





Pollinators and Plants

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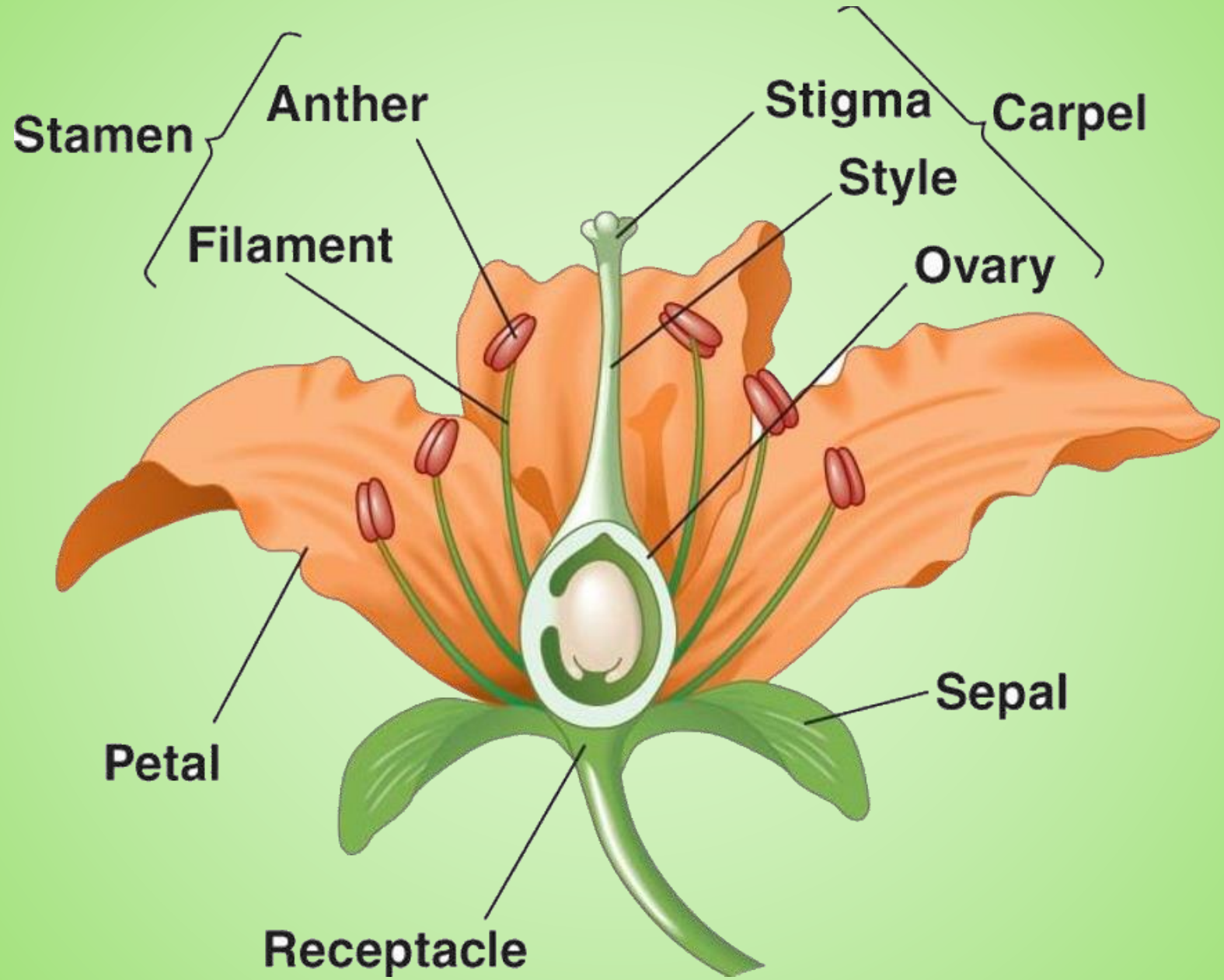
Plant Diversity

Gymnosperms naked-seed	Ferns seedless vascular	Bryophytes nonvascular	Angiosperms flowering
			

Angiosperms

- ▶ Seed plants
- ▶ Special characteristics – flowers, fruits and life-cycle.
- ▶ Last to arise, but most successful of the groups (presently)
- ▶ The evolution of angiosperms includes the specialized relationships between flowers and their pollinators
- ▶ Co-evolution of plants and their insect pollinators drove both groups to diversify unusually rapidly
- ▶ Angeion = vessel; sperma = seed
- ▶ Many variations in flower structure

