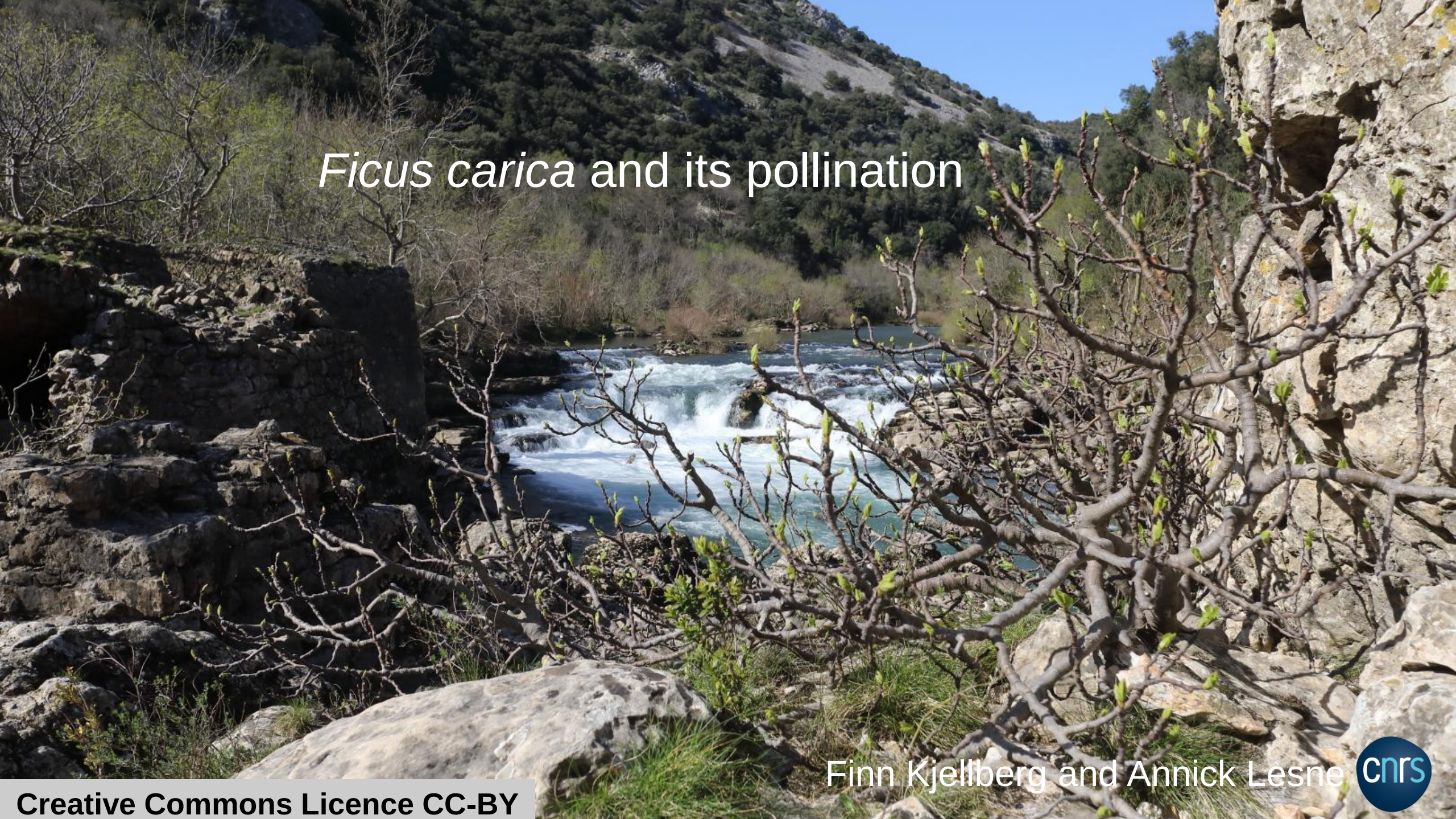
Ficus carica and its pollination

Finn Kjellberg, Annick Lesne



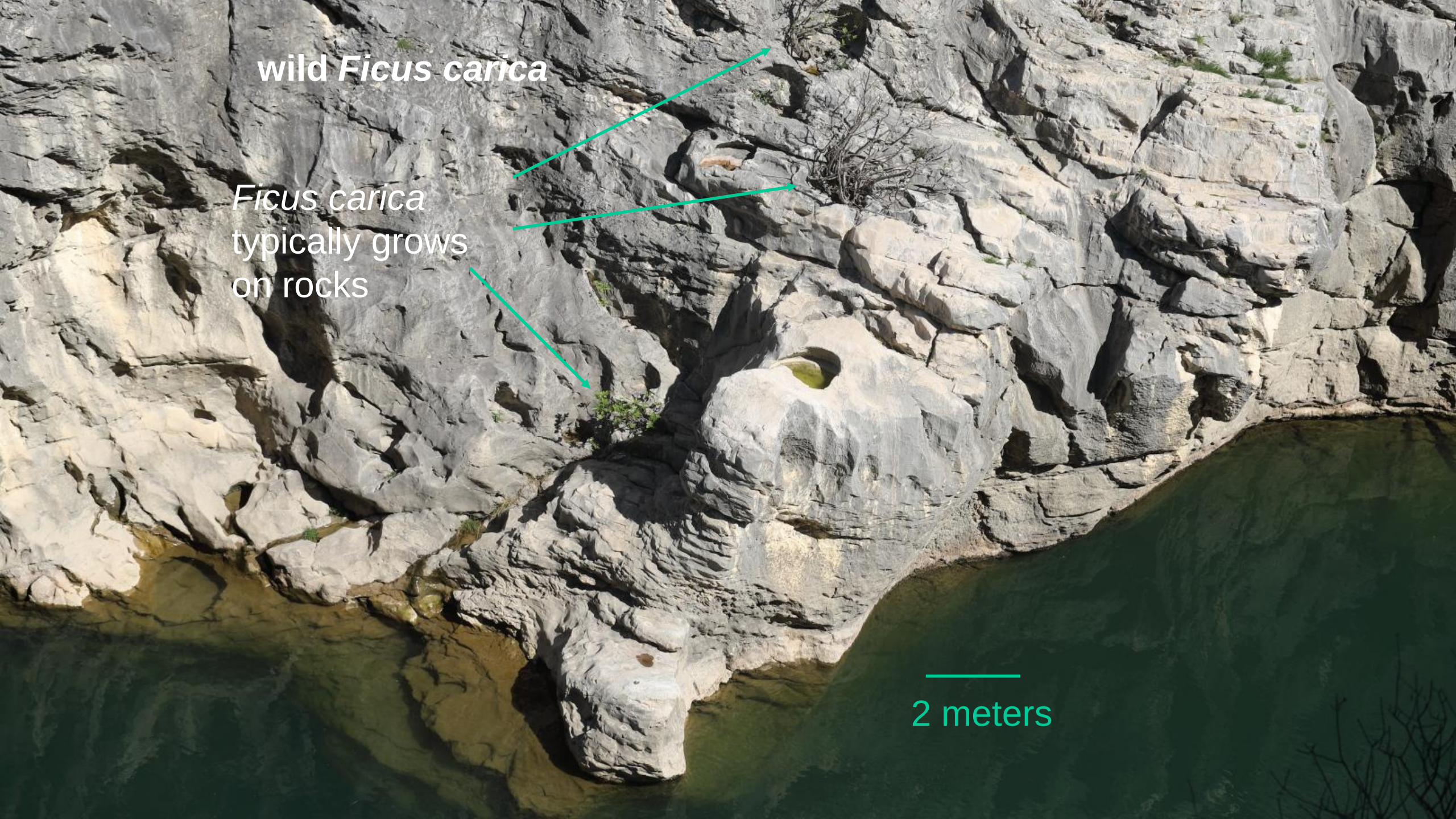
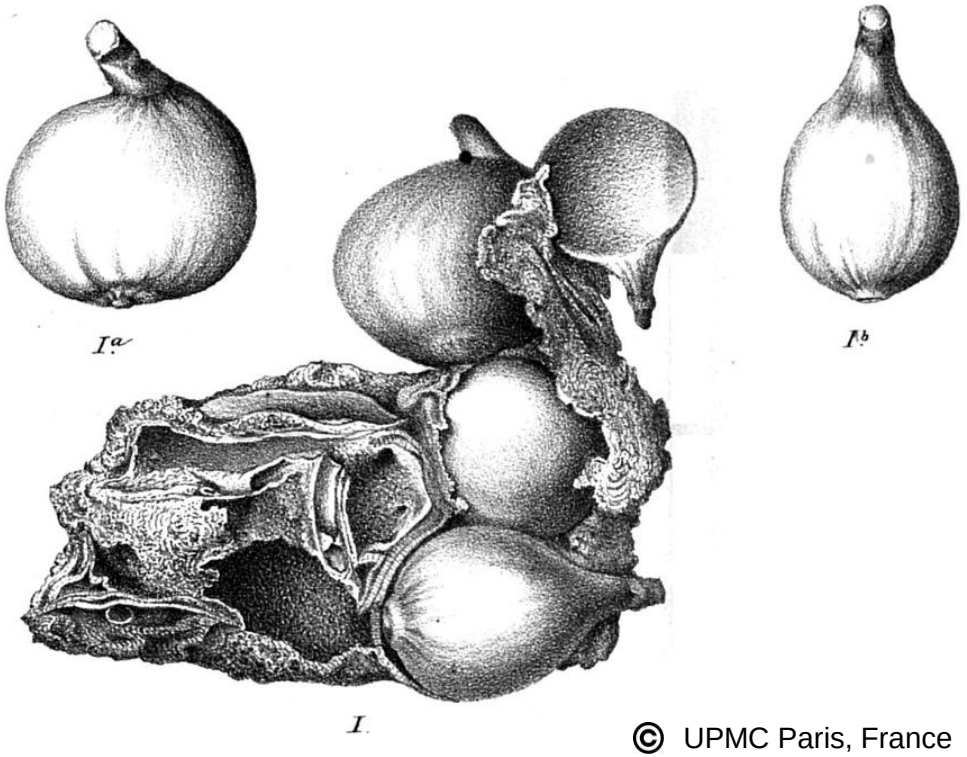

wild *Ficus carica*
Ficus carica typically grows on rocks
2 meters

fig tree

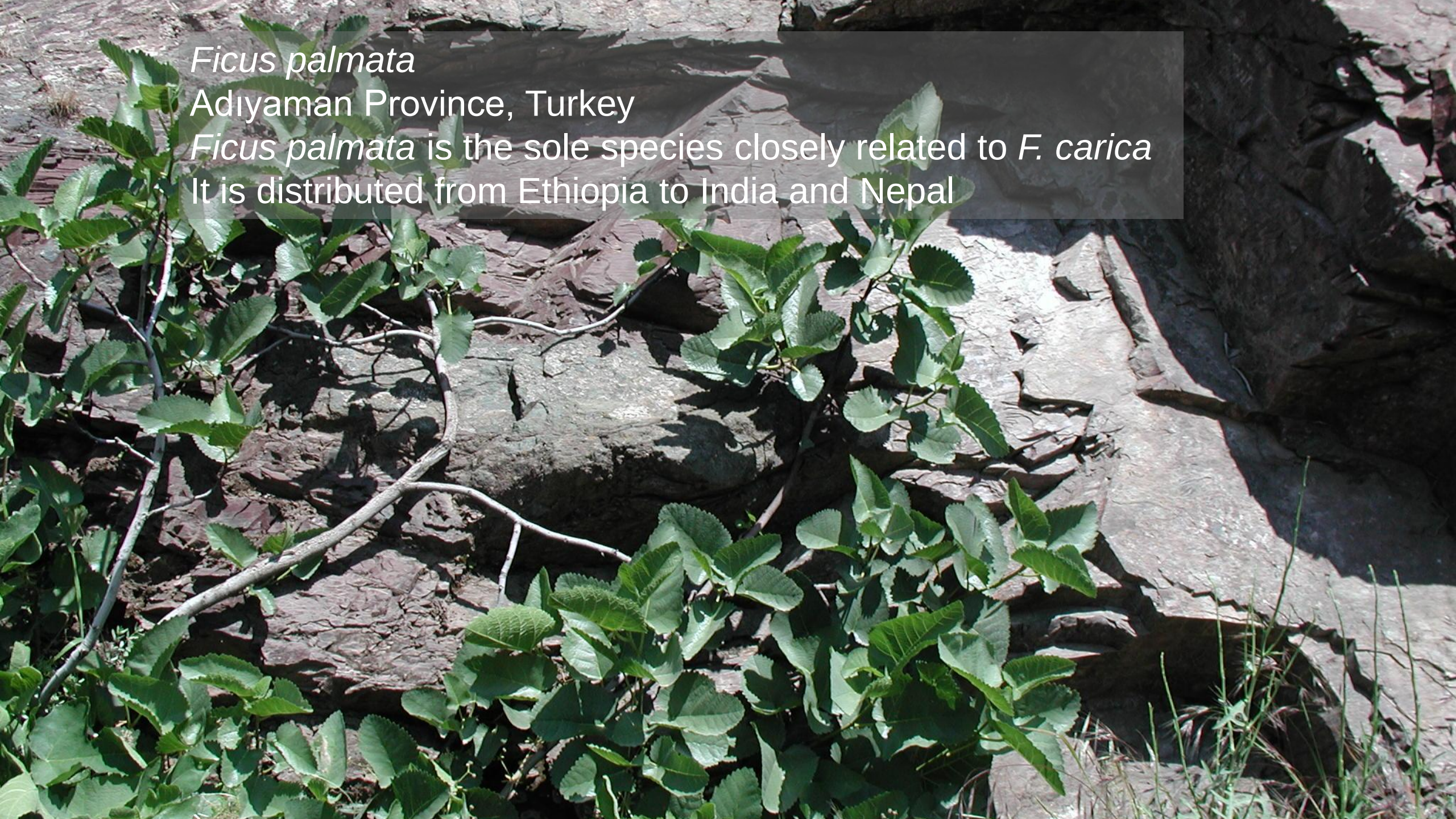
Ongoing tufa deposition
Hérault, France

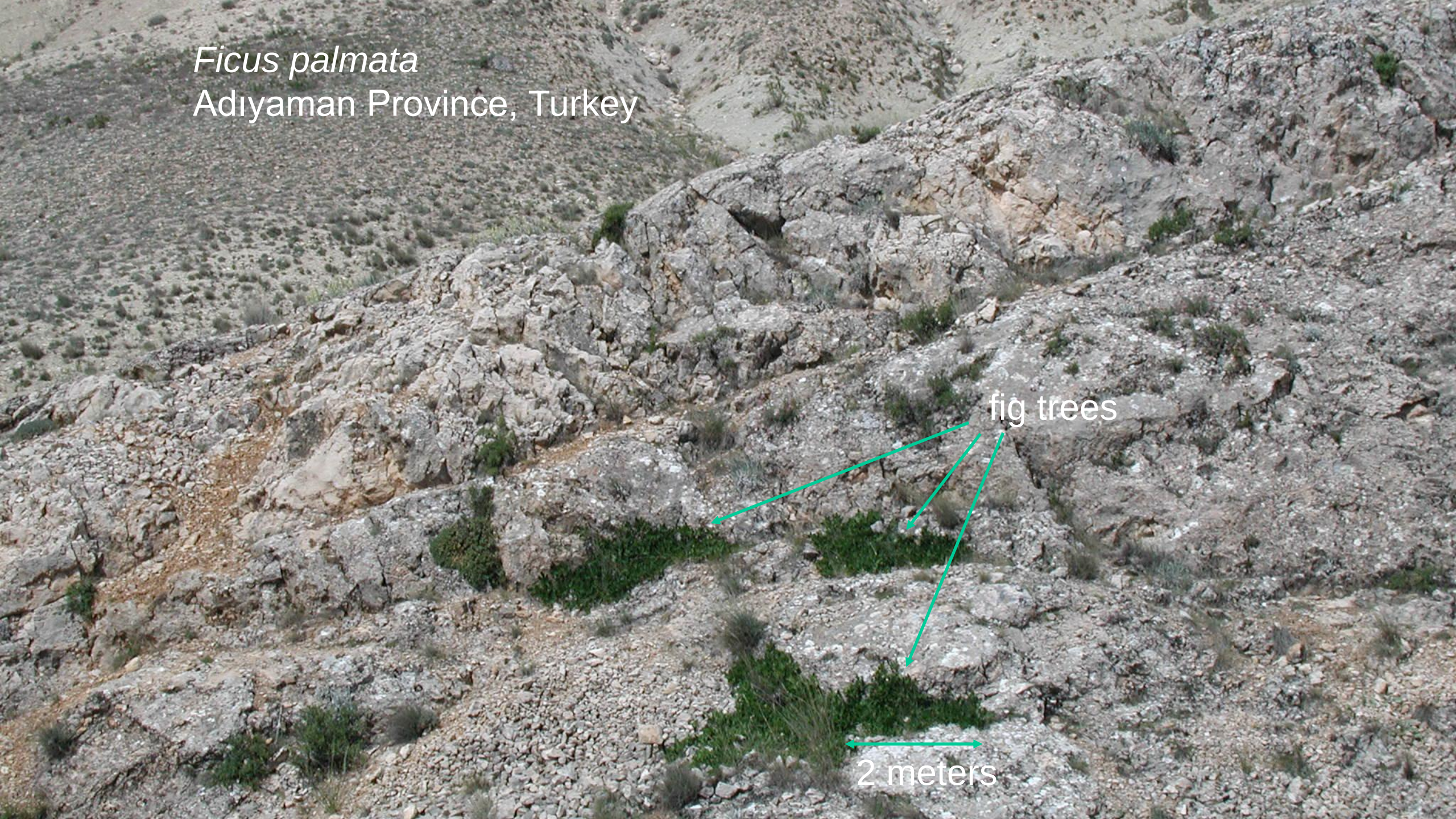


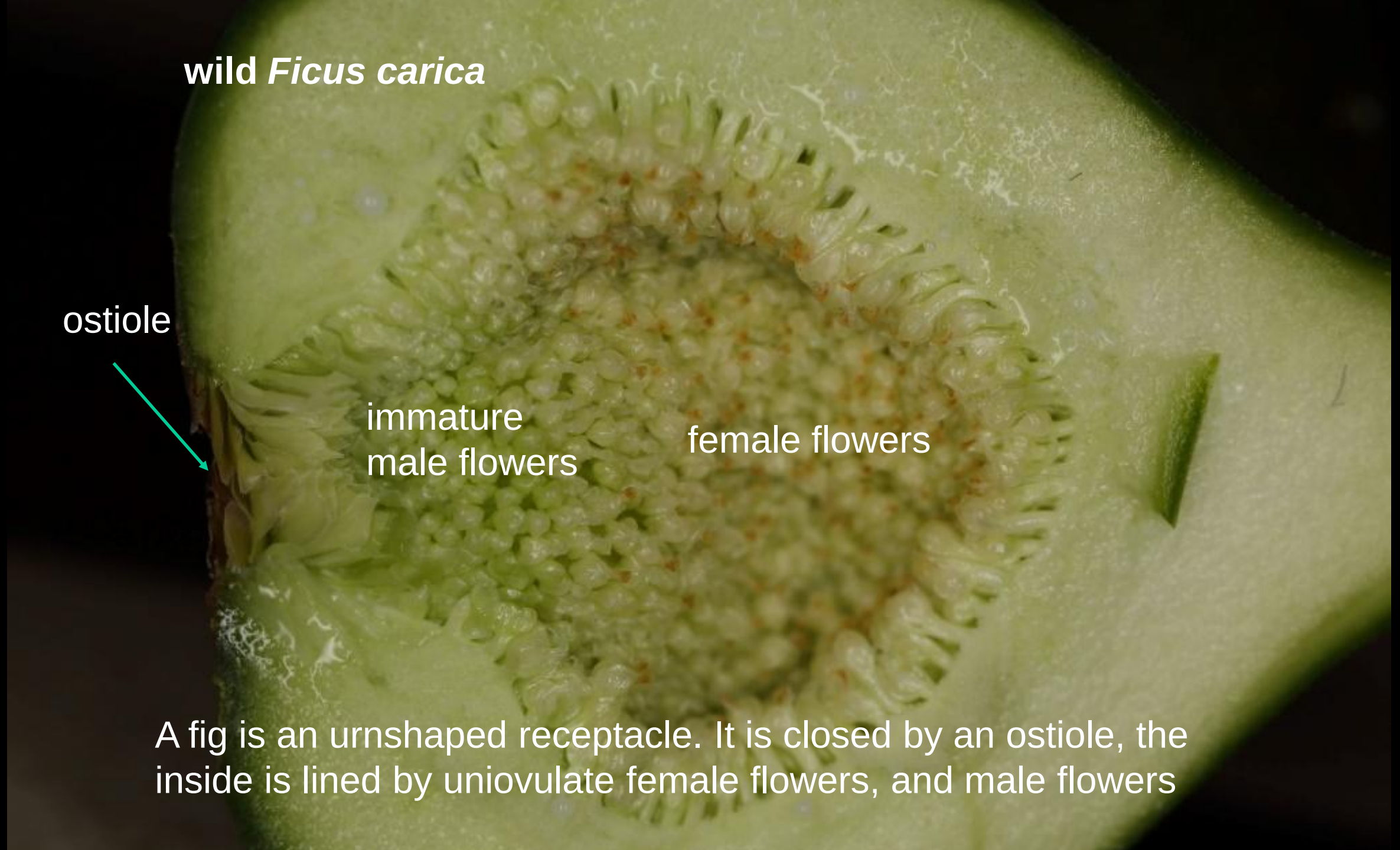
I: original tufa concretion
Ia and Ib, *Ficus carica* fossil figs isolated from I
Hérault, France >60.000 years BP
G. Planchon 1864, Paris, France


wild *Ficus carica*
*Ficus carica (*form *Ficus colchica* Grossh.*)*
This is morphologically the most divergent form of *Ficus carica*
Black Sea coast, Turkey

