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ISOTOPIC (Δ14C, δ13C) AND ANATOMICAL STUDY ON RADIAL INCREMENT LAYERS OF A TYPICAL SHRUB (HALOXYLON AMMODENDRON) FROM THE GURBANTUNGGUT DESERT, NORTHWESTERN CHINA

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year	2014-12
出版者	Shizuoka University
URL	http://doi.org/10.14945/00008736

（課程博士・様式７）（Doctoral qualification by coursework,Form 7）

学 位 論 文 要 旨

Abstract of Doctoral Thesis

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論文題目：中国北西部グルバンテュンギュト砂漠における典型的低木(*Haloxylon ammodendron*)の成長層に関する同位体的($\Delta^{14}C$, $\delta^{13}C$)及び解剖学的研究

Title of Thesis : Isotopic ($\Delta^{14}C$, $\delta^{13}C$) and Anatomical Study on Radial Increment Layers of a Typical Shrub (*Haloxylon ammodendron*) from the Gurbantünggüt Desert, Northwestern China

論文要旨：

Abstract：

Dryland degradation-desertification has become a serious international environmental issue. The *Haloxylon* species is xero-halophytic C_4 desert shrub which exhibiting excellent drought resistance and salt tolerance, and is major dominant species widely distributed in Central Asia arid areas and plays an important role for maintaining the desert ecosystem. It is known that *Haloxylon* has successive cambia and its stem can form multiple radial increment layers through successive cambia (RISC layers) in one growing season. Its age is not clear because the annual growth boundary cannot be confirmed by dendrochronological approach. It is difficult to clearly distinguish RISC layers from seasonal annual rings, because the RISC layers possess similar morphological character comparing with seasonal annual rings through megascopic cross sectional observations. Two *Haloxylon ammodendron (H.ammodendron)* specimens (S1 and S2) were collected from the Gurbantünggüt Desert in Northwestern China. The objective of present study is to clarify the radial growth rate and attempt to illuminate the mechanism that multiple RISC layers of *H.ammodendron* are formed in one growing season. This thesis focuses on the radiocarbon dating, the stable carbon isotopic ($\delta^{13}C$) and anatomical analysis of *H.ammodendron*, with the goals of (1) clarifying the annual radial growth rate of the RISC layer; (2) demonstrating the main effect factor of RISC layers formation in *H. ammodendron* stems; and (3) attempting to illuminate the mechanism of the seasonal multiple RISC layers formation.

Research methods are including: (1) α-cellulose extracting; (2) α-cellulose combustion; (3) the

CO_2 purifying: (4) graphitization; (5) the $\delta^{13}C$ measurement; (6) the ^{14}C measurement; (7) the radiocarbon dating ($F^{14}C$); (8) the microstructural features observation.

Results show:

(1) A series of radiocarbon dating reveals that the numbers of annual RISC layer to be 2.98 ± 0.51 (S1) and 3.65 ± 0.53 (S2). Linear regression shows a strong relationship between growth period (x) and radial increment accumulation (y): y = 1.52x + 0.76 (R^2 = 0.96, P < 0.001) for S1 and y = 1.70x + 4.49 (R^2 = 0.94, P < 0.001) for S2, respectively.

(2) The stable isotope ratios ($\delta^{13}C_{PDB}$) results show that both specimens have similar average $\delta^{13}C$ values and ranges (**S1**: −11.73 ± 0.03‰, range −9.63 to −13.44‰; **S2**: −11.11 ± 0.04‰, range −9.51 to −12.80‰). The water use efficiency (W_i) results that calculated by the $\delta^{13}C_{PDB}$ show that the W_i are appropriately from 3.7 to 5.6 μmol mol^{-1} for S1 and from 3.5 to 5.1 μmol mol^{-1} for S2. One-way ANOVA test demonstrates that the annual radial growth rates are not significantly correlated with the mean precipitation (r^2 = 0.021 for S1 and r^2 = -0.022 for S2), with the mean temperature (r^2 = 0.093 for S1 and r^2 = -0.005 for S2), but was positive correlation with W_i (r^2 = 0.51, P < 0.01 for S1 and r^2 = 0.42, P < 0.01 for S2).

(3) Anatomical observations with scanning electron microscope (SEM) and wood staining show that the special anatomical features of the RISC layers are completely different from that in normal annual rings morphologies. Meanwhile, a high frequency of lenticels on its bark has been observed. The results show the lenticels that facilitate gas exchange can effectively prevent cavitation. This thesis hypothesizes that the trigger for meristematic cells division in successive cambia is water stress. Under the environmental (water) stress, the meristematic cells will be divided into more meristematic bands for maximum water storage in the stem tissue. It may be an evolutionary survival strategy of the *H.ammodendron* surviving and widely distributing in the harsh environment. In spite of the multiple layers and seasonal annual rings possess similar morphological character, their occurrence reason and formation mechanism are essentially different, the dendrochronological research methodology cannot be applied to the *H.ammodendron*, maybe also in other successive cambia species. However, the occurrence reason and formation mechanism are still need to be plant physiology and ecophysiology further explored.

Keywords: *Haloxylon ammodendron;* Radial increment layer through successive cambia (RISC layer); Radiocarbon dating; Stable carbon isotope ($\delta^{13}C$); Wood anatomical analysis; Dendrochronological research; Gurbantünggüt Desert.