

PK2



Entomology for master gardeners

Philip McNally, Phd
Arizona State university, School of Life Sciences
Faculty Affiliate

JEFF SCHALAU
University of Arizona Cooperative Extension



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

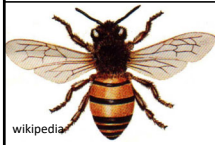
- Disease vectors
 - Malaria, Western Nile, Zika Virus, Encephalitis, Yellow Fever, Rocky Mt. Spotted Fever, Leishmaniasis
- Induce Asthma
- Agriculture and Ornamental Pests
- Structural Pests

2

Slide 1

PK2 Paula Krainz, 3/13/2020



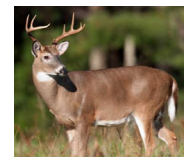
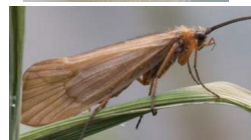
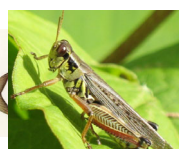
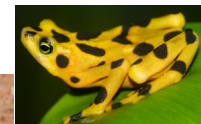
The Importance of Insects and other Arthropods beneficial impacts

- 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



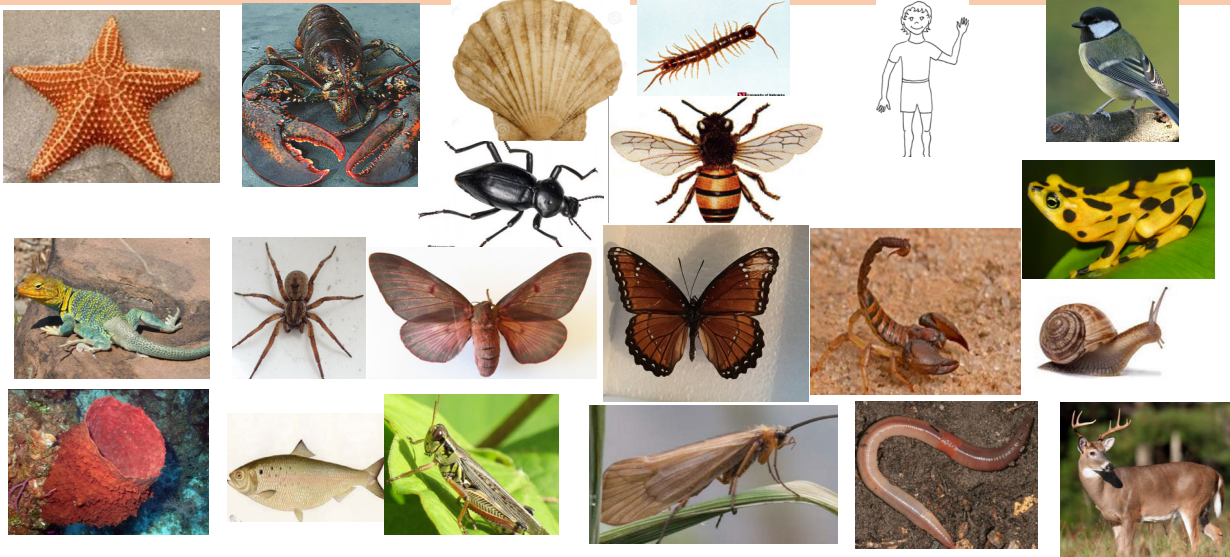
3

What is an insect?



4

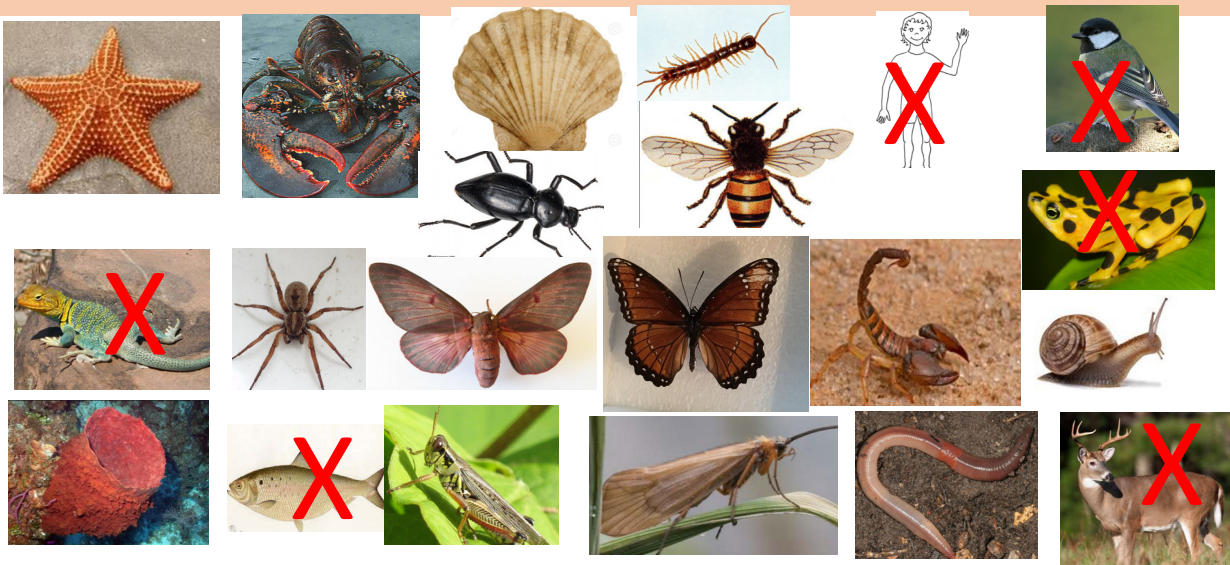
Do insects have backbones?



5

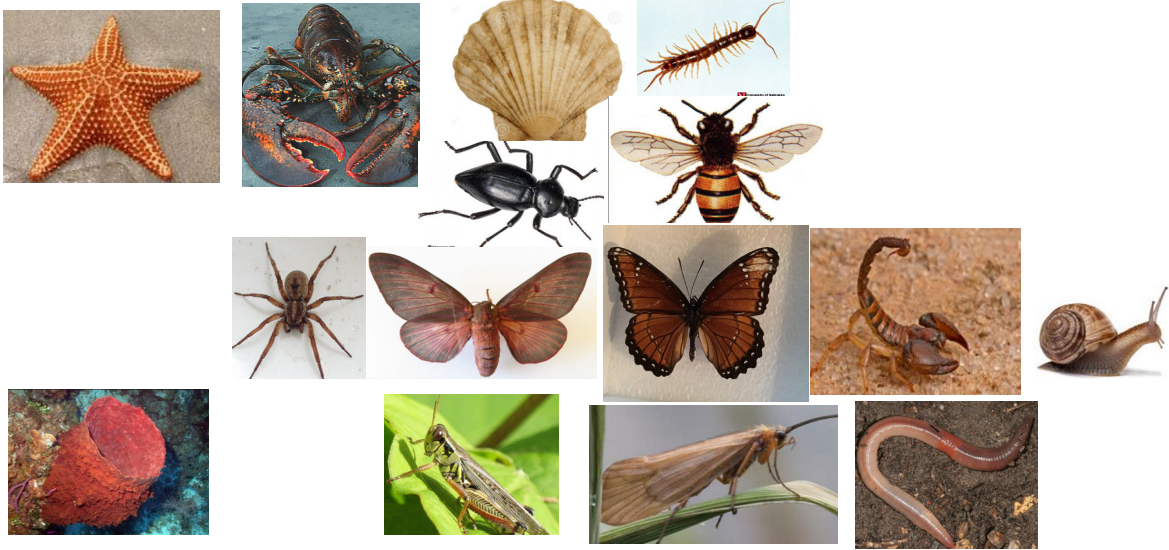
Do insects have backbones?

NO



6

Insects are invertebrates



7

Do insects have jointed appendages?



8

Do insects have jointed appendages?
YES



9

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



10

How many legs do insects have?



11

How many legs do insects have? 6



12

How many body segments do insects have?



