An Ancient Technique for Ripening Sycomore Fruit in East-Mediterranean Countries

J. GALIL[1]

Introduction

Sycomore trees (*Ficus sycomorus* L.) are widespread in the Near East, in Egypt, Israel, Lebanon and Cyprus. They grow chiefly in plains and along rivers, where the soil remains humid even during the hot and dry summer. They are tall trees with a broad crown and spreading branches, standing out conspicuously from other plants.

Sycomores originate from the savannas of eastern Central Africa and from Yemen, where they grow spontaneously and reproduce by seeds. The flowers are pollinated regularly by the small chalcidoid wasp *Ceratosolen arabicus* Mayr.

It is not known how the sycomore was introduced into the Near East. Perhaps seeds or branches were swept with the Nile flood, or man may have brought it along from the south (20). In any case, remains of the sycomore tree (wood, roots and fruit), discovered in Egypt, date as far back as the predynastic period; i.e., more than 3000 years B. C. (17).

The original pollinators of the sycomore did not reach the Mediterranean countries, and, consequently, seeds were not formed there, nor in Egypt nor Israel. Theophrastus (372-287 B.C.) stated that the sycomore did not produce seeds in Egypt. Dry sycomore fruit found in the grave of Ani of the XXth dynasty (about 1100 B.C.) contained neither seeds nor *Ceratosolen* wasps (7). Thus, sycomore trees growing in the Near East are outside the spontaneous area of the plant and depend on man for their propagation. They are easily increased through cuttings and stakes.

Apart from its importance as a good shade tree, the sycomore also provides timber and fruit. In desert-dry Egypt, which was always very short on trees, the wood of the sycomore was highly valued. The ancient Egyptians used it to make a wide assortment of household utensils and factory implements, houses, all kinds of boxes and especially coffins (23). Figuratively speaking and from the standpoint of construction timber, the ancient Egyptian civilization may be said to have been firmly based on the sycomore tree (17). Although the taste of sycomore fruit is not superlative, in Egypt it has been held in high esteem since earliest times.

The Egyptians of old expressed their affection and appreciation for the sycomore in many ways. It was held sacred to various deities, especially to Hathor, the goddess of love. Representations of the tree and its fruit are to be found on bas-reliefs and ancient papyri, and songs have been written in its praise. Of special interest to the botanist are the fruit and leafy branches placed as funeral offerings in the tombs of kings and noblemen; owing to dryness of the air, these specimens have been very well preserved and can be studied now just as readily as any recent plant (7, 15).

It is not known when the sycomore was brought to Israel from Egypt, but it is quite evident that this must have taken place very early in history, as the tree was well known in Biblical times. In Israel, the sycomore grows chiefly in the coastal plain and in the Jordan Valley. Both the tree and its fruit were appreciated by the inhabitants, but not so highly as in Egypt. The fruit could not compete with the common figs, pomegranates and grapes. In ancient Israel, sycomore was eaten mostly by the poor who could not afford the more expensive fruits.

The wood of the sycomore was held in relatively higher esteem than its fruit. It was used extensively in building and wherever long and stout beams were needed. Accordingly, in Talmudic literature, mainly in

[1] Department of Botany, Tel-Aviv University, Tel-Aviv, Israel.
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the Mishna and the Tosephta, we find many rules governing use of the tree and its products. (4).

The extensive literature on the sycomore accumulated from the time of Theophrastus to the present makes repeated reference to a unique treatment of the sycomore fruit, as practiced in Egypt and in Cyprus. Theophrastus states (21, vol. 1, book IV, p. 291): "It cannot ripen unless it is scraped, but they scrape it with iron claws; the fruit thus scraped ripens in four days." Keimer (14) quotes an Egyptian farmer on the same subject: "Before I begin the work of cutