Biology 103

Measuring Potential Reproductive Success in Wingstem (*Verbesina alternifolia*)

Objectives:
1. Understand the role of reproductive success in natural selection.
2. Practice collecting and analyzing data.
3. Learn about the biology and natural history of wingstem.

Introduction:

One of the central postulates of Charles Darwin's theory of natural selection is that there is variation in the reproductive success of organisms. Natural selection is basically a theory about the differential survival and reproductive success of organisms. Organisms that have no reproductive success obviously do not contribute to the following generation's genetic make-up. Organisms with a relatively high reproductive success contribute more offspring (and genes) to the next generation. Thus, traits that contribute to high reproductive success become more common in the subsequent generations (all else being equal.) Thus, natural selection favors traits that contribute to relatively high reproductive success.

There are basically two ways an organism can have high reproductive success: it can survive a longer time -- hence have more time to reproduce, e.g. go through more breeding seasons. Or it can live the same amount of time as others in its cohort, but produce a greater number of offspring in that same amount of time.

Generally speaking, organisms will have their highest reproductive success when they are living in the habitat and conditions to which they are best adapted. For example, a plant adapted to a moisture-rich habitat may manage to survive and reproduce in a dry environment, but may do so in a depauperate condition. Its reproductive success may be relatively low when compared to another member of the same species growing in a moisture-rich environment. Thus, by measuring reproductive success of a species in various environments we can get some idea of the kind of habitat an organism is best adapted to.

Wingstem (*Verbesina alternifolia* (L.) Britt. ex Kearney) is a perennial wildflower native to the eastern U.S. It is in the family Asteraceae. The Asteraceae include the asters, daisies, sunflowers, dandelions, mums, and lettuce, as well as about 25,000 other species in 1100 genera. The Asteraceae is commonly known as the Composite Family, or 'composites.' The name 'Composite' is in reference to the way the flowers are arranged on the plant. An inflorescence is a grouping of individual flowers on a plant. Among the 250,000 species of flowering plants, there are many different kinds of inflorescences. The Composite family is distinguished by an inflorescence called a capitulum; the flowers are arranged in compact heads.

Take a daisy, as an example. What the layman often thinks of as a single daisy flower (a yellow center with white 'petals') is actually a cluster of many small flowers. In the yellow center of a daisy are many tubular **disc flowers**. The disc of the daisy is surrounded by many white strap-shaped **ray flowers**. See Figure 1. Each flower in the disc matures into a fruit with a single seed. A sunflower is put together in a similar fashion. Each of the many disc flowers in the head matures into a fruit, i.e. what most people call a sunflower seed is actually an entire fruit containing a single seed. A sunflower head contains hundreds of ripe fruits, because there were hundreds of flowers on that head. In a dandelion, the inflorescence is made up entirely of ray flowers.

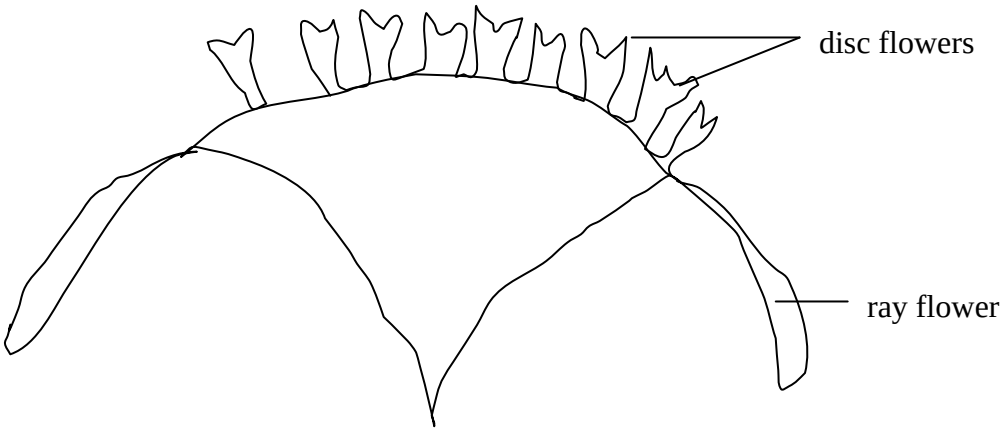

Figure 1: Longitudinal section through a typical inflorescence of the Composite family

A seed contains an embryonic plant of the next generation. The plant grew from a fertilized egg; the egg was fertilized by a sperm that was carried to the flower inside a pollen grain. Once fertilization takes place, the zygote divides to form the embryonic plant while the fruit and seed mature. The embryonic plant then goes into a state of suspended animation within the seed. The embryo will germinate (come out of suspended animation and grow) when certain environmental conditions (hydration is often the main component) are met.

