

Ghosts in the Garden Night-flying Moths




Janet Knodel
Professor and Extension Entomologist







Moths as Pollinators

- Night flying
- Better at pollinating than previously thought
- Hairy underbellies
- Food source
 - Bats, frogs, small owls
 - songbirds, flying squirrels, grizzly bears







Moth Eyes

- 2 compound eyes on either side of their head
 - Each containing thousands of individual lenses (called ommatidia)
 - Anti-reflective film
- Detect movements
- See colors
- Some detect ultraviolet light



Surface structure of a moth's eye



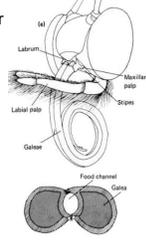
Small bumps on the surface of a moth's eye (OMM) image!



<https://naturallycuriouswithmariyaholland.wordpress.com/2013/07/01/moth-eyes-and-biomimicry/>

Moth Mouthparts

- Siphoning for probing into a flower and sucking out nectar
- A long, slender proboscis
- At rest, this tubular structure remains coiled beneath the head
- Mouthparts absent (vestigial)



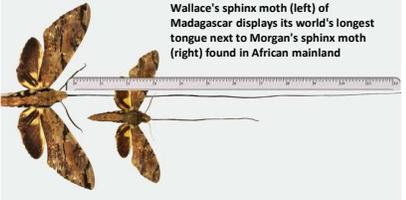



Longest Moth Tongue

- **Wallace's sphinx moth** a new species in 2021!



Madagascar star orchid with its extremely long nectar tube. (Source: New York Botanical Garden)



Wallace's sphinx moth (left) of Madagascar displays its world's longest tongue next to Morgan's sphinx moth (right) found in African mainland

Minet et al. 2021



Moth Life Cycle

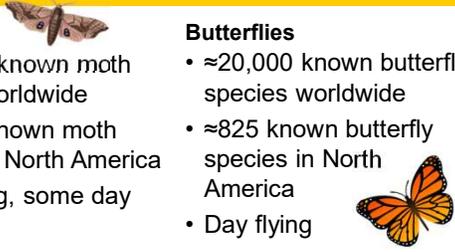
- Complete Metamorphosis
- Egg to larval stages to pupa to adult
- Each life stage looks different
- Pupal stage (cocoon)

Moth Life Cycle



Order Lepidoptera: Moths versus Butterflies

<p>Moths</p> <ul style="list-style-type: none"> • ≈160,000 known moth species worldwide • ≈12,000 known moth species in North America • Night flying, some day flying 	<p>Butterflies</p> <ul style="list-style-type: none"> • ≈20,000 known butterfly species worldwide • ≈825 known butterfly species in North America • Day flying
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Moths versus Butterflies

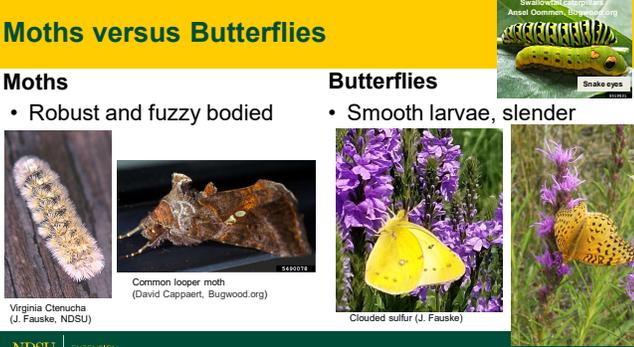
<p>Moths</p> <ul style="list-style-type: none"> • Straight filaments or feathery or branched 	<p>Butterflies</p> <ul style="list-style-type: none"> • Knobbed antennae
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Moths versus Butterflies

<p>Moths</p> <ul style="list-style-type: none"> • Robust and fuzzy bodied 	<p>Butterflies</p> <ul style="list-style-type: none"> • Smooth larvae, slender
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Moths versus Butterflies

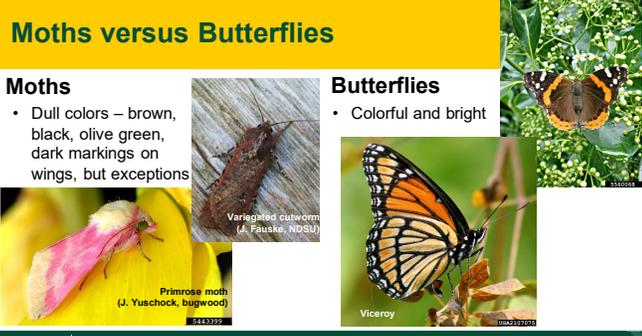
<p>Moths</p> <ul style="list-style-type: none"> • Spread out wings at rest 	<p>Butterflies</p> <ul style="list-style-type: none"> • Rest with wings held upright
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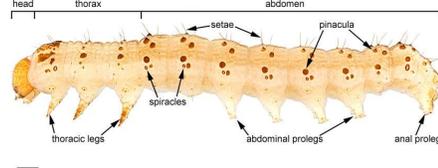
Moths versus Butterflies