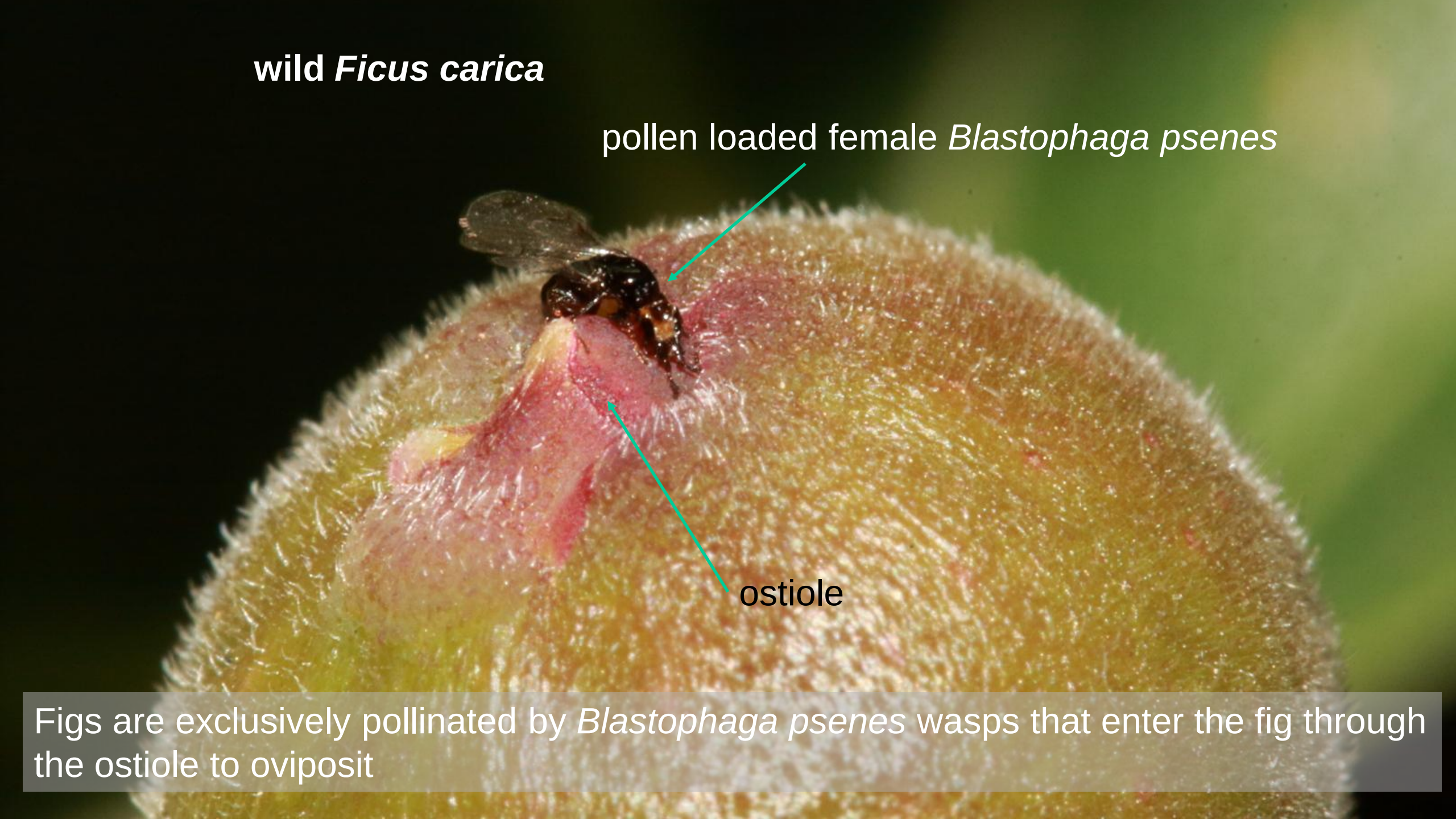

wild *Ficus carica*
*Ficus carica (*form *Ficus colchica* Grossh.*)*
Note the gracile branches and flexible leaves
Black Sea coast, Turkey


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
Adıyaman Province, Turkey
fig trees
2 meters



A fig is an urnshaped 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

wild *Ficus carica*

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

Photo G. Valdeyron

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

wild *Ficus carica*

long-styled flower:
turns into seed

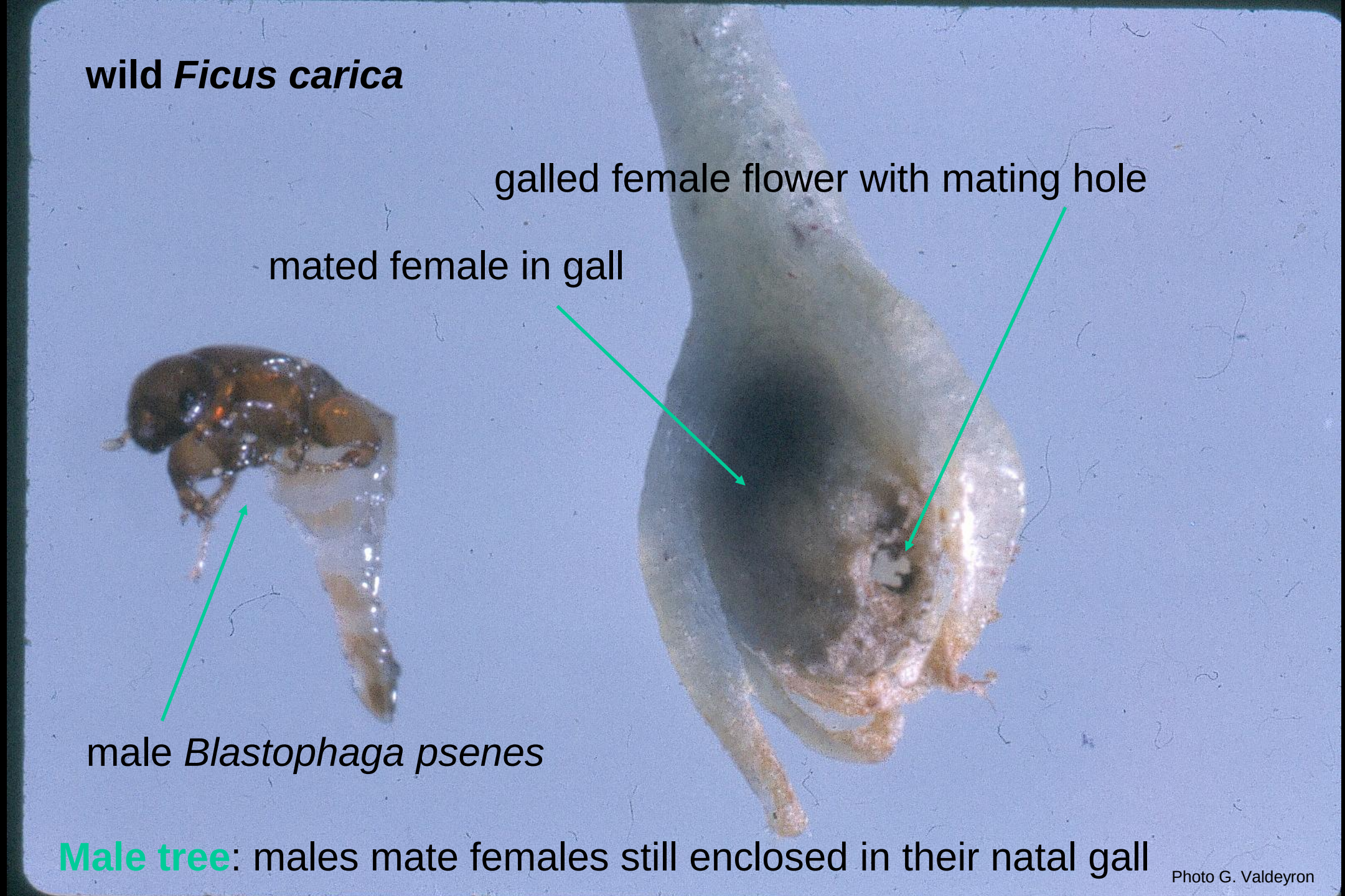
ovipositor

seed

short-styled flower:
turns into gall containing wasp larva

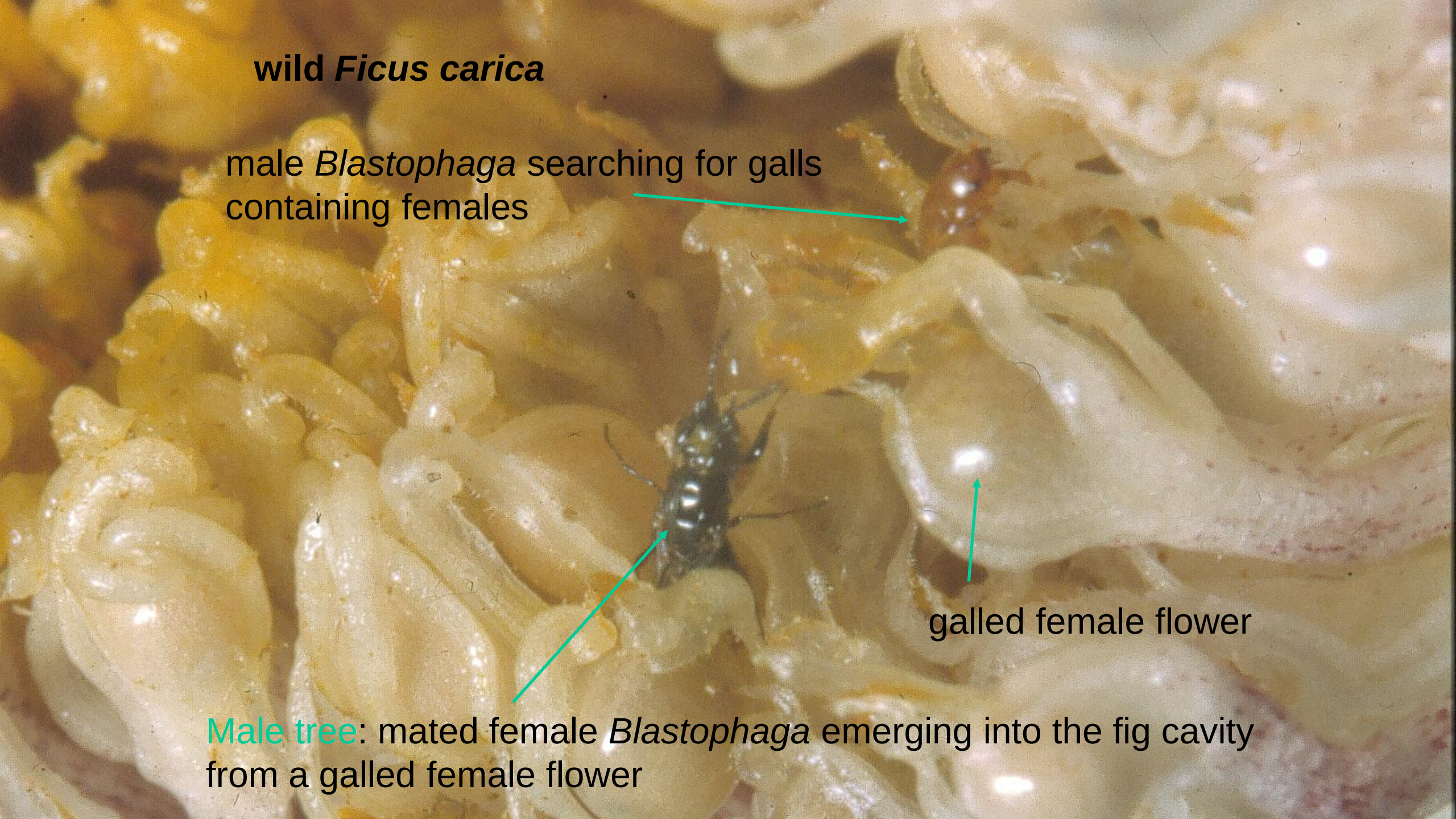
In long styled flowers the ovipositor does not reach the ovule, no egg is laid, the flower gives a seed. In short styled flowers an egg is laid and the ovule is transformed into a gall.

Photo G. Valdeyron

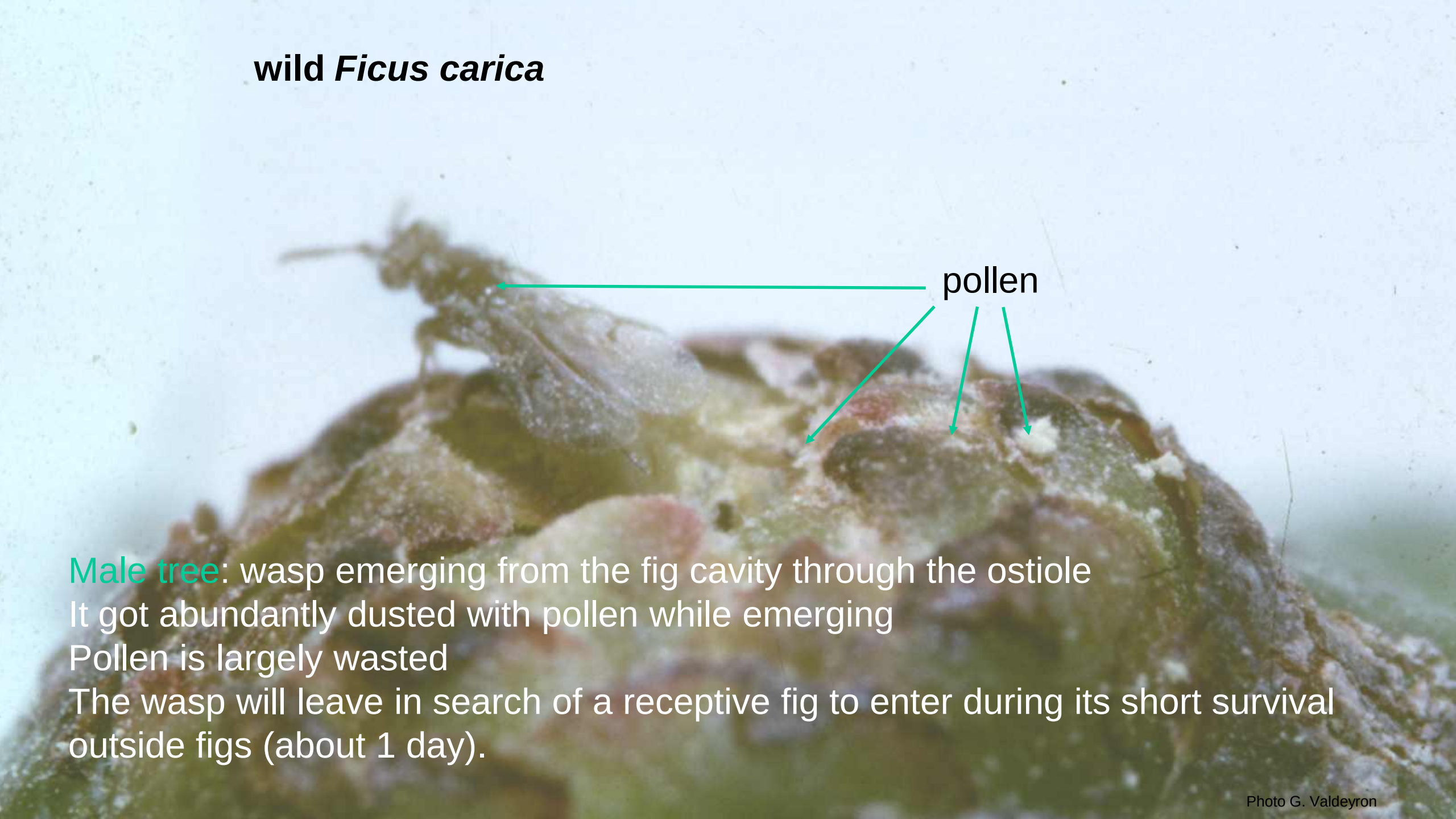


Male tree: males mate females still enclosed in their natal gall

Photo G. Valdeyron


wild *Ficus carica*
male *Blastophaga* searching for galls containing females
galled female flower
Male tree: mated female *Blastophaga* emerging into the fig cavity from a galled female flower

wild *Ficus carica*



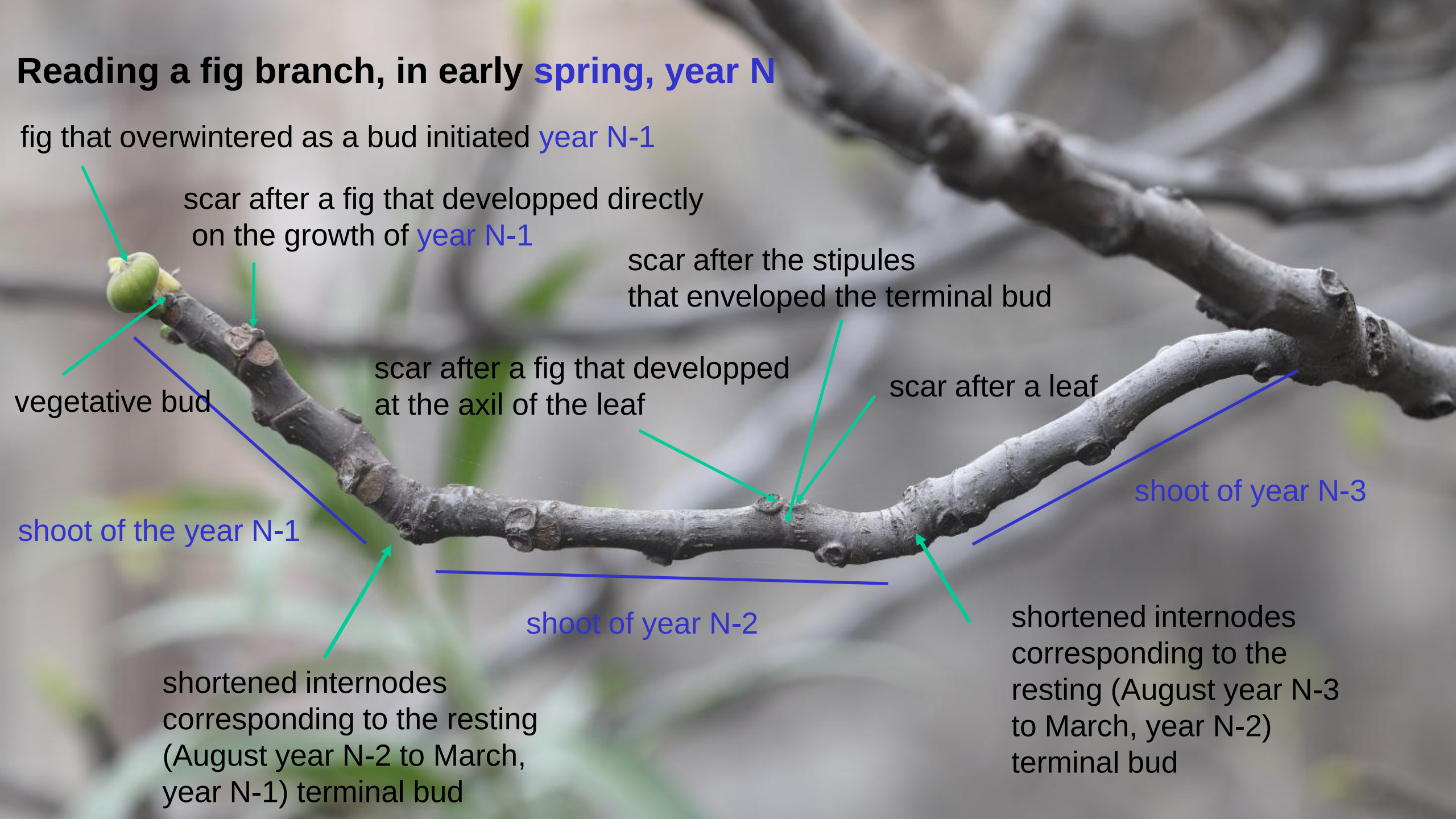
Male tree: wasp emerging from the fig cavity through the ostiole
It got abundantly dusted with pollen while emerging
Pollen is largely wasted
The wasp will leave in search of a receptive fig to enter during its short survival outside figs (about 1 day).

