The Phenology of *Ficus fistulosa* in Singapore

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ABSTRACT

*Ficus fistulosa* is a small dioecious tree of forest margins and old hedges. In Singapore both male and female trees show intratree synchronization of fig production but little synchronization between trees. Individual trees bear 4–7 crops a year and leaf production occurs at irregular intervals throughout the year.

Many species of *Ficus* have been reported to exhibit asynchronous intraspecific flowering and fruiting coupled with strong synchronization within the crown of an individual tree (Janzen 1979, Newton and Lomo 1979, August 1981, Milton et al. 1982). An exception to these reports is the study by Hill (1967) on the figs of Hong Kong, where most species had more or less synchronized crops at predictable times of the year. This presumably reflects the extreme (for figs) seasonality of Hong Kong’s climate (latitude 22°11’N).

Singapore (latitude 1°17’N) has a typical equatorial climate with high temperatures year round and an average rainfall of more than 100 mm/mo. *F. fistulosa* Rehnn. ex Blum. is a small dioecious tree, abundant in forest margins and old hedges. The figs are borne in clusters on woody knobs or short, leafless twigs on the trunk and main branches. Its pollination ecology was studied in Singapore by Galil (1973) and its phenology in Hong Kong by Hill (1967).

METHODS

I observed 6 female and 11 male trees over a period of 14 months from November 1982 to December 1983. February 1983 was an exceptionally dry month with only 7 mm of rain. The trees were 5–12 m tall and 4–15 cm DBH—the normal size range for reproductively mature trees in Singapore. All the plants were in a 200-m section of an old hedge in a residential area of Singapore. The hedge consists of at least 20 woody species typical of secondary forest, including 6 other species of *Ficus*. It is 3–7 m wide and quite variable in height. The lower part of the hedge is occasionally trimmed, but this did not affect any of the trees under observation during the period of study. Observations were made at intervals of 7–21 days. On each occasion the developmental stage (or stages) of the syconia present were noted and the crop size recorded as sparse, medium, or heavy. The presence or absence of new leaves, recognized by their light green color, was also noted and an estimate made of what percentage of the crown was leafing. In addition, detailed daily observations were made during critical developmental stages in 2 female and 2 male crops.

RESULTS

Approximately 48 days elapsed from first appearance until the exit of the wasps in individual “gall” (functionally male) syconia. Mature gall figs are yellow and spongy and fall uneaten from the tree. The gall fig development on an individual tree was more or less synchronized, usually achieving the next developmental stage within 2–4 days of each other. Individual female syconia took 70–100 days from first appearance until removal from the tree, apparently by fruit bats. A few female figs turned yellow, soft, and sweet before removal, but the great majority disappeared while hard and green. The seeds are viable by 70 days. Sometimes all the female figs in a crop were removed overnight, but more often, removal was spread over several nights or even several weeks. The developmental stages of female figs on the same tree were slightly less synchronized than the gall figs, with individual syconia reaching the next stage within 4–8 days of each other.

The observations on reproductive phenology are summarized in Figure 1. The bar for each fig crop represents the period that figs from that crop were present on the plant. At least 71 percent of nonaborted female fig crops and 41 percent of male fig crops were initiated while figs from the previous crop were on the tree. These frequencies are almost certainly underestimates because only observed overlap is included: more cases of overlap probably occurred between successive observations. Most trees were without figs only a small proportion of the time (a mean of 18% for female trees and 30% for male trees), and two female trees were bearing figs every time they were observed. The degree of overlap on female trees sometimes made it difficult to assign figs to particular crops. In contrast, young syconia on the male trees only once reached the receptive stage while wasps were leaving the previous crop on the same tree. Female figs bore up to 5 crops a

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FIGURE 1. Reproductive phenology of 6 female and 11 male individuals of *F. fistulosa*. Truncated bars are aborted crops.

year, male trees up to 7. Some crops on both male and female trees were aborted without having been entered by agaonid wasps. Crop abortion was commonest on the most heavily shaded trees, numbers 5, 6, and 10.

The degree of intertree synchronization was variable. Trees 7 and 8 were nearly perfectly synchronized throughout the period of observation. These two trees are adjacent and almost certainly are connected below ground. Concerning the other trees, during certain times of the year many trees are initiating crops simultaneously, most notably early March (6 trees), the beginning of May (7), and early June (9). The last occasion was particularly striking as most of the 9 trees initiating crops at this time were already bearing immature figs from the previous crop, although this crop had been smaller than average. No consistent correlation between crop initiation and rainfall records could be detected by inspection, and the sample size is too small for statistical analysis.

The trees were never leafless. Production of new leaves occurred in flushes, each lasting 7–10 days. Senescence and fall of old leaves occurred at the same time as leaf production. Individual trees had 2–5 leaf flushes/yr at irregular intervals, with no perceptible relationship to reproduction. The population as a whole sustained 6 periods during the 14 mo of observation when more than half the trees had leaf flushes, as well as periods when no trees were flushing (Fig. 2). No consistent relationship with rainfall records could be detected.

**DISCUSSION**

*F. fistulosa* in Hong Kong shows strong intertree synchronization, with 4 population-level crops a year, although most individual trees had only 3 crops (Hill 1967). Crops of female figs were produced 2–4 wk after the corresponding gall fig crops, and the trees were bare for some time between crops. All trees were leafless for a fortnight in spring and had a second growth period later in the year with no leaf fall. In contrast, the *F. fistulosa* population in Singapore is much less synchronized. Individual trees bear 4–7 crops a year, and some trees are never without figs. No tree is ever leafless and leaf production occurs at irregular intervals throughout the year.

The greater number of crops per tree and the lesser synchronization may result from the absence of a cold winter in Singapore. Within a species, the number of crops per tree seems likely to be greater in climates that are favorable for fig production all year. *Ficus hispida* Linn. also had 4 crops a year in Hong Kong (Hill 1967) but 6 in Calicut, which is 11° nearer the equator (Abdurahman and Joseph 1976). With regards to intrapopulation synchronization, if individual fig trees fruit whenever they have amassed sufficient reserves and received an environmental cue (Milton et al. 1982), we would expect almost continuous asynchronous fruiting in the year-round favorable climate of Singapore, whereas the unfavorable winter season in Hong Kong might resynchronize fruiting each year.

In dioecious fig species, intratree synchronization is not necessary to ensure outcrossing, yet it occurs in both male and female *F. fistulosa*. The less pronounced synchronization in female trees is probably not ecologically signif-
ificant since figs are removed at a range of ages. Synchroni-
zation in female trees may be favored by the necessity of
attracting dispersal agents. In contrast, in 2 other dioe-
cious species in Singapore, Ficus gratissimoides Burm.f.
and Ficus fulva Reinw. ex Blume, individual female trees
usually bear figs at many stages of development. A selective
advantage of dioecy in figs may be that it permits fruiting
phenology to adjust to the biology of the dispersal agent.
In all the dioecious species observed, however, the male
trees show some degree of intrtree synchronization. Per-
haps there is selection against allowing departing wasps
to immediately re-enter gall figs on the same tree, thus
wasting their pollen load.

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