Idealized flower structure



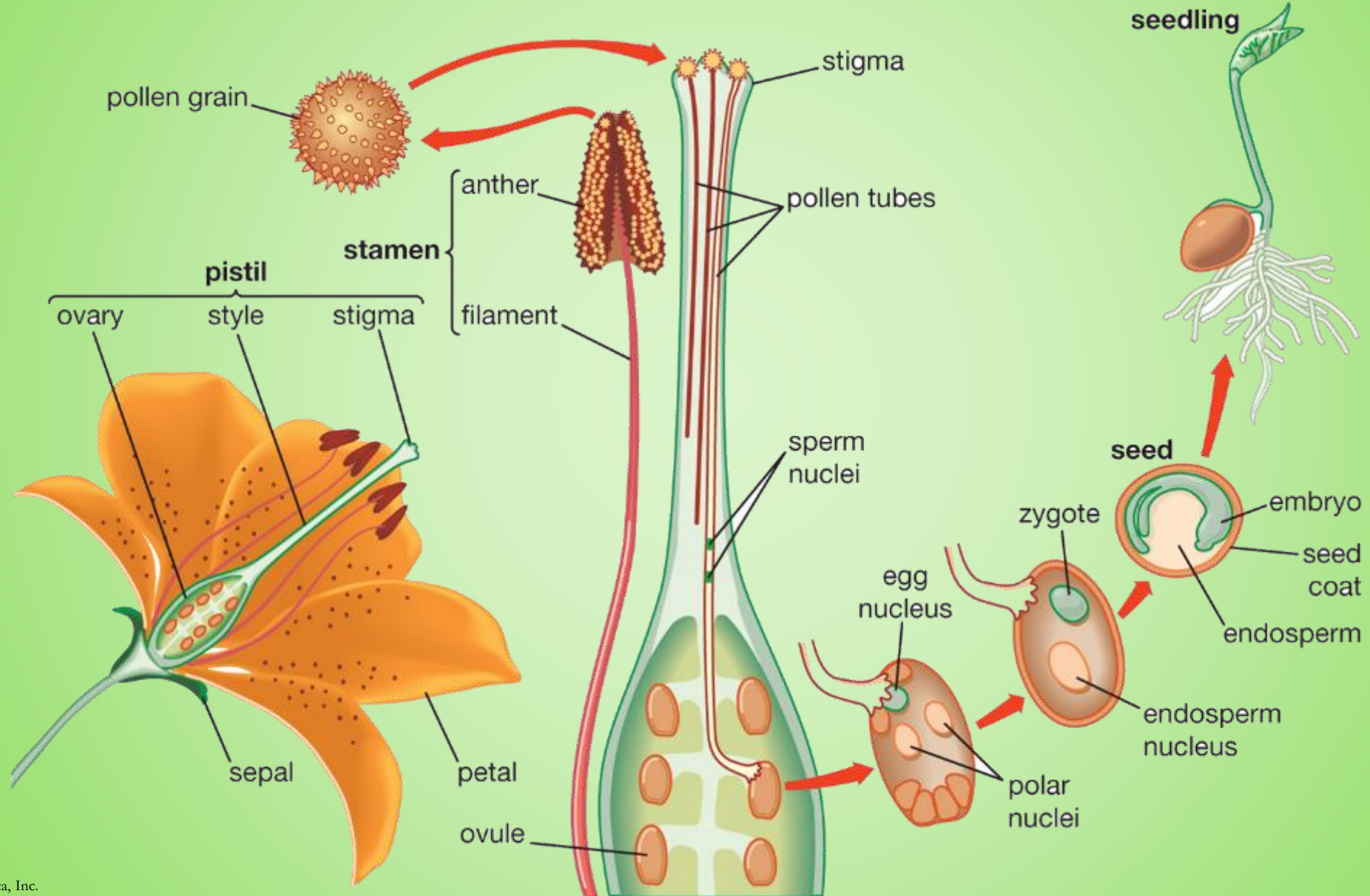
Inflorescence



- ▶ A group or cluster of flowers arranged on a stem
- ▶ They present the flowers (florets) such that pollination is facilitated
- ▶ The term was introduced by Linnaeus, he also introduced many of the terms for the various types of inflorescences (e.g., raceme, panicle, etc.)



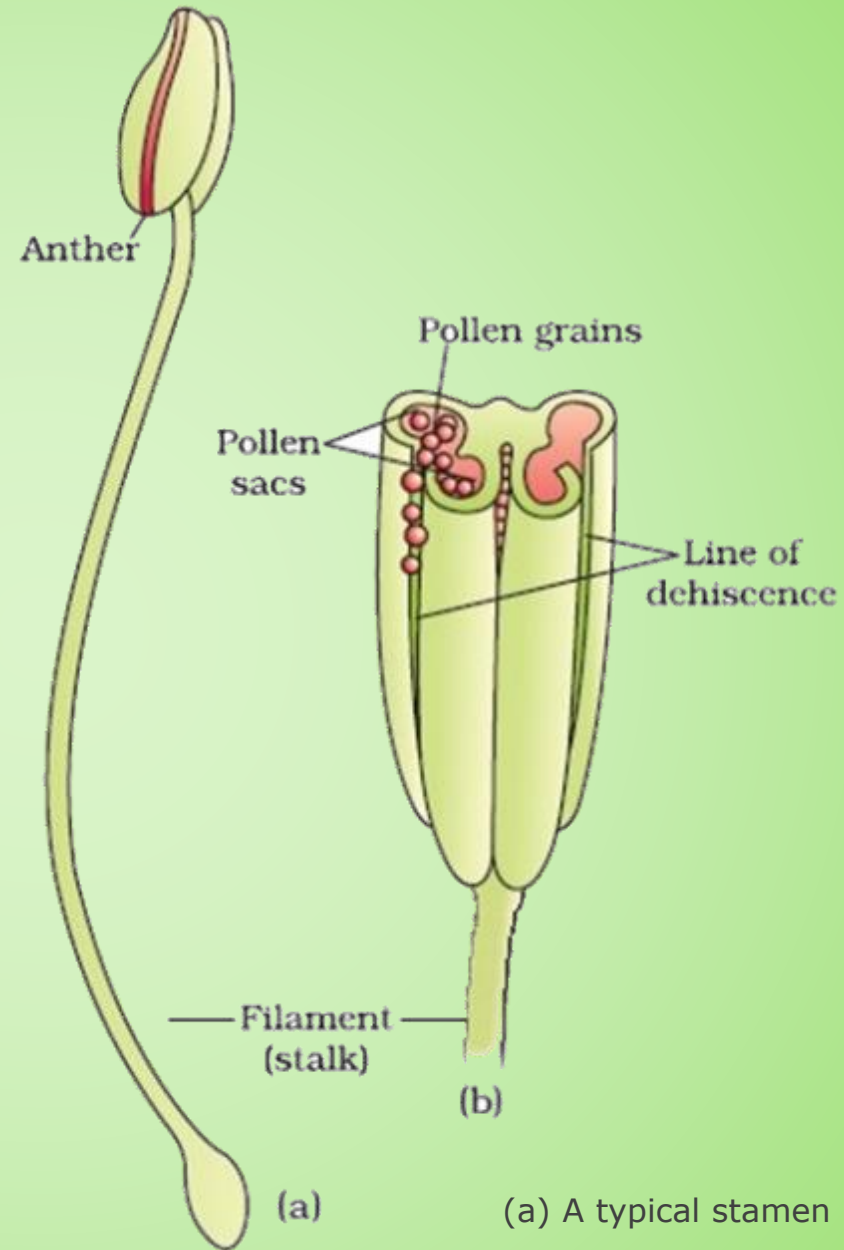
How flowering plants reproduce



Stamen structure

Anthers are usually two-lobed and attached to the filament at the base or middle of the anther.

