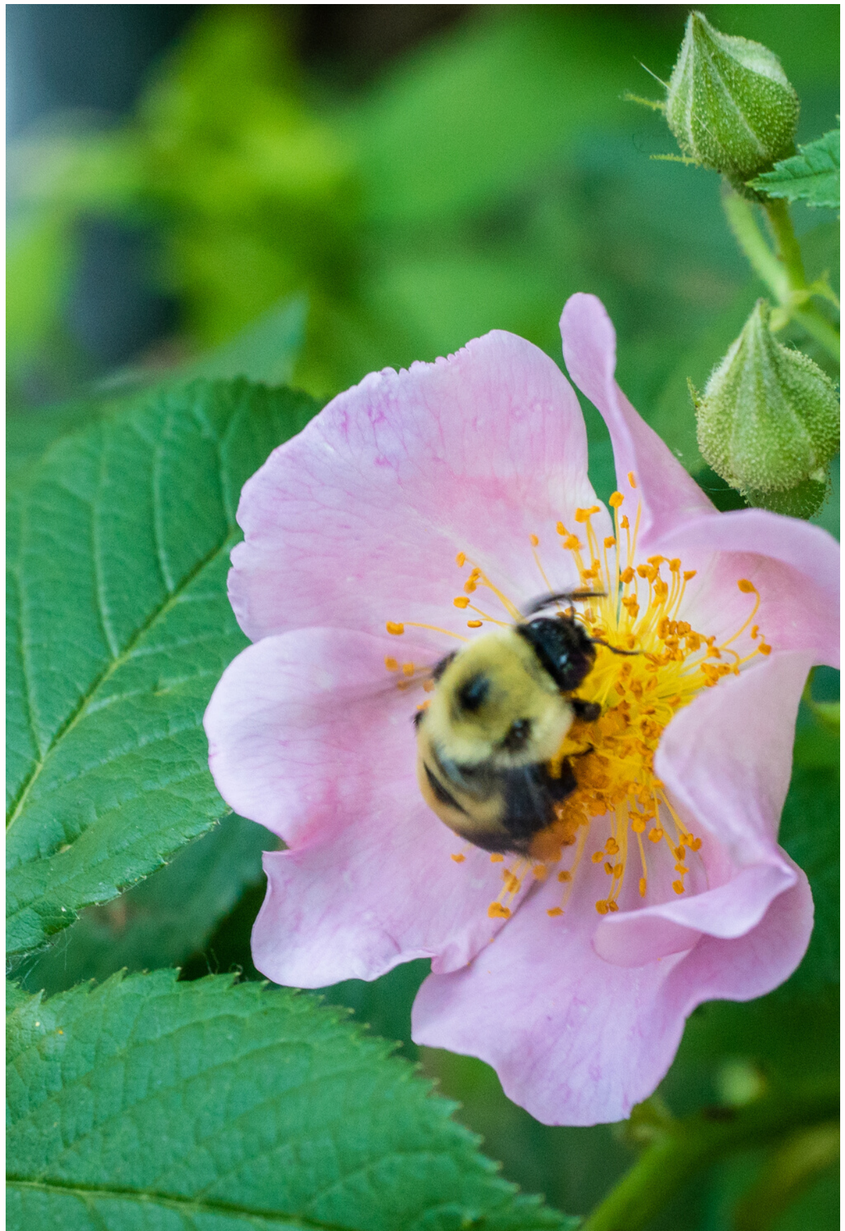
OBSERVING POLLINATOR RELATIONSHIPS



PHILADELPHIA
ORCHARD PROJECT

OVERVIEW OF LESSON

OVERVIEW

- Intro to POP / Food Forest Orchards
- Evolution of Plants
  - Parts of A Flower (Moncot / Dicot)
  - LIFE CYCLE of Flowering Plants
- What is POLLINATION? How does it happen?
- What is a POLLINATOR?
- How do flowers attract pollinators?
  - Flower Shapes, Colors, & Forms
- Types of Pollinators
  - Bees, Caterpillars/Butterflies, Moths, Wasps, Flies, Beetles, Birds, Bats
- Threats to Pollinators
- Importance of Building Habitat
- ACTIVITY: Observing Pollinators in Action & Graphing

CONTENT STANDARDS

PA SCIENCE CONTENT STANDARDS

ELEMENTARY

- Kindergarten:
  - SWBAT: Use a simple thermometer, rain gauge, and wind gauge to measure temperature, precipitation, and wind strength and direction
  - SWBAT: recognize observable physical attributes of living organisms and identify how it helps them move, eat, survive
  - SWBAT: use observation skills to describe similarities and differences in the appearance of living things
  - SWBAT: compare and understand the difference in various habitats of animals
  - SWBAT: identify ways that animals depend on plants for food or shelter, understand the important role plants play in our world
- First Grade:
  - SWBAT: read a thermometer to determine temperature inside/outside and record a daily temperature log
  - SWBAT: create a graph or table to organize and compare data they collected
  - SWBAT: analyze a graph to answer questions related to the data
  - SWBAT: utilize a scientific notebook to record predictions, questions, observations about data with pictures, numbers or in words

