Introduction:

Conditions and resources determine many of the boundaries, or dimensions, of the fundamental niche of an organism and so it is important to appreciate how individuals and populations respond to variation in these environmental factors.

In today’s lab we will measure the response of a population of aquatic organisms to gradients of temperature, light intensity and salinity. Your lab research will be to measure distribution and abundance patterns like those shown in nature by Figure 2.18 from Begon et al. (1996) and lecture 1.

Figure 2.18. Distribution of three closely related gammarid shrimps in British rivers relative to water salt concentration (Begon et al. 1996).
Freshwater shrimps in the order Amphipoda are found in most aquatic habitats from fresh to fully saline waters. Most are members of the family Gammaridae and some of the commonest species include, *Gammarus pulex* and *G. lacustris*. These shrimps are abundant in any water with a good supply of organic debris suitable as food. Gammarids provide a convenient and easily observed candidate for measurement of response to variation in conditions.

*Gammarus* sp. – male and female in precopular pair just before mating (photograph by D.I. Hollingworth, Department of Animal and Plant Sciences, University of Sheffield, UK).

http://www.shef.ac.uk/aps/level2modules/aps201/gammarus.htm

The **assay** or measurement of response and redistribution we will use is to count the number of original shrimps that have moved with elapsed time to different distances along a linear tube of water. Thus you will measure time and space components of population redistribution by an animal in response to temperature.

**Exercise:**

In order to examine the significance of a response you will need to consider what you are actually testing and how you are going to reach a conclusion about what happens. To do this you need to use the **Popperian** method of **hypothesis falsification** (see “methods & acclimation powerpoint”).
This is the standard scientific method championed by Karl Popper who carefully explained that we cannot prove hypotheses. Instead, we can only falsify incorrect hypotheses and accept the most plausible and parsimonious alternative hypotheses. **Parsimony** means “economy of explanation”, or the simplest explanation of a phenomenon is the most likely to be correct. This does not mean that complex explanations are not correct, but we can only get to them by rejecting or falsifying less complex hypotheses.

**Hypothesis generation:**
In this exercise and in all lab exercises that you conduct in this class we want you to make a statement of no effect with a **NULL HYPOTHESIS**. In this case your null hypothesis (H₀) is that the shrimps will not move with time in response to a temperature gradient. This means that the shrimps show no response to temperature and their distributions will probably be random. If you can reject this null hypothesis, then you may be able to accept one or more alternative hypotheses. Examples of plausible, simple, alternative hypotheses include:

- H₁: shrimps will move towards warmer temperatures
- H₂: shrimps will move towards cooler temperatures
- H₃: shrimps have a clear temperature preference

Please make these statements in your laboratory notebook and make sure in the future that you do this for all experimental exercises.

Work in groups of 2-4 and count the numbers of shrimps in marked sections of the tubes at 15-minute intervals. When you have at least an hour of data, use Excel to graph your data against time so that you have a sense of what is happening in your experiment. Then pool your data with all other groups in the class and use the pooled data to calculate means and variances (standard deviations or the square root of variance) for the numbers of shrimps at each location and for each time interval. To do this you should use MS Excel and the analysis tool pack (which may need to be installed from the tools menu).

Groups should organize so that replicate data sets are gathered for each of the environmental conditions you test: these can include temperature, light intensity and salinity. Obviously, these experiments will all be performed to test their relevant null and alternative hypotheses! Ideally, each group will test each of these conditions and each group will represent a single replicate for each condition.
**Replication:**
Each experimental set-up (each tube with shrimps) represents an individual replicate and the total number of these is your sample size or degree of replication. You must replicate so that you can measure the variance of your data (note: data are always plural!). The timed measurements are not replicates, they are simply repeated measures of the same population redistributing itself in space and time.

**Analysis:**
In order to attempt to reject the null hypothesis you need a statistical test that analyzes the distribution of your replicated data. In this case the simplest test is to use a Chi square test to compare your observed shrimp numbers with an expected outcome of no effect of temperature. Again you can use the statistical tools in the analysis tool pack in Excel to analyze your tabulated class data. If you have observed shrimp numbers that differ significantly from the expected distribution of randomly distributed numbers in all parts of the tube (less than a 5% chance (P<0.05) that your observed data are the same as the expected data). In this instance we are going to make a simplifying assumption and expect equal numbers of shrimps in all parts of the tube rather than random numbers.

**Communication:**
Lastly, the work is not completed until it is communicated. Thus for each lab exercise you will complete a written report based on the notes and data collection you perform in your lab notebook. You should aim to keep meticulous notes in your notebook bearing in mind that you should be able to explain to yourself or anyone else in the future exactly what you did to collect your data. This is the essence of “good laboratory practice” and all scientists should practice meticulous note-taking that is the foundation of their published work. In this case, your published work is the report you hand in to your TA.