111. FLOWER MORPHOLOGY AND POLLINATION

There are two major parts to the process of producing viable seeds:

1. The flower, and
2. The fruit and seeds.

FLOWER

The entire reason for flowers' existence is the need to bring about successful cross-pollination, the recombining of genes from two different plants. Cross-pollination produces variable offspring in the next generation, which is a way of providing new genetic combinations. Such combinations may succeed in successful adaption to new environments to further the future success of the species!

Flowers are first noticed as special buds. Flowers usually depend upon the right combination of daylength, temperature, and moisture before they're produced. For each species the importance of these factors is different. While still in bud, the reproductive parts of the flower are busy: the stamens making microscopic pollen grains and the ovary producing tiny ovules, each with an egg inside. Tough sepals protect flower buds, and are thus the outermost layer of the flower.

When the flower finally opens (a stage called anthesis), it's for the purpose of attracting pollinators. Let's take a look at the layers of a typical flower:

- Sepals (collectively the calyx). The outermost, usually green layer protecting the flower parts in bud.

- Petals (collectively the corolla). The next layer in, petals are brightly colored to attract pollinators. Details of petal number, shape, size, and color are important in determining which pollinators visit, and are important in identifying flowers.

- Perianth. The collective term for BOTH sepals and petals. Some flowers may have only one row of perianth (not both sepals and petals). When parts of the perianth look alike, they're often referred to as tepals.

- Stamen. The next layer in, and the male part of the flower. Stamens produce the fine powder called pollen, which gets carried from one plant to another by pollinators. Each stamen has two parts:
- Filament. The stalk which positions the pollen at the right place for the pollinator to pick it up.
- Anther. The hollow sacs at the end of the filament, inside of which the pollen is produced by the millions. Anthers split open at just the right time to dust the pollinator with pollen.

- Pistil. The centermost part of the flower, and the female. Pistils produce tiny preformed seeds--ovules--and receive pollen from the pollinator. Each pistil consists of three parts:
- Ovary. The bottom of the pistil, a swollen sac Which protects the developing preformed seeds or ovules. Later the ovary becomes the fruit or container for the seeds.
- Style. The slender stalk on top of the ovary.
- Stigma. The swollen end of the style, where pollen has to be deposited for successful pollination. Stigmas are receptive to pollen for a specific time, and are sticky or fuzzy to help trap the maximum number of pollen grains from the pollinator.

Two additional, important structures relating to the flower are:

e Receptacle. The end of the flowering stem, to which the parts of the flower are attached. In most flowers the receptacle is short, but in some large flowers, such as magnolias, the receptacle is long and cone shaped.

' Bract. Any modified leaf associated with a flower. Bracts are often no more than tiny versions of functional green leaves, but sometimes may masquerade as integral parts of the flower in two ways:

- As extra sepals. If there appears to be a second set of sepals around the flower, the outermost set is probably specialized floral bracts.
- e As petal-like structures. Bracts may be brightly colored to replace lost petals in such diverse flowers as poinsettia, dogwood, and skunk cabbage.

Let's now turn to how pollination works. As the flower opens, its color, smell (or lack of it), and shape serve to attract potential pollinators from a distance. At closer range, the pollinator may be further enticed by smell, nectar guides (colored lines or dots on. petals), pollen, and nectar (a sugar-water substance offered by many flowers as a reward). Once the pollinator has found its reward, it moves on to another flower. In the process of reaching nectar (or pollen), the pollinator rubs against the anthers of the stamens, with the result that pollen adheres to its body. At the next flower, it may rub against the stigma of the pistil, thereby transferring pollen. Pollination for most flowers works best when pollen is taken from the flower of one plant to a flower of a different plant. If this doesn't happen, we have self-pollination which, over time, may lead to genetic weaknesses. Flowers have developed ways of avoiding self-pollination, including self-incompatiblity and the shedding of pollen (the male stage) at a different time from the receptivity of the stigma (the female stage).

When pollen is transferred to the stigma, a new set of processes begins. If the pollen is chemically compatible (from the same species but a different plant), the pollen soon grows a tube. This tube bores its way down the style, all the while digesting tissue from the style for its nourishment and growth. Obviously, however, orchid pollen on a rose will not have the right chemistry and so will soon shrivel and die. Hormones are excreted by the ovules inside the ovary to guide the growth of pollen tubes. Each tube must travel to an ovule, where it then delivers a sperm to the egg inside the ovule. Fusion of sperm and egg is called fertilization, the second necessary step in producing seeds. Please note that pollination just involves getting the pollen from anther to stigma; fertilization can only happen when the second part of the process is completed.

