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Ficus carica and its pollination

Finn Kjellberg and Annick Lesne

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Ficus carica typically grows on rocks.

Wild Ficus carica

2 meters
I: original tufa concretion
Ia and Ib, *Ficus carica* fossil figs isolated from I
Hérault, France >60.000 years BP
G. Planchon 1864, Paris, France
Ficus carica (form Ficus colchica Grossh.)
This is morphologically the most divergent form of Ficus carica
Black Sea coast, Turkey
Ficus carica (form Ficus colchica Grossh.)
Note the gracile branches and flexible leaves
Black Sea coast, Turkey
Ficus palmata
Adıyaman Province, Turkey

Ficus palmata is the sole species closely related to F. carica. It is distributed from Ethiopia to India and Nepal.
Ficus palmata
Adiyaman Province, Turkey

fig trees

2 meters
A fig is an urn-shaped receptacle. It is closed by an ostiole, the inside is lined by uniovulate female flowers, and male flowers.
Figs are exclusively pollinated by *(Blastophaga psenes)* wasps that enter the fig through the ostiole to oviposit.
Within the fig: *Blastophaga psenes* oviposits in female flowers, transforming them into galls. The ovipositor is inserted through the style of the flower. The egg is laid in the ovule, between the inner integument and the nucellus.
*Ficus carica* is a functionally dioecious species

- **Female trees** have long styled female flowers that do not host wasp larvae; their figs produce seeds and no pollen

- **Male trees** have short styled female flowers that host wasp larvae and only very few seeds; their figs produce wasps (pollen vectors) and pollen, *i.e.* they are functionally male
In long styled flowers the ovipositor does not reach the ovule, no egg is laid, the flower gives a seed. In short styled flowers an egg is laid and the ovule is transformed into a gall.
Male tree: males mate females still enclosed in their natal gall.
Male tree: mated female *Blastophaga* emerging into the fig cavity from a galled female flower
Male tree: wasp emerging from the fig cavity through the ostiole. It got abundantly dusted with pollen while emerging. Pollen is largely wasted. The wasp will leave in search of a receptive fig to enter during its short survival outside figs (about 1 day).
The year-round cycle of wild *Ficus carica* in Montpellier, France
Reading a fig branch, in early **spring, year N**

- Fig that overwintered as a bud initiated **year N-1**
- Scar after a fig that developed directly on the growth of **year N-1**
- Scar after the stipules that enveloped the terminal bud
- Vegetative bud
- Shoot of the year **N-1**
- Scar after a fig that developed at the axil of the leaf
- Shoot of year **N-2**
- Shortened internodes corresponding to the resting (August year **N-2** to March, **year N-1**) terminal bud
- Scar after a leaf
- Shoot of year **N-3**
- Shortened internodes corresponding to the resting (August year **N-3** to March, year **N-2**) terminal bud
winter: *Ficus carica*

**Scars after figs that ripened in August-September**

**Scars after leaf petioles**

Fig buds appear on the shoot of the year and develop directly into figs receptive in June-July and ripe in August-September

winter: **female tree**
winter

**wild *Ficus carica***

fig bud from previous growth season, it will resume its development in spring

figs that developed directly from fig buds on the shoot of the year and containing last larval stage *Blastophaga*

winter: male tree

**fig bud**
winter: male tree

wild *Ficus carica*

gall containing a wasp larva

female flowers have short styles, contain insect larvae and only very few seeds
Fig buds appear progressively along the shoot of the year from July to September. Their fate depends on wasp visitation at their receptivity and climatic conditions.
April: male tree, wasps are ready to emerge from the overwintering figs to visit receptive figs on male trees.
April: male tree, wasps are ready to emerge from the overwintering figs to visit the receptive, future polliniferous figs. The receptive figs have grown large, waiting for Blastophaga to visit them.
April: male tree without overwintering figs
The receptive figs have grown large, still waiting for Blastophaga from another male tree to visit them
April: male tree, wasps that have just emerged through the ostiole from the fig in which they overwintered.
The wasps are not dusted with pollen as these figs produce no pollen.
April: male tree, a newborn female *Blastophaga psenes* has reached a receptive fig
April: male tree, a female *Blastophaga psenes* close to the ostiole on a receptive fig
wild *Ficus carica*