Anther **dehiscens** – forms openings, to release the pollen

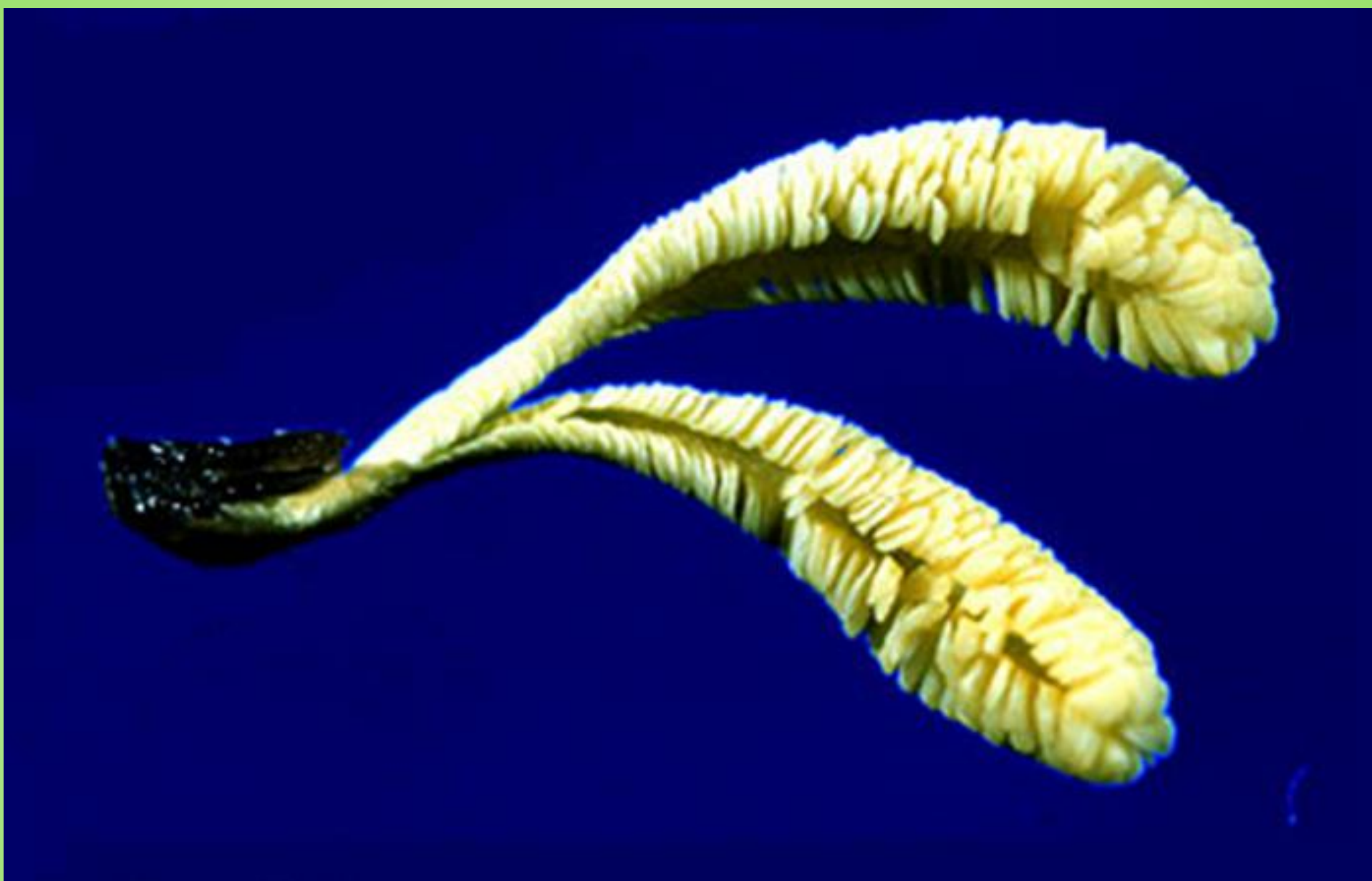


(a) A typical stamen

(b) three-dimensional cut section of an anther

Tulip anther with grains
of pollen





Pollinium (pl. **pollina**) – a mass of pollen produced in each anther lobe.
Produced by Orchidaceae and Asclepiadaceae .





Closeup of a *Melissodes trinodis* Robertson (Hymenoptera: Apidae) leg with attached pollinia.

Pollination syndromes

- ▶ **A collection of flower traits that have evolved through natural selection in response to different vectors**
- ▶ **Convergent evolution** - based on environment and pollinators has produced many similar forms in distantly related species
- ▶ Some pollination is general, some is specialized. There are advantages and disadvantages to both.
 - ▶ **General** – pollinators in an area may fluctuate, insures pollination
 - ▶ **Specialized** – very efficient, nectar and pollen is expensive to make, esp. pollen, which is high in nitrogen. Pollinator is constant.

Charles Darwin predicted the existence of an (at the time) unknown insect with a very long proboscis, based on the morphology of the flower of the *Angraecum sesquipedale* orchid. The moth was discovered 21 years after his death.



Anemophily

- ▶ **Wind pollination** – no need to waste energy on showy petals, pigments or fragrance. Flowers can be small. Pollen may be small but will be made in large quantities
- ▶ Stamen are usually long, stick out of or hang down from the flower to be exposed to the wind
- ▶ Stigmas can be feathery to increase surface area.
- ▶ Gymnosperms are wind pollinated
- ▶ Grasses, sedges, rushes and many tree species such as oak, elm, hickory, etc.
- ▶ Approximately 12% of all plant species are wind pollinated.

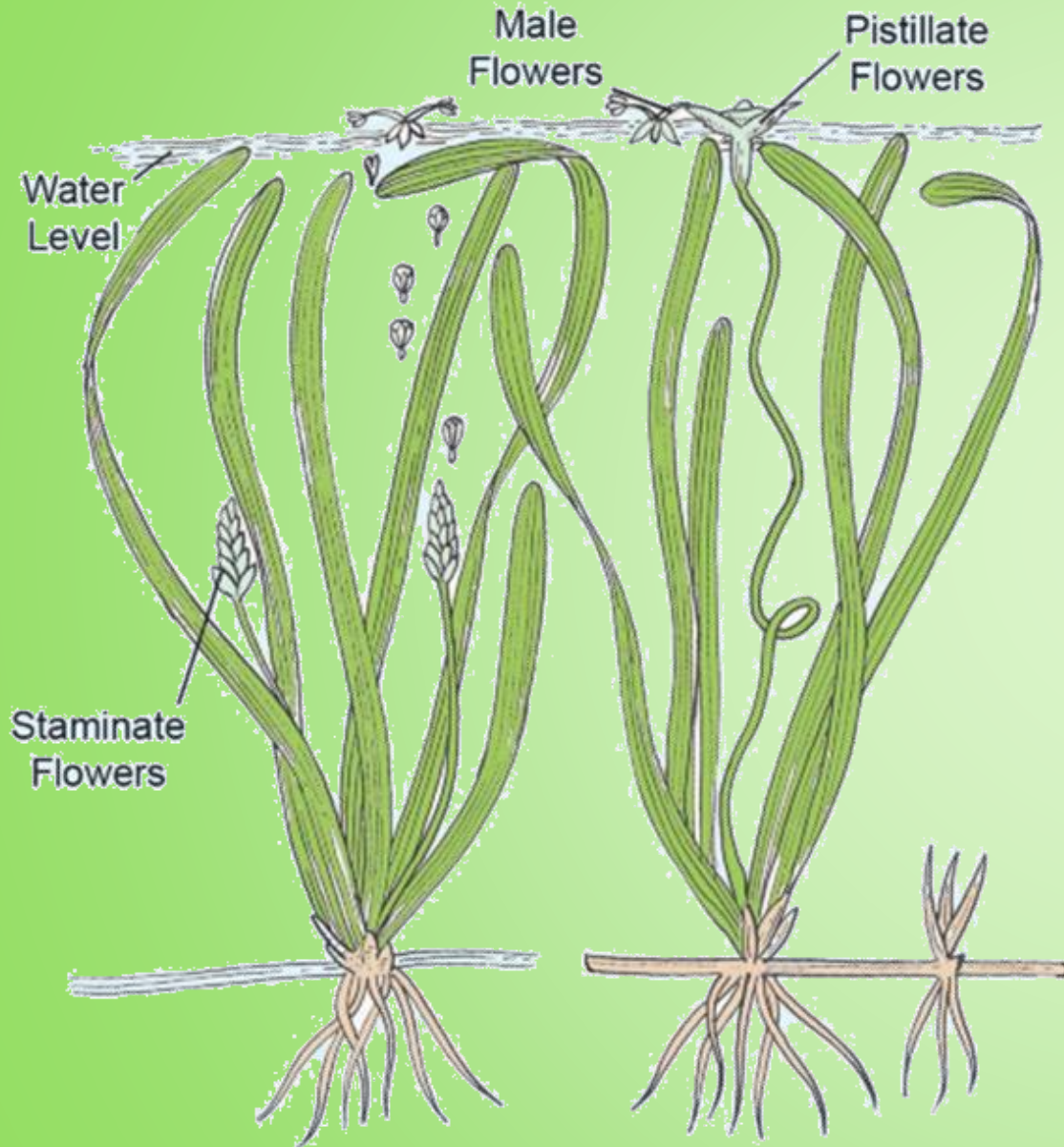


Cynodon dactylon, Bermuda grass



Quercus acutissima, Sawtooth oak

Hydrophily



- ▶ **Water pollinated** – for aquatic species, water currents acts similarly to wind
- ▶ Flowers small and inconspicuous, copious amounts of pollen, feathery stigmas
- ▶ Not common. Most aquatics are insect pollinated
- ▶ *Potamogeton crispus*, *Zostera* (eel grass), *Hydrilla verticillata*, *Ceratophyllum*

