

Study on property of soil organic matter decomposition by global warming using radiocarbon

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Current research indicates that future atmospheric CO₂ concentration may be increased more than predicted value by furthering of soil organic matter decomposition due to global warming. The information on soil organic matter decomposition property in long-term warmer environment has not yet been obtained. We have carried out artificial soil warming experiment in six forest sites having different vegetation in Japan for long time. We planed vertical ¹⁴C measurement of soil core at an even-green Japanese oak forest in Setonaikai region (Higashi-Hiroshima). A soil core was collected from both the soil warming and the control plot in December 2011, and was cut into 1cm layers in laboratory. Each sample was hydrolyzed with 1N HCl overnight to remove inorganic carbon in the sample, and then was analyzed particulate organic carbon (POC) and organic nitrogen (PON) by an elemental analyzer. For ¹⁴C analysis by an accelerator mass spectrometer (AMS), soil samples adjusted to a weight of approximately 3mg-C were first converted to CO₂ gases by combustion with CuO and Ag foil at 900 °C, and then purified cryogenically in a vacuum line. The CO₂ gas samples were reduced to graphite with H₂ gas over Fe powder. The ¹⁴C/¹²C ratios of the sample graphite were measured at the Tandem AMS Facility in the Mutsu Office of the Japan Atomic Energy Agency. The ¹⁴C results are expressed as Δ¹⁴C. The typical analytical error of the Δ¹⁴C values was about ± 4 ‰ based on the 1σ value of the counting statistics.

Both of POC and PON weight percent in the soil were high above 3cm depth and decreased sharply with depth from 5cm to 15cm. Both of POC and PON of the soil warming plot were 20-30% lower than those of the control plot irrespective of depth above 15cm depth. The result indicates that the soil warming experiment was encouraged the microbial decomposition of soil organic matter up to comparatively deep layer. The Δ¹⁴C profile of the warming plot was unique with a maximum (220 ‰) at 5cm depth, although the Δ¹⁴C of the control plot was approximately constant from surface to 10cm depth. In terms of Δ¹⁴C vertical profile above 10cm depth, although the Δ¹⁴C of the warming plot above the 3cm depth having POC >15 wt% were lower than those of the control plot, the Δ¹⁴C of the warming plot below the 3cm depth were obviously higher than those of the control plot. The results indicate that microbes selectively decomposed young POC at surface layer and old POC at intermediate layer by the soil warming experiment.

Keywords: soil carbon, radiocarbon, global warming, organic matter decomposition, forest soil