

# Mistletoes, Dodder & Plant Cannibals

## Master Gardeners


### January 21, 2021





Jim Chatfield, OSU Extension

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“Roses have thorns, and silver fountains mud;  
 Clouds and eclipses stain both moon and sun,  
 And loathsome canker lives in sweetest bud,  
 All plants make faults.”



William Shakespeare  
 Sonnet 35

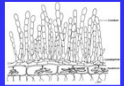
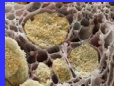


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## Definitions of Infectious Plant Pathogens & Plant Disease

- “[Living] pathogens...usually cause disease in plants by **disturbing the metabolism** of plant cells through enzymes, toxins, growth regulators and other substances they secrete and by **absorbing foodstuffs** from the host cells for their own use.
- Some pathogens also cause disease by growing and multiplying in the **xylem or phloem** vessels of plants, thereby blocking the upward translocation of water and downward movement of sugars.”

◆ “Plant Pathology” (Agrios)

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## Definitions of Infectious Plant Pathogens & Plant Disease

- “In general, a plant becomes diseased when it is **continuously disturbed** by some causal agent that results in an **abnormal physiological process** that disrupts the plant’s normal structure, growth, function, or other activities.  
 This interference with one or more of a plant’s essential physiological or biochemical systems elicits **characteristic pathological conditions or symptoms.**” – Britannica

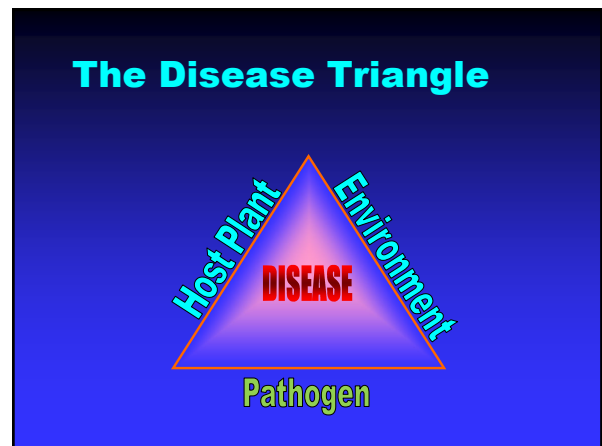
“Plant disease is defined as the state of **local or systemic abnormal physiological functioning** of a plant, resulting from the continuous, prolonged ‘irritation’ caused by **phytopathogenic organisms (infectious or biotic disease agents).**” - Encyclopedia of Microbiology




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## Types of Plant Pathogens

- Plant Pathogenic Fungi
- Plant Pathogenic Oomycetes
- Plant Pathogenic Viruses
- Plant Pathogenic Bacteria
- Plant Pathogenic Nematodes

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## Types of Plant Pathogens

- Plant Pathogenic Xylem-Limited and Wall-less Bacteria
- Plant Pathogenic Plants
- Plant Pathogenic Protist
- Plant Pathogenic Algae
- Plant Pathogenic Viroids

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## A Curious Claim

- "Mistletoe recognized as the first plant pathogen." – by Albertus Magnus, ~ 1200 A.D. George N. Agrios, "Plant Pathology, 5<sup>th</sup> Ed. (2005).

But...Homer (~1000 B.C.), the Old Testament (~750 B.C.), and Theophrastus (~300 B.C.) talked of rusts and mildews and even of sulfur as a control. So...

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## However...

- Theophrastus, for example, philosophized that plant diseases were caused by the **wrath of the gods**, not by a **pathogen**. And that control (though sulfur was used for mildews) was mainly a matter of appeasing those gods.

- Thus the god Robigus brought on cereal rust diseases, for which the holiday Robigalia was celebrated to appease Robigus by animal sacrifices.

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## Mistletoe and Albertus Magnus...

- ...On the other hand, was correctly seen to be a plant that was a parasite that infected other plants by sending structures into stems and robbing them of water, minerals, and sugars and causing swellings that damaged branches.
- These were true mistletoes, of the genus *Viscum*, similar to the genus *Phoradendron* we have in the New World.

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## Albertus Magnus Said...

- "Natural science does not consist in ratifying what others have said, but in seeking the causes of phenomena."

