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## The pollination of the fig tree (*Ficus carica* L.) and its control in horticulture

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### ABSTRACT

The fig grows spontaneously all around the Mediterranean Basin but it is also widely cultivated in the southern regions of its distribution. A normal pollination requires special care by the farmers. They often "caprify" the trees: spring figs from caprifig trees or *profichi*, when ripe, are hung on the branches of the domestic fig trees when their figs are receptive. The *profichi* then liberate the pollinating hymenopterans (blastophagas), which are dusted with pollen from inside.

It is difficult to understand why an artificial control of the pollination, while seriously practiced in most of the regions of culture, is ignored or viewed as a superstition when the figs are only gathered in natural stands.

Travelling in several countries where both situations are met leads to the following hypothesis: planting and growing large numbers of domestic fig trees upset the natural equilibrium between the two sexual forms (caprifig trees and domestic fig trees are found approximately in a 1:1 ratio in the wild) and deplete the populations of wasps to a level below the minimum necessary for a correct spontaneous pollination.

The efficiency of the wasp as a pollinator seems to be the same in all the visited regions. This is an argument against the hypothesis that artificial control is required under special ecological conditions.

KEY-WORDS: *Ficus* - *Blastophaga* - *Pollination* - *Coevolution* -  
*Symbiosis* - *Reproduction*.

### RÉSUMÉ

Le figuier est spontané dans tout le bassin méditerranéen mais il est aussi largement cultivé, surtout dans les régions méridionales de cette aire. Une pollinisation normale demande alors l'intervention de l'agriculteur. Souvent, celui-ci « caprifie » les arbres : des figues de printemps de caprifiguiers, ou *profichi* sont pendues, à maturité (c'est-à-dire quand elles sont prêtes à libérer les hyménoptères pollinisateurs ou blastophages, chargés de pollen), dans les branches des figuiers domestiques, dont les figues sont alors réceptives.

Il est difficile de comprendre pourquoi ce contrôle artificiel de la pollinisation, pris très au sérieux dans la plupart des régions de culture, n'est pas connu lorsque les figues sont seulement ramassées sur les arbres spontanés — à moins qu'il ne soit alors considéré comme une simple superstition.

La visite de différents pays où les deux situations coexistent conduit à l'hypothèse suivante. Dans les populations spontanées, on trouve à peu près autant de caprifiguiers que de figuiers domestiques; au-delà d'un certain nombre de figuiers domestiques cultivés dans la région, l'équilibre numérique entre les deux formes sexuelles est modifié et la production de blastophages ne suffit plus aux besoins d'une pollinisation correcte.

L'efficacité du blastophage en tant que pollinisateur semble être la même dans toutes les régions visitées. C'est là un argument à l'encontre de l'hypothèse selon laquelle la nécessité du contrôle artificiel est liée à des circonstances écologiques particulières.

MOTS-CLÉS : *Ficus* - *Blastophage* - *Pollinisation* - *Coévolution* -  
*Symbiose* - *Reproduction*.

Pollination in the genus *Ficus* is effected by symbiotic wasps of the family Agaonidae, Hymenoptera. The symbiosis is one of the most fascinating systems which have been interpreted as examples of coevolution (GALIL, 1977; JANZEN, 1979; RAMIREZ, 1970; WIEBES, 1979). Up to the sixties, the case of *F. carica* L was probably the best documented one: agronomists (RIXFORD, 1918) as well as botanists (LECLERC DU SABLON, 1908, 1910) and zoologists (GRANDI, 1920), to cite only some important examples, have published a vast amount of literature concerning the culture and the biology of the fig tree, in which they reviewed previous work.

### CONTROLLING THE POLLINATION (1947)

For this species, however, Condit's book "The Fig" (1947) is known as the most reliable monography. On p. 46, one reads: "Smyrna type figs, which require caprification, are grown in the Smyrna district, in Greece, Algeria, Portugal, in parts of Spain and in California."

By caprification, the author means the practice of hanging spring figs of caprifig trees, or *profichi*, on the branches of the domestic fig tree<sup>(1)</sup>.

The caprification is performed when the year figs (the main crop) of the domestic fig tree are receptive, *i. e.* apt to be pollinated and when the spring figs (*profichi*) of the caprifig tree are ready to let the pollinating wasps escape, dusted with pollen. This takes place in June in North Africa and the Middle East and at the beginning of July in South France.

The fig tree known in horticulture as of the Smyrna type cannot ripen figs except if pollinated (There are two other "types" of domestic fig trees, in which parthenocarp is possible: ripening may occur without a fertilization of the flowers and, consequently, without a development of viable embryos in the seeds. This is the case of the *brebas* only for the "San Pedro type" and of both crops of the "common type"). It is generally admitted that only the pollinated figs can be dried. This explains why only Smyrna type varieties have been used, up to now, in regions where the fig tree is (or has been) an important crop, yielding an easily preserved product, that is used as part of the carbohydrate diet of the inhabitants as well as exported.