Photo G. Valdeyron

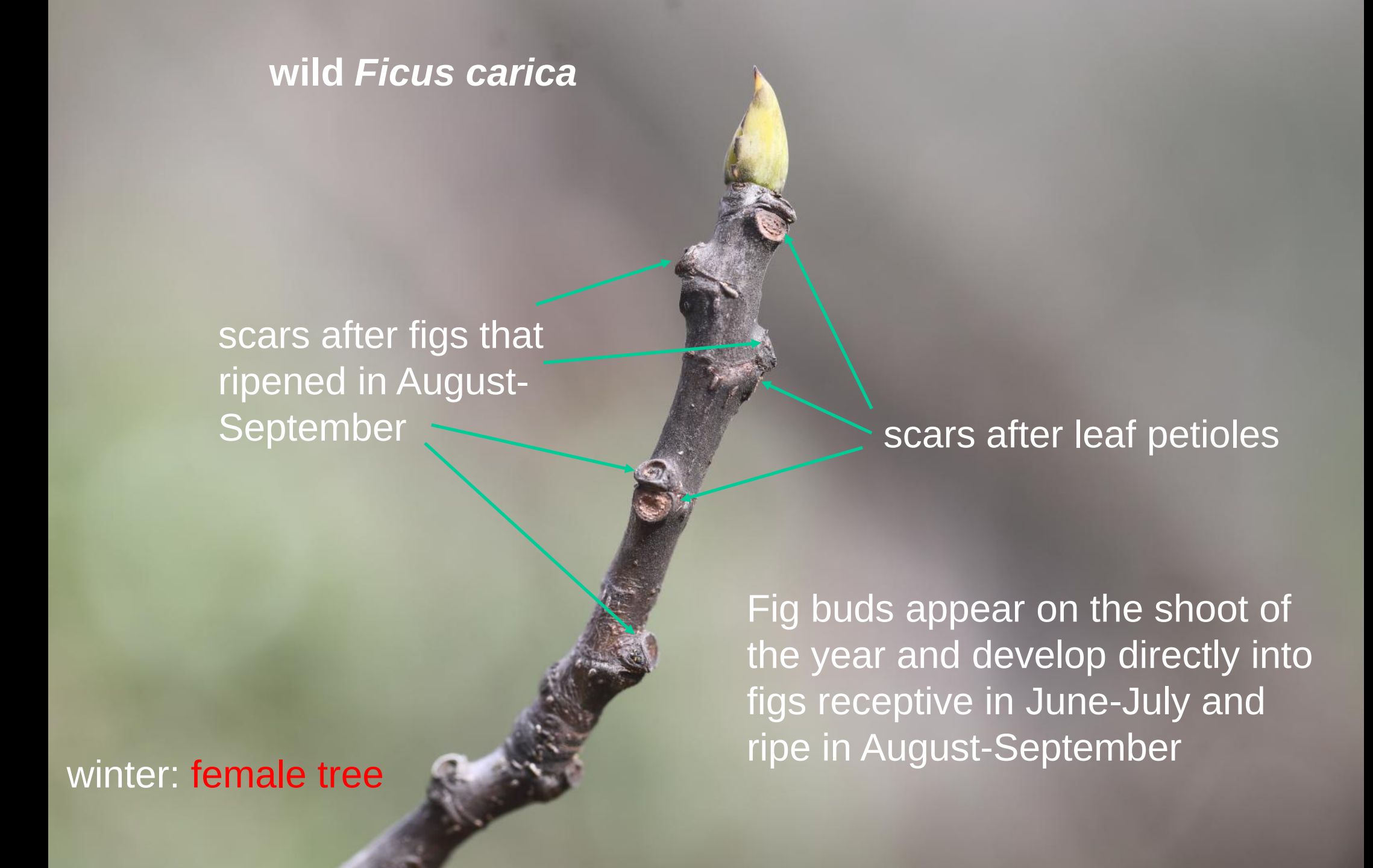
wild *Ficus carica*

The year-round cycle of wild *Ficus carica*
in Montpellier, France

Reading a fig branch, in early spring, year N



wild *Ficus carica*

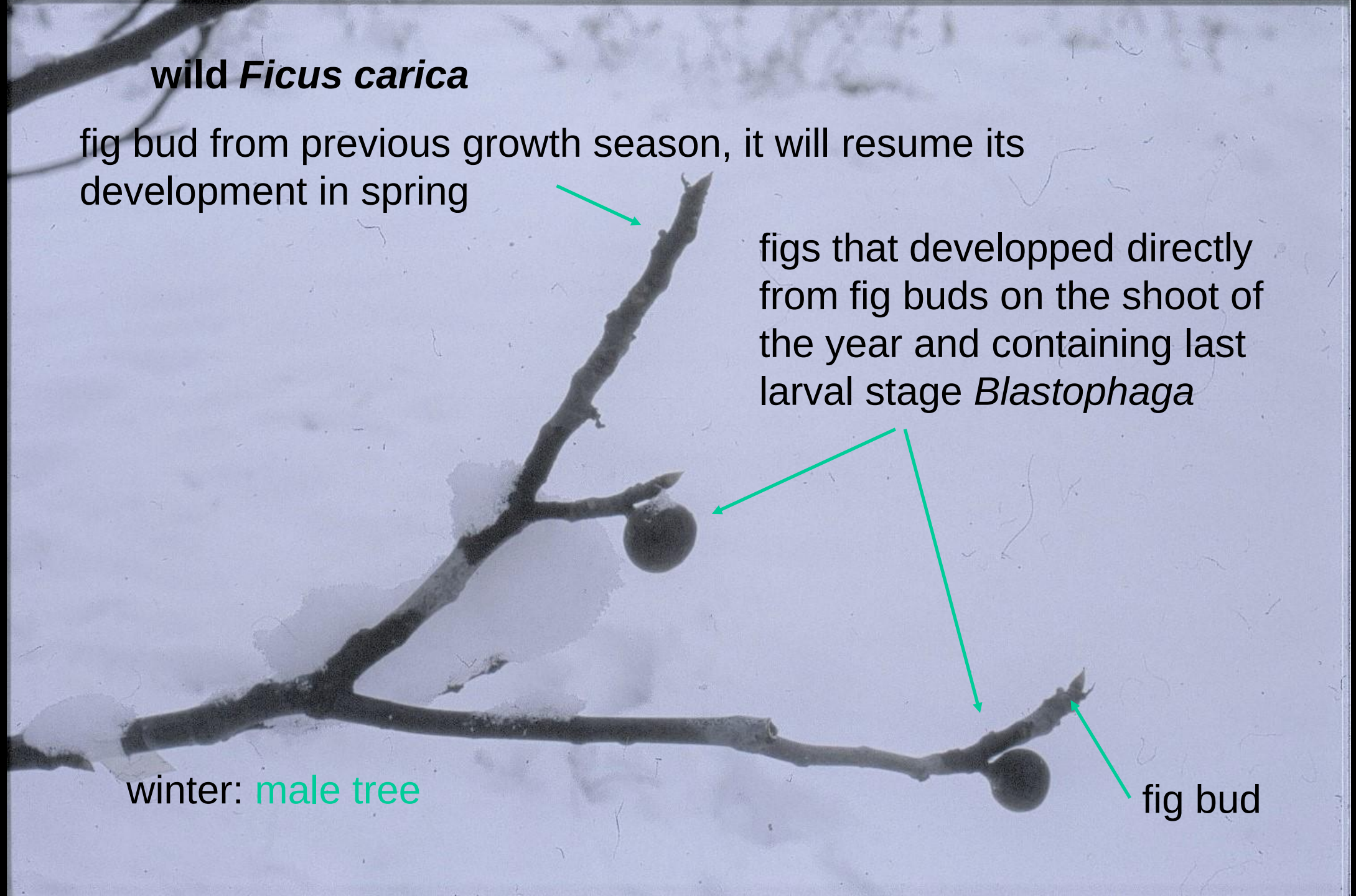


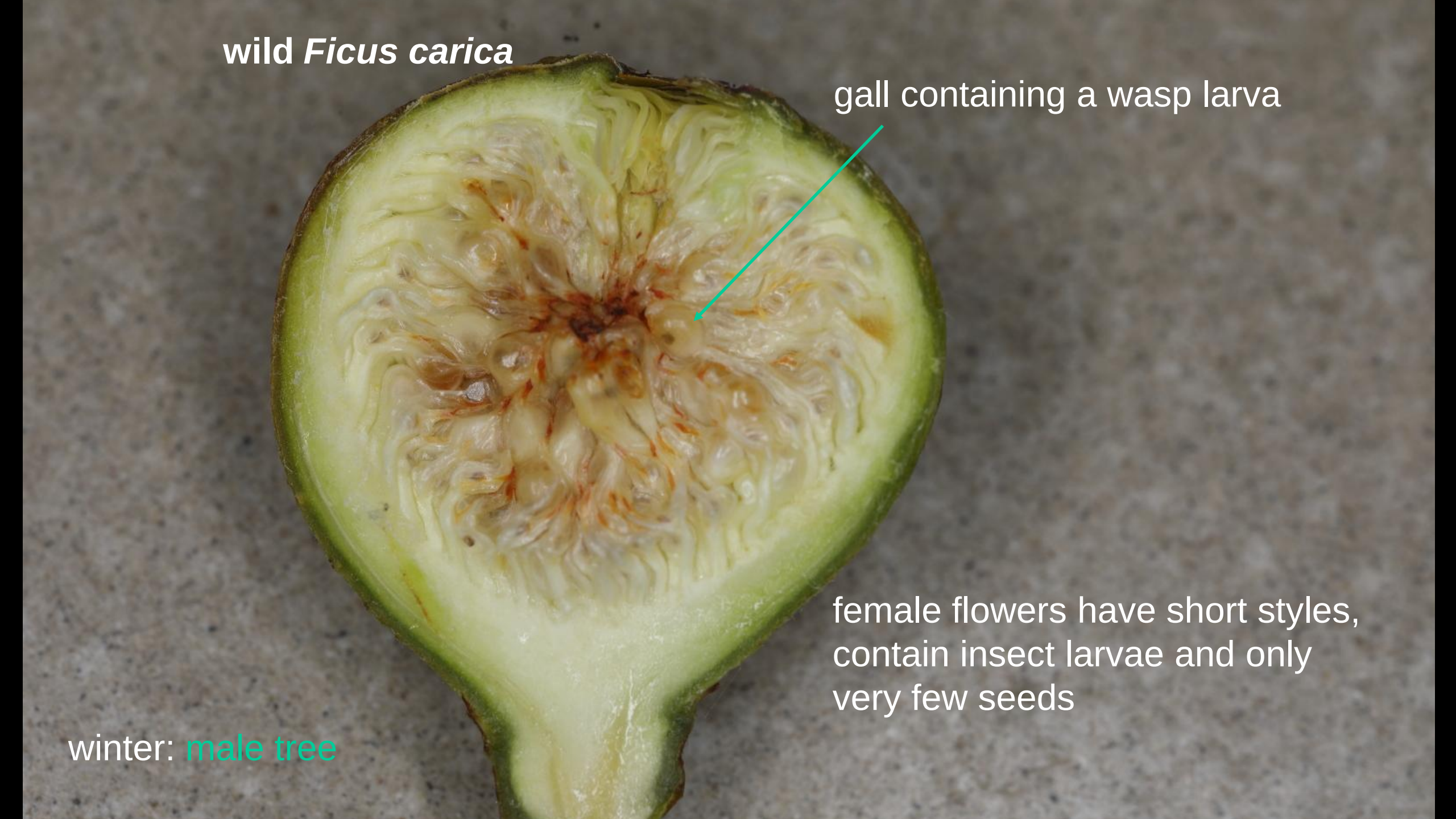
scars after figs that ripened in August-September

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


wild *Ficus carica*
fig bud from previous growth season, it will resume its development in spring
figs that developped directly from fig buds on the shoot of the year and containing last larval stage *Blastophaga*
winter: male tree
fig bud


wild *Ficus carica*
gall containing a wasp larva
female flowers have short styles, contain insect larvae and only very few seeds
winter: male tree

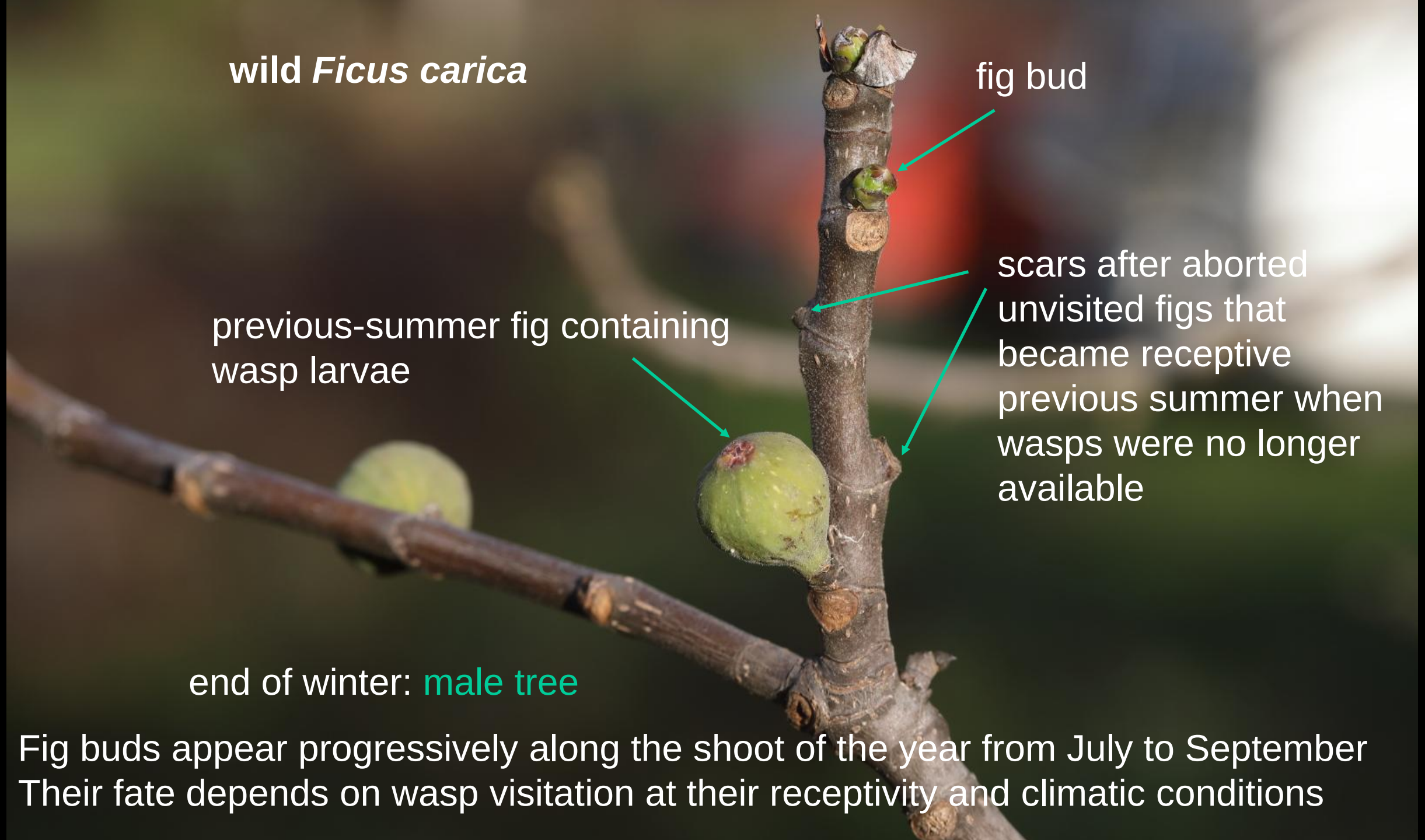


Fig buds appear progressively along the shoot of the year from July to September
Their fate depends on wasp visitation at their receptivity and climatic conditions