CONTENT STANDARDS

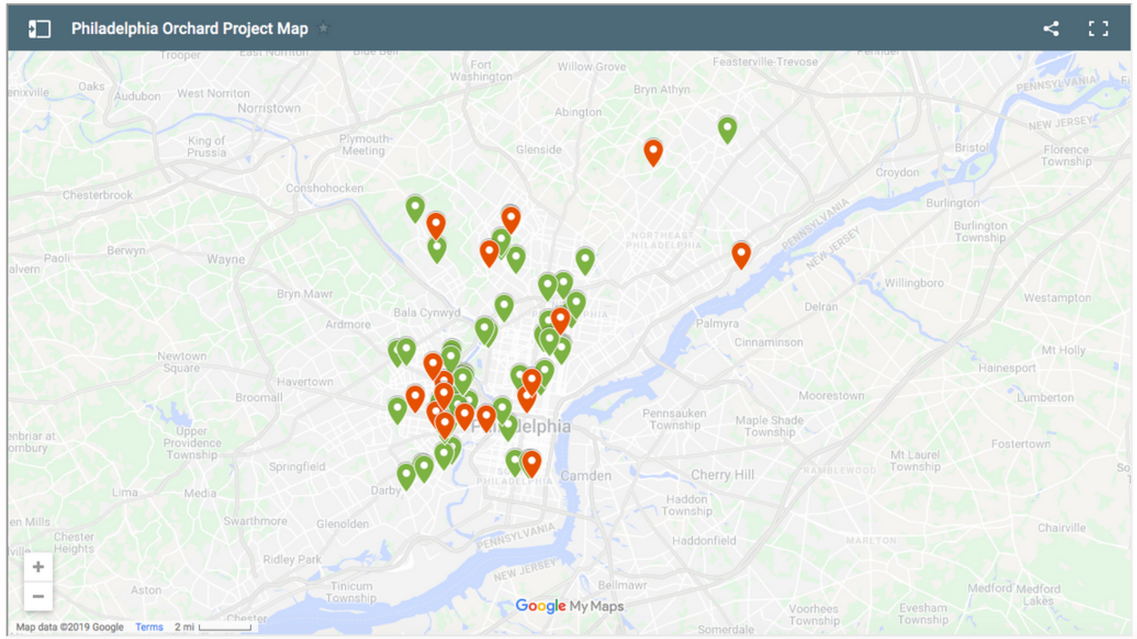
PA SCIENCE CONTENT STANDARDS

- SWBAT: use their observation skills to describe similarities and differences in the appearance of living things / animals

- Second Grade:
  - SWBAT: observe, record, and compare physical characteristics, and behaviors of animals and understand how they meet their basic needs in an ecosystem
- Fourth Grade:
  - SWBAT: analyze the structures of plants and determine how plants meet their needs
  - SWBAT: identify and describe similarities and differences in the structures of various animals and describe how different structures can perform the same function
- Sixth Grade:
  - SWBAT: conduct investigations of plant or animal growth and behavior, observe and compare environmental factors such as light, temperature, soil, and water that affect organisms
- Eighth Grade:
  - S8.A.3.2.1: Describe how scientists use models to explore relationships in natural systems
  - S8.B.3.2.2.: Use evidence to explain how diversity affects the ecological integrity of natural systems
- High School
  - CHEM.A.1.1.2: Classify observations as qualitative or quantitative
  - BIO.B.4.2.4.: Describe how ecosystems change in response to natural and human disturbances
  - BIO.B.4.2.4: Describe interactions and relationships in an ecosystem

INTRO TO THE PHILADELPHIA ORCHARD PROJECT

POP has planted orchards with a diverse range of community-based organizations throughout Philadelphia.

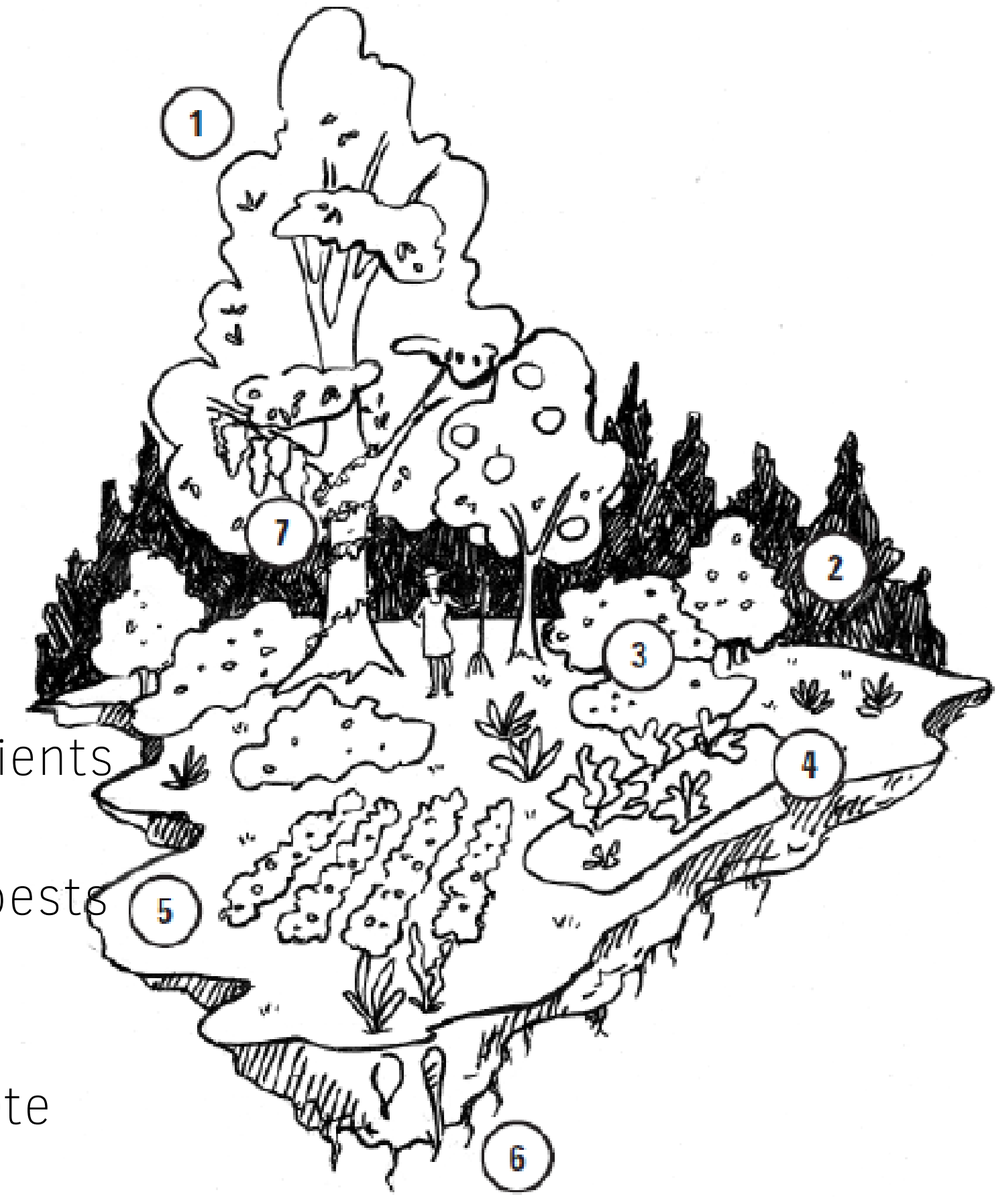


65 COMMUNITY ORCHARDS
PLANTED WITH FRUIT TREES, SHRUBS, PERENNIAL HERBS/FLOWERS & POLLINATOR GARDENS IN PHILLY

WWW.PHILLYORCHARDS.ORG

WHAT IS A FOOD FOREST?

