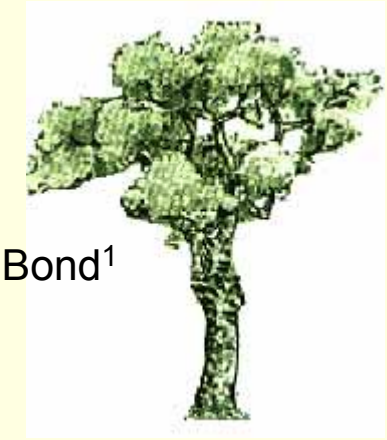
Water use of two savanna tree species in relation to leaf phenology

Richard Verweij[1]; Edmund February[1]; Steven Higgins[2]; William Bond[1]

1 Botany Department, University of Cape Town
2 Institut für Physische Geographie, Universität Frankfurt a.M.



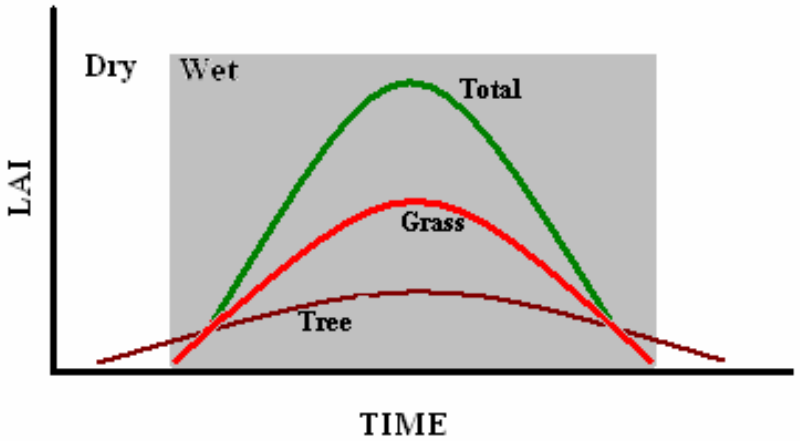
Phenological niche differentiation

- Hypothesis:

  Trees in savannas start flushing leaves before or directly after the start of the rainy season and can continue to photosynthesize longer into the dry season.

  This allows them to coexist with grasses which have a shorter growing season, but are the better competitor for water in this shorter time span.

  (Seghieri et al 1995; Scholes & Archer 1997)

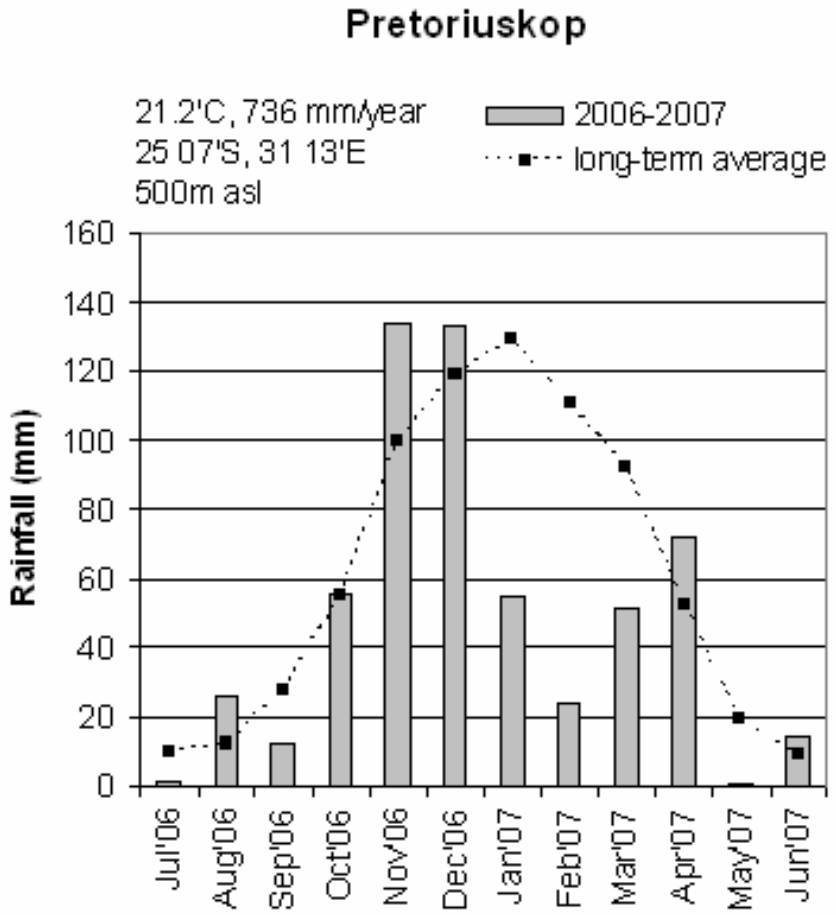


(Archibald & Scholes 2007)

