Bees & Wasps:
A Review of Colorado Species

Whitney Cranshaw

Colorado State University

What is a bee?

What is a wasp?

Common Families of Bees and Wasps

Bees

- **Apidae** (honey bees, bumble bees, digger bees, carpenter bees)
- **Megachilidae** (leafcutter bees, mason bees, sower bees)
- **Andrenidae** (ground-nesting bees)
- **Halictidae** (sweat bees)
- **Colletidae** (plasterer bees)

Wasps

- **Vespidae** (paper wasps, yellowjackets, hornets, potter wasps)
- **Sphecidae** (hunting wasps)
- **Pompilidae** (spider wasps
- **Mutillidae** (velvet ants)
- **…..other families of predatory Hymenoptera**
- **…..myriad families of parasitic Hymenoptera**
- **…. Gall wasps?**

Bees collect nectar and pollen

Pollen is used primarily for rearing young

Nectar is used primarily as an energy source for the adults

Wasps collect animal matter to feed their young

Adults may feed on nectar as an energy source.

Habits of Bees & Wasps

- **Bees**
  - Social bees
    - Perennial colony (honey bee)
    - Annual colony (bumble bees)
  - Solitary bees (leafcutter bees, digger bees)
    - 1-2 generations/year
- **Wasps**
  - Social wasps (yellowjackets, hornets, paper wasps)
    - Annual colony
  - Solitary wasps (hunting wasps, parasitic wasps)
    - 1-2 generations/year

Some solitary bees and some solitary wasps nest in stems and above-ground cavities

Some solitary bees and some solitary wasps
nest in the soil

Mud dauber nest

Resin/pebble nest of *a Dianthidium* bee

Potter wasp nests

Some solitary wasps and a few solitary bees will construct nest cells of mud, pebbles or other materials (e.g., leaf pieces)

Social bees use wax for nest construction

Social wasps use paper for nest construction

Social Structures of Bees

How many species of bees are known to occur in Colorado?

- A. 37
- B. 124
- C. 946
- D. 1576

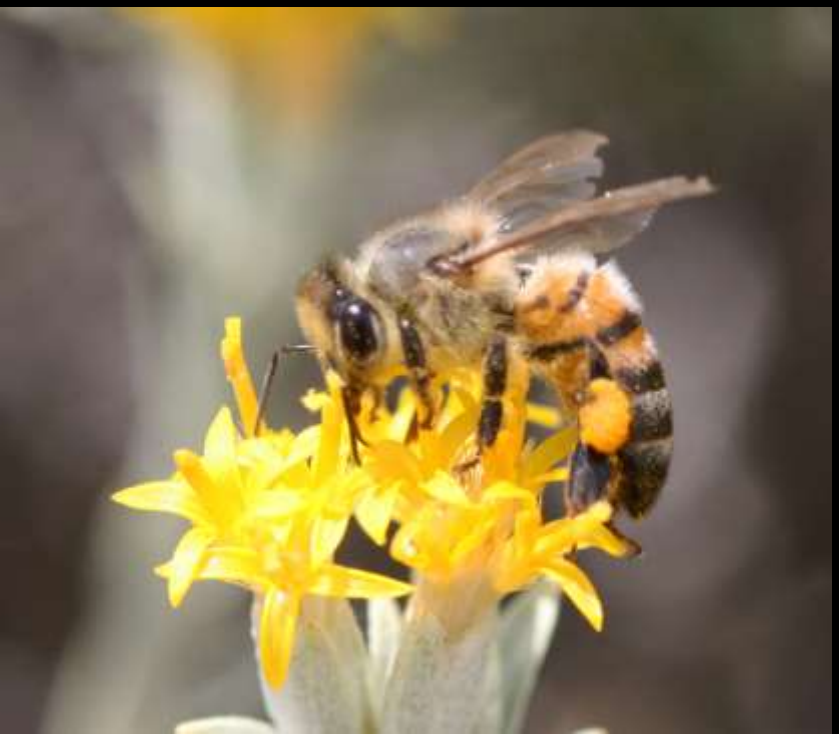
How many species of bees are known to occur in Colorado?

- A. 37
- B. 124
- **C. 946**
- D. 1576

Common Social Bees

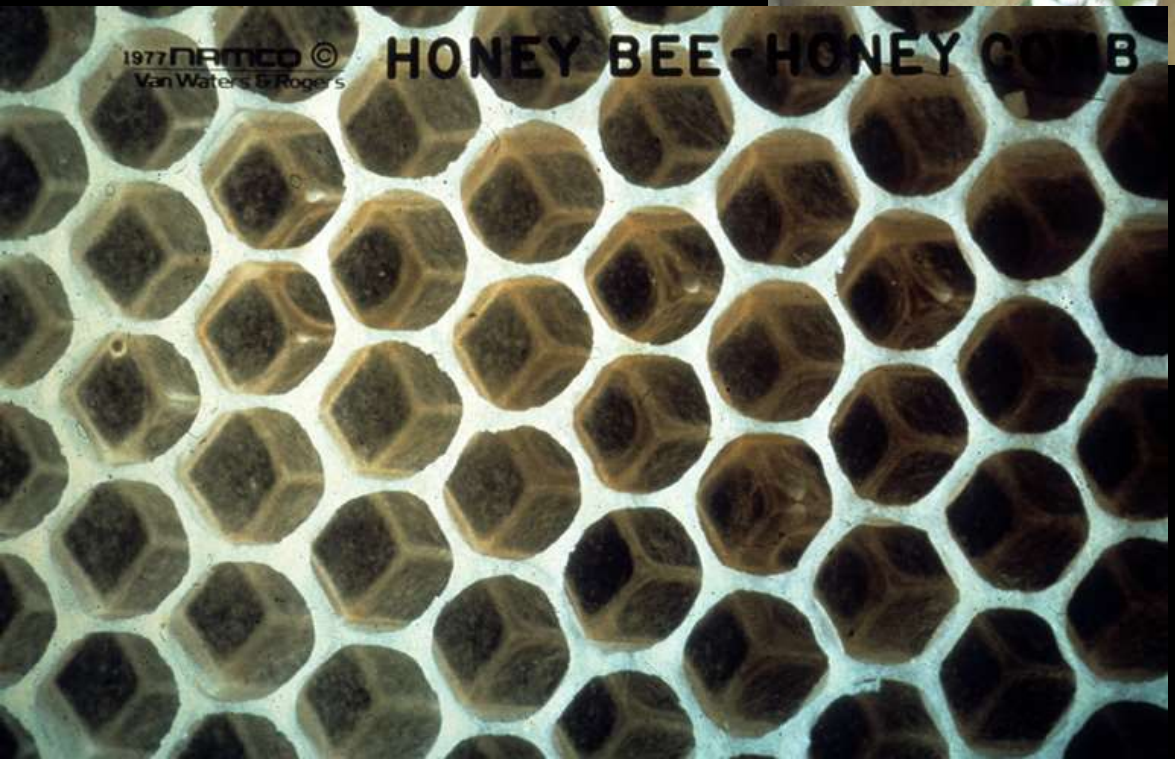
Honey Bee

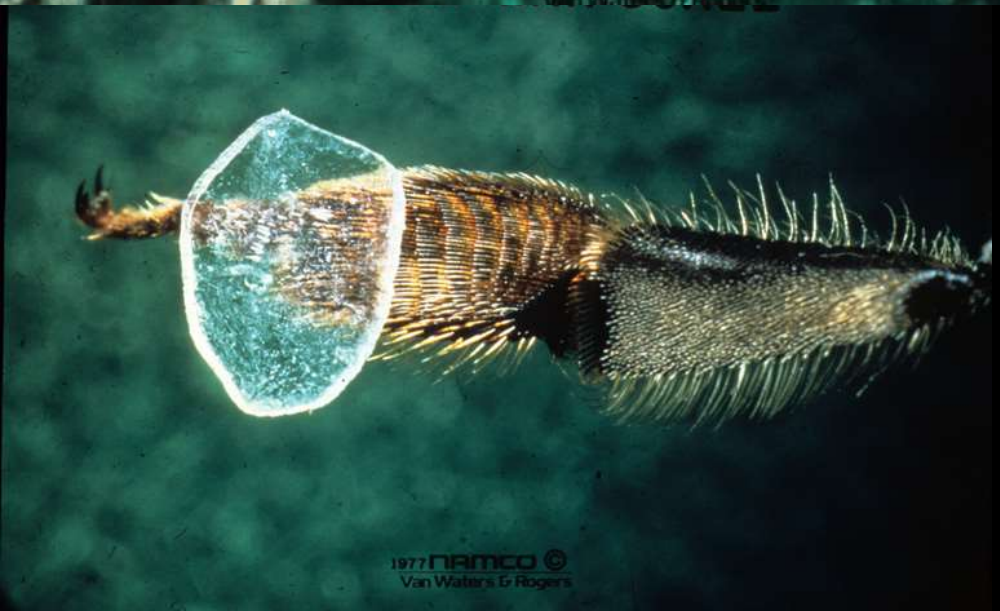
Apis mellifera



Honey bee

Nest constructed of wax

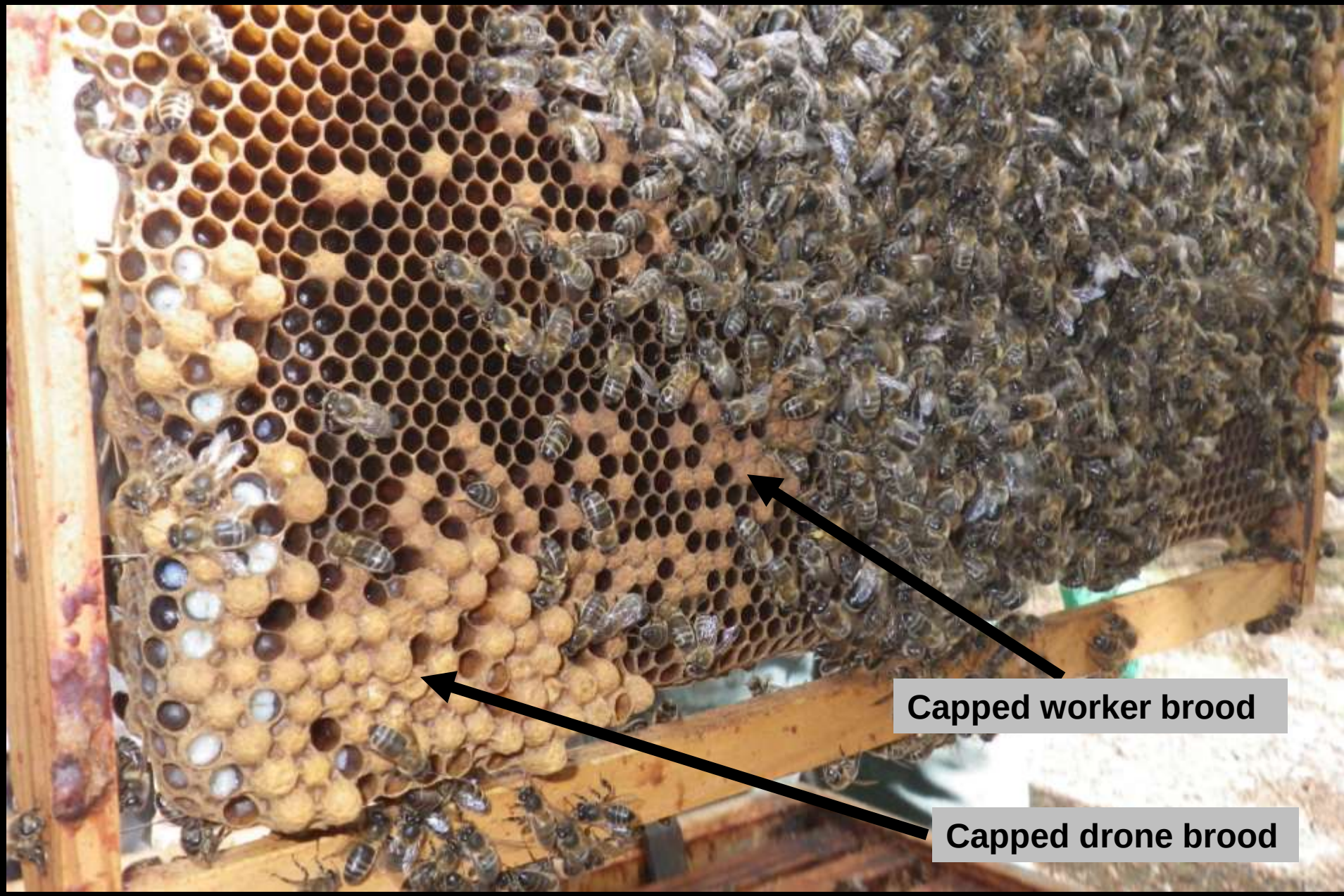




Wax flakes are produced by special glands of the thorax, then are molded into comb

Hexagonal cells: Maximize space and minimize materials

Developmental Stages of Honey Bees


Capped worker brood
Capped drone brood

Honey bee colonies have specialized castes that include a **queen** (fertile female), **drones** (males) and numerous **workers** (infertile females)

Queen (fertile female)

The only thing that determines whether a honey bee differentiates into a queen or a worker is larval diet – specifically the percentage of royal jelly.

Royal Jelly

A nutrient rich glandular substance fed to larval bees that is produced by honey bee workers “tasked” with its production (nurse bees)

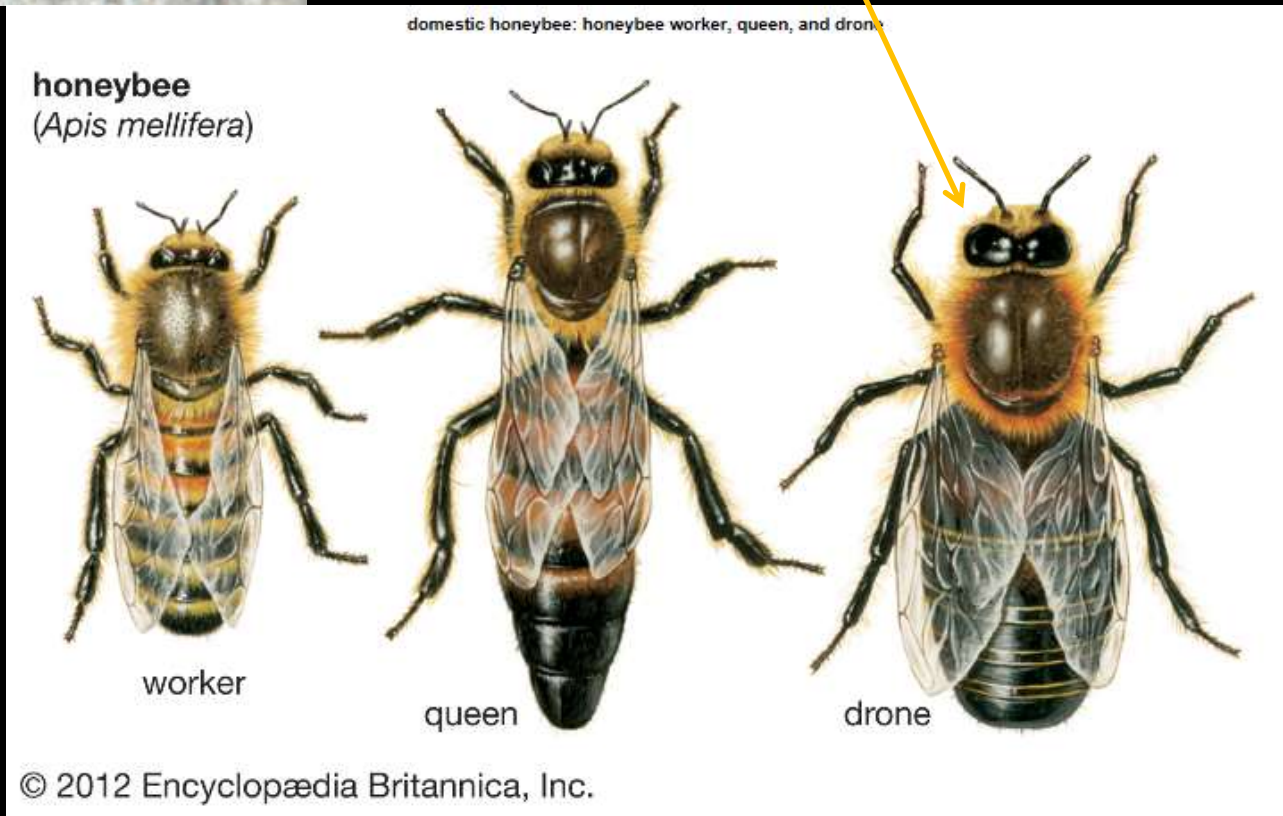
A small percentage of the colony are males – the drones

Males are produced from unfertilized eggs

Worker (left) and drone (right)

The male honey bee (drone) cannot sting

Stinger is a modified ovipositor



Honey Bees produce a perennial nest

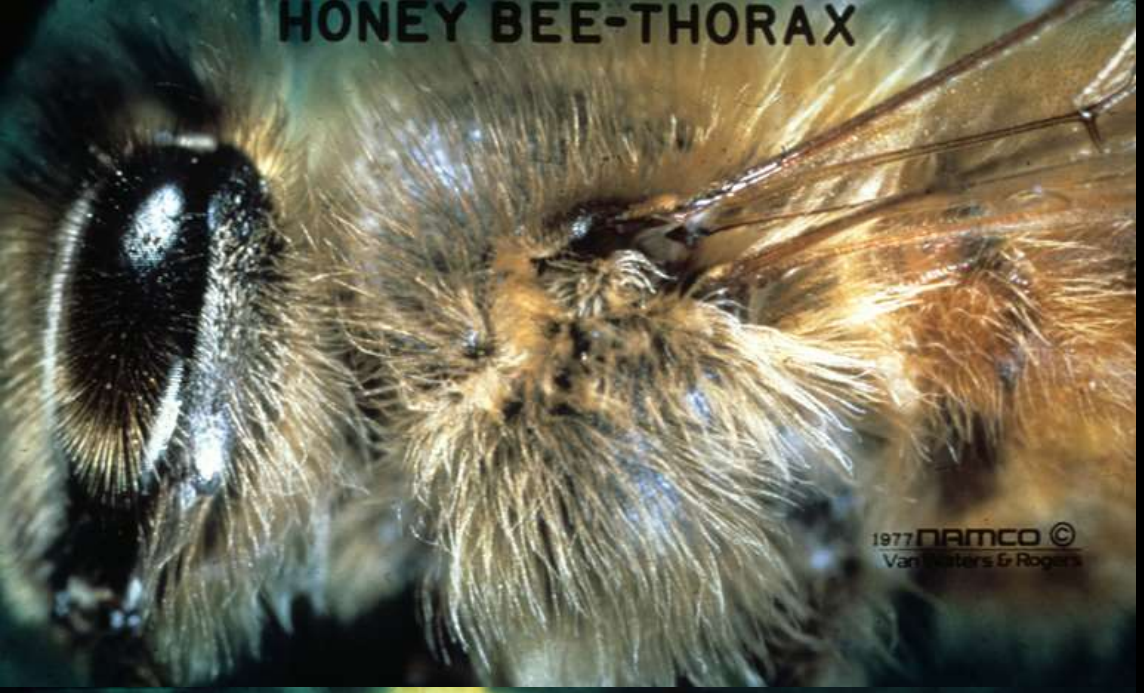
Honey bees – and most bees – collect nectar as their primary energy source.