- Designed like a natural forest ecosystem
- Varied harvests through seasons!
- Plants selected for multiple jobs
  - FOOD
  - MEDICINE
  - SOIL BUILDING
    - fixing nitrogen, drawing nutrients
  - ATTRACTING POLLINATORS!
    - providing habitat, repelling pests
  - BEAUTY
    - form, texture, color, bloom through seasons, out-compete weeds

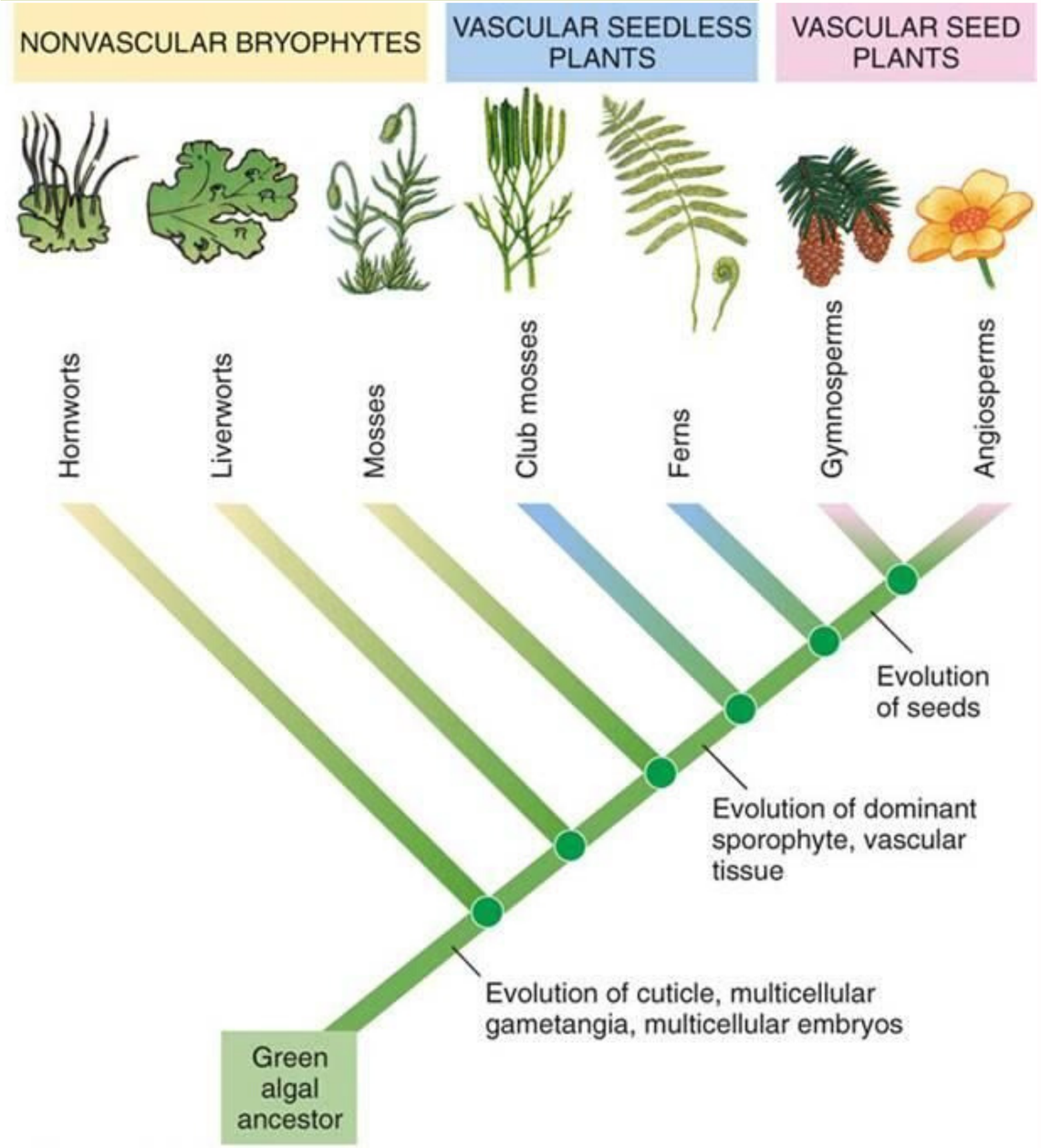


LAYERS OF A FOOD FOREST

1. **Canopy**
   Large Fruit & Nut Trees
2. **Low Tree Layer**
   Dwarf Fruit Trees
3. **Shrub Layer**
   Berry Bushes & useful Shrubs
4. **Herbaceous**
   Flowers, Herbs & Vegetables
5. **Soil Surface**
   Low-Growing Ground Covers
6. **Root Layer**
   Fungi and Root Vegetables
7. **Vertical Layer**
   Vines & Espaliers

