

Entomology for master gardeners

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Photo Credits: Jeff Schalau, Univ. of Arizona
Allen, Brock, and Glassberg; Caterpillars in the Field and Garden
Bugguide.net
Crenshaw and Redak, Bugs Rule

1

The Importance of Insects and other Arthropods negative impacts




- Disease vectors
 - Malaria, Western Nile, Zika Virus, Encephalitis, Yellow Fever, Rocky Mt. Spotted Fever, Leishmaniasis
- Induce Asthma
- Agriculture and Ornamental Pests
- Structural Pests

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The Importance of Insects and other Arthropods beneficial impacts

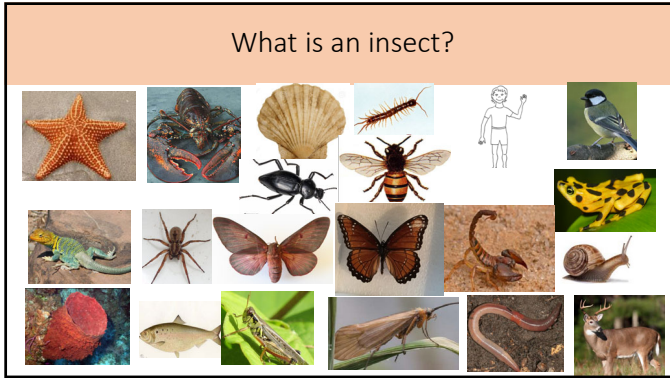
- Pollinators and seed distributors
- Biological control agents (predators & parasitoids)
- Honey, silk, shellac, dye
- Important link in Food Chain. Convert plant biomass to animal biomass and serve as the primary source of food for other insects, invertebrates and vertebrates.
- Macro-decomposers, recycle nutrients. Soil formers and mixers, maintain fertility.
- Aesthetics, subjects of art
- Ecotourism

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Slide 1

PK2 Paula Krainz, 3/13/2020



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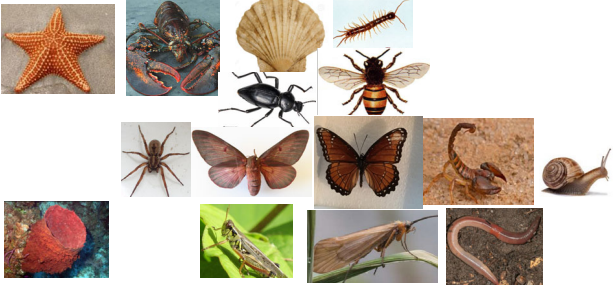


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Insects are invertebrates



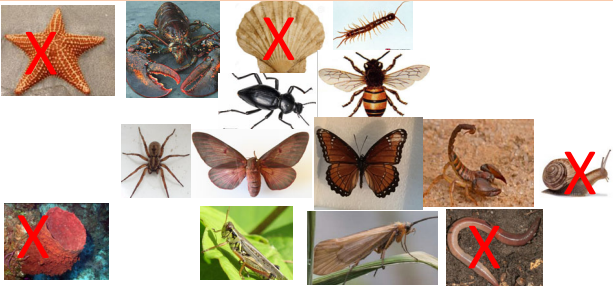
7

Do insects have jointed appendages?



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Do insects have jointed appendages?
YES



9

If you have no backbone, but have jointed appendages, then you are an **ARTHROPOD**



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How many legs do insects have?




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How many legs do insects have? 6



12

How many body segments do insects have?




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How many body segments do insects have?
3 (head, thorax, abdomen)

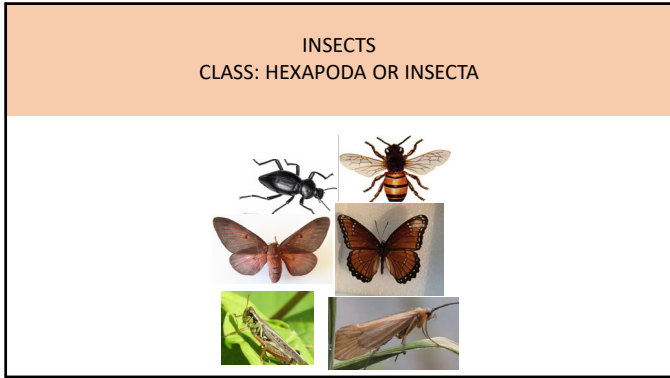


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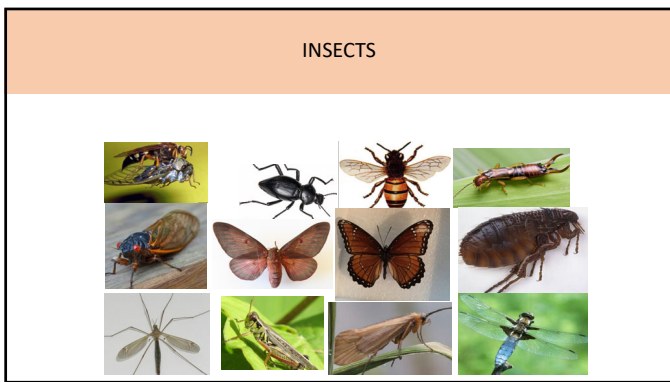
If you have 6 legs and 3 body segment (head, thorax, abdomen)
then you are an **INSECT**



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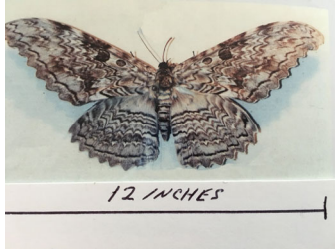


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Insects vary greatly in size



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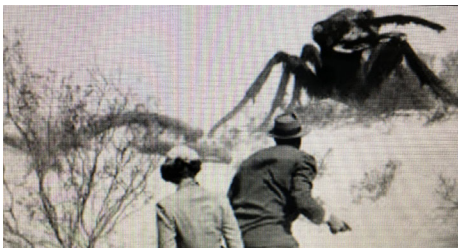
Dragonflies 300 years ago had a wingspan of over 28 inches

Meganeura - Wikipedia
en.wikipedia.org

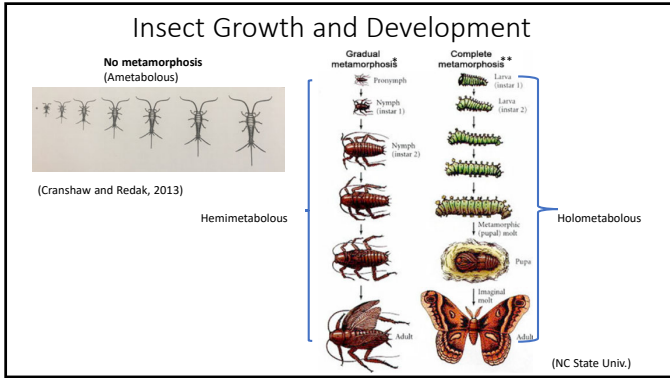


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Gigantic ants in the 1950s




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How are insects classified?