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# Broadening The Discussion

## Plant on Plant Crime: Examples

- Mistletoes, dodders, other plants that are infectious plant pathogens
- Biochemical allelopathy, such as juglone
- Plant Movie Monsters
- The Many Faces of Symbioses
- Wicked and Killer Plants & The Hazards of Horticulture
- And of course... WEEDS or far today ...








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# Some Terms We Will Clarify



- Plant pathogen
- Haustoria
- Allelopathy and allelochemicals
- Symbiosis
- Mycoheterotrophs
- Mistletoes: dwarf and true




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# Plant Parasitic Plant Pathogens: Most Important

- Orobanchaceae (broomrape family): *Striga*, *Orobanche*
- Convolvulaceae (morning-glory family): *Cuscuta*
- Sandalwood Parasites:
  - Loranthaceae (showy mistletoe family)
  - Santalaceae (sandalwood family) Includes dwarf mistletoe
  - Viscaceae (Christmas mistletoe family)


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# The Horro: *Tapinanthus bangwensis*

## Mistletoe on *Theobroma cacao*





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# *Theobroma cacao*: Food of the Gods









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## Types of Parasitic Plant Pathogens

- Stem Parasites Vs. Root Parasites**

Stem: Dodder (*Cuscuta*), *Cassytha*, and most mistletoes.

Root: Broomrape Family ((*Orobanchaceae*). *Witchweed* (*Striga*); *Orobanche*


- Hemiparasites Vs. Holoparasites**

Hemiparasites: Contain chlorophyll, but acquire water and dissolved nutrients via haustoria that access host xylem and phloem

Holoparasites: Lack chlorophyll, rely totally on host xylem and phloem


- Its's Nature, so there are **intermediate types**.
- Above relates to **Angiosperm plant parasitic pathogens**. Not, e.g. green algae such as *Cephaleuros virescens*.





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## Some Terms We Will Clarify

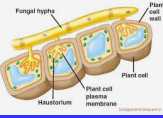

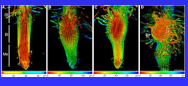
- Plant pathogen
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- Allelopathy and allelochemicals
- Symbiosis
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- Mistletoes: dwarf and true**




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## Haustorium (haustoria)

- Haustorium**, highly modified stem or root of a parasitic plant or a specialized branch or tube originating from a hairlike filament (hypha) of a fungus. The **haustorium** penetrates the tissues of a host and absorbs nutrients and water.

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## Mistletoes

- The Name: from Old German "mist" (dung) and "tan" (twig). Birds defecate seeds (of true mistletoe) plants onto plant twigs.






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## True or Leafy Mistletoes

- Phoradendron* spp. in most of U.S.
- Viscum* spp. in California, Europe, Asia
- Viscaceae; attack mostly deciduous trees
- Green leaves, stems up to an inch, most with dioecious flowers, white fruits
- No roots; haustorial sinkers
- Swelling, witches-brooms, dieback, reduced growth




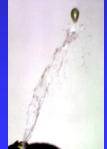





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## Dwarf Mistletoes

- Arceuthobium* spp.; mostly western U.S.
- Viscaceae; attack conifers
- Tawny, tiny leaves, stems produce haustoria of longitudinal strands and vascular "sinks", no roots; dioecious flowers, seeds expelled from fruits
- Stunting, deformation, stem and tree death
- Disruption of hormonal balance of host
- Controls: Pruning or roguing

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## How Do Mistletoes Spread

- Some say Luther Burbank spread the European true mistletoe (*Viscum xx*) to the U.S. joining our native *Phoradendron* spp.
- Birds spread true mistletoes well.
- Our native dwarf mistletoes (*Arceuthobium*, e.g.) spread shorter distances, mostly by explosive ejection of fruits/seeds.





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## Mistletoe Traditions




One source claims it started in **Greece**, with the late summer Kronia celebration, followed by the **Romans** Winter Solstice Saturnalia, with mistletoe's association with fertility involving kissing.

Another dates to warring classical **Rome**, with combatants signaling reconciliation with mistletoe sprigs.

**Druids** in the 1<sup>st</sup> century saw the evergreen mistletoe as representing vivacity.

In **Norse** mythology, Frigg, the goddess of love, asked Nature to spare the prophesized death of her son Baldur. She neglected mistletoe in her pleas and Loki retaliated with an arrow made from mistletoe wood. To repent, in one version Frigg then declared mistletoe a symbol of love and vows to kiss anyone passing beneath it.