Study site

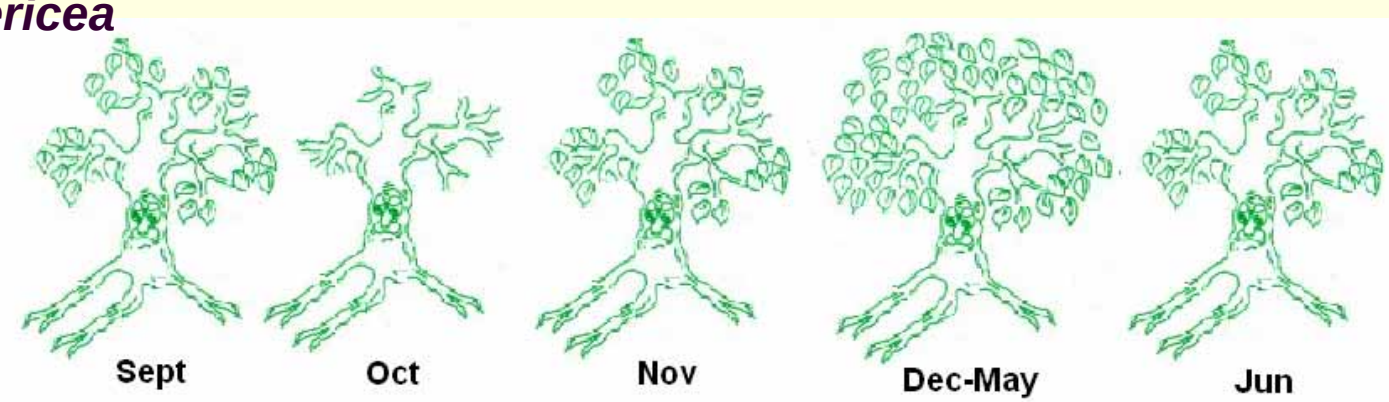
Pretoriuskop

- Sandy soils on granites
- Low nutrient availability
- Mesic savanna (730mm rain/yr)