Frame Filled With Honey

One 8 fl oz “honey bear” is the result of:

ca. 1,000,000 flower visits

The lifetime efforts of ca. 570 honey bees making a total of 14,400 foraging trips



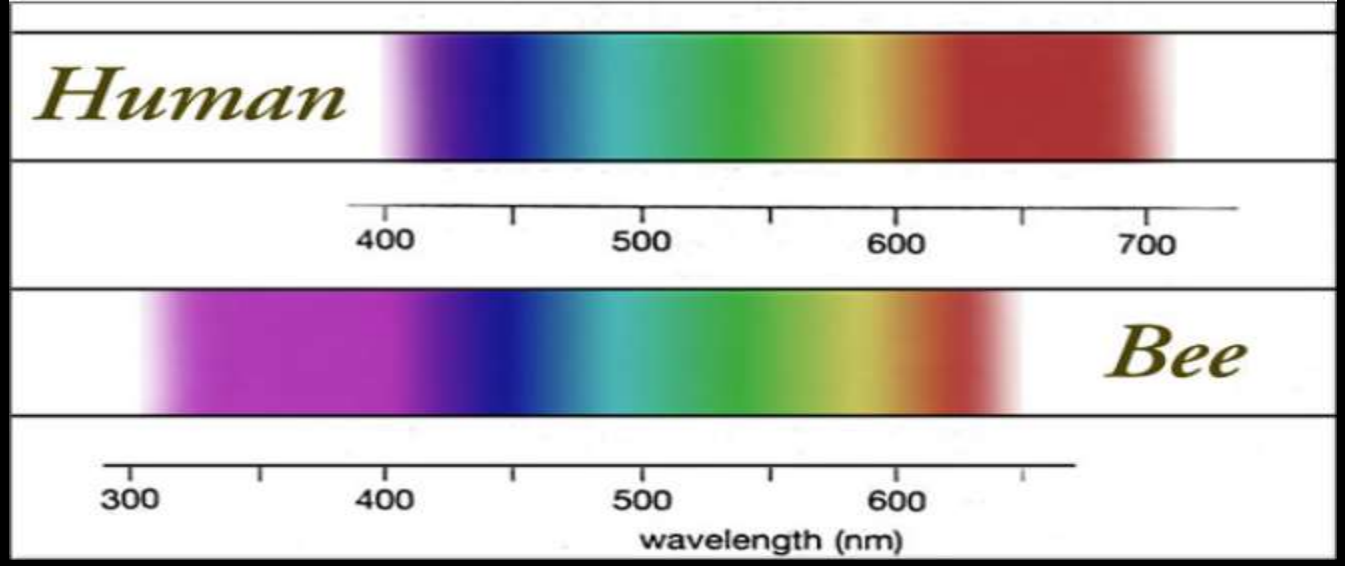
Honey bees – and most bees – use pollen as their primary source for proteins, fats and most other nutrients

Honey bees carry pollen in a “pollen basket” (corbicula) on the legs

Individual foraging honey bees are ‘flower constant’

Visual acuity of the honey bee

Honey bees can distinguish shape on the bottom line from the of the top line. They can not distinguish shapes within a line.

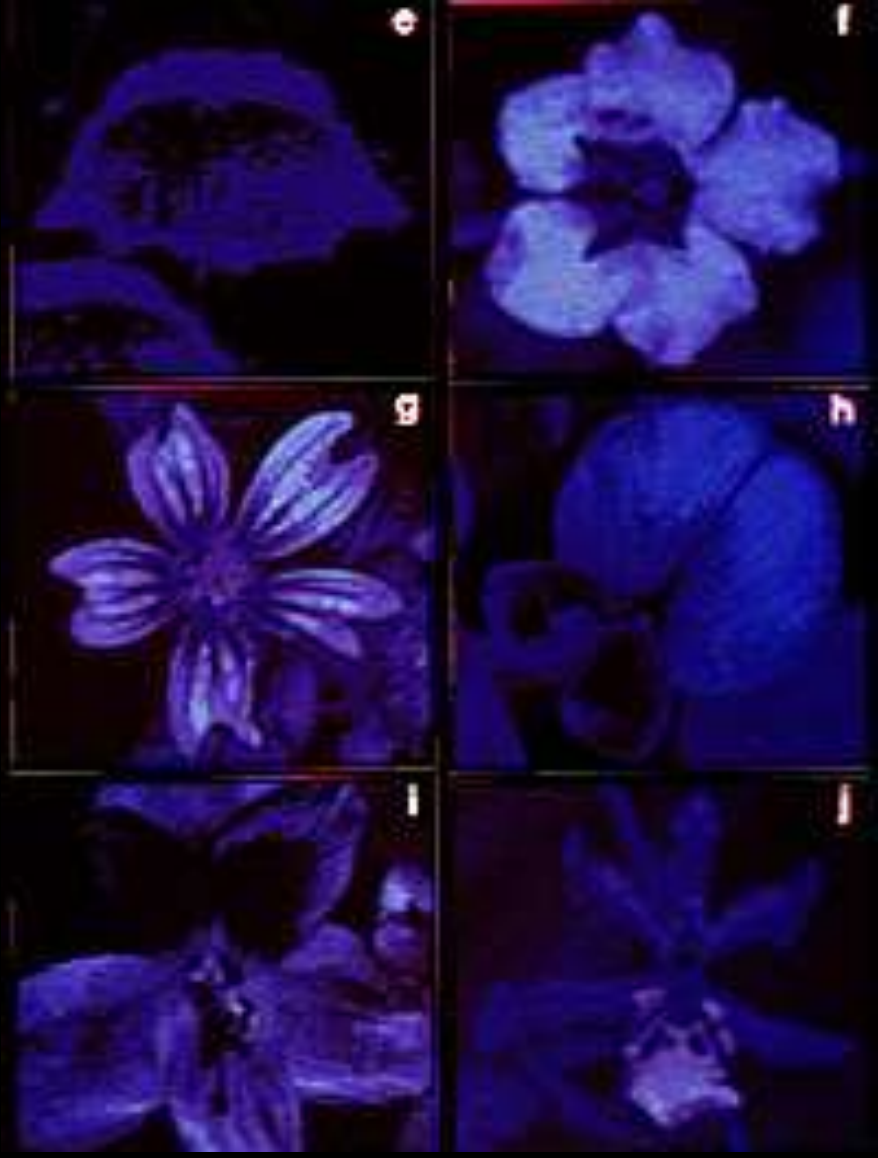


"Nectar guide"

"Nectar guide"

Honey bees can detect polarized light

Honey bees can detect ultraviolet light



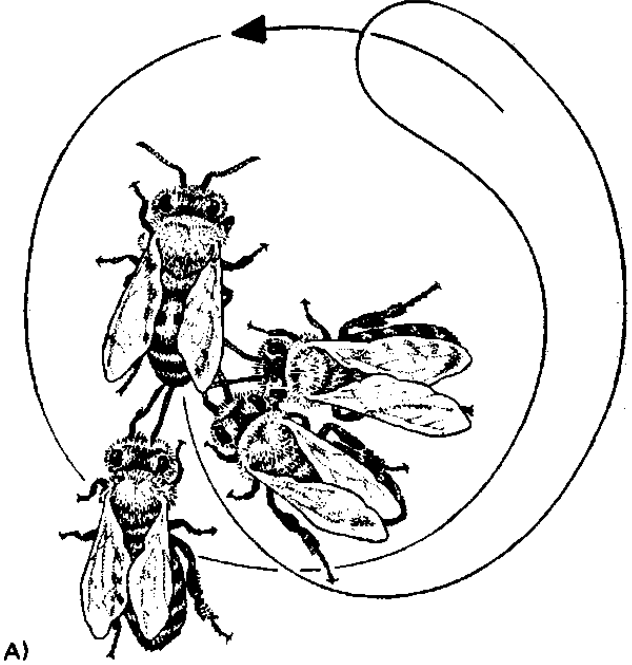
Honey bees can detect polarized light

Honey bees can detect ultraviolet light

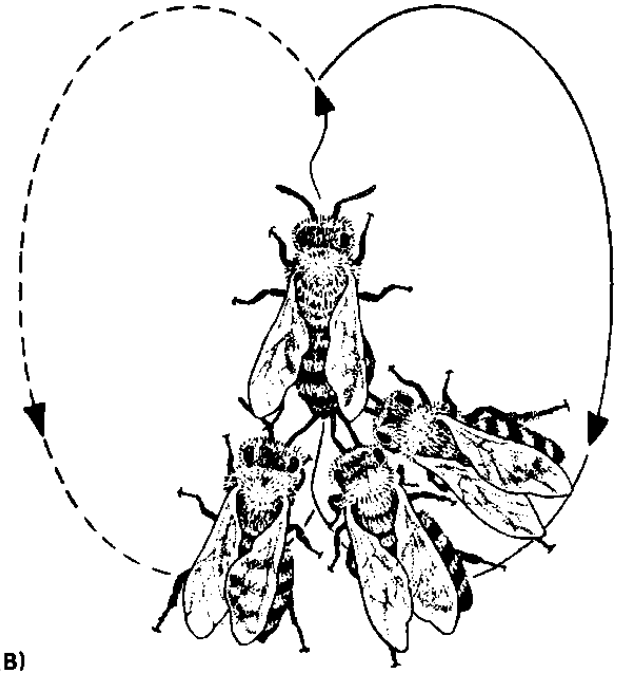
Karl von Frisch

The Bee “Dance Language”

Communication of distance and direction through hive dancing



Round Dance – Short distance to food source (within 100 meters)

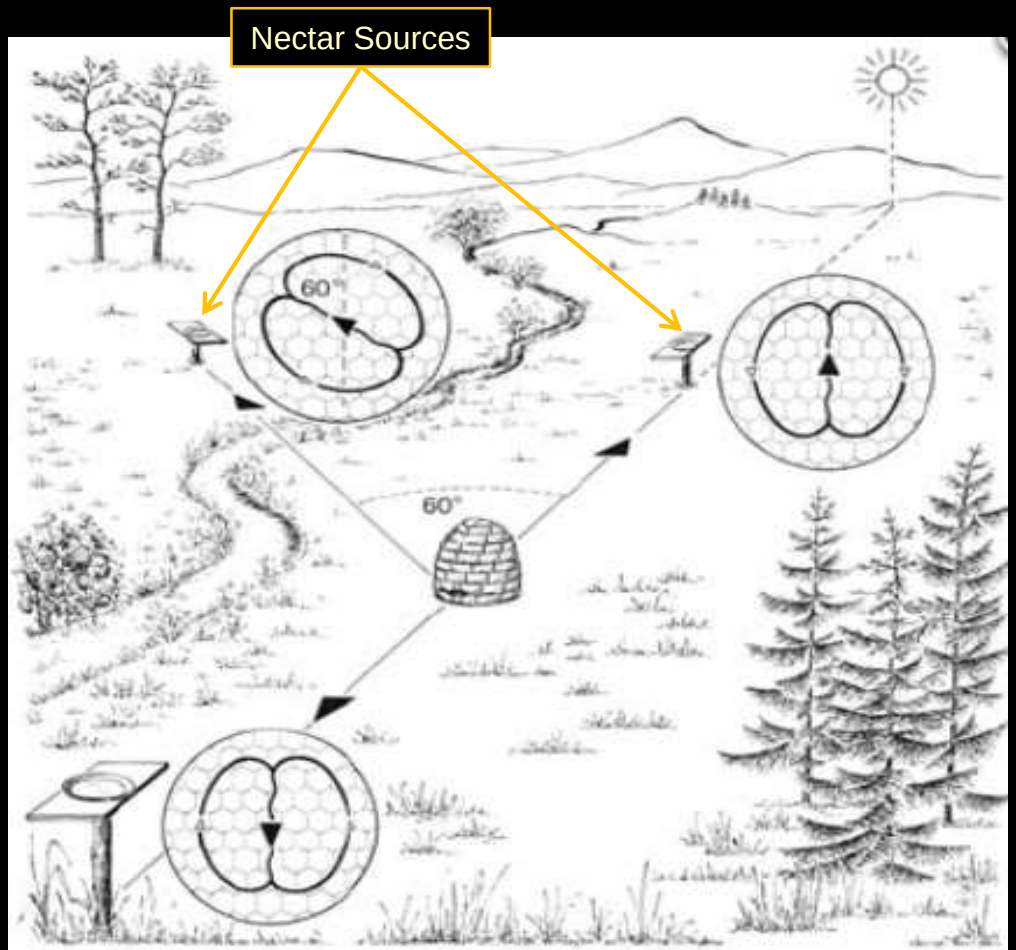


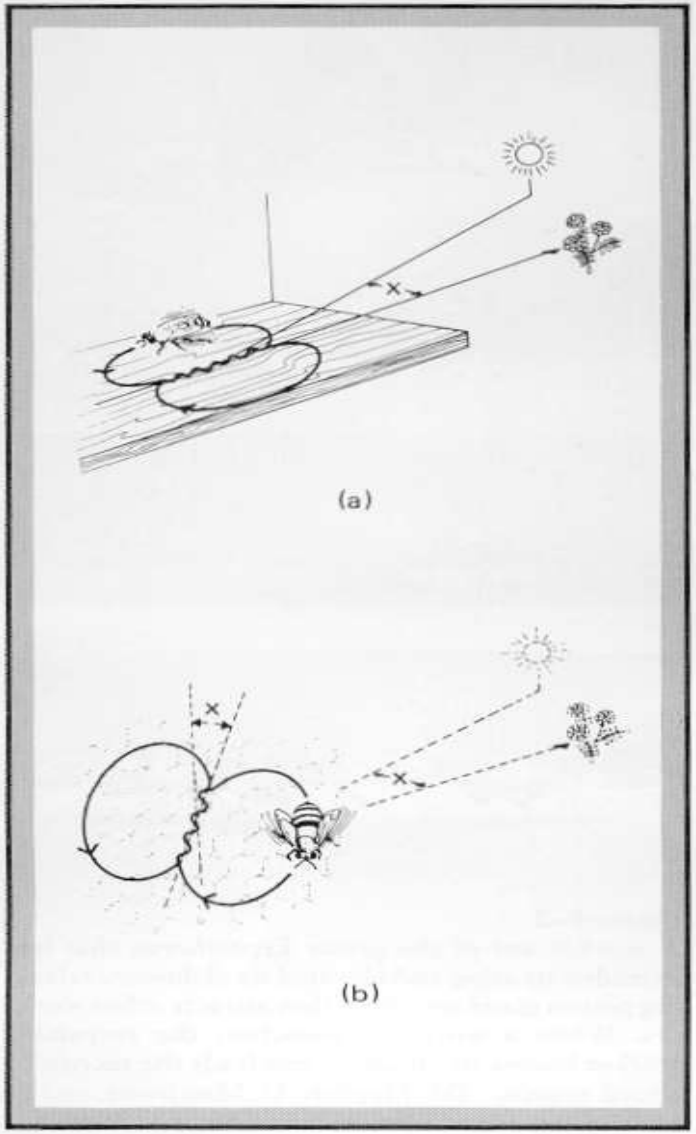
Waggle Dance – Communicates sources beyond 100 meters of the hive

Types of dances by honeybees used in communicating nectar sources. (A) round dance indicating a source near the hive; (B) wagging dance indicating direction (angle of the straight run to gravity is same as angle of nectar to sun) and distance farther away than in the round dance.

Direction

The waggle dance is performed on the vertical comb. Its orientation is related to the angle of the sun with respect to the hive entrance.

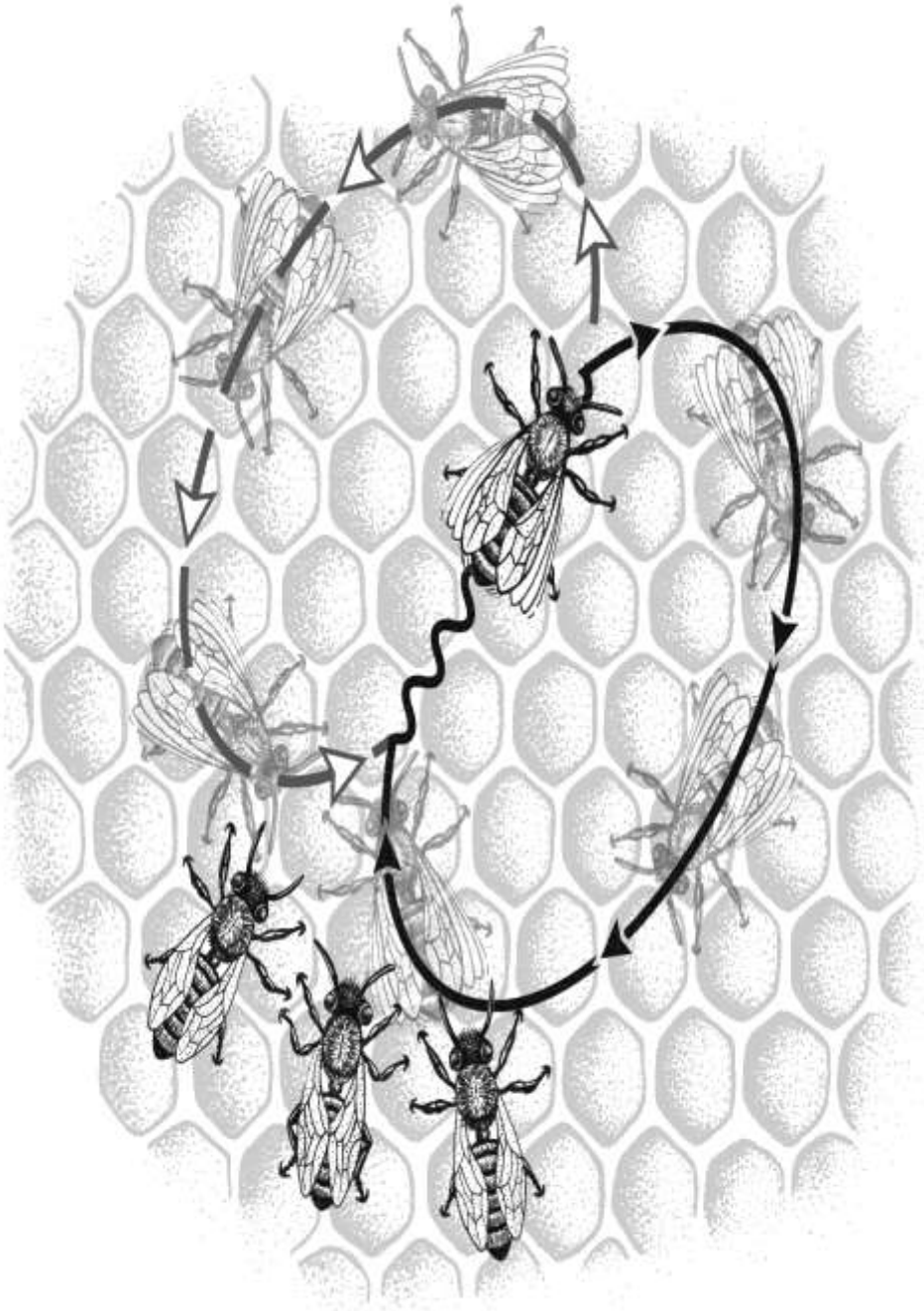




Waggle dance of the honey bee. On a horizontal surface (a) the straight part of the dance points directly toward a food source, but on the vertical surface of a comb (b) the straight part points to an angle with the sun as if the sun were directly above.