13

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



14

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



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INSECTS
CLASS: HEXAPODA OR INSECTA



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INSECTS



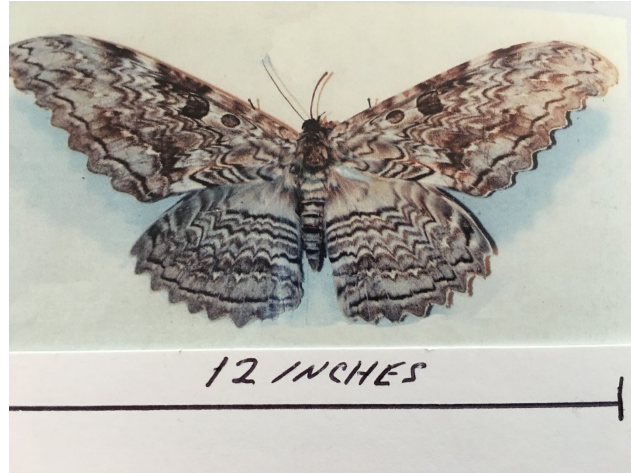
17

Insects vary greatly in size



18

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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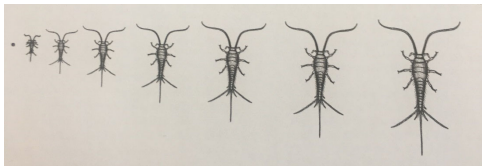
Gigantic ants in the 1950s



21

Insect Growth and Development

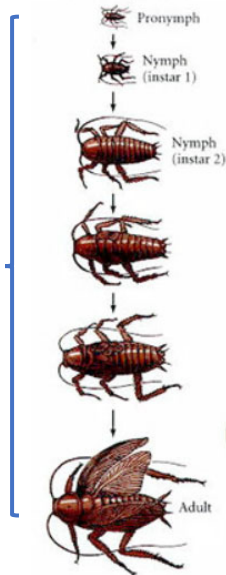
No metamorphosis
(Ametabolous)



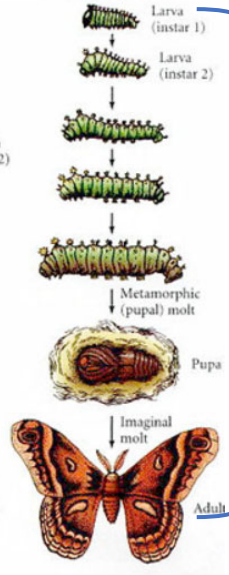
(Cranshaw and Redak, 2013)

Hemimetabolous

Gradual
metamorphosis *



Complete
metamorphosis **



Holometabolous

(NC State Univ.)

22

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



26



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	
<i>Pinus</i> 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 Lyon, 1991 (p. 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.



Copyright © 2015 Deb Whitecotton

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Capturing ground-dwelling insects
Pit fall trap



32



33



34

Pit fall trap catch – 14 days
(Williamson Valley Rd)



35

Pleasing fungus beetle
(erotylidae)



- Found in pine forests
- Feeds on fungi in wood and debris
- Non-damaging

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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

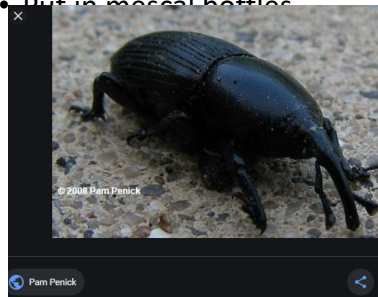
- Hosts: plant matter, but not a pest
- When disturbed, they will “stand on their head.”
- When really disturbed, they will spray an irritating chemical (benzoquinone) to ward off predators.
- More active at night.



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Agave Snout Weevil & Management

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



Dead *Agave americana* colonized by agave snout weevils, *S. acupunctatus*, in Cottonwood, AZ (Jeff Schalau, University of Arizona Cooperative Extension).



40

Flea Beetles

Hosts: many crops
and ornamentals

Damage:
Skeletonizes leaves
Defoliation
Worse on young plants



41

Flea Beetle Management

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

42



43

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)

44

Round-headed borers (Cerambycidae)



45

Giant root borer

Prionus heroicus/californicus



Photo: Bob Gessner



Copyright © 2016 Salvador Jimenez

- 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

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GIANT WOOD BORER

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



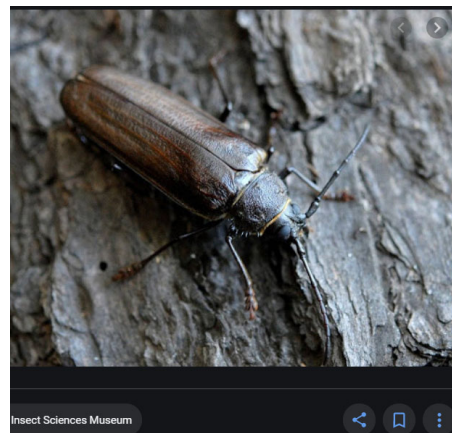
(Fig. 1) Adult prionus root borer, female (left) with ovipositor extended, and male (right) with larger antennae for detecting female sex pheromone.

Utah State University Coop. Extension

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Ponderous borer

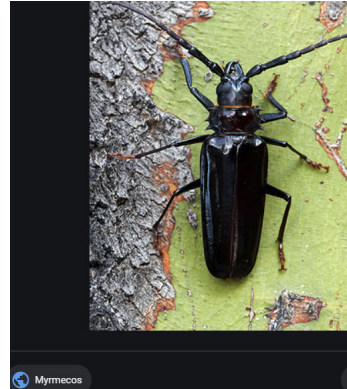
- ID: elongate body and fine spines on the sides of the thorax
- Hosts: Pine
- Damage:
Lives in dead stumps, trunks, roots



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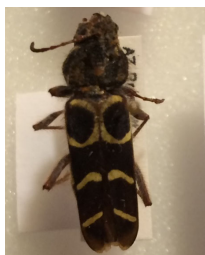
Palo Verde borer

- 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

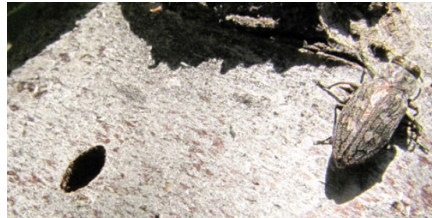


Banded ash borer
Neoclytus caprea
Infests firewood
(hackberry in Dewey)



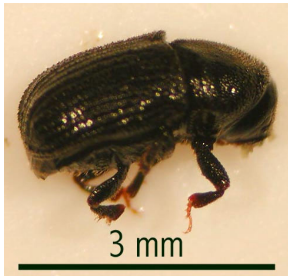
50

Flat headed borers



51

Cypress Bark Beetle



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



52

Cypress Bark Beetle Management

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

53

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

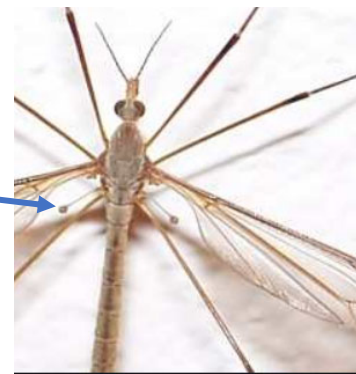


55

Flies (mosquitos, midges, maggots)

(Diptera)

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



56

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

57

FLIES (MAGGOTS)

Important in decomposition

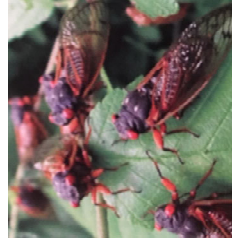


Photo credit: USAF, Roswell, NM, 1947

58

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



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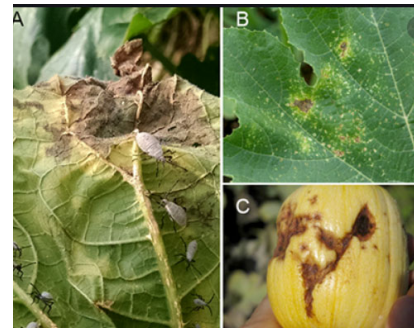
Box Elder Bug Management

- 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

61

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

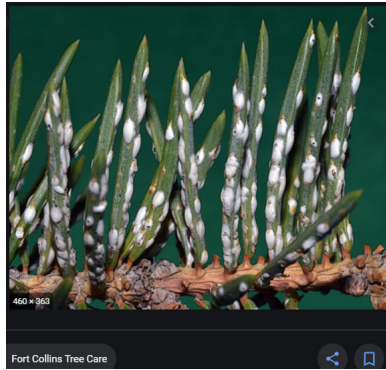
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Pine needle scale

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.

63

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



66

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)