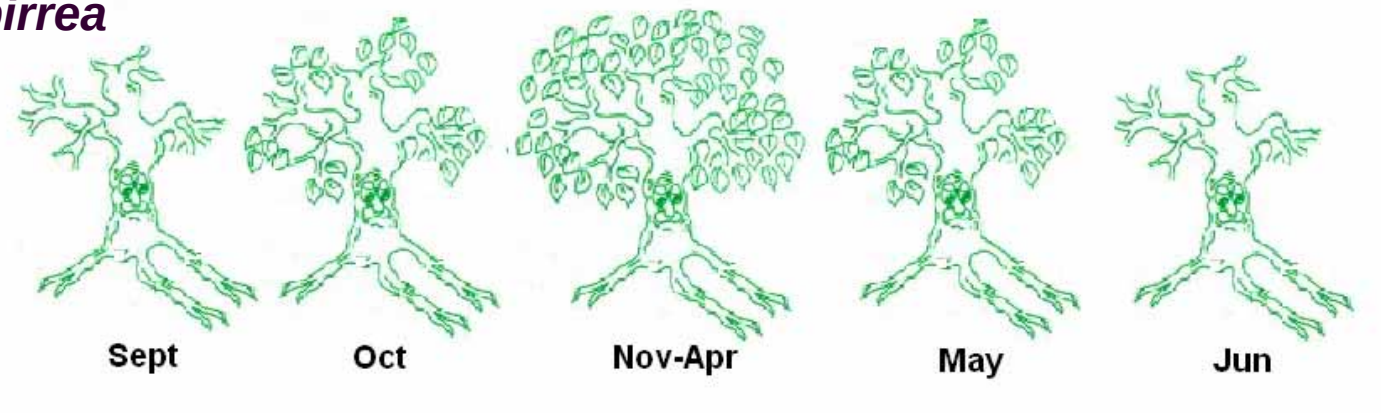


Leaf Phenology

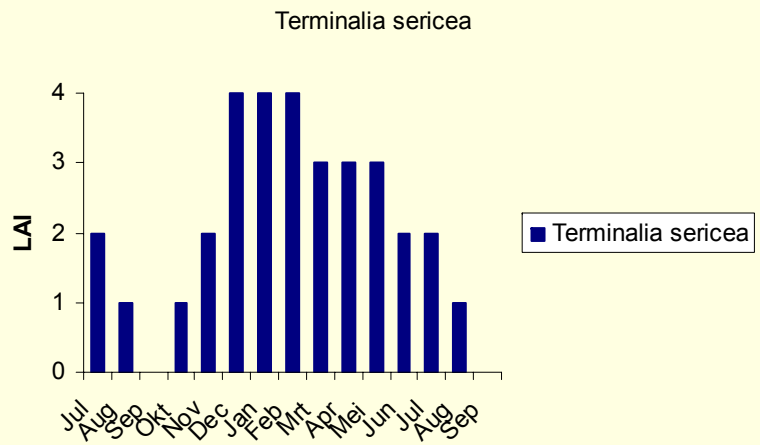
Terminalia sericea

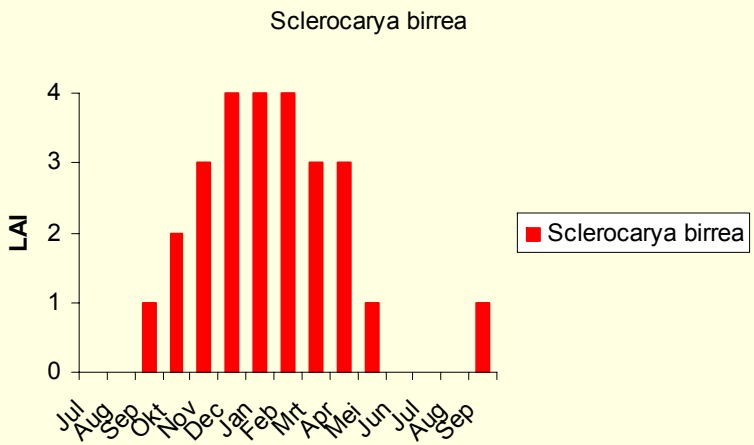


Sclerocarya birrea

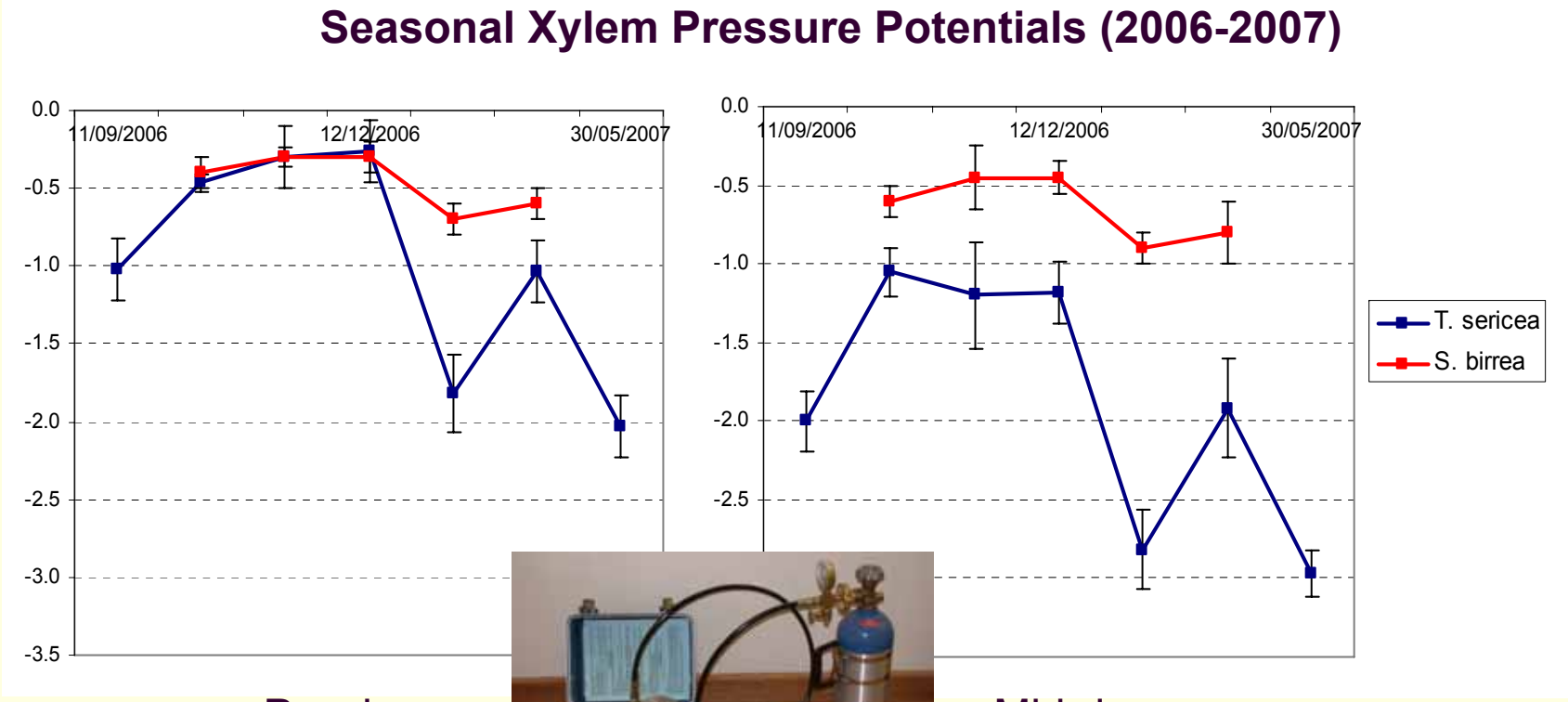


Leaf Phenology

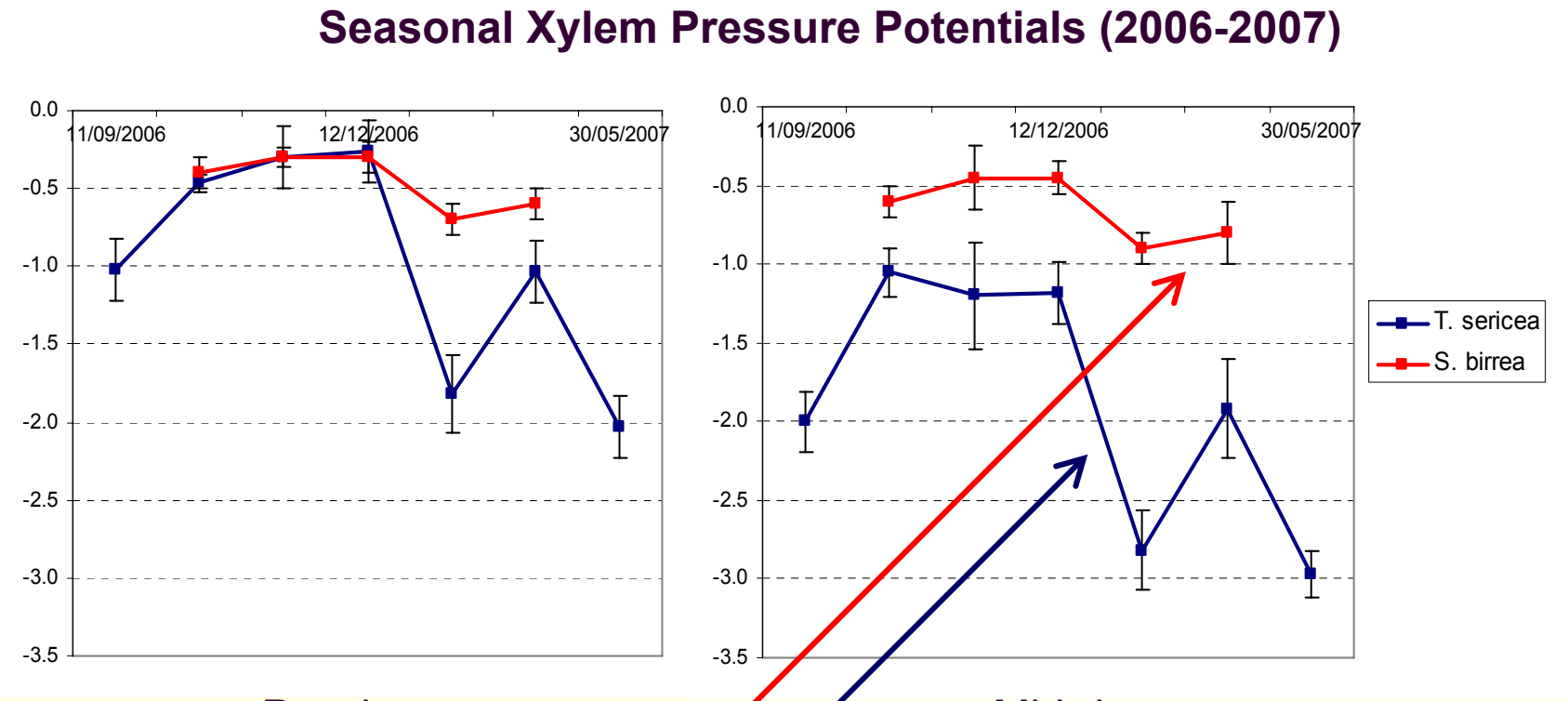




Water stress

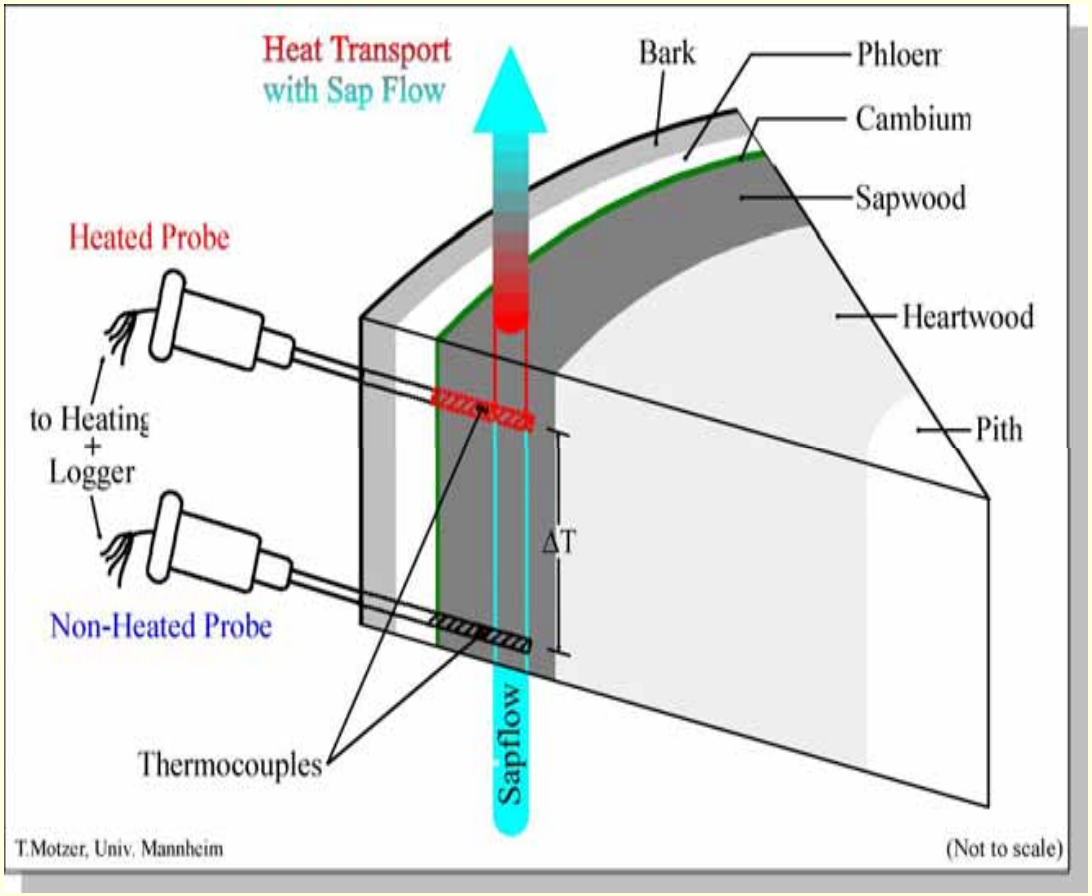


Water stress



The Granier Sap Flow System

- Two probes are inserted horizontally into the sapwood of the stem, 15cm apart. The upper probe is continuously heated at constant power (0.2W), the lower probe is left unheated.
- Temperature difference between the two probes is influenced by the heat dissipation effect of sap flow in the vicinity of the heated probe