Distance

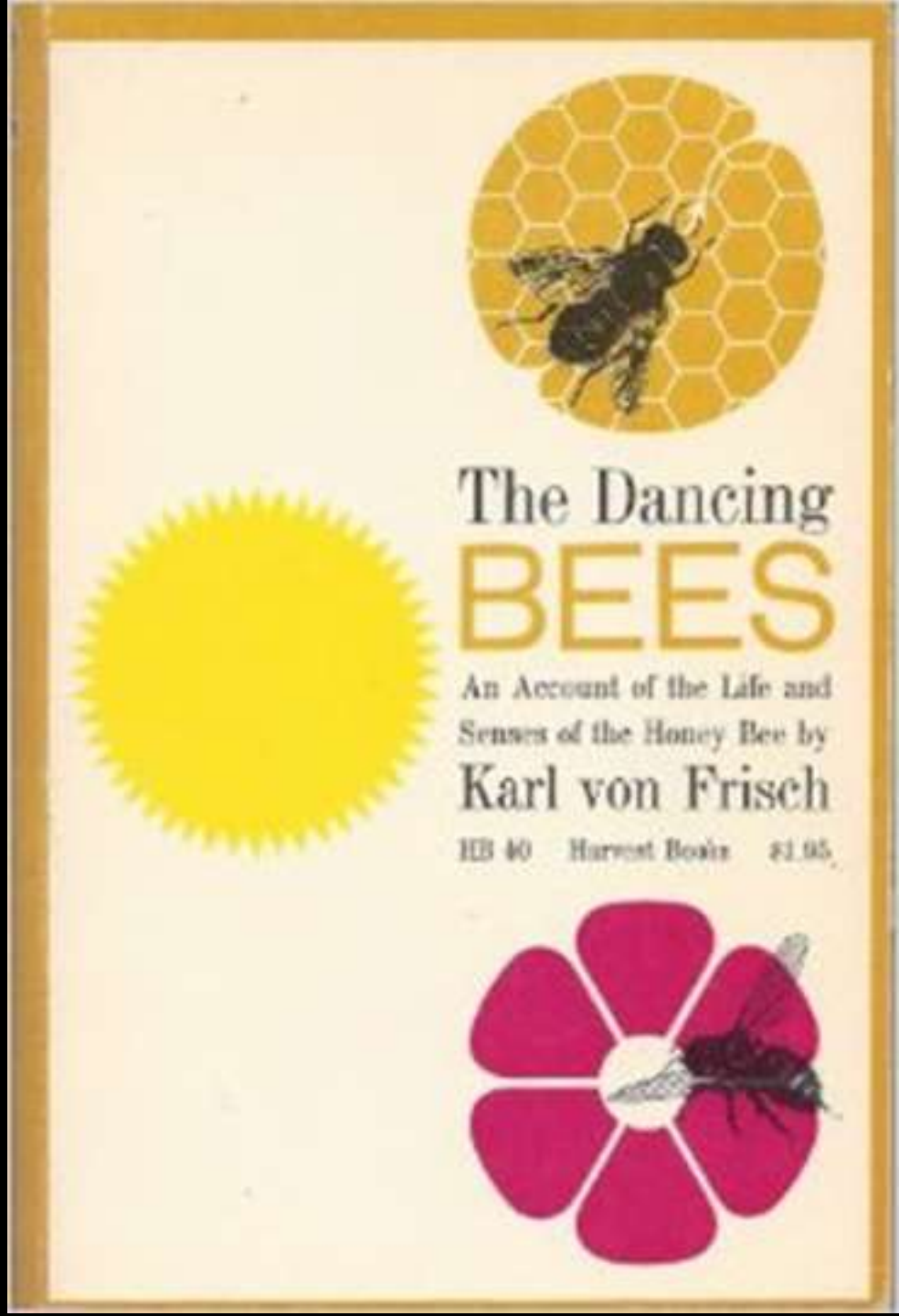
The intensity (number of dances/time) of the waggle dance indicates distance of the source



Bee Dance Language

- Direction
  - Orientation of the dance on the surface of the comb
- Distance
  - Number of “waggles”/ intensity of dance
- Chemical cues
  - Floral compounds for final host location

A excellent – and very readable – account of the studies used to understand honey bee communication



Honey bees produce a perennial nest

Honey Bee Colonies Produce Swarms

This may be thought of as a type of budding as a means for the colony – a superorganism – to reproduce.

Honey bee colonies produce swarms

Sequence of events:

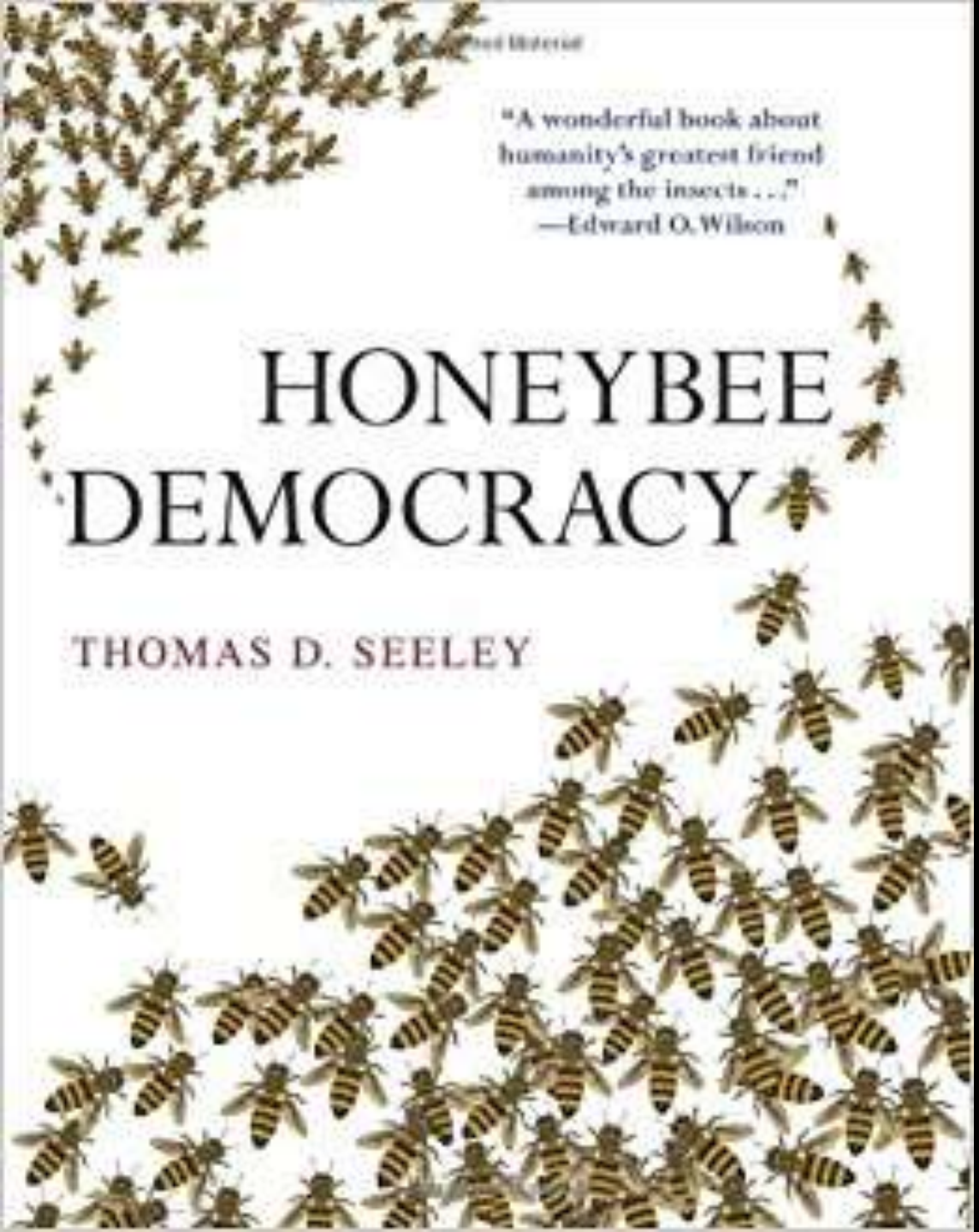
1) In early spring the old queen leaves with ½ of the workers (old colony produces new queens via queen cells).

2) Swarm lands at a temporary location and sends out scouts to find a permanent nest site.

3) Entire swarm will fly to new site once it is selected.

Ideal Site for Wild Honey Bee Hive

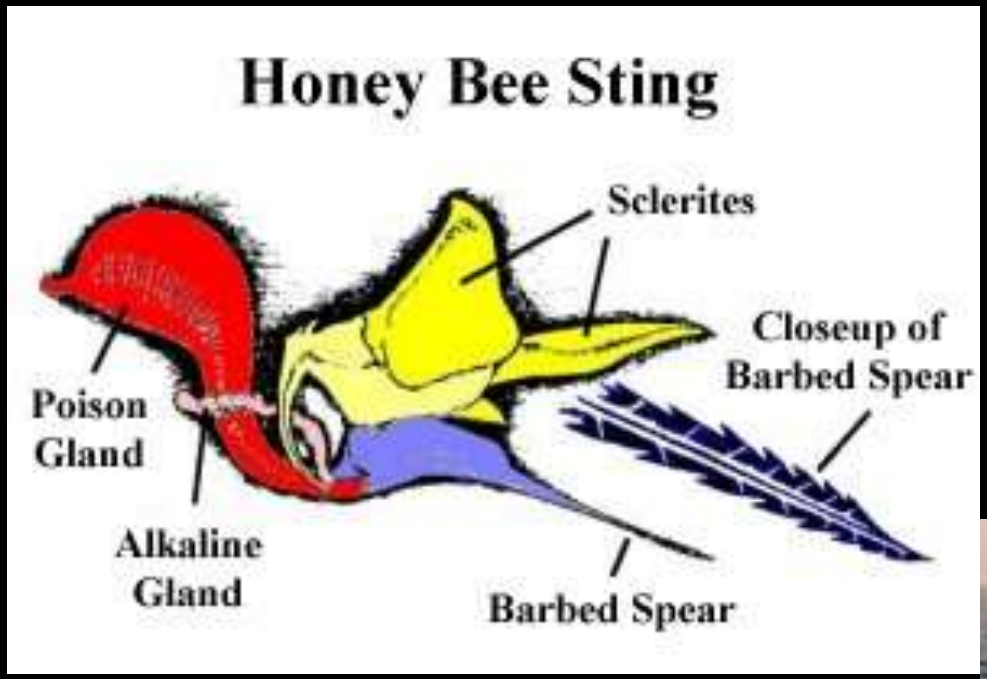
-Located well above ground
-Capacity of 15L to 75L
-Small entrance, located at bottom of cavity



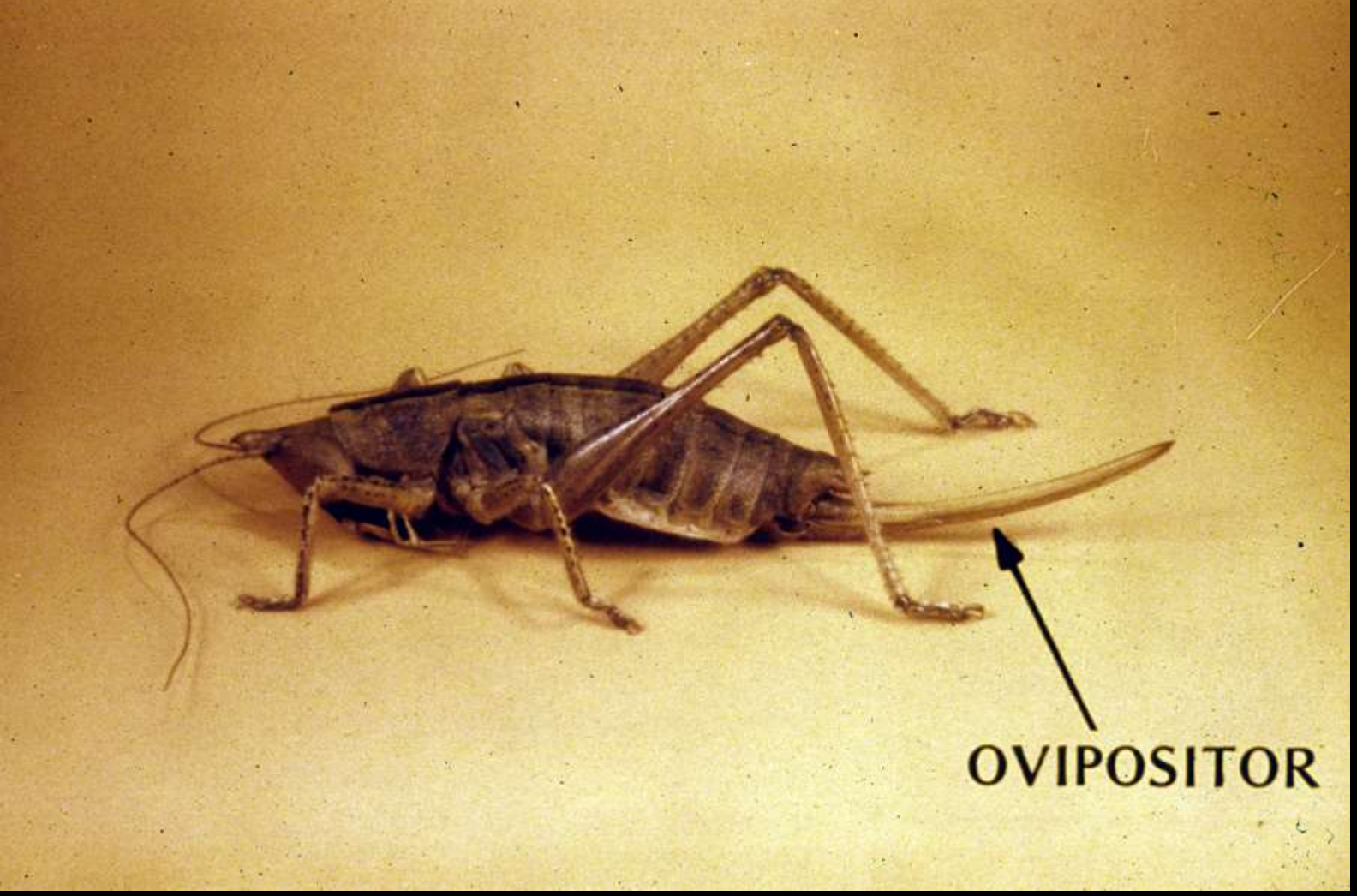
Another excellent book that describes ***how the worker honey bees collectively come to decisions*** (e.g. when to swarm, where to start a new colony)

Rescue

Copoc

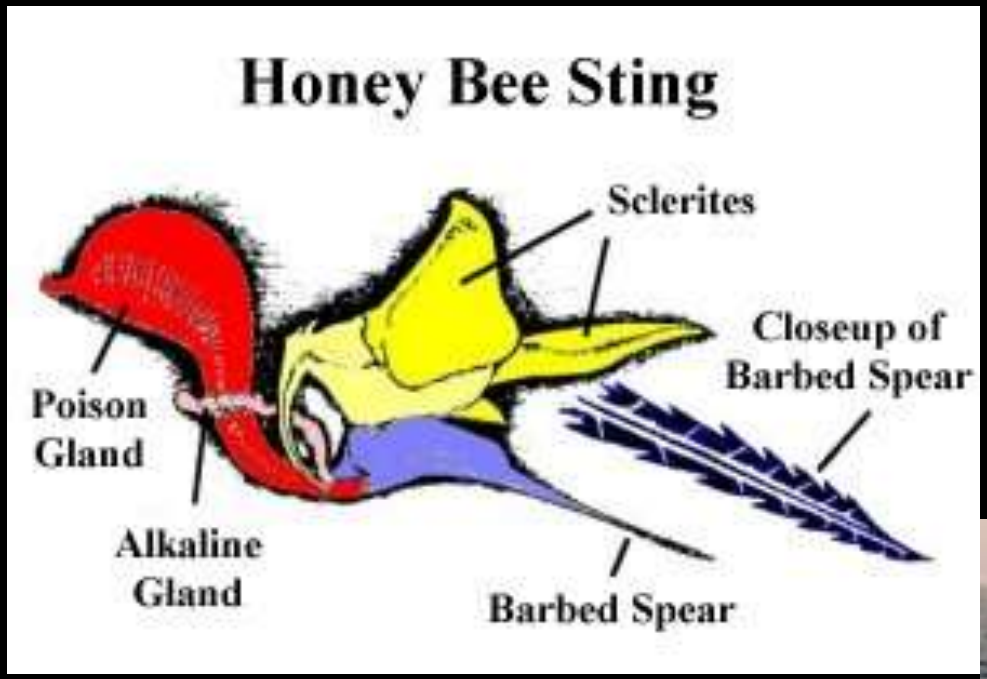


Bees, some wasps, and some ants have a stinger used for defense. The stinger is a modified ovipositor.



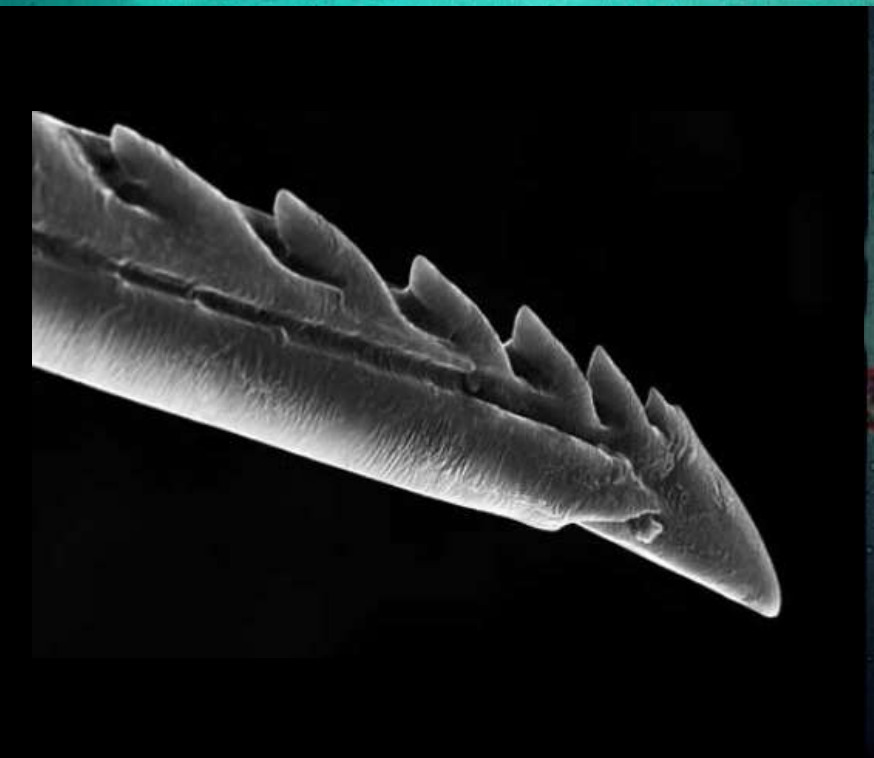
The ovipositor is the structure used by female insects to lay eggs.

Male and female house cricket



Bees, some wasps, and some ants have a stinger used for defense. The stinger is a modified ovipositor.