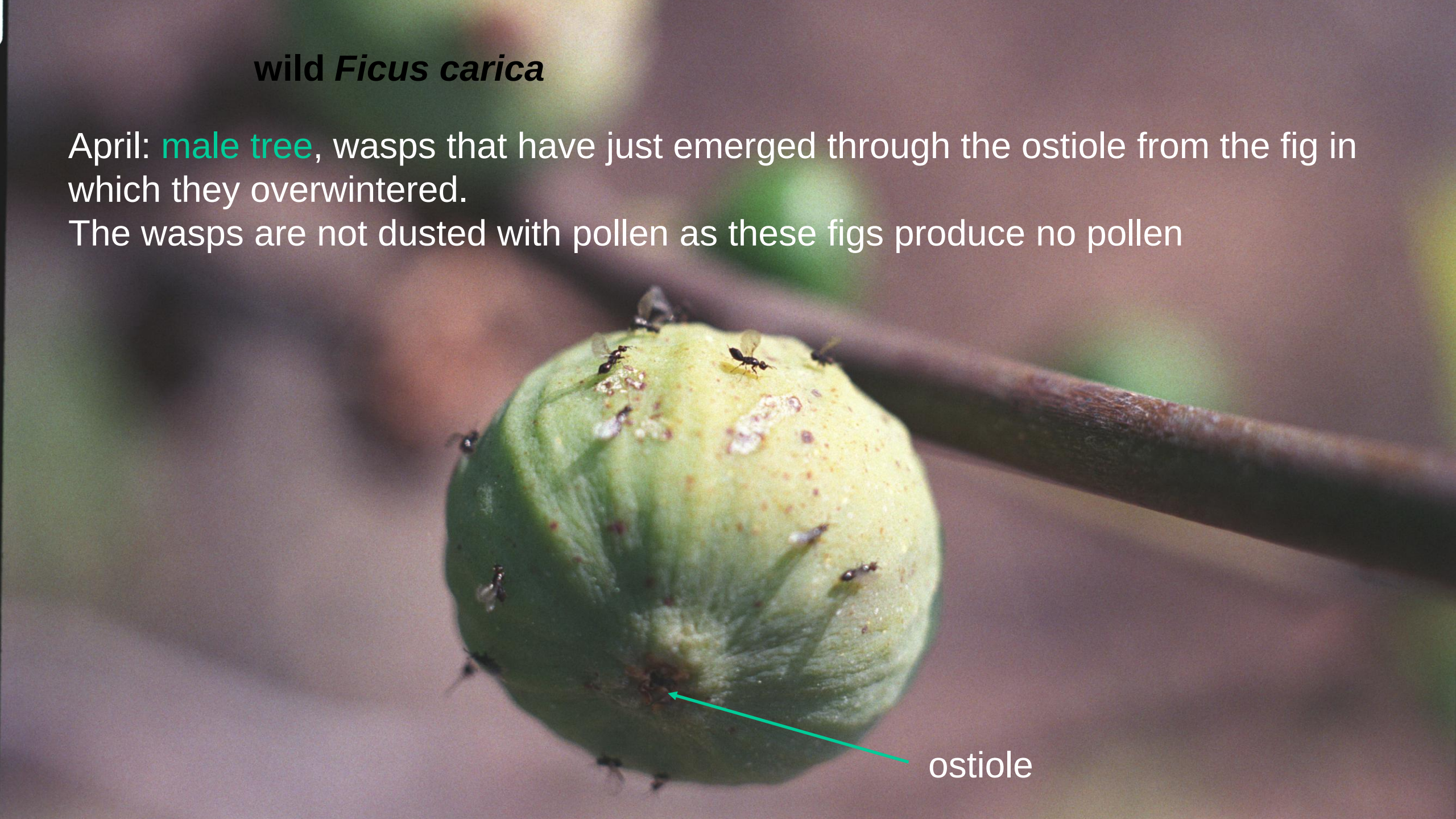

wild *Ficus carica*
receptive figs
(attractive to wasps)
fig in which the wasps overwintered
April: male tree, wasps are ready to emerge from the overwintering figs to visit receptive figs on male trees

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


wild *Ficus carica*
receptive figs (attractive to wasps)
April: male tree without overwintering figs
The receptive figs have grown large, still waiting for *Blastophaga* from another male tree to visit them

wild *Ficus carica*

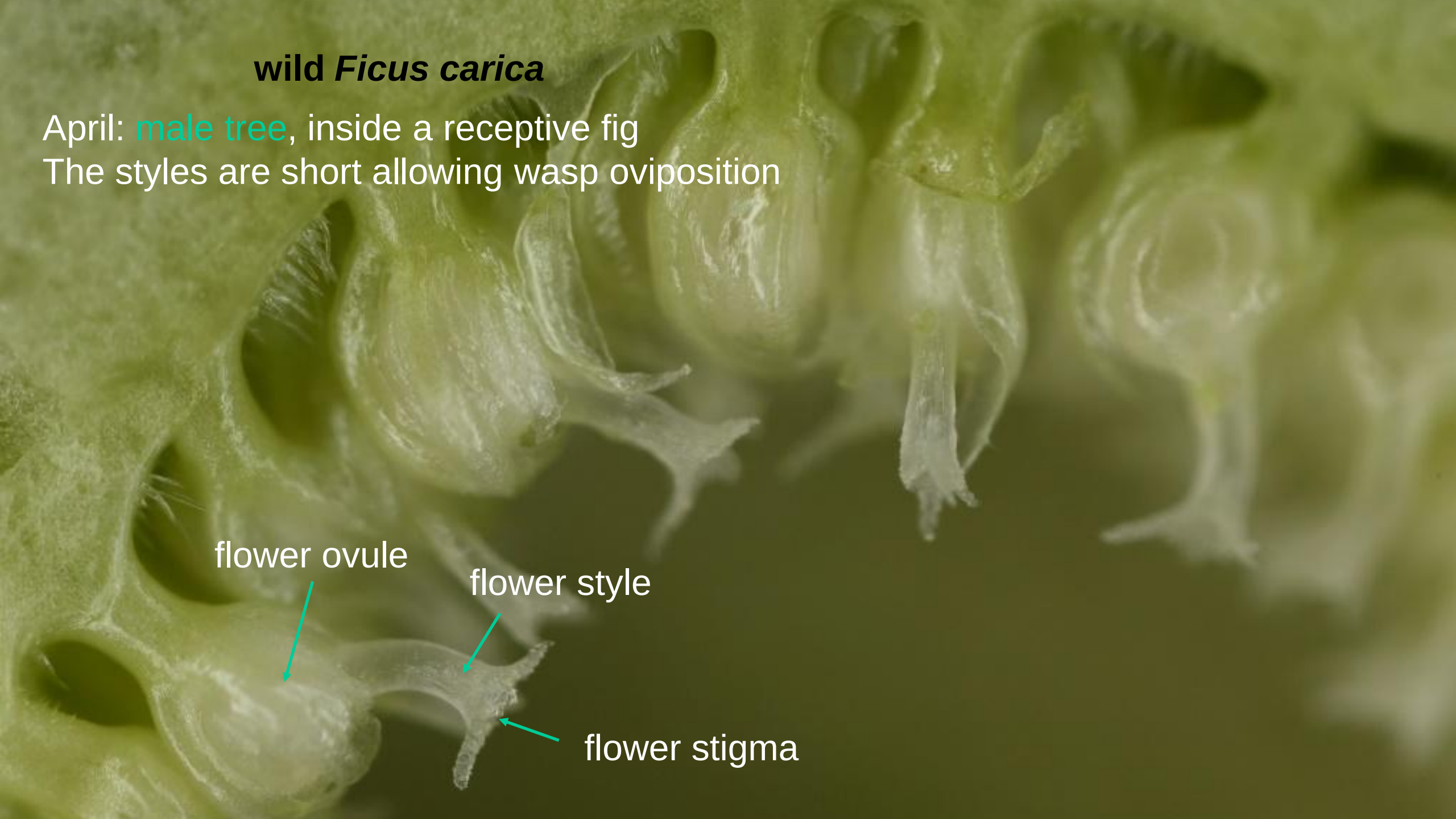
April: male tree, wasps that have just emerged through the ostiole from the fig in which they overwintered.
The wasps are not dusted with pollen as these figs produce no pollen



wild *Ficus carica*

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

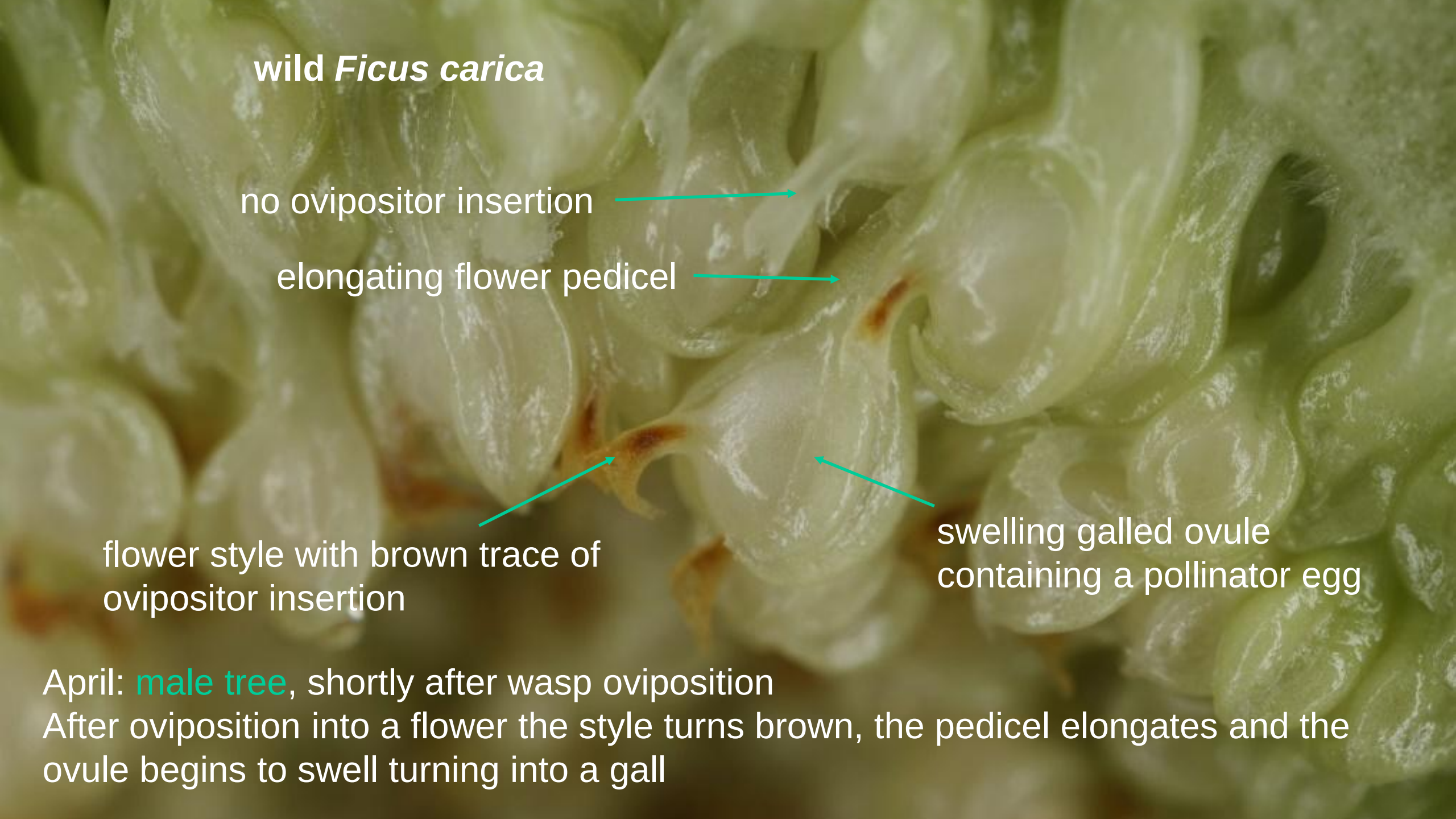

wild *Ficus carica*
April: male tree, inside a receptive fig
The styles are short allowing wasp oviposition
flower ovule
flower style
flower stigma

April: male tree, receptive fig
The stigmas form a platform within the fig on which the wasps will walk

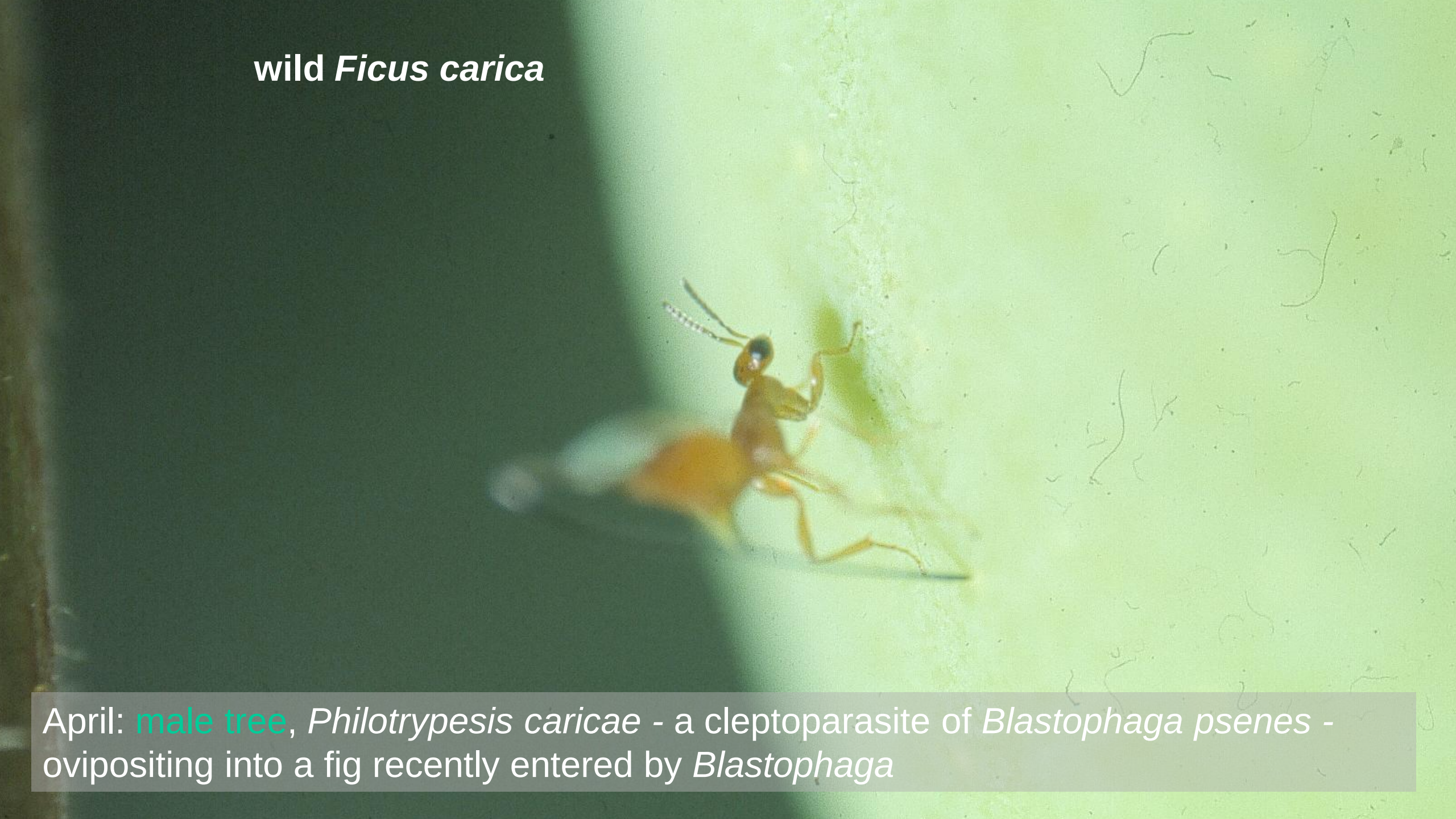
wild *Ficus carica*

April: male tree, *Blastophaga* ovipositing in a receptive fig

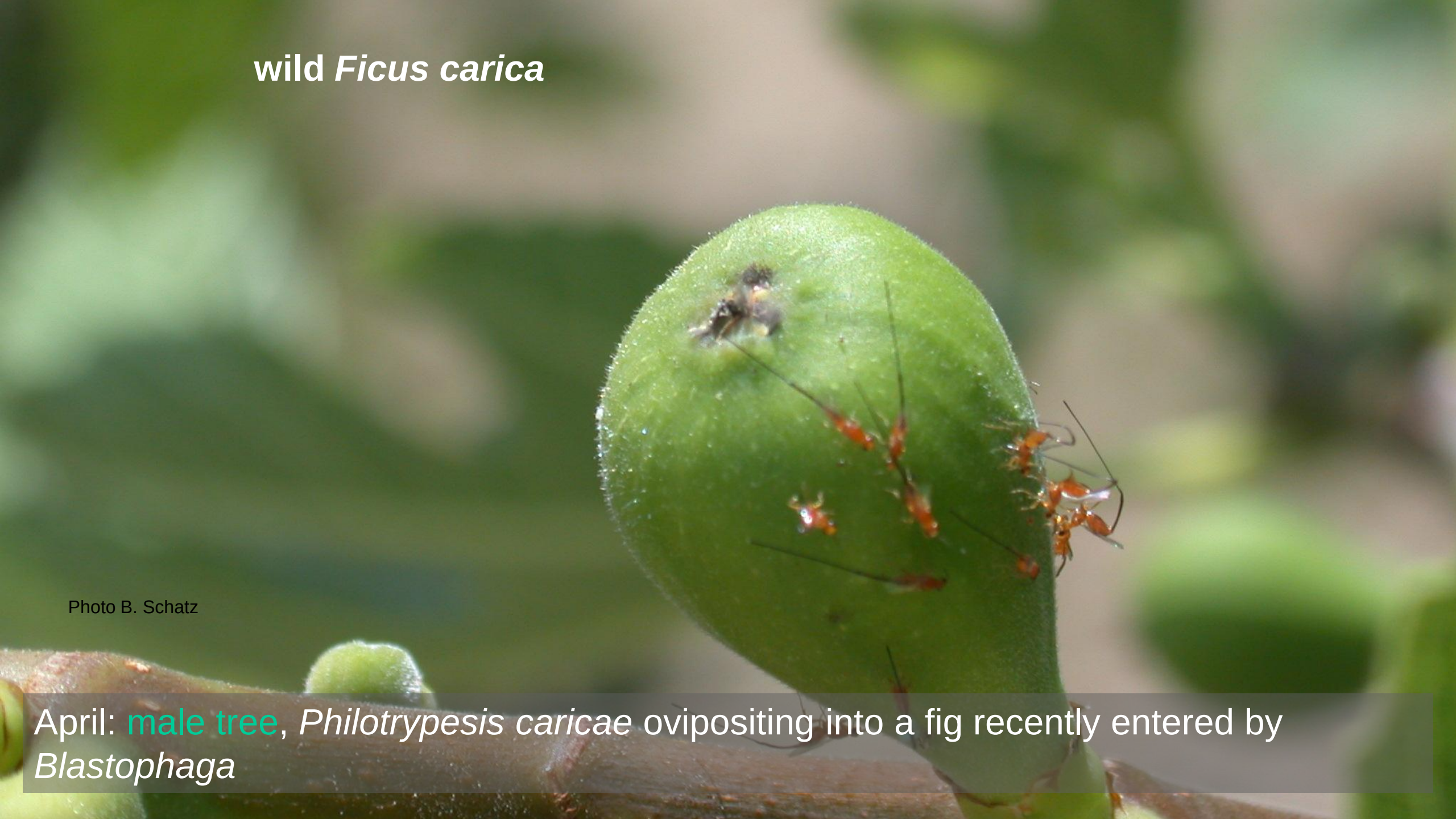
Photo G. Valdeyron



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, *Philotrypesis caricae* - a cleptoparasite of *Blastophaga psenes* - ovipositing into a fig recently entered by *Blastophaga*

