It is thought that the Weatherly's had originally migrated west to Wanship, UT from Weatherly, PA (ca. 41°N, 57° W). Wilford and Wanda Weatherly went back a few years ago for a visit, stayed longer than they had expected, and collected data related to the primary productivity of lands in that region where their ancestors had come from. Specifically, they collected primary productivity data and vegetation structure data from agricultural wheat fields and forest sites in this part of the USA. Of course, it should be rather evident to a plant ecologist as to what kinds of forests are in this beautiful stretch between Pittsburgh and New York City. (Yes, you can even GOOGLE to learn more about the town and region).

At the moment, the primary productivity data and vegetation structure data in Wanda Weatherly's data notebooks are a bit disorganized and certainly not as well described as we expect. While the data appear to be thorough and complete, interpretations of the data are lacking. Some of the available data from the trip to Weatherly PA include:

- data on the relationships between leaf area index (LAI) at a particular height in the canopy and relative canopy height (from top to bottom of the canopy) for both vegetation types
- data on the relationships between leaf angle at a particular height in the canopy and relative canopy height (from top to bottom of the canopy) for both vegetation types
- data on the relationships between leaf nitrogen content of leaves in the canopy and relative canopy height (from top to bottom of the canopy) for both vegetation types
- data on the relationships between photosynthetic rate and intercellular carbon dioxide concentrations on leaves during well watered and water-stressed conditions.

While it is unfortunate that Wanda Weatherly's did not identify the native vegetation type in her notebook, it is rather obvious once your remember Professor Ehleringer's lectures.

Our observations of the leaf area index (LAI) at different heights in the canopies of the forest and wheat fields (shown below) showed that each of the canopies had a different distribution of photosynthetic tissues from each other.

	Vegetation: ___	Vegetation: ___	Vegetation: ___	Vegetation: ___
Relative canopy height (%)	LAI by level	LAI by level	leaf angle by level (degrees above horizontal)	leaf angle by level (degrees above horizontal)
100	1.20	0.05	72	45
90	1.25	0.05	70	33
80	1.00	0.05	68	21
70	0.60	0.10	64	14
60	0.20	0.35	58	9
50	0.10	0.65	50	7
40	0.05	0.75	42	5
30	0.03	0.70	33	3
20	0.02	0.60	21	2
10	0.00	0.60	12	2
0	0.00	0.55	3	0

While it is perhaps not unexpected that the total LAI values were similar to each other (both had a total LAI = 4.45), it is perplexing to me as to why the vertical distributions of leaves were so different. One of our cousins suggested that the vertical distribution of LAI values in trees had to due with competition (i.e., shading or something like that), while another cousin suggested that the vertical distribution of LAI values was simply a consequence of tree size, and yet another cousin suggested that we consider microclimatic features. That sure gives me a lot to think about.

Assuming that the LAI values had been measured correctly, we then measured the average leaf angles of leaves at each vertical level in the two canopies. These data are provided above as well. These vertical distributions of leaf angles were exactly what we had expected, given our observed leaf area distributions.

We brought an instrument along with us that would measure the leaf photosynthetic rate. This instrument contained a light source so that we could measure the light-saturated photosynthetic rate (under normal temperature, humidity, and atmospheric conditions) in terms of the number of moles of carbon dioxide taken up per unit leaf area per unit time. We also brought along a second instrument to measure the leaf nitrogen content of each of the very same leaves that we measured for photosynthesis. Below I have provided these photosynthesis and nitrogen content data for both canopy types and as a function of canopy height.

	Vegetation: ___	Vegetation: ___	Vegetation: ___	Vegetation: ___
Relative canopy height (%)	leaf N by level (%)	leaf N by level (%)	Light saturated photosynthesis rate (μmol CO_2 m^{-2} s^{-1})	Light saturated photosynthesis rate (μmol CO_2 m^{-2} s^{-1})
100	2.8	3.2	19.0	22.0
90	2.5	3.3	16.0	22.0
80	2.1	3.3	12.0	23.0
70	1.9	3.4	10.0	24.0
60	1.7	3.7	9.0	25.0
50	1.5	3.8	8.0	26.5
40	1.3	3.6	6.0	25.0
30	1.1	3.3	4.0	23.0
20	0.9	2.9	2.5	19.0
10		2.6		16.0
0		2.2		13.0

I am still intrigued by the observation that one canopy had a different vertical profile of leaf nitrogen contents than the other canopy.

The data help resolve one of the issues that I had been having when comparing wheat leaf and forest leaf photosynthesis patterns. I thought that the intrinsic leaf-level photosynthetic rates differed between forest and crop species even when they had the same nitrogen contents. The data resolve this issue.

Having cleared up these questions so quickly, we decided to evaluate just how drought affected photosynthesis rates in one species. Plants were grown under well water conditions for most of the summer. In late summer, we divided the plants into two different groups: one group continued to be well watered (control), while plants in the other group received no further water (drought). Not surprisingly, leaves of plants in the 'drought' treatment had lower photosynthetic rates after only 20 days.

Here are the data that we collected.

Photosynthesis watered µmol CO_2 m^{-2} s^{-1}	Intercellular CO_2 watered µL L^{-1}	Photosynthesis droughted µmol CO_2 m^{-2} s^{-1}	Intercellular CO_2 droughted µL L^{-1}
0	50	0	50
5	100	3	100
10	150	6	150
15	200	9	200
20	250	12	250
25	300	15	300
28	350	17	350
30	400	18	400
32	450	19	450
33	525	20	525
34	600	21	600

Interestingly, the intercellular CO_2 value of leaves exposed to both well-watered and droughted conditions remained at 250 µL L^{-1} under daytime conditions. Keep in mind that the experimental measurements were done in an atmospheric environment of 370 µL L^{-1} CO_2. That provided lots of information for me as to the biochemical, nitrogen content, and stomatal changes that had occurred within leaves exposed to drought. Acclimation had occurred.

Given the Ohm's Law analogy for describing the relationships between photosynthetic rate, stomatal conductance, and intercellular CO_2 values, I was easily able to calculate the stomatal conductances of both control and treatment plants under midday conditions.

Remember that 1 µL L^{-1} is the same as 1 ppm.