# Water supply and photosynthesis in terrestrial, climbing and semi-epiphytic *Freycinetia excelsa* F. Muell (Pandanaceae)

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## INTRODUCTION

*Freycinetia excelsa* is a secondary hemi-epiphytic vine with a three phase life-cycle: terrestrial, terrestrial but climbing a host, and semi-epiphytic (Fig. 1). Beginning life as ground-dwelling plant with normal roots, *F. excelsa* climbs a host and the basal portion of the stem dies back, in most cases remaining connected to the soil via aerial feeder roots. We ask whether water supply and photosynthesis differs between the three morphological forms of *F. excelsa*.

**Fig. 1** Three growth stages of *F. excelsa*: (a) terrestrial, (b) climbing, and (c) semi-epiphytic stages.

# METHODS

Samples from Paluma Range National Park (18°57'S, 140°11'E, 900 m a.s.l.) in north Queensland were collected before dawn and hydraulic conductivity was measured using a variable pressure flow system (Sperry *et al*. 1988; Choat 2005). Leaf water potential and $CO_2$ uptake of fully expanded mature leaves of plants of each growth habit were measured during the wet and dry seasons. Soil moisture was also monitored.

# RESULTS AND SUMMARY

For all growth forms of *F. excelsa*, pre-dawn leaf water potentials correlated with volumetric soil moisture (Fig. 2), and leaf water potential and $CO_2$ assimilation rates were generally lower in the dry season than in the wet season (Figs. 3 and 4).

Within each season, water potentials of leaves from all growth forms were similar but the patterns of daily $CO_2$ exchange differed, with $CO_2$ uptake by terrestrial plants most affected by dry season conditions. Terrestrial plants exhibited the lowest $CO_2$ exchange in the dry season, but the $CO_2$ exchange rates were similar for the three forms during the wet season.

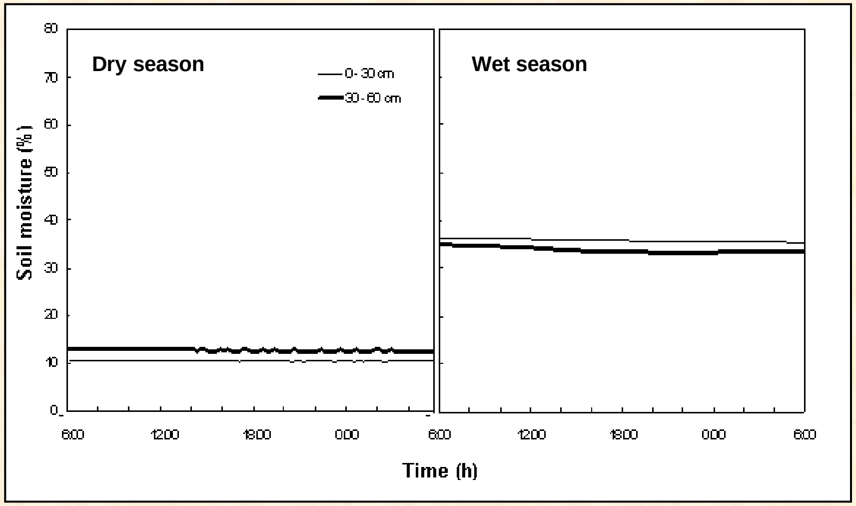

**Fig. 2** Diurnal patterns of soil moisture at two different soil depths over 24 hours during dry and wet seasons at the study site.

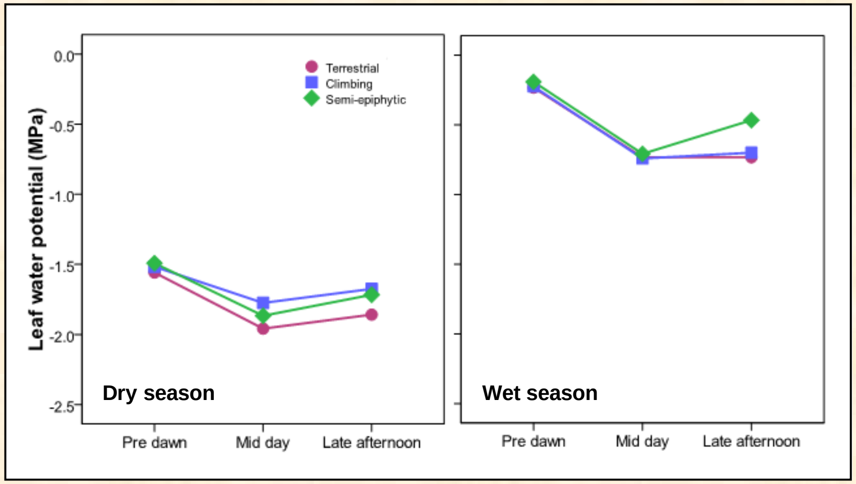

**Fig. 3** Diurnal variation in leaf water potential ($\Psi_l$) of terrestrial, climbing and semi-epiphytic individuals of *F. excelsa* in the dry and wet seasons. Each point represents the mean of 12 measurements (3 leaves on 4 plants).