EVOLUTION OF PLANTS

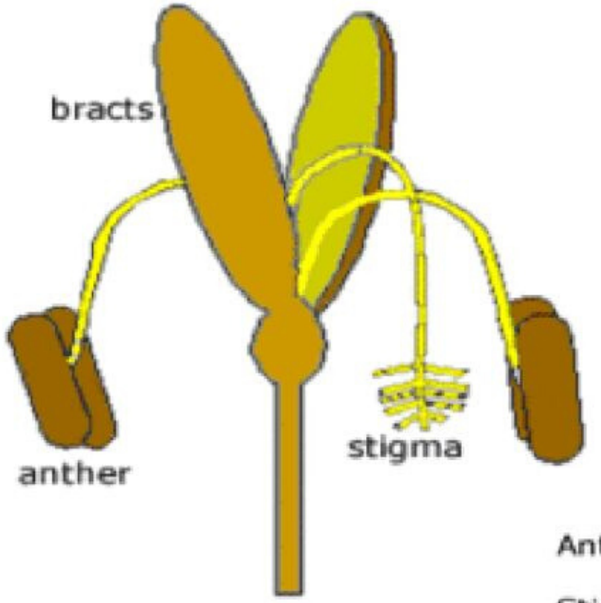
05



- FOUR MAJOR PERIODS OF PLANT EVOLUTION
  - 425 million years ago/ AQUATIC / MOSSES
    - plants evolved from algae with formation of cuticle and tube-shaped vascular tissue
  - 400 million years ago / LACKING SEEDS / FERN
  - 360 million years ago / NAKED SEEDS/ CONIFER
    - seeds not protected by coating
  - 130 million years ago / FLOWERING PLANTS / ANGIOSPERMS
    - seeds protected within fruits

