Ecology of willow in the Arctic and its feedback to Indigirka river condition and its tributaries using stable isotopic methods

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In northeast Siberian Arctic, rapid warming have been observed(Serreze and Barry, 2011; ACIA, 2004; IPCC, 2013) and Yana-Indigirka-Kolyma lowland located there has a large area. River changes is one of key parameters to control material cycling through water level changes. From our former work (Morozumi, in preparation), we found willow growing widely along river, so that willow there can be good records of river condition. Foliar $\delta^{13}C$ and $\delta^{15}N$ values are known as integrated indicators of environment, meanwhile plant $\delta^{18}O$ is expected to record source water isotope ratio.
This study was conducted in taiga-tundra ecosystem along Indigirka river (70.63˚N, 147.91˚E). Three transect sites were set up along mainstream and also tributary. In each site, sampling was made at three points along a transect from river to land. Willow current year shoot were collected, other samples including river water, soil water, willow stem were collected weekly in summer, both 2015 and 2016. In the end of July in both year, there are also widely random sampling of willow current year shoot.
In 2015, N content ranged from 1.5% to 3.9% and $\delta^{15}N$ from -5.6‰ to 5.3‰ showed clear spatial variation with high N content and $\delta^{15}N$ near river and low N content and $\delta^{15}N$ on land in 2015. No clear differences was observed for willow foliar $\delta^{13}C$ which ranged from -31.1‰ to -25.3‰. In 2016, same trend as last year was found in foliar $\delta^{15}N$ (from -6.84‰ to 4.91‰) in large area and showed clear spatial variation from water logging points (0.6±2.6‰), near water points (-2.3±1.05‰) and land points (-3.8± 0.9‰). This maybe caused by denitrification and enhanced leaching in waterlogging points. Willow foliar $\delta^{13}C$(-31.6‰ to -25.7‰) and N content (1.4% to 4.3%) didn’ t show difference. In summer of 2015, the $\delta^{18}O$ value of mainstream was little different from tributaries, because the relative high water level in summer of 2015. Soil water $\delta^{18}O$ at the nearest location of river was affected by river water, and in addition, stem water $\delta^{18}O$ varied with that of 20cm-soil water (R^2=0.55, $p<0.001$). At the points by river, cellulose $\delta^{18}O$ of current year shoot along tributary was little higher than along mainstream. The points by river also has lower $\delta^{18}O$ compared to the points on land. These together proved $\delta^{18}O$ of willow could record $\delta^{18}O$ of river. In future work, tree-ring studies to reconstruct water level and the water level differences between mainstream and its tributaries will be challenged.
This study showed the physiology and phenology of willow growing in Indigirka lowland and tried to reveal the relationship with river and willow growing from stable C and N isotopic aspect. And also tried to figure out source water changes which related to river water level changes by $\delta^{18}O$ ratios of willow.

Keywords: Eastern Siberia, Taiga-Tundra ecosystem, Willow, Stable isotope, δ13C and δ15N, δ18O

