**April 16 – Angiosperms II**

Angiosperms are by far the most diverse lineage of terrestrial plants. Depending upon the source, estimates of the number of species in each lineage are as follows:

- Bryophytes: ~ 20,000
- Fern and allies: ~ 12,000
- Gymnosperms: ~1000
- Angiosperms: ~300,000 (a common range suggested is 250,000-400,000)

Four of the largest angiosperm families (yep, you need to know these):

- Asteraceae (daisy/aster/sunflower family): ~23,500 spp.
- Orchidaceae (orchid family): ~25,000 spp.
- Fabaceae (bean/pea/legume family): ~ 19,500 spp.
- Poaceae (grass family): ~ 10,500 spp.

This high diversity begs the question: "why are there so many species of angiosperms?" A corollary to this is the question: why are angiosperms so "successful" (cover such a large percentage of the Earth's land surface)? This is a complex issue – and there are no simple answers. That being said, you know by now that angiosperms (like gymnosperms) have features that enable them to occupy dry habitats: vascular tissue, seeds, true roots, pollen tube for fertilization (water need not be present for fertilization and sperm are not flagellated), and leaves with an epidermis and cuticle (and stomata, of course).

In addition to the features shared with gymnosperms, there are a number of hypotheses that account for angiosperm diversity and abundance, and most are not mutually exclusive (i.e., all may be valid and contribute to some extent). There are many complex hypotheses that we will not explore, chief among them is that flowering plants seem to be able to reduce or double the number of chromosomes present, or alter the expression of certain genes over the course of a single generation (epigenetics). Hypotheses that we will cover, and that you need to know are:

1) Presence of **vessels in xylem**, which allows for opportunistic and rapid movement of water, and subsequent growth.
2) **Short generation times** (annual and biennial herbaceous angiosperms)
   - **Annual plant:** A plant that completes its life cycle (from germination to seed production) in one year).
   - **Biennial:** A plant that completes its life cycle (germination to seed) in two years
   - **Perennial plant:** A plant that lives for more than two years

Short generation times contribute to angiosperm diversity and ecological success for two reasons:

2a) An additional strategy for survival and reproduction – herbaceous annuals/perennials can survive and reproduce in locations and/or timespans previously unoccupied (evolutionarily) by gymnosperms.

2b) short generation times = faster rates of evolution

{VIDEO: Planet Earth, "seasonal forests" 37:10-38:50}
http://vimeo.com/123700368

3) **Pollination by animals** (flowers that facilitate directed pollination by animals). Increases diversity for two reasons (see details below):

3a) reproductive efficiency at low plant density,
3b) faster speciation.

3a) **Reproductive efficiency at low plant density**: animal pollination increases **pollination/reproductive efficiency** (relative to wind pollination) especially at low population densities for individual plant species. Note that conifers such as pine trees typically grow in dense stands in which many members of the same species are present. This is absolutely necessary for effective wind pollination of female cones. Some angiosperms, such as grasses, also grow densely, you should not be surprised to learn that their flowers are wind pollinated.

Pollination by animals releases species of flowering plants from the need to exist within "wind-shot" of a conspecific if they hope to reproduce, and/or it allows them to reproduce at lower population densities. As mentioned above for grasses, note that many angiosperms (e.g., grasses, oaks, alders, willows) still pollinate via wind! They tend to have flowers that are small and not colorful. Why do you think that is?!

3b) **Faster speciation**: Highly specialized plant-pollinator relationships also lead to speciation by creating reproductive isolation even when plants of the same species, or those that are newly speciated (so called "insipient species"), are in the same area (sympatric speciation).

**Speciation**: The process by which populations of a species evolve to become two or more distinct species. (In short: "The formation of a new species".) Speciation can only occur if 2 or more populations of a species are reproductively isolated from each other.

**Reproductive isolation**: A barrier to reproduction in two populations or species.

**Allopatric speciation:** a speciation event in which populations of the common ancestor are reproductively isolated from each other due to geographical separation (e.g., by an ocean or mountain range).

**Sympatric speciation:** a speciation event in which populations of the common ancestor are reproductively isolated but their populations overlap (NO geographical separation).

If sympatric speciation is to occur, there must be some mechanism of reproductive isolation. In flowering plants, specific relationships between plants and pollinators can provide that mechanism (there are other important mechanisms that we will not explore!). Clearly, wind pollination is not a good mechanism for sympatric speciation…

4) Fruits that increase dispersal via animals, water, and other mechanisms…(we'll cover dispersal next lecture)!

Incentives for pollination: Pollinators do not transfer pollen altruistically - they visit flowers because they get (or they think they are getting!) some benefit from these visits. Flowers incentivize pollinator visits in a number of ways, which can be grouped into two categories:

**I. Food**

**1) Pollen**: pollen is collected by a number of insects, most notably bees that use it to make a food for larvae. Bee pollen is available at some health food stores and smoothie shops.

**2) Nectar**: nectar is perhaps the most common reward for pollinators. It is produced at the base the flower in a chamber called the nectary (wow!), and depending upon the flower the nectar may contain glucose, fructose, and/or sucrose. This is the payment of choice among birds and mammals especially, as well as many insects.

**3) Carrion:** Some flowers produce odors that smell like rotting flesh (carrion) and in so doing they lure carrion flies – flies that eat dead animals – into their body. The flies might NOT RECEIVE any nutrition for their troubles in which case they have been deceived and the plant has successfully mimicked dead meat.

{VIDEO: Private Lives of Plants, episode 3 "flowering" 41:26-44:50 – or 47:25 if time permits}

**II. Sex**

**1) Sexual deception**. What better lure? A group of orchids mimic the appearance or aroma of female insects in order to attract males with hopes of making some sweet love. The orchids attach their pollinia to the would-bee loverboys as they flail about in a futile attempt to mount the "female". This practice is called sexual deception, it is a type of mimicry. Apparently female insects don't fall for this kind of trickery…sound familiar?

{VIDEO: Private Lives of Plants, episode 3 "flowering" 34:20-37:00} – or 41:00 if time…

Some orchids accomplish sexual deception even though they do not visually resemble female insects. They do so by producing chemicals that mimic the aroma of sex pheromones released by female insects of the same species!! The males approach the flower, lured by the scent of female bees. Although love is in the air, "nobody is home"…so sad.

**Pollinia**: Small "cherry-shaped" and sticky packets of pollen produced by orchids.

**Mimicry**: Situation in which one species resembles a second species in order to deceive the second or another species.

**Sexual deception**: Type of mimicry in which an orchid attracts a male insect pollinator by mimicking the appearance or scent of a female insect.

**2) Oils:** Males of the Euglosini tribe of tropical bees (contains 5 genera) known as "orchid bees" collect oils from orchids and uses these oils in courtship to score big with female bees. The bees are a beautiful iridescent green and/or blue, but apparently that is not good enough for the female bees (*princesses…!*). The males carry the oils in specialized pouches on their hind legs. The orchids may also attract the bees by producing chemicals mimicking the odor of females.

{VIDEO: Private Lives of Plants, episode 3 "flowering" 28:32-30:43}

Concluding points:

{VIDEO: Private Lives of Plants, episode 3 "flowering" 47:30-end}