Pollinators

- ▶ Pollinators are essential as over 85% of flowering plant species depend on them for reproduction
- ▶ They are keystone species in many terrestrial ecosystems
- ▶ Fruits and seeds are a major part of the diet of birds and mammals
- ▶ They help maintain genetic diversity
- ▶ Plants provide clean air and carbon cycling
- ▶ Plants help maintain soil and water quality

Pollinators

- ▶ Two thirds of the world's crops are dependent on pollinators
- ▶ Over 100 crops in the US depend on them
- ▶ Many of the oils we use are from animal pollinated crops (sunflowers, canola, etc)
- ▶ Many of the foods we eat depend on pollinators – apples, strawberries, blueberries, etc.
- ▶ Alfalfa and clover which is feed to livestock, depend on pollinators
- ▶ Medicinal plants
- ▶ Plant-based dyes
- ▶ Beauty!

Animals (Zoophily)

- ▶ The form of pollination where the pollen is transferred by animals
- ▶ Usually it is insects, but other animals can be pollinators also.



Black lemurs have a taste for the nectar and pollen of the traveler's palm



Bats (Chiropterophily)



A lesser long-nosed bat pollinates a cross section of a saguaro cactus flower.

Our bats are not
pollinators but are
insectivores.



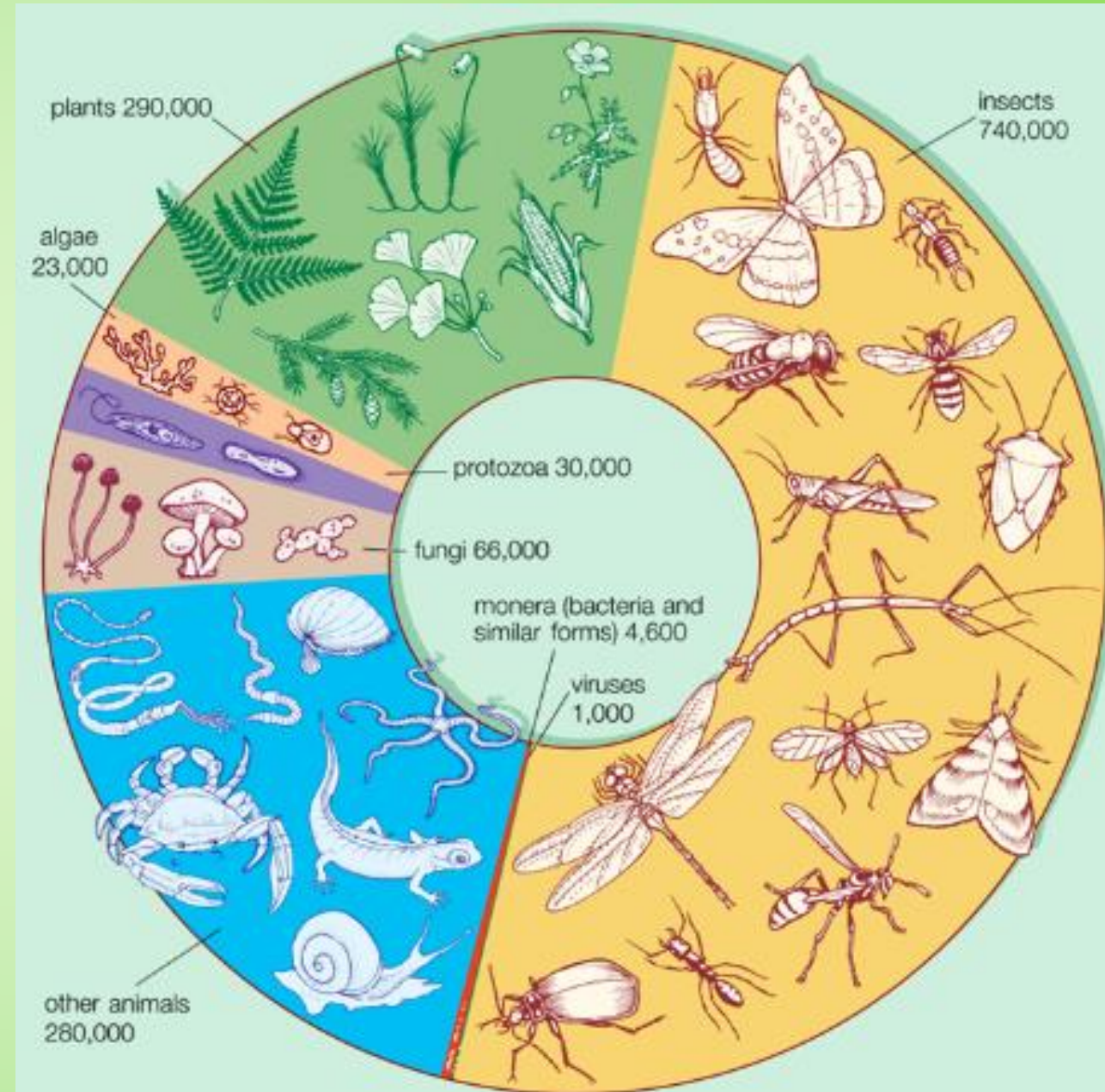
Eptesicus fuscus
Big Brown Bat
Central Park

Birds (Ornithophily)



Insects (Entomophily)

- ▶ Insects and other invertebrates make up 94% of animal species
- ▶ They perform many services besides pollination (e.g., dispersing seeds, being part of the food web, recycling nutrients, etc.)
- ▶ They are the "little things that run the world"



Bees

- ▶ The most important group of pollinators
- ▶ They gather pollen, not just nectar feeders
- ▶ Flower consistency – repeatedly visit many flowers of one species
- ▶ 3,600 native species in North America

Bees: Solitary bees

- ▶ 90% are solitary, not social
- ▶ 70% of those are ground nesting.
- ▶ Most are not aggressive and are stingless
- ▶ Possess hairs and other structures that help them transfer pollen and consequently help pollination