On wingstem both the disc and ray flowers are yellow. The ray flowers are usually sterile; sometimes they have pistils and can thus produce a fruit an a seed. Wingstem blooms from late summer to early fall. The flowers are visited primarily by long-tongued bees, especially bumblebees, and some short-tongued bees.

The fruits are broad, flat, and winged, they are distributed to some extent by the wind. They are dry and contain one seed.

V. alternifolia has a central stem with longitudinal leafy wings, hence the common name 'wingstem.' The stem produces long rhizomes, allowing the plant to reproduce asexually, and the species is often found in large colonies. Wingstem grows up to 2.5 meters tall. The trivial name 'alternifolia' refers to the **alternate** arrangement of leaves on the stem ('altern' = alternate, 'folio' = leaf). The leaves are up to 25 cm long and 6 cm wide and have a rough texture.

Another species in this genus, *V. occidentalis* (L.) Walt. , is known as 'Small Yellow Crownbeard.' Like wingstem, crownbeard has yellow flowers that bloom in the fall, so these two species can be confused if you look at them superficially. *V. occidentalis,* however, has opposite leaves on its stem.

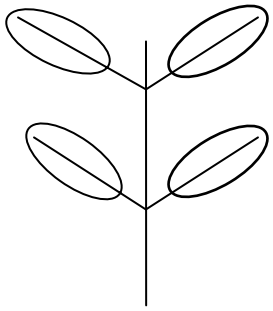

Figure 2: Opposite leaves

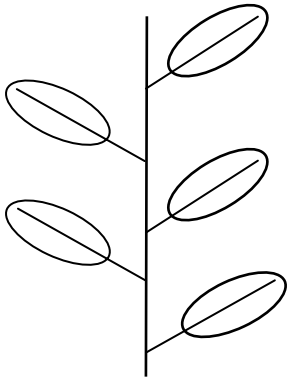

Figure 3: Alternate leaves

Be aware that both species are present in Radford, and make sure you have identified your plants correctly before collecting data.

In this lab you will attempt to discover which to which habitat Wingstem is best adapted. Wingstem should have the highest measured fitness in the environment to which it is best adapted.

Methods: Select wingstem plants growing in two different environments. Examples of some possible choices are listed below or you may choose others. You may want to discuss and decide on the habitat or conditions your want to sample as a class , so you can pool your data and thus increase your sample size. You should discuss which of these can be practically measured in your lab period as well.

Some suggest environments you may want to sample from are listed below. (These categories may be coarse ; you may want to discuss how best to categorize or quantify the environments you choose to sample.)

Sun / shade
north slope / south slope
riparian / upland
crowded / uncrowded

Discuss: As you gather data on your plant, what are some other things you might want to keep track that might have an affect on the organism's reproductive success. For example, might it be valuable to measure the height of the plants or the number of leaves per plant ?

Decide on how are you going to measure potential reproductive success. Is it best to measure number of inflorescences or number of flowers ?
Now that you've made some decisions, just to make sure you are aware, state exactly what will be your:

Independent variable

Dependent variable

Variables you will try to keep constant

Hypothesis

Alternative hypothesis

Prediction (i.e., deduction) if the hypothesis is true

Prediction (i.e., deduction) if the alternative hypothesis is true

Results: Here you describe and graphically represent your data. This is purely a descriptive section; you do not yet report any conclusions.
You can report the descriptive statistics you have calculated, such as means, standard errors, and ranges. Graphs of your data can be included here as well.

If you do a correlational study , include those results here as well. Possible correlational studies may address these questions, among others:
Does height of plants correlate with numbers of flowers per plant ?
Does number of leaves per plants correlate with numbers of flowers per plant ?

Conclusion and Discussion:

Main question to answer: In which environment does wingstem achieve its highest potential reproductive success ? To answer this question, you first want to see whether there is a significant difference in flowers per plant in the two different environments.

Often, during or after a study, unforeseen problems or questions arise. Are there any problems with how this study was conducted that you could correct in a future study ? For instance:

Are there better ways to measure reproductive success in Verbesina ? How ?

Are there better ways to control the environmental conditions you studied ? How ?

Verbesina reproduces asexually by rhizomes. How doe this affect your answer as to its reproductive success, and the way you measured reproductive success ?

References

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