Parasitic Castration of Plants by Fungi


A. Introduction
   Nature of selection favoring sex has been difficult to explain, given its substantial disadvantages
   1. Sexual reproduction leads to variable offspring which give offspring advantages in habitats that . . .
      a. Heterogeneous in time and space
      b. Rare genotypes have higher fitness than common genotypes
   2. Impact of parasites
      a. Parasites attack and become specialized upon most common genotypes
      b. Fitness of rare host genotypes would initially be high
      c. Fitness declines as they become common and experience greater rates of parasitism

B. Parasite alteration of host reproductive systems
   1. Some (rhizocephalan barnacles, trematodes in snails) parasites “castrate” their hosts by specifically destroying the reproductive organs
   2. Others (*Wolbachia*) cause reproductive incompatibility between infected and uninfected individuals in host populations
   3. Plant-fungus associations
      a. Infected plants do not reproduce sexually, but do reproduce vegetatively
      (1) Thus, castrated plants can persist and spread despite loss of sexual reproduction
      (2) Increase fitness of parasite
      (a) Maintains existence of susceptible host strains
      (b) Prevents production of resistant strains

C. Examples of specific fungi on host plants
   1. Clavicipitaceous endophytes
      a. Infect grasses and sedges
      b. Different mechanisms of castration
      (1) Some hosts produce no flowers
      (2) Other hosts
         (a) Flower as normal
         (b) Fungus invades seeds & causes reproductive isolation
      c. Vegetatively produced offshoots contain fungus
      d. Infected plants characteristics as compared to uninfected conspecifics
         (1) Larger than uninfected
         (2) Greater survival (Fig. 2)
            (a) Uninfected plants are annuals
            (b) Infected plants can overwinter and persist as perennials
         (3) Faster growth & competitive ability
2. Smuts
   a. Infect grain crops
   b. Mechanism of castration
      (1) Infect anther (Male portion of flower)
      (2) Hosts do not produce pollen, but smut spores
   c. Infected plants are larger & produce more tillers (= runners)
3. Rusts
   a. Infected plants do not flower, but produce more leaves
   b. Frequency of infection was significantly higher in undisturbed sites, suggesting that infected plants are competitively superior in dense vegetation.

D. Consequences for hosts and parasites
1. Cost on hosts
2. Loss of seed production
   (1) Detrimental to short-lived plants where colonization by seeds in especially important
   (2) Not so detrimental to longer-lived plants in stable habitats where they can spread vegetatively
b. Uninfected plants may spend more energy on reproduction (sexual) than do infected (vegetative) plants
   c. Infected plants re-allocate energy to . . .
      (1) Growth
      (2) Survival
      (3) Maintenance of parasite
3. Impact upon host populations
   a. Change genetic structure and evolutionary potential
      (1) Infected plants
         (a) Limited to vegetative reproduction
         (b) Parasite-compatible genotypes are maintained
         (c) Resistance can only be developed via mutation
         (d) Uninfected plants can develop resistant progeny by out-crossing with resistant plants
      (2) Infected plants are reproductively isolated from uninfected plants
   b. Disadvantages of host castration for fungi
      (1) Infections cannot be propagated except by contagious spread
      (2) Infected populations have reduced potential form adaptive evolution in face of environmental change
      (3) Reduced ability to colonize, given the lack of seeds
      (4) May accumulate deleterious mutations over time
      (5) Susceptible to other parasites and pathogens which may lead to selection for parasites that defended hosts against other pathogens (= mutualism)