

I Parasitic Plants (No Chapter) 2009  
[Guest lecture by Dr. Brian Axsmith]

A. Introduction

1. The parasitic life-style has evolved less frequently among plants than animals
  - a. Only 1 species of parasitic gymnosperm
  - b. Less than 2% of the described species of dicotyledons are parasitic
2. Implications of autotrophy (plants) vs. heterotrophy (animals)
  - a. Selective advantages from acquiring energy-containing compounds from another organism may not outweigh costs of circumventing host defenses for organisms that undergo photosynthesis
  - b. Situations where parasitism could provide a selective advantage to an autotroph
    - (1) Acquisition of inorganic nutrients from hosts
    - (2) Shaded environments where competition for light is intense
3. Divergent evolution: Most parasitic plants [=PPs] are on outside of hosts rather than inside as is the situation with animal parasites
4. Convergent evolution: PP and animals show many similar traits
  - a. PPs have lost structures found in taxonomic relatives: Indian pipes have no chlorophyll

Picture Slide: Indian Pipes Lack Chlorophyll; Raven et al, 1986, *Biology of Plants* 4th ed. Fig. 18-40b

- b. High rates of reproduction: PPs such as witchweed produce smaller but orders of magnitude more seeds than their host plants

Picture Slide: Relative Seed Size of Hosts and Parasite; Witchweed seeds (center) compared with corn (left) and sorghum (right); Parker & Riches, 1993, *Parasitic Weeds of the World*, Fig. 1.4

- c. Manipulate hosts: Many PPs secrete hormones that affect host growth
5. Trophic comparison with animal parasites
    - a. Lifelong intimacy
    - b. Do not kill
    - c. Relative size varies:
      - (1) Indian pipes are much smaller than hosts
      - (2) Dodders & mistletoe can cover host
      - (3) Biomass of witchweeds can be greater than host plants

Picture Slide: Dodder on Cactus; <http://www.sarracenia.com/photos/miscplant/ccali01.jpg>

Picture Slide: Impact of Witchweed; Witchweed caused complete failure of early crop of sorghum (foreground) while crop planted later (background) was less affected; Parker & Riches, 1993, *Parasitic Weeds of the World*, Pl. 5B

- d. Relative number varies
  - (1) Mistletoes and witchweeds will infect one host plant

Picture Slide: Mistletoe

- (2) Dodders will parasitize adjacent plants

Picture Slide: Dodder; Raven et al, 1986, *Biology of Plants* 4th ed. Fig. 18-40a

5. HAUSTORIUM (Plural *haustoria*)
  - a. Modified structure from roots and stems of PP that penetrate host plant tissues
  - b. Vascular system of PP fuses with vessels of host (Analogous to blood vessels of a parasitic animal fusing with those of its host)

Picture Slide: DODDER; *Cuscuta europaea* on a nettle, arrow indicates position of *haustorium*

B. Examples of parasitic dicotyledons

1. Mistletoes
  - a. Autotrophs: Use own chlorophyll for photosynthesis
  - b. Utilize host plant as a source of water

Picture Slide: Mistletoe, Biomass compared to host plant can be relatively large (Green regions on tree are mistletoe.); [http://www.sarracenia.com/photos/miscplant/p\\_spp01.jpg](http://www.sarracenia.com/photos/miscplant/p_spp01.jpg)  
Mistletoe2

2. Dodders (*Cuscuta* spp.)
  - a. Characteristic yellow thread-like stems cover host plants
  - b. Ability to photosynthesize varies among species
    - (1) One species produces no chlorophyll (= heterotroph)
    - (2) Other species retain photosynthetic capability in tissues near flowers (semi-autotrophic)

Picture Slides :Dodder Plant and Flowers;

3. Indian pipes (*Monotropa uniflora*)
  - a. Plants with white stems and flowers typically found on shaded forest floors near trees
  - b. Do not produce chlorophyll, do not undergo photosynthesis

Picture slide: Indian Pipe

- c. Myco-heterotrophic epiparasites
- d. Ectomycorrhizal fungi (= EMF) form a mutualistic association with host plants
  - (1) Form a sheath around host root
  - (2) Hyphae penetrate between but not into host cells
  - (3) Break down organic material in soil
  - (4) EMF provide nitrogen and phosphorus to and receive sugars from host plant

Picture slides: Diagram of EMF association; plants grown with and without EMF illustration mutualistic association

- e. Roots of Indian pipe tap into the MYCELIA (= network of hyphae) of EMF
  - (1) Extract sugars from fungus that were produced in tree
  - (2) Since Indian pipe is taking and not exchanging nutrients with fungus, the relationship is parasitic

Picture slide: Indian Pipe

4. Witchweeds
  - a. Plant will damage crop plants even before they become visible above ground

b. Attach to roots of host plants

Picture Slide: Young witchweed plant connected to root of corn host; Parker & Riches, 1993, *Parasitic Weeds of the World*, Pl. 4B

Picture Slide: Witchweed attached to root of host cowpea; Parker & Riches, 1993, *Parasitic Weeds of the World*, Pl. 7C

Picture Slide: Xylem vessels of witchweed connect to xylem of sorghum host root; Parker & Riches, 1993, *Parasitic Weeds of the World*, Pl. 4A

c. Increased root length relative to stem size of host plant

Picture Slide: Effects on Host Plants; Soil-root mass in which sorghum had been grown with (left) and without (right) witchweed showing stimulation of host root development by the parasitic plant; Parker & Riches, 1993, *Parasitic Weeds of the World*, Fig. 1.9

5. *Rafflesia arnoldii*

a. World's largest flower

b. Parasitizes grape vines in jungles of Sumatra

c. Pollinated by carrion flies (= odoriferous)

Picture Slide Series: *Rafflesia arnoldii* 1 Day Prior to Opening; Fully Opened; World's Largest Flower

<http://www.lostworldarts.com/asia/rafflesia1.htm> Rarnoldii 1