

# PLANTS AND THEIR POLLINATORS — THE RELATIONSHIP THAT FEEDS THE WORLD

Wild Flowers come in a variety of shapes, colors, and sizes, variously arranged on the plant stem and with or without odors — some sweet, some not so sweet. Why are flowers so varied? What is the function of all this variation? Observation of flowers and their visitors over many years by naturalists in the nineteenth and twentieth century led to the formation of classes of flowers and pollinators called "plant pollinator syndromes." While these syndromes overly simplify these complex relationships, they are nevertheless useful in organizing plant characteristics associated with groups of pollinators. These syndromes are listed below for the major pollinator groups. Keep in mind that rarely will one flower species exhibit all, or even most, characters. In addition, many species will be more generalized, incorporating characteristics which may bridge more than one pollinator group. True evaluation of pollinator importance can only be made with proper observation and sometimes only with experimental work.

## BEETLES (COLEOPTERA)

Flowers generally large and flat  
Pollen and nectar exposed  
Floral color white or dull  
Nectar guides absent  
Odor heavy and sweet or fruity  
Pollen production copious  
Nectar variable

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Magnolias (*Magnolia* spp.)  
Sweet Shrub (*Calycanthus floridus*)



## FLIES (DIPTERA)

Flowers small, radially  
symmetrical, flat or with  
small tube  
Pollen and nectar mostly exposed  
Floral color white or dull  
Nectar guides frequently present  
Odor imperceptible, or foetid  
Pollen production moderate  
Nectar production scant to moderate

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Speedwell (*Veronica* spp.)  
Bluets (*Houstonia caerulea*)  
Chickweed (*Stellaria* spp.)  
Carrion Flower (*Smilax herbacea*)



## BEES (HYMENOPTERA)

Flowers variable in size  
Often bilateral  
Nectar mostly hidden  
Pollen present for specialized contact  
Floral color often yellow or blue with  
ultraviolet reflectance  
Nectar guides generally present  
Odor variable but generally not strong  
Pollen production copious  
Nectar production moderate to copious  
generally high in glucose & fructose

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Great Blue Lobelia (*Lobelia siphilitica*)  
Violets (*Viola* spp.)  
Larkspur (*Delphinium* spp.)  
Impatiens (*Impatiens*)



## Wasps (Hymenoptera)

Flowers variable in size and shape  
Nectar exposed or hidden  
Pollen in close proximity to nectar source  
Floral color variable  
Nectar guides frequently present  
Odor sweet and strong  
Pollen production minimal  
Nectar production moderate to copious,  
often with high amounts of protein,  
sugars sucrose-dominant.

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Figworts (*Scrophularia* spp.)  
Swamp Parsley (*Oxypolis* spp.)  
Blueberries (some *Vaccinium* spp.)  
Goldenrods (*Solidago* spp.)



## BUTTERFLIES (LEPIDOPTERA)

Flowers radially symmetrical  
and with long floral tubes  
Flowers erect, with flat rim  
for landing  
Nectar hidden  
Pollen at rim or well extended in short-  
tubed flowers  
Floral color bright - often orange or purple  
Odor weak, generally sweet  
Pollen production moderate  
Nectar production moderate to copious  
high in amino acids, sucrose dominant



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Phlox (*Phlox* spp.)  
Butterfly Weed (*Asclepias tuberosa*)  
Yellow Fringed Orchid (*Habenaria ciliata*)  
Thistles (*Carduus* spp.)

## BIRDS (AVES)

Flowers tubular often bilaterally  
symmetrical  
Nectar hidden  
Pollen presented for contact with beak or  
forehead  
Floral color often red  
Nectar guides simple or absent  
Odor absent  
Pollen production moderate  
Nectar production copious and sweet  
sucrose dominant

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Coral Honeysuckle (*Lonicera sempervirens*)  
Fire Pink (*Silene virginica*)  
Columbine (*Aquilegia canadensis*)  
Indian Paint Brush (*Castilleja coccinea*)  
Cross Vine (*Anisostichus  
capreolata*)



## MOTHS (LEPIDOPTERA)

Flowers radially symmetrical and with  
long floral tubes  
Flowers horizontal or pendent, rim absent  
or bent back  
Nectar hidden  
Pollen at rim or well extended in short-  
tubed flowers  
Floral color white or dull  
Odor strong, heavy-sweet at night  
Pollen production moderate at night  
Nectar production copious  
high in amino acids, sucrose dominant

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Angel Trumpet (*Datura* spp. )  
Agave (*Agave virginica*)  
Night-blooming Cereus  
(*Hylocereus undatus*)  
Yucca (*Yucca* spp.)



