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Water use and physiology of the riparian tree species Eucalyptus victrix in the semi-arid Pilbara region of Western Australia

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We examined the water use and physiology of trees growing in a riparian community within the seasonally arid Pilbara region of north-western Australia. This region is arid during the winter months, but monsoonal during summer (November to April). Maximum monthly mean temperatures in summer exceed 40 °C and are c. 25 °C during the winter months.

The Millstream study site is located on a section of the Fortescue River system along the base of the Chichester Range c. 100km south of Karratha. This system creates a unique landscape in the Pilbara as it forms several large permanent pools. These pools are maintained by springs from an aquifer beneath the alluvial plain. The groundwater from this aquifer is used as a public water supply for towns in the west Pilbara but industrial development and a growing population will place greater demand on this aquifer.

Changes to the local hydrology may have dramatic effects on the local plant community, dominated variously by stands of Eucalyptus victrix (Coolibah) and Eucalyptus camaldulensis (River red gum).

This study seeks to understand the dependence of the Millstream riparian ecosystem on the height of the aquifer and to characterise the water use and physiology of Eucalyptus victrix.

We used a number of techniques to determine the hydraulic and photosynthetic status of the tree canopy, including isotope, sap flow, water-potential and gas exchange measurements. Initial results from this study show:
a) Soil water d18O and d2H is strongly enriched towards the surface, which coincides with a strong increase in salinity. The water source accessed by these trees has been identified by d18O and d2H analysis of xylem water. d18O and d2H were additionally analysed in atmospheric and leaf water pools.
b) Sap flow in Coolibah trees shows a unique pattern of sharp early morning rise to a plateau maintained throughout the hottest part of the day, followed by a sharp decline in flow late in the afternoon.
c) Leaf water potential follows a similar pattern to sap flow with changes of c. 1 MPa (from c. 0.5 MPa to 1.5 MPa) within 45 min at the beginning and the end of the light period.
d) Stomatal conductance appears to be disconnected from this pattern and shows a slower opening phase in the morning, no discernible midday-afternoon depression and a slower closure in the evening, well after night-fall.

Combining isotopic, sap flow, physiological and meteorologic information will help to understand how these riparian ecosystems function and how they respond to rapid environmental changes, both natural and introduced by human activities.