The stinger of a worker honey bee is barbed



Honey bee stinger and poison sac detach and remain embedded in skin

The only insect that regularly leaves a stinger in the skin is a worker honey bee

Honey Bee Sting on Human Skin

University of Florida - Entomology and Nematology

-Squeamish alert: Shows close up of a sting on a human arm.
-Note the stinger still pulsating after the honey bee has been removed

Honey bee stinger and poison sac detach and remain embedded in skin

Schmidt Sting Pain Index

- **Attempts to rank relative painfulness of the sting by various bees, wasps, ants (Hymenoptera)**
  - **1 to 4 ranking**
- **Descriptive comments may be added**
- **Top ranking sting – Bullet ant (4.0+)**
  - **“Pure, intense brilliant pain. Like fire walking over flaming charcoal with a 3-inch rusty nail in your heel”**

Schmidt Sting Pain Index

Honey Bee (2.x)

“Like a match head that flips off and burns your skin”

Some Features of Honey Bees

- Colony construction material – Wax (hexagonal form)
- Colonies have strict social structure
  - Queen, workers, drones
- Nectar and pollen used for food
  - Pollen is carried on pollen baskets of the legs

Some Features of Honey Bees

- Colony is perennial
- Reproduction is through swarming
- Stinger of workers is barbed

Bumble Bees

Bombus species

5393468

Bumble Bee
Van Waters & Rogers
1985 division of Univar

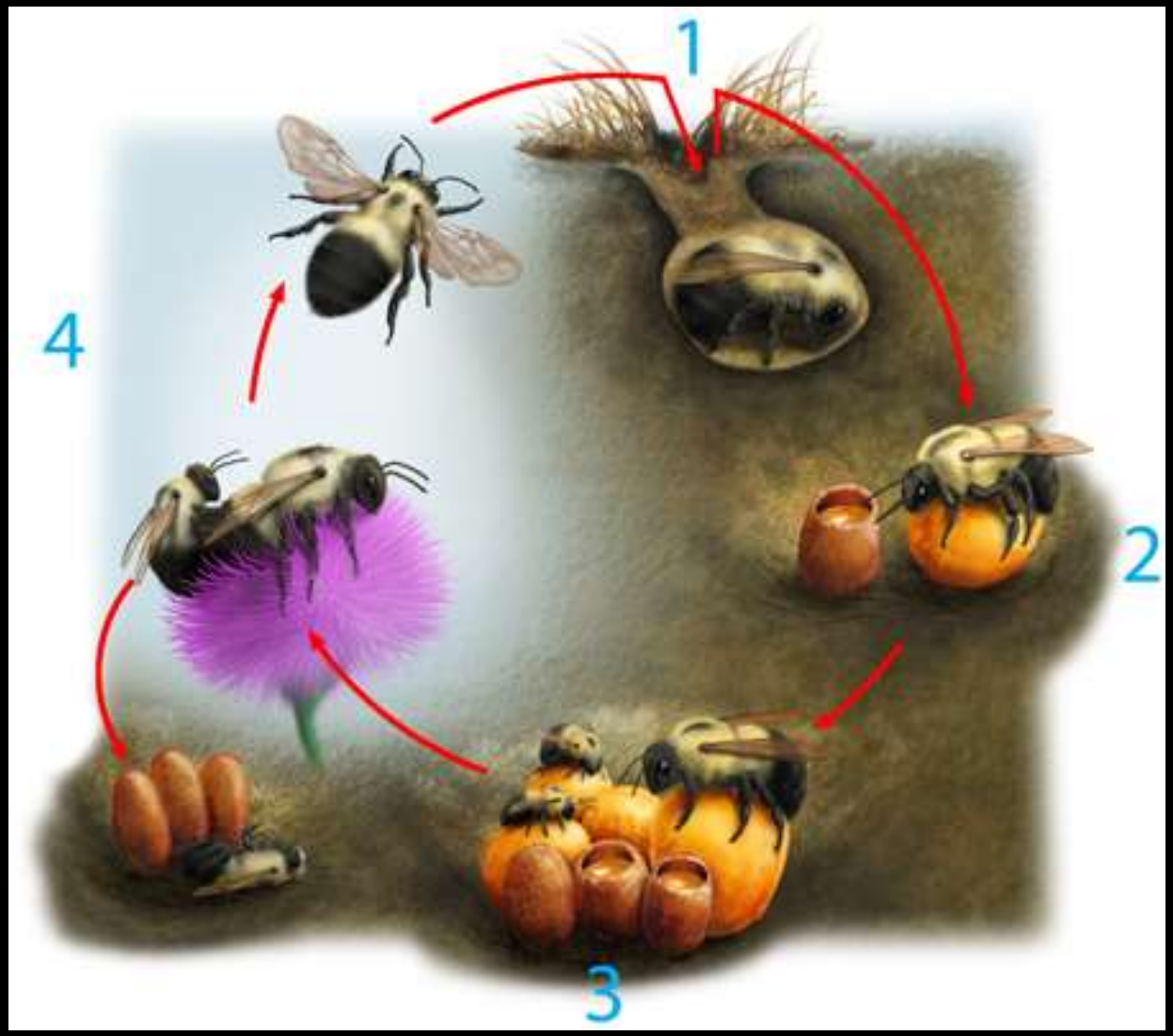
Bumble Bees

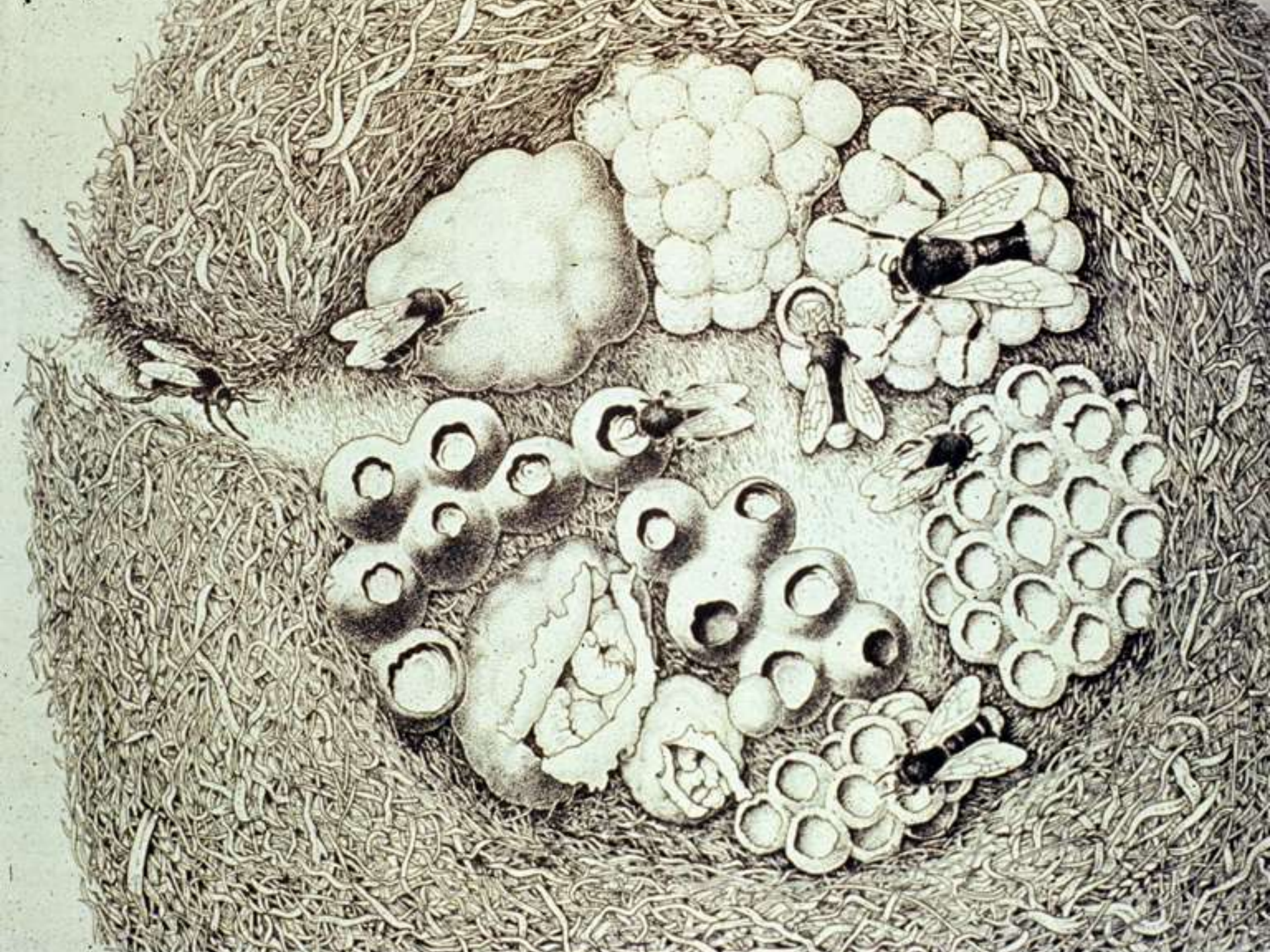
Photograph by Bob Hammon

FROM:

THE XERCES SOCIETY
FOR INVERTEBRATE CONSERVATION

Bumble Bee Life History





Vacated Bird House inhabited by Bumble Bees

Van Waters & Rogers
1986 division of Univar

Bumble Bee Stages

Top Left: Capped Pupae

Above: Pupa

Left: Larva

Wax Storage Pots of Bumble Bees

Perennial Colony or Annual Colony?

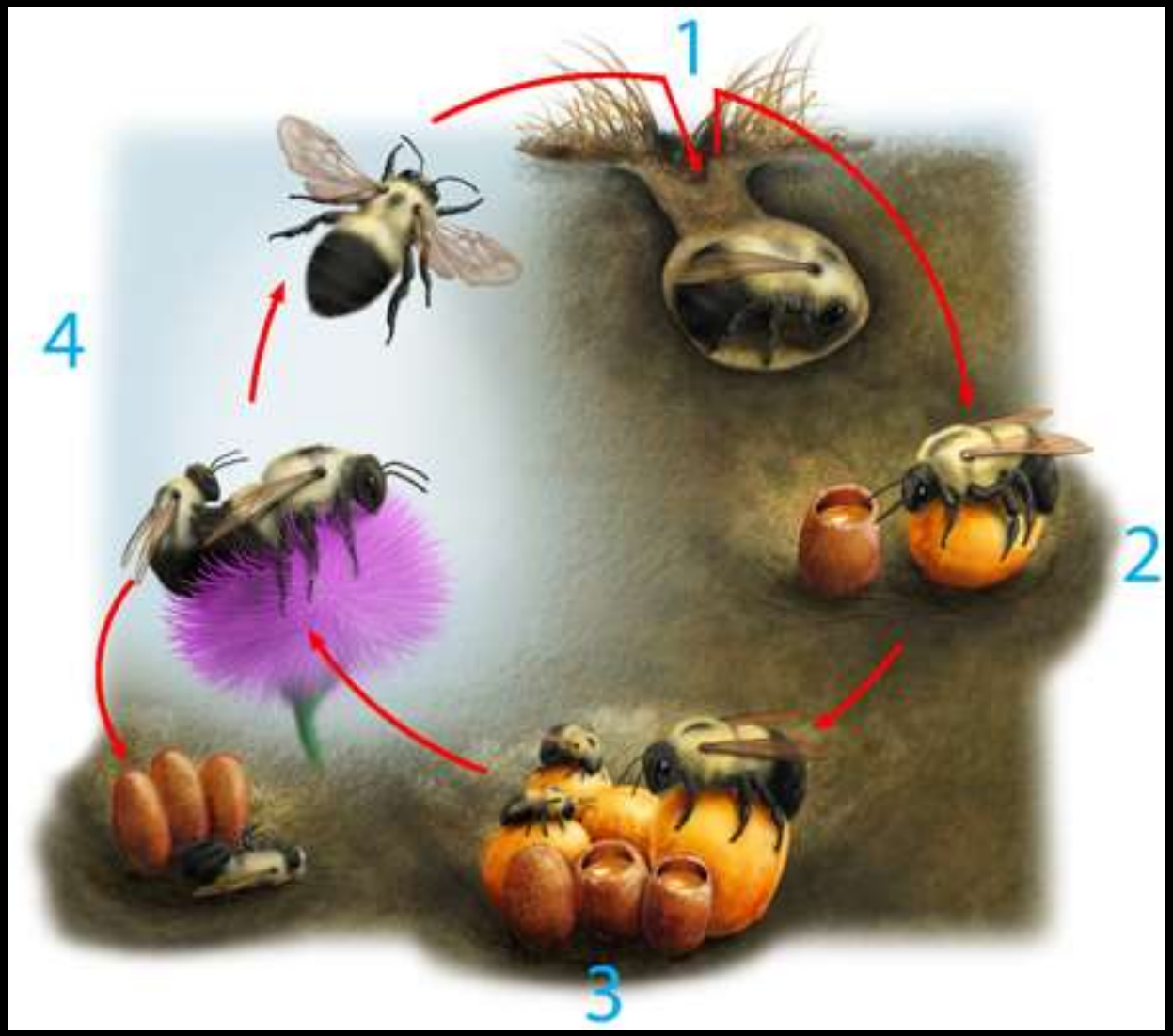
Bumble bees make annual colonies

Bumble Bee Queen and Worker

FROM:

THE XERCES SOCIETY
FOR INVERTEBRATE CONSERVATION

Bumble Bee Life History



Bombus huntii – Overwintered queen on left

Male bumble bees

Bumble bees carry pollen in pollen sacs on the hind legs

Bumble Bees are “buzz pollinators”

Some plants are dependent on buzz pollination

Bumble bee brushing pollen from body into pollen baskets

Giant Greenhouses Mean Flavorful Tomatoes All Year

Stacey Cramp for The New York Times

Some plants (e.g. the tomato) are dependent on buzz pollination

biobest
Bombus occidentalis
biobest
BUMBLEBEE POLLINATION

THIS IS NOT JUST A BUMBLEBEE
THIS IS NATUPOL® EXCEL

Opening the top of the bumble bee hive allows viewing of the colony within

Entrance/Exit

Wax pots

Workers

Queen

Food source (sugar water)

Some Features of Bumble Bees

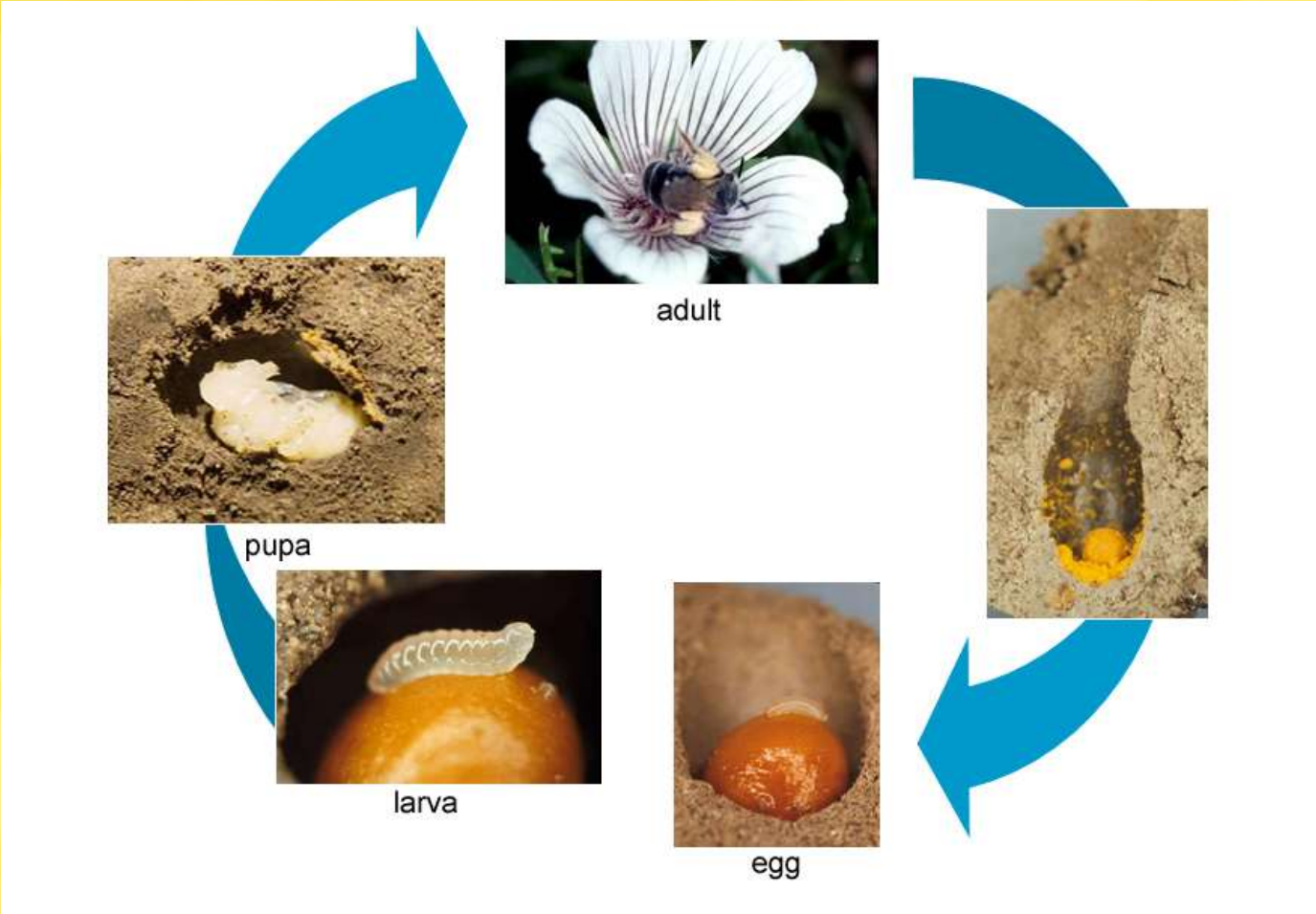
- Colony construction material – Wax (round cells)
- Colonies have social structure
  - Queen, workers, drones
- Nectar and pollen used for food
  - Pollen is carried on pollen baskets of the legs

Some Features of Bumble Bees

- Colony is annual
- Reproduction is through production of overwintering queens
- Stinger of workers is not barbed

Social Structures of Bees

Native solitary bee life cycle



The life cycle of a solitary bee consists of four stages: egg, larva, pupa and adult. Solitary adult bees provision their young with a pollen-ball, illustrated above.

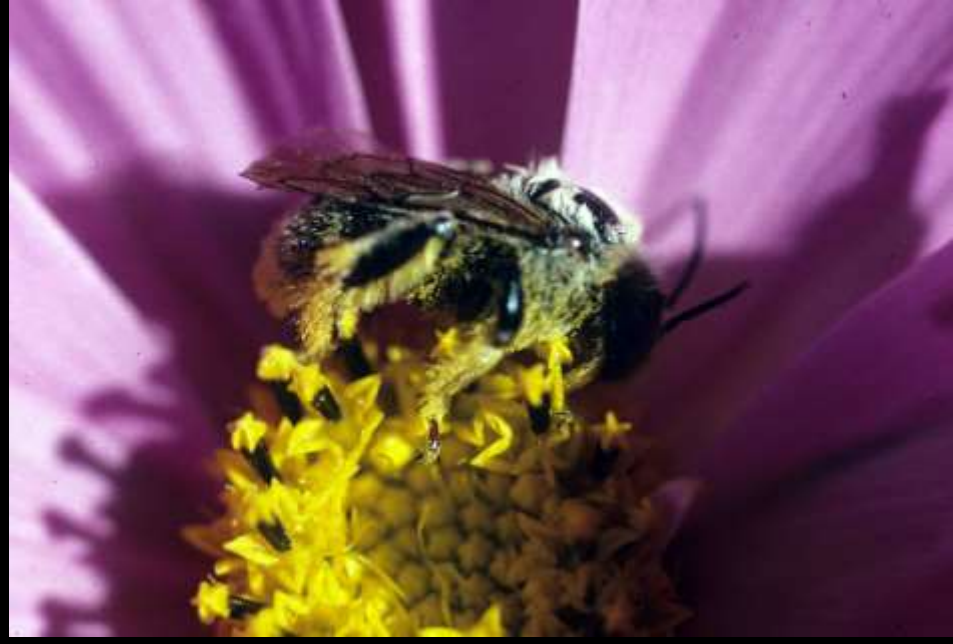
All photographs in this illustration are by Dennis Briggs except the photograph of the pupa, which is by Robbin Thorp.