By the 18<sup>th</sup> century, **English** servants stole kisses under mistletoe to ward off bad luck. One kiss per berry until exhausted.





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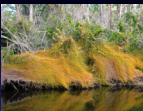
## Saturnalia!

- In Ancient Rome, the Winter Solstice festival referred to as *Saturnalia* began on December 17 and lasted for seven days.
- It was held to honor Saturnus, the Roman god of agriculture and harvest, and was characterized by the **SUSPENSION OF DISCIPLINE** and reversal of the usual order.
- Grudges and quarrels were forgiven, wars were postponed, and people engaged in carnival-like festivities.





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## Dodder

- *Cuscuta* is a genus of over 201 species of yellow, orange, parasitic plants also known as Amar bail in India. Formerly treated as the only genus in the family Cuscutaceae, it now is accepted as belonging in the morning glory family, **Convolvulaceae**, on the basis of the work of the Angiosperm Phylogeny Group. [Wikipedia](#)



"mate in a feeble or unsteady way, especially because of old age." "an elderly couple gave us a concerned glance as they doddered past"



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## Impact and Control of Dodder

- Biggest problem further south. Debilitates, vectors pathogens, reduced host resistance to viral pathogens.
- Annual. Wide host range.
- Worldwide: Lady's laces, wizard's net, devil's guts, hairweed, hellbine, love vine, strangleweed, angel hair, and witch's hair.
- Mildly photosynthetic; water & minerals & nutrients mostly from host plants.
- Remove infested host plants and dodder seedlings before seed set. Herbicides: glyphosate & preemergents. Seed survival: >20 years.
- *Cuscuta chinensis* seed used as herbal medicine.

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## Dodders I Have Seen






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# Dodder

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## Host Range of Plant Parasitic Pathogens

- Can be very broad: *Cuscuta* (dodder) can infect hundreds of hosts in diverse families
- Can be very narrow: *Epifagus virginiana* parasitizes only *Fagus grandifolia* (American beech)
- Mistletoes: Some specialists; some generalists
- Host range > host preference

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## Beech Drops American beech *Epifagus virginiana* *Fagus grandifolia*

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## Plant Parasitic Plant Pathogens: Most Important

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# Striga

- *Striga* spp (witchweed). Roots produce haustoria that infect host plant roots and then vascular systems; stunting and possibly death results. Hosts include corn, sugarcane, legumes, tobacco in Africa, Asia, Australia. Serious pest. Inursion in Carolinas in 1956. Controlled by plowing under and herbicides.

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# Orobanche (Broomrape)

- *Orobanche* spp are also serious root pathogens that infect vascular systems. Wide range of herbaceous hosts. West Asia and the Mediterranean. Prevention of seed spread is a primary control strategy.

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## Broadening The Discussion Plant on Plant Crime: Examples

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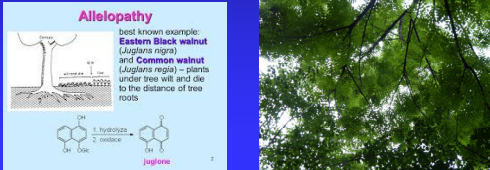
## The Darwin Awards



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## Allelopathy

“The chemical inhibition of one plant (or other organism) by another, due to the release into the environment of substances acting as germination or growth inhibitors.”



**Allelopathy**  
 Best known example: Eastern Black walnut (*Juglans nigra*) and Common walnut (*Juglans regia*) – plants under tree will and die to the distance of tree roots.