- Carl Linnaeus
 - *Systema Naturae* (1735)
- Established classification system based on shared characteristics.
- Used a hierarchical groupings
 - Kingdom, Phylum, Class, Order, Family, Genus, species




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Classification of the honey bee

- Animal Kingdom
- Phylum Arthropoda
 - Jointed appendages
 - Includes insects, spiders, scorpions, crustaceans, centipedes, millipedes.
- Class Hexapoda (Insecta/six legs)
- Order: Hymenoptera (bees, wasps, ants)
- Family: Apidae (bees)
- Genus: *Apis*
- Species: *mellifera*






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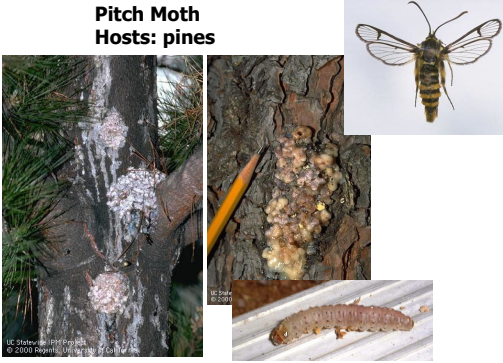
Insect Orders Butterflies and Moths

- Lepidoptera
- 150,000 species
- Development: 4 stages (complete metamorphosis)
- Wings – covered in scales
- Mouthparts:
 - Adults – siphoning proboscis
 - Larvae – mandibles
- Antennae:
 - Knobbed (butterflies)
 - Hooked (skippers)
 - Feathery or threadlike (moths)




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Pitch Moth Hosts: pines



UP Statewide IPM Program
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Sequoia Pitch Moth
resin masses

Fig. 1. SPM resin masses on Austrian pine (Ryan S. Davis, Utah State University Extension).

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Susceptibility of Pines to SPM Attack	
Pinus Species	Common Name
<i>P. radiata</i>	Monterey pine
<i>P. mugo</i>	mugo pine
<i>P. pinea</i>	Italian stone pine
<i>P. ponderosa</i>	ponderosa pine
<i>P. thunbergiana</i>	Japanese black pine
<i>P. densiflora</i>	Japanese red pine
<i>P. contorta</i>	lodgepole pine
<i>P. jeffreyi</i>	Jeffrey pine
<i>P. banksiana</i>	Jack pine
<i>P. nigra</i>	Austrian/black pine
<i>P. halepensis</i>	Alleppo pine
<i>P. sylvestris</i>	Scotch pine

Table 1. List of common *Pinus* species relative to their susceptibility to SPM attack. Trees at the top are least susceptible to SPM attack; trees at the bottom are most susceptible. (Table modified from Johnson and Ivimey 1991, Ina: 72-1)

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Pitch Moth Management

- Natural Enemies
 - None known
- Cultural Control
 - Monitor adult activity with pheromone traps
 - Prune after the adults have flown (fall-winter)
 - Irrigate susceptible species to maintain vigor
 - Physical control: remove resin masses and kill the larvae
- Chemical Control
 - None

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Beetles

- Coleoptera
- 350,000 species
- Development (4 stages)
- Forewing thick/opaque, hindwing membranous
- Mouthparts:
 - Adults – mandibles
 - Larvae – mandibles
- Antennae: Variable



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Dung beetle, *phanaeus* sp.



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Capturing ground-dwelling insects
Pit fall trap



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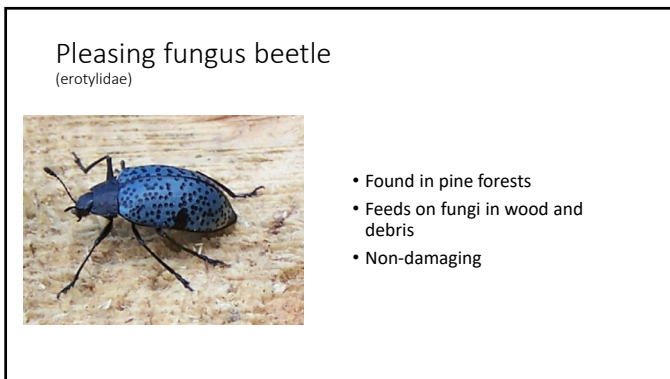
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BLISTER BEETLES

- Hosts: larvae are parasitic on grasshoppers and bees
- Adults feed on flowers and leaves
- Secrete an irritating and ulcerating compound (cantharidin) when disturbed
- Sometimes appear in high numbers in alfalfa and can cause gastric ulceration in livestock that feed on the hay



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Blister Beetle Management

- Natural Enemies
 - Birds, robber flies
- Cultural Control
 - Physical barriers
 - Blister beetles are attracted to flowers, so if infesting alfalfa, try cutting before peak bloom.
- Chemical Control
 - Carbaryl, malathion, pyrethroids

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Pinacate beetles


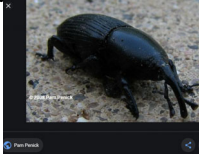

- Hosts: plant matter, but not a pest
- When disturbed, they will "stand on their head."
- When really disturbed, they will spray an irritating chemical (benzoquinone) to ward off predators.
- More active at night.