<https://www.nature.com/articles/d41586-017-00664-0>

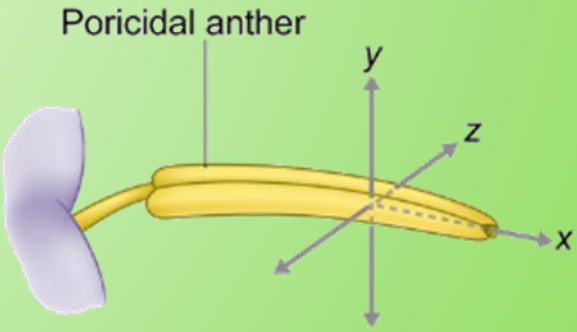
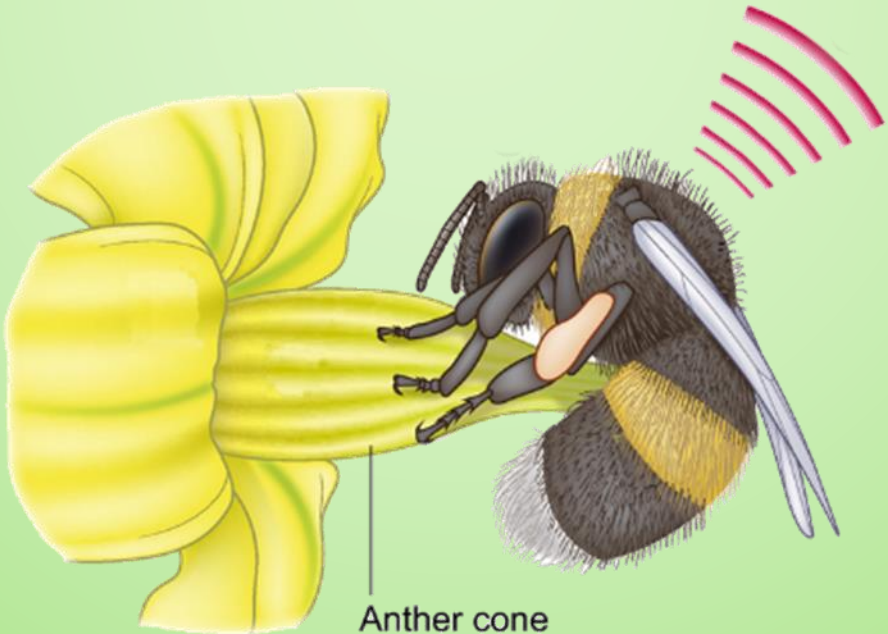
Closeup of hairs on the thorax of a worker bee. Notice that each hair is branched (plumose), enabling it to trap pollen grains more effectively. Photo courtesy of Zachary Huang.

Bees: Bumble bees

- ▶ Important pollinators of wildflowers and some agricultural crops
- ▶ Recognizable by their round hairy bodies
- ▶ Buzz pollination – tomatoes, peppers, cranberries and others
- ▶ More than 25% of North American bumble bees face extinction



<https://www.youtube.com/watch?v=3Y10F4N7Eys>



Top Left: <https://blog.seedsavers.org/blog/exploring-tomato-flower-structure>
Top Right: <https://plant-evolution.org/wp/research/buzz-pollination/>
Bottom: New Phytologist, Volume: 224, Issue: 3, Pages: 1068-1074, DOI: (10.1111/nph.15666)

Bees: Honeybees

- ▶ Not native!
- ▶ Important for agriculture, livestock...BUT....
- ▶ Honeybees are not at risk for extinction
- ▶ They compete with our native bees for pollen and nectar and suppress native bee numbers
- ▶ They can also carry and spread diseases from apiaries



Hamilton Heights, on Sedum





Mormodes badia
Orchidaceae



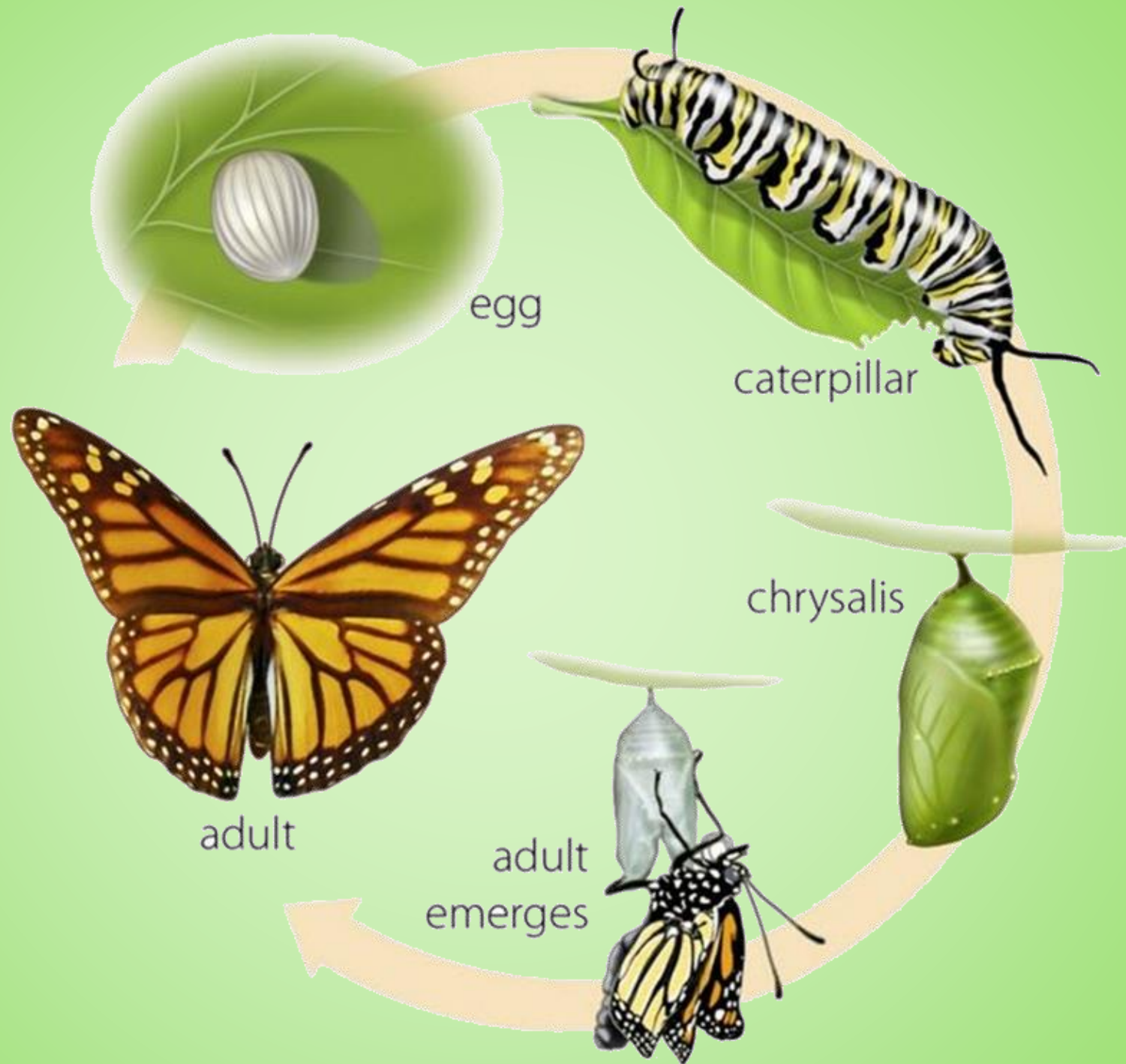
Euglossine bees

Bees collect essential oils and use it to make pheromones
Front legs are like brushes, and they mop up the chemicals and deposit into baskets on hind legs

