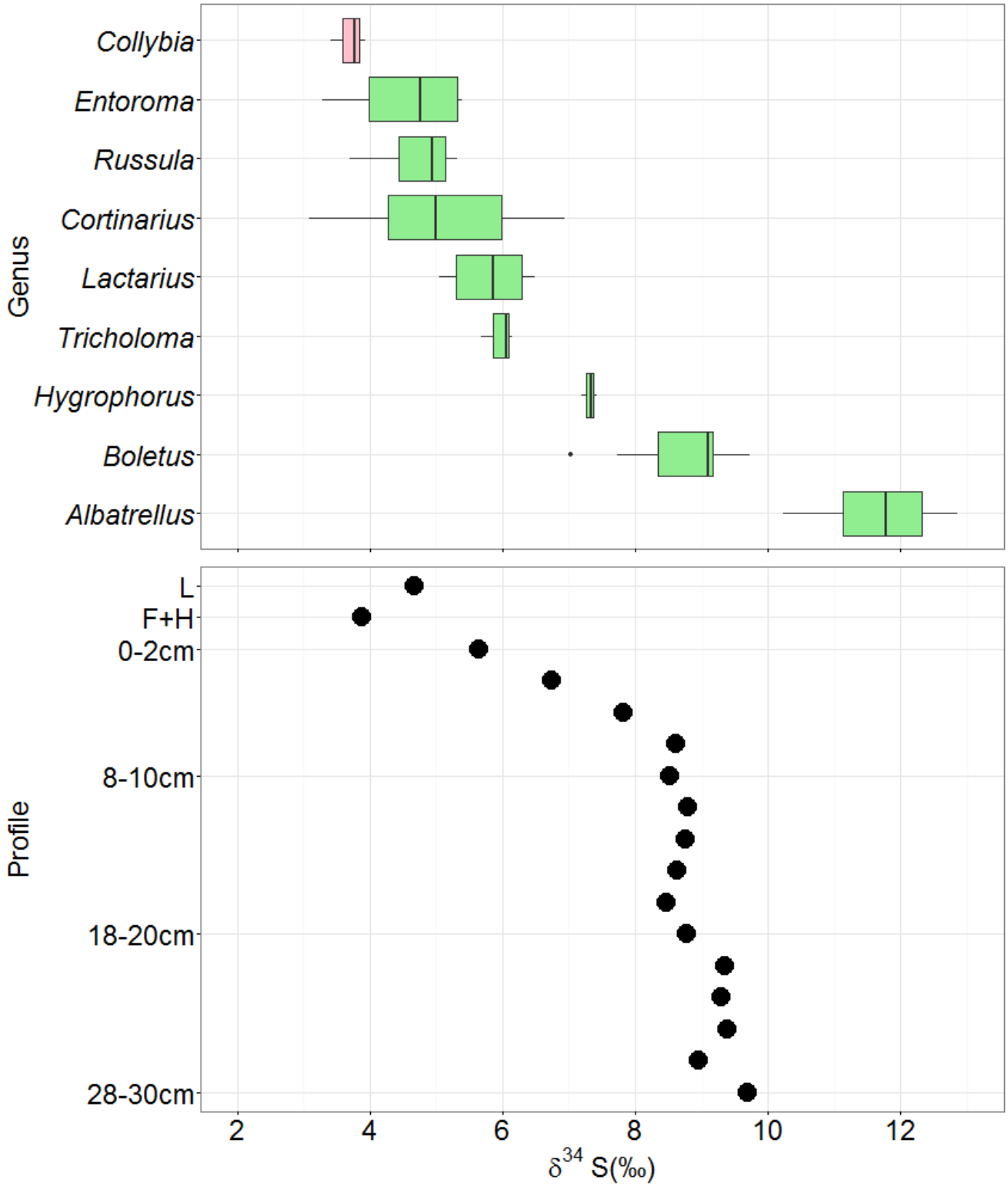
Many studies after the Chernobyl nuclear accident in 1986 have reported that fungal fruit bodies accumulated higher ^{137}Cs concentration than other organic materials in forest ecosystem. Some of the studies pointed out soil hyphal distribution as one of the main factors determining ^{137}Cs concentration in fungi, but the viewpoint has not yet been examined well. We therefore have attempted multi stable isotopes (^{13}C, ^{15}N and ^{34}S) to examine the relationship between hyphal vertical distribution and ^{137}Cs concentration in fruit bodies.
Study site was a broad-leaved forest dominated by konara oak, mixed with fir, located at 20 km southwest from the Fukushima Daiichi Nuclear Power Plant, in Kawauchi Village, Fukushima Prefecture. Fruit bodies and soil core samples (down to 30 cm below the soil surface) were collected. After oven-dried, the fruit bodies were ground into powder, and isotope ratio ($d^{13}C$, $d^{15}N$ and $d^{34}S$) and ^{137}Cs concentrations of samples were measured. Each soil core was separated into 2-cm long, sieved after air-dried, and isotope ratio and ^{137}Cs concentrations were measured. For ^{34}S measurement, sulfur was extracted from samples with Parr bomb and collected as precipitation of $BaSO_4$. Litter and humus layers were also collected, treated and analyzed as other samples.
^{137}Cs concentration in saprophytic fungi was lower than that of ectomycorrhizal (ECM) fungi in average, but there was wide variation among genera and within genus in ECM fungi. Saprophytic fungi did not accumulate so much ^{137}Cs despite the high ^{137}Cs concentration in litter and humus layers. The vertical profiles of $d^{13}C$, $d^{15}N$ and $d^{34}S$ had a common trend; d values decreased with the depth. Saprophytic fungi showed most negative delta values for N and S isotopes, but most positive for C isotopes in the fungus groups. Genus-specific d values were observed for N and S isotopes, which variation was comparable to those observed for soil vertical profiles (figure).
Results of isotopes analysis suggested hyphal distributions of saprophytic and ECM fungi were completely different and that there was considerable difference in ECM fungi. Saprophytic fungi had $d^{13}C$ and $d^{15}N$ values close to those in organic layers after being adjusted based on the suggestions from previous studies about isotope fractionation. $d^{34}S$ values in saprophytic fungi also were close to those in organic layers. The results of 3 isotopes indicated the hyphae of saprophytic fungi were restricted almost to soil organic layers. On the contrary, hyphal distribution of ECM had wide variations in mineral soil as indicated by genus-specific variations of $d^{15}N$ and $d^{34}S$.
We did not observe significant relationships between hyphal distribution and ^{137}Cs concentration in fruit bodies. Saprophytic fungi showed lower ^{137}Cs concentration than ectomycorrhizal fungi regardless of shallow distribution of hyphae; and some genera of ECM fungi had similar values though they had different stable isotope ratios. These data are not consistent with the view that emphasized the relationship between hyphal distribution and ^{137}Cs concentration in fruit bodies. The view of soil-depth dependent ^{137}Cs accumulation by fungi needs to be re-examined.
Sulfur isotope seemed to be useful for estimating hyphal vertical distributions. Since the vertical profile of $d^{34}S$ was similar to those of $d^{13}C$ and $d^{15}N$, multi isotope approach will provide an effective tool for investigating biological processes in soil ecosystems. For further application to fungi study, isotope fractionation of sulfur and $d^{34}S$ of available sulfur by fungi has to be studied.

Keywords: radioicesium, hyphae, stable isotope



δ34S in fruit bodies and soil profile