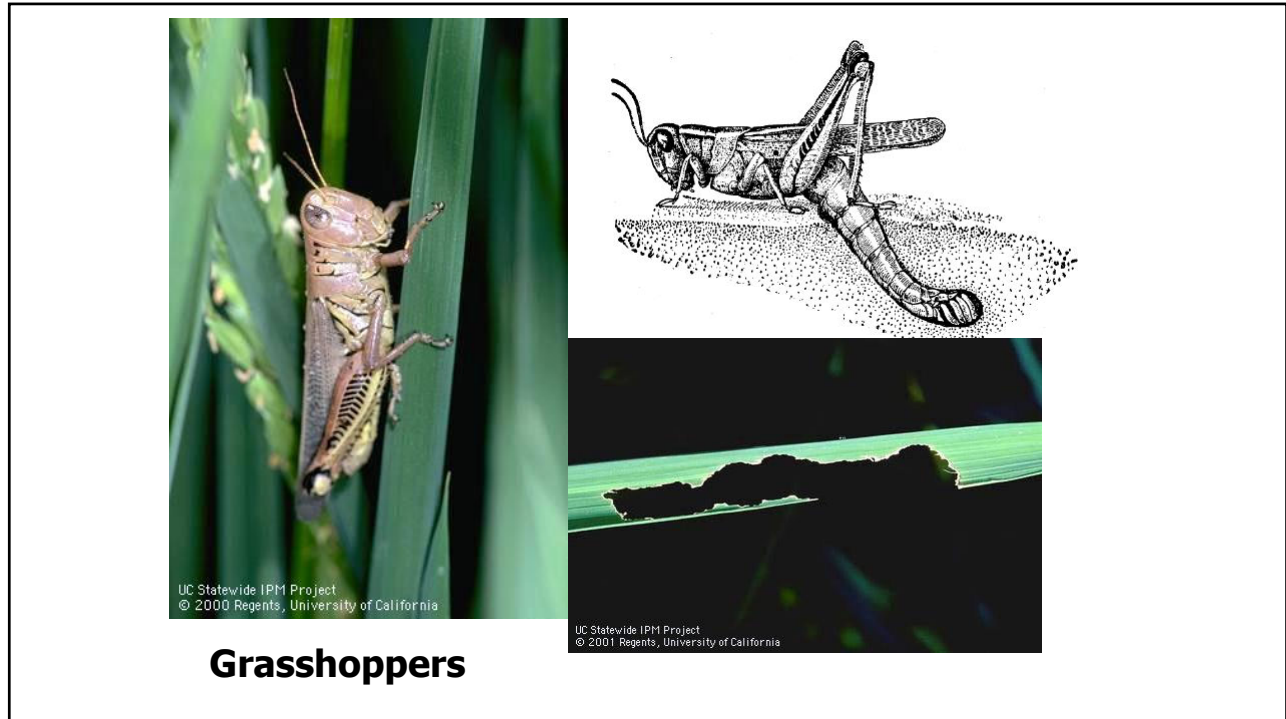
Copyright © 2014 Nikole Loomis (Bush Cricket and Buckeye Lover)

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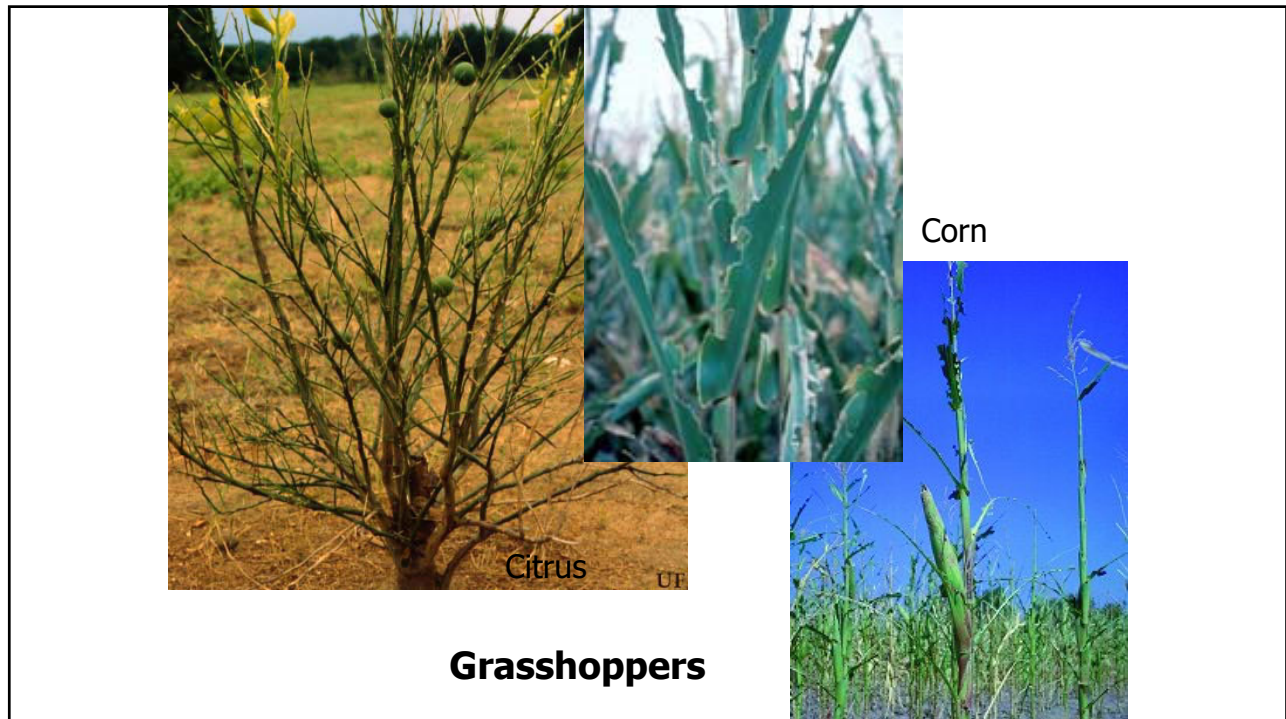
Katydid eggs



68



69



70

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 USAID committed \$ 8 Mio for humanitarian assistance and locust control programs.

71

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

72

??????



73

Mantid egg sac (ootheca)



74

Praying mantis

- Beneficial predators
- Live nearly one year
- Make great temporary pets



75



DECAPITATION OCCURS, BUT NOT ALL THE TIME



<http://ie.oxfordjournals.org/> at Don Thomson on June 29, 2016

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?

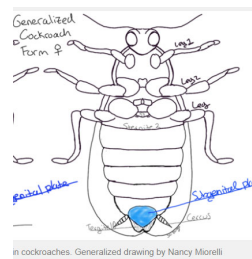


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Cockroaches

Closely related to mantids. Why?

- Ootheca
- Holes in the tentorial 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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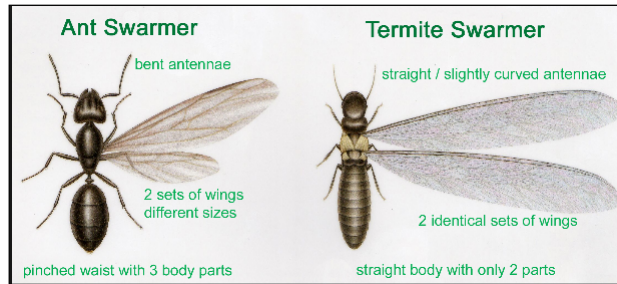
Termites

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



80

Ants vs termites - adults



81

Subterranean termite workers and soldier



Copyright © 2014 Cynthia Bingham Keiser



Copyright © 2014 Cynthia Bingham Keiser

82

Ants vs termites – larva/worker



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

83

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.



86

Drywood termites No mud in the wood

No tubes
No ground contact
No mud
Fecal pellets



87

Drywood termites fecal pellets

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



88

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



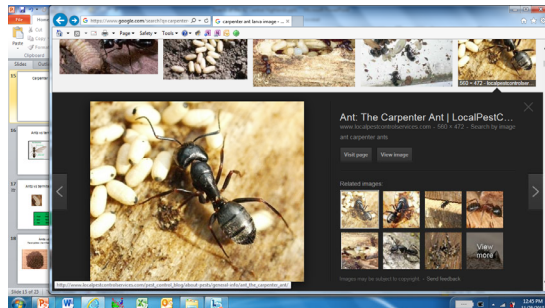
Copyright © 2008 Dick Wilson

Carpenter ants

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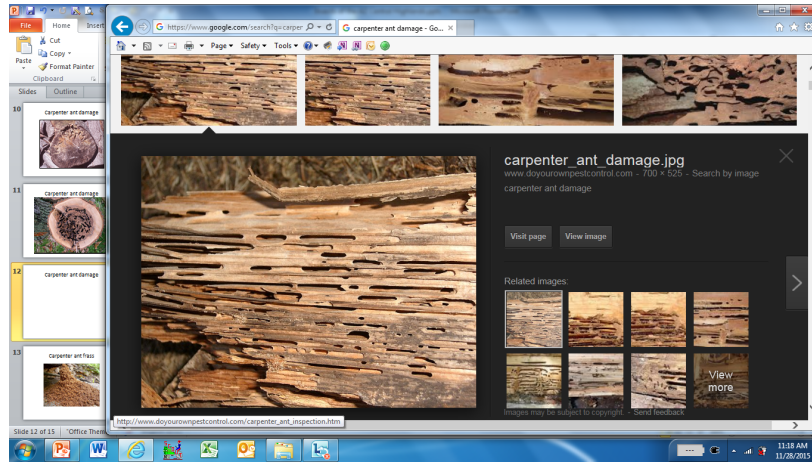
Carpenter ants

- 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



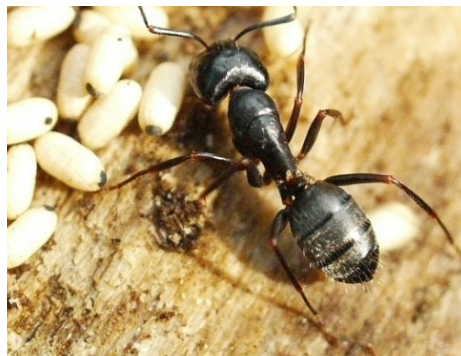
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Carpenter ant eating a flat headed borer