April: male tree, inside a receptive fig

The styles are short allowing wasp oviposition
April: male tree, receptive fig
The stigmas form a platform within the fig on which the wasps will walk
April: male tree, *Blastophaga* ovipositing in a receptive fig wild *Ficus carica*
April: **male tree**, shortly after wasp oviposition
After oviposition into a flower the style turns brown, the pedicel elongates and the ovule begins to swell turning into a gall.
April: male tree, *Philotryptesis caricae* - a cleptoparasite of *Blastophaga psenes* - ovipositing into a fig recently entered by *Blastophaga*
April: male tree, Philotrypesis caricae ovipositing into a fig recently entered by Blastophaga
ovipositor of *Philotrypesis* inserted through the fig wall and entering the flower through the pedicel: the egg is laid beside the *Blastophaga* egg between the inner integument and the nucellus.
April: male tree, fig a few days after oviposition
There are many male flowers
June: male tree, the female flowers have turned into galls each hosting a wasp larva. Male flowers with pollen are conspicuous.
June-July: male tree, *Blastophaga* emerging through the ostiole from a polliniferous fig, covered with pollen before cleaning themselves. Some pollen remains caught in the intersegment pleura.
June-July: male tree, *Blastophaga* emerging from a polliniferous fig.
Two wild *Ficus carica*  
June-July

Male tree: polliniferous figs at the stage of *Blastophaga* emergence

Female tree: a recently pollinated fig  
two receptive figs

At that period, there are no receptive figs on male trees
The wasps can only go from male figs to figs on female trees
June-July: female tree

*wild Ficus carica*

- Wasps trying to enter fig
- Pre-receptive fig
- Very recently pollinated figs
July: female tree, pollen-bearing wasp trying to enter a fig
wild *Ficus carica*

July: female tree, receptive fig

elongate stigmas that will brush the body of the wasp, collecting pollen and ensuring seed set
wild *Ficus carica*

- Long style, the wasp cannot oviposit
- Elongate stigmas with papillae on which pollen will stick

July: female tree, receptive fig
Late July: male tree, the very earliest young figs are visited by the wasps emerging from the very latest polliniferous figs. This sensitive point in the yearly cycle of the wasps is present throughout the wild range of *Ficus carica*. 
September: *female* tree, ripe seed-containing figs
September: female tree, ripe seed-containing figs
The climacteric ripening involves nutriment transfer, ethylene production and respiratory peak.
Ripening can be artificially sped up by depositing a drip of olive oil on the ostiole.
September: fig seed dispersal by a mammal
wild *Ficus carica*, in man-made habitat

Valleraugue, Hérault, France
Church of Saint Simeon the Stylite, Syria

wild *Ficus carica*, in man-made habitat
Wild-germinated *Ficus carica*, outside the range of the pollinator, Britany, France
Fig cultivation and domestication
Wild figs are as good as domesticated ones.
cultivated wild-germinated fig tree
Montpeyroux, Hérault, France
Fig plantation, Syria
Fig plantation, Meander valley, Turkey
Figs of the cultivars producing the best dry figs abort if not pollinated. How is pollination achieved in large fig plantations? Turkey, Meander valley.
June: **female tree**, receptive figs of the **second crop** (= the crop present on wild female trees), requiring pollination. This phenotype is very similar to typical wild female trees in Turkey, Meander valley.
Fig plantation for dry fig production with *caprifig trees* (male trees) planted upwind of the female trees so wasps are blown towards the receptive figs. Idlib governorate, Syria.
June: **caprification** = **profichi** (polliniferous figs of male trees) are suspended in female trees to ensure pollination. Greece, Kalamata.
June: tying profichi (polliniferous figs from male trees) together to suspend in female trees. Kalamata, Greece.
June: weeding is neglected, but caprification is still performed. With caprification many female trees can be pollinated with figs from few distant caprifig trees. Greece, Kalamata.
June: caprification of female tree for dried fig production

Idlib governorate, Syria
Preparing profichi for caprification in a village of dried fig producers, Meander valley, Turkey
A village specialized in profichi cultivation for sale at the market in the city Meander valley, Turkey
June: caprifig cultivar from a village specialised in profichi production. Pollinator reproduction is facilitated by the early development of the next generation of figs on the shoot of the year. Meander valley, Turkey.
A caprifig cultivar from the Meander valley.