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## A Few Plants That Practice Allelopathy

- Black Walnut (*Juglans nigra*)
- Ailanthus or Tree-Of-Heaven (*Ailanthus altissima*)
- Fragrant Sumac (*Rhus aromatica*),
- Rice (*Oryza sativa*)
- Mustards



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## Walnut Wilt from Juglone

- Information is often of dubious quality.
- Susceptibility Lists Usually Include:


Tumans and other solanaceous vegetables  
 Lilac  
 Peony  
Rhododendron and other ericaceous plants



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## Issues Surrounding Allelopathy

- Allelopathy refers to the beneficial or harmful effects of one plant on another plant, both crop and weed species, from the release of biochemicals, known as allelochemicals, from plant parts by leaching, root exudation, volatilization, residue decomposition, and other processes in both natural and agricultural systems.
- “Allelochemicals” more broadly-based term: includes secondary metabolites involved in plant/herbivore interactions.
- Juglone and tumans: fairly straightforward
- Theophrastus, 3<sup>rd</sup> century B.C.: pigweed and alfalfa
- “Soil sickness”
- Garlic mustard and interference with mycorrhizas
- Chemical warfare or more mundane competition?
- Major role with desert shrubs



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## The Darwin Awards

### WHY WOMEN LIVE LONGER THAN MEN

1. Because of stuff like this:






**DARWINISM**  
Many bad ideas start with the phrase "Hold my beer and watch this."

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## Carnivorous Plants

- Carnivorous plants are plants that derive some or most of their nutrients from trapping and consuming animals or protozoans, typically insects and other arthropods. However, carnivorous plants generate energy from photosynthesis. [Wikipedia](#)
- A **protocarnivorous plant** (sometimes also **paracarnivorous**, **subcarnivorous**, or **borderline carnivore**), according to some definitions, traps and kills insects or other animals but lacks the ability to either directly digest or absorb nutrients from its prey like a carnivorous plant.
- Five plant orders ; 14 families. Both dicots and monocots (Poales order; Bromeliaceae family).





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## Killer Plants

- Carnivorous plants:
  - Attract
  - Catch
  - Kill
  - Digest

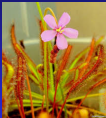
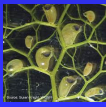

Typically develop in poor nutrient soil  
Widely distributed, except Antarctica. More in U.S.  
Evolved in six different plant groups



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## Examples of Carnivorous Plants


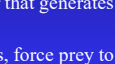
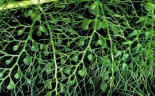


- Venus flytrap: *Dionaea muscipula*. Droseraceae.
- Sundews: *Drosera*. 150+ species. Droseraceae.
- Tropical pitcher plants. *Nepenthes*. 170+ species. Nepenthaceae.
- Bladderworts

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## Trapping Mechanisms of Carnivorous Plants

1. Pitfall traps (pitcher plants) trap prey in a rolled leaf that contains a pool of digestive enzymes or bacteria.
2. Flypaper traps use a sticky mucilage.
3. Snap traps utilise rapid leaf movements.
4. Bladder traps suck in prey with a bladder that generates an internal vacuum.
5. Lobster-pot traps, also known as eel traps, force prey to move towards a digestive organ with inward-pointing hairs.

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## Linnaeus and Carnivorous Plants

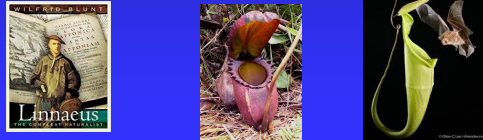
- Bladderworts: Named by Linnaeus (1753). *Utricularia vulgaris* is the common bladderwort (Lentibulaceae; Lamiales). “Bladders” first thought to be flotation devices; later seen to be loci for trapping and digestion. Darwin noted their “traps” shut 100 times faster than Venus flytrap.



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## Linnaeus and Pitcher Plants

- When brought a pitcher plant, Linnaeus placed it in the genus *Nepenthes*, from the Greek “without grief” as it was so beautiful.
- Bats live in “pitchers” in Borneo; *Nepenthes rajah*, the largest carnivorous plant in the world there can store ½ gallon of liquid in a pitcher (including bat guano) and have a second pitcher for the bat habitat.



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## Charles Darwin on Insectivorous Plants

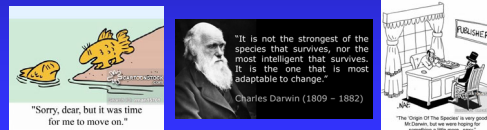
- “During subsequent years, whenever I had leisure, I pursued my experiments, and my book on *Insectivorous Plants* was published July, 1875 – that is sixteen years after my first observations... The fact that a plant should secrete, when properly excited, a fluid containing an acid and ferment, closely analogous to the digestive fluid of an animal, was a remarkable discovery.”