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Agave Snout Weevil & Management

- Natural Enemies
 - Vertebrates (not significant)
- Cultural Control
 - Remove and destroy infested plants
- Chemical Control
 - Put in escape bottles


2003 Agave americana colonized by agave snout weevils, S. scydorhinus, in Cottonwood, AZ (Jeff Schalko, University of Arizona Cooperative Extension)

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Flea Beetles

Hosts: many crops and ornamentals

Damage:
Skeletonizes leaves
Defoliation
Worse on young plants



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Flea Beetle Management

- Natural Enemies
 - Parasitic wasps
- Cultural Control
 - Control weeds
 - Row covers on vegetables
- Chemical Control
 - Carbaryl
 - Malathion
 - Acephate

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Elm Leaf Beetle Management

- **Natural Enemies**
 - Black Tachnid Fly, parasitic wasp, lacewings, earwigs (marginally effective)
- **Cultural Control**
 - Tolerate some damage
- **Chemical Control**
 - Bark banding with carbaryl
 - Bt var. tenebionis (more effective on larvae)
 - Neem
 - Systemics (neonics, acephate)


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Round-headed borers (Cerambycidae)

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Giant root borer

Prionus herolicus/californicus




- ID: stout body and coarse spines on each side of the thorax
- Hosts: oaks, cottonwoods, fruit trees
- Damage:
 - Root feeder, may cause some dieback; can kill younger trees.
- Management:
 - Plant non-hosts

Photo: Bob Geisner

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GIANT WOOD BORER

Feeds on living oak, cottonwood, fruit trees and dead conifers-at the soil



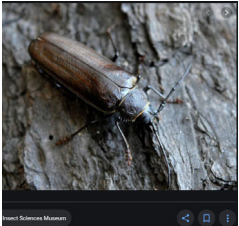
(Fig. 1) Adult prionus root borer, female (left) with ovipositor extended, and male (right) with larger antennae for detecting female sex pheromone.

Utah State University Coop. Extension

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Ponderous borer

- ID: elongate bode and fine spines on the sides of the thorax
- Hosts: Pine
- Damage:
 - Lives in dead stumps, trunks, roots

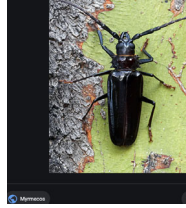


Insect Sciences Museum

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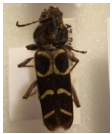
Palo Verde borer

- ID: elongate body, four prominent spines on each side of the thorax
- Host: Palo Verde, mesquites, oaks, poplars, grapes, citrus
- Damage: Root feeding causes dieback in older trees and can kill younger trees
- Management: ??



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Other Round-headed borers



Banded ash borer
Neoclytus caprea
Infests firewood
(hackberry in Dewey)



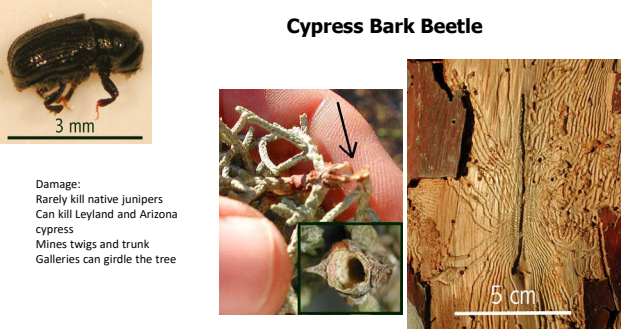
50

Flat headed borers



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Cypress Bark Beetle



Damage:
 Rarely kill native junipers
 Can kill Leyland and Arizona cypress
 Mines twigs and trunk
 Galleries can girdle the tree

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Cypress Bark Beetle Management

- Natural Enemies
 - ???
- Cultural Control
 - Irrigate susceptible species to maintain vigor
- Chemical Control
 - Trunk sprays containing carbaryl

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Fig beetle


- ID: Oval metallic green is distinctive
- Hosts: Fruit (especially rotting or damaged), mulch, lawn clipping piles.
- Damage: occasionally large populations may eat mature sweet fruit.
- Management:
 - Exclusion with netting.
 - Spread out mulch/grass piles



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Harmless larval root feeders

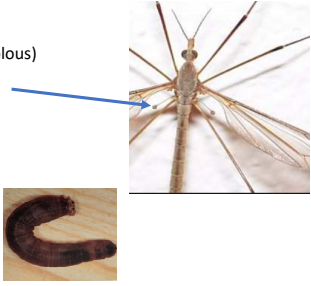
Hercules Beetle Ox Beetle Rhinoceros Beetle



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Flies (mosquitos, midges, maggots)
(Diptera)

- Diptera
- 154,000 species
- Development: 4 stages (holometabolous)
- Wings – 2 + modified hindwings (halteres)
 - Halteres act as vibrating gyroscopes/orientation
- Mouthparts:
 - Adults – Sponging, lapping, piercing
 - Larvae – hooks, or siphons
- Larvae: legless



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Flies (mosquitos & midges)



ID: Proboscis (facilitates piercing and transmission of disease organisms, and hairy wings)

ID: No proboscis (no disease transmission), and wings are without hair

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FLIES (MAGGOTS)

Important in decomposition



Photo credit: USAF, Roswell, NM, 1947

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Aphids, whiteflies, cicadas, etc

- Hemiptera
- 82,000 species
- Development: 3 stages (hemimetabolous)
- Wings:
 - Clear wings held roof-like over body (aphids, leafhoppers, etc)
 - Forewing half pigmented/half clear (true bugs/Heteroptera)
 - Wingless (bedbugs)
- Mouthparts: sucking, piercing
- Antennae: straight
- Aphids whiteflies, leafhoppers, psyllids vector plant diseases



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Box Elder Bug



Milkweed Bug

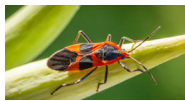


Photo: San Diego Union-Tribune

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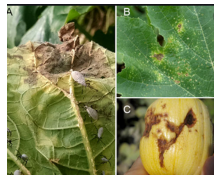
Box Elder Bug Management

- Natural Enemies
 - Mantids, spiders, assassin bugs
- Cultural Control
 - Eliminate host trees
 - Exclusion from the home: screen windows, caulk, weatherstrip
- Chemical Control
 - Not recommended- nuisance insect

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Squash Bugs

- Hosts: Squash, watermelon, pumpkins; zucchini not as preferred.
- Damage:
 - leaf yellowing, browning and necrosis
 - wilt (can kill young plants)
 - fruit scarring, young fruit can abort
- Management
 - Sanitation: destroy overwintering crop debris
 - Apply a cover (fine netting) on young plants to exclude the pests
 - Insecticides as needed
 - If growing other cucurbits primarily, squash could be planted as a trap crop



Photos: Morning Ag Clips

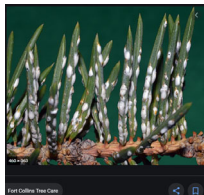
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Pine needle scale

Host: Pines.