THE FRUrr

We now move on to the development of the seed. The fertilized egg inside each ovule now rapidly grows into an embryo plant. The surrounding tissue of the now developing seed grows into the endosperm, a nutritive layer to feed the growing embryo. Because the embryo and endosperm enlarge, the whole seed is constantly growing bigger, and because the developing seeds are contained inside the ovary, the ovary, too, must enlarge. To the naked eye, successful fertilization is signalled by the ever-enlarging ovary, which is often the only part of the flower that now remains. By the time the embryo has reached a size large enough to start life on its own, we say the seeds and ovary are ripe. The ovary now becomes the fruit, and signals its ripeness by color-immature ovaries are green or white, mature ones change to brown, black or, when fleshy, take on bright colors such as red or orange. Likewise, the seeds inside change from greenish or whitish to some dark color. At their maturity, seeds are ready for the last stage--dispersal. This stage is as important to survival as pollination and fertilization; if seeds land in the wrong place, they will fail to germinate and die.

Let's finish by talking about some of the remarkable pollination strategies that have evolved. Flowers are thought to have co-evolved with certain insect groups, as one became more and more specialized to the other. Some major pollinators include:

- Beetles. Many beetles have relatively unspecialized behavior. Beetles often pollinate relatively, open, unspecialized flowers. However, dung beetles are an exception: their flowers are lurid purple or maroon, smell rotten (some also smell musty or fruity), and often heat up to expedite the bad smell. Many such flowers temporarily trap the beetles. Examples include pipevine (Aristolochia), wild ginger (Asarum), and western spicebush (Calycanthus occidentalis).

- Flies. Like beetles, many flies are unspecialized in their behavior and predilections. Flies often visit dully colored small blossoms in white, greenish, or browns. Hover flies, by contrast, are striped to resemble bees and move in jerky motion from flower to flower, probing for nectar with a long tongue, while hovering in place.

- Bees. Honeybees are perhaps the most important pollinators for crop plants. Bee flower features include asymmetrical petals, nectar guides, (often) pleasant smell, colors of purple, blue, yellow, or ultraviolet (not visible to human eyes). Rewards include nectar and/or pollen (extra pollen is used to nourish the young). Although honey bees are not native to California, they have become well established here and often displace the smaller native non-hive-forming bees. Many designs are successfully pollinated by bees, including masses of numerous tiny flowers (<u>Ceanothus</u>) or daisylike patterns. Bumblebees include some especially large, furry native bees, with longer tongues. Bumblebees often visit tubular or spurred flowers. (Coyote mint--Monardella, thistles--Cirsium, and larkspurs--Delphinium, for example.)

- Butterflies. The adults live almost entirely on nectar and visit a wide range of flowers. However, only certain flowers are effectively pollinated by them. Features include tubular nectaries, flowers of pink, rosepurple, or red-purple with protruding stamens and stigmas. Examples: Coyote mint--Monardella, thistles-Cirsium, and milkweeds--Asclepias.

- Moths. Because many moths fly at night, moth flowers are nocturnal. Petals are white or pale colors, exude a very sweet, cloying perfume, and produce nectar in long, narrow tubes; stamens and stigmas protrude. Examples: Jimson weed--Datura, evening primrose--Oenothera, four o'clock--Mirabilis.

- Hummingbirds. These active, tiny birds have high metabolisms and so require copious nectar. Flowers are brilliant colors--often red or other strongly saturated hues--without odor or landing platform (hummers hover in front of flowers). Nectar is in deep tubes; stamens and stigmas protrude. Examples: wooly blue-curls-Trichostema lanatum, California fuchsia--Znuschneria, scarlet larkspur--Delphinium nudicaule, and red columbine--Aquilegia formosa.

- Wind. Some flowers have returned to using wind, flowering when weather is windy. Wind flowers have lost their petals; no nectar is produced; pollen is dry and doesn't stick together; stamens and stigmas protrude; stigmas are feathery, with large surface area to trap pollen grains. Examples: members of the grass family Poaceae and sedge family Cyperaceae; oaks--Quercus, alders--Alnus, and cottonwoods--Populus.