Australian Plant Ecology

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Background – Plant communities on upland sites in Victoria, Australia, show an astonishing range in maximum plant height, from > 90 m in *Eucalyptus regnans* (the tallest flowering plant in the world) growing in tall sclerophyll forests and temperate rain forests in the Yarra Ranges near Melbourne, to < 3 m in *Eucalyptus dumosa* and other woody plants native to mallee near Mildura in nw Victoria 400 km away. Along this gradient, the ratio of rainfall to pan evaporation – P/E_p, a measure of moisture supply relative to demand – drops 11-fold, and the range of maximum tree height covers nearly the entire span worldwide. We have begun a four-year, $1M NSF-funded study along this gradient, aimed at identifying plant adaptations to different levels of moisture supply relative to demand, and focusing on ten species of *Eucalyptus* that dominate different portions of this climatic gradient.

The Victoria gradient offers outstanding possibilities for a course in physiological ecology, aimed at inspiring a new cadre of students from UW-Madison and the University of Sydney, and addressing some of the striking patterns in plant form and physiology on this gradient. The course would involve 14 days in the field (16 days total, with trans-Pacific travel), and we plan to include 12 undergraduate and graduate students from UW-Madison. Admission requires faculty permission, based on an application detailing past preparation and stating how participation in this course would benefit a student's education and future career. Special students, other faculty, and other departmental affiliates could participate if they paid all costs and were not subsidized in any way by the Botany Department.

Instructors in the field would include Givnish and McCulloh, our post-doc Duncan Smith, and Australian colleague Mark Adams (expert on *Eucalyptus* ecology, and until recently Dean of the Faculty of Agriculture and the Environment at the University of Sydney). Our proposed course would involve a one-credit lecture and seminar series – led by faculty and by students – giving background on Australia geology, climate, ecology, and biogeography during Spring 2018, a field trip to Victoria in August 2018, and a three-credit set of meetings in Fall 2018 to analyze, write up, and submit results from our field trip. Course costs would be roughly $1700/student, reduced by a generous gift from the Humboldt Fund of the UW Department of Botany.

The field trip would include introductory trips to a wide diversity of Australian ecosystems, including temperate rain forests, tall sclerophyll forests, *Eucalyptus* woodlands, mallee, billibongs, phreatophytic communities along river courses, inland halophytic communities, and mangroves, as well as visits to our research common gardens. The remainder of our time would be spent on a variety of

research projects that take advantage of the tremendous ecological variation along the gradient to study phenomena that we are not addressing in our NSF study. Depending on student interest, these might include two or more of the following: (1) trends in the orientation, reflectance, and hydraulic conductivity of leaves on adult plants in natural stands of several species of *Eucalyptus*, as well as studies of branch hydraulic conductivity in those species; (2) comparisons of stem and leaf hydraulics, and the sensitivity of stomatal conductance and mesophyll photosynthetic capacity in *Eucalyptus regnans* and *Tasmannia lanceolata* (Winteraceae), a vessel-less angiosperm that never exceeds 10 m, aimed at understanding some of the reasons for the great difference in height between these co-occurring trees; (3) the allometry of tree diameter vs. height in various species of eucalypts and non-eucalypts, to determine whether the unusual isometry seen in certain eucalypts along the Victoria gradient generalizes across species and is seen in other Australian woody plants; (4) shifts in community leaf area index (LAI, m^2 leaf tissue/m^2 ground) with P/E_p; and (5) leaf hydraulic conductance and sensitivity of stomatal conductance and mesophyll photosynthetic capacity to leaf water potential in mistletoes vs. their hosts at different points along the P/E_p gradient. We will also offer a Great Barrier Reef side trip to Heron Island as an option to all students, to be covered entirely at their own expense. The areas to be visited are listed below.

Field trip sites, Victoria, Australia

1. **Marysville** – 1.5 hrs from Melbourne International Airport
   a. Roughly 40% of the P/E_p gradient from Camberville to foot of Snobs Hll Road, in National Parks (Yarra Ranges, Lake Mountain, Kinglake) and State Forests. Tall wet sclerophyll forest and cool temperate rain forest to eucalypt woodlands
   b. Toolangi and Mt. Disappointment sites nearby
   c. High-elevation snow-gum woodlands at Lake Mountain NP
   d. Tallest living *Eucalyptus regnans* on mainland; populations of co-occurring *Tasmannia* (short, vessel-less Winteraceae; interesting subjects for comparative hydraulic studies)
   e. Tallest standing dead *E. regnans*, regenerating juveniles at Kinglake NP
   f. Lady Talbot Drive, good examples of cool temperate rain forest (*Nothofagus cunninghamii*), extensive areas of dead E. regnans
   g. Healesville Sanctuary nearby, extensive displays of native Australian mammals and birds, including platypus and parrots
   h. Possible night walk to see giant gliders?
2. **Phillip Island** – 2.5 hrs from Marysville
   a. Koala Conservation Centre
   b. Penguins on Parade (fairy penguins coming ashore at sunset)
   c. Mangrove swamp with boardwalk

3. **St. Arnaud –** 4 hrs from Marysville
    a. Knowsley woodland – *E. goniocalyx*, 2.5 hrs from Marysville
    b. Whipstick mallee and taller forests on heavier soils, north of Bendigo, ca. 3 hrs from Marysville
    c. Kingower woodland – *E. sideroxylon*, 1 hr from St. Arnaud
    d. St. Arnaud woodland – *E. macrorhyncha*
4. **Little Desert National Park –** 2 hrs from St. Arnaud
    a. Short woodland, *E. arenacea, Xanthorrhoea*
    b. Tall mallee
    c. Pink Lakes saline areas to north in Wyperfield NP (lakes won't be pink in late winter!). Extensive areas of river red gum (phreatophytic species common along riverways in northern Victoria)
5. **Hattah-Kulkayne National Park –** ca. 3 hrs from Nhill
    a. Mallee, *E. dumosa* et al., *Triodia* spinifex grass; billebongs; hemiparasites
6. **Mildura –** ca. 1 hr from Hattah-Kulkayne, 5.5 hrs from Melbourne
    a. Murray-Darling river system, river red gum phreatophytic woodland