Butterflies & moths

- ▶ Valuable pollinators
- ▶ 19% at risk of extinction – specialists with certain habitat needs as well as generalists
- ▶ Approximately 14,300 species in North America
- ▶ Most people focus on nectar plants for butterflies
- ▶ Larval host plants are critical!
- ▶ Sites for overwintering – structures, leaf litter

Lifecycle



Butterflies (Psychophily)



Danaus plexippus Monarch butterfly, pupa and chrysalis
Central Park, NY

Butterflies



Papilio polyxenes
Black Swallowtail
Central Park, NY

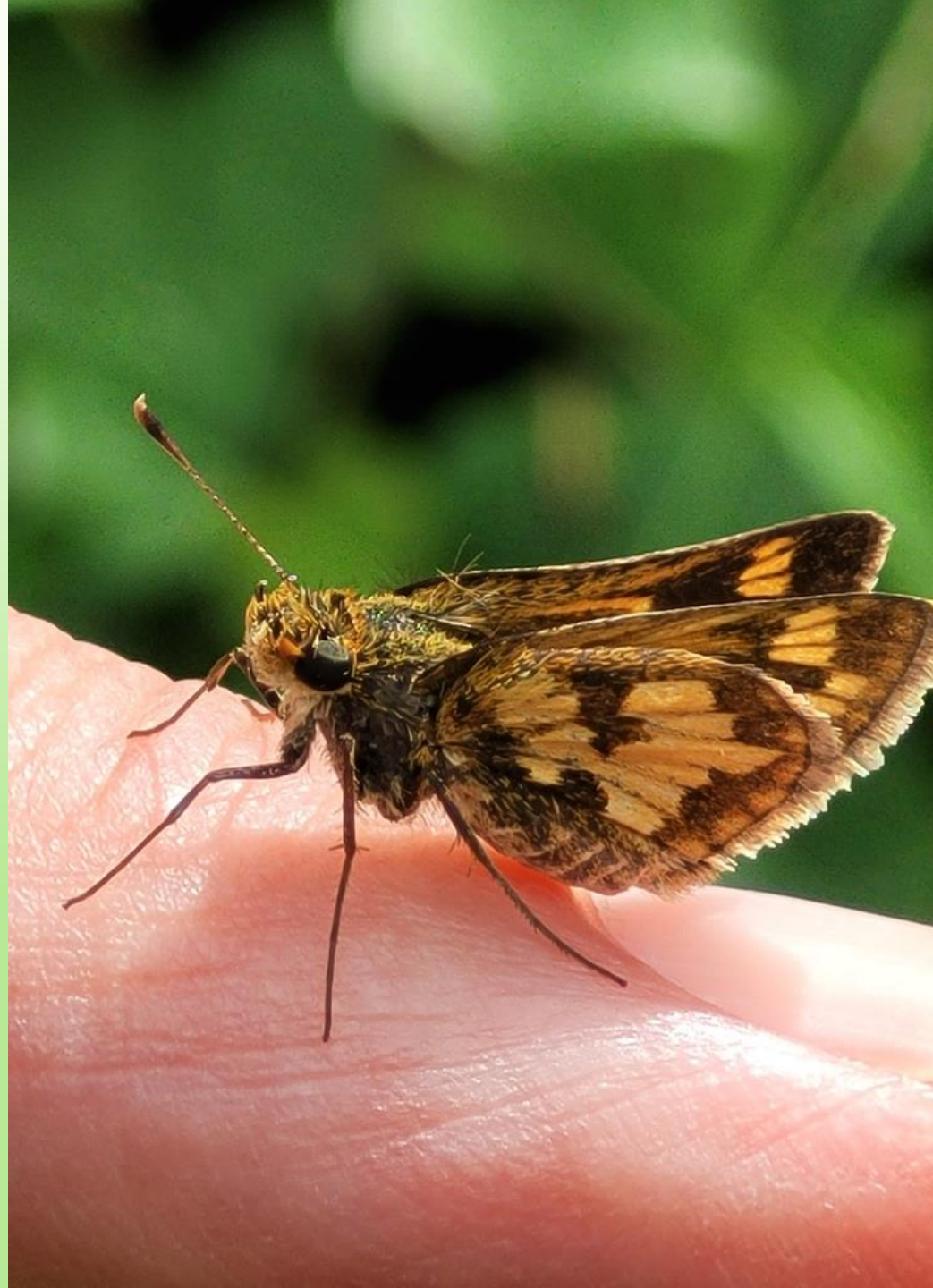
Moths (Phalaenophily)



Hawkmoth



Polites peckius
Peck's skipper
Orangeburg, NY
Ken Chaya
Beth Concepcion



Wasps

- ▶ Hunters, help keep other insect populations in check
- ▶ Nectar drinkers, they do not actively collect pollen
- ▶ Beneficial insects, they manage pests
- ▶ Many have smooth bodies, or hairs that are not adapted for trapping pollen
- ▶ Minor pollinators, but beneficial
- ▶ Many are small and not scary – beautiful, in fact!



Polistes sp.
Paper wasp
Orangeburg, NY



Dolichovespula maculata
Bald-faced hornet
Blauvelt, NY



Trypoxylon politum
Mud dauber wasp nest
Orangeburg, NY

Sphecius speciosus
Cicada killer wasp
Central Park



Flies

- ▶ Many are beneficial as pollinators and as food source for birds
- ▶ Important pollinators of specific plants and some are generalists
- ▶ Chocolate! Skunk cabbage, corpse flower
- ▶ They are nectar drinkers and pollination is incidental
- ▶ Some are beautiful!

Amaorphophallus titanum
Titan-Arum (Corpse flower)
NY Botanical Garden





Symplocarpus foetidus
Skunk cabbage
Harriman State Park



Theobroma cacao
Cacao





<http://www.montosogardens.com>
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Eastern
calligrapher
Toxomerus
geminatus
Orangeburg, NY



