The variations of drought tolerance along soil depth gradient and the physiological mechanisms of drought-induced and pathogenic tree die-offs in the Bonin Islands

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Summary

Drought-induced tree die-offs, probably due to climate change, have been reported in many biomes in the world, reducing the carbon stocks and biodiversity in forest ecosystems. To obtain more exact projecting in the effects of prolonged drought on forest ecosystems under climate change, we need to clarify how woody plants respond to drought and how they die by prolonged drought. The Bonin Islands are one of the model sites to predict the change of forest ecosystems under global climate change, based on the physiological mechanisms of trees. I show how tree heights and plant traits related to hydraulics in mature trees vary along soil depth gradients from the dry ridges to the wet valleys among three species with different water-use strategies (chapter 2), and how physiological traits change with declining tree health in the mature trees facing to lethal drought (chapter 3). Recently, many trees have been killed by root rot fungus (*Phellinus noxius* (Corner) G. Cunn.) in the islands. I have examined the physiological mechanisms of tree wilting caused by this fungus based on an inoculation test, using the saplings of *Rhaphiolepis indica var. integerrima* Hook. et Arn. (chapter 4). The regulation of the differences in xylem water potential at the midday and predawn ($\Delta\Psi$) play an important role of determining water-use strategies. The values of $\Delta\Psi$ remained unchanged from the valley to ridge sites (called isohydrodynamic), whereas $\Delta\Psi$ decreased from the valley to ridge sites (called anisohydrodynamic). The values of P_{50} (xylem water potential at 50% loss of hydraulic conductivity) values and leaf wilting points remained unchanged in isohydrodynamic trees, whereas they decreased from the valley to ridge sites in anisohydrodynamic trees. As the results, the percent loss of conductivity on the branchlets decreased from the valley to ridge sites in isohydrodynamic trees, but it remained unchanged in anisohydrodynamic trees (chapter 2). I found that the metabolic failures associated with cell damage occur before carbon starvation and hydraulic failure in the branchlets during tree-wilting processes (chapter 3). The physiological processes of tree wilting caused by root rot disease (*P. noxius*) are similar to those caused by lethal drought. Both photosynthetic depression (carbon starvation) and the hydraulic dysfunction (hydraulic failure) are the main causes of tree death caused by *P. noxius,* occurring prior to the invasion of *P. noxius* into inner bark and xylem and the cavitation of xylem (chapter 4). The balance between carbon starvation and hydraulic failure is dependent on water-use strategies.