Causes accelerated defoliation and sometimes after a chronic infestation, death.

Damage is more severe when pines are under water or disease stress.



- Management:
- Prevention: Do not plant in areas with low water availability nor in dusty areas.
- Remediation: 1) First try: prune off infested limbs.
- Remediation: 2) If chemical control is needed, use a foliar systemic (such as dimethoate) or a soil systemic (neonic), but ensure the soil systemic is accompanied by liberal irrigation to ensure uptake by the roots.
- Not to worry about pollinators.

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What caused this?



64

The twig scars of One Cicada female laying eggs

Young adults employ their piercing/sucking mouthparts to derive fluids from forbs and grasses, then later on young twigs.

Cicada nymphs feed innocuously on roots



65

One of the AZ Central Highlands' representatives:
Grand Western Cicada

Many species of cicadas in AZ

This is one of many in Yav. Co.

This species is associated with cottonwoods and boxelder

This species is an annual one



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Grasshoppers, Katydid, Crickets Mantids, Walkingsticks

- Orthoptera - 25,000 sp
- Mantoidea – 3,000 sp
- Phasmatoidea – 3,000 sp
- Development: 3 stages (hemimetabolous)
- Wings: Forewings leathery, hindwings membranous..OR wingless (walkingsticks)
- Mouthparts: mandibles
- Antennae: straight (long or short)
- Eggs laid in branches – sometimes in an egg case (mantids)

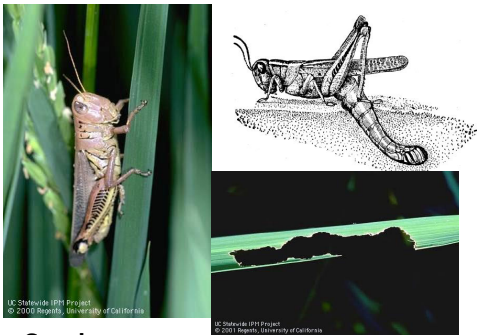


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Katydid eggs

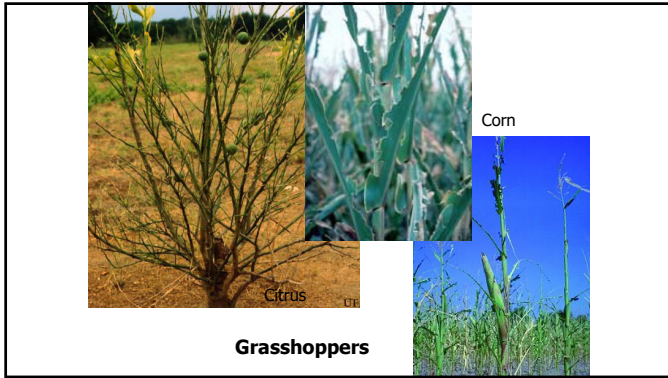


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Grasshoppers

69



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Locusts are grasshoppers

Asia in the worst infestation for a quarter of a century, threatening crops and livelihoods.

BBC.com March 10, 2020

Locust Management in Africa/Asia:

Local countries quit funding the area-wide aerial spray program.

Feb. 20 2010 - Trump Administration through ASAIID committed \$ 8 Mio for humanitarian assistance and locust control programs.

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Grasshopper Management

- **Natural Enemies**
 - Poultry, blister beetles
- **Cultural Control**
 - Maintain green border
 - Physical barriers
- **Chemical Control**
 - Baits and sprays containing carbaryl, pyrethroids
 - Nolo Bait (*Nosema locustae*) not effective

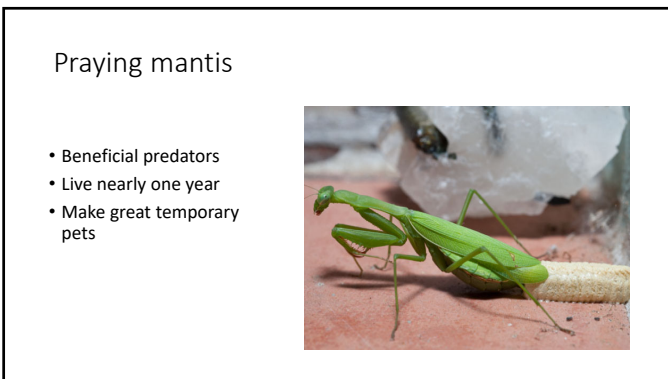
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74



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DECAPITATION OCCURS, BUT NOT ALL THE TIME

NOW SHOWING:
PRAY LOVE EAT
HEADLESS IN SEATTLE

http://www.fox.com/news/article/0,2933,praying_mantis_eat_headless_in_seattle,00.html

76

Cockroaches

- Blattodea
- 4,000 species
- Development: 3 stages (hemimetabolous)
- Wings: Forewings thickened, hindwings clear
- Mouthparts: mandibles
- Antennae: straight
- Eggs in egg case (ootheca)

MAIN PEST SPECIES:
German Cockroach

MANAGEMENT:
Sanitation
Gel Baits

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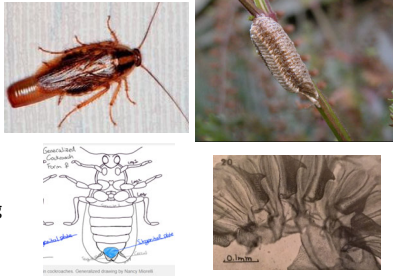
Cockroaches

Closely related to mantids. Why?

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Cockroaches Closely related to mantids. Why?