Lu et al. 2004, Motzer 1998

The Granier Sap Flow System

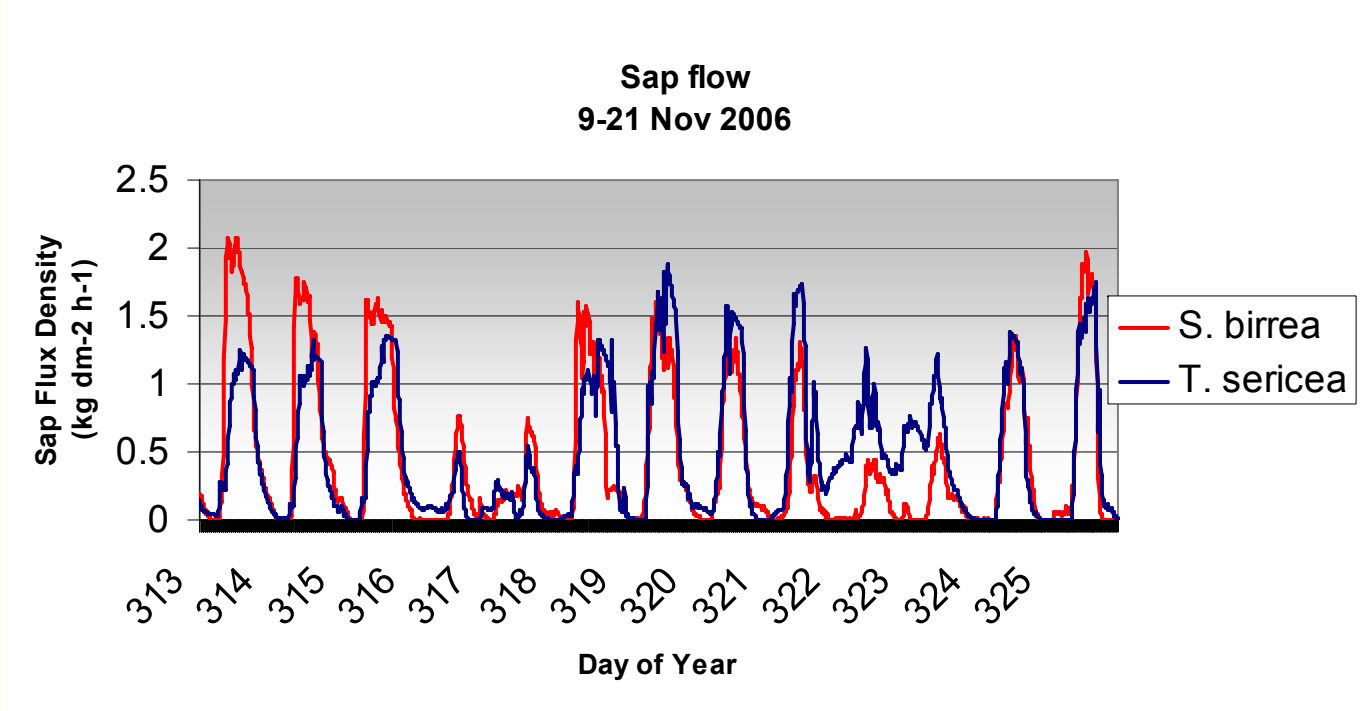
- The Granier system directly measures the electrical potential difference (ΔV) between the two thermocouples
- Sap Flux Density (F_d) - the sap flow per unit sapwood area- can be directly calculated from the voltage measurements with the formula:

$$F_d = 118.99 \times 10^{-6} [(\Delta Vmax - \Delta V)/ \Delta V]^{1.231}$$

- Total sap flow (F) (kg h^{-1}) can be calculated by multiplying F_d with the sapwood cross sectional area

(Granier 1985, Lu et al. 2004)