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## Charles Darwin

- “Insectivorous Plants”
- Of Venus flytrap: “One of the most wonderful plants in the world”.
- Of Sundews (*Drosera*): “I care more about *Drosera* than the origin of species.”



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## Broadening The Discussion Plant on Plant Crime: Examples

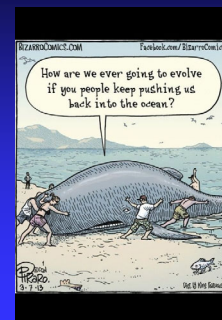
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- And of course... WEEDS or for today ...



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## The Darwin Awards

Nothing can be more improving to a young naturalist, than a journey in a distant country.  
Charles Darwin



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## Plants That Kill People From: Westword



Little Shop of Horrors (1960, 1986)  
 Attack of the Killer Tomatoes (1978)  
 As Sete Vampiras  
 The Crawlers/Troll 3/Contamination.7  
 The Thing From Another World  
 Dr. Who: Seeds of Doom  
 Invasion of the Body Snatchers (1956, 1978, 2007)  
 Piranha Plants  
 The Day of the Triffids (1962, 1981, 2009)  
 The Navy Vs. The Night Monsters

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## Invasion of the Body Snatchers



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## Invasion of the Body Snatchers



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## The Day of the Triffids



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## Little Shop of Horrors



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## Attack of the Killer Tomatoes



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## Little Joe

- "Little Joe's unorthodox approach may baffle horror fans lured in by its premise – but like its title character, the end result exerts a creepy thrall." – Rotten Tomatoes

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## Little Joe






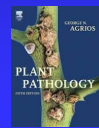







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## Resources for *Plant Cannibals*

- Introduction to Parasitic Flowering Plants. Daniel L. Nickrent and Lytton J. Musselman. apsnet.org. 2004.
- Plant Pathology. George N. Agrios. 5<sup>th</sup> edition. 2005.
- Wicked Plants: The Weed That Killer Lincoln's Mother and Othe Botanical Atrocities. Amy Stewart. 2009.
- Killer Plants: Growing and Caring for Flytraps, Pitcher Plants, and Other Deadly Flora. Molly Williams. 2020.

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## The Darwin Awards



**REMEMBER THAT TIME YOU FORGOT TO THINK?**

This Year's Darwin Award goes to...





Elizabeth...  
For picking the worst moment to admit to having an affair with Tom's brother

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## Wicked Plants

- Coca: *Erythroxylum coca*
- "A cocainezation of the left nostril had helped me to an amazing extent...I have felt wonderful as if there had never been anything wrong at all." - Sigmund Freud.
- Possibly used as early as 3000 years ago.
- Coca-Cola, probably to this day; without cocaine alkaloids.

OC(=O)CN(C)COP(=O)(O)O

**Glyphosate**

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## Wicked Plants

- Peppers and Scoville Heat Units (SHU)
- SHU: the ratio of water to pepper extract to balance fiery flavor. From capsaicin
- Bell pepper (*Capsicum annuum* cultivars) = 0.
- Habanero pepper (*Capsicum chinense*) hottest Scotch bonnet types hottest of the hot
  - 'Red Savina' approaches 500,000 SHU
  - 'Dorset Naga' from Bangladesh ~1,000,000

Pepper spray used by police: 2-5 million.

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## Wicked Plants

- Jimsonweed (*Datura stramonium*) was once called "Jamestown Weed". Why?
- Colonists (1607) learned early adding this solanaceous plant to their diet was a mistake: hallucinations; seizures.
- Tropane alkaloids, a la belladonna.
- British soldiers called in the 1670s to put down a rebellion were fed food with leaves. Incapacitated for 11 days.

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## Wicked Plants

■ "One would blow up a feather in the air; another would dart straws at it with much fury; and another, stark naked, was sitting in a corner like a monkey, grinning and making mows (grimaces) at them: a fourth would fondly kiss and paw his companions." – Nathaniel Bacon's Rebellion, in Jamestown, 1676.

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## Wicked Plants Death and Taxus

- *Taxus baccata* (common yew): All parts poisonous – except the fleshy arils
- Gastrointestinal upset, drop in pulse rate, possible heart failure. "Victims could not describe symptoms – because dead"
- In Caesar's *Gaulic Wars*: [Catuvolcus] "Worn out by age...unable to endure the fatigue either of war or flight...destroyed himself with the juice of a yew tree."

