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学 位 論 文 題 名

Effect of waterlogging on plant carbon isotope discrimination
（湛水が植物炭素同位体分別に及ぼす影響）

Isotope signatures of plants are useful for ecological studies to understand and predict the potential impacts of climate change on trees and forest ecosystems. Soil moisture is a major environmental factor controlling carbon isotope discrimination ($\Delta^{13}C$), which has been demonstrated to decrease under dry conditions in many studies. There are two factors that control $\Delta^{13}C$. One is stomatal conductance and the other one is carboxylation rate. When stomatal conductance decreases, $\Delta^{13}C$ decreases; when carboxylation rate decreases, $\Delta^{13}C$ increases. Many studies on plant physiological responses to waterlogging have been done, and one typical response is stomatal conductance decrease. However, few studies on $\Delta^{13}C$ under waterlogging condition have been conducted. Therefore the objective of this study is to clarify the effect of waterlogging on plant $\Delta^{13}C$.

A pot experiment was conducted with *Larix gmelinii*, a major larch species in the east Siberian Taiga, to investigate the effect of waterlogging on $\Delta^{13}C$ during photosynthesis. To measure instantaneous $\Delta^{13}C$, experimental chamber system and analytical line of carbon isotope composition of CO_2 were developed and CO_2 carbon isotope composition was measured. Assimilation rate and $\Delta^{13}C_{RD}$ (instantaneous $\Delta^{13}C$

calculated with Rayleigh Distillation equation) decreased drastically soon after waterlogging, and then recovered to some extent. This was caused by the decrease in stomatal conductance and the subsequent recovery. Thereafter, assimilation rate decreased gradually, whereas $\Delta^{13}C_{RD}$ decreased more gently. These results were thought to be caused by the decrease in both stomatal conductance and carboxylation rate. Instantaneous $\Delta^{13}C$ showed temporal change but decreased in total under waterlogging.

Besides the instantaneous discrimination, $\delta^{13}C$ of current year shoot of waterlogging trees, which is mainly formed of carbon fixed during waterlogging experiment, was larger than current year shoot $\delta^{13}C$ of control trees. This means that plant tissue $\delta^{13}C$ increased and the integrated $\Delta^{13}C$ decreased under waterlogging.

Both instantaneous and integrated $\Delta^{13}C$ decreased under waterlogging condition. This is the same with $\Delta^{13}C$ response to dry condition. It is important information for detecting flooding events in the past using tree-ring isotope analyses and for studying impacts of waterlogging in areas where flooding might occur.

The above results showed that plant carbon isotope discrimination during photosynthesis decreases and at the same time plant $\delta^{13}C$ increases under waterlogging condition, although the discrimination increases and plant $\delta^{13}C$ decreases in wet condition in general. This is the first experimental study in the world that showed decrease in carbon isotope discrimination and increase in plant $\delta^{13}C$ when the soil is waterlogged under extreme wet condition. These responses are the same with those under dry condition. Extreme events are expected to occur more frequently, therefore this result is important for soil moisture reconstruction using tree-ring $\delta^{13}C$.

All the examination committee members deem this result valuable and the candidate to be honest and enthusiastic as a researcher. Also considering the intensive study and obtained academic credit during her doctoral course, all committee members judged that the candidate is qualified enough to obtain doctoral degree (Environmental science).