- Ootheca
- Holes in the tentoria suture in the head
- Enlarged posterior plates on the underside
- Tooth-like structures in the digestive tract (proventriculus)
- Mantids and roaches belong to the Superorder: Dictyoptera



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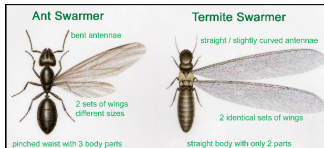
Termites

- Isoptera
- 3,000 species
- Development: 3 stages (hemimetabolous)
- Wings: equal size, clear
- Mouthparts: mandibles
- Antennae: straight
- Social caste system with queen



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Ants vs termites - adults



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Subterranean termite workers and soldier



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Ants vs termites – larva/worker



	Ant	Termite
• Head	Small	Large/Distinct
• Color	Pearl	Cream
• Legs	Absent	Present

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Subterranean termite mud-filled tubes



84

Subterranean termite tubes

Tubes must have ground contact
(except Formosan termites)



85

Subterranean termite tubes

Management:
Establish a treated soil barrier (from the surface to below the footer 8-12" deep in a trench around the structure and at cement slab joints.
Inject infested wood with a non-repellent insecticide.



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Drywood termites No mud in the wood

No tubes
No ground contact
No mud
Fecal pellets



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Drywood termites fecal pellets


Management:
Inject wood with foamed
Products
Surface treat wood with
Pyrethroids, fipronil, borates



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Bees, wasps, and ants

- Hymenoptera
- 150,000 species
- Development: 4 stages (holometabolous)
- Wings – clear
 - Workers are wingless
- Mouthparts:
 - Adults – mandibles
 - Larvae – variable
- Antennae:
 - Straight or knobbed, sometimes elbowed
- Females have an ovipositor
- Many are social-caste system in ants, bees

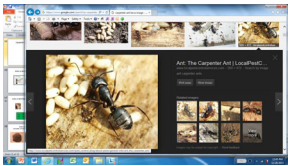


Carpenter ants

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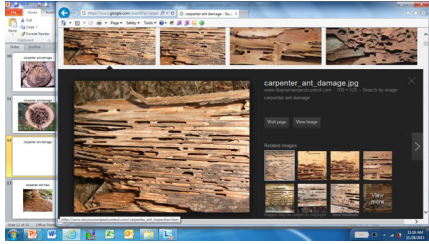
Carpenter ants

- Diet: nectar, honeydew, sweet foodstuffs, insects and other protein
- Damage: bore into wood for shelter/nest
- Management:
 - Insecticide baits
 - Wood treatment
 - Surface barrier treatment around structure



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Carpenter ant damage



91

Carpenter ant damage



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Carpenter ant eating a flat headed borer



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Carpenter ant worker



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Carpenter ant wood debris



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Ants vs termites

Fecal pellets (termites) vs wood debris (ants)



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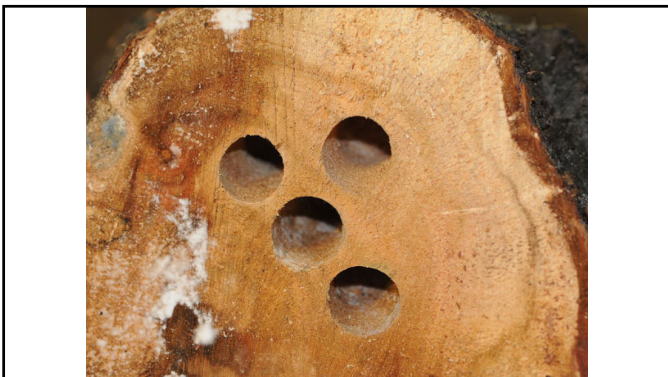
Carpenter Bees



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Carpenter Bee Management

- Remove infested wood, if feasible.
- Plug holes
- Dust holes with an insecticide
- Preventative: ensure all surfaces are painted.
- Preventative: Apply a residual insecticide.



100

Mud dauber

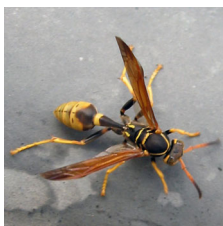
(Annophila sp.)



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Western Paper Wasp

Mischocyttarus sp.



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Western yellowjacket
Nest is in the ground
(vs German yellow jacket)

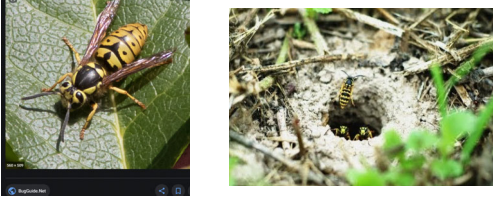



Photo: San Mateo Co.

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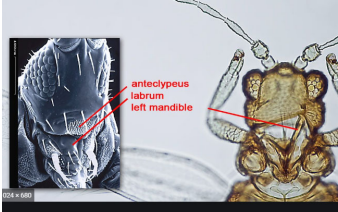
Thrips

- Thysanoptera
- 5,500 species
- Development: 3 stages (hemimetabolous)
- Wings: Fringed
- Mouthparts: Mandible for puncturing, labium for siphoning plant fluids
- Antennae: straight
- Vectors tomato spotted wilt virus.



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Thrips have one mandible modified into a stylet



anteclypeus
labrum
left mandible

Thrips-ID English

105



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Thrips damage

- Leaf wrinkling
- Leaf scarring and deformation
- Shortened internodes and stunting
- Fruit scarring
- Vector viral diseases
 - Tomato spotted wilt disease

Photo credits: Research Gate, PNW Handbooks, UCANR

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Thrips Management

- Natural Enemies
 - Minute Pirate Bug, predaceous mites
- Cultural Control
 - Control weeds, high pressure hose, remove old flowers, row covers, reflective mulch, be patient
- Chemical Control
 - Neem, systemics (Orthene, Merit) on non-edible crops

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Spider Mites

UC Statewide IPM Project
© 2000 Specialty, University of California

UC Statewide IPM Project
© 2000 Specialty, University of California

Damage:
Leaf stippling
Leaf bronzing/defoliation
Active stages tend to be on the underside of the leaf

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Spider Mite Management

- Natural Enemies
 - Predatory mites, minute pirate bugs, lacewings, bigeyed bugs
- Cultural Control
 - Avoid dust build up with high pressure hose
- Chemical Control
 - Sometimes populations blow up after treatments of pyrethroids or neonics (natural enemies are killed)
 - Soaps/oils, miticides in extreme cases

Two-spotted mite damage on strawberries. UCANR

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Galls – not just oak wasps

- Sawflies (wasp) (willow)
- Gall mites
- Midge Flies (silk tassel/Garrya)
- Oak gall wasps

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More galls


Hackberry Petiole Gall Psyllid *Pachypsylla venusta*



The *Hackberry Petiole Gall* (*Pachypsylla venusta*) was reported as a very large population of psyllids. It was found in Radermark Canyon, Maricopa Co., Arizona, USA.