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## Hazards of Horticulture I

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## Shameful Plants

■ "Would not the earth, quickened to an evil purpose by the sympathy of his eye, greet him with poisonous shrubs... Would he not suddenly sink into the earth, leaving a barren and blasted spot, where, in due course of time, would be seen death rightitude, disease, barrenness, and whatever else of vegetable wickedness the climate could produce, all flourishing with hideous luxuriance"

– Nathaniel Hawthorne, *The Scarlet Letter*  
From "Wicked Plants", Amy Tanzer

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## Name This Butterfly



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## *Zanthoxylum americanum* & *Papilio cresphontes*



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## A Tale of Great Sensitivity

- Furocoumarins
- Phytophotodermatitis
- Rutaceae
- *Xanthoxylum americanum*
- Giant swallowtail butterfly a bit, and





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## Lime Disease



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## Sporotrichosis

- Rose Gardener's Disease; unusual/serious
- *Sporothrix schenckii*
- Usual infections from cuts from thorns







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## Symbiosis

- **Symbiosis** is *close and often long-term interaction between two or more different biological species.*
- There are different types of symbiosis:
  - Mutualism:** +, +...lichens, mycorrhizae, endophytic fungi/turfgrasses
  - Commensalism:** +, ~...sooty mold fungus
  - Parasitism:** +, -...*Verticillium* fungus
  - Amensalism:** +, x}, root competition, juglone

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## Mutualistic Symbiosis

- Lichens
- Mycorrhizae
- Endophytic Fungi and Turfgrass

- **Final Exam:** Name a Tripartite Mutualistic Symbiosis!

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## Mutualistic Symbiosis

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## What Are Lichens?

In the words of Irwin Brodo, Sylvia and Stephen Sharnoff, in their wonderful "*Lichens of North America*," they are a "composite of a fungus and an organism capable of producing food by photosynthesis."

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Which of the following is an example of a mutualistic symbiotic relationship between a fungus and plant roots?

- A. **Mycorrhizae**
- B. *Rhizobium* nodulations on plants in the Fabaceae (Leguminosae).
- C. *Phytophthora cinnamomi* on *Taxus* roots.
- D. Allelopathy of black walnuts to tomatoes.

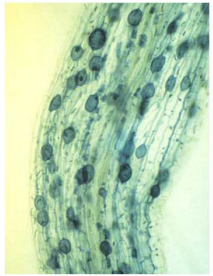
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I-M  
N-R  
S-V  
W-Z

EM: electron micrograph  
SEM: scanning electron micrograph

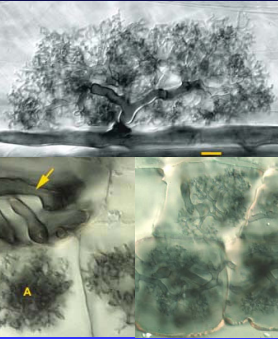
To purchase a CD-ROM of 20 plant disease lessons and an illustrated glossary, click [here](#).



**endomycorrhiza:** (pl. endomycorrhizae; syn. vesicular-arbuscular mycorrhiza)  
symbiotic association between a nonpathogenic or weakly pathogenic fungus and the roots of plants in which fungal hyphae invade cortical cells of the root (see ectomycorrhiza)  
(vesicles of an endomycorrhizal fungus in alfalfa root stained with trypan blue)

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**ARBUSCLES**  
(=tiny trees)



Mark Brundrett

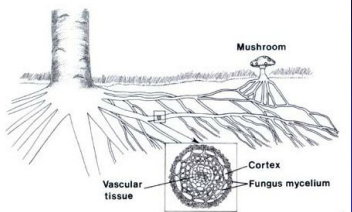
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**APSnet**  
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A-D  
E-H  
I-M  
N-R  
S-V  
W-Z

EM: electron micrograph  
SEM: scanning electron micrograph

To purchase a CD-ROM of 20 plant disease lessons and an illustrated glossary, click [here](#).