Some data

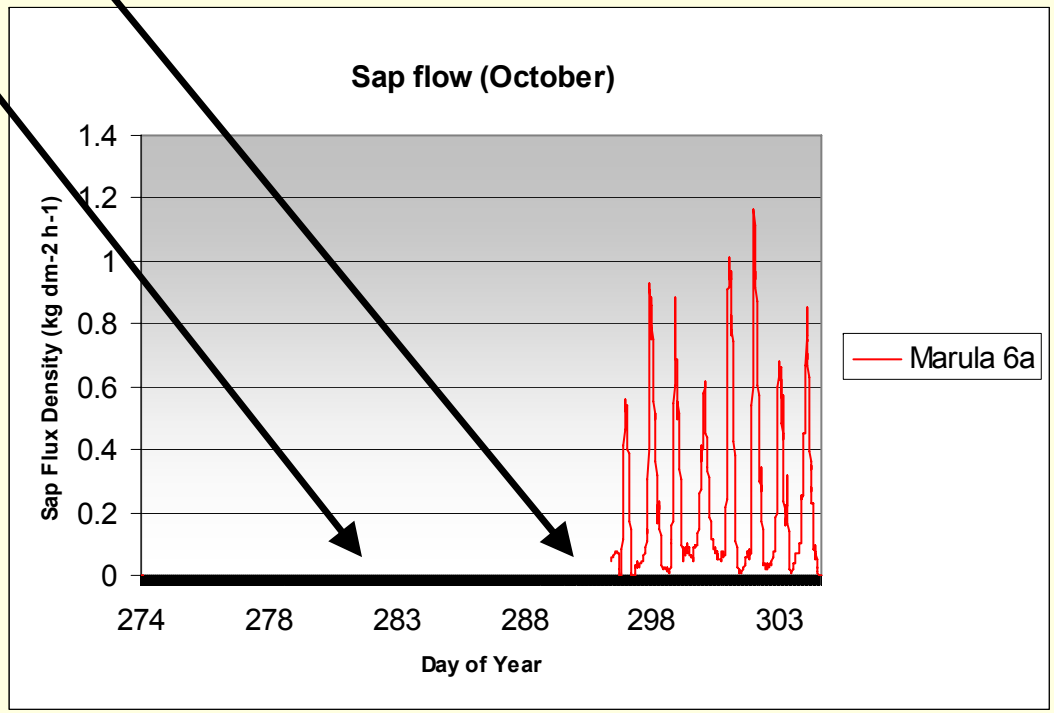

Sap flow
9-21 Nov 2006
Sap Flux Density
(kg dm-2 h-1)
2.5
2
1.5
1
0.5
0
313
314
315
316
317
318
319
320
321
322
323
324
325
Day of Year
S. birrea
T. sericea

Start of the growing season

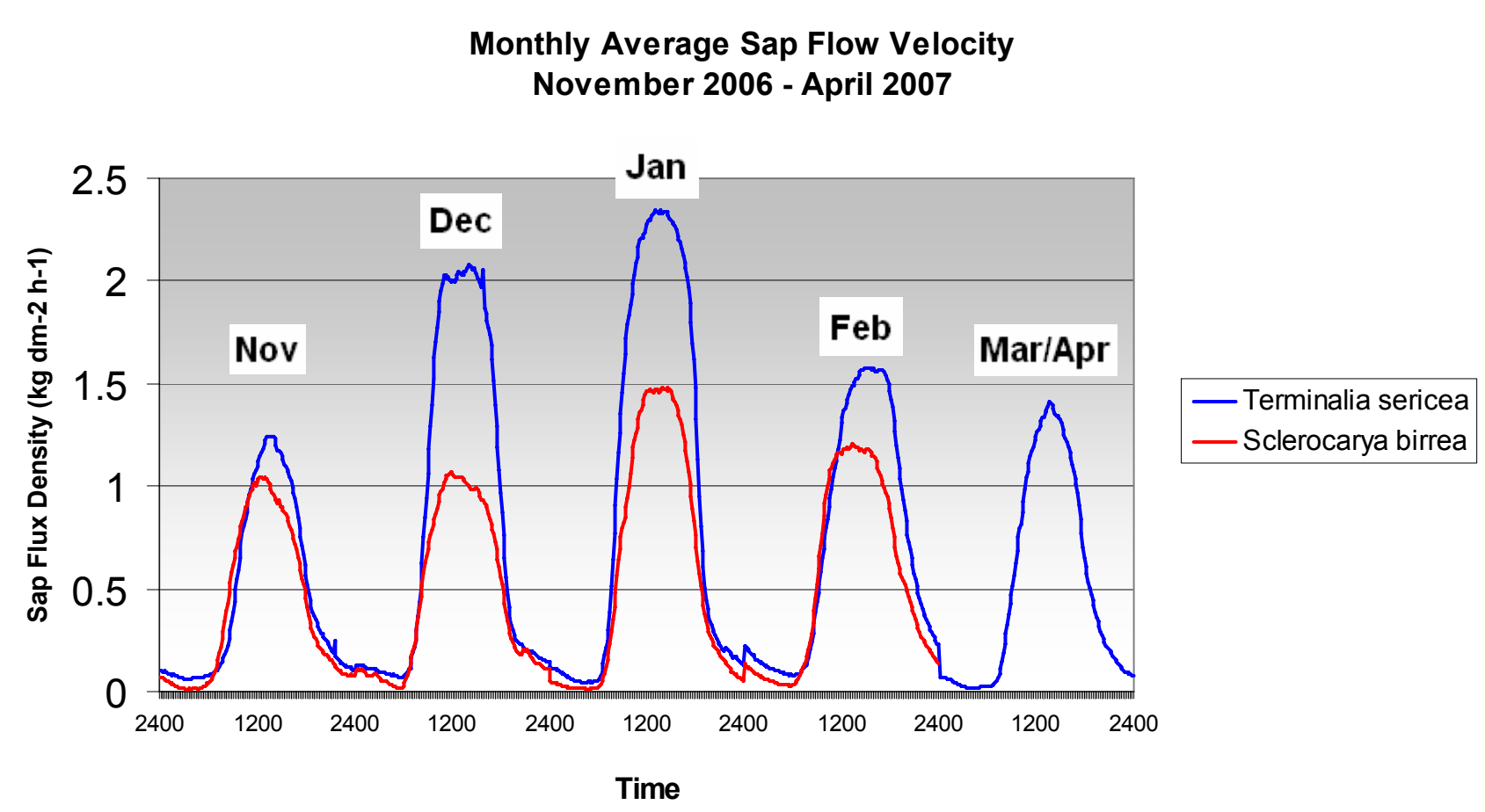
First significant rainfall event (20 October 2006)