Psyllidae -- Jumping Plant Louse Family

Sonoran Desert Naturalist





Manzanita Leaf Galls and Aphids - Photography on the Run

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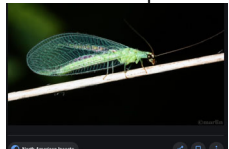

Antlions, lacewings, snakeflies


- Neuroptera
- 6,000 species
- Development: 4 stages (holometabolous)
- Wings: 4 equal-sized clear wings with a matrix of veins folded rooflike over the body
- Mouthparts: mandibles
- Antennae: straight
- Predatory on other insects

113





Green lacewings voracious predators – even cannibalistic



114

Green lacewings as biological control tools

 Green Lacewing Larvae - 1,000 ... \$24.00 Arbico Organics	 Green Lacewing Adults - Pre-Fe... \$170.00 Arbico Organics	 Green Lacewing Eggs - Pest &... \$15.95 Gardeners.com
 Green Lacewing Eggs - Hangin... \$45.00 Arbico Organics		

Adults of many species feed on nectar, pollen, and honeydew

Larvae feed on aphids and other insects

Work best when the pest population is low, but if too low, then they will leave

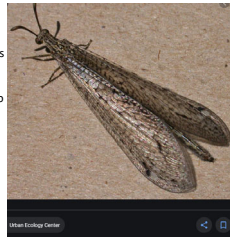
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antlions



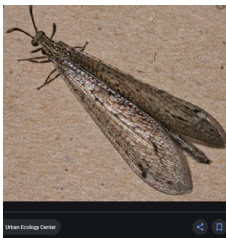
Antlion nymphs are predatory mainly on ants

Antlion adults are predatory, but some also eat pollen and nectar



116

AntLion vs. damselfly adults



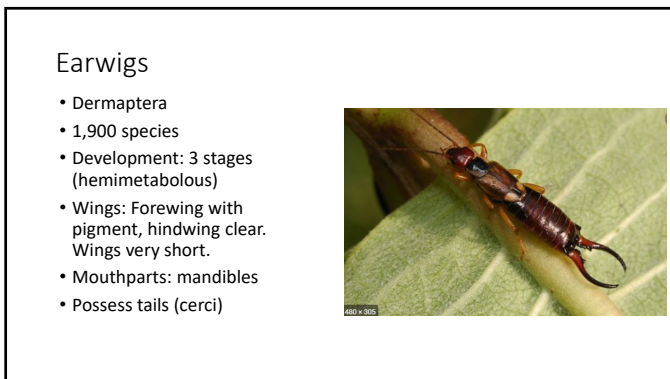
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119



120

Earwigs

- General predators, but also chew stems and holes in leaves
- Reside under bark, under rocks, wood, etc
- Some live in caves and are ectoparasites on bats in the tropics




121

earwigs

Management:
Usually not a problem, but if they are:
Place traps with oil

Chemical control:
pyrethroids




Fill an empty tuna can with vegetable oil then embed it next to the infested plant

122


Silverfish and Jumping Bristletails

- Thysaneura/Microcoryphia
- 400/350 species
- Development: 2 stages (ametabolous)
- Wings: None
- Mouthparts: mandibles
- Antennae: long threadlike
- 3 tails
- Bristletails: body humped.
- Silverfish: body flat
- Bristletails jump.



123

other insect orders




The slide displays six images of different aquatic insect orders. The top row shows a hellgramite (amphipod), a hellgramite (amphipod), and a hellgramite (amphipod). The bottom row shows a hellgramite (amphipod), a hellgramite (amphipod), and a hellgramite (amphipod).

124

Mayflies

- Ephemeroptera
- 2,500 species
- Development: 3 stages (hemimetabolous)
- Wings: Clear, folder upright over body.
- Mouthparts:
 - Adults: vestigial
 - Nymphs: mandibles
- Aquatic – 2-3 tails on nymph
- Gills on exterior sides of abdomen




The slide features two images of mayflies. The top image shows an adult mayfly with its wings folded over its body. The bottom image shows a nymph with two tails and gills on its abdomen.

125

Stoneflies

- Plecoptera
- 20500 species
- Development: 3 stages (hemimetabolous)
- Wings: Clear and flat over body
- Mouthparts:
 - Mandibles
- Aquatic – 2 tails
- Gills on underside of abdomen



The slide contains two images of stoneflies. The left image shows an adult stonefly with its wings spread. The right image shows a nymph with two tails and gills on its abdomen.

126

Caddisflies

- Trichoptera
- 12,000 species
- Development: 3 stages (hemimetabolous)
- Resemble moths
- Wings: Clear with hairs
- Mouthparts: mandibles
- Aquatic
- Gills on abdomen
- Nymphs live in case (pebbles and small sticks)



127

Dragonflies Damselflies

- Odonata
- 4,000 species
- Development: 3 stages (hemimetabolous)
- Wings:
- Mouthparts: mandibles
- Gills:
 - Internal rectum (dragonflies)
 - External tails (damselflies)



128

Booklice

- Psocoptera
- 4,400 species
- Development: 3 stages (hemimetabolous)
- Winged and wingless
- Mouthparts: mandibles
- Antennae: filamentous
- Feed on glue in books, fungi, lichens



129

Springtails

- Collembola
- 6,000 species
- Development: 2 stages (Ametabolous)
- Wingless
- Mouthparts: internal scraping
- Tail-like spring mechanism (furculum) used for jumping



130

Fleas

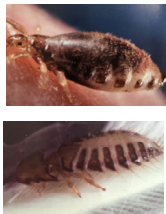
- Siphonaptera
- 1,900 species
- Development: 4stages (holometabolous)
- Wingless
- Mouthparts:
 - Larvae: mandibles
 - Adults: piercing (blood)
- Vectors plague



