Key Concepts -- Lecture 15 (pollination) **IB 168 Spring 2009**
Reading: pp. 465--472 in Simpson

Plant dilemma - rooted in place (as sporophyte) but must mate with other plants and must disperse young to new safe sites.

Two major types of dispersal in seed plants:
Pollination: the **transfer of pollen** from its source to a receptive surface (**stigmatic surface or** (in gymnosperms) **micropyle of naked ovule**). Essentially, pollination is the **dispersal of the male gametophyte** to the female gametophyte, which is encased within the ovule. Pollination occurs in all groups that have pollen; namely, all (and only) seed plants (gymnosperms and angiosperms).
Seed dispersal: the movement of seeds (or in some angiosperms, fruits -- including seeds) away from the parent plant (usually by a vector). **Dispersal of the sporophyte generation**.

Dispersal vectors (of pollen and/or seeds)
Many different vectors of two general categories:
Abiotic - wind and water (may or may not be ancestral in gymnosperms)
Biotic - insect, birds, and mammals; rarely lizards (biotic pollination is ancestral in angiosperms)

Pollination syndromes (general)

Abiotic pollination
Wind pollination is more common than water pollination.
Generalizations about abiotic pollination
- less precise than biotic pollination; often pollen produced in large amounts
- wind pollinated plants often have unisexual flowers with small, non-showy perianth (or no perianth)
- reduction of inert surfaces, which can block path of pollen to receptive surface; flowering often occurs before leaves fully emerge
- anthers open only when weather is favorable (warm and dry); pollen dry, with smooth surface
- in angiosperms, stigmatic surface is enlarged

Biotic pollination
General Syndrome: blossoms possess an **attractant** or advertisement, often (but not always) present a **reward**. Large and conspicuous perianth or bract(s) and/or odor or fragrance. Pollen grains vary but are usually sculpted and sticky or in the extreme case united together in dispersal units, pollinia. Anthesis and the production of an attractant and reward are **synchronized** with the activity of the pollinator.

Relationship between visitor and blossom is established by means of an **attractant** and (usually) **reward** system, corresponding to 3 basic activities in animals:
1) feeding (pollen, nectar, fat, or oil; **nectar is relatively cheap** and commonly the main reward)
2) sexual (**fragrances** -- precursors of pheromones, collected by **male** insects)
3) brood rearing and nest building (e.g., **resins** -- collected by **female** insects; or egg laying in blossom)

Some angiosperms (especially orchids) **do not provide a reward** and instead **deceive** pollinators into visiting (e.g., carrion flowers, flowers that mimic female bees), potentially reducing pollinator fitness but potentially enhancing plant fitness.

Different **floral syndromes** are evident for animal-pollinated plants that are **most importantly associated with particular lineages or ecological groups of animals** (even if other floral visitors sometimes are effective in pollination). Different plant groups associated most strongly with particular animals show **similar evolutionary trends involving four main sets of floral characteristics**:
(1) Reward (type or chemical composition / amount): e.g., bird-pollinated flowers generally with more nectar than insect-pollinated flowers. Bat-pollinated flowers especially rich in pollen and/or nectar reward.

(2) Morphology of blossom/flower: e.g., bee-pollinated flowers often with visual guides (nectar guides); moth or butterfly-pollinated flowers generally without guides, with long, narrow tubes or spurs bearing nectar; bird- and bat-pollinated flowers often relatively large, sturdy, tubular.

(3) Color of blossom/flower: e.g., bee-pollinated flowers various, but not often red; bird-pollinated flowers often red; bat- and moth-pollinated flowers often pale or white; butterfly-pollinated flowers often showy.

(4) Odor/fragrance of blossom/flower: e.g., moth-pollinated flowers often fragrant; bird-pollinated flowers not fragrant.

Mechanisms that promote outcrossing (militate against inbreeding)
First, general definitions:
Cross-pollination (allogamy): pollen from one flower to another flower **on different plants**
Self-pollination (autogamy and geitonogamy): Pollination taking place within one flower or between flowers of **the same plant**

Genetically, cross-pollination is often favored by natural selection; selfing can have deleterious consequences, such as expression of deleterious recessive alleles. But selfing (at least delayed selfing) can be selected for if mates or pollinators rare or unpredictably present (e.g., colonist plant species, such as weeds, or plants of extreme environments) or if flowering time short.

Internal mechanism to prevent selfing: **self-incompatibility (SI)** (antigen/antibody-like reaction of pollen on stigma that prevents pollen from fertilizing ovules of same plant), found in many angiosperm families.

External devices that promote cross-pollination:
4 main types (although great variability does exist)
1) Dichogamy**: separation** of stigmatic receptivity and pollen release **in time**. Protandry - anthers mature first. Protogyny - pistils mature first. Dichogamy limits selfing within a flower only (does not limit crosses between flowers on the same plant).
2) Herkogamy**: spatial** separation of anthers and stigma in one blossom. Limits selfing within a flower only.
Herkogamy frequently found in combination with dichogamy.

3) Heteromorphy: includes heterostyly - for example, in **distyly, two types of flowers on different plants**: "pin", with long styles and short stamens, and "thrum", with short styles and long stamens. Pollen placement on pollinators favors crosses between pin and thrum individuals, not between pin and pin or between thrum and thrum individuals, which are incompatible.
4) Dicliny: (unisexual flowers) monoecy (staminate flowers and pistillate flowers on the same plant) and dioecy (staminate flowers and pistillate flowers on different plants).

Despite all of these structures observed in blossoms that appear to counteract self-pollination, it appears that, with the exception of strongly self-incompatible species, some self-pollination usually occurs. On the other hand, plants that are strongly selfing appear to undergo enough outcrossing to maintain some level of heterozygosity. **Mixed-mating strategies are commonplace in plants**.