Such varieties are, indeed, grown and caprifigged in the countries named by Condit and, generally, in all the countries of the Southern part of the Mediterranean basin. Nevertheless, it seems that this author has neglected the fact that the common fig is a spontaneous species. It grows in the wild in most of the mediterranean regions

(1) The fig species *Ficus carica* L has two sexual forms. Linné thought these were two different taxa and named them *F. c. caprificus* and *F. c. domesticus*. The first one, the caprifig or male tree, has figs with short styled female flowers, in which the pollinating wasp, *Blastophaga psenes* L is able to lay its eggs. The other form, the domestic or female fig tree, has flowers with long styles. This protects it against parasitism. Ordinarily, only this female form produces edible figs.

In the axil of the leaves, both forms bear year figs resulting from the development of undelayed buds. In the caprifig tree, these are called *mamme*; they are few, just assuring the completion of the wasp's cycle in winter and, possibly, in autumn. The undelayed figs of the domestic fig tree constitute the so-called *second crop*, in fact the main one. Neither year figs produce pollen.

In the axils of the scars left by the leaves of the preceeding season, that is, below the current year shoot, grow the spring figs, developing from delayed buds of the distal part of the preceeding year shoot. They are called *profichi* in the caprifig tree and *brebas* in the domestic fig tree. The *profichi* produce pollen but the *brebas* do not. *Brebas* are only produced by exceptional genotypes: generally, they are very few and fall before they are receptive (VALDEYRON & LLOYD, 1979).

of the Old World—and has been doing so for many millions of years. A vast majority of the trees, in these spontaneous populations, are of the “Smyrna type”. The parthenocarpy might play a certain part in maintaining a fauna of disseminating birds or bats; it is nevertheless a sublethal feature, which must be strongly counter selected. One may think that its relatively high frequency is mainly due to its horticultural value; a part of the crop can be naturally pollinated, so that fertile seeds of parthenocarpic trees grown in orchards are disseminated in the wild (VALDEYRON, 1967).

#### FIG GATHERING VERSUS FIG GROWING

The common fig is practically not a cultivated plant in many regions of its area. This is the case of southern France.

In ancient times, there was a cultivation of parthenocarpic varieties in the region of Argenteuil, near Paris. Nowadays, there is, to our knowledge, only one place in France where the common fig is grown on a large scale: this is the region of Solliès-Pont, on the mediterranean coast, near Toulon. It replaced the cherry tree after World War II, because the cost of cherry picking became too high. The production is of around some hundreds tons of figs a year, which are sold as fresh fruits.

Yet in southern France, the figs are frequently gathered. Up to the middle of the present century, the figs, dried at home, probably represented as much as 5 to 10 % of the energetic diet of the peasants of the Languedoc region. A part of that crop was produced on isolated trees in family orchards but most of it was gathered on spontaneous seedlings, growing alone in the country, on roadsides, in ruins, etc. One out of two such seedlings is a caprifig tree (VALDEYRON & LLOYD, 1979). Once such a tree has been known not to produce edible figs, it is ordinarily simply neglected, rarely eradicated or grafted with a domestic variety. As a whole, the natural 1 : 1 ratio between the two sexual forms is not seriously upset by the users. These have, of course, no knowledge of the pollination process. If told about caprification, they are inclined to think that it is a superstitious practice.

However, in all regions visited by us where the common fig is or has been a major crop, for dried fig production (Algeria, Tunisia, Syria, Cyprus, Israel and Greece), any farmer, even if quite uneducated, knows that a good crop cannot be obtained without man making efforts to improve the pollination (the same as for other dioecious fruit trees, pistachio nut and date palm).

In the case of figs, caprification is not the only method to achieve this improvement. Pollination may also be enhanced by scattering caprifig trees in the orchard or planting them in a solid block, in such a way that the dominant wind brings the pollinating wasps in the rest of the plantation (as in the Idlib region, in Syria). Even then, in fact, profichi are frequently gathered and distributed onto the branches of the domestic fig trees; sometimes they are just put on the soil, under the trees. In other places (the Kalamata region, in the South Peloponese, in Greece) caprification *sensu stricto* is viewed as necessary if one wants to prevent a loss of as much as 70 %. Several tens of profichi are brought to each tree of average size twice a week, during all the receptivity period, *i. e.* up to the time when all the young syconia have lost their bright green color, to become dull green—this change being characteristic of the end of receptivity.

An average sized caprifig tree can produce some ten thousand profichi. Since several hundreds of profichi are needed for each domestic fig tree, it is not surprising to learn that the growers deem that one caprifig tree is necessary for the pollination of

twenty domestic fig trees—as an average. It is noteworthy that such a proportion, at least in this order of magnitude, is given by the farmers of most of the regions where fig pollination is controlled—no matter what the mode of control is. This is rather far from the 1 : 1 ration found in spontaneous populations.