<p>Moths</p> <ul style="list-style-type: none"> • Dull colors – brown, black, olive green, dark markings on wings, but exceptions 	<p>Butterflies</p> <ul style="list-style-type: none"> • Colorful and bright
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How to Identify a Larva or Caterpillar of Lepidoptera (Moth and Butterflies)



Source: LepIntercept - An identification resource for intercepted Lepidoptera larvae by Todd M. Gilligan and Steven C. Passoa

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Larvae – Crochets

Crochet arrangement on abdominal prolegs;
 A: *Helicoverpa armigera* (Noctuidae); B: *Mamestra brassicae* (Noctuidae); C: *Capitarsa* sp. (Noctuidae);
 D: *Trichoplusia ni* (Noctuidae); E: *Diaphania nitidalis* (Crambidae); F: *Diatraea lineolata* (Crambidae);
 G: *Crocidosema plebejana* (Tortricidae); H: *Thaumatotibia leucotreta* (Tortricidae);
 I: *Pectinophora gossypiella* (Gelechiidae)

Source: LepIntercept - An identification resource for intercepted Lepidoptera larvae by Todd M. Gilligan and Steven C. Passoa

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Larvae – How to Identify a Moth Caterpillar

Lepidoptera: Moth larva (caterpillar)

Hermit sphinx moth (Courtesy of J. Fauske, NDSU)

2-5 pairs of prolegs on the abdomen, crochets on prolegs. Smooth, hairy or spiny, horn, and vary in size

Hymenoptera: Sawfly larva

https://extension.umn.edu/yard-and-garden-insects/sawflies

Six or more pairs of prolegs, smaller prolegs, no crochets on prolegs, smooth, about 1 inch long when mature

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How to Identify a Moth Caterpillar (larva)

Lepidoptera: Moth larva (caterpillar)

Hermit sphinx moth (Courtesy of J. Fauske, NDSU)

Head capsule, 2-5 pairs of prolegs on the abdomen, thoracic legs behind head, smooth, hairy or spiny, and vary in size

Coleoptera: Grubs or wireworms

White grubs (J. Knodel, NDSU)

Wireworm larva (P. Beauzay, NDSU)

Lack prolegs or have very few, 3 pairs of thoracic legs, body shape diverse

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How to Identify a Moth Caterpillar (larva)

Lepidoptera: Moth larva (caterpillar)

Hermit sphinx moth (Courtesy of J. Fauske, NDSU)

Head capsule, 2-5 pairs of prolegs on the abdomen, thoracic legs behind head, smooth, hairy or spiny, and vary in size

Coleoptera: Larva or wireworms

Larva CPB (J. Knodel, NDSU)

Larva lady beetle (P. Beauzay, NDSU)

Lack prolegs or have very few, 3 thoracic legs, body shape diverse

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How to Identify a Moth Caterpillar (larva)

Lepidoptera: Moth larva (caterpillar)

Hermit sphinx moth (J. Fauske, NDSU)

Head capsule, 2-5 pairs of prolegs on the abdomen, thoracic legs behind head, smooth, hairy or spiny, and vary in size

Diptera: Fly larva (maggot)

Blow flies (Susan Ellis, Bugwood.org)

No legs and no prolegs, no head capsule, burrow into moist, decaying organic matter or dead animals

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Common Moth Families Spingidae - Hornworms, Sphinx, or Hawk moth

Leafy spurge hawkmoth

Norman E. Foster, USDA ARS, Bugwood.org, 604022903

White-lined sphinx

Terry Curtis, Bugwood.org

Fast-flying

Patrick Beauzay, NDSU

Source: https://extension.sdstate.edu/night-blooming-flowers-and-host-plants-moths

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Common Moth Families Noctuidae – Owlets, Cutworms, Underwings

Winter cutworm or large yellow underwing
Copyright © 2003 Larry Line, Mostly Moths of Maryland, Bugwood.org

Red-backed cutworm
Gerard Fauske, NDSU

Copyright © 2013, Jennifer S. Matthews, Ag. NDSU

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Common Moth Families – Erebiidae (Lymantriidae) - Tussock Caterpillars

Milkweed tussock moth and caterpillars
Whitney Cranshaw, Colorado State University, Bugwood.org

Pale tussock moth and caterpillar
Kevin D. Arvin, Bugwood.org

Invasive Spongy moth
Mark Drelling, Bugwood.org

Jon Yuschick, Bugwood.org

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Common Moth Families - Erebiidae (Arctiidae) Tiger moths, Lichen moths