http://botanystudies.com/four-major-periods-of-plant-evolution/ text

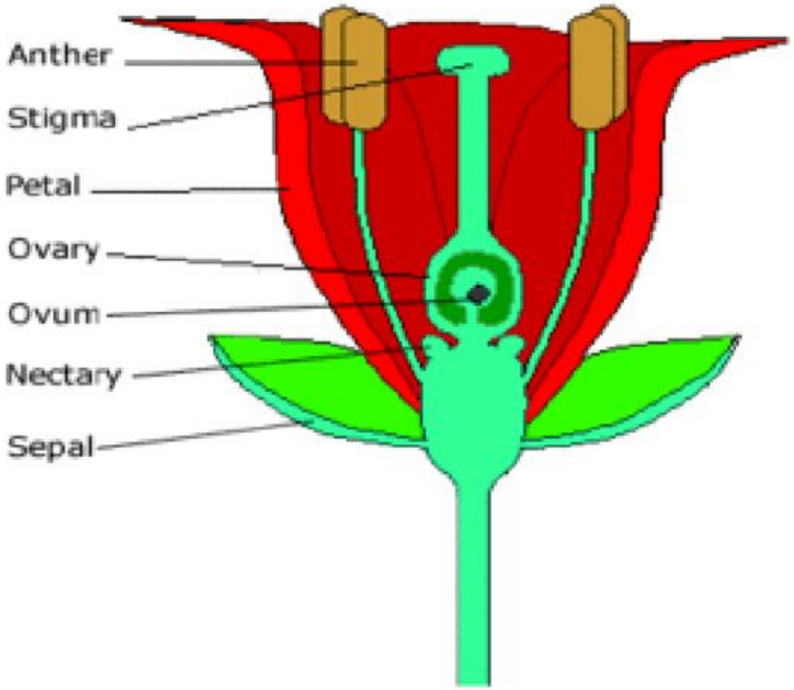
ANGIOSPERM FLOWER STRUCTURE



Wind pollinated

DICOT

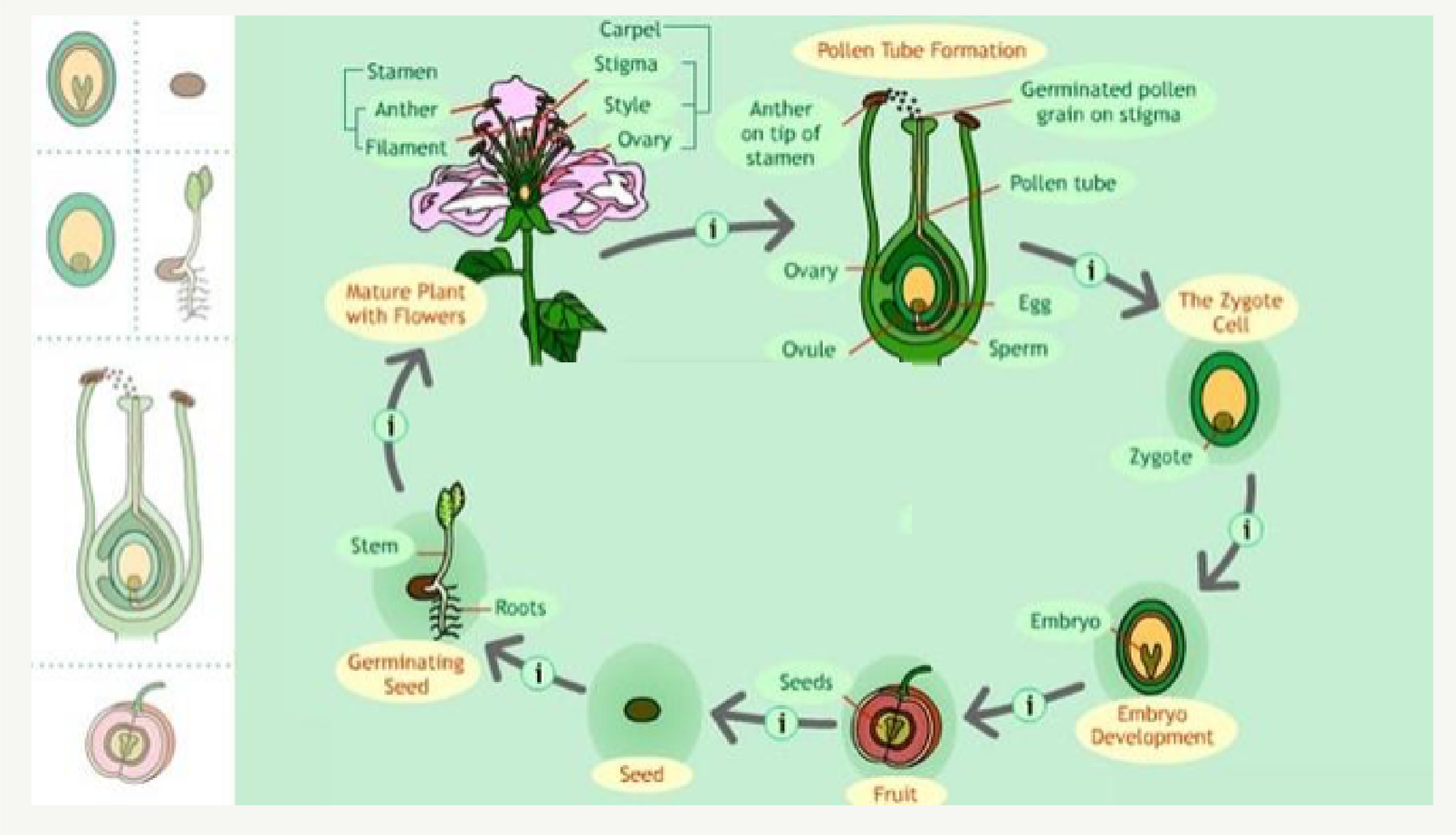
MONOCOT



Insect pollinated

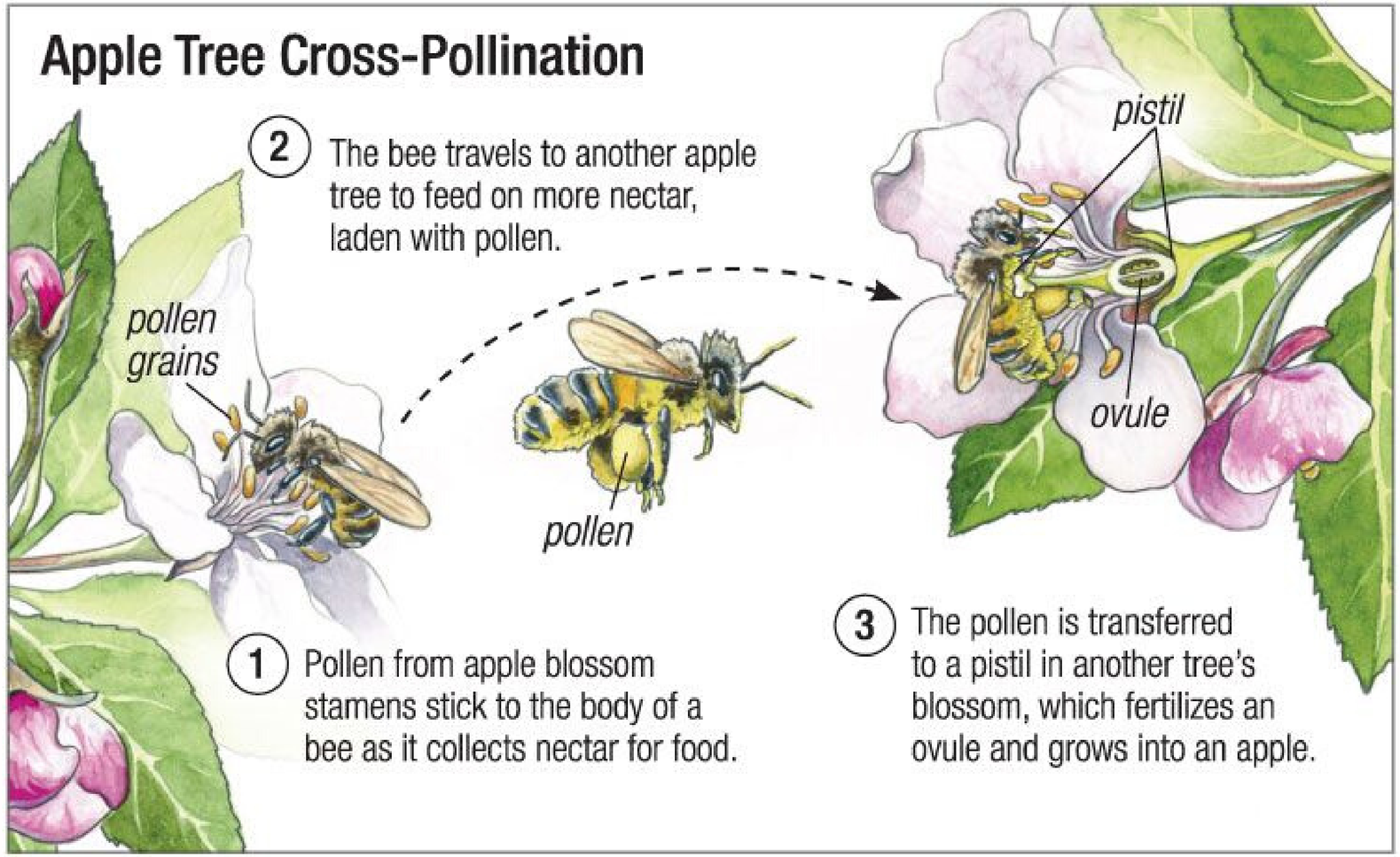
- DEFINITIONS:
  - Anther: the part of the **stamen** (male reproductive part) that contains POLLEN
  - Stigma: the sticky part of the **pistil** (female reproductive part) where the pollen attaches and germinates
  - Bracts: a specialized papery leaf in grass-family plants akin to petals
  - Petals: modified leaves that surround the reproductive parts of a flower, often brightly colored. Petals are collectively called the **corolla**.
  - Sepal: a modified leaf in flowering plants found on the outermost part of the flower that protect the flower in the bud
  - Ovary: part of the female reproductive organ of the pistil that holds the **ovule(s)**
  - Ovum: the egg cells in the ovary that become fruit
  - Nectary: the sugar-rich liquid produced by plants to attract animals to pollinate or protect the plant from being eaten

LIFE CYCLE OF A SEED PLANT



https://www.pbslearningmedia.org/resource/lsps07.sci.life.stru.seedplant/life-cycle-of-a-seed-plant/

WHAT IS POLLINATION?



Pollen is produced in stamens, or the male part of flowers, and must be transported to the pistils, or female part. After fertilization, the ovary begins to ripen into fruit. For successful pollination, blossoms on compatible tree varieties must appear at the same time. Wind and insects then transfer the pollen, with bees being the most effective method.