## BATS (MAMMALIA)

Flowers large, tough, variable in shape  
Nectar hidden  
Pollen presented for contact with forehead  
Floral color white or dull  
Odor strong, often mouse-like  
Pollen production copious at night  
Nectar production copious and sweet  
varied sugar content

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Banana (*Musa* spp.)  
Kapok (*Ceiba pentandra*)  
Calabash (*Crescentia cujete*)  
Saguaro Cactus (*Carnegiea gigantea*)



## SOME DEFINITIONS:

**Actinomorphic Flower**— radially symmetric flower

**Alternation of Generations** — Life cycle characteristic in which a plant organism with two sets of chromosomes, the sporophyte, alternates with a plant organism with one set of chromosomes, the gametophyte

**Angiosperm** —The Flowering Plants, Division of Plants characterized with the flower as a reproductive unit, double fertilization, a more complex vascular system.

**Anther** — site of meiosis, or reduction division, in the flower where pollen (the male gametophyte) is formed

**Anthesis** — anthers releasing pollen – the time of pollen release

**Chasmogamous Flower** — showy, animal pollinated flower

**Cleistogamous Flower** — closed, non-showy selfing flower – never opens

**Cross Pollination** — pollination between two different genotypes

**Dioecy** — male and female flowers on separate plants

**Diploid** — two sets of chromosomes – the sporophytic generation

**Embryo sac** — the female gametophyte

**Fertilization** — the union of the egg and sperm

**Gametes** — the egg and sperm produced by the gametophyte

**Gametophyte** — mature plant with one set of chromosomes

**Haploid** — one set of chromosomes – the gametophytic generation

**Hermaphroditic** — primitive condition in angiosperms, male and female function within the same flower

**Heterostyly** — two flower forms, one with long styles, one with short styles that are cross compatible between forms and cross incompatible within forms

**Illegitimate Pollen** — pollen either from self pollinations in a self-incompatible plant or from pollen of another species - inter-specific pollen that cannot germinate on the stigma or grow through the style

**Incompatibility** — failure of the pollen grain to either germinate on the stigma or grow through the style

*Self Incompatibility* – incompatibility to pollen of the same genotype

*Cross Incompatibility* – incompatibility to pollen from different species

**Monoecy** — male and female flowers separate in the same plant

**Petals** — whorl of colorful derived leaves involved in attraction (collectively known as the corolla)

**Pistil** — female portion of flower made up of stigma, style, and ovary

**Pollen grain** — male gametophyte that carries the sperm nucleus to the female gametophyte

**Pollen vector** – abiotic or biotic elements that effectively move pollen from one plant to another – wind, water, or animals

**Pollination** — the transfer of the pollen grain, the male gametophyte, to the stigma of the pistil of the flower.

**Pollinia** — specialized pollen bearing sac found in the Milkweed and Orchid families

**Protandry** — anthers dehisce first within a flower (male first)

**Protogyny** — stigma is receptive first within a flower (female first)

**Self Pollination** — pollination within the same genotype

**Sepals** — outer whorl, usually protective “leaves,” sometimes also “petaloid” and showy for attraction, collectively known as the calyx

**Spore** — product of meiosis, or reduction division, in the sporophyte that germinates and develops into the gametophyte