(5 October 2006)

20-40% leaves



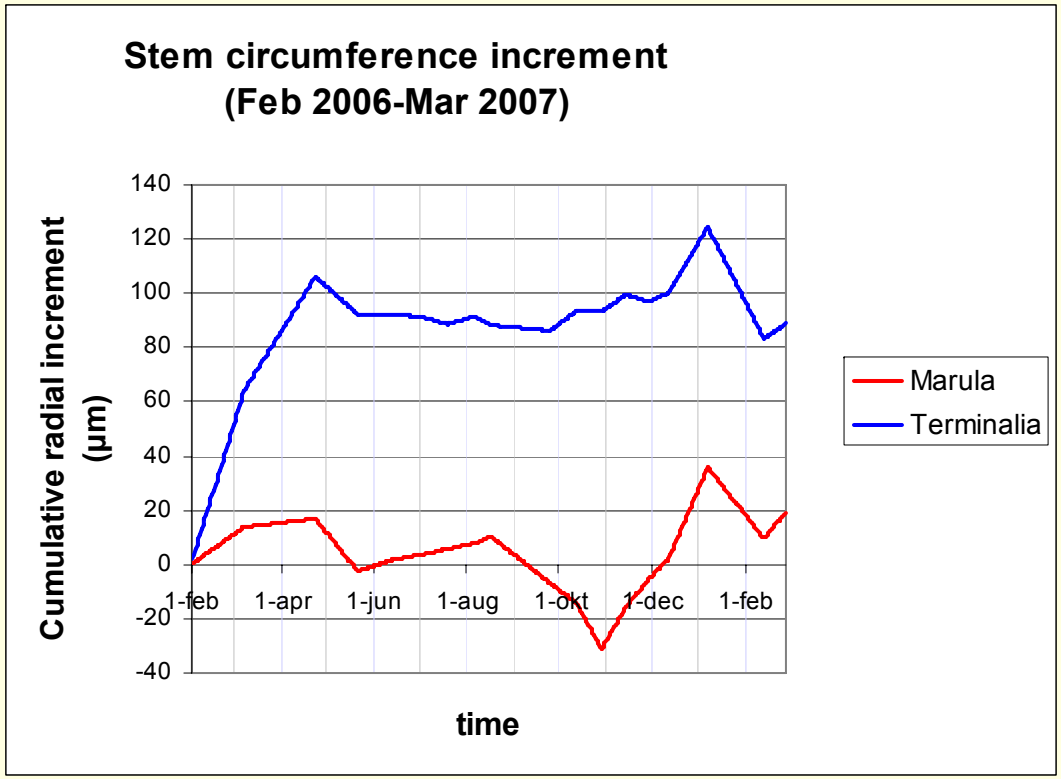
Monthly water use



Growth rates

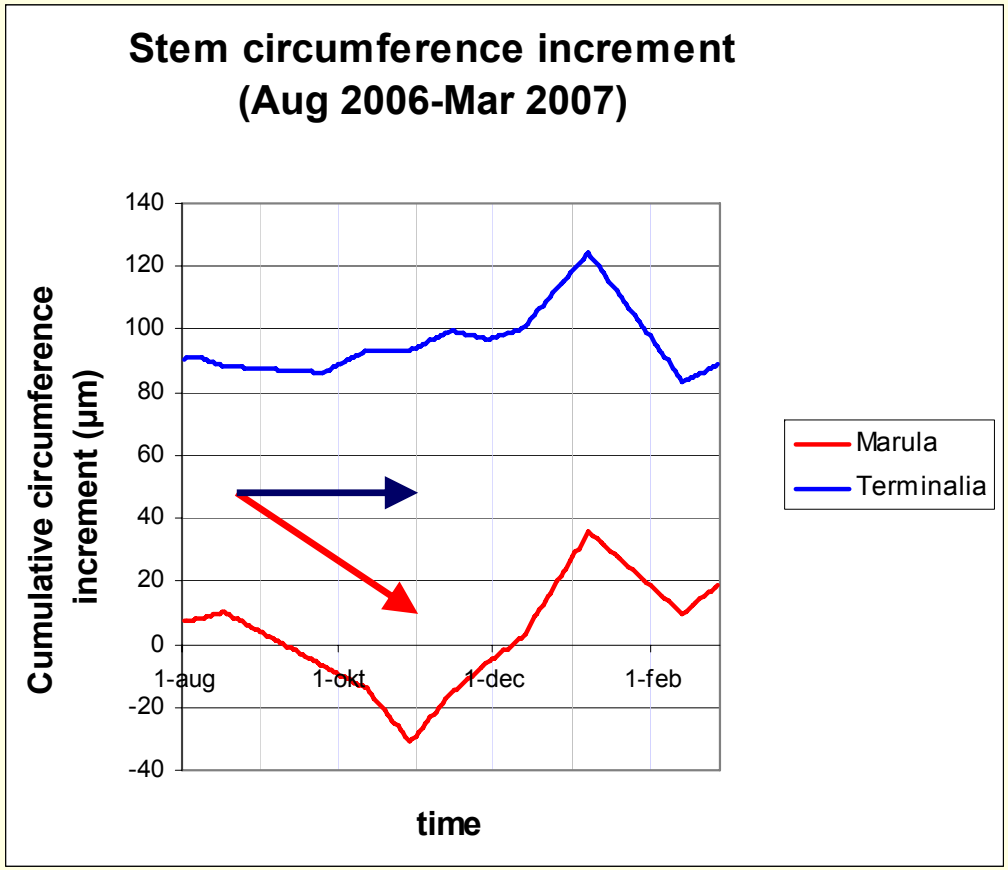
Stem circumference increment was measured every two weeks using dendrometer bands