- **Pollination** is the process in by which pollen from the **stamen** (male part of the flower) is transfered to the **pistil** (female part of the flower) where it becomes **fertilized** in the **ovary** becoming the fruit or seed for the next generation

- Some plants are **self-fertile** meaning they can produce fruit by themselves, others require **cross-pollination** between plants. Some plants have mechanisms to prevent self-pollination (in-breeding).

- The relationships between flowers and their pollinators is an example of coevolution. Plants use their color, scent, and flower shape to attract pollinators that will help in the transfer of their pollen. Look to the red text on the following slides to learn more about these plant traits!

WHAT IS A POLLINATOR?

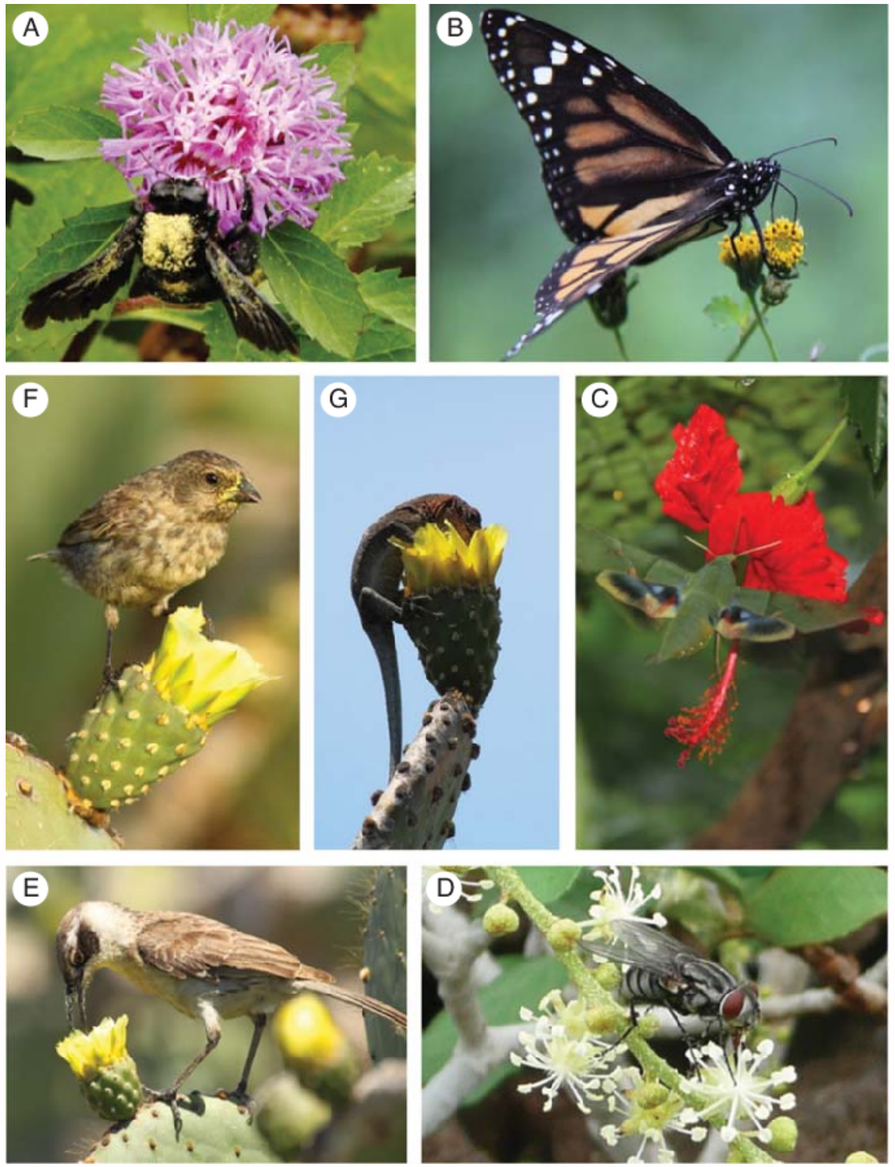
- A pollinator is any animal or insect that helps to carry pollen from the male part of the flower to the female part of the same flower or another flower. The movement of pollen when fertilized becomes fruits, seeds, and young plants.

- The sticky pollen can be carried by the bodies of these creatures as they visit plans for drinking, feeding, laying their young, or looking for shelter.

- Pollinators are as important as SUNLIGHT, SOIL, and WATER and are crucial for the success of 75% of the world's flowering plants including most fruits, nuts and berries.

- Over 150 crops in the U.S. including blueberries, apples, almonds, oranges, squash, and tomatoes depend on pollinators.

- Pollinators can include bats, beetles, flies, butterflies, bees, birds, and more!



https://www.fws.gov/pollinators/pdfs/pollinatorbookletfinalrevweb.pdf

https://www.researchgate.net/figure/Examples-of-flower-visitor-interactions-not-yet-described-in-the-Galapagos-All-pictures_fig1_225302433

HOW DO FLOWERS ATTRACT POLLINATORS? FLOWER SHAPE, COLOR, FORM

Focusing upon 6 most observable classes of pollinators

- The relationship between flowering plants and the insects/animals that interact with them is an example of co-mutualistic coevolution. Co-evolution is the biological process whereby two or more organisms evolve together.

- Flowering plants' color, shape, form, scent, and blooming patterns help them attract their pollinating species. Pollinators may have specialized mouth parts for collecting nectar from the plants they visit!

- Let's examine the relationship between plants and their pollinators!

10

BEES

Are attracted to WHITE, YELLOW, BLUE, PURPLE flowers with contrasting U.V. patterns and fresh, mild, or sweet scented flowers.

Common flower shape/family: Disc/Aster* 5-petalled Open-Center/Rose*, Lipped Flowers with Landing Platform/Pea Family / Mint*

BUTTERFLIES

Are attracted to BRIGHT RED, PURPLE, and ORANGE flowers with a faint or fresh scent. Often LONG/TUBE shaped flowers that they can draw nectar up with proboscis.