93

Carpenter ant worker



94

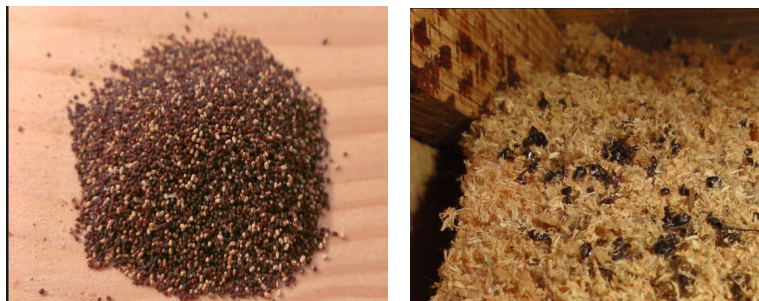
Carpenter ant wood debris



95

Ants vs termites

Fecal pellets (termites) vs wood debris (ants)



96

Carpenter Bees



Copyright © 2015 [Evan Dankowicz](#)



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98



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Carpenter Bee Management

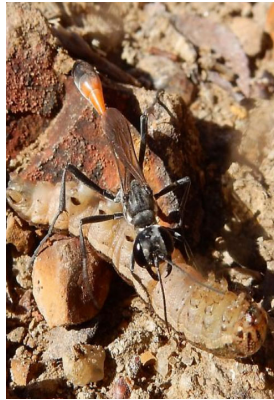
- Remove infested wood, if feasible.
- Plug holes
- Dust holes with an insecticide
- Preventative: ensure all surfaces are painted.
- Preventative: Apply a residual insecticide.



100

Mud dauber

(*Annophila* sp.)



Copyright © 2014 eileen miller

101

Western Paper Wasp

Mischocyttarus sp.



102

Western yellowjacket

Nest is in the ground

(vs German yellow jacket)

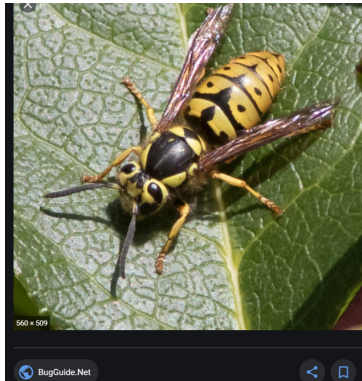


Photo: San Mateo Co.

103

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.



104

Thrips have one mandible
modified into a stylet



105



106

Thrips damage

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



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Photo credits: Research Gate, PNW Handbooks
UCANR

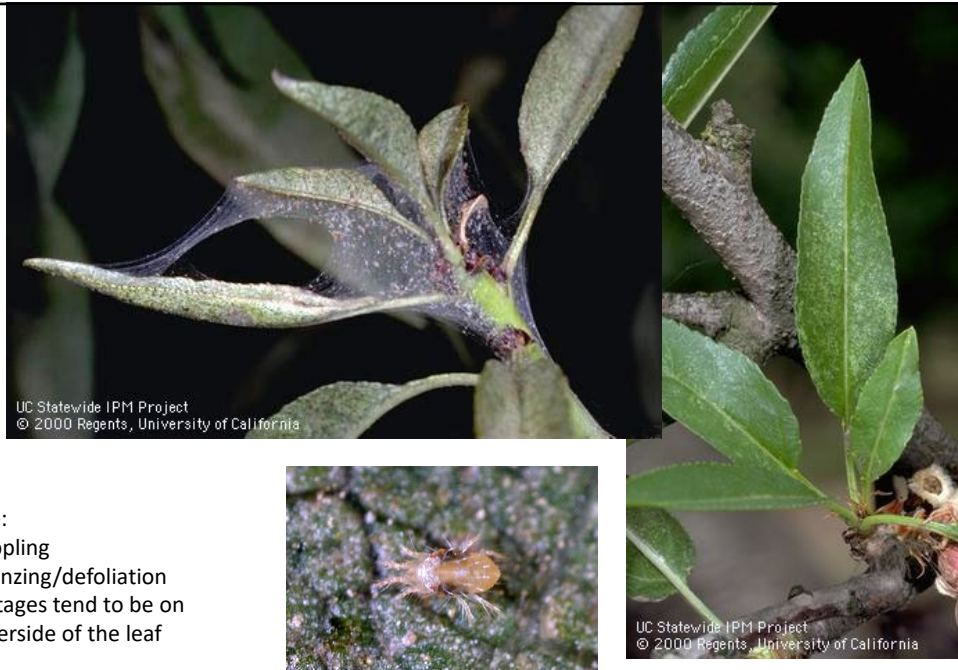
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Thrips Management

- 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

108

Spider Mites



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

109

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

110

Galls – not just oak wasps



- Sawflies (wasp) (willow)



- Gall mites



- Midge Flies (silktassel/Garrya)

- Oak gall wasps



111

More galls

Hackberry Petiole Gall Psyllid *Pachypsylla venusta*



This Netleaf Hackberry (*Celtis laevigata reticulata*) was supporting a very large population of psyllids. It was found in Rackensack Canyon, Maricopa Co., Arizona, USA.

Psyllidae -- Jumping Plant Louse Family

Sonoran Desert Naturalist



Photography on the Run

Manzanita Leaf Galls and Aphids - Photography on the Run

112

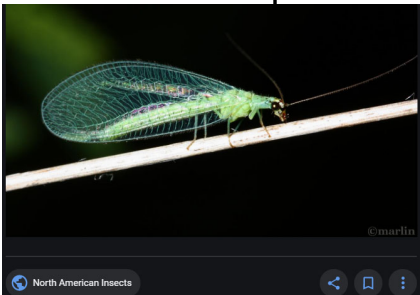
Antlions, lacewings, snakeflies

- 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

115

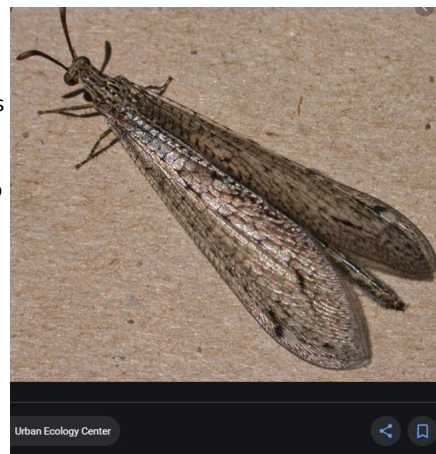
antlions



M. J. Raupp

Antlion nymphs are predatory mainly on ants

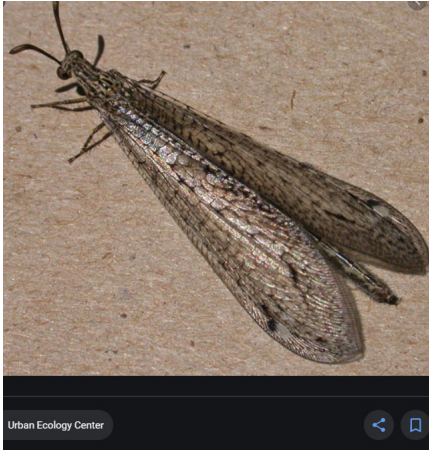
Antlion adults are predatory, but some also eat pollen and nectar



Urban Ecology Center

116

AntLion vs. damselfly adults



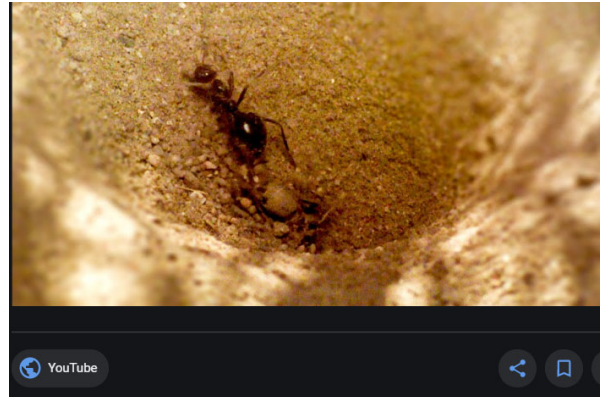
117

AntLion traps



118

AntLion and trap



119

Earwigs

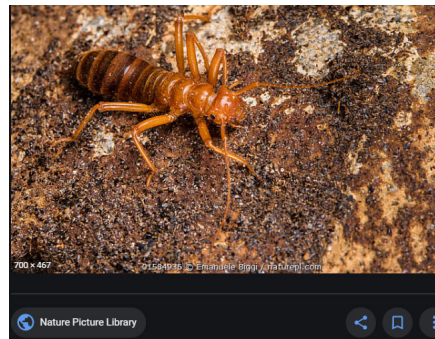
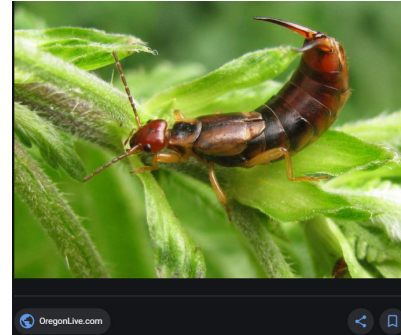
- Dermaptera
- 1,900 species
- Development: 3 stages (hemimetabolous)
- Wings: Forewing with pigment, hindwing clear. Wings very short.
- Mouthparts: mandibles
- Possess tails (cerci)