**ectomycorrhiza:** (pl. ectomycorrhizae)  
symbiotic association between a nonpathogenic or weakly pathogenic fungus and the roots of plants with fungal hyphae between and external to root cells (see endomycorrhiza)

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**Main Types of Mycorrhizae**

- Arbuscular Mycorrhizae (AM/VAM)
- Ectomycorrhizae (EM)
- Ericacid mycorrhizae
- Orchid mycorrhizae



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**Ecological Interactions**




Two types of fungal partners in symbiosis with plants

<p><b>PARASITE</b> -----&gt;<b>MUTUALIST</b></p> <p>gains nutrients from live organism (host)</p> <p>examples: potato late blight chestnut blight (also pathogens)</p>	<p>gains nutrients from host but gives something back</p> <p>examples: mycorrhizal fungi lichen fungi</p>
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**Main Types of Mycorrhizae**

- Arbuscular Mycorrhizae (AM/VAM)
- Ectomycorrhizae (EM)
- Ericacid mycorrhizae
- Orchid mycorrhizae



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## Mycorrhizae Through the Looking Glass

"I passed through the woodland and marked with one eye,  
The Orchid and Fungi were sharing a pie.  
The Orchid had gravy and piecrust and meat,  
The fungi took the dish as their share of the treat.  
When the pie was all finished, Fungi as a boon.  
Were kindly permitted to pocket the spoon.  
Whilst the Orchid seized knife and fork with a cry,  
And ended the banquet by eating Fungi".



- J. L. Harley

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## Indian Pipe: Parasitic Plant Or some other Symbiosis?

- I always thought it was **parasite** of tree roots.
- Turns out its symbiosis is as a **parasite** of mycorrhizal fungi, that are themselves a **mutualism** with tree roots or possible a parasitism of tree roots. **A TRIPARTITE SYMBIOSIS!**



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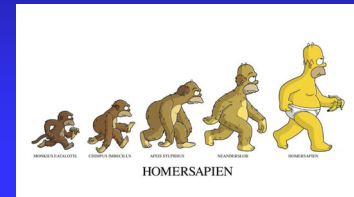
## Resources for *Plant Cannibals*

- Introduction to Parasitic Flowering Plants*. Daniel L. Nickrent and Lytton J. Musselman. apsnet.org. 2004.
- Plant Pathology*. George N. Agrios. 5<sup>th</sup> edition. 2005.
- Wicked Plants: The Weed That Killer Lincoln's Mother and Othe Botanical Atrocities*. Amy Stewart. 2009.
- Killer Plants: Growing and Caring for Flytraps, Pitcher Plants, and Other Deadly Flora*. Molly Williams. 2020.



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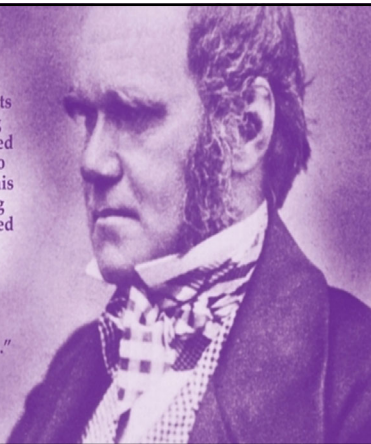
## The Darwin Awards



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"There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved."

Charles Darwin

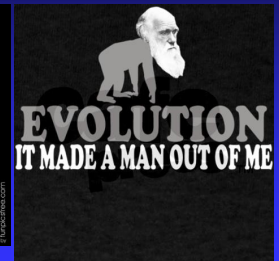


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## The Darwin Awards



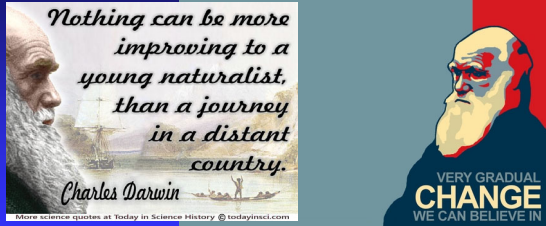
When you are in deep trouble, say nothing, and try to look like you know what you're doing.



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## Charles Darwin



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We can allow satellites, planets, suns, universe, nay whole systems of universes, to be governed by laws, but the smallest insect, we wish to be created at once by special act.

False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for every one takes a salutary pleasure in proving their falseness.

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