Common flower shape/family: Tube/Honeysuckle Family*, Composite Disc / Aster*, Tubed Clusters / Lilac Family

MOTHS

Are attracted to PALE WHITE, YELLOW tube or BELL SHAPED flowers that bloom at night and have a strong, perfumed scent (Datura, primrose, night-blooming tobacco)

Common flower shape/family: Tube/Honeysuckle Family*, Primrose Family*

HOW DO FLOWERS ATTRACT POLLINATORS? FLOWER SHAPE, COLOR, FORM

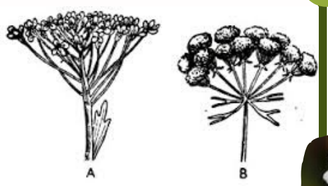


Fig. 79. A—corymb of *Iberis* (Candytuft); B—compound umbel of coriander.

WASPS

Are attracted to CLUSTERS of small WHITE, CREAM, and YELLOW flowers with a sweet or neutral scent (ex. fennel, dill, parsley, mint, yarrow)

Common flower shape/family: Umbel/Parsley Family*, Lobed/Mint, Corymb / Aster Family*

FLIES

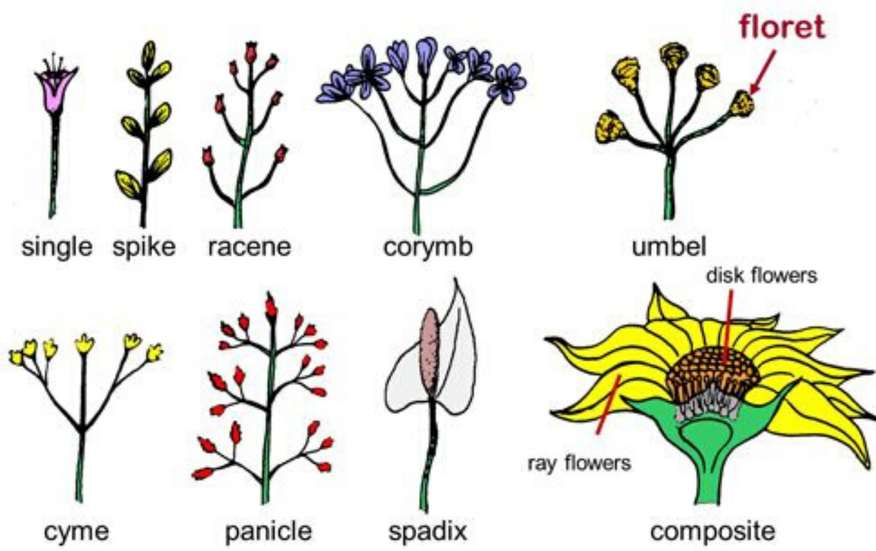
Are attracted to PALE, DULL, dark PURPLE and BROWN flowers with a FUNNEL or TRAP shape, and scent of decay like blood, rotting meat, dung, or sap.

Common flower shape/family: Reverse Bell-Shaped / Custard Apple Family (Paw Paw)*, Trap/Spadix / Arum (Jack in Pulpit)*, Umbel / Parsley Family

BEETLES

Are attracted to YELLOW, ORANGE, WHITE day-blooming flowers that are large and solitary. Often bowl-shaped flowers that have exposed sexual organs or small clusters of small flowers (goldenrods, spirea).

Common flower shape/family: Bowl Shaped Flowers/Squash Family*, Spike-Small Disc / Aster Family



TYPES OF POLLINATORS: BEES

HONEYBEE
(APIS MILLIFERA)

- Oval-shaped with bands of yellow-black, brown
- Live in Queen-led colonies
- Forage for nectar/pollen

BUMBLEBEE
(BOMBUS SPP.)

- Larger than honeybee
- Appear fuzzy due to pile covering on body
- Store nectar and pollen in colony wax cells

SWEAT BEE
(AGAPOSTEMON SPLENDENS)

- Smaller than honeybee
- Known for their metallic coloring
- Attracted to sweating
- Solitary and live underground
- Pollinate stone fruit, apples

DISTINGUISHING CHARACTERISTICS:

- Over 16,000 known species
- Short, thick bodies covered with hair
- 6 legs and three body parts: head, thorax, abdomen
- two pairs of wings
- antennae
- mandibles (chew), proboscis (suck)
- range in size from 0.08 inch long to 1.54 inches
- Tend to visit nectar & pollen-rich white, purple, blue, yellow flowers

TYPES OF POLLINATORS: CATERPILLARS/BUTTERFLIES

MONARCH
(DANAUS PLEXIPPUS)

- Wings have a black, orange, and white pattern
- Migrates in late summer
- Feeds on milkweed

CLOUDED SULPHUR
(COLIAS PHILODICE)

- Pale yellow wings trimmed in brownish-red
- Gather at mud puddles
- Feeds on alfalfa, clover, and dandelion

SPICEBUSH SWALLOWTAIIL
(PAPILIO TROILUS)

- Black wings with colorful tips
- Found in deciduous woods or woody swamps
- Feed on jewelweed and honeysuckle

DISTINGUISHING CHARACTERISTICS:

- 750 species have been reported in North America
- Wings are covered with tiny scales
- 3 jointed legs and a three-part body
- two pairs of two wings
- antennae
- proboscis for sucking nectar
- range in size from 0.5 inch to 6 inches
- Tend to visit nectar-rich plants with groupings of flowers, rather than a few blooms

TYPES OF POLLINATORS: MOTHS

INTERRUPTED DAGGER MOTH *(ACRONICTA INTERRUPTA)*

- Wings have a grey, lacy pattern
- Adults are alive from April to September
- Feed on many fruit trees

PALE BEAUTY *(CAMPAEA PERLATA)*

- Pale green to grayish white
- Females are larger than males
- Feeds on both coniferous and deciduous trees

SMALL-EYED SPHINX *(PAONIAS MYOPS)*

- Brown and orange moth with doubly-indented wings
- 1 to 4 generations per year
- Feeds on trees such as birches and hawthorns

DISTINGUISHING CHARACTERISTICS:

