学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

The study on physiology and ecology of willows under flooding in Indigirka River lowland, Northeastern Siberia, using stable isotope tools
（同位体比を用いた北東シベリアインディギルカ河川低地氾濫域のヤナギの生理学的および生態学的研究）

With the enhanced global warming in recent years, the increasing frequency and severity of river floods in Arctic regions lead to more waterlogging on plants that are widely distributed in river lowland, finally result in changes in plant physiology and nutrient condition. And these changes can also affect climate change in turn. Therefore it is necessary to investigate into the effects of flooding on plants. We reached to the objective by using stable carbon and nitrogen isotope methods. As stable carbon isotopic composition (δ^{13}C) of plants has been widely used to indicate different water regimes in terrestrial ecosystem, and stable nitrogen isotopic composition (δ^{13}C) of plants has been conducted to illustrate nitrogen processes. The willow growing in Indigirka River lowland, Northeastern Siberia, was selected to be the study material.

To investigate the physiology and related foliar δ^{13}C values of plants respond to different flooding conditions (including waterlogging), we measured the δ^{13}C values in the leaves of willows species, *Salix boganidensis*, *S. glauca*, and *S. pulchra*, and also monitored changes in plant physiology, under several major flooding conditions. The foliar δ^{13}C values of willows varied, ranging from −31.6‰ to −25.7‰ under the different flooding conditions, which can be explained by: (i) under normal conditions, the foliar δ^{13}C values decrease from dry (far from a river) to wet (along a river bank) areas; (ii) the δ^{13}C values increase in frequently waterlogged areas owing to stomatal closure; and (iii) after prolonged flooding periods, the δ^{13}C values again decrease, probably owing to the effects of not only the stomatal closure but also the reduction of foliar photosynthetic ability under long period of waterlogging. Based on these results, we predict that plant δ^{13}C values are strongly influenced by plant physiological which responses to the diverse hydrological conditions, particularly the long periods of flooding regions, as occurs in the Arctic regions.

To survey the nutrient conditions, foliar δ^{15}N values and foliar N content of plants correlate to different flooding conditions which has been mentioned above, we measured the δ^{15}N values in the same leaves of willows as stable carbon isotopic analyses, and also analysed the δ^{15}N values of soil bulk, concentrations of NO_3^-, NH_4^+, and total dissolved N (TDN) river water. The foliar δ^{15}N values of willows varied, ranging from −6.8‰ to 5.3‰ under the different flooding conditions. Unlike lack of differences in foliar δ^{13}C among different flooding conditions, high foliar δ^{15}N values, which was always found near river, was clearly caused by frequent flooding. And foliar N content, ranged from 1.37% to 4.25%, was found high near river in low water level year 2015 and no significant differences in high

water level year 2016. The high foliar $\delta^{15}N$ values caused by flooding can be explained by additional N brought by river, available soil N in deeper soil because of deeper maximum thaw depth under waterlogging, and also denitrification under reductive conditions. The former two processes which can increase the nitrogen availability can be the reason for the high foliar N content in frequently waterlogged area near river in 2015, and the last process which may decrease the nitrogen availability and absorption can be the explanation for low foliar N content after prolonged flooding periods in 2016.

Therefore, as one of water-tolerant plants which prefer relatively high water content, willows growing in Indigirka River lowland prefer frequently waterlogging caused by flooding, which can lead to increased carbon fixation and more available nitrogen for willow. Meanwhile prolonged flooding periods (i.e., continuous waterlogging in whole growing season) may hamper carbon fixation and nitrogen availability for willows. These all suggest that the flooding levels under warming can be the key point determined willows' distributions in Arctic region. And it implied that the stable isotopic values of plants related to the different flooding levels can be good indicators to evaluate the plants' feedbacks under different flooding levels.