Saltmarsh caterpillar
Whitney Cranshaw, Colorado State University, Bugwood.org

Banded woollybear
Sturgis McKeever, Georgia Southern University, Bugwood.org

Whitney Cranshaw, Colorado State University, Bugwood.org

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Common Moth Families Erebiidae (Arctiidae) Banded woolly bear

WOOLY BEAR CATERPILLAR WINTER PREDICTIONS

- HARSH WINTER, THE MORE BLACK THE MORE WASHY
- MODERATE WINTER
- MILD WINTER, THE MORE BROWN THE MORE MILD
- WINTER BEGINS HARSH (MORE MILD (MORE BLACK NEAR HEAD))
- WINTER BEGINS MILD (MUCH HARSH (MORE BLACK NEAR TAIL))

<https://www.adirondackalmanack.com/wp-content/uploads/2021/12/WB-digital-art-2021.jpg>

Banded woollybear
Sturgis McKeever, Georgia Southern University, Bugwood.org

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Host Plants for Moths

- Typically white or pale in color
 - Datura (*Datura wrightii*)
 - Morning glory (*Convolvulus* spp.)
 - Common evening primrose (*Oenothera biennis*)
- Long tubular flowers with lots of nectar
- Landing platforms/clusters
- Open late afternoon or night
- Plant larval host plants

Datura

Evening primrose

Morning glory

Source: <https://www.xerces.org>

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Food Sources and Host Plants for Moths

- Most nectar generalists
- Some nectar specialists
- Native plants
- Oaks, birch, willows, cherries
- Native flowers and grasses
 - Leadplant
 - Blazing star
 - Joe Pye weed
 - Milkweed

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Source: <https://extension.ad.state.edu/night-blooming-flowers-and-host-plants-moths>

Host Plant – Moths Relationship

- Yucca plant – solely pollinated by yucca moths, and the moth caterpillars feed only on yucca seeds
- Yucca plant and yucca moths have coevolved to rely entirely on each other



Source: <https://www.xerces.org/blog/the-right-shit-moths-as-nocturnal-pollinators>

Night-blooming Flowers for Moths

Common Name	Scientific Name	Sun	Height	Bloom	Characteristics
Angel's trumpet	<i>Burgmansia</i> sp.	Sun	5-10'	Fragrant yellow or white flowers	Subtropical annual
Devil's trumpet, Moonflower	<i>Datura innoxia</i>	Sun	2-5'	Large white, fragrant, trumpet shaped flowers	Annual
Evening scented stock	<i>Mathiola longipetala</i>	Sun, part shade	12-15"	Summer flowering, Creamy yellow, pink, or white	Annual
Flowering tobacco	<i>Nicotiana</i> sp.	Sun	2-7'	Fragrant white flowers	Annual
Moonflower	<i>Ipomoea alba</i>	Sun	Vine to 20'	White, saucer shaped fragrant flowers	Annual

Source: <https://extension.sdstate.edu/night-blooming-flowers-and-host-plants-moths>

Night-blooming Flowers for Moths

Tuberose	<i>Agave amica</i>	Sun	2-3' stalks	Tubular white, fragrant flowers	Annual
Four o'clocks	<i>Mirabilis jalapa</i>	Sun, part shade	6-12"	Tubular orange, white, pink, or yellow flowers	Annual
Night phlox	<i>Zaluzianskya capensis</i>	Sun	6-12"	Lacy white flowers with burgundy petals with honey fragrance	Annual
Foamflower	<i>Tiarella</i> sp.	Part-shade, shade	6-12"	Groundcover with pink flowers	Perennial
Evening primrose	<i>Oenothera biennis</i>	Sun, part shade	1-5'	White, pink, or yellow flowers	Biennial
Yucca	<i>Yucca glauca</i>	Sun	3-4'	White, yellow flowers	Perennial

Source: <https://extension.sdstate.edu/night-blooming-flowers-and-host-plants-moths>

Food Sources and Host Plants

- Most nectar generalists
- Some nectar specialists
- Native keystone plants
- Oaks, birch, willows, cherries
- Native flowers and grasses

Common Name	Scientific Name	Sun	Moisture	Height	Bloom	Color	Form	Moth Visitors/Hosts
Oak	<i>Quercus</i> sp.	Sun	Dry, medium	50-80'	NA	NA	Tree	Imperial, Polyphemus, Banded tussock
River birch	<i>Betula nigra</i>	Sun, part shade	Medium to wet	40-70'	NA	NA	Tree	Luna, Imperial
Wild grape	<i>Vitis riparia</i>	Sun, part shade	Dry, medium	Up to 20' long	May-Jun	White, green	Vine	Eight spotted forester
Leadplant	<i>Amarpha canescens</i>	Sun, part shade	Dry	1-3'	Jun-Jul	Purple	Shrub	Leadplant flower, Magdalen underwing
Northern bush honeysuckle	<i>Diervilla lonicera</i>	Sun, part shade	Dry, medium	1-3'	Jun-Aug	Yellow	Shrub	Laurel sphinx, Snowberry clearwing
Serviceberry	<i>Amelanchier</i> sp.	Sun, shade	Medium	10-25'	May-Jun	White	Shrub	Small-eyed sphinx, Interrupted dagger

