Use of stable oxygen isotope ratio in detecting annual fluctuation of xylem growth in mangrove trees

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Trees in the temperate and boreal regions form annual rings, through the influence of environmental factors such as temperature and precipitation, and its hereditary characteristics. Tree rings indicate not only the tree age but also growth which can be traced measuring their widths. Furthermore, tree ring analysis enables one to estimate tree size in the past or to predict it for the history. However most tropical trees lack visible and distinct tree rings because seasonal variability of tropical climate is not sufficient to let them form tree rings. It is difficult to identify age and annual increment of tropical tree if the tree rings are not distinct. So it has been difficult to estimate forest development processes in tropic trees by the use of tree ring analysis. These are major difficulties in the tropical regions, where forest degradation is accelerating, for evaluation of forest function as carbon sink and for development of sustainable forest management. To solve problems various methods have been tried to estimate age and annual growth of tropical trees. One of such attempts is the stable oxygen isotope analysis. In previous studies oxygen isotope ratio was measured in temperate or boreal trees. They reported that oxygen isotope ratio of wood was influenced by relative humidity and oxygen isotope ratio of precipitation. Furthermore, some oxygen isotope analyses of tropical trees reported that variation of oxygen isotope ratio was also influenced by these climate factors. Thus, if seasonal variation of oxygen isotope ratio is detected from tropical trees without distinct tree rings, it may be possible to estimate their annual growth. This possibility has remained untested.

In this study, I measured radial variation of oxygen isotope composition in some mangrove species to detect annual cyclicity of its variation. I examined whether it is possible to estimate annual growth of tropical trees that do not form clear annual rings by using oxygen isotope analysis.

Firstly, for three mangrove species *Kandelia obovate*, *Bruguiera gymnorhiza*, *Rhizophora stylosa* in Okinawa, I marked the wood to delineate one year of growth by electric cambium marking. Then I measured oxygen isotope composition in these species. The oxygen isotope variations showed annual cyclisity in all species. Even more, the results suggested that the oxygen isotope ratio of wood was more influenced by precipitation than relative humidity.

Secondly, I conducted oxygen isotope analysis for two mangrove species, *Rhizophora apiculata* and *Avicennia alva* in Thailand. The oxygen isotope ratio in *A. alva* did not show annual cyclisity because *A. alva* has complex wood structure; many layers of phloem were observed intermingled with xylem. On the other hand, *R. apiculata* showed clear annual ciclicity of oxygen isotope ratio. And the variation reflected that of precipitation similar to the mangrove species in Okinawa. Using this result, I calculated tree radii in the past with considering eccentricity and shrinkage ratio of wood and bark. The calculated value was smaller than the measured radii in the past particularly near the core. It is suspected that this underestimation may be resolved by analyzing samples from one tree, and modifying the assumption on the shrinkage ratio of the wood.