The great majority of Colorado's 900+ species of solitary bees nest in the ground

Solitary Bees

Digger Bees, Andrenid Bees, Sweat Bees

Hymenoptera: Apidae (Anthoporinae)
Hymenoptera: Andrenidae
Hymenoptera: Halictidae



Digger Bees

Digger bee nesting site near Roggen, Colorado

Bushmuh 50

Alkali bee nesting sites

Andrenid Bee nest site

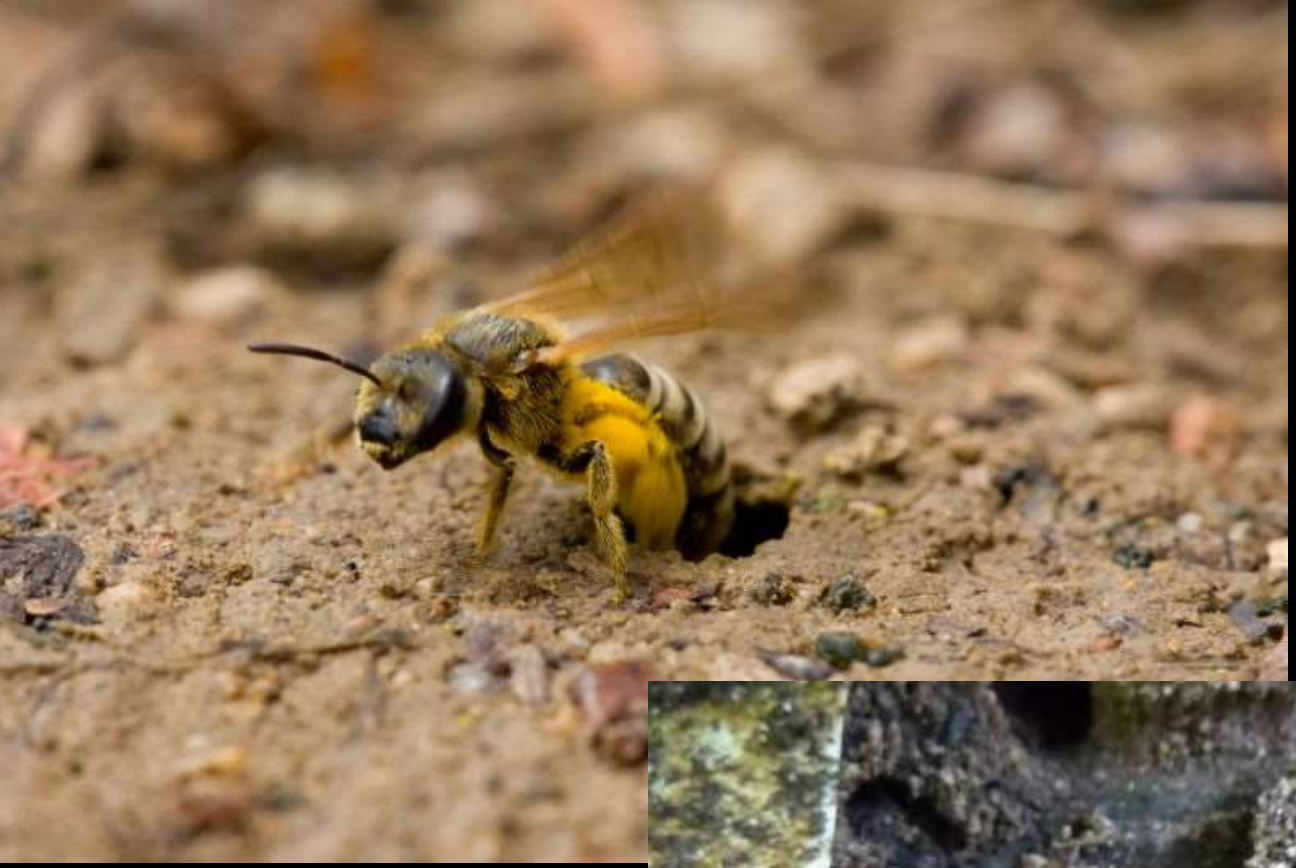
Solitary Bees

Sweat Bees

Hymenoptera: Halictidae

Sweat bee (left) and honey bee (right) in thistle flower

Sweat Bees



Schmidt Sting Pain Index

Sweat Bee (1.0)

“Light, ephemeral almost fruity. A tiny spark has singed a single hair on your arm”

Solitary Bees

Leafcutter Bees

Hymenoptera: Megachilidae

Leafcutting Bee damage to rose leaves

Van Waters & Rogers
1983 division of Univar

Leafcutter Bee Excavating Rotten Porch Board

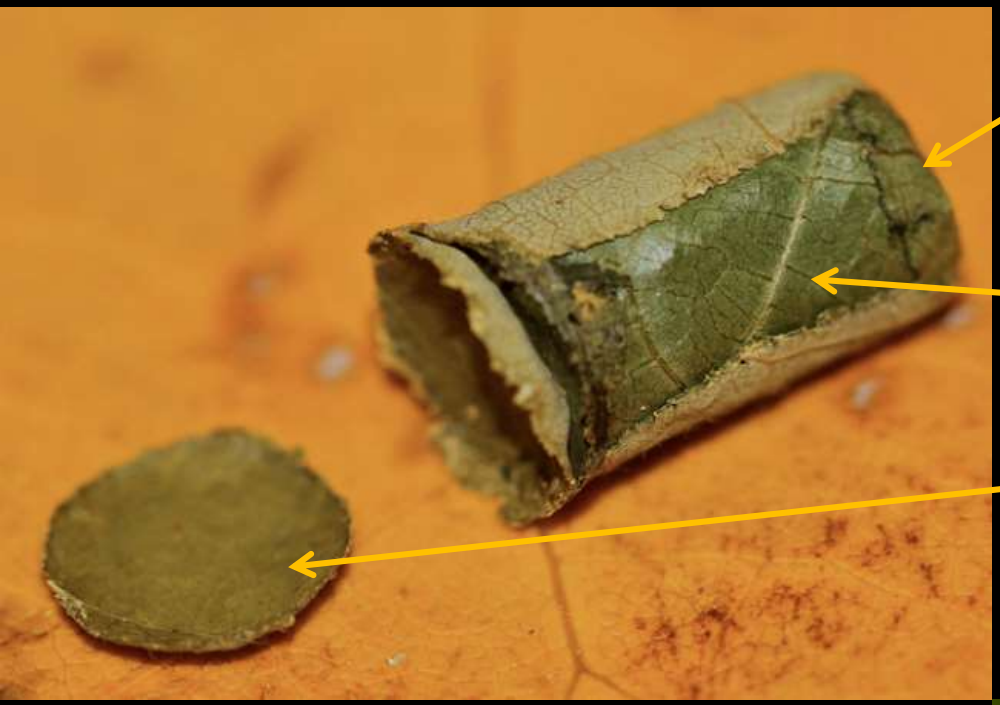
Leafcutter bee excavation in rotten garden timber

Leafcutter bee cutting leaf fragment (above) and carrying it back to nest (left)

Leafcutter Bee Damage to Rose, Lilac and Virginia Creeper

Leafcutter bee returning with leaf fragment

For nest construction:



- 3-4 rectangular pieces, crimped for the base
- Oval pieces along the sides of the cell
- Nearly perfect circles used to cap the cell

For nest construction:

3-4 rectangular pieces, crimped for the base

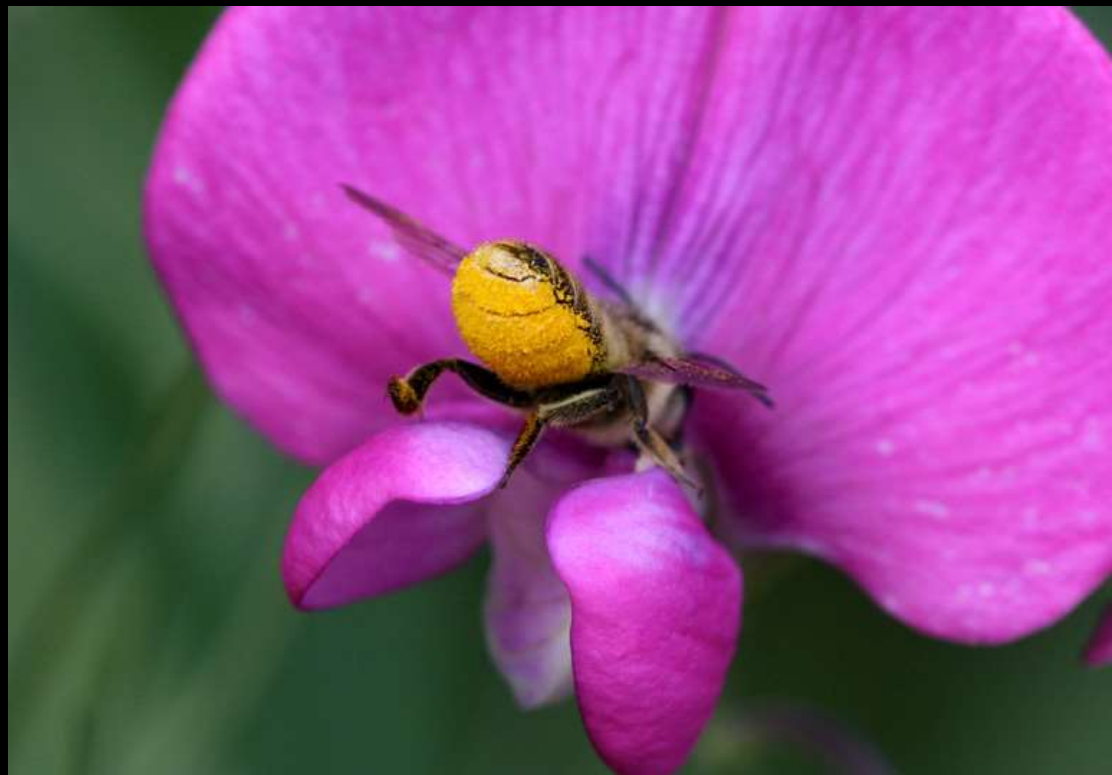
Oval pieces along the sides of the cell

Near perfect circles used to cap the cell

All leaf fragments are oriented with the smooth side inwards

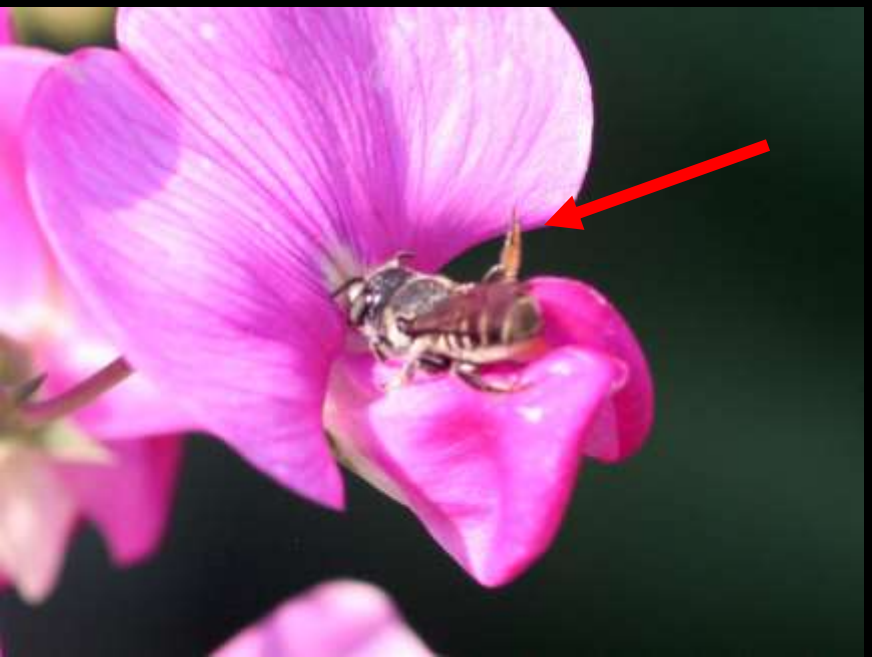
Leafcutter bee collecting pollen

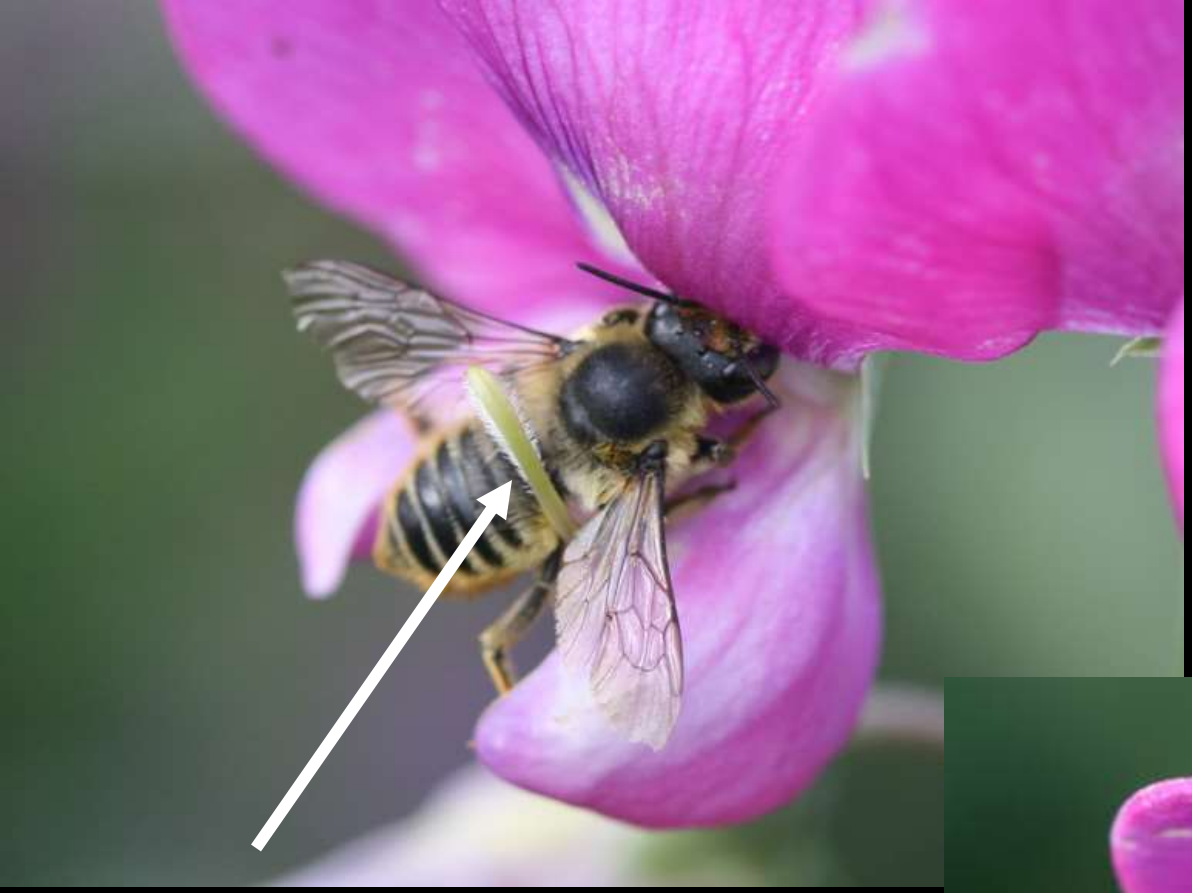
Leafcutter bees carry their pollen on the underside of the abdomen



Leafcutter bee working sweet pea flower.

Note how the anthers become exposed as the bee pushes the flower while nectaring





Leafcutter bee cells in hollowed stem of a weed

Leafcutter Bee Boards

Alfalfa leafcutter bees for alfalfa seed pollination

Leafcutter Bees used to pollinate alfalfa for seed in southern Montana

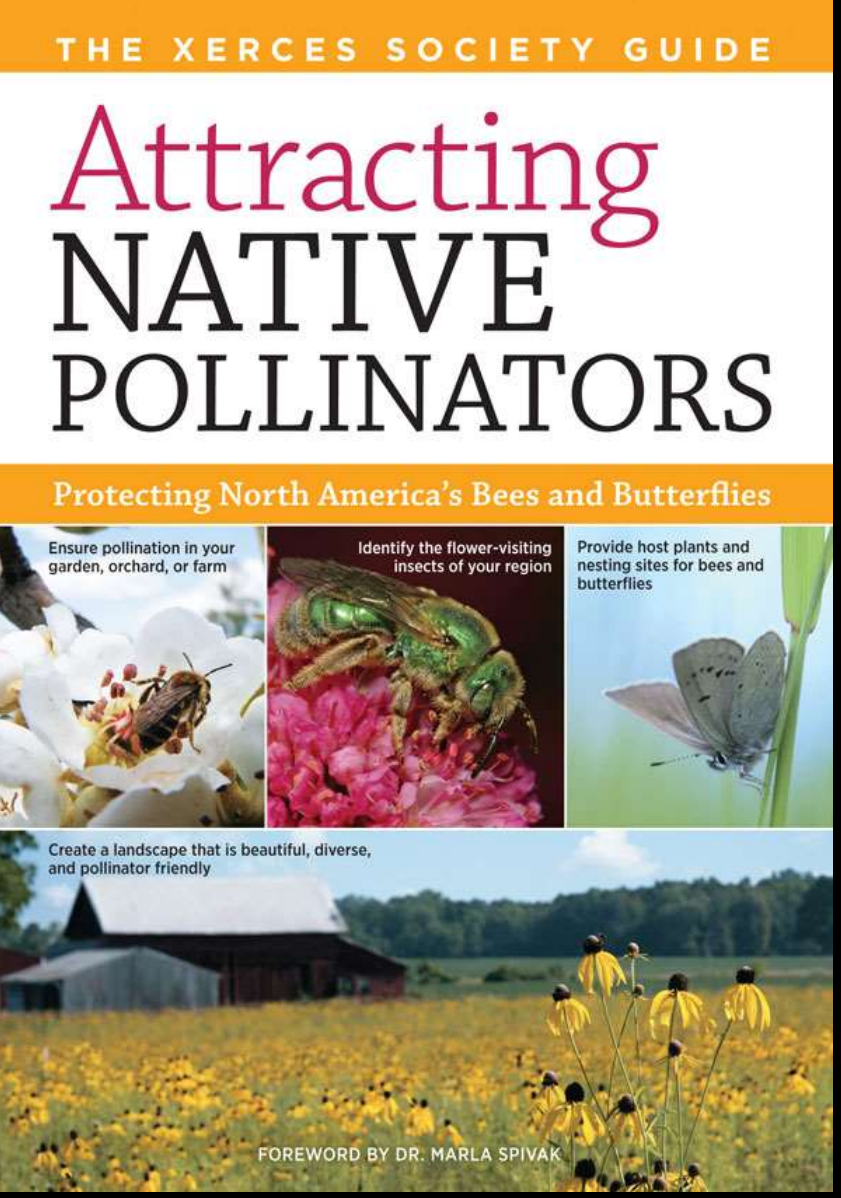
Photograph by Sami Waters

Photograph by Sami Waters

Leafcutting Bee adult
cutting a leaf for its nest
Van Waters & Rogers Inc.
1989 subsidiary of Univar

Mason Bees
(*Osmia* species)