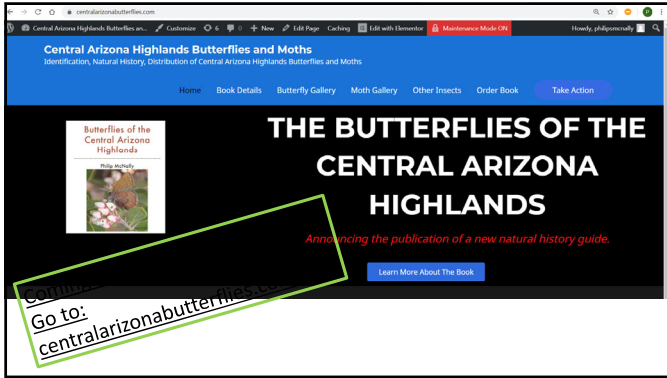
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Lice

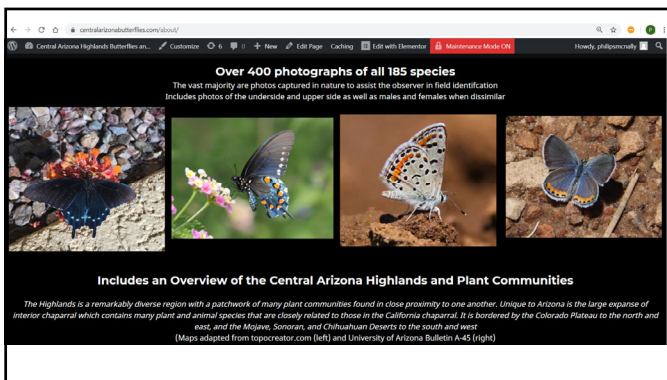
- Phthiraptera
 - "phthir"= "louse"
- 4,900 species
- Development: 3 stages (hemimetabolous)
- Wingless
- Mouthparts:
 - Mandibles-mostly birds
 - Sucking – mammals
- Vector typhus fever



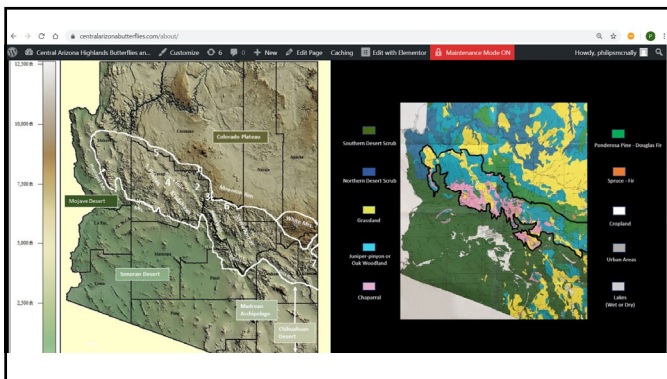
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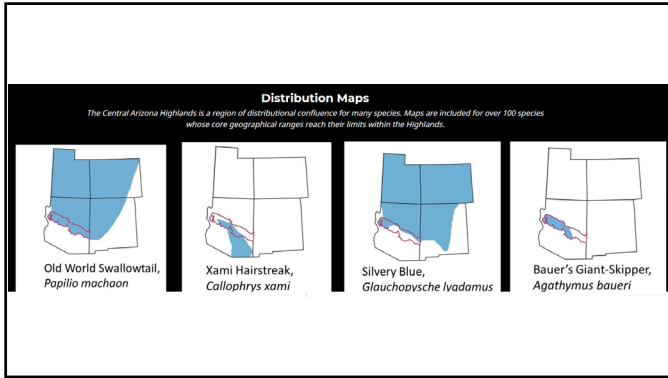
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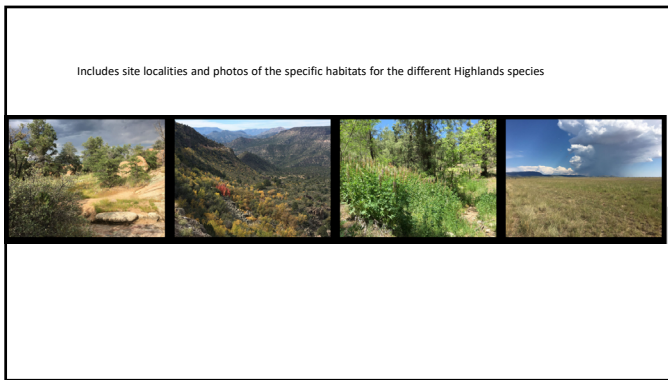
134



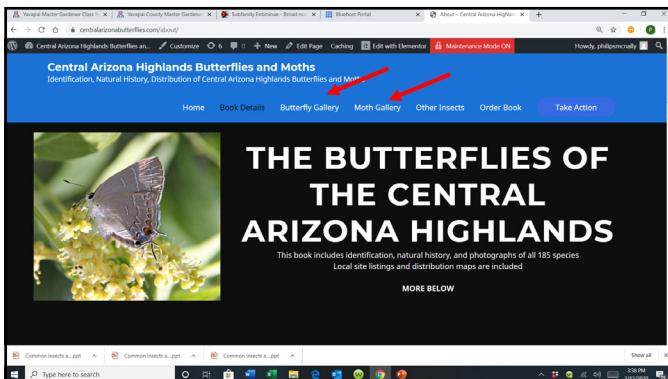
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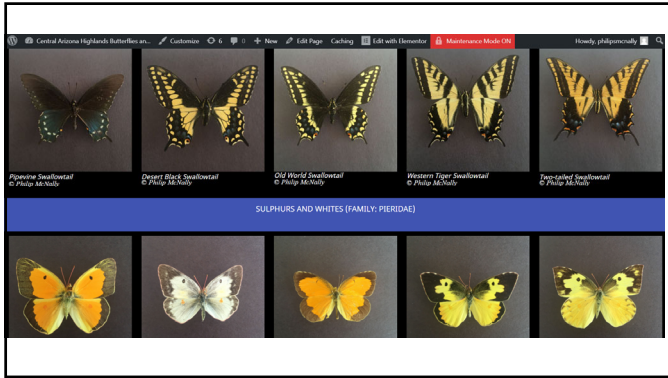
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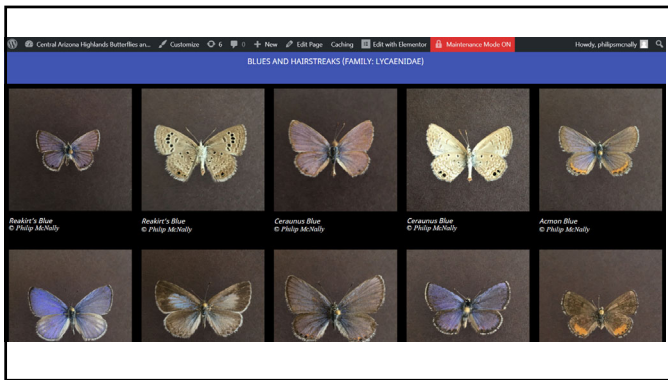
137