Hoverfly
Helophilus sp.
Flies that mimic
wasps



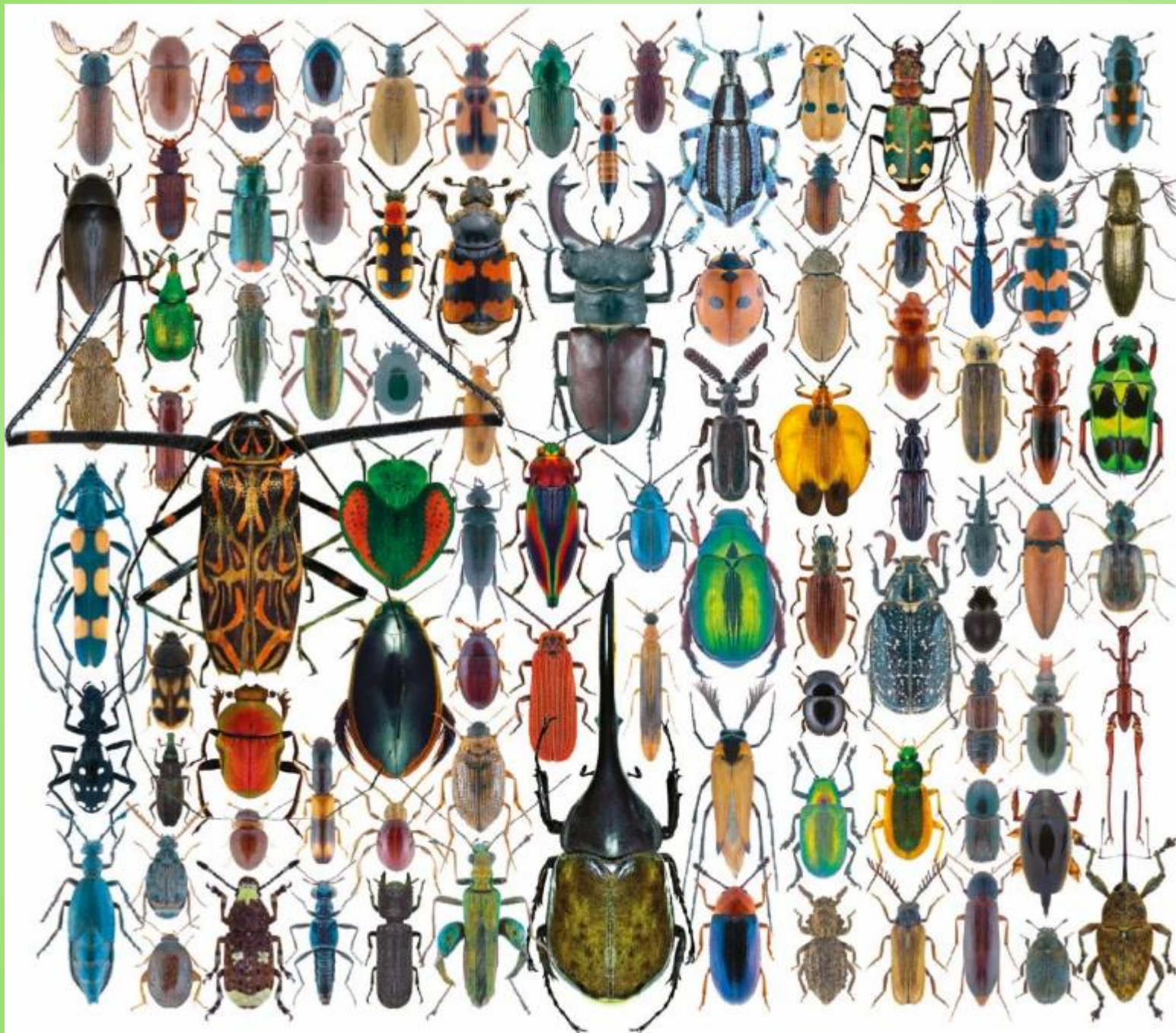
P. Shrewsbury

Bumblebee Hoverfly
Volucella bombylans
Fly that mimics
bumblebee



Beetles

- ▶ Most diverse group of insects
- ▶ 30,000 species in North America
- ▶ Probably the first pollinators, found in the fossil record, late Jurassic
- ▶ Like all other insects, threatened by habitat loss, habitat fragmentation, pesticides
- ▶ Releasing non-native ladybeetles displaces native ladybeetles



Harmonia axyridis
Asian lady beetle



Coccinella novemnotata
Nine-spotted lady beetle





Fireflies
Pyractomena sp.
Orangeburg, NY



Common Eastern
Firefly
Photinus pyralis
Inwood Hill Park, NY



Flower long horned
beetle
Xestoleptura crassipes
Mount St. Helen's,
Washington

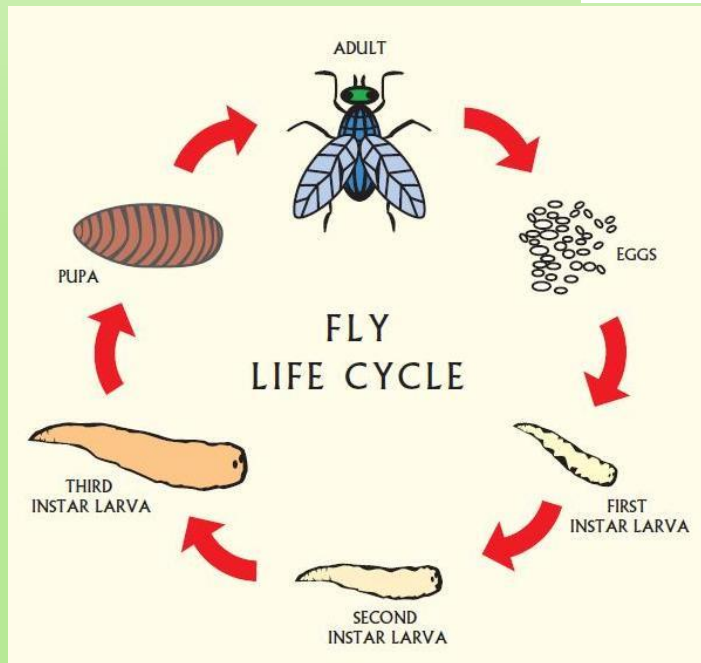
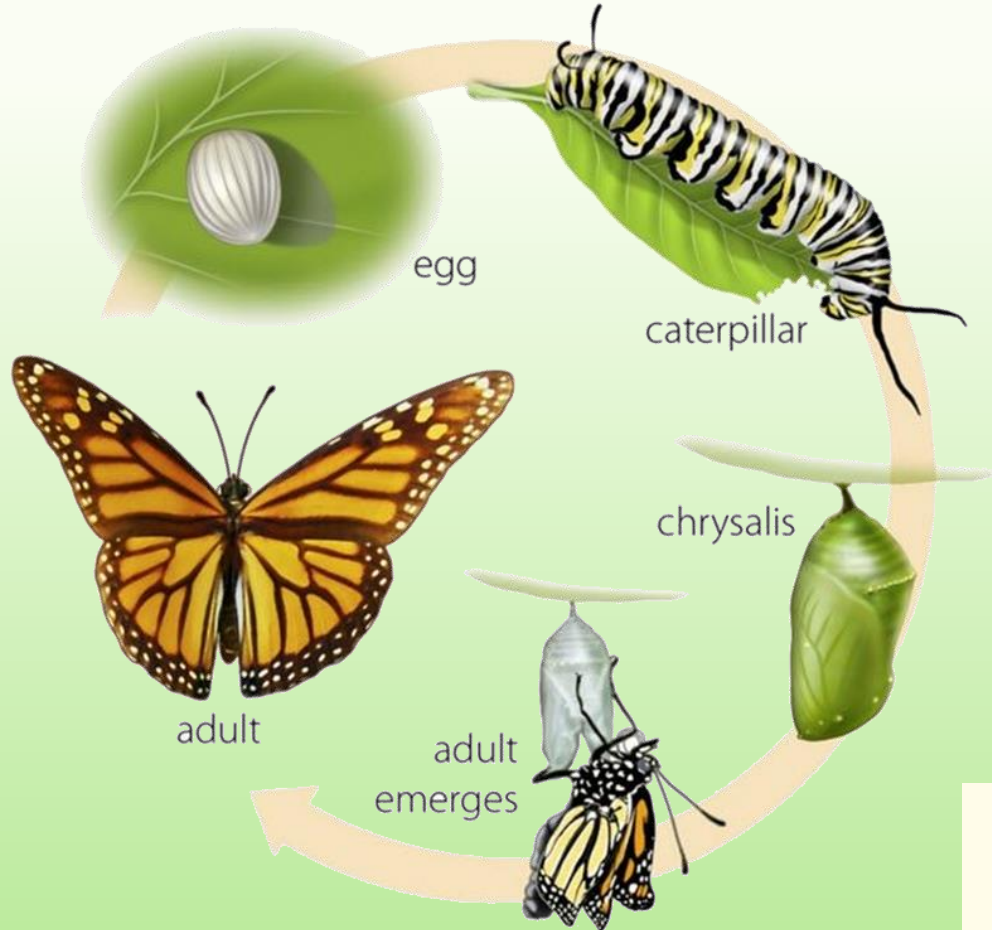