- 12,000 species have been reported in North America
- unlike butterflies, antennas are feathered
- 3 jointed legs and a three-part body
- two pairs of two wings
- thick, hairy bodies
- when perched, their wings lie flat
- tend to be nocturnal
- Moths' hairy bodies make them very good at picking up pollen when they move around

TYPES OF POLLINATORS: WASPS

PAPER WASP
(POLISTES SPP)

- Gather fibers from wood and plants
- Feed on garden pests
- Generally not aggressive unless the nest is attacked

EASTERN CICADA-KILLER
(SPHECIUS SPECIOSUS)

- Black to reddish brown with light yellow stripes
- Males cannot sting
- Prefer full sun areas with little vegetation

GREAT BLACK WASP
(SPHEX PENSYLVANICUS)

- Found across the continental U.S. and northern Mexico
- Adult females build underground nests
- Important milkweed pollinator

DISTINGUISHING CHARACTERISTICS:

- 30,000 identified species
- unlike bees, wasps can sting repeatedly
- 3 jointed legs and a three-part body
- two pairs of wings
- some live in self-contained colonies, many are solitary
- feed meat to their young
- wasps have slimmer waists than bees
- Many pest insect species are hunted by wasps, which helps diminish pest populations

TYPES OF POLLINATORS: FLIES

BEE-LIKE TACHINID FLY *(HYSTRICIA ABRUPTA)*

- Feed on caterpillars of moth species
- Red and black bodies
- Tend to stay in flowers around marshy areas

BLACK HORSE FLY *(TABANUS ATRATUS)*

- Females feed on blood, but males on nectar
- Can be up to an inch long
- Females lay eggs close to water sources

COMMON GREENBOTTLE FLY *(LUCILIA SERICATA)*

- Pollinate vegetable crops, such as broccoli and kale
- Lifecycles used by forensic teams
- Larvae are dangerous to sheep

DISTINGUISHING CHARACTERISTICS:

- 20,000 reported species in the United States
- 3 jointed legs and a three-part body
- two pairs of wings
- not as hairy as bees
- some plants meant for other pollinators trap smaller flies
- many fly pollinators mimic bees in their looks
- Flies tend to pollinate flowers with more putrid smells, which are reminiscent of meat or sap

TYPES OF POLLINATORS: BEETLES

RED-NECKED FALSE BLISTER BEETLE *(ASCLERA RUFICOLLIS)*

- All black with red head
- Have toxic chemical defenses
- Prefer wooded areas

LOCUST BORER BEETLE *(MEGACYLLENE ROBINIAE)*

- Resembles a wasp or hornet
- Often visit goldenrod flowers
- Prefer uncultivated fields

VALLEY ELDERBERRY LONGHORN BEETLE *(DESMOCERUS CALIFORNICUS DIMORPHUS)*

- Feed on elderberry leaves and flowers
- Soon to be endangered

DISTINGUISHING CHARACTERISTICS:

- 25,000 reported species in the United States
- 3 jointed legs and a three-part body
- one of the first evolved insect pollinators
- capable of color-vision
- important pollinators for ancient tree and other plant varieties
- Typically visit flowers that open during the day, have a strong, fruity smell, and are white to yellow-green

TYPES OF POLLINATORS: BIRDS

RUBY-THROATED HUMMINGBIRD *(ARCHILOCHUS COLUBRIS)*

- Can stop instantly and hover when flying
- Visit tube-shaped flowers
- Prefer open meadows

BALTIMORE ORIOLE *(ICTERUS GALBULA)*

- Feed on flower nectar and ripe fruit
- Spend a lot of time in trees
- Are often found in stands of trees along rivers

WOOD THRUSH *(HYLOCICHLIA MUSTELINA)*

- Very melodious songbird
- Prefer deciduous forests near a water source
- Feed on ants, fruits, and berries

DISTINGUISHING CHARACTERISTICS:

- 2,000 birds species that feed on pollen or nectar
- prefer tube or cup shaped flowers
- hummingbirds are by far the most important bird pollinators in the United States
- important pollinators for native wildflowers
- do not pollinate commercial crops in North America
- Birds have a poor sense of smell so are not attracted to flowers based on their scent.

TYPES OF POLLINATORS: BATS

LESSER LONG-NOSED BAT *(LEPTONYCTERIS YERBABUENAE)*

- Males and females are almost indistinguishable
- Summer migrants in the United States

RED FRUIT BAT *(STENODERMA RUFUM)*

- Feed on ripe fruit with the flesh exposed
- Threatened species
- Found mostly in Puerto Rico

MEXICAN LONG-TONGUED BAT *(CHOERONYCTERIS MEXICANA)*

- Feeds on nectar, pollen, and various fruits
- Found in the Southern United States

DISTINGUISHING CHARACTERISTICS:

- 45 bat species in the U.S., and many are threatened
- pollinate flowers open at night as bats are nocturnal
- very important pollinators in tropical / desert climates
- pollinate large flowers that are white or pale in color
- are attracted to very fragrant flowers with fermented scents
- Bats are the primary pollinators for many tropical fruits, such as mangoes, bananas, and guavas.

THREATS TO POLLINATOR SPECIES

- Overuse of pesticides -- especially neonicotinoids, a class of neuro-active insecticides that disrupts the central nervous systems of insects and commonly found on seed coatings (corn, soy, ornamental plants) and as a pest-management spray
- Warming climate -- interfering with migration patterns and pollinator food supply
- Habitat loss, fragmentation, and destruction (ex. loss of host plants like milkweed for monarch populations)
- The rolling-back of conservation legistation protecting the environment for diverse animal and insect species

WAYS TO SUPPORT POLLINATOR HABITAT

- Promoting awareness and advocacy efforts around restoring habitat and food supply for pollinator species.
- Reducing use of pesticides in the environment and advocating for natural controls (birds, special insects).
- Creating densely planted habitats of multi-purpose, native plants that provide a long bloom window for pollinators.
- Planting urban forage zones for pollinators including backyard gardens, green roofs, planted boulevards to support pollinator diversity.
- Consider replacing turf lawns with nitrogen-fixing groundcovers and bee-forage with white clover.

Are you ready to observe pollinator relationships in your orchard?

Grab your notebooks and observation sheets, and let's go outside!