On this phenotype wasps visit figs on the same tree instead of ensuring pollen transfer to female trees, and the reproduction of the male tree. This phenotype is counterselected in the wild.

June: caprifig cultivar with early receptive figs selected in the villages specialised in profichi production, Meander valley, Turkey.
June: caprification of male trees, Tunisia, Kerkennah Islands

data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAIgAAAAHCAIAAAD6gaNMAAAAGXRFWHRTb2Z0d2FyZQBBZG9iZSBJbWFnZVJlYWR5ccllPAAAAaXRFWHRDQ2L0AAAJZvGJwA/6QAAAAElFTKsuOScAA/8wJ3YU+5YgAAAGtklEQd+7hAAAAAElFTkSuQmCC

fig cultivation

under insular conditions, overwintering figs containing wasps may lack in spring: wasps are brought from the continent

mamme (=overwintering fig on male tree) picked on the continent and used to ensure wasp colonization of profichi figs

Photo G. Valdeyron
fig cultivation

diseases spread by pollinating wasps

*Fusarium* growing in a mamme fig

California, USA

Photo Themis Michailides UC Davis
Fusarium moniliforme on Blastophaga
California, USA

Fig cultivation
gardens spread by
pollinating wasps

Photo Themis Michailides UC Davis
fig cultivation diseases spread by pollinating wasps

second crop figs, *Endosepsis* caused by *Fusarium*

Photo Themis Michailides UC Davis
fig cultivation
diseases spread by pollinating wasps

Smut
Aspergillus niger
Aspergillus japonicus
Aspergillus carbonarius

Endosepsis
Fusarium spp.

Alternaria rot
Alternaria, Ulocladium

Photo Themis Michailides UC Davis
fig cultivation

controlling diseases spread by pollinating wasps

a caprifig plantation, preparation to collect mamme for sanitation

California, USA

Photo Themis Michailides UC Davis
Fig cultivation

Profichi collected in specialised orchard, before sanitation
California, USA

Photo Themis Michailides UC Davis
Profichi collected in specialized orchard before sanitation
California, USA

fig cultivation

Photo Themis Michailides UC Davis
fig cultivation

sanitation with fungicide of profichi figs split open, just before wasp emergence

California

Photo Themis Michailides UC Davis
Packaging of profichi sanitised just before wasp emergence, ready for use in caprification.
June: female tree, biferous cultivar (=2 crops, the typical one of wild female trees, and the one corresponding to the generation of profichi figs, only present in cultivars)

Mamme figs do not produce pollen so that first crop figs are never pollinated.

First crop figs develop without pollination, they are parthenocarpic.

The second crop is also parthenocarpic in some cultivars.
fig cultivation

Winter: female tree, biferous cultivar

first crop fig buds

scars after second crop figs

shoot of the previous summer
Receptive female fig, first crop
First crop figs are larger and have a thicker wall, the flowers are less densely packed and the styles are shorter than in second crop figs.
The overwintering first crop fig bud presented differentiated flower primordia.
Morphological differences with second crop figs are induced during winter.
Receptive female fig, first crop
The stigmas will never be pollinated as mamme do not produce pollen
First crop figs artificially pollinated with preserved pollen produce seeds
at the northern limit:
second crop figs that will never ripen
March, Normandy, France

buds that will give ripe first
crop figs next August
Croisic, a caprifig cultivar cultivated outside the range the fig wasp. It produces edible figs. Britany, France.
Other-fig cultivation

Jelly fig
(*Ficus pumila var. awkeotsang*)
Taiwan