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

Organic lesson.com

122

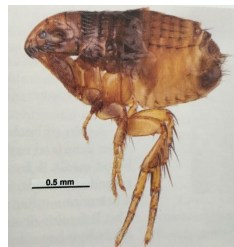
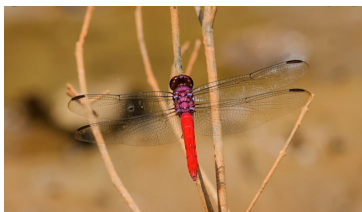
Silverfish and Jumping Bristletails

- Thysanura/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



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



125

Stoneflies

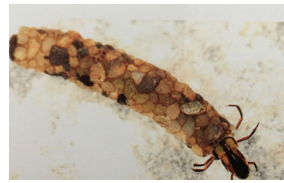
- Plecoptera
- 20500 species
- Development: 3 stages (hemimetabolous)
- Wings: Clear and flat over body
- Mouthparts:
 - Mandibles
- Aquatic – 2 tails
- Gills on underside of abdomen



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)



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Dragonflies Damselflies

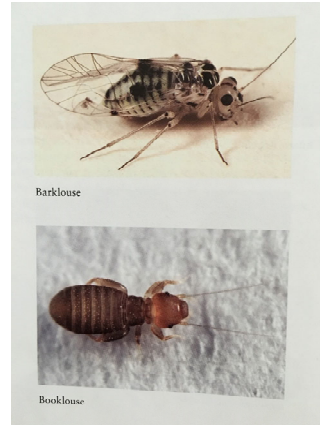
- Odonata
- 4,000 species
- Development: 3 stages (hemimetabolous)
- Wings:
- Mouthparts: mandibles
- Gills:
 - Internal rectum (dragonflies)
 - External tails (damselflies)



128

Booklice

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



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Springtails

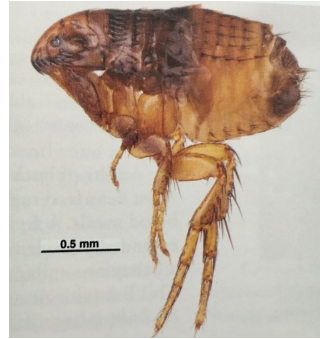
- Collembola
- 6,000 species
- Development: 2 stages (Ametabolous)
- Wingless
- Mouthparts: internal scraping
- Tail-like spring mechanism (furculum) used for jumping



130

Fleas

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



131

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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centralarizonabutterflies.com

Central Arizona Highlands Butterflies and Moths
Identification, Natural History, Distribution of Central Arizona Highlands Butterflies and Moths

Home Book Details Butterfly Gallery Moth Gallery Other Insects Order Book Take Action

THE BUTTERFLIES OF THE CENTRAL ARIZONA HIGHLANDS

Announcing the publication of a new natural history guide.

Learn More About The Book

Go to: centralarizonabutterflies.com

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centralarizonabutterflies.com/about/

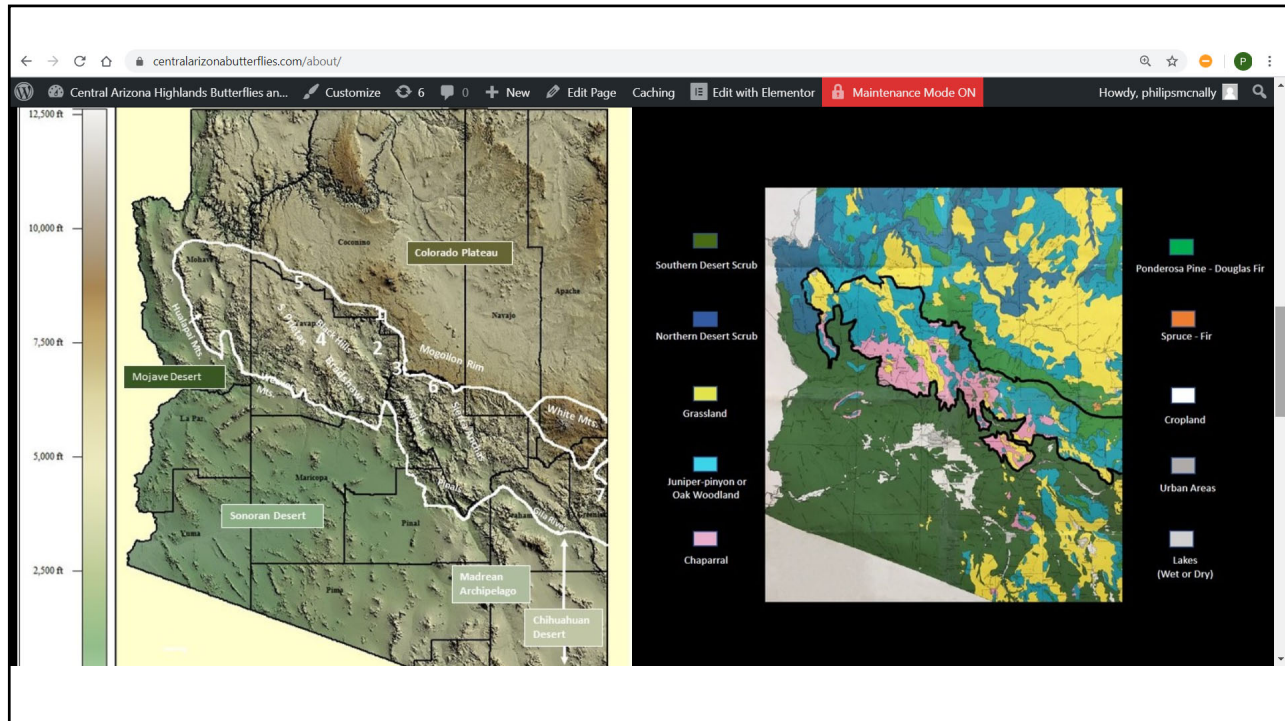
Over 400 photographs of all 185 species

The vast majority are photos captured in nature to assist the observer in field identification
Includes photos of the underside and upper side as well as males and females when dissimilar

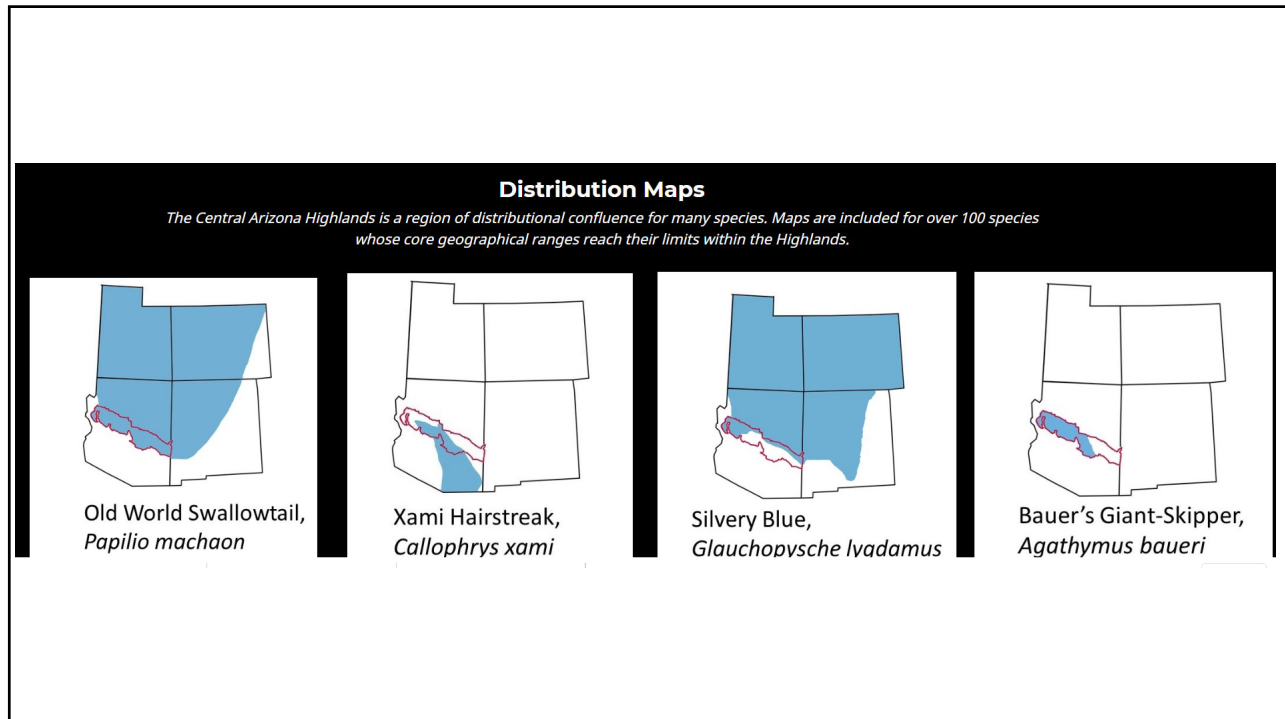
Includes an Overview of the Central Arizona Highlands and Plant Communities

