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Chapter 25 *Greatest Host Specificity*

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Fig wasps (Hymenoptera: Agaonidae) show incredible host specificity which is essential to their survival in an obligate mutualism with figs. Hybrids do not occur in figs and fruit not pollinated is often aborted. A mistake by a wasp entering the wrong syconium (receptacle with multiple flowers) and ovipositing will likely cause the demise of its brood. The fig likewise will fail to produce seed and propagate. Figs have evolved intricate entrances and chemical cues which select their specific pollinators. Blastophaga psenes *is typical of the agaonids, the insect group showing the greatest host specificity.*

Host specificity is common among many insects during all stages of their life cycles. Often though, stages of the same insect are not specific to the same host or the same stage of one host. A larva may well derive its nourishment from the leaves of a plant and its adult stage survive on the nectar from the plant's flowers. This paper attempts to determine the insect group and designate a representative species whose complete life cycle is most dependent on one stage of a single host—i.e., the greatest host specificity.

Methods

Professors and colleagues were asked to nominate candidates and the Internet searched for pertinent information. Secondary literature on insect life cycles, parasitoids, and symbiosis were reviewed. Primary literature was obtained from references in the secondary literature and by searching Agricola, Biological Abstracts, and CAB Abstracts from the year 1986 to the present.

Results

Mutualism is a mutually beneficial association between different kinds of organisms—i.e., a symbiosis in which both partners gain fitness. Often it is obligate so that each organism's existence is dependent on the other. Insects involved in an obligate mutualism are often extremely host specific as is the case with fig wasps, yucca moths, and fungus-culturing ants.

The 900-odd species of *Ficus*, some subspecies and many varieties, constitute the most distinctive of the widespread genera of tropical plants (Hill 1967; Janzen 1979). For the pollination of their flowers, figs are dependent upon Hymenoptera Chalcidoidea of the family Agaonidae (fig wasps). Correct pollen transfer is essential because hybrids are not viable. For the propagation of their kind, the fig wasps are dependent upon the ovaries of the figs, in which their larvae develop. Males never leave the syconium (multiple flowers embedded in a hollow fleshy receptacle), dying after mating with females and cutting an exit hole for them. Females do not feed in the adult stage and have only a few days at most to find a receptive syconium of a like fig. Pollinating fig wasps are species-specific to their host, although in some instances the fig or the wasp may have developed into distinct subspecies (Wiebes 1979). One of the best-documented cases of a species of fig needing its distinct pollinator is that of the edible fig (Ramirez B. 1970). *Blastophaga psenes* is the

pollinator of the edible fig (*Ficus carica*) and will serve as the representative of the family Agaonidae which displays the greatest host specificity.

There are approximately 40 species of *Yucca* which are pollinated exclusively and obligately by yucca moths (Lepidoptera: Incurvariidae) in two closely related genera (*Tegeticula* and *Parategeticula*) containing a total of four species. Two of these four species are host specific, another pollinates two species of *Yucca*, while the fourth is now known to actually be a complex of species whose members exhibit high, but not complete, host specificity (Addicott et al. 1990).

Fungus-culturing ants (Formicidae: Attini) with a normal garden, never culture an alien fungus or an alien part of the normal fungus garden of a different genus of attine. Occasionally the ants will accept a part of the garden of another ant species in the same genus but will eventually discard it if its own mycelium (mass of interconnected fungus hyphae) is in ample supply. Tests in Trinidad in 1934-35 showed variable results with workers of several different genera not only feeding upon, but also tending to fungus from outside their genus (Weber 1979).

Discussion

It has been shown that agaonids from different varieties of the same fig species are often morphologically indistinguishable, although it is strongly felt that they must be biologically distinct (i.e. sibling species). An extreme case was found in Hong Kong where the agaonids from the closely related species *Ficus pyriformis*, *F. variolosa*, and *F. erecta* var. *beecheyana* were not separable on morphological grounds. A complication in this case was that there was considerable ecological and phenological difference between the respective plants and their fig crops. It was possible, but unlikely, that all three species of *Ficus* were being pollinated by different populations of the same wasp species. The final opinion was that most probably there were three sibling species of *Blastophaga* involved (Hill 1967). A supposedly shared wasp, *Secundeisenia mexicana*, of *F. aurea* and *F. citrifolia* in south Florida, has recently been separated into two species, *Pegoscapus jimenezi* and *P. assuetus* (Bronstein 1989).

There are a few reports in the literature of one species of fig being inhabited by two agaonid wasps. The best documented is *F. tuerckheimii* which is always pollinated by two species of *Blastophaga* (*B. carlosi* and *B. mariae*) in both Costa Rica and Mexico. These two wasps apparently never attempt to enter any other related figs (Ramirez B. 1970).

Bronstein (1987) tried to determine the mechanism which isolates the common neotropical fig *Ficus pertusa* from its sympatric congener *F. tuerckheimii* and two rarer *Ficus* species at one site in Costa Rica. In general, only the correct pollinator converged on each *F. pertusa* tree, even when syconia of other species were available and all the pollinator species were present. The evidence suggests the existence of species-specific recognition of flowering fig trees by their pollinator wasps. It appears that a species-specific, volatile chemical attractant is released briefly from *F. pertusa* trees when the florets are mature enough to be pollinated.

Fig culture was established in Greece as early as the 9th century B.C. by the process of caprification. This process is designed to secure the pollination of the cultivated fig (*Ficus carica*), which produces only female flowers. It consists of suspending figs of the male form of the wild fig (caprifig) in the cultivated trees to provide pollen via the emerging female wasps, *Blastophaga psenes*. In California the production of edible figs with viable seeds failed until the correct pollinator (*B. psenes*) was introduced in 1889 after many failed attempts with other species of *Blastophaga* (Ramirez B. 1970).

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