Predrilled wood for nesting by the orchard mason bee/ Blue orchard bee

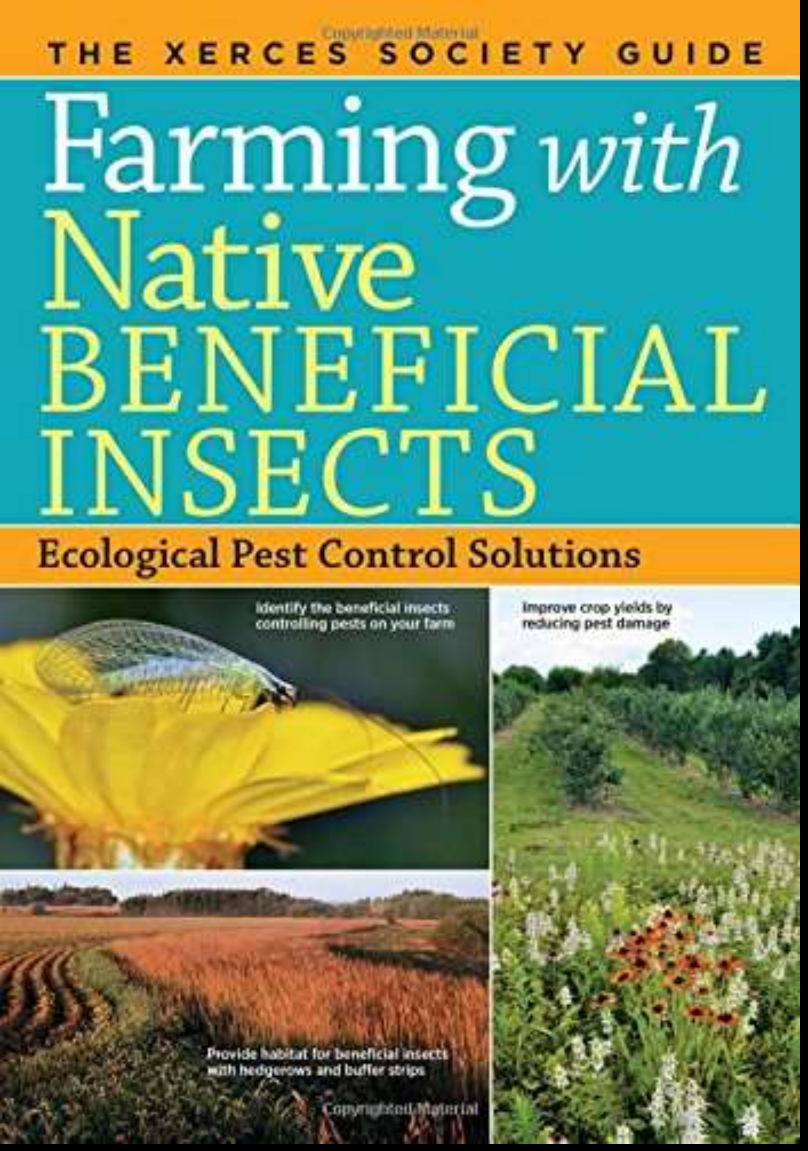


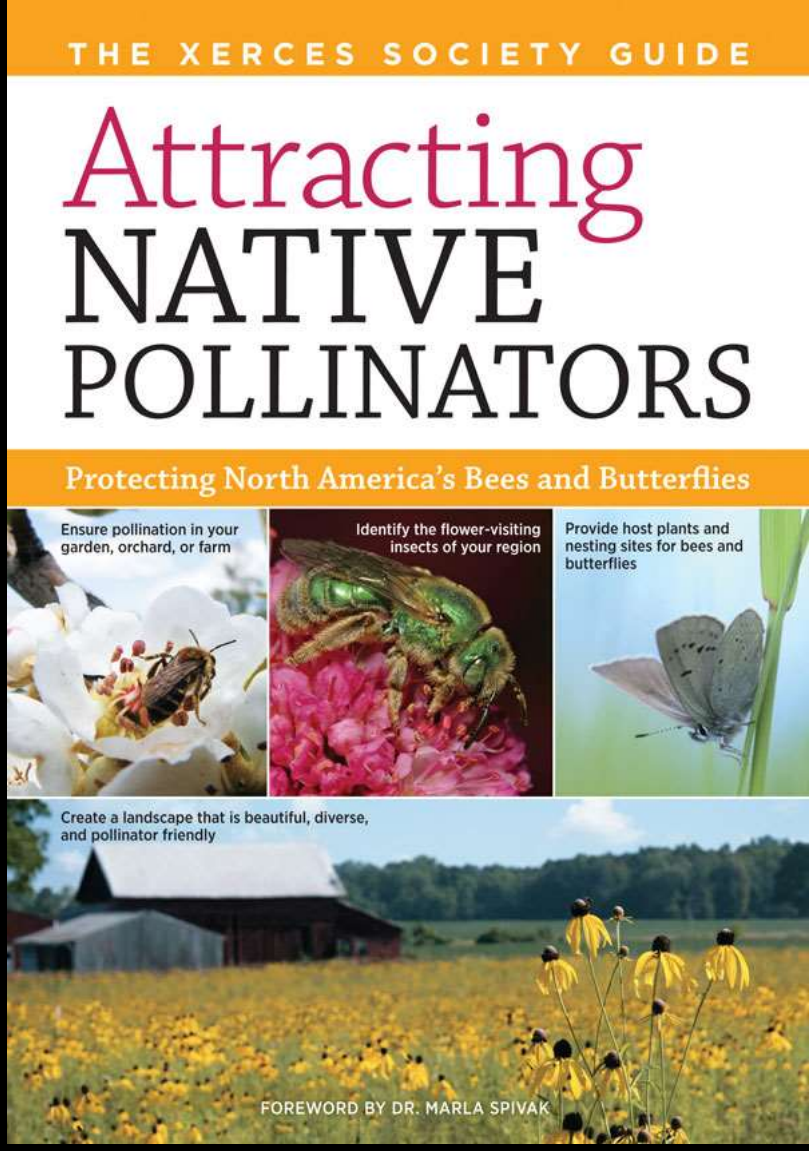
Best publication on the subject of improving habitat for native pollinators!

Another good publication – *and free online*

"Gardening for Native Bees in Utah and Beyond"

Utah State Extension Bulletin ENT-133-09





A pair of publications on how to modify habitat to augment populations of "beneficial" insects (pollinators, natural enemies)

Common Families of Bees and Wasps

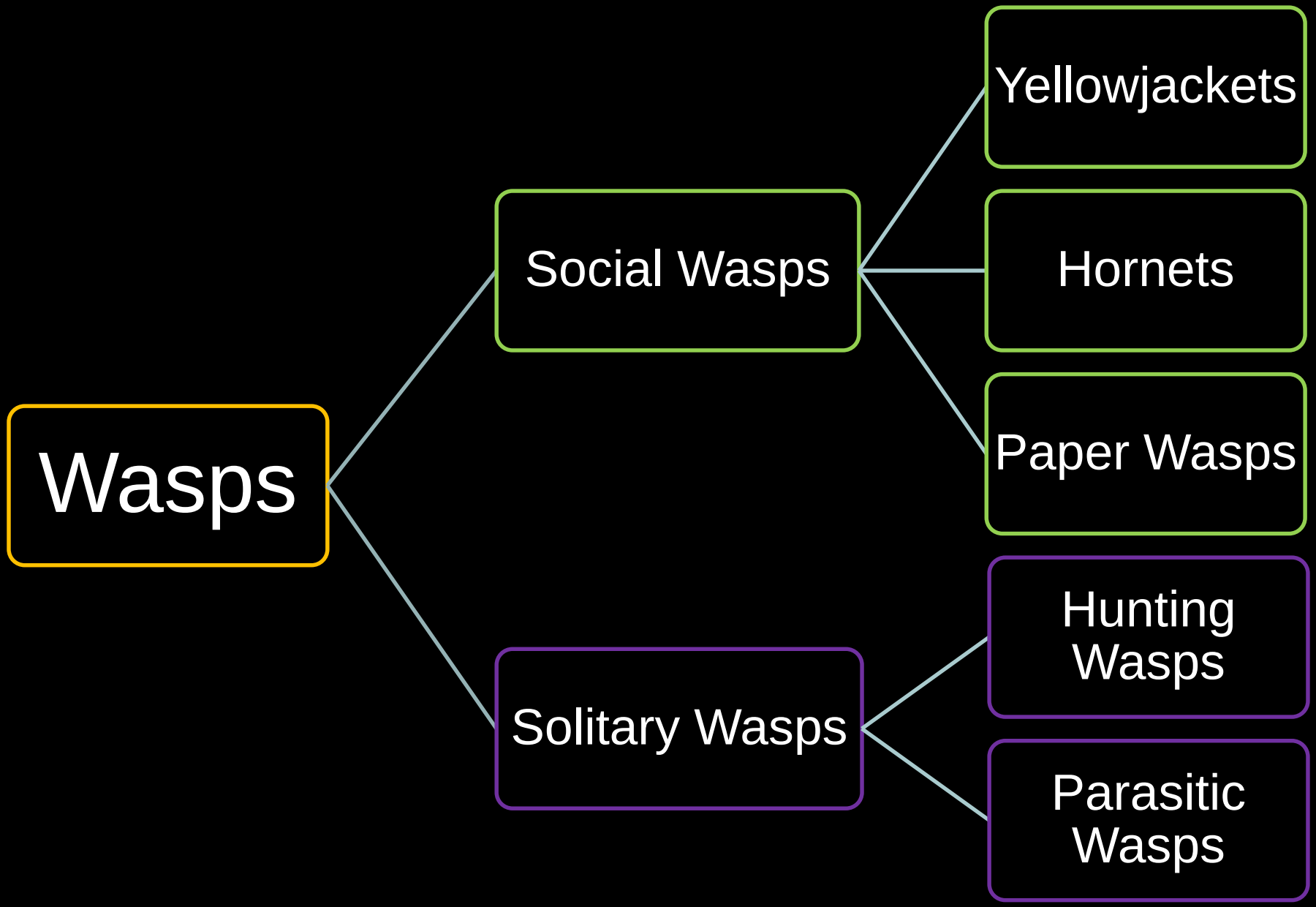
Bees

- **Apidae** (honey bees, bumble bees, digger bees, carpenter bees)
- **Megachilidae** (leafcutter bees, mason bees, sower bees)
- **Andrenidae** (ground-nesting bees)
- **Halicticidae** (sweat bees)
- **Colletidae** (plasterer bees)

Wasps

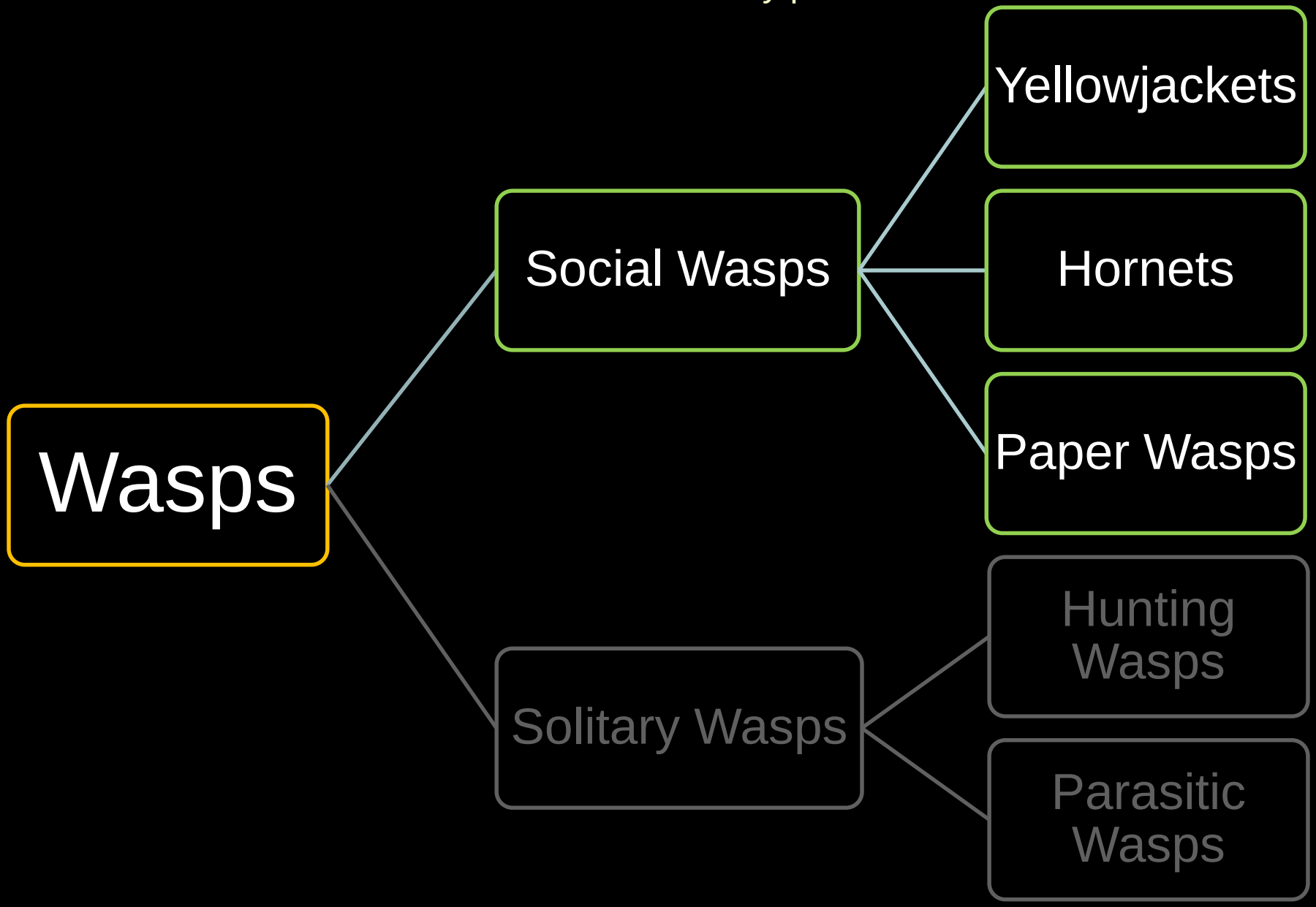
- **Vespidae** (paper wasps, yellowjackets, hornets, potter wasps)
- **Sphecidae** (hunting wasps)
- **Pompilidae** (spider wasps
- **Mutillidae** (velvet ants)
- **…..other families of predatory Hymenoptera**
- **…..myriad families of parasitic Hymenoptera**
- **…. Gall wasps?**

Social Structures of Wasps



Common Social Wasps

Note: All are annual colony producers



Yellowjackets

Vespula species

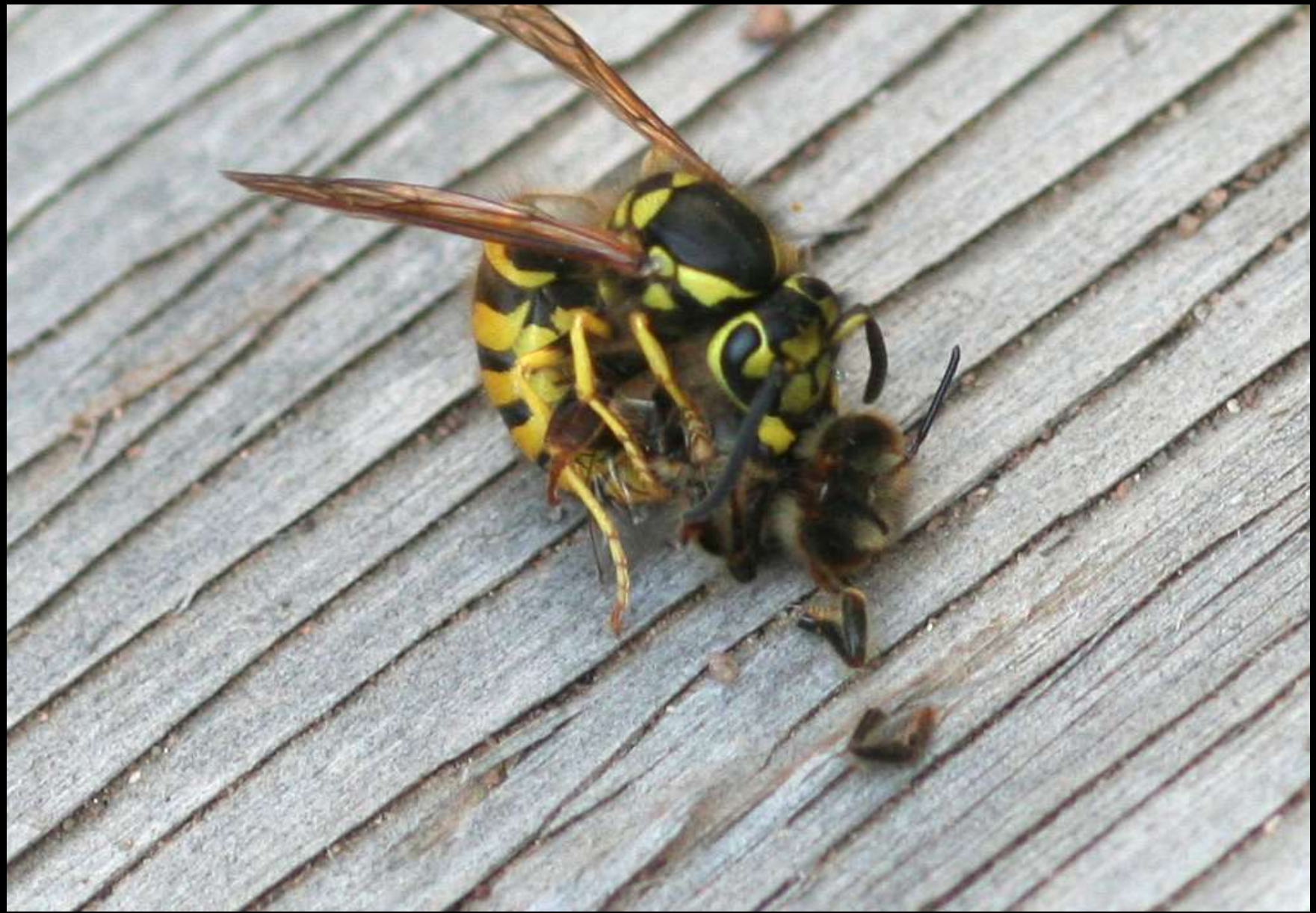
Western Yellowjacket (*Vespula pensylvanica*)

The most important stinging insect in western North America

The western yellowjacket feeds its young animal matter – usually carrion or dead insects

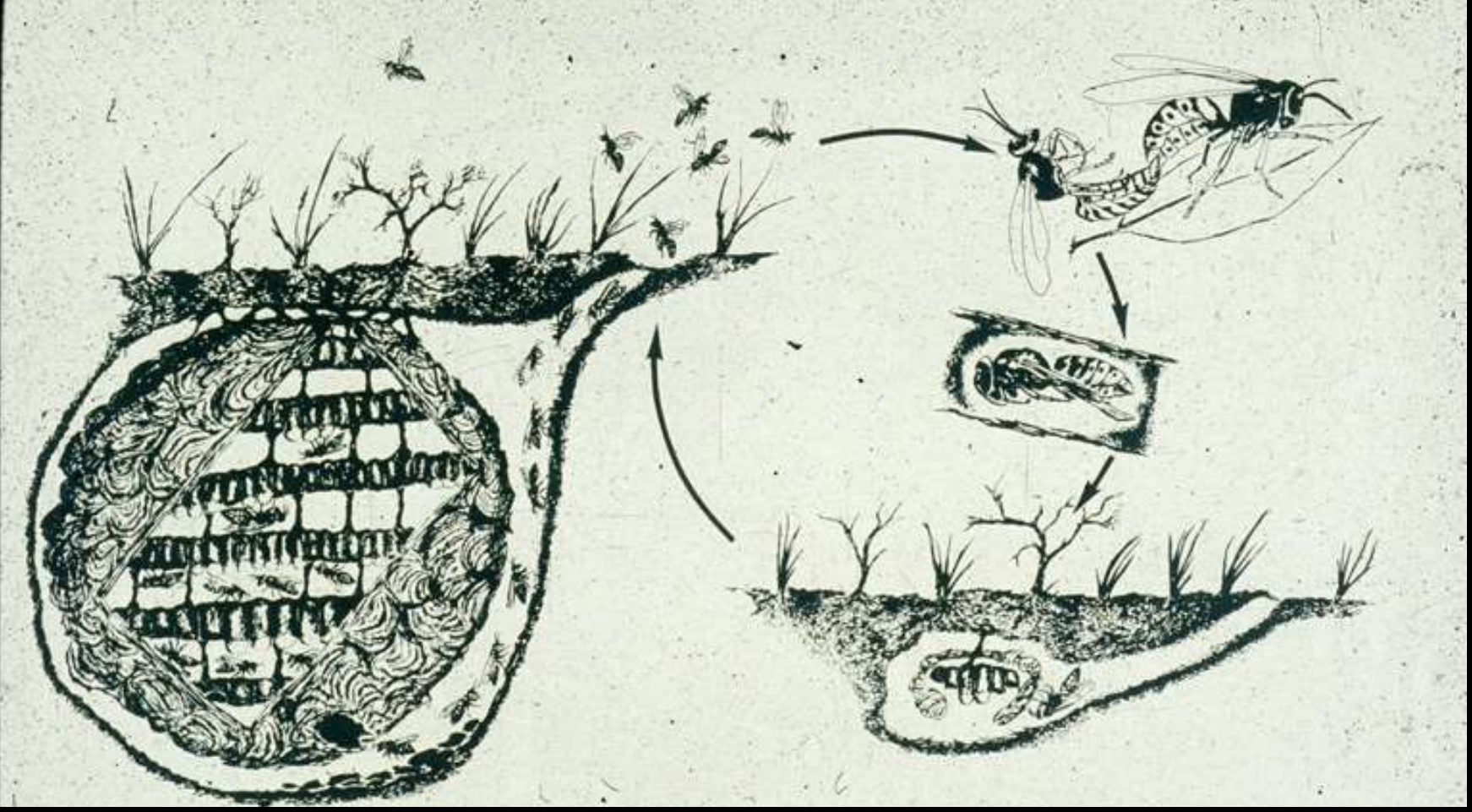
Western yellowjacket scavenging on meat (left), dead earthworm (below, left) and splattered insects on automobile