The difference of attitude concerning the pollination control of the fig consumers whether they grow the trees or just gather the figs is particularly striking when they live in neighbouring regions. In the mountains near Lattakieh, on Syria's coast, the common fig is grown and regularly caprifigged. Any peasant one may meet along the road knows that figs must be pollinated. He has the word "tin" to describe the species but uses it specifically for the domestic fig tree and uses another one, "toub", for the caprifig tree<sup>(1)</sup>. He knows that the production of profichi on the spontaneous trees of the region is not abundant enough to face the needs and he reports that farmers frequently complete it by importing profichi from the coastal region. But, in this last region (of about twenty kilometers wide) the common fig is not cultivated, with the exception of some trees in home orchards. Here, farmers are *absolutely ignorant* about caprifigation and do not know what the word "toub" means. After long explanations about what a caprifig looks like, they understand that it may be a tree they know that has no value; they generally ignore it except when found as a volunteer tree in an orchard, in which case they recommend grafting it with a domestic fig tree.

We have found the same situation in other places in Syria, where the fig trees grow abundantly in the wild but are scarcely cultivated as important plantings and in Upper Galilea, where fig trees used to be rather more intensively planted but where the density of spontaneous stands is very high. We have been told that the same situation is found in Lebanon.

#### WHY A POLLINATION CONTROL?

Condit's description and our own informations about North Africa, Spain and Portugal had led us to think that caprifigation, as it was practiced in a zone roughly limited at the north by the 40th parallel, was related to the dryness of the air; this condition would prevent the wasp from covering the sufficient distance so that every domestic fig tree would be regularly pollinated. The sensitivity of the female insect to humidity has been demonstrated by GALIL & NEEMAN (1977). One could have thought that the arid climate of the southern part of the Mediterranean Basin did not permit the wasp to live more than the time needed to cover only some meters. Some exceptions were known: at Hammamet, in Tunisia, farmers say that caprifigation is not necessary if caprifig trees stand not too far from the plantation. The well known mildness of the climate of that region gave some weight to the above "ecological" hypothesis. It would have limited the area where the common fig is really spontaneous to the northern part of the Mediterranean coast; only there would the pollinator have been able to play its role of obligatory symbiont without the intervention of man. The latter would then have been responsible for the wasp introduction and its maintenance in the southern part of the area. This rather appealing hypothesis hardly

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<sup>(1)</sup> In the Damas region, we have heard the caprifig tree called "tin dokkar". The word "dokkar" is used in arabic for the male of any species. However, one can note that in the arabic dialect of North Africa, the fig syconium is described by the word "kermous", while "kerma" means "domestic fig tree". The latter cannot be confused with the caprifig tree, simply called "dokkar": the context must indicate the species one is speaking about.

holds in view of the fact that both situations may be met in the immediate vicinity one of the other—only some kilometers—as in the coastal part of Syria. We found fig plantings where caprification is ignored (and where the syconia are nevertheless pollinated, as verified on seeds of dried products) in regions such as the one around Homs, certainly at least as arid as the Alep and Idlib regions, where the control is viewed as obligatory.

It is likely that the “ecological” hypothesis must be substituted by an “agronomic” one: it is cultivation itself, by its extension and its raising the density of domestic fig trees, which would be responsible for the pollination deficiency. The numerical ratio of caprification trees: domestic fig trees, as stated above, is about 1 : 1. Planting caprification trees (when importing profichi is not feasible) would become necessary when the ratio falls below a certain value following the extension of the domestic fig trees plantation in the region. As each caprification tree takes the place of a domestic fig tree, the farmers use the minimum necessary number of caprification trees, about one for twenty domestic fig trees. With such a low proportion of caprification trees, a new problem arises: most wasps emerging from the profichi are attracted by the closest domestic fig trees so that, without the intervention of man, some trees are overvisited by the wasps and others are so very poorly. To avoid this, the farmer performs the caprification, *i. e.* he homogenizes the repartition of the wasps by picking the profichi just before the wasps emerge and distributing them evenly among the domestic fig trees. What is important here is not the potential flight distance of the wasp (probably hundreds meters or more) but the effective one (sometimes only less than one meter). A confusion between these two distances often appears in the literature. In the rare plantings of commercial size in France, some pollination deficiencies have been noted, while the second crop syconia of the spontaneous stands are always stuffed with numerous fertile seeds.

Due to the diversity in the density and structure of the stands—whether spontaneous or cultivated—, it is not possible to give an average estimate of the size of what would be a “region”, in which the necessity of control and its mode might be fixed. As a guess, it seems to us that it would rather have a diameter of some tens of kilometers, as in a group of villages, where cultivation practices as well as natural conditions are about the same, than have the extent of a whole geographic area.

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