The Highlands is a remarkably diverse region with a patchwork of many plant communities found in close proximity to one another. Unique to Arizona is the large expanse of interior chaparral which contains many plant and animal species that are closely related to those in the California chaparral. It is bordered by the Colorado Plateau to the north and east, and the Mojave, Sonoran, and Chihuahuan Deserts to the south and west
(Maps adapted from topocreator.com (left) and University of Arizona Bulletin A-45 (right))

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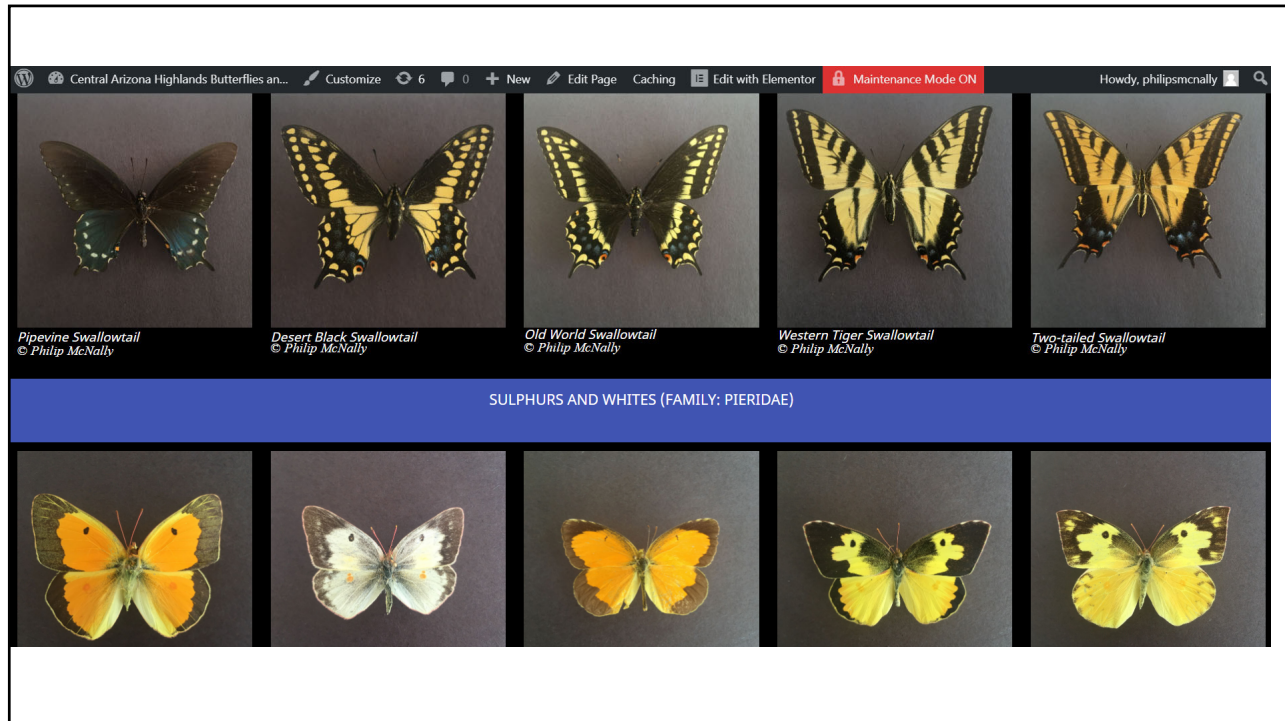
136

Includes site localities and photos of the specific habitats for the different Highlands species