Yellowjackets scavenge at weak honey bee colonies and eat dead bees



They will commonly feed on meaty materials in outdoor dining areas

…and also take sweets

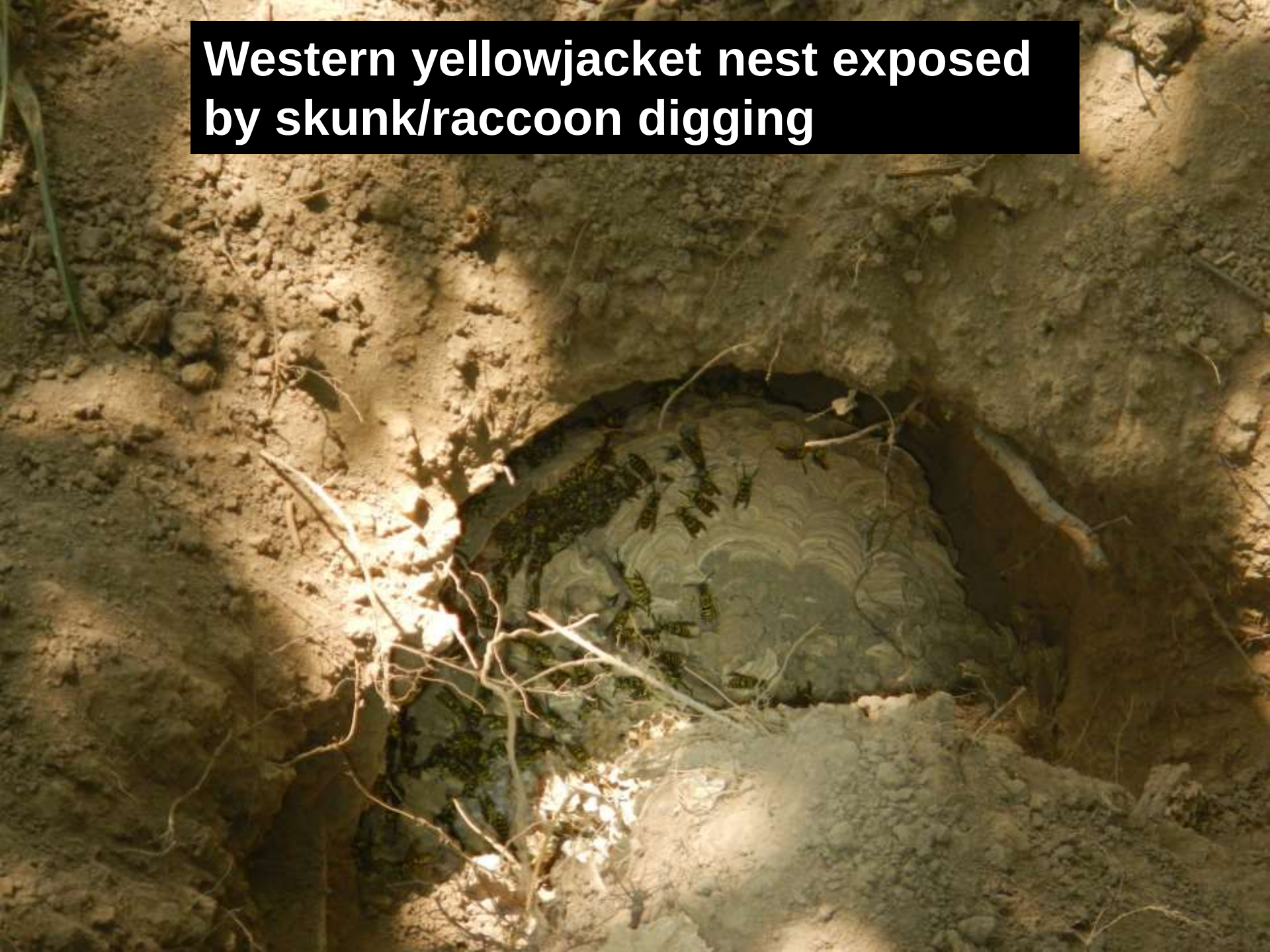


Yellowjackets produce new nest every year.

Nests are established in spring by a single queen.

Nest are abandoned at the end of the season. Fertilized females – queens – produced near the end of the year are the only stage that survives between seasons.

Yellowjacket nests are always hidden, usually underground


Western yellowjacket nest exposed
by skunk/raccoon digging

Nest form is a series of paper combs – used for rearing larvae – surrounded by a paper envelope

Yellowjacket adult wasp
tending larvae
Van Waters & Rogers Inc.
1987
subsidiary of Univar

Western yellowjacket nest at base of wall and spruce tree in my yard

Note mud at entrance from excavations during colony expansion

Yellowjacket nest with excavated mud piled near nest entrance

Nest entrances are often inconspicuous

Nest entrances are usually guarded

Wasp stingers *are not* barbed

Most “bee stings” *are not* produced by bees*!!!!*

Yellowjackets likely cause 90%+ of all “bee stings” in Colorado

Schmidt Sting Pain Index

Yellowjacket (2.0)

“Hot & smoky, almost irreverent. Imagine W.C. Fields extinguishing a cigar on your tongue.”

Yellowjackets as pollinators?
***Marginal*, at best.**

Yellowjackets almost always nest below ground

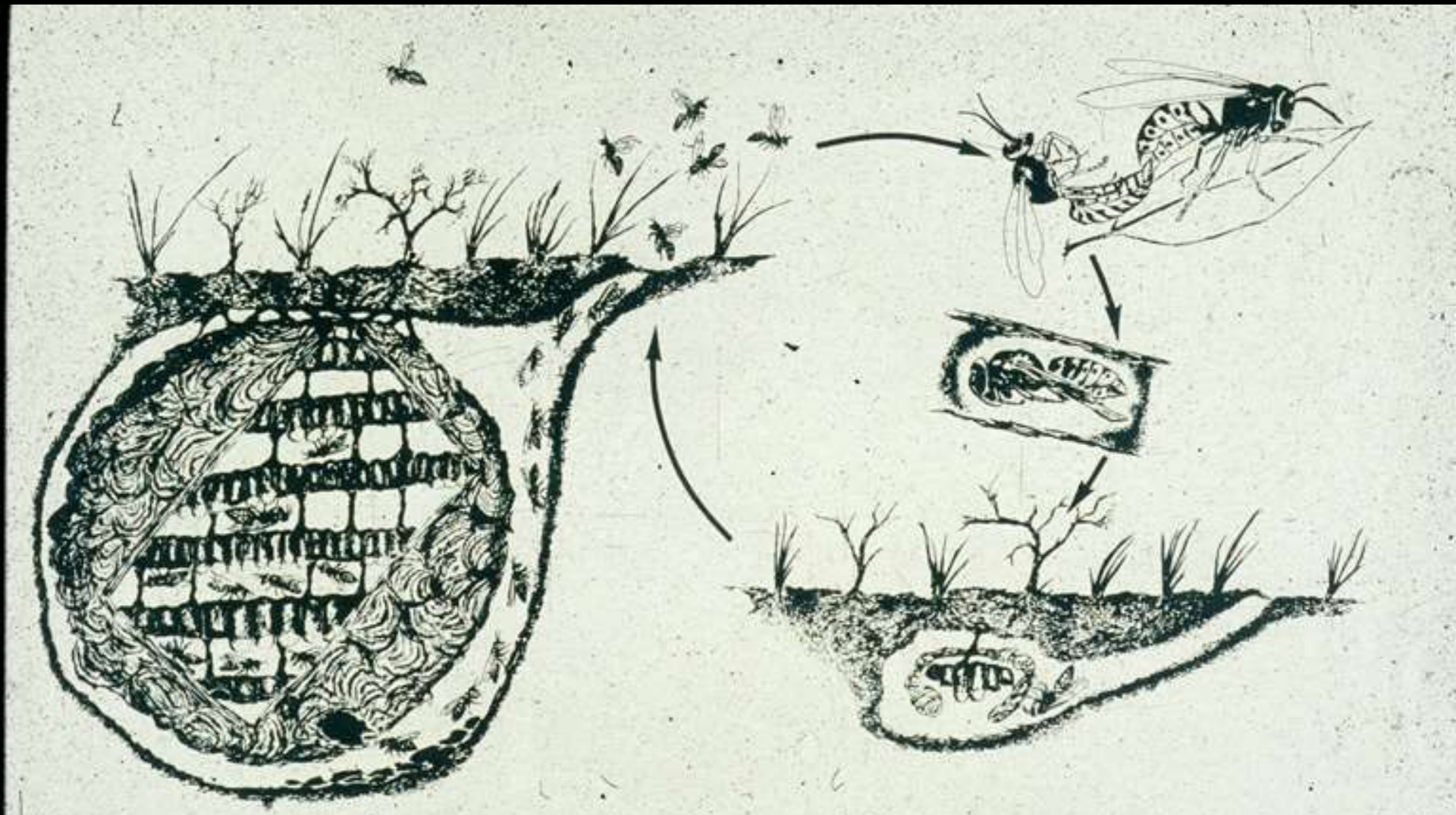


FIGURE 29 — Yellowjacket life cycle (*Vespula pensylvanica*): *a*, Mating; *b*, fertilized queen in diapause during winter months; *c*, queen nest beneath soil surface; *d*, nest at peak of colony development (J. Krispyn).

Western yellowjacket nest located in an abandoned compost pile. This was dissected on September 28, 2018

About a foot below the surface
the top of the nest was reached

More complete excavation of
the nest showed it to be about
a foot in diameter

The entrance of the nest was about 18 inches from the opening to the outside of the compost pile

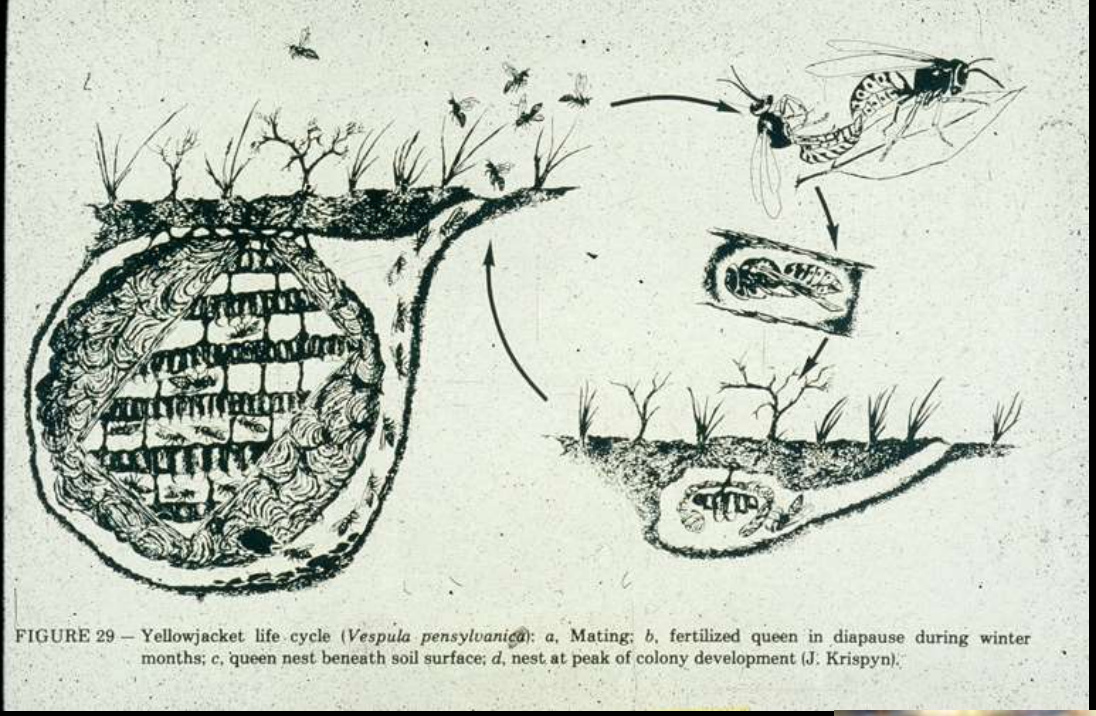


FIGURE 29 — Yellowjacket life cycle (*Vespula pensylvanica*): *a*, Mating; *b*, fertilized queen in diapause during winter months; *c*, queen nest beneath soil surface; *d*, nest at peak of colony development (J. Krispyn).

Nests are **annual**, constructed anew each year

The only stage surviving between seasons are **fertilized queens**, produced in late summer and early fall.

Ultimate colony size can be many hundreds by the end of summer.

The nest consisted of multiple layers of paper comb.

Developing brood were present – almost all of which were reproductive forms (future queens, males)

Only *a few* females, fertilized potential future queens will survive between seasons.

A rough guesstimate of the number of capped brood

> 750!!!!!!

Date of nest dissection – September 28

Many traps are sold to capture yellowjacket wasps

2015 Yellowjacket Trapping Trials

Traps that caught the most western yellowjackets in 2015 trials

Rescue! OnamenTrap (Liquid trap)

SpringStar (Oak Stump) Liquid Trap

AlphaScent Lure with Yellow Card

Traps that are *very poor* in capturing yellowjackets

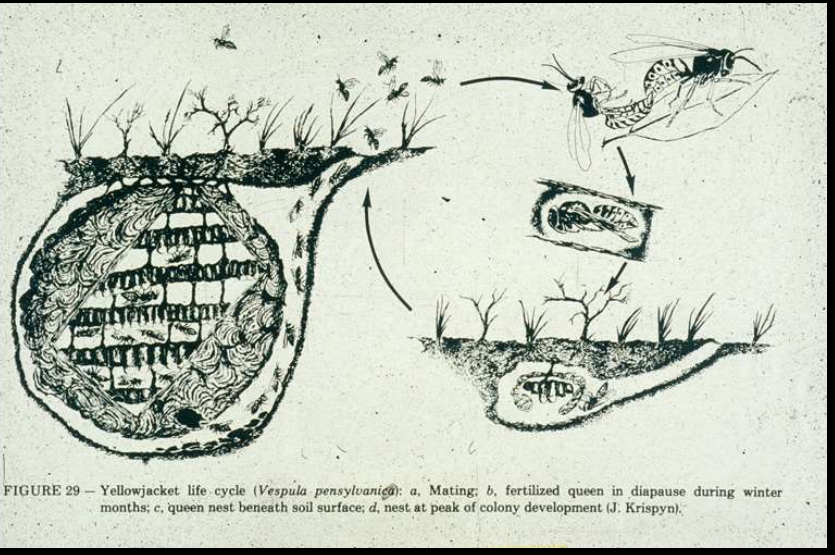


FIGURE 29 — Yellowjacket life cycle (*Vespula pensylvanica*): *a*, Mating; *b*, fertilized queen in diapause during winter months; *c*, queen nest beneath soil surface; *d*, nest at peak of colony development (J. Krispyn).

Most effective use of yellowjacket traps?

Probably early in the year targeting overwintered queens

A rough guesstimate of the number of capped brood

> 750!!!!!!

Date of nest dissection – September 28

Hornets

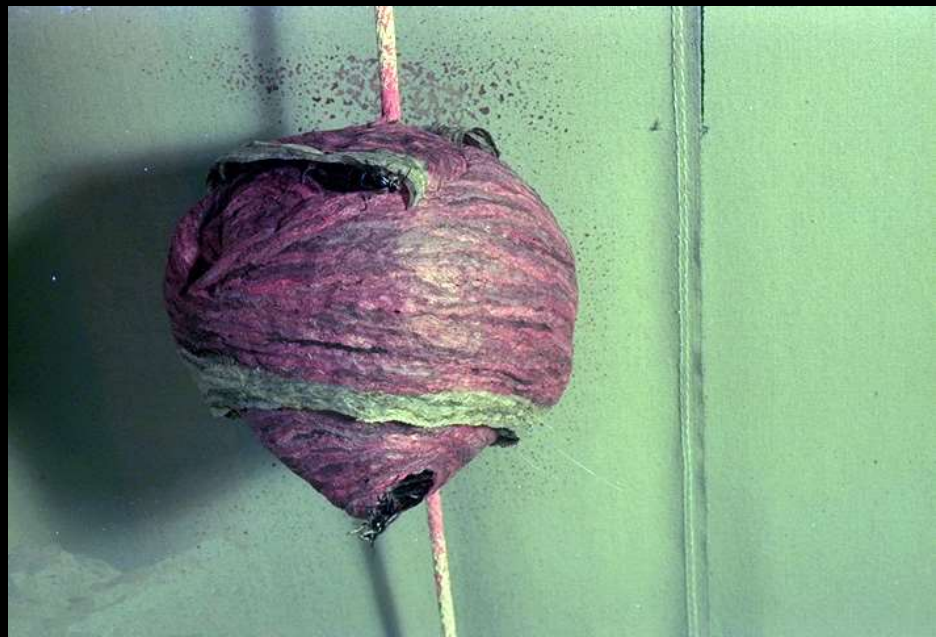
Dolichovespula species

Two species in Colorado. **Both are predators of live insects.** Neither visits dining areas for food.