Loss of pollinators

- ▶ Causes include
- ▶ Habitat loss and degradation
- ▶ Pesticide use
- ▶ Introduced diseases

What can we do?

- ▶ Understand the biology of pollinators
- ▶ Provide habitat for all stages of their life cycle – not just nectar sources!
- ▶ Reduce/eliminate pesticide use
- ▶ Provide good habitat, biodiversity, control invasives – help control diseases.



Solitary bees

- ▶ 90% are solitary, not social
- ▶ 70% of those are ground nesting. Some emerge early in spring, important for early flowering species
- ▶ 30% are cavity nesters



70% of solitary bees are ground nesting, forming burrows in loose soil. The remaining 30% are cavity nesting, forming brood chambers in hollow stems, holes in dead wood, or other materials.

Photos: (left) Rich Hatfield, (right) Katharina Ullman.

Nesting sites



Bare untilled soil



Deadwood, hollow stems
brush piles
“Bee hotel”



Protected underground
cavities
Keep a brush pile where you can



Don't cover everything with mulch!

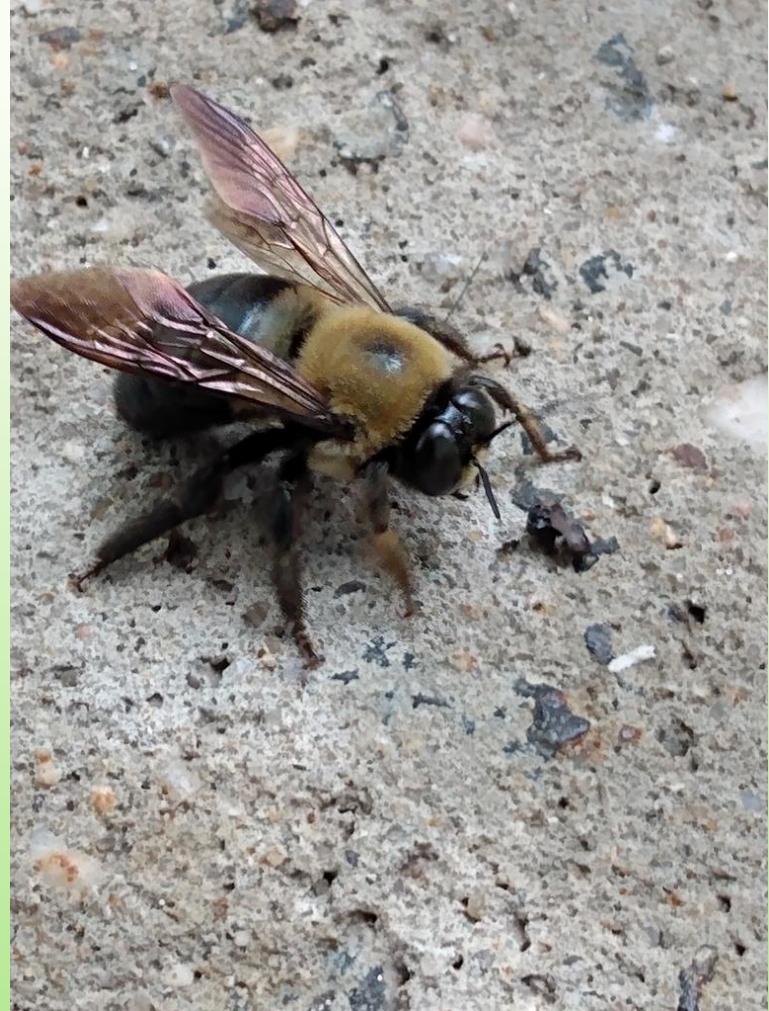
Use shredded leaves instead of bark or wood mulch where possible

Leave some areas un-mulched





Eastern bumblebee, *Bombas impatiens*
on *Eupatorium serotinum* late flowering thoroughwort
Central Park, NY



Carpenter bee, *Xylocopa virginica*
Hamilton Heights, NY



Eutrochium purpureum
Sweet Joe-Pye Weed
Central Park, NY



Sambucus canadensis
Elderberry
Blauvelt, NY

Plants with hollow stems provide natural cavities for nesting



Hydrangea quercifolia
Oakleaf hydrangea
Hamilton Heights, NY

Rhus typhina
Staghorn sumac
Orangeburg, NY



Plants with hollow stems provide natural cavities for nesting



Plants with pithy stems can be excavated by small carpenter bees and other cavity-nesters.
Photo: Nancy Lee Adamson. Xerces Society



The holes in this tree stump were likely made by beetles who are breaking down the wood. Cavity nesting bees will also use these holes. Photo: Don Keirstead. Xerces Society

Leave some dead branches in your trees where it is safe to do so.

Butterflies and moths

- ▶ Need host plants for larvae
- ▶ Many species need trees and shrubs, not just herbaceous
- ▶ Oaks host the highest numbers of butterfly and moth larvae, up to 500 species!
- ▶ “If you can only plant one tree, plant an oak” Douglas Tallamy
- ▶ Select native species for nectar plants
- ▶ Provide a diversity of plants

Butterflies



Danaus plexippus Monarch butterfly, pupa and chrysalis
Central Park

Native plants



Eurybia divaricata
White wood aster
Central Park

Native plants

Asclepias syriaca
Common milkweed



Asclepias tuberosa
Butterfly milkweed

Asclepias incarnata
Swamp milkweed
Central Park



Native plants



Lobelia cardinalis
Cardinal flower
Central Park

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Native plants

Pycnanthemum virginianum.
Virginia Mountain mint



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Wild Flower Society.
<https://gobotany.nativeplanttrust.org/species/pycnanthemum/virginianum/>

Native plants

Sanguinaria canadensis
Bloodroot



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Flower Society
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<https://gobotany.nativeplanttrust.org/species/sanguinaria/canadensis/>

Native plants

Impatiens capensis
Jewelweed
Central Park



Native plants



Liriodendron tulipifera
Tuliptree
Kakiak Park, NY

Native plants

Cephalanthus occidentalis
Buttonbush
Kakiak Park, NY



Native plants

Vaccinium pallidum
Blue Ridge Blueberry
Harriman State Park, NY



QUESTIONS?