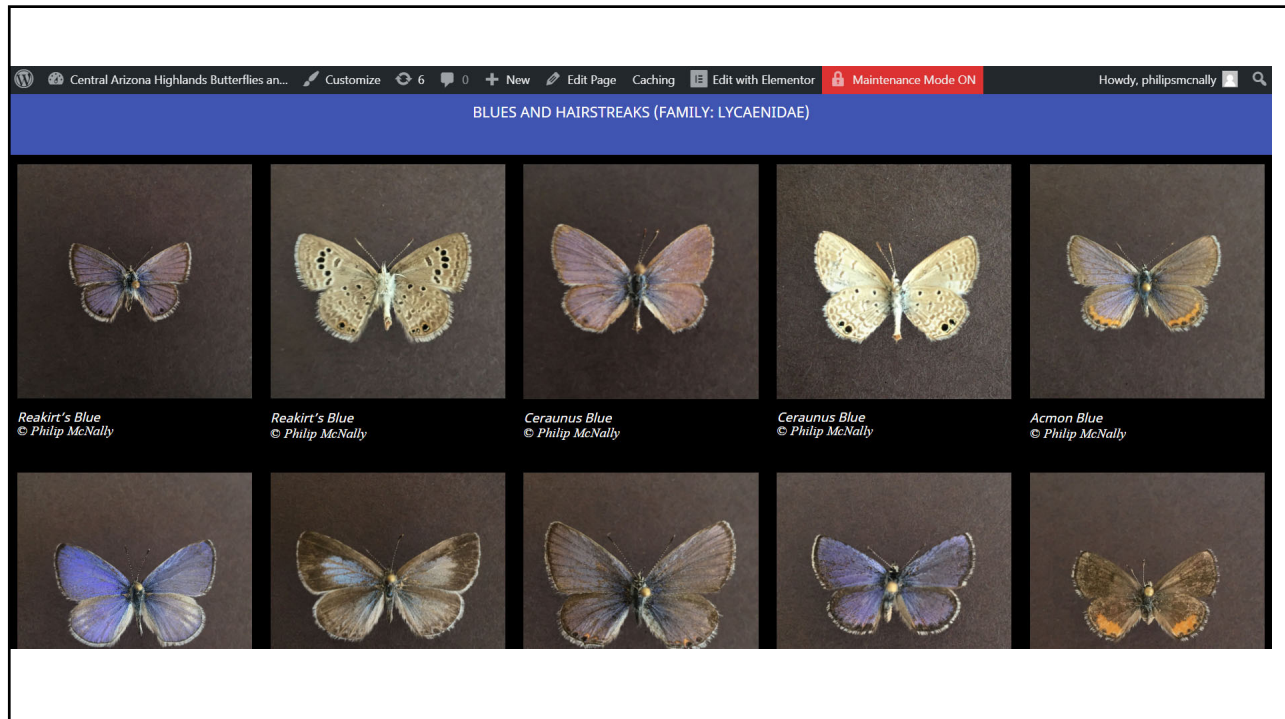


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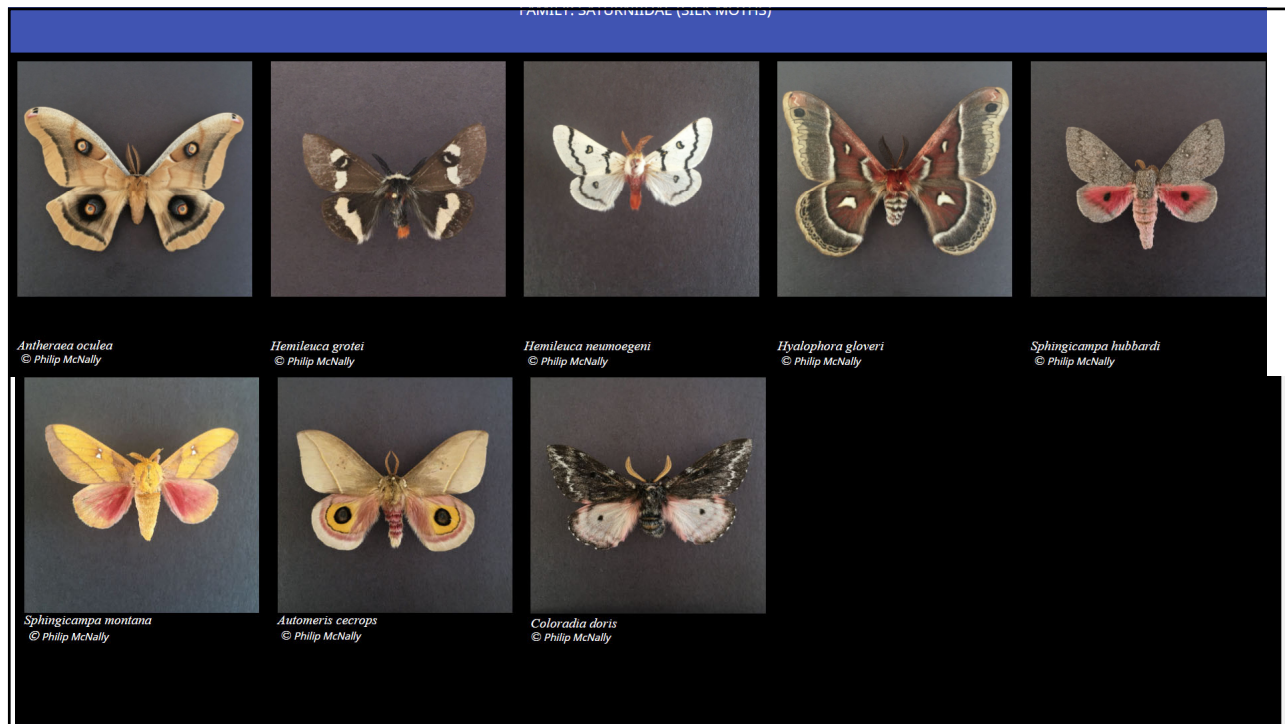
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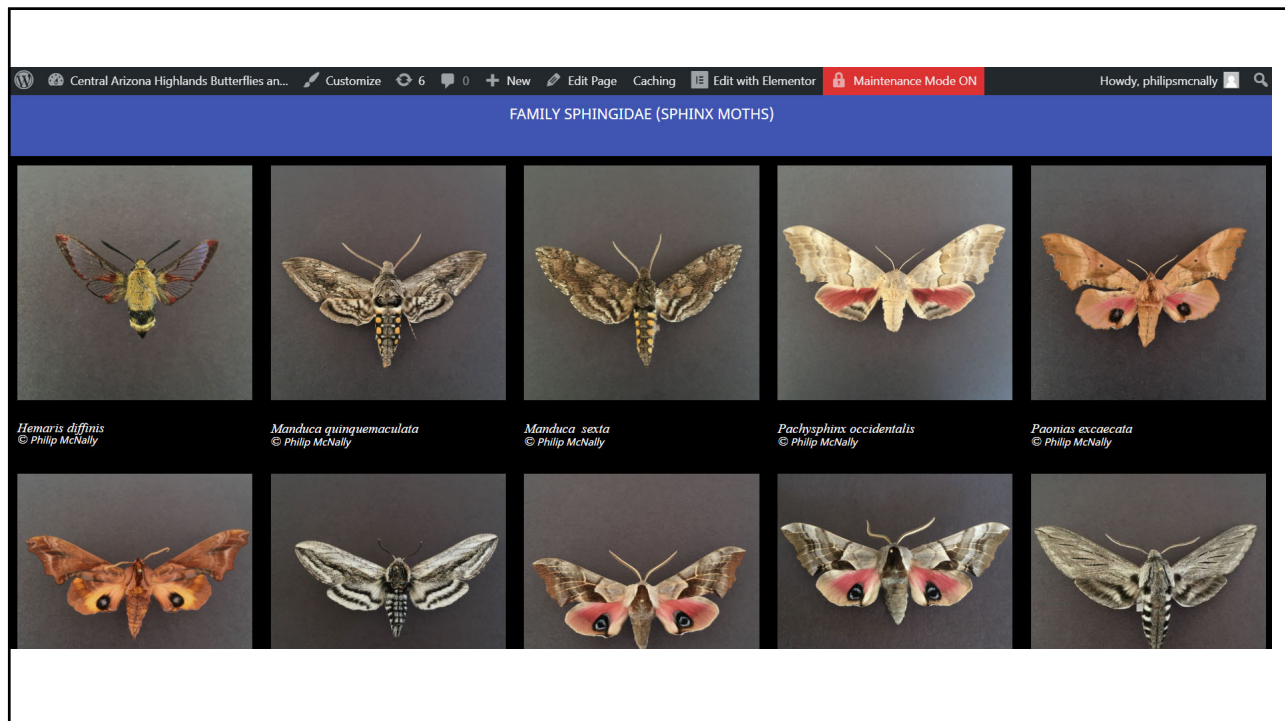
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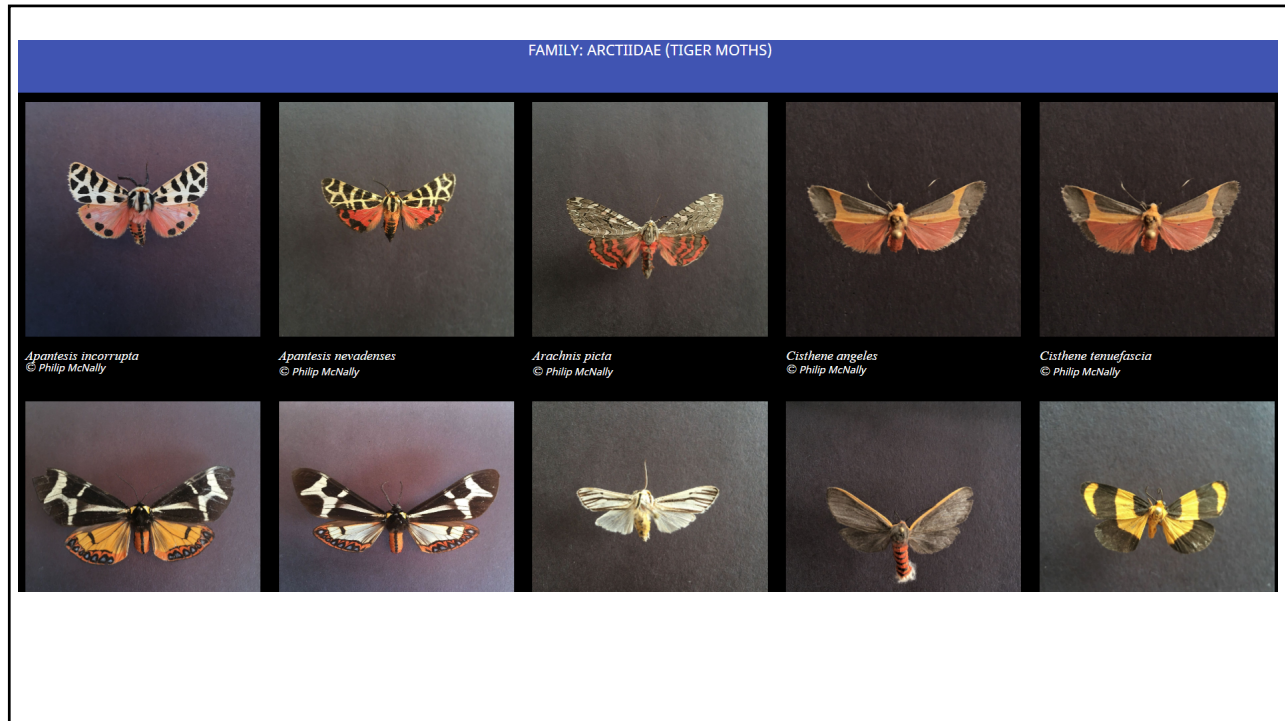
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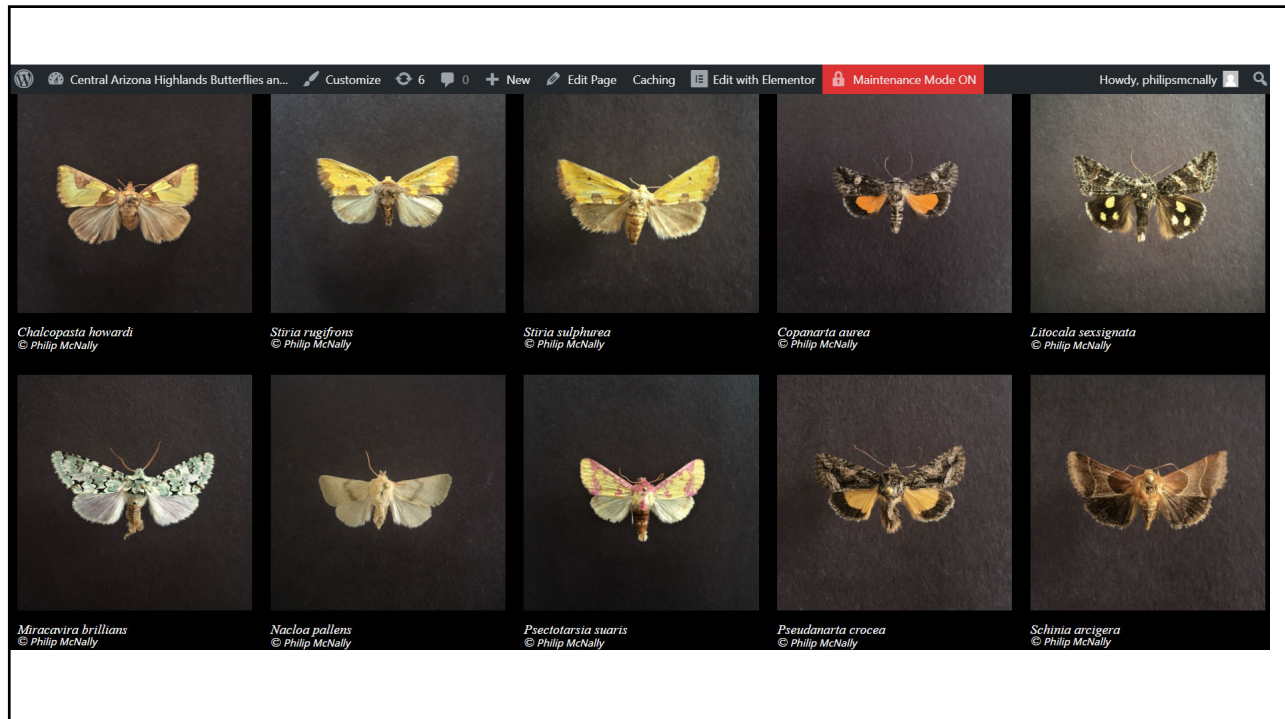