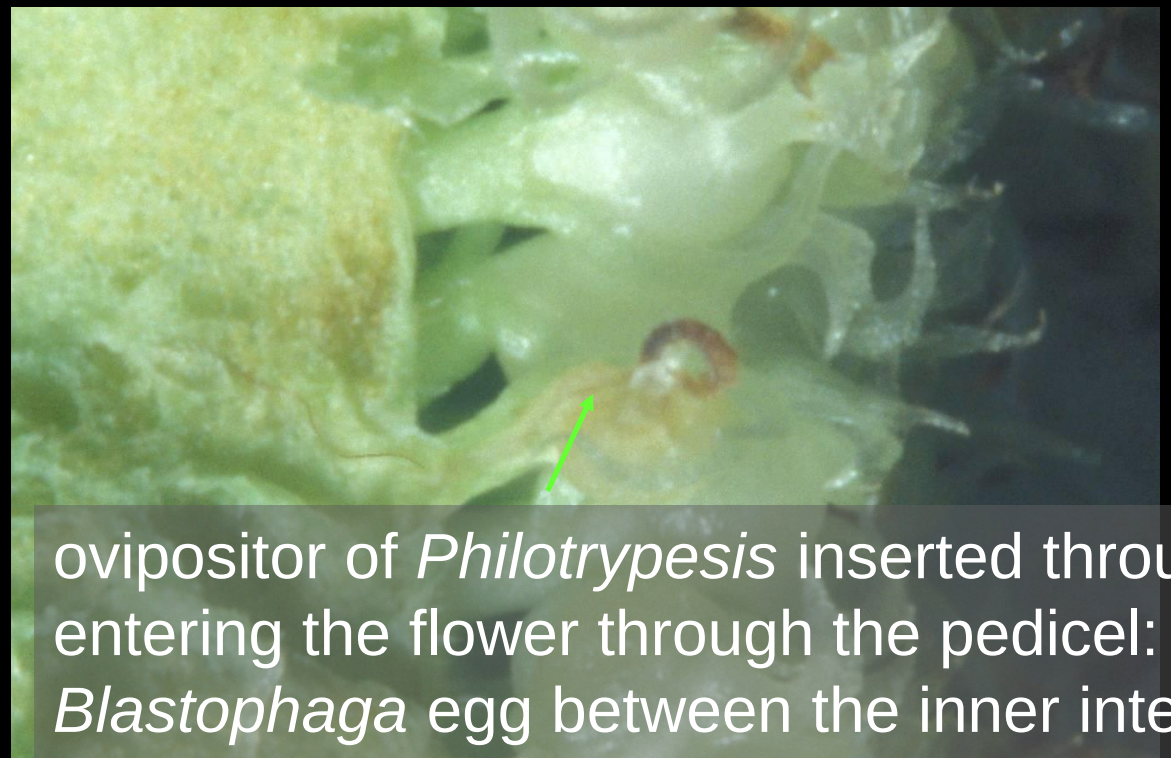


April: male tree, *Philotrypesis caricae* ovipositing into a fig recently entered by *Blastophaga*

wild ***Ficus carica***

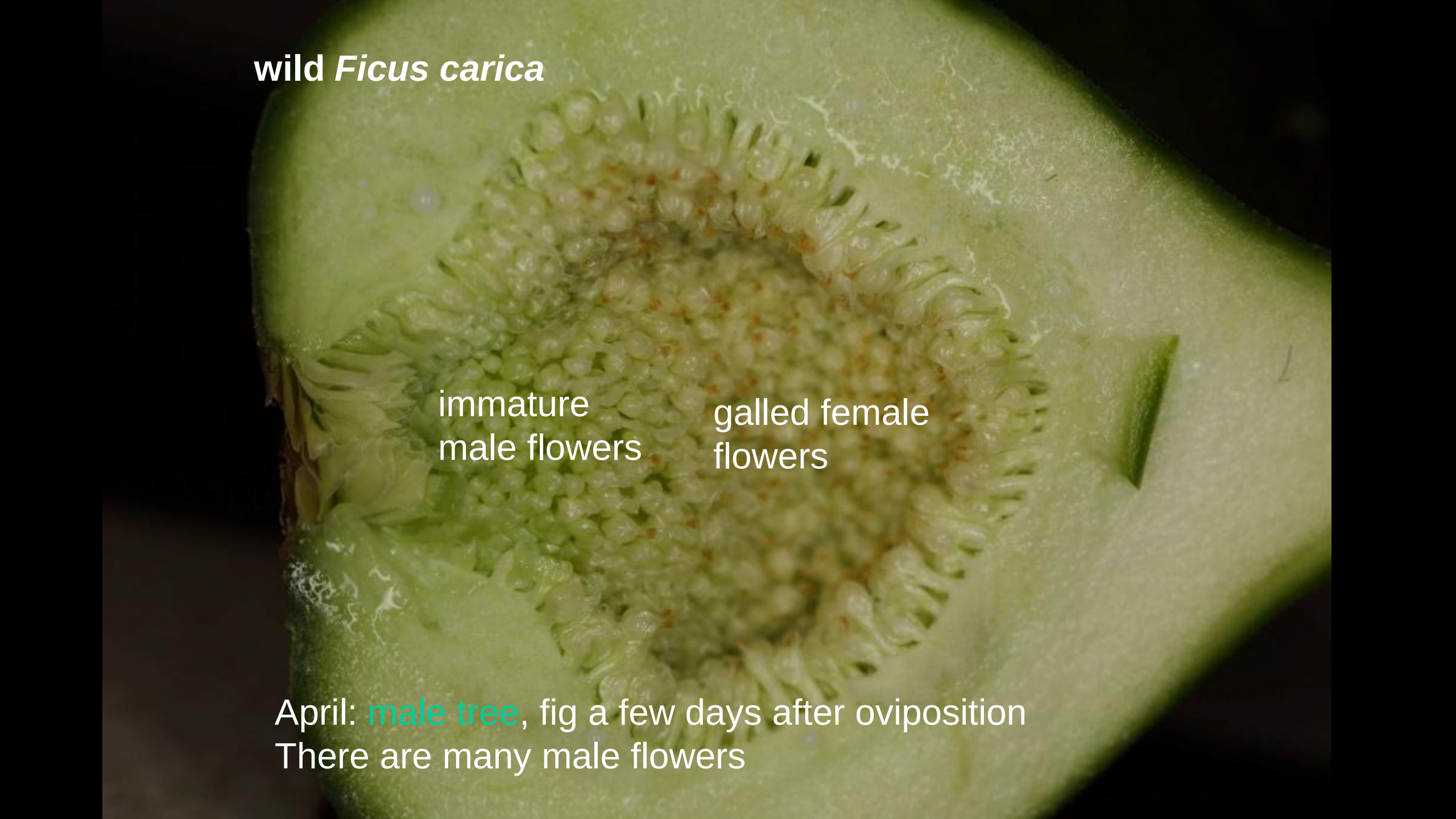
Philotrypesis ovipositors

April: male tree

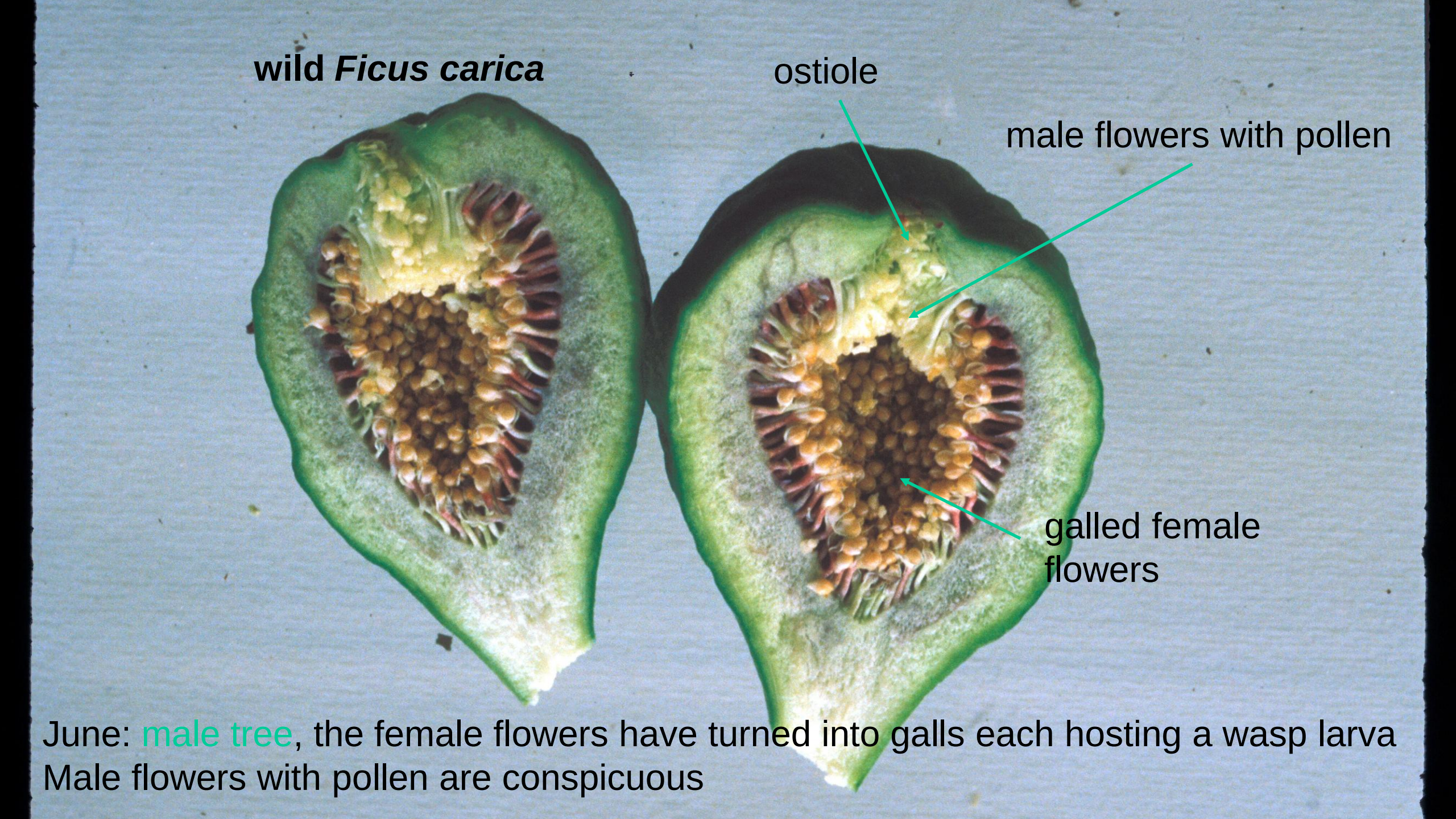


ovipositor of *Philotrypesis* inserted through the fig wall and entering the flower through the pedicel: the egg is laid beside the *Blastophaga* egg between the inner integument and the nucellus

wild *Ficus carica*



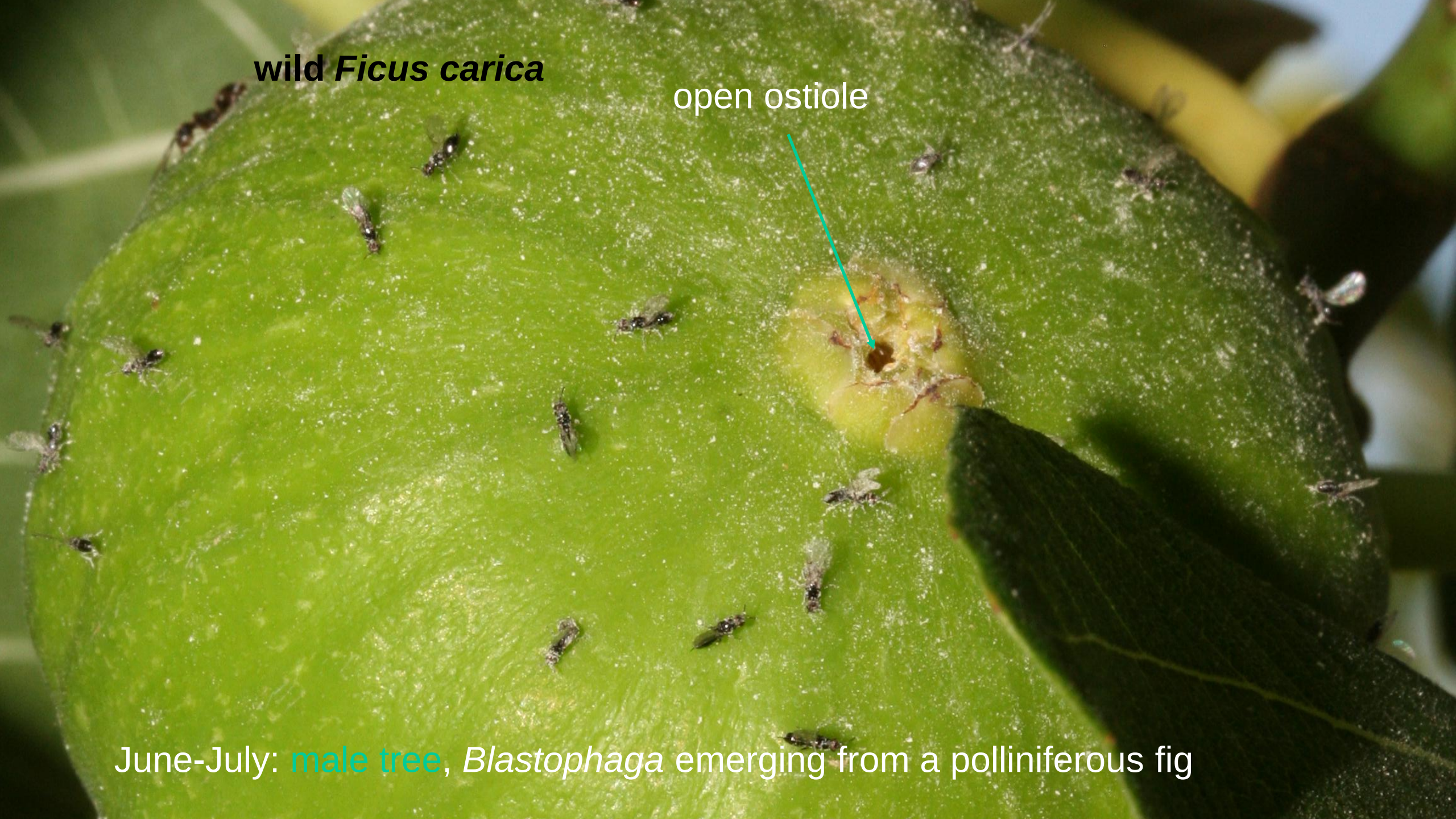
April: male tree, fig a few days after oviposition
There are many male flowers



June: male tree, the female flowers have turned into galls each hosting a wasp larva
Male flowers with pollen are conspicuous

wild *Ficus carica*

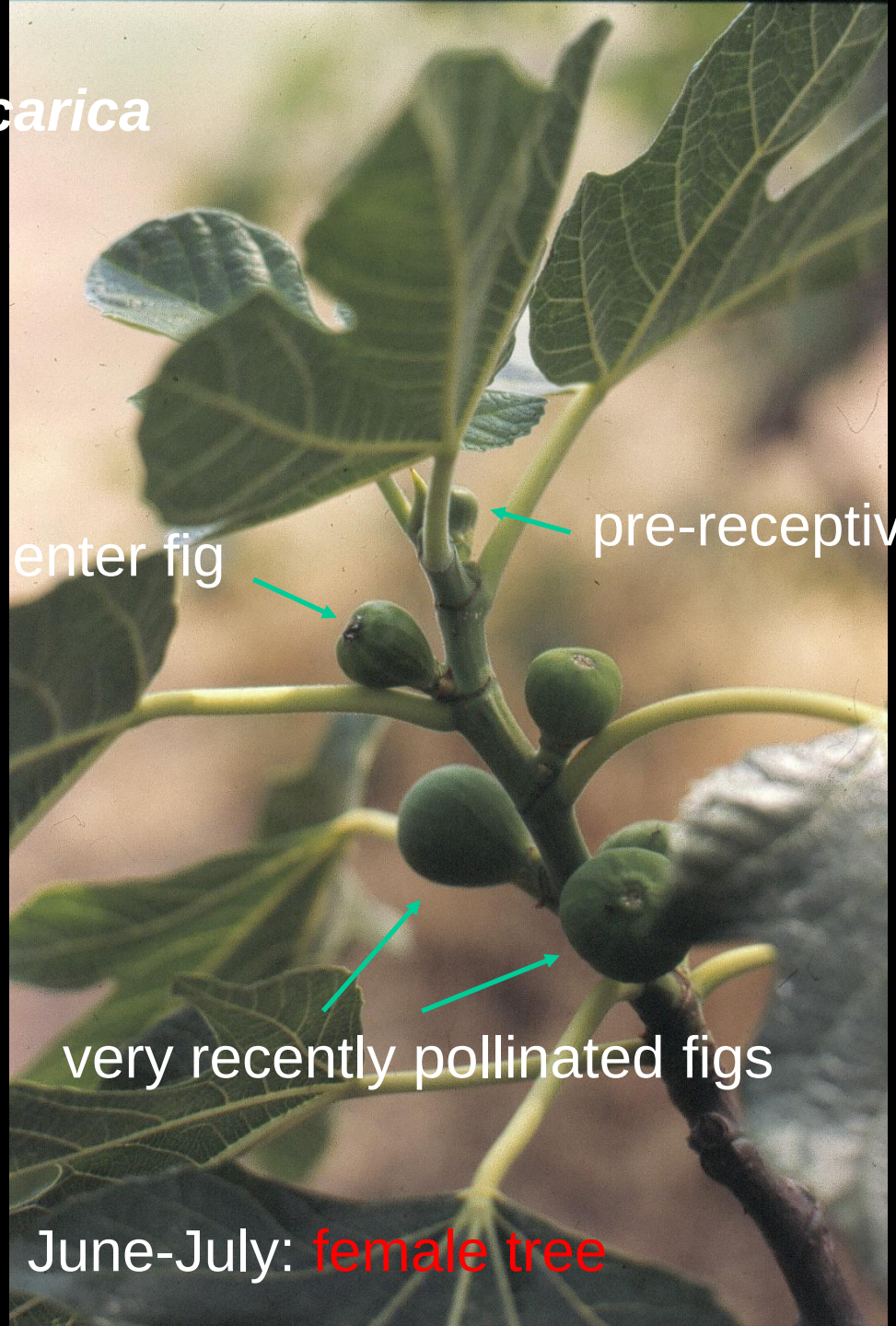
June-July: male tree, *Blastophaga* emerging through the ostiole from a polliniferous fig, covered with pollen before cleaning themselves
Some pollen remains caught in the intersegment pleura