**Sporophyte** — mature diploid plant with two sets of chromosomes

**Stamen** — male part of the flower made up of the pollen producing anther and its stalk, or filament

**Stigma** — receptive part of the pistil of the flower

**Stigmatic Clogging** — when illegitimate pollen blocks germination sites for legitimate pollen

**Zygomorphic Flower** — bilaterally symmetrical flower

**Zygote** — the first product of the union of egg and sperm that will develop into the embryo within the seed

## FROM SECTION 11315 POLLINATOR PROTECTION ACT OF 2007

### **(b) Congress finds:**

- many of the crops that humans and livestock consume rely on pollinators for healthy growth;
- pollination by honey and native bees adds more than \$18,000,000,000 annually to the value of United States crops;
- 1/3 of the food supply of the United States depends on bee pollination, which makes the management and protection of pollinators an issue of paramount importance to the security of the United States food supply system;
- colony collapse disorder is the name that has been given to the latest die-off of honey bee colonies, exacerbating the continual decline of pollinators in North America;
- honey bee colonies in more than 23 states have been affected by colony collapse disorder;
- if the current rate of decline continues, the United States will be forced to rely more heavily on imported foods, which will destabilize the food security of the United States through adverse affects on the availability, price, and quality of the many fruits, vegetables, and other products that depend on animal pollination; and
- enhanced funding for research on honey bees, native bees, parasites, pathogens, toxins, and other environmental factors affecting bees and pollination of cultivated and wild plants will result in methods of response to colony collapse disorder and other factors causing the decline of pollinators in North America.

## POLLINATOR GARDENING: POLLINATOR CONSERVATION HANDBOOK

### **Pollinator Gardens:**

- Should incorporate a succession of flowers:
  - that bloom throughout the season
  - that have diverse color and form
  - that are native or heirloom varieties of non-natives
  - that are planted in a clustered pattern
- Should have several different species in bloom at any one time - need overlapping of bloom time
- Should combine annuals and perennials
- Should be free of pesticides
- Could include provisions for the pollinators including::
  - nest boxes for bees
  - extra food for butterflies
  - over-wintering protection for all pollinators

## FOR FURTHER READING:

- Barth, Friedrich G. 1985. *Insects and Flowers the Biology of a Partnership*. Princeton University Press, Princeton, NJ. (great detail on insect senses and behavior with relation to pollination)
- Buchmann, Stephen L. and Gary Paul Nabhan. 1996. *The Forgotten Pollinators*. Island Press, Washington, DC. (a good overview of the previous 15 years of pollination ecology emphasizing community studies and conservation issues )
- Grant, Verne and Karen A. Grant. 1965. *Flower Pollination in the Phlox Family*. Columbia University Press, New York. (a wonderful look at diversification in one flowering plant family)
- Grant, Karen A. and Verne Grant. 1968. *Hummingbirds & Their Flowers*. Columbia University Press, New York. (a closer look at flowers visited by one pollinator group)
- Heinrich, Bernd, 1979. *Bumblebee Economics*. Harvard University Press. (a fascinating account of the economics of foraging and its relationship to pollination; a great synopsis of the Bumblebee life cycle; and overall perspective from the Bumblebee point of view)
- Meeuse, B.J.D. 1961. *The Story of Pollination*. The Ronald Press Co., New York. (Anecdotal and fun!)
- Meeuse, B.J.D. and Sean Morris. 1984. *The Sex Lives of Flowers*. Oxford Scientific Films Ltd. (put together for film, a wonderful look at some of the exotic pollination mechanisms)
- Proctor, Michael., Peter Yeo & Andrew Lack. 1996. *The Natural History of Pollination*. Timber Press, Inc., Portland. (for detailed descriptions of pollinators and their flowers)
- Shepherd, Matthew et al.. 2003. *Pollinator Conservation Handbook*. The Xerces Society Portland Oregon. (emphasis on the conservaton of insect pollinators in NA)
- Waser, Nickolas M. and Jeff Lllerton. 2006. *Plant-Pollinator Interactons: from Specialization to Generalization*. University of Chicago Press, Chicago.(up to date academic overview of pollination ecology)

## WEB SITE RESOURCES:

**XERCES.ORG** — international nonprofit organization dedicated to protecting biological diversity through invertebrate, including pollinator, conservation - includes specific fact sheets on pollinator gardening, pollinators and agriculture, and individual stories of pollination.

**COEVOLUTION.ORG** — The Coevolution Institute, a non-profit organization with the mission to catalyze stewardship of biodiversity

**NAPPC.ORG** — North American Pollinator Protection Campaign with the mission to encourage the health of resident and migratory pollinating animals in North America

**POLLINATOR.ORG** — The Pollinator Partnership sponsored by the North American Pollinator Protection Campaign and the Coevolution Institute dedicated to education about the importance of pollinators - an impressive listing of resources including a pollinator curriculum for grades 3-6