Paleoecology Problem Set
(In Preparation for your Field Research Project)

1. Suppose you are interested in studying the population structure of a species of brachiopod that is found in abundance in two adjoining strata. Stratum #1, which consists of primarily shale, has individuals of the following sizes (mm): 1, 2, 2.4, 1.9, 34, 25, 30, 30, 21, 19, 1.1, 2.3,4.3 , 5, 6, 7, 8, 23, 23, 45, 10, 9, 8, 16, 20, 1, 3, 4, 5, 2, 1, 35, 45, 38, 35, 36, 37, 39, 35, and 33.

Stratum #2, mostly limestone, has individuals of the following sizes (mm): 1, 2, 3, 2, 1, 2, 4, 5, 2, 5, 6, 1, 1, 1, 3, 3, 4, 2, 5, 6, 7, 3, 2, 7, 8, 9, 10, 10, 10, 11, 1, 12, 13, 14, 16, 17, 18, 4, 4, 4, 3, 3, 2, 3, 5, 5, 6, 6, 7, 7, 8, 9, 10, 11, 12, 15, 14, 13, 14, 15, and 16.

Task:

1-Size frequency distributions can tell us many things about the **age structure** of living and once living organisms and taphonomy such as information loss and the transportation of shell material. Prepare size frequency distribution diagrams for each of your populations from each stratum. Label each axis. **Predict** the shape of each distribution before drawing them. Do the populations appear to be "normally" distributed?

2-Calculate the mean and standard deviation according to the following formulas, and <u>show your work.</u> Before you do so though, **estimate the mean and standard deviation** of both populations.

Mean= $x = \sum x/n$ standard deviation= $s =$

For the standard deviation, **fill** in the table below.

Population 1

X	**x-mean**	**$(x-x)^2$**

Population 2

X	**x-mean**	**$(x-x)^2$**

X	**x-mean**	**$(x-x)^2$**

$=\sum(x-x)^2$

Pop. 2

X	**x-mean**	**$(x-x)^2$**

$=\sum(x-x)^2$

3. Calculate the mean, standard deviation, and range for each population. **Indicate** these **values** on your **size frequency diagrams**.

4. Based upon your measurements, do you think there is a difference between the brachiopod populations from the two sites? Why? How do they differ?

4. As a budding young ecologist, you are expected to come up with an ecological or other explanation as to why the distributions are shaped the way they are. If it turns out that your populations are indeed different, and the difference is too great to be due to chance, suggest (at least two or three) explanations of how these size differences might arise.

5. A t-test can be used to compare the two populations size structure by comparing the deviation from each population's mean . If a t-test is done and a probability value of $P<0.05$ is found, the results are said to be **significant**--size **differences** this large (between these populations) might be expected to occur by **chance** less than 5% of the time (or lower, depending upon the probability value). The 5% P value is an arbitrary cutoff for significance for statistical tests. Sometimes investigators use lower or higher P values as cutoff points. The choice depends upon the investigator's hypothesis and type of test being used. The lower the P value, the more likely the differences between populations are really there and not due to random chance. **Do** a t-test of your population data using computer programs available at Western (or elsewhere). Did you find that the populations were significantly different from one another? What was the probability value? Articulate, in plain English, what these results mean.

Part 2. Oftentimes, ecologists and paleoecologists compare habitats separated by space and time using species abundance, dominance, similarity, species richness and diversity. To better aquaint you with the biometrics involved in these calculations, I, as you probably guessed, have included another exercise. Undoubtedly, some of these calculations will prove **extremely useful** in your upcoming field work. So,....

The index of dominance within each stratum

The index of dominance can be used to compare the concentration of species dominance within each stratum using the formula (Odum, 1971): $c=\sum (n_i / N)^2$ where c = index of dominance, n_i = importance value for each species (# indiv., biomass, etc.), and N = total number of individuals

Values can range from 0.0 to 1.0. A high value implies community dominance by few species while a low value implies that dominance is shared by all species in the community.

Index of Similarity Between Two Samples

The index of similarity can be used to compare species composition of strata in terms of the number of species present and the number of species in common using the formula (Odum, 1971) where: S=Index of similarity $S=\frac{2C}{A+B}$ where A= number of species in **stratum 1**, B= number of species in **stratum 2**, C= number of species common to both stratum 1 and 2

The higher the value, ranging from 0.0-1.0, the more similar in species composition are the strata. A lower value is indicative of less similarity.

Species Richness

Species richness can be calculated to compare richness of each stratum. The Margalef's index of species richness minimizes the effect of sample size bias (Odum, 1971; Dodd and Stanton, 1990)

using the formula: D = species richness value, $D = \frac{S-1}{\ln N}$ where S = number of species and N = number of individuals collected.

Diversity

You hear alot about it, now's your big chance to learn how its done and used. The Shannon index of general diversity is as follows: $H = -\sum (\frac{ni}{N}) \log (\frac{ni}{N})$ where ni= importance value (Number of importance values (#indiv. etc.) for each species, N=total of importance values

Tasks: The table below represents marine species obtained from "Lost Gulch Outcrop" in the Oxfordian Stage of the Ordovician Period. You are a paleoecologist who is attempting to document species relationships in space and time as they relate to past environments. Use the measurements discussed above (do all of them for practice!!) to compare the biotic community in these three strata. How can these calculations of dominance, similarity, richness, and diversity be used in paleoecological reconstruction? Which measurements will you use in your research study?

Stratum 1	Species ID	# indiv Present	**Stratum 2**	Species ID	# indiv Present	**Stratum 3**	Species ID	# indiv Present
	1	23		1	0		1	0
	2	67		2	0		2	0
	3	89		3	34		3	0
	4	21		4	56		4	34
	5	1		5	21		5	56
	6	2		6	8		6	2
	7	4		7	3		7	123
	8	90		8	2		8	56
	9	5		9	1		9	76