Baldfaced Hornet

Dolichovespula maculata

Baldfaced hornet usually nests in trees and shrubs



Aerial Yellowjacket

Dolichovespula arenaria

Aerial yellowjacket nests under eaves and on sides of buildings

The stinger of baldfaced hornet and aerial yellowjacket is not barbed

Schmidt Sting Pain Index

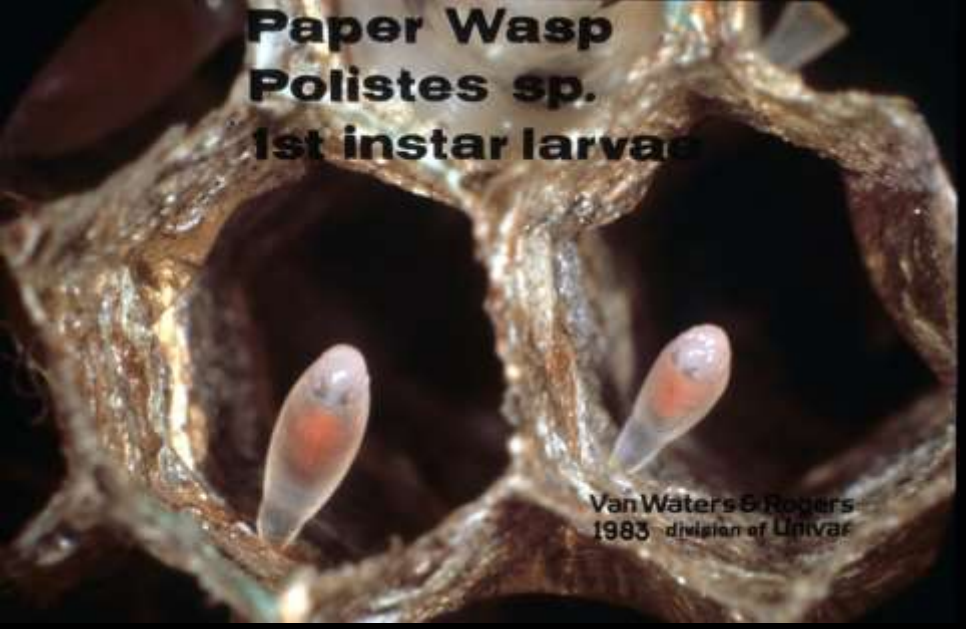
Baldfaced Hornet (2.0)

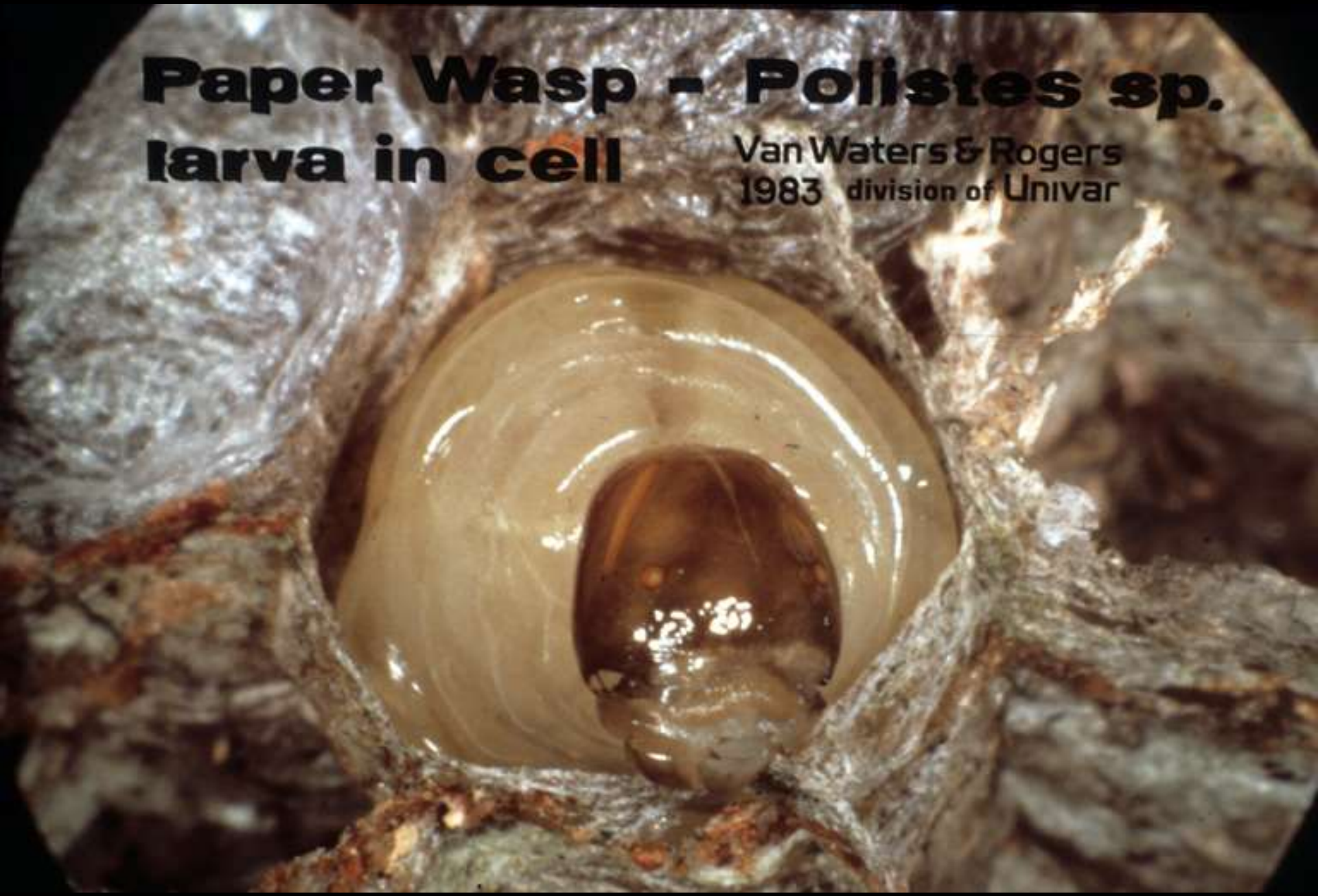
“Rich, hearty, slightly crunchy. Similar to having your hand mushed in a revolving door.”

Paper Wasps

Polistes **species, primarily**

Paper wasp gnawing on weathered board for wood fibers


Paper Wasp
Polistes sp.
1st instar larvae
Van Waters & Rogers
1983 division of Univar


Paper Wasp - Polistes sp.
larva in cell
Van Waters & Rogers
1983 division of Univar

The food fed to paper wasp larvae

Live insects chewed into “bug burger”

Paper wasps native to Colorado

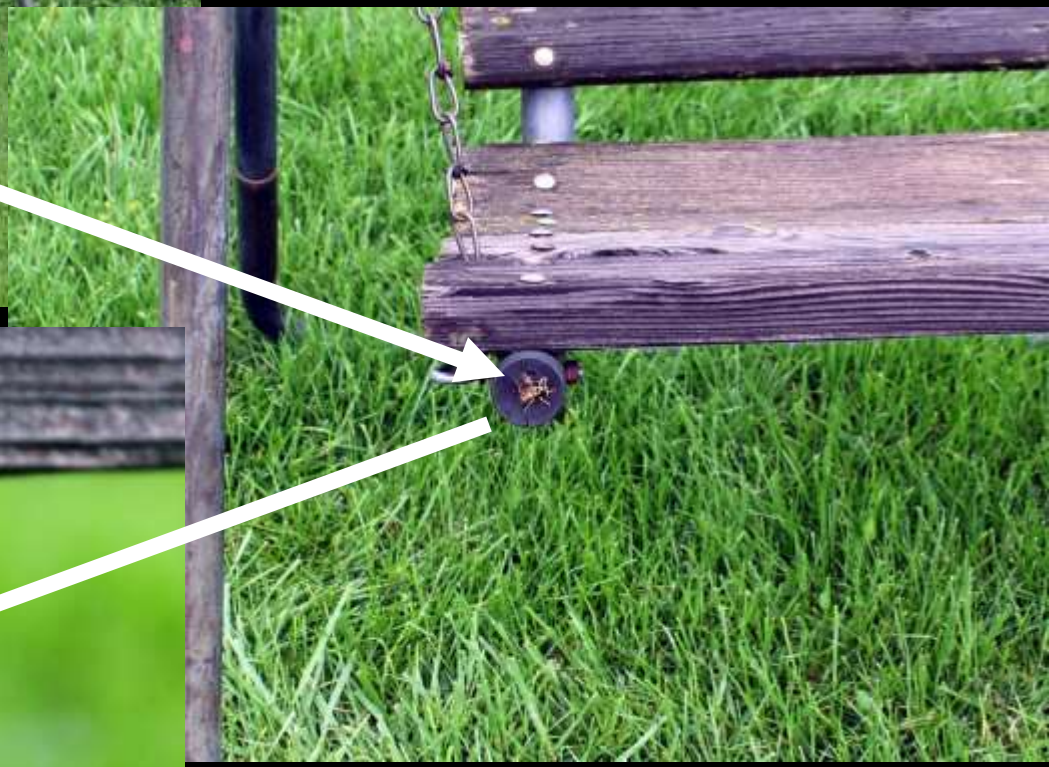
Nests produced by native species of paper wasps

European Paper Wasp

Polistes dominula

A new species in Colorado (post 1998 in Western CO, 2001 Eastern CO)

European paper wasp nesting in metal building support



European paper wasps in our clothes line

Schmidt Sting Pain Index

Paper Wasp (3.0)

“Caustic and burning. Distinctly bitter aftertaste. Like spilling a beaker of hydrochloric acid on a paper cut.”

European paper wasp nest established on growing sweet corn!

Photograph courtesy of Joseph Berger/BugWood.org

Large Nest of European Paper Wasp

Some Impacts of the European paper wasp on the Rocky Mountain West

- Added a significant new stinging pest to region
  - Highly visible
- Impacts on yard/garden Lepidoptera
- Stimulates inappropriate purchases of wasp traps

Nests are found everywhere and very frequently observed.

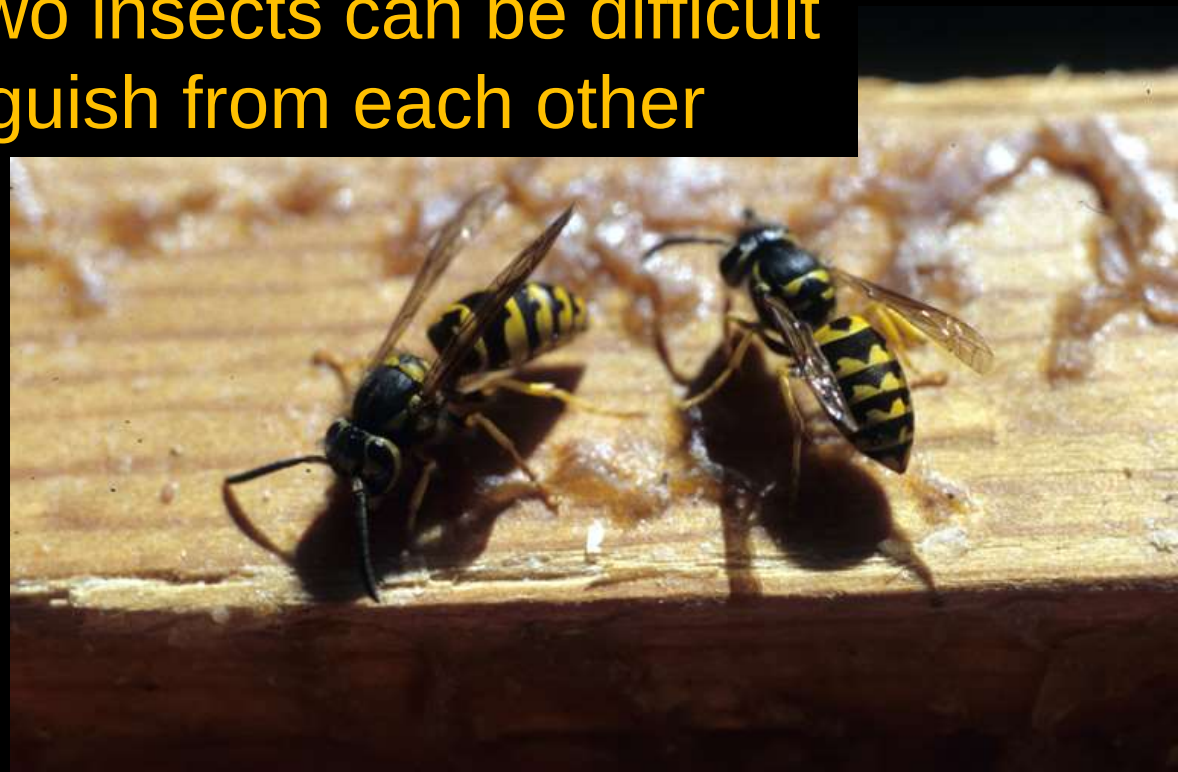
Stings are common, although not as common as by western yellowjacket.

Impacts on yard/garden Lepidoptera

European Paper Wasp

These two insects can be difficult to distinguish from each other

Western Yellowjacket



Western yellowjacket
Note trailing legs of European paper wasp

European Paper Wasp vs. Western Yellowjacket

European paper wasp

- Predator of insects, primarily
- Produces open nests above ground
- Less likely to sting than most social wasps/bees
- Not attracted to wasp traps

Western yellowjacket

- Scavenger. Commonly visits food and garbage.
- Produces below-ground or hidden nest
- Readily stings when nest disturbed
- Attracted to wasp traps

Traps do not capture the European paper wasp or any other paper wasps

Social Structures of Wasps

Hunting Wasps

Families Sphecidae, Crabronidae, Pompilidae

Hunting Wasp Habits

- Solitary wasps – no colony structure
- Young are fed paralyzed prey
- Nests are produced to rear young
  - Dug in soil, plant stems
  - Constructed of mud
  - Existing cavities
- Adults can sting, but are not aggressive
  - Sting of hunting wasps (Sphecidae) are mild
  - Sting of spider wasps (Pomplilidae) are very painful

Ammophila **wasp digging nest (left), carrying caterpillar prey (lower left), at nest entrance with prey (below)**

Bembix wasp digging while holding horse fly prey

Golden Digger Wasp –
Predator of grasshoppers and katydids

Steel-blue cricket hunter with prey

Photograph by Bob Hammon

Cicada Killer –
Colorado's largest hunting wasp

Bicyrtes quadrifasciatus – a hunting wasp that nests in sandy soils

Stink bugs and leaffooted bugs are prey for this insect

Insect prey collected from nests of sand wasps at a Longmont playground

Grass Carrying Wasps (I*sodontia* spp.)

Predators of tree crickets

Grass carrying wasps may nest in tracks of windows

Nest of Isodontia mexicana with cocoons and cells provisioned with tree crickets

Kevin O'Neill/MSU

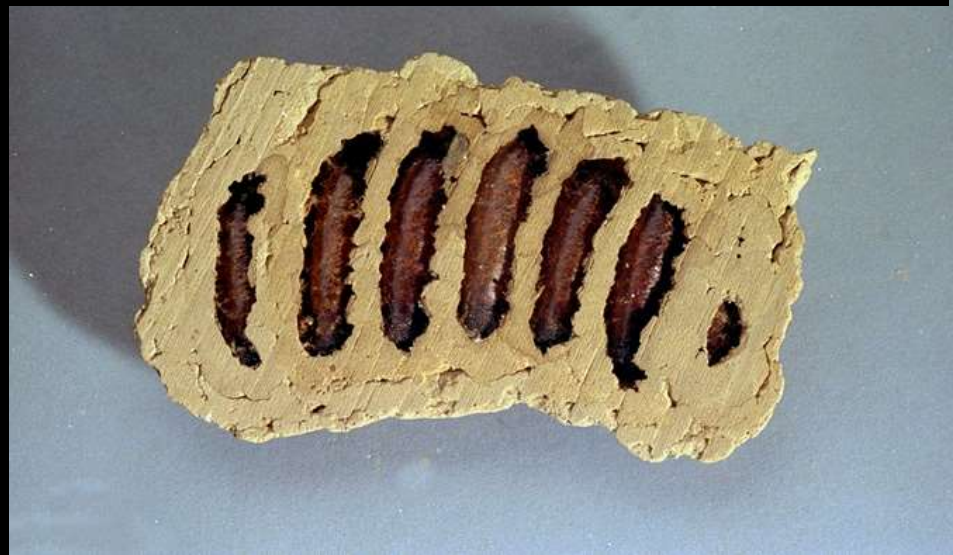
Pseneo punctatus

A hunting wasp that preys on leafhoppers, and nests in soil cracks (often around the edges of flower pots)

Black and Yellow Mud Dauber

Black and Yellow Mud Dauber (*Sceliphron caementarium*)

Nest (top left), crab spider prey cache (top right), larva feeding on spider prey (below left) and cocoons of pupae (below right) . Photographs courtesy of Ken Gray Collection, Oregon State University

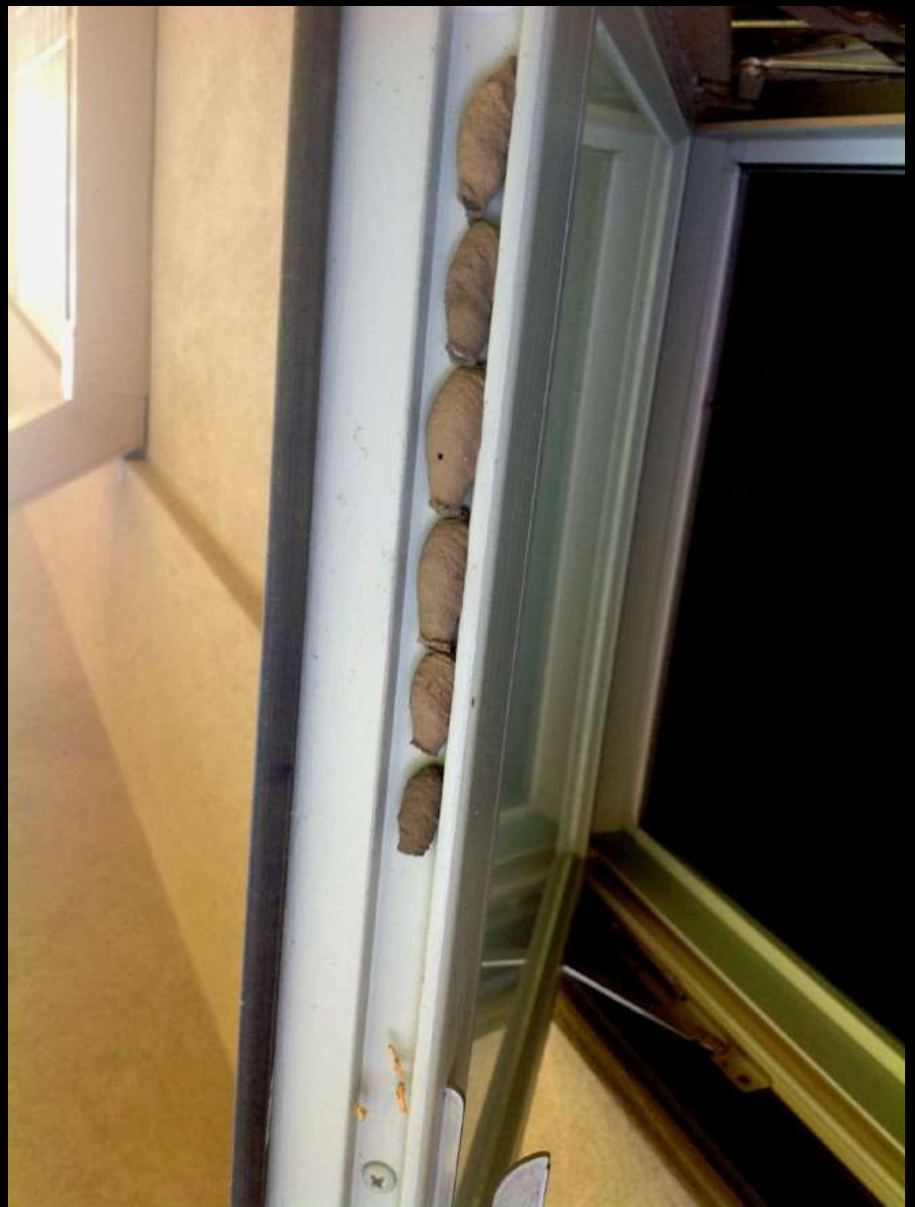


Colorado's Newest Mud Dauber!

Sceliphron curvatum

Photo by Eric R. Eaton

Present records from
El Paso, Denver, Larimer
and Mesa Counties



Adult collecting mud for nest cells (Mesa County)

Photo credit: Fireundertheice BugGuide (Mesa County)

Nest cells around windows (Denver County)

Photos by Betty Cahill

Spider prey extracted from one nest cell

Spider Wasps

Hymenoptera: Pompilidae

www.birdspiders.com

“Tarantula Hawks”

www.wdrp.org

Wanted!

Asian Mud Dauber Sightings

A new species of mud dauber wasp, *Sceliphron curvatum*, has begun to colonize Colorado and I would like to learn of sightings of this insect. A tentative proposed name for this insect is **"Asian mud dauber"** as it is native to areas of central/south Asia, including India, Pakistan, and Kazahkstan.

The most obvious evidence of this insect are the distinctive nest cells it forms from mud. These may be located along cavities around windows or other similar protected sites. Adults may be seen searching plants for spiders and visiting flowers for nectar/pollen.

The nest cells are distinctly different from those produced by the **black-and-yellow mud dauber** (*Sceliphron caementarium*),

Mud nest cells of the Asian mud dauber along the track of a window.

Adult female Asian mud dauber

which has long been a resident of the state. Cells of the black-and-yellow mud dauber are usually clumped together and typically constructed on under eaves or in outbuildings.

If you see evidence of this insect, please take a photo of it and send it to:
whitney.cranshaw@colostate.edu

whitney.cranshaw@colostate.edu

Colorado's Newest Mud Dauber!

Sceliphron curvatum

Photo by Eric R. Eaton

We would like to hear about other state records of this insect!