June-July: male tree, *Blastophaga* emerging from a polliniferous fig

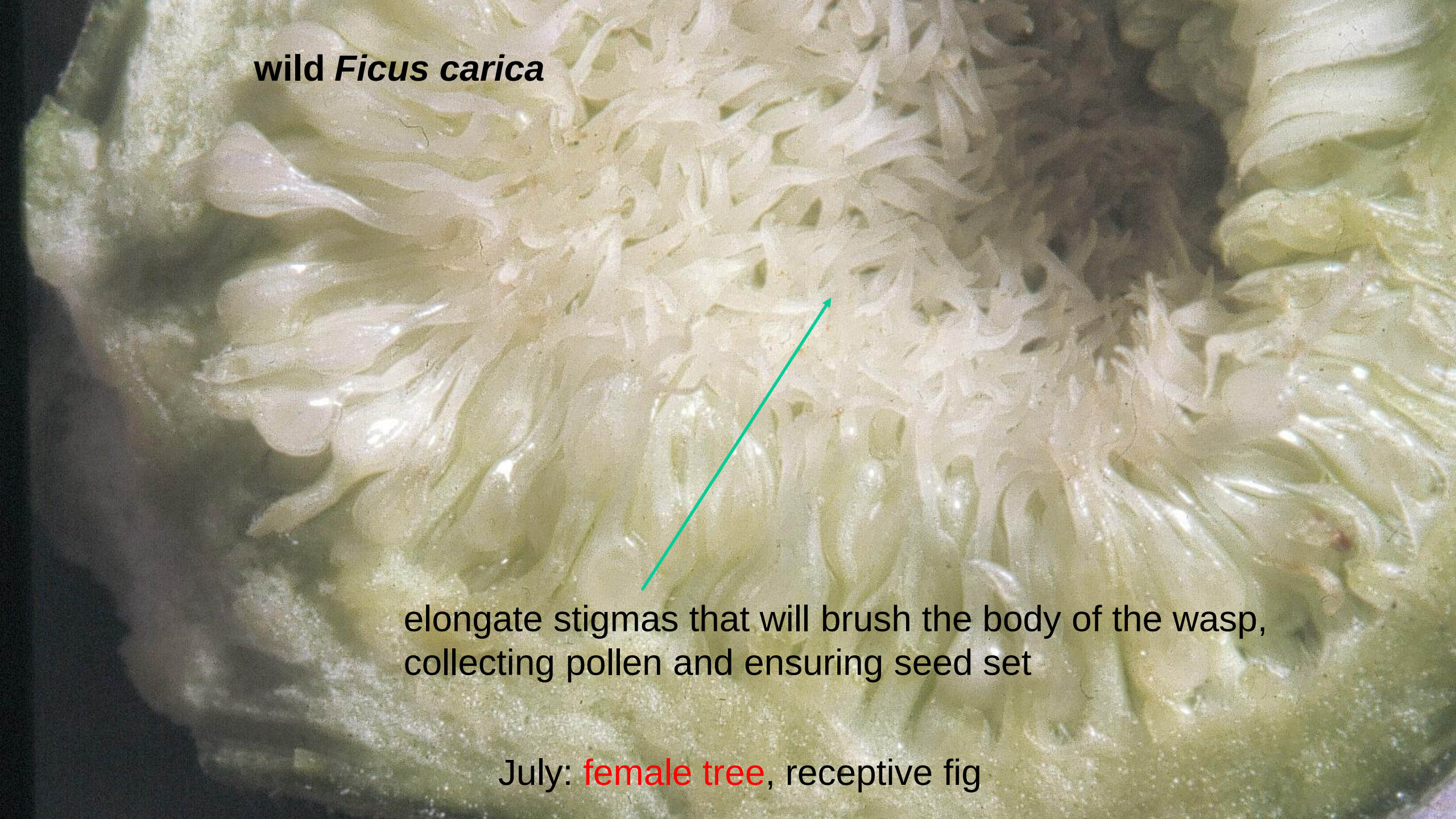

Two wild *Ficus carica*
June-July
Female tree: a recently pollinated fig
two receptive figs
At that period, there are no receptive figs on male trees
The wasps can only go from male figs to figs on female trees
Male tree: polliniferous figs at the stage of *Blastophaga* emergence

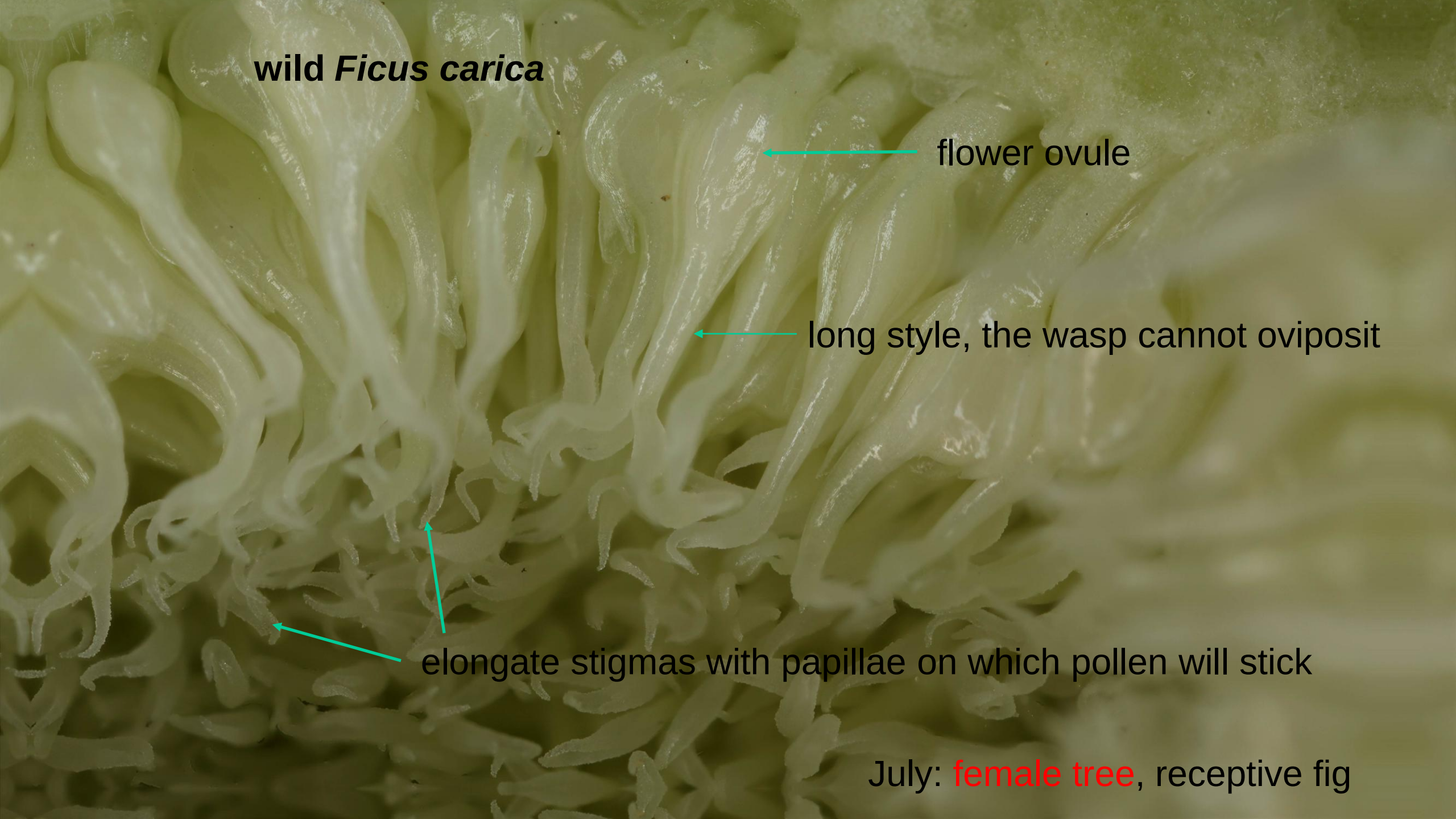
wild *Ficus carica*



wild *Ficus carica*

July: female tree, pollen-bearing wasp trying to enter a fig


wild *Ficus carica*
elongate stigmas that will brush the body of the wasp, collecting pollen and ensuring seed set
July: female tree, receptive fig


wild *Ficus carica*
flower ovule
long style, the wasp cannot oviposit
elongate stigmas with papillae on which pollen will stick
July: female tree, receptive fig

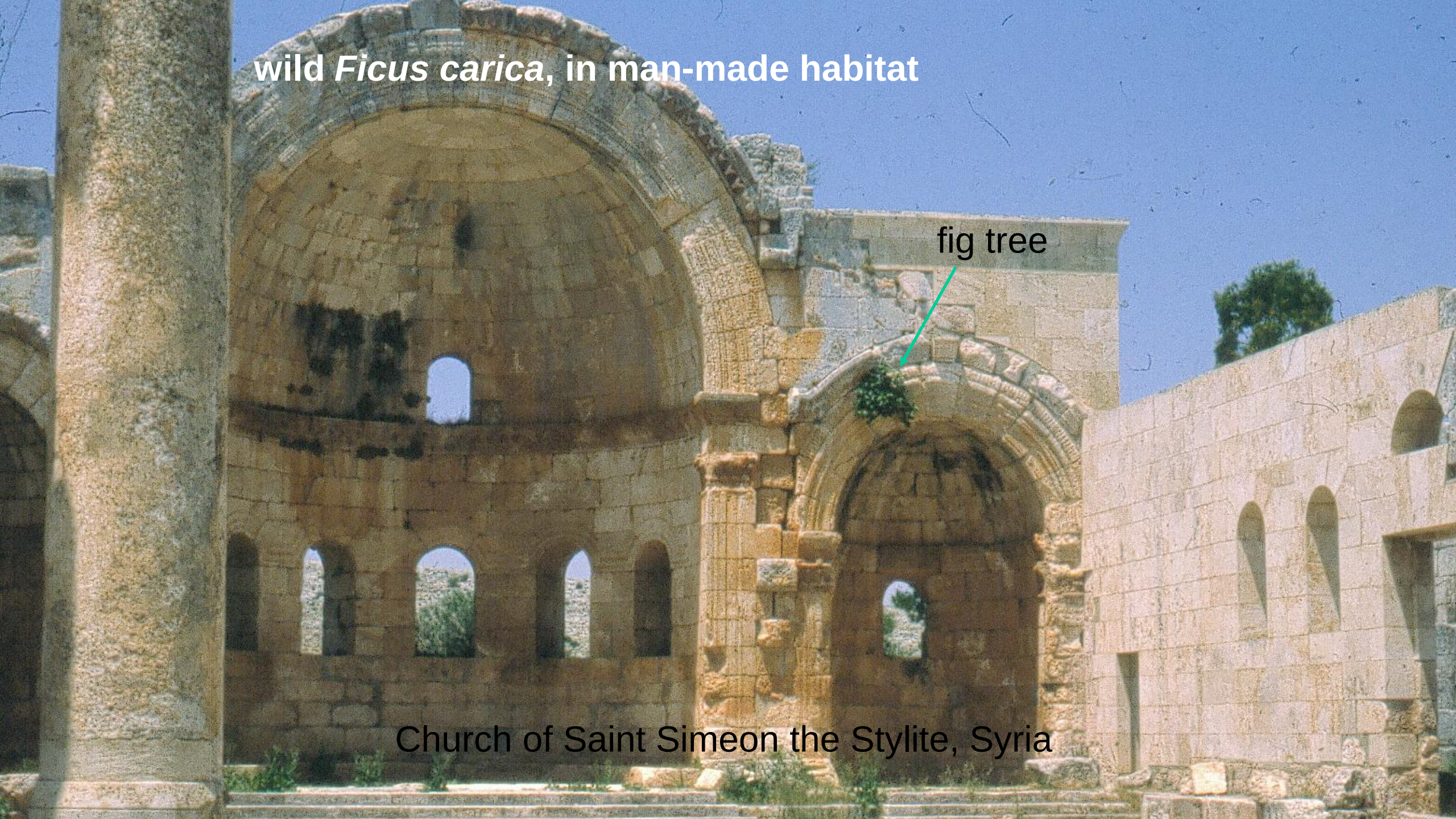
Late July: male tree, the very earliest young figs are visited by the wasps emerging from the very latest polliniferous figs. This sensitive point in the yearly cycle of the wasps is present throughout the wild range of *Ficus carica*


wild *Ficus carica*
September: female tree, ripe seed-containing figs

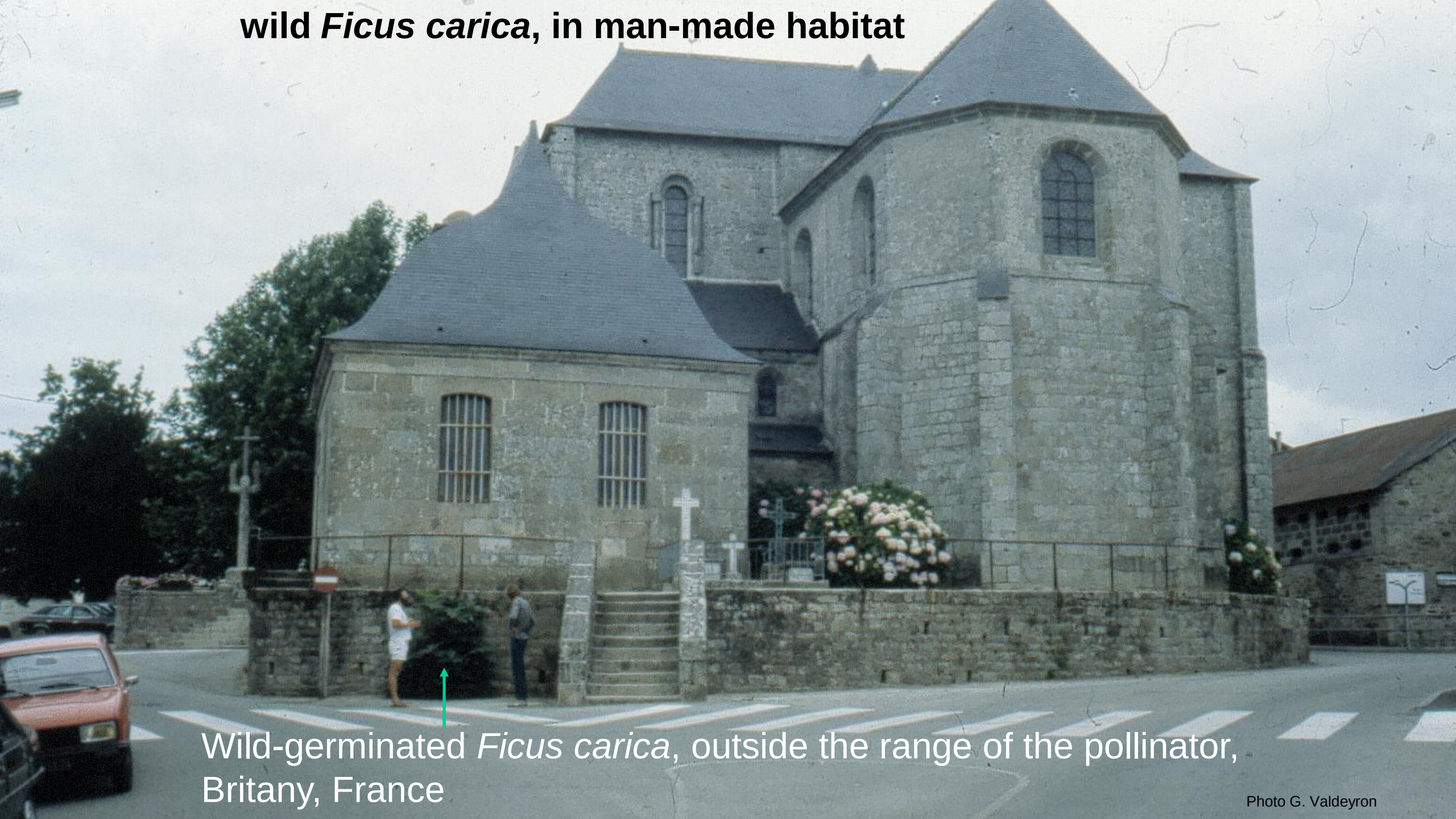
September: female tree, ripe seed-containing figs
The climacteric ripening involves nutriment transfer, ethylene production and respiratory peak
Ripening can be artificially sped up by depositing a drip of olive oil on the ostiole

September: fig seed dispersal by a mammal


wild *Ficus carica*, in man-made habitat
fig tree
Valleraugue, Hérault, France


wild *Ficus carica*, in man-made habitat
fig tree
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

Photo G. Valdeyron

Fig cultivation and domestication

From wild to cultivated

Wild figs are as good as domesticated ones

fig cultivation

cultivated wild-germinated fig tree
Montpeyroux, Hérault, France

Photo G. Valdeyron

fig cultivation

Fig plantation, Syria

fig cultivation

Fig plantation,
Meander valley, Turkey

fig cultivation

Figs of the cultivars producing the best dry figs abort if not pollinated
How is pollination achieved in large fig plantations?
Turkey, Meander valley