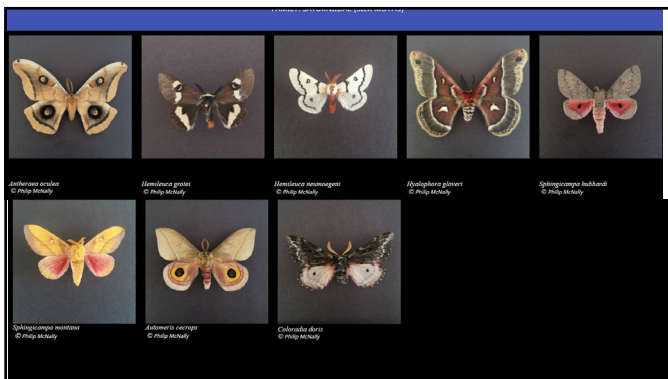
138



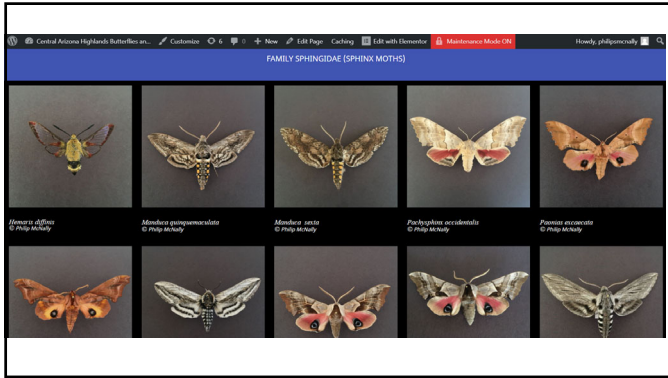
139



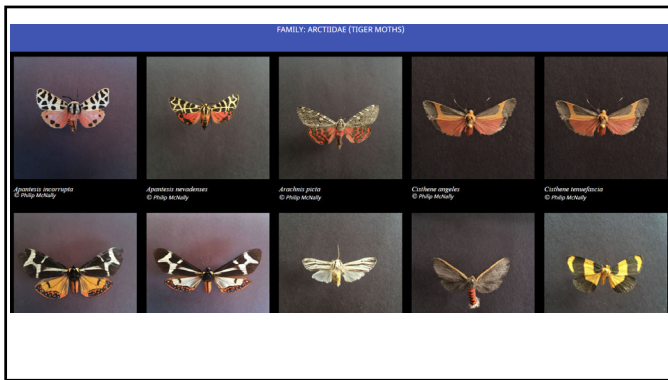
140



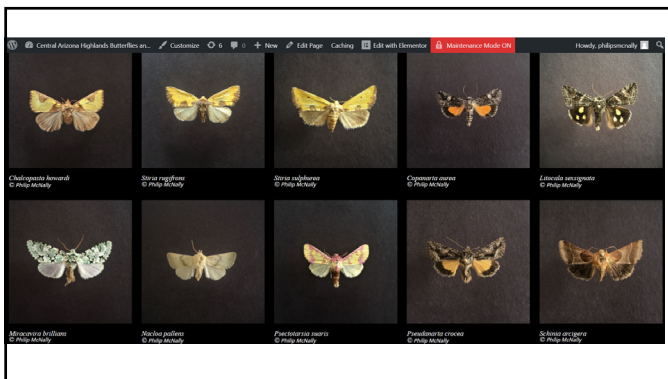
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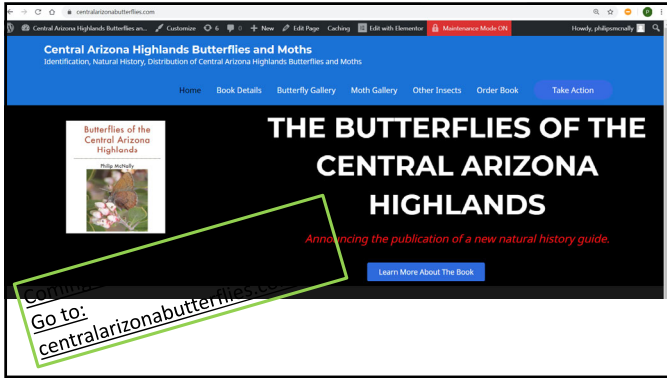
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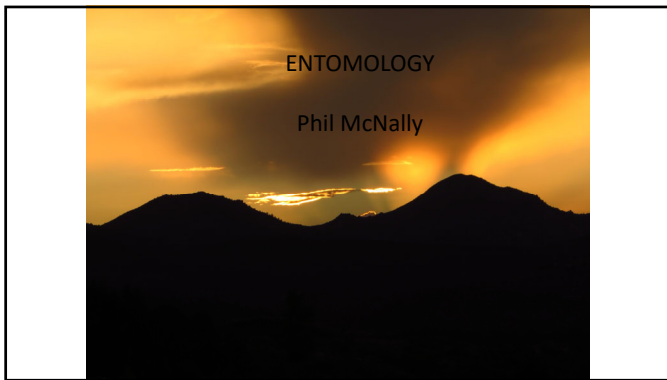
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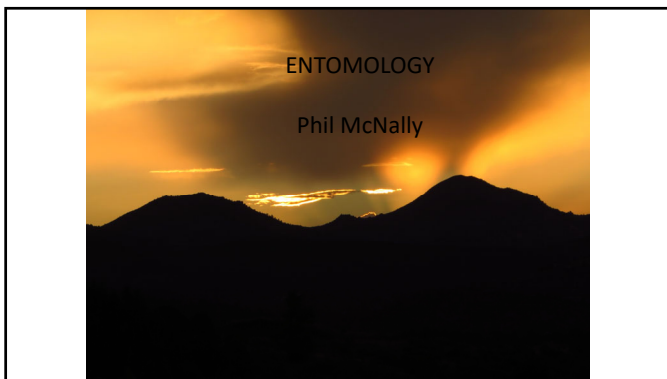
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