Recent trends in the intrinsic water-use efficiency of ringless rainforest trees in Borneo

Abstract

Stable carbon isotope (δ 13C) series were developed from analysis of sequential radial wood increments from AD 1850 to AD 2009 for four mature primary rainforest trees from the Danum and Imbak areas of Sabah, Malaysia. The aseasonal equatorial climate meant that conventional dendrochronology was not possible as the tree species investigated do not exhibit clear annual rings or dateable growth bands. Chronology was established using radiocarbon dating to model age- growth relationships and date the carbon isotopic series from which the intrinsic water-use efficiency (IWUE) was calculated. The two Eusideroxylon zwageri trees from Imbak yielded ages of their pith/central wood (±1 sigma) of 670±40 and 759±40 years old; the less dense Shorea johorensis and Shorea superba trees at Danum yielded ages of 240±40 and 330±40 years, respectively. All trees studied exhibit an increase in the IWUE since AD 1960. This reflects, in part, a response of the forest to increasing atmospheric carbon dioxide concentration. Unlike studies of some northern European trees, no clear plateau in this response was observed. A change in the IWUE implies an associated modification of the local carbon and/or hydrological cycles. To resolve these uncertainties, a shift in emphasis away from high-resolution studies towards long, well-replicated time series is proposed to develop the environmental data essential for model evaluation. Identification of old (greater than 700 years) ringless trees demonstrates their potential in assessing the impacts of climatic and atmospheric change. It also shows the scientific and applied value of a conservation policy that ensures the survival of primary forest containing particularly old trees (as in Imbak Canyon and Danum).