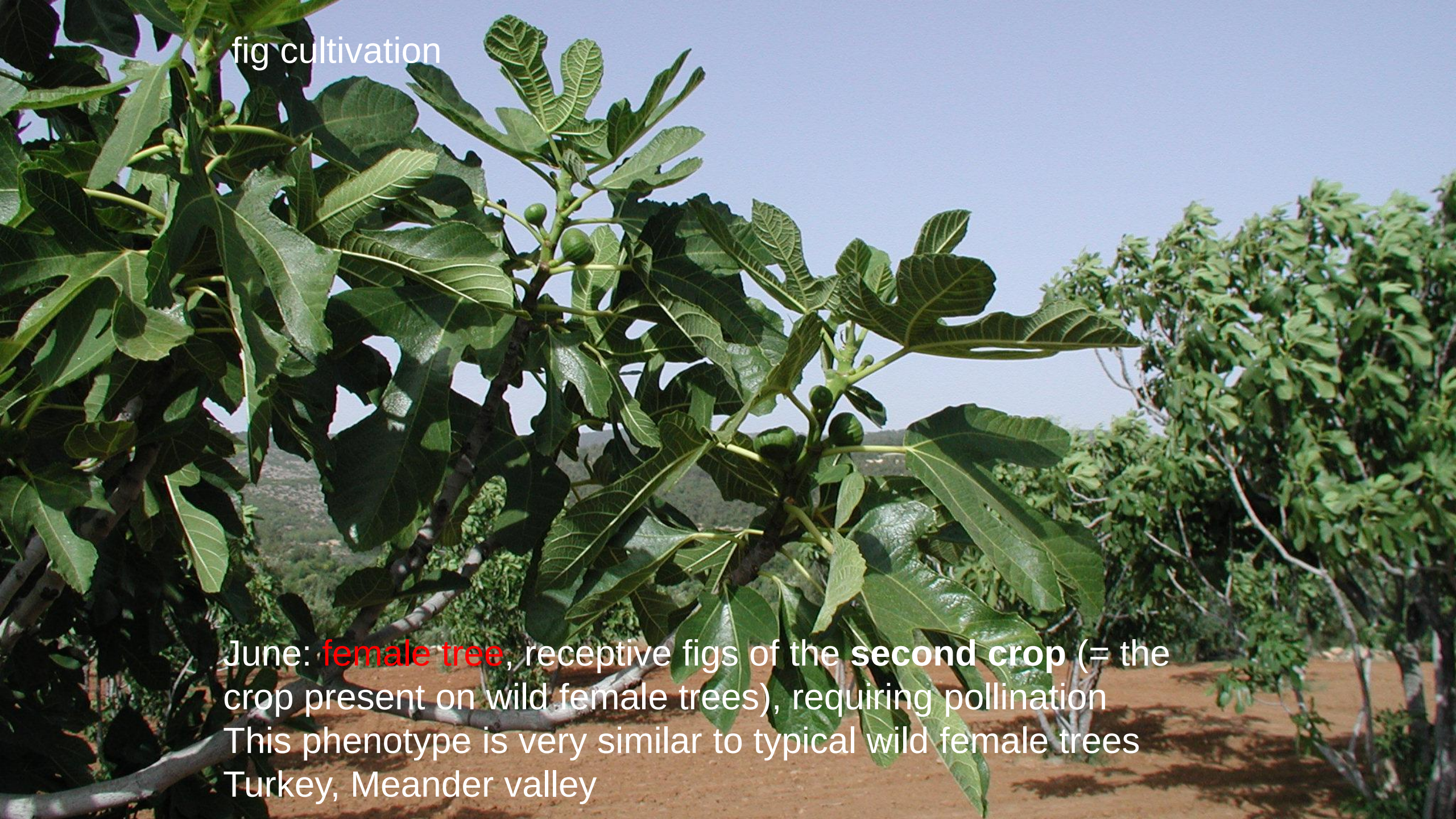


fig cultivation

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
Turkey, Meander valley

fig cultivation

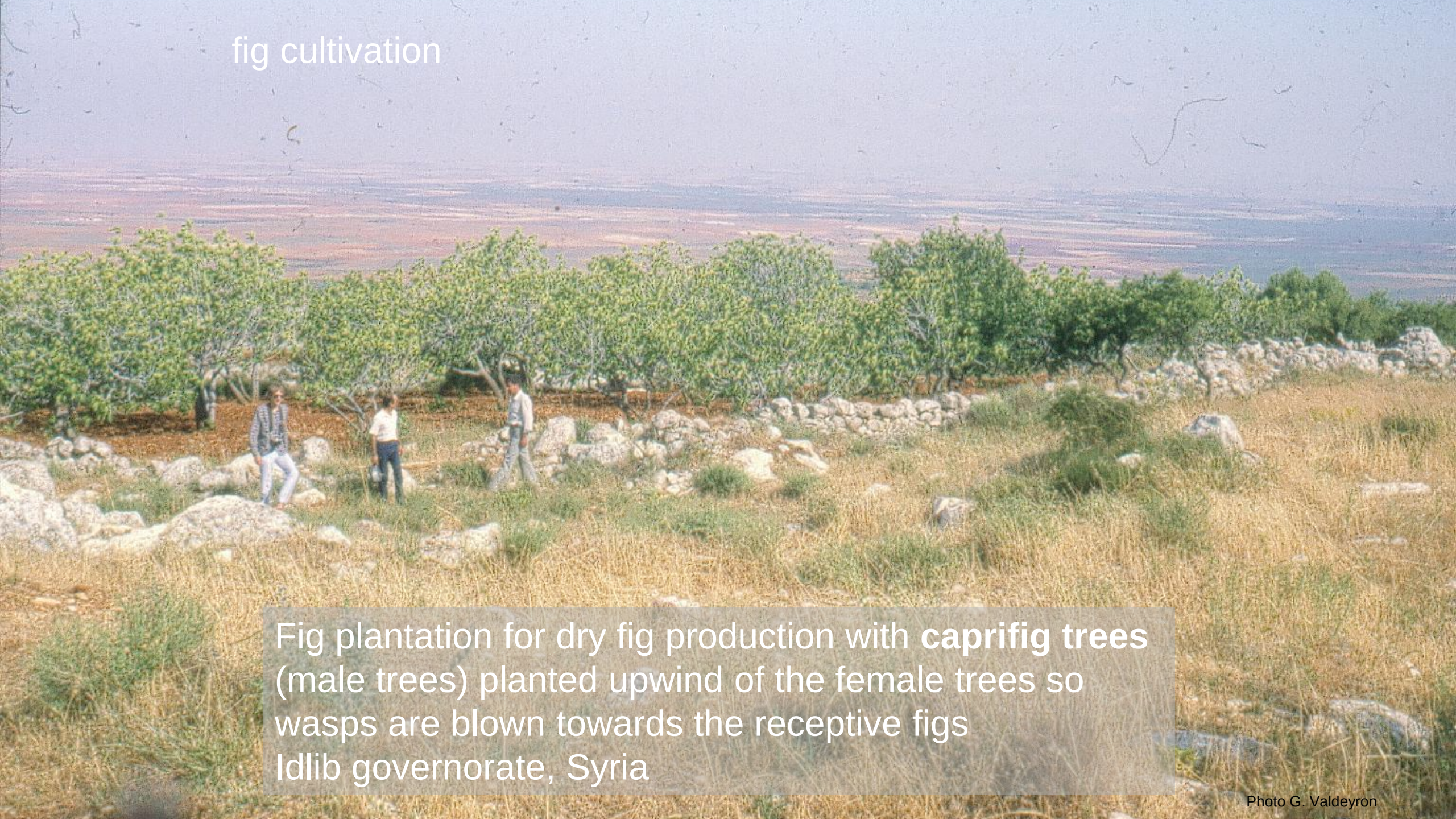


Fig plantation for dry fig production with **caprifig trees** (male trees) planted upwind of the female trees so wasps are blown towards the receptive figs
Idlib governorate, Syria

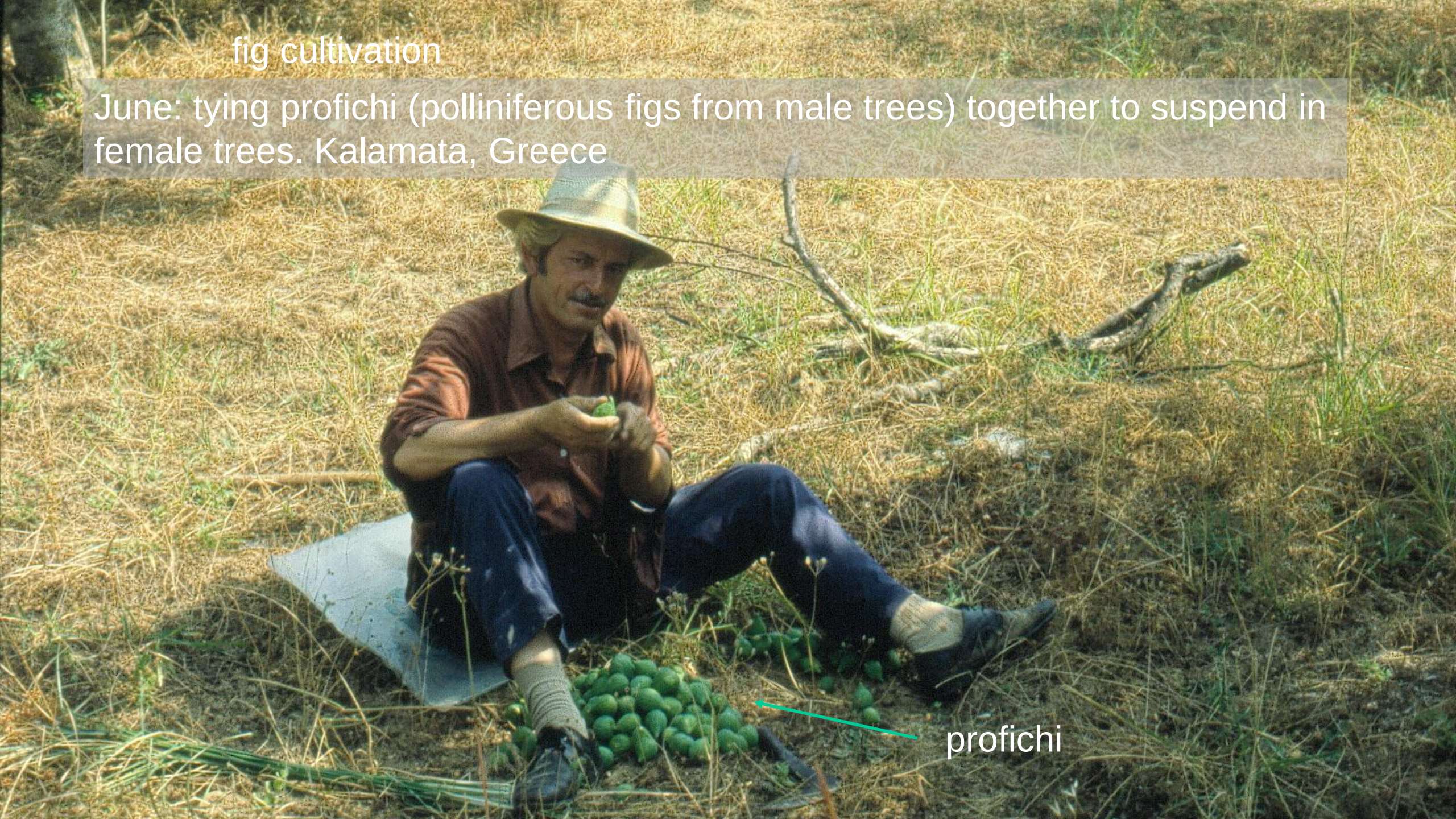
Photo G. Valdeyron

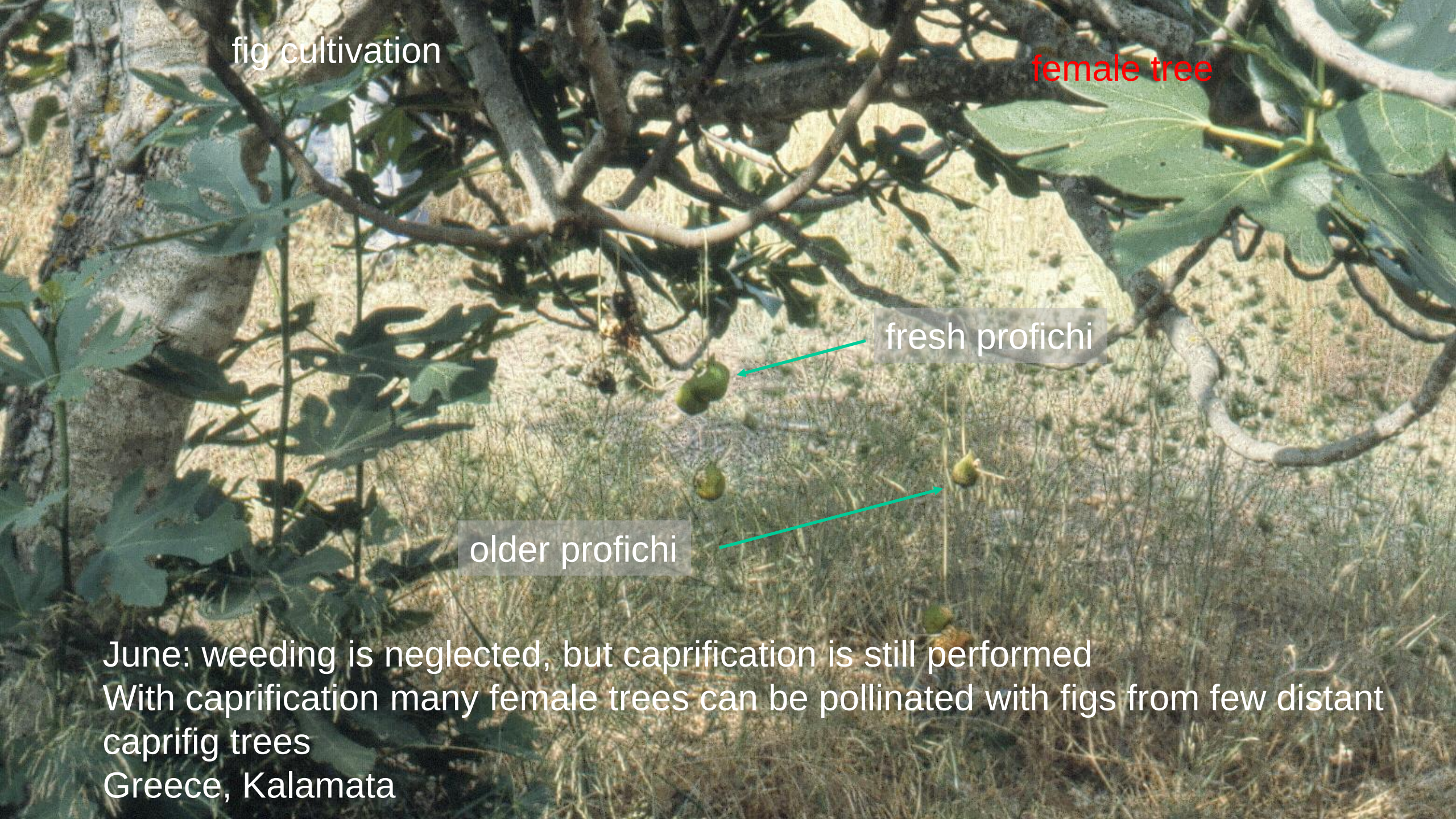
fig cultivation

June: **caprification=profichi** (polliniferous figs of male trees) are suspended in female trees to ensure pollination
Greece, Kalamata

fig cultivation

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

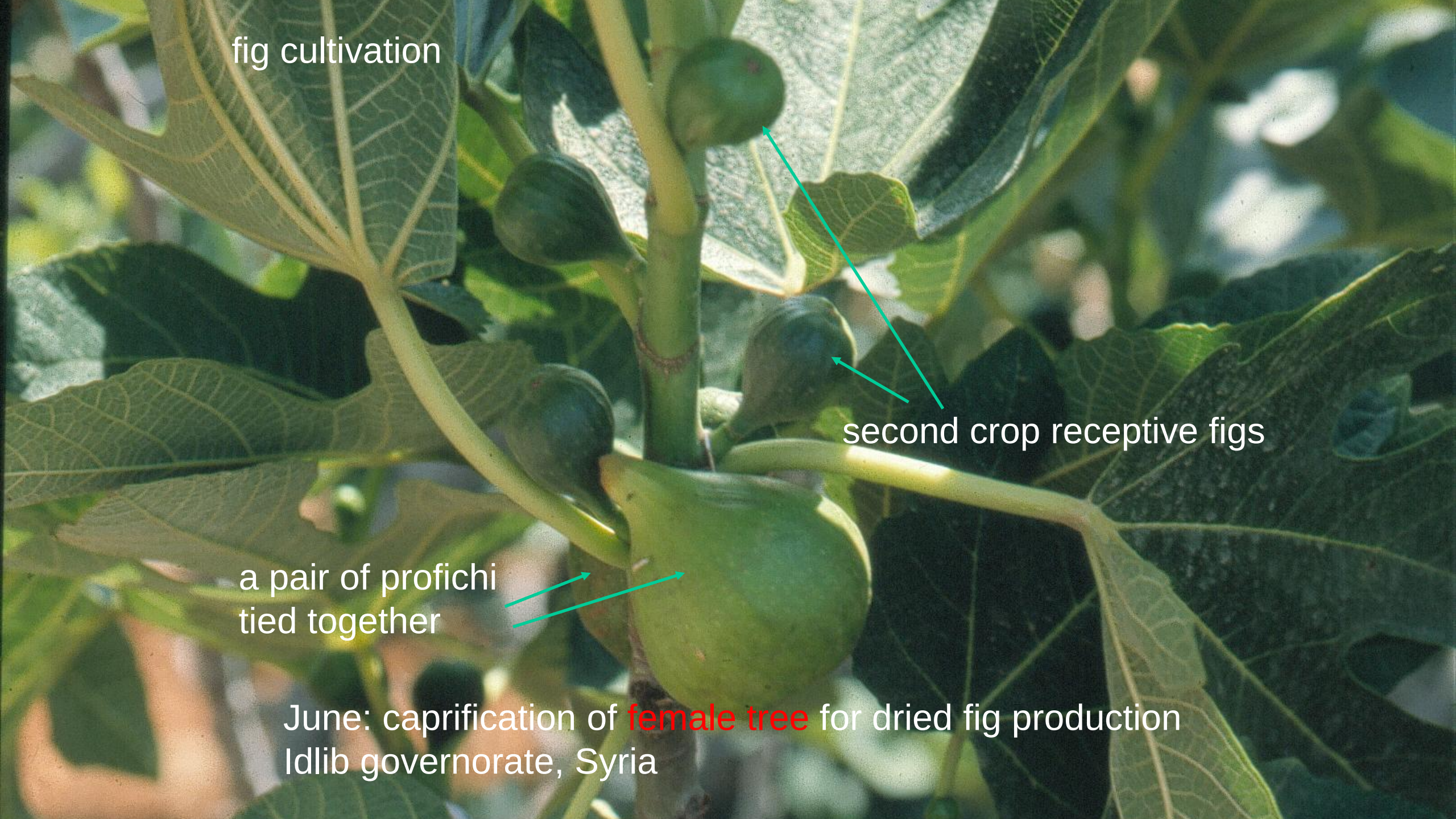
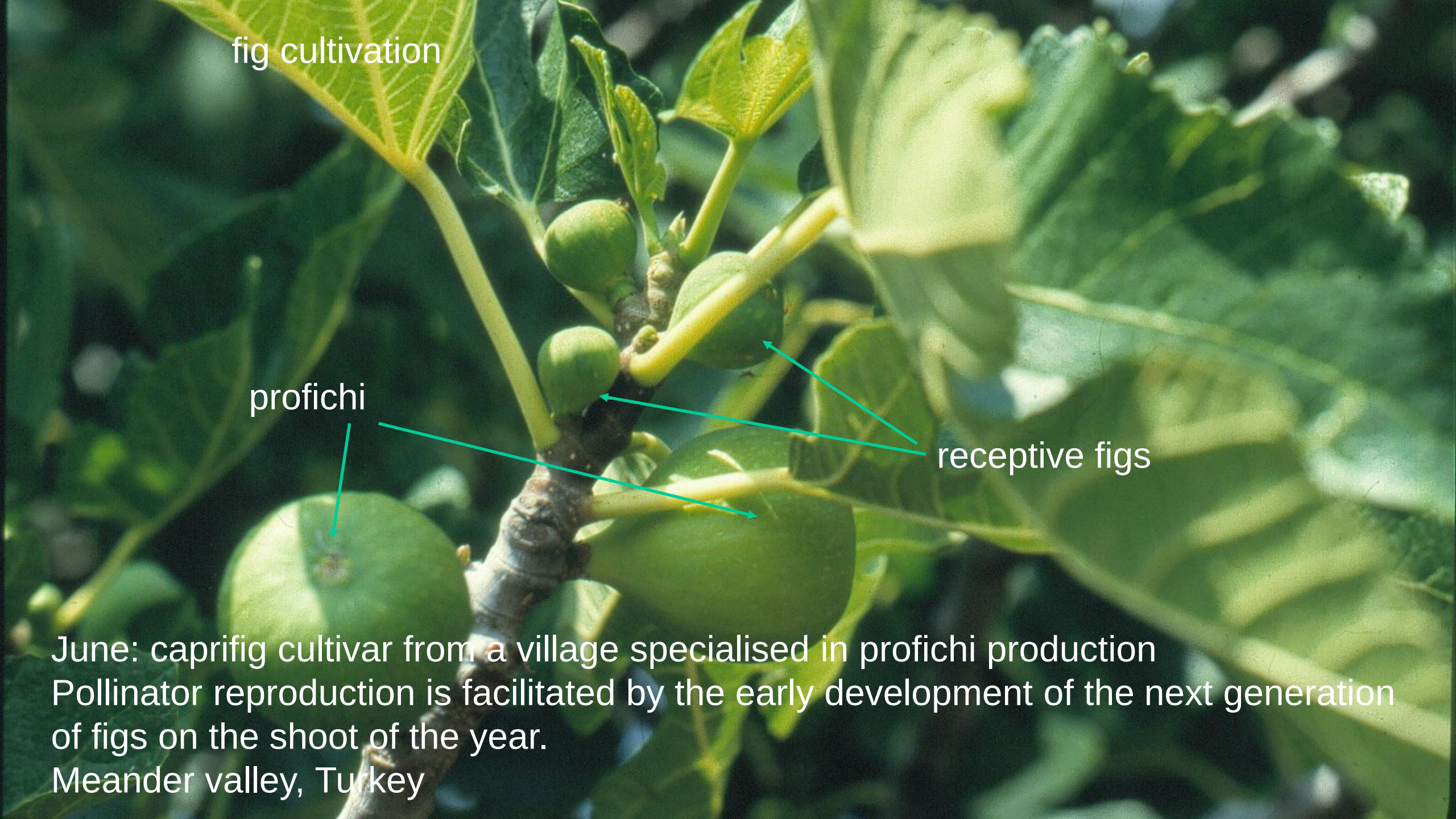


fig cultivation
second crop receptive figs
a pair of profichi
tied together
June: caprification of female tree for dried fig production
Idlib governorate, Syria

fig cultivation

Preparing profichi for caprification in a village of dried fig producers, Meander valley, Turkey


fig cultivation
A village specialized in profichi cultivation for sale at the market in the city
Meander valley, Turkey
the day’s unsold profichi



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


fig cultivation
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
numerous wasps attracted to a receptive fig on the same tree
just emerged wasp on natal fig
June: caprifig cultivar with early receptive figs selected in the villages specialised in profichi production, Meander valley, Turkey