Stem hydraulic conductivity (*K*H) and xylem anatomy differed between the growth forms (Fig. 5). Terrestrial plants, with conventional roots and a main stem, have narrow xylem and lower hydraulic conductivity. In comparison, climbing and semi-epiphytic plants are attached to the soil by narrow aerial roots and hydraulic conductivity of the stem is greater.

Down-regulation of $CO_2$ exchange in the dry season was greatest in the terrestrial plants, but all forms operated at similar pre-dawn water potentials of -1.5 MPa and afternoon water potentials of not less than -2 MPa. The lower hydraulic conductivity of the stems of terrestrial plants may restrict water supply such that down-regulation of $CO_2$ uptake and stomatal opening are necessary to diminish water loss and maintain water potential. Water supplied to climbing and semi-epiphytic plants by aerial roots variously inserted at a number of sites along a stem (Figs. 1B and C) is evidently sufficient to sustain higher rates of $CO_2$ exchange and water loss.

**References**: Choat *et. al.* (2005) Hydraulic architecture of deciduous and evergreen dry rainforest tree species from north-eastern Australia. *Trees – Structure and Function* **19,** 305–311; Sperry *et al*. (1988) A method for measuring hydraulic conductivity and embolism in xylem. *Plant, Cell and Environment* **11**, 35-40.

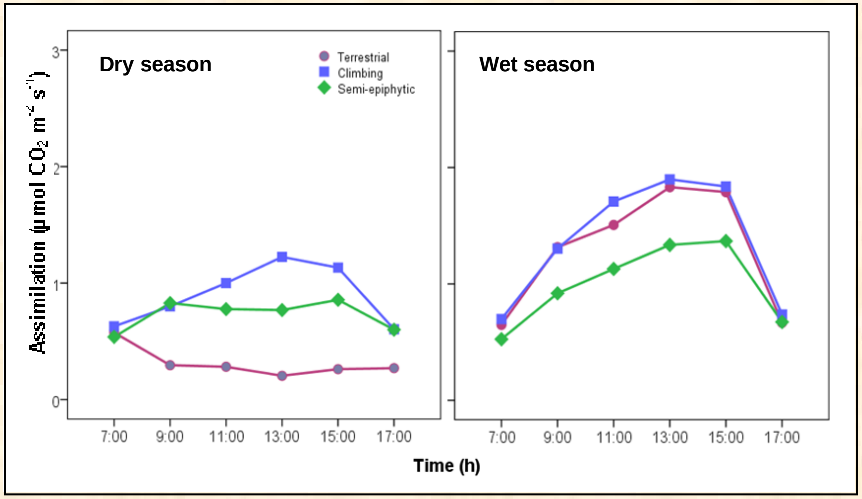

**Fig. 4** Diurnal variation in $CO_2$ assimilation of terrestrial, climbing and semi-epiphytic individuals of *F. excelsa* in the dry and wet seasons. Each point represents the mean of 12 measurements (3 leaves on 4 plants).

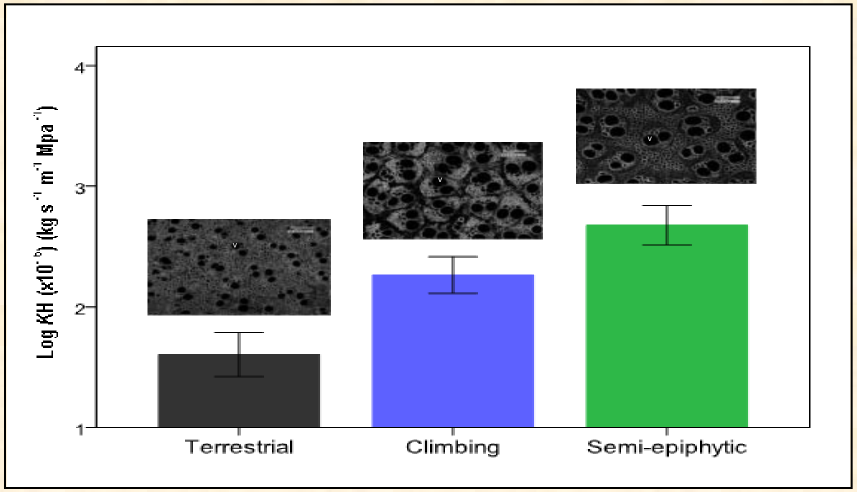

**Fig. 5** Stem hydraulic conductivity of terrestrial, climbing and semi-epiphytic individuals of *F. excelsa*. Images on the top of the bars show vessel size (v) of each habit.