Source: <https://extension.sdstate.edu/night-blooming-flowers-and-host-plants-moths>

Food Sources and Host Plants

Aster	<i>Symphoricarichum</i> sp.	Sun, part shade	Dry, medium	2-5'	Aug-Oct	Purple-blue	Perennial forb	Wavy-lined emerald
Blazing star	<i>Liatris</i> sp.	Sun	Dry, medium	3-5'	Aug-Sep	purple	Perennial forb	Glorious flower, 3-lined flower, Wavy-lined emerald
Goldenrod	<i>Solidago</i> sp.	Sun	Dry, medium	3-5'	Aug-Oct	Yellow	Perennial forb	Wavy lined emerald
Joe Pye weed	<i>Euthrochium purpureum</i>	Sun, part shade	Medium, wet	3-7'	Jul-Sep	Pink, purple	Perennial forb	Clymene, 3-lined flower, Ruby tiger, Great tiger
Rose milkweed	<i>Asclepias incurvata</i>	Sun	Medium, wet	3-5'	Jun-Aug	Pink	Perennial forb	Hawk moth, Dogbane tiger, milkweed tussock
Yucca	<i>Yucca glauca</i>	Sun	Dry	3-4'	Jun-Aug	White	Perennial forb	Yucca moth

Source: <https://extension.sdstate.edu/night-blooming-flowers-and-host-plants-moths>

Moon Gardens

- White or silvery foliage
 - White hydrangeas, moonflowers, white cosmos, white lilies, white phlox
- Night-blooming plants with strong scents (fragrant flowers)
 - Jasmine, night-scented stock
- Soft lighting - moon's light
- Peaceful ambiance
 - Water features or wind chimes



Watching Moths in your Gardens

- Light trap
 - Take photographs instead of “killing and collecting” moths
- Flashlight with red lens
- National Moth Week



NDSU | EXTENSION | <https://www.xerces.org/blog/moths-are-cool-too>

ALL MOTHS in Trouble! Help save!

- Turn Out the Lights! **Light pollution**
 - Decline in moths and fireflies
 - Disruptive to bird migrations
- Outdoor lights (rising sun) attract night-flying moths
 - Confuses moth and fly in circles around artificial light
 - LED lights increase the mortality of insects
 - Use warm colors, dim low-voltage lighting
 - Motion-activated lights



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ALL MOTHS in Trouble! Help save!

- Electric bug zappers
 - Useless for controlling mosquitoes and other insect pests
 - Total catch per summer – 13,789 moths and only 31 biting insects
 - 1990 study – 4 million bug zappers in use in the U.S.
 - Killing 71 billion harmless and beneficial insects
 - Electrocuting insects are blasted and release a fine mist containing insect parts and, bacteria and viruses up to 7 feet from the device.
 - Detrimental to your health
- Pesticides, Habitat loss, invasive species



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Protect Moths

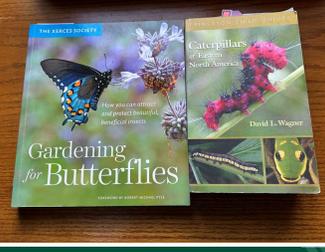
- Brush piles
- Leaf litter
- Limited pesticide use



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Moth Resources

- Xerces website – “Moths”
 - <https://www.xerces.org/>
- SDSU Extension
 - “Night-Blooming Flower and Host Plants for Moths”
- U.S. Forest Service
 - “Moth Pollination”
- McCormac, J., & Gottfried, C. (2023). *Gardening for Moths: A Regional Guide*. Ohio University Press.



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Moth Resources

Butterflies and Moths of North America
<https://www.butterfliesandmoths.org>



Achemon sphinx moth
Eumorpha achemon (Drury, 1773)



Family: Sphingidae
Subfamily: Sphinginae
Distribution: Eastern U.S. to Florida, southern Mexico, and the Caribbean.
Life Cycle: Larvae feed on night-blooming plants like tobacco and tomato.
Host Plants: Tobacco, tomato, and other members of the Solanaceae family.
Range: Eastern U.S. to Florida, southern Mexico, and the Caribbean.
Management: Larvae are voracious feeders and can be a pest on tobacco.

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