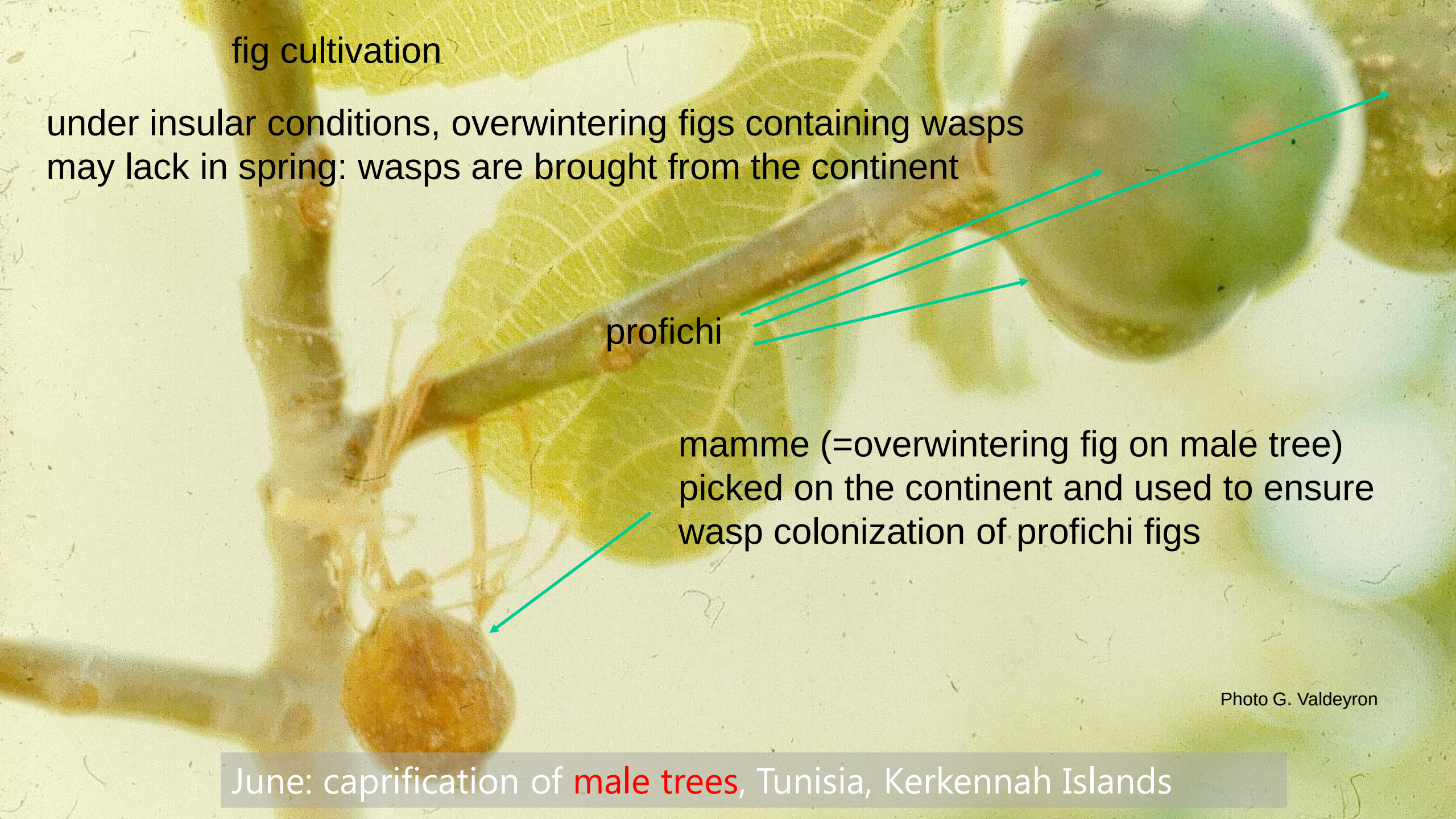


fig cultivation
under insular conditions, overwintering figs containing wasps may lack in spring: wasps are brought from the continent
profichi
mamme (=overwintering fig on male tree) picked on the continent and used to ensure wasp colonization of profichi figs
Photo G. Valdeyron
June: caprification of male trees, Tunisia, Kerkennah Islands

fig cultivation

diseases spread by
pollinating wasps

Fusarium growing in a mamme fig

California, USA

Photo Themis Michailides UC Davis


fig cultivation
diseases spread by
pollinating wasps
Fusarium moniliforme on *Blastophaga*
California, USA
Photo Themis Michailides UC Davis

fig cultivation

diseases spread by pollinating wasps

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

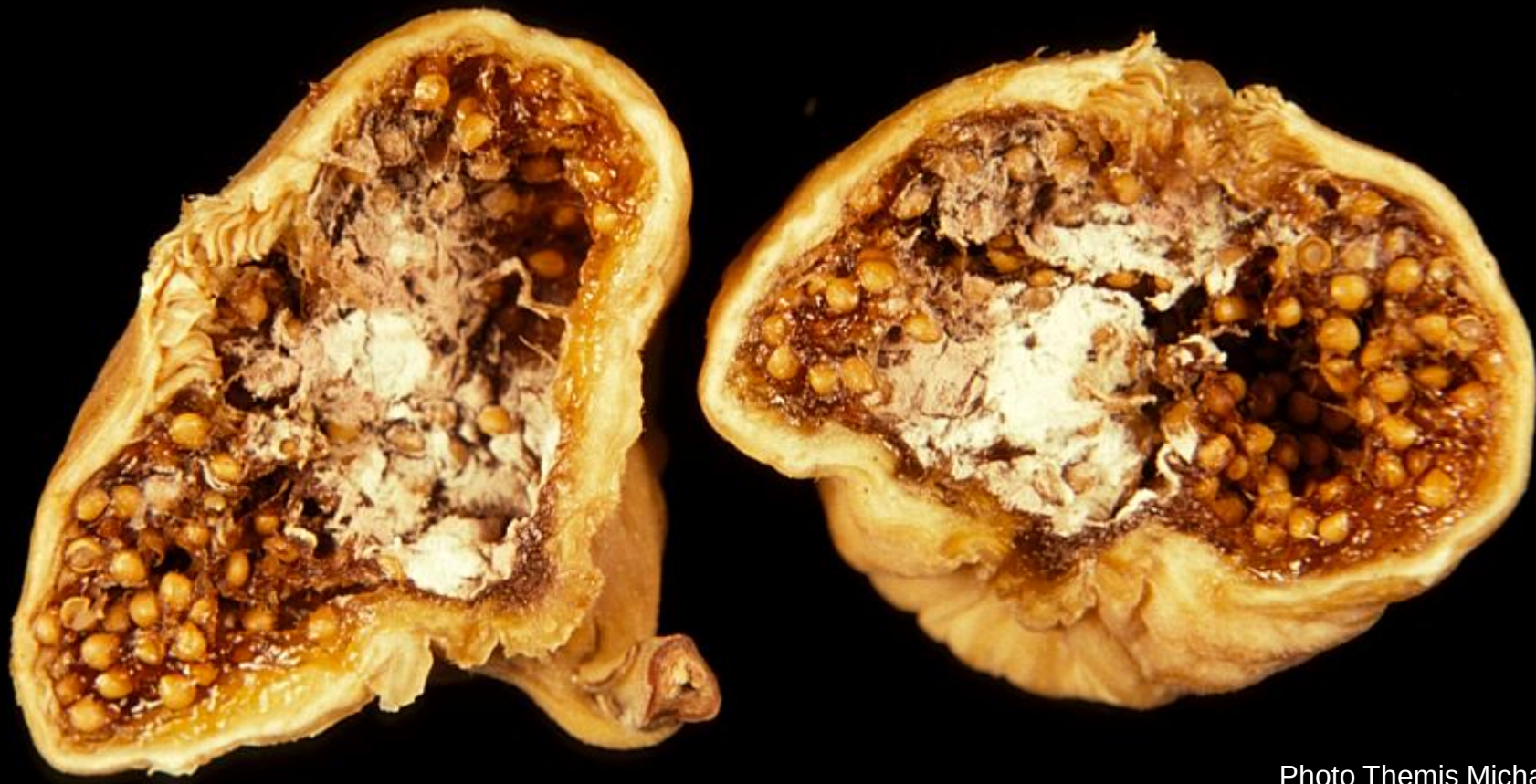
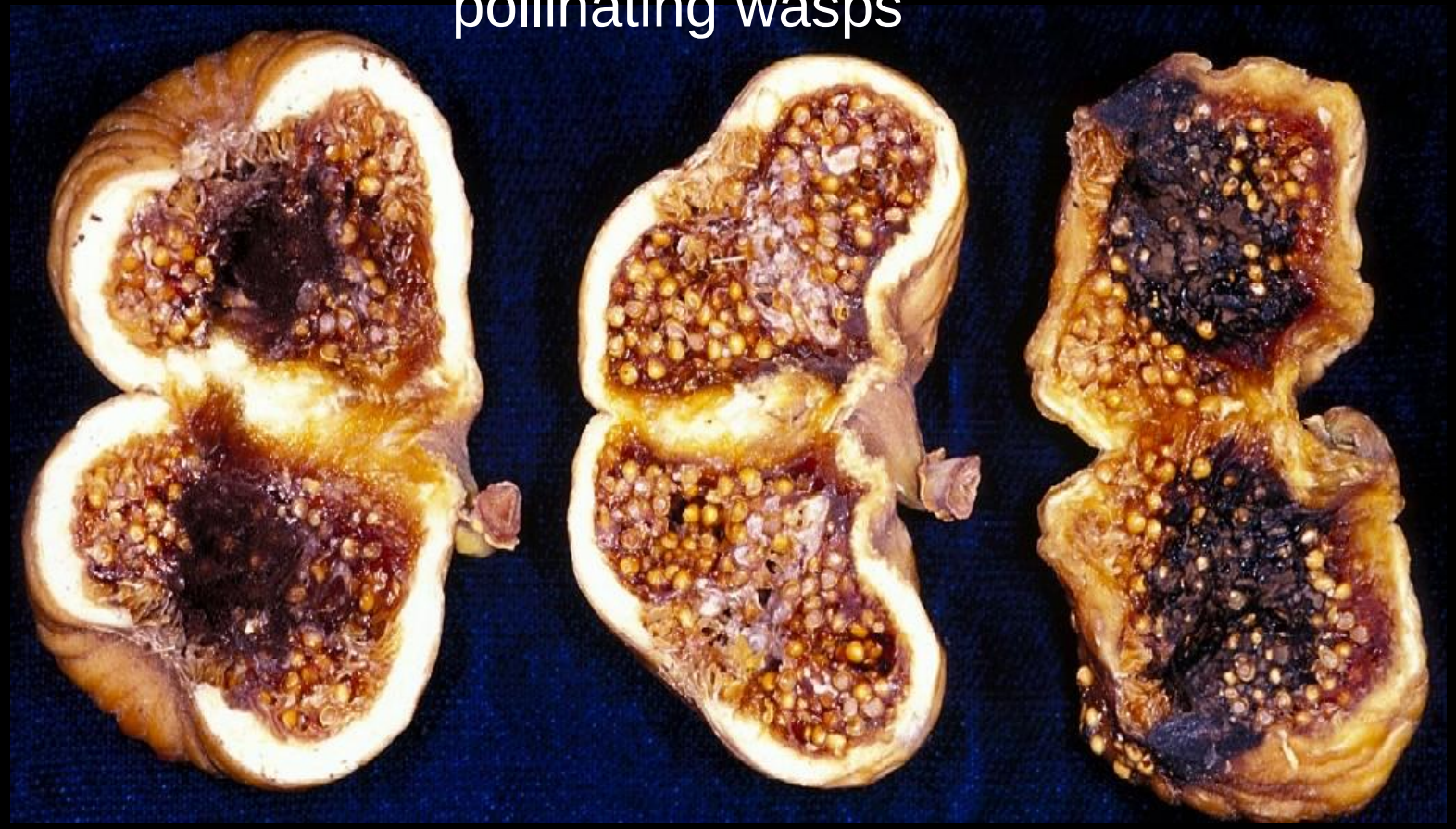


Photo Themis Michailides UC Davis

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

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

fig cultivation

Profichi collected in specialized orchard before sanitation
California, USA

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

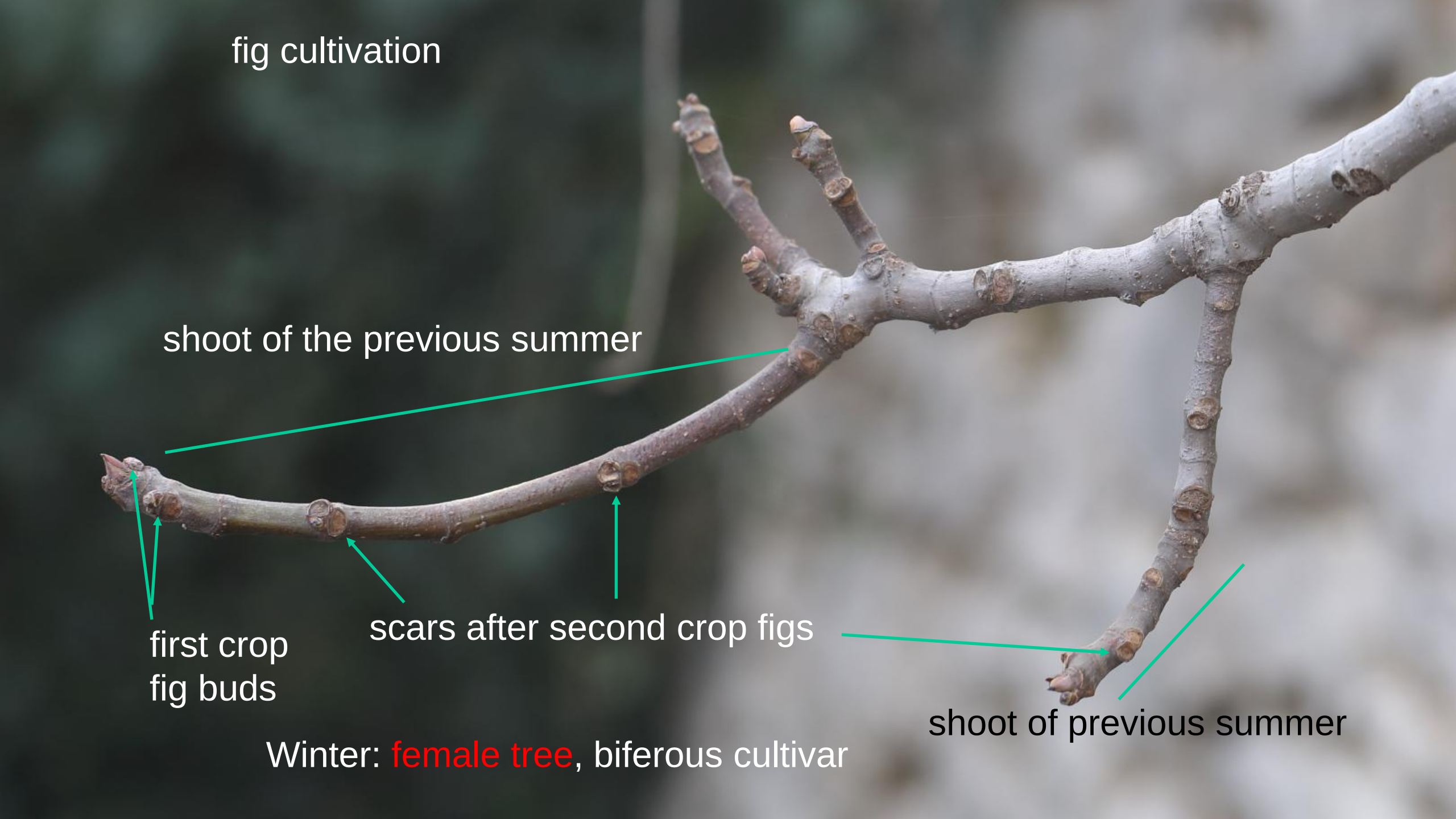


fig cultivation
shoot of the previous summer
first crop
fig buds
scars after second crop figs
shoot of previous summer
Winter: female tree, biferous cultivar

fig cultivation

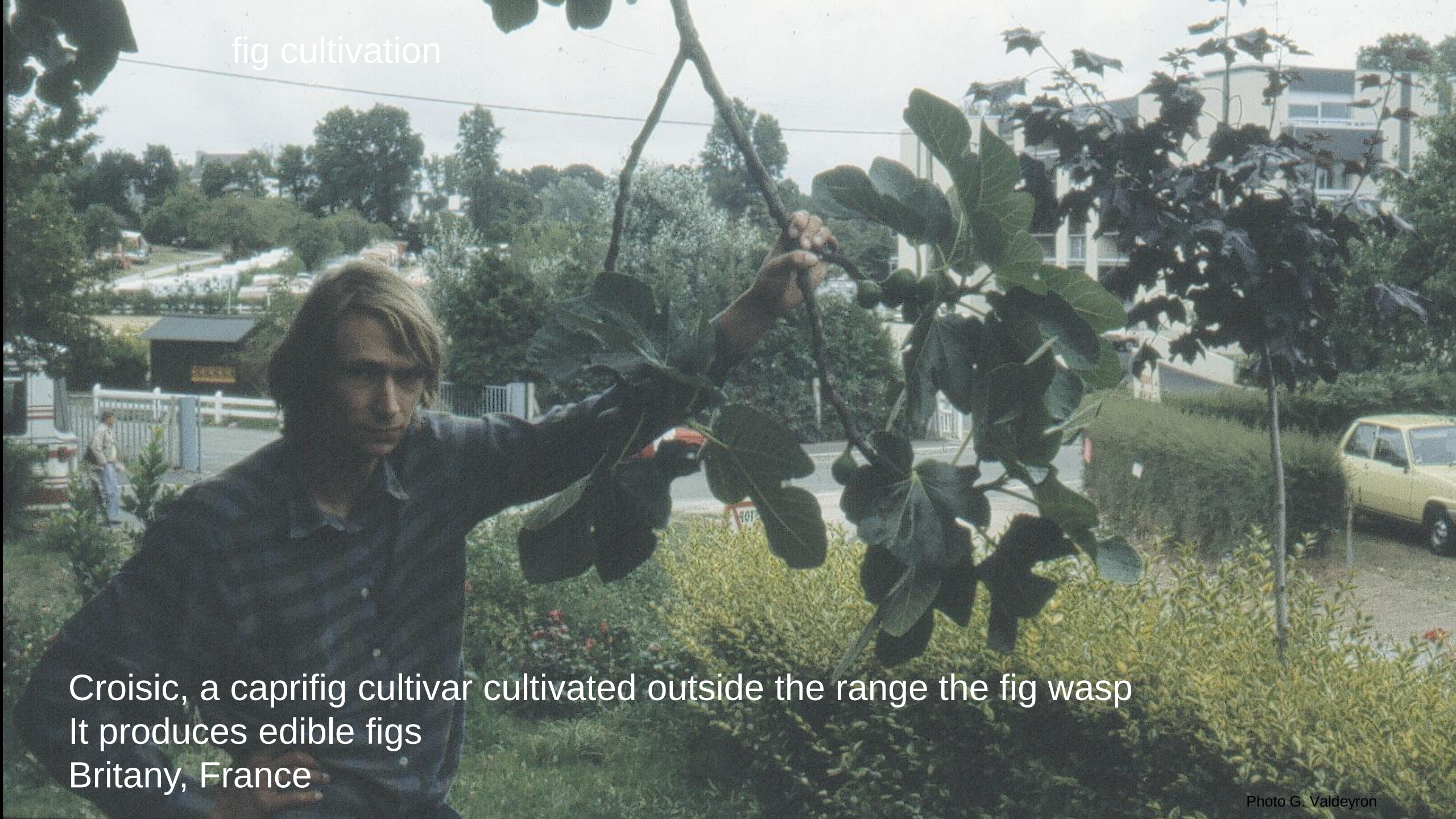
Receptive female fig, first crop
First crop figs are larger and have a thicker wall, the flowers are less densely packed and the styles are shorter than in second crop figs
The overwintering first crop fig bud presented differentiated flower primordia
Morphological differences with second crop figs are induced during winter

fig cultivation

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


buds that will give ripe first crop figs next August
at the northern limit:
second crop figs that will never ripen
March, Normandy, France

fig cultivation



Croisic, a caprifig cultivar cultivated outside the range the fig wasp
It produces edible figs
Britany, France

Photo G. Valdeyron

Other-fig cultivation

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