Plant Ecology, Examination 2

November 13, 2001 Name _____

Please restrict your response to the space available. Answer directly and fully - don't beat around the bush. The point values for each question are given in parentheses. Any notes you added to Wanda's notebook printout may be helpful in answering the exam.

During the past month we have examined photosynthetic characteristics of *Kallsalot bell*a, an attractive shrub with deep purple flowers from Mediterranean climate regions of southern California. We took our instrumentation to the field and measured the photosynthetic performance of different leaves within the canopy. *K. bella*, what a beautiful plant to work with - the photosynthetic responses were easy to measure and highly repeatable. At first, we measured the light-saturated photosynthetic rate for leaves at different positions in the canopy. We controlled ambient [CO_2] at 370 ppm, leaf temperature at 25 °C, and relative humidity at 60%. From those observations, we obtained the following data. Each observations represents a separate leaf within the canopy.

leaf location	Maximum photosynthetic rate (μmol CO_2 m^{-2} s^{-1})	Leaf conductance to CO_2 (mol m^{-2} s^{-1})	Photon flux (% of full sun)	Intercellular [CO_2] (ppm)
1	25		100	250
2	19		80	250
3	10		52	250
4	5		23	250

1 (12) Please calculate the leaf conductances to CO_2 and insert those values into the table above.

2 (10)Please provide the mechanistic explanation for the maximum photosynthetic rate (measured at 100 % full sun) measured on different leaves decreases with leaf position in the canopy.

3 (10)Are the maximum photosynthetic rate and leaf conductance values above **negatively** correlated with each other? Yes or no. Why or why not?

Well, once we had measured the maximum photosynthetic rates on *K. bella* leaves, we measured the photosynthetic dependence on intercellular [CO_2] (called the A - c_i response curve). The data were collected under experimental conditions in which we kept the incident photon flux density (PFD) at full sunlight (2,000 μmol m^{-2} s^{-1}), leaf temperature at 25 °C, and relative humidity at 60%. In each of these curves, the response at low CO_2 (50-200 ppm) was linear and later at high CO_2 saturated. Observations for *K. bella*:

leaf location	Initial slope of the A - c_i curve	Leaf nitrogen content (%)
1	0.125	4.0
2	0.093	3.0
3	0.050	1.6
4	0.025	0.8

4 (10) What is the nature of the relationship between the initial slope of the A-c_i curve and leaf nitrogen content? From an ecophysiological perspective, why is this pattern to be expected?

5 (10) Why is maximum photosynthetic rate positively correlated with leaf nitrogen content?

6 (10) Why is the initial slope of the A-c_i curve steeper in leaf location 1 than in leaf location 4?

On a recent series of field trips through the deserts of North America with students, we collected the following remarkable data. Basically, these data suggest that there is a relationship between precipitation patterns and the life form of plants in the habitat. None of these habitats were grazed by cattle or sheep.

Coefficient of variation in annual precipitation	Faction of the entire flora that are perennials	Faction of the entire flora that are annuals
2.5	0.45	0.55
1.0	0.90	0.10
1.9	0.70	0.30
1.6	0.75	0.25
0.5	0.94	0.06
3.5	0.17	0.83

7 (15) When we visited desert locations that were highly grazed we saw a very different relationship between the life form distribution and variability in precipitation. Graph the pattern we saw above for the relationship between the coefficient of variation in annual precipitation and the fraction of the entire flora that are annuals. Onto this graph now place the modified relationship when we separately look at grazed sites along this environmental gradient. Provide a brief explanation for why this different grazing related pattern occurs.

Yesterday in class, we had a very excited discussion on what parameters to measure in an exotic weed that is invading Utah's arid land ecosystems. This plant is *Heterotheca grandiflora* (telegraph weed). It has dimorphic seeds and seems to be spreading throughout the southern portions of the state at an alarming rate. We know that this plant is a member of the Asteraceae and that it is an annual. In summary, we came up with the following as parameters to measure in each plant. Obviously students had different reasons to measure the different parameters, but I wonder just how many of these measurements are really relevant to understanding the "bet-hedging" strategy used by this plant. Parameters proposed to measure on each plant:

a ________ the number of ray versus disk flowers
b ________ flower color and petal length
c ________ biomass produced of seed type 1 versus seed type 2 on each plant
d ________ biomass of the carpels associated with each flower head
e ________ biochemical composition of seed type 1 versus seed type 2 on each plant
f ________ dispersal distance of seed type 1 versus seed type 2 on each plant
g ________ germination rates of seed type 1 versus seed type 2 on each plant
h ________ growth rates of seed type 1 versus seed type 2 following germination
i ________ photosynthetic rates on plants developing from seed type 1 versus seed type 2
j ________ determinate versus indeterminate flowering
k ________ seed coat thickness of seed type 1 versus seed type 2 on each plant

7 (11)Place a "yes" or a "no" into each blank space, indicating whether or not variation in this character is indeed thought to be related to bet-hedging associated with plant dimorphism.

8 (12)Justify your answers for

(b)

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(f)

– –

(g)

9 (10) **BONUS** Justify your answers for

(a)

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(e)

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(k)