Lab 1.

Experimental measurement of the intrinsic rate of increase in Fruit Flies.

Objective:

If we know r, the intrinsic rate of increase, and N_0, the starting population size then we can easily determine the growth curve of an exponentially growing population from the relationship $dN/dt = rN$ (we will do this in Lab #2). It follows that if we know N_0 and can determine the shape of an exponential curve observationally, then we can determine r; probably the most fundamental parameter in ecology.

Practical Uses:

Calculation of r for an exponentially growing population is likely to be of direct value in applied microbiology (calculation of microbial growth rate in fermenters), and in biological control applications (e.g. large scale production of sterile fruit flies for pest control).

Introduction.

We will use the familiar laboratory fruit fly, *Drosophila melanogaster,* as our experimental organism. *Drosophila* are easy to sex and count, and have a relatively short life cycle. We will determine R_0, the number of female eggs produced per adult female per unit time, and then use this value to derive r.

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The Exercise

1) Working in groups of two, prepare three *Drosophila* culture tubes per group, by placing approximately 1 inch of dry fly medium in each tube, and adding an equal volume of cold water. Add one or two grains of dry yeast.

2) Anaesthetize a vial of flies (don't over-do it, or you will kill or sterilize them!), and sex them under a dissecting scope:

Males (left) have shorter bodies, with solid dark coloration of their abdomens; females have brown stripes on their abdomens.

Place **two** female flies and several males in each of the **culture tubes,** and label them with your name and the time. These flies will be released tomorrow, after exactly 24 hours in the tubes.

We will examine the tubes in a few days time, and count the number of pupae, which gives us eggs/female/day. With a 50/50 sex ratio, one half of this value gives us an estimate of R_0, the number of female eggs/female/day. Class data will be posted.

Calculate the mean and standard deviation of the number of presumed female eggs/larvae per female per 24 hr day.

The life span of an adult *D. melanogaster* can be taken to be 30 days. The rate of development is temperature dependent, but the generation time can be assumed to be 10 days (egg laying to egg laying) at 22^0C. (for simplicity, we will assume females can lay eggs from eclosion ("hatching"; in fact they reach sexual maturity after 8-10 hours).

You will recall that the intrinsic rate of increase, r, is calculated as:

$r = \ln R_0 / T_g$

(the natural log of R_0 divided by the generation time, where R_0 is the number of females produced per female)

Calculate r for your flies, using the class mean and standard deviation for R_0

Report (due one week hence)

If a single fertile female fruit fly were to establish a new population in a pristine, food-rich environment (for example, an exotic species of fruit fly accidentally introduced into California citrus groves), how large might the resulting population be in 90 days? What are the confidence limits on this population estimate?[1]

Things to Consider (this is the more important part of lab report!)

Why would this approach to the measurement of r be inappropriate to finding r for a population of deer living in the Angeles National Forest?

A female Brown Rat, *Rattus norvegicus*, living under optimum conditions can average 5 offspring per litter, and produce 3 litters per year. *R. norvegicus* reaches sexual maturity at 6 months, and the average life span in the wild is 2 years. If a rat-free island is colonized by a single pregnant female rat, approximately how long will it take for the population to reach 1000 animals (assuming carrying capacity is very much greater than 1000, and growth proceeds exponentially).

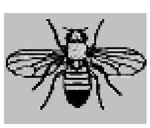
Useful Formulae:

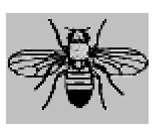
The size of any exponentially growing population at time t is given by:

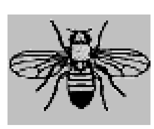
$$N_t = N_0 e^{rt}$$ (where e is the mathematical constant 2.718…..).

The time needed for a population to reach size N_t is:

$$t = \frac{\ln(N_t)}{r}$$





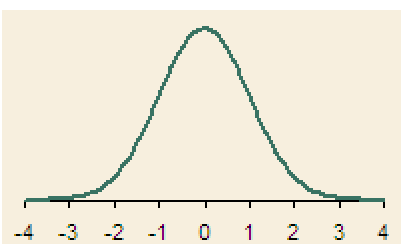


A Note on Standard Deviations and Confidence Limits.

A mean (average) value should always be accompanied by its standard deviation. The standard deviation is a measure of the "spread" of the data around the mean. For example, these two data sets have (approximately) the same mean (=9.9) but the first has a standard deviation of 2.2, and the second a standard deviation of 4.5 The second column is much more variable!

	10.7	14.2
	6.1	13.5
	10.1	18.3
	8.0	9.2
	10.0	8.2
	13.3	3.1
	9.5	5.3
	13.2	8.5
	8.4	7.5
	9.5	10.8
mean	9.9	9.9
st dev	2.2	4.5

Graphically, the distribution of theses data points will approximate Gaussian (or "Normal") curve:



Standard deviations from the mean

By DEFINITION, 95% of the total distribution will lie within 1.96 standard deviations either side of the mean. So, if a population of snails has a mean weight of 5 grams and a standard deviation of 2 grams, we can conclude that 95% of all snails in the population will weigh between 5 + (1.96 * 2) and 5 – (1.96 * 2) = 8.92grams - 1.08 grams.

These values , 1.08 and 8.92 grams, are the **95% confidence limits** for our snail population weights.