Terminalia seems to grow faster than Marula… (adult trees)

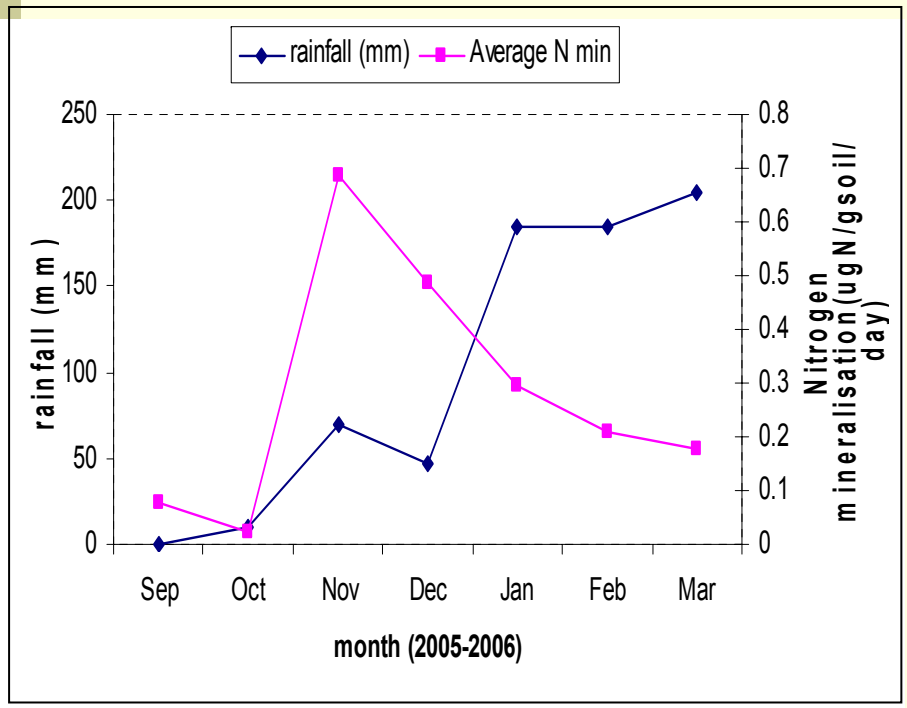


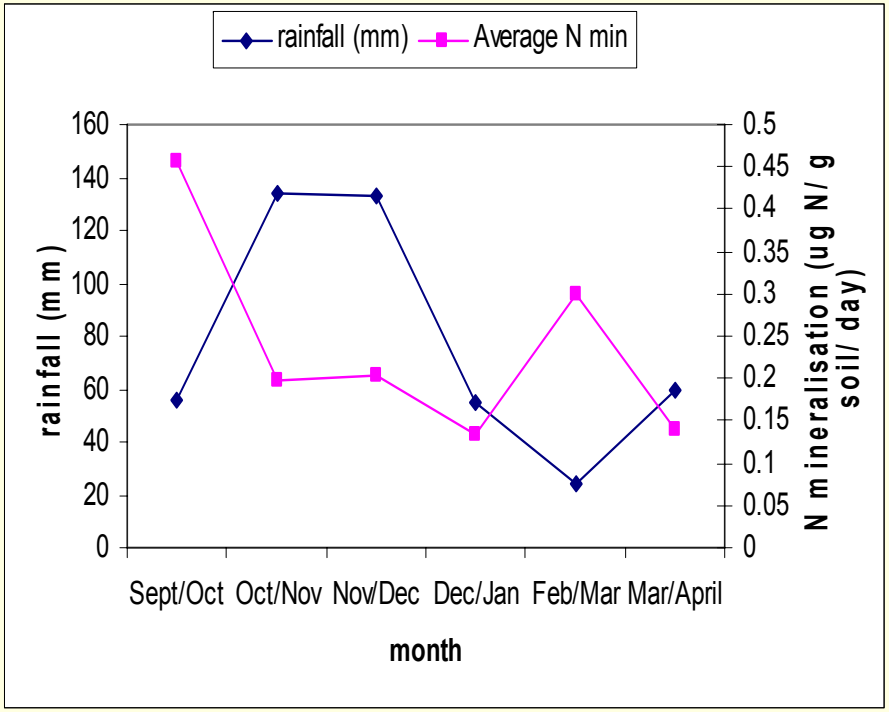
Growth rates

Does *S. birrea* use water stored in the stem to support leaf flush before the first rains?



Nitrogen mineralization





(Moagi Keretetse 2008)

Conclusions

- *S. birrea* is the more conservative water user of the two considered species.
- Leaf abscission in *S. birrea* occurs soon after the last rains of the season, while still well hydrated. *T. sericea* keeps a portion of its leaves until very late into the dry season.
- Water stored in the stem of *S. birrea* may enable the pre-rain leaf flush, possibly leading to a competitive advantage over grasses in the early growing season.
- We hypothesize that the nitrogen mineralization peak in the early growing season may be a reason for early leaf flush.

Thank you