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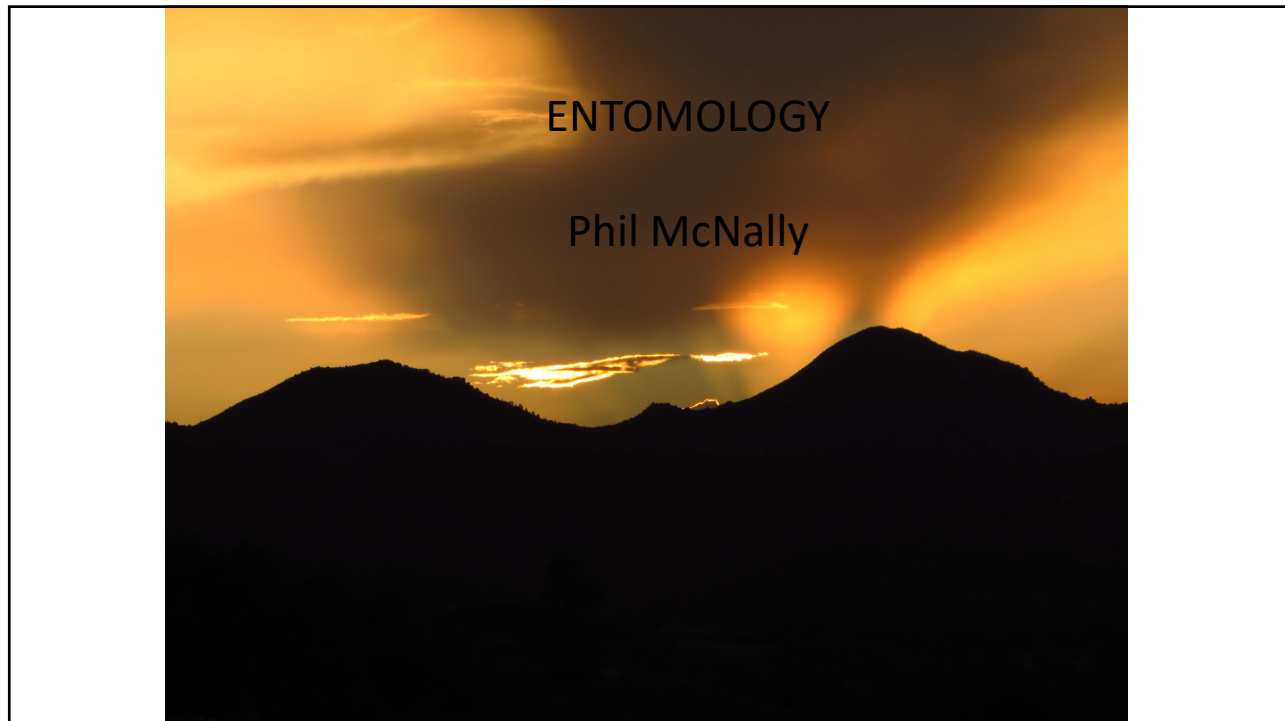
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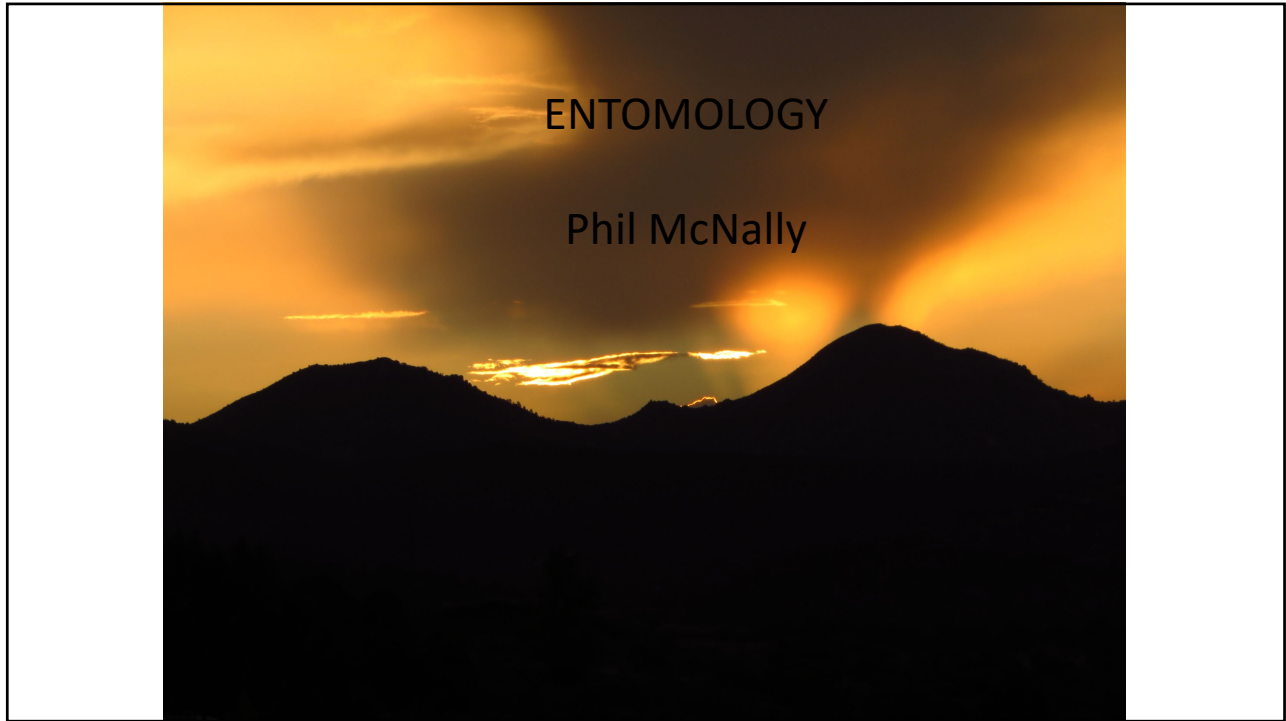
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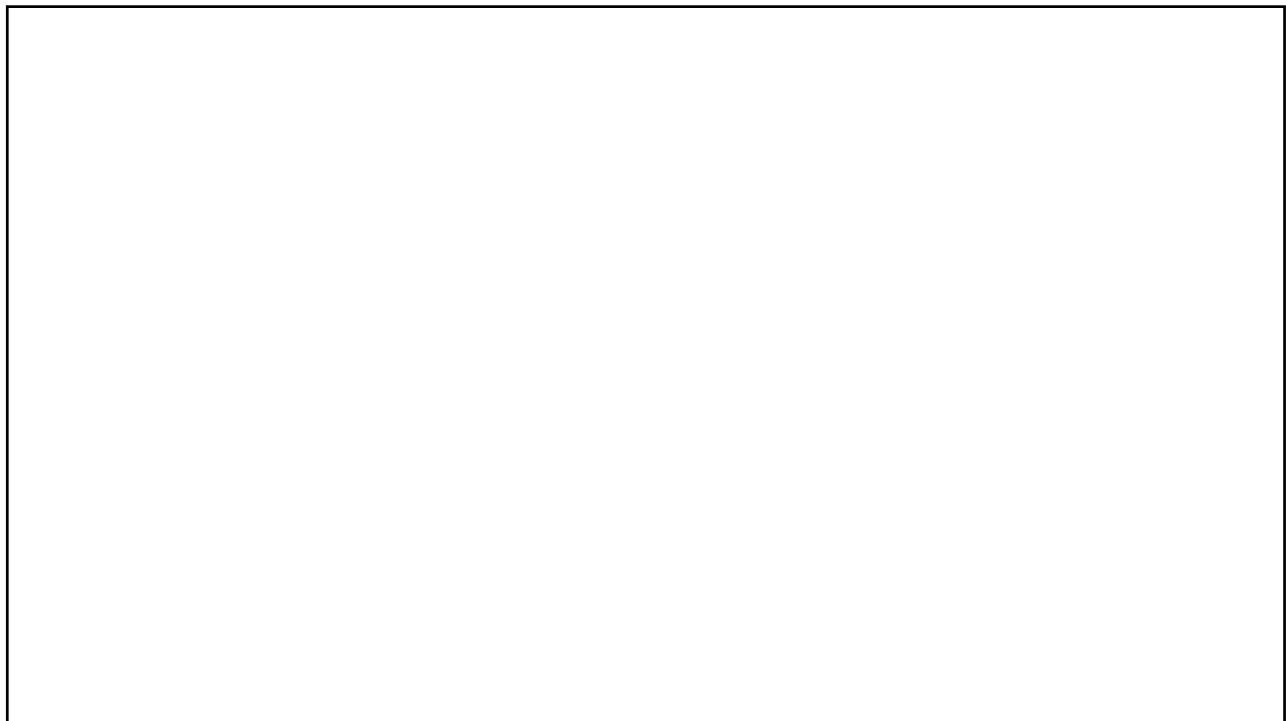
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