

Botany 940-Seminar- Questions Oct 25 2011

C4 clades, traits and mechanisms

C4 photosynthesis differs from C3 in that it requires both the sequestration of CO₂ into the bundle sheath cells and the enzyme PEP carboxylase. In the species that have reverted from C4 back to C3, do you know which of these aspects of C4 have been lost?

Within the other clades exhibiting C4 photosynthesis, is the gain and loss of the C4 pathway as "frequent" as in the Poaceae?

From the PNAS paper "18 of 20(or 21) inferred C4 origins were correlated with marked reductions in mean annual precipitation", yet in figure 3 there are four divergences of C-4 to C-3 as aridity increases. Why do these lineages behave differently?

From the Science paper, "To keep pace with these developments, comparative biological investigations of grass species are urgently required to understand trait evolution in grassland dominants." What traits should be selected for such a study? How about for a study comparing C-3 dominant vs. C-4 dominant grasslands?

Phragmites australis is an example of a C3 grass that dominates its location. Because *Phragmites* is C3, is it only able to dominate in the wet conditions it is found in, being excluded from drier habitats by C4 grasses? Does *Phragmites* have any close relatives that are C4?

If the C4 syndrome is a suite of features (see Christin et al. 2010, Trends in Ecology and Evolution, p403-409) and not a single character, how should scientists address evolutionary studies on C4. How should 'C3-C4 intermediates', plants that possess only a subset of C4 properties, be treated?

It's interesting that less than 1% of grass species are considered ecologically dominant in grasslands. The authors mention that these taxa are phylogenetically clustered and some lineages may be more likely to develop that allow them to dominate - what might some of these traits be?

Given that 36 (60%) of the 62 recognizable lineages of C4 photosynthesis occur in eudicots, how does C4 evolution in grasses compares to the evolution of C4 in eudicots, regarding age, origin and diversification? What can explain the greater amount of C4 species in monocots (>5900) compare to eudicots (~1600)?

CO₂ levels and Climatic change

What are the major drivers behind the fluctuations in CO₂ throughout geological history?

In the Science paper figure 1b, shows a tension between C-3 and C-4 grasses. As atmospheric carbon dioxide increases due to anthropogenic climate change (ACC) will

C-3 grasses become more prevalent?

Since C4 photosynthesis evolved in response to shift into "drier, but not warmer, environments" I wonder how this adaptation will fare as modern day climate change continues to warm the planet, as well as dry certain portions of it out (like the Amazon Basin). Will C4 grasses continue to inhabit the tropics, or will the track north, pushing C3 grasses further north still.

Methods (in PNAS paper)

I'm interested in what people think about the phylogenetic reconstruction methods used in the PNAS paper, where the percentage of missing data is very high. How much stock can we put in a phylogeny that has ~70% missing data?

How sensitive is character evolution analysis to sampling? If you are interested in knowing how many times a trait has been gained or lost in a particular clade, it seems to me you would want to have fairly complete sampling within that clade. But, dealing with a family as large as Poaceae, complete sampling would be impractical. Should our confidence in the results (# of gains and losses of C4) suffer as a result of incomplete sampling, or is the breadth of sampling across the entire family sufficient?

I'm curious as to the process behind using PHLAWD and how it works. Is it practical to use and how accurate are its results? It seems like such large datasets would be hard to match up and could get out-of-hand.

The PNAS paper used a 1230 taxon dataset. Was the quality of the study increased by this large dataset or just made more cumbersome?

Do you agree with Edwards and Smith (2010) removal of the 5% most heavily collected taxa? How could that have affected their results?

They acknowledge biases in estimating geographical ranges from herbarium specimens, and specifically state "In general, with the exception of India, the GBIF coverage of the major tropical and subtropical grassland areas is quite good" (p 2535). What were the sampling issues with India? In Fig 1 of Edwards et al. (2010), much of India is shaded orange (C4 grasslands). Nearby Pakistan is considered to have a well described geological history.

The authors states that c4 dominant species are phylogenetically clustered, but looking at the phylogenetic tree (Figure 4 of SCIENCE article) it roughly looks like that, all dominant species appear scattered in all c4 independent lineages. Since it's highly probably almost all dominant species are already sampled, an expanded phylogeny it's more likely to include non dominant ones. Is it possible that in an expanded phylogeny the dilution of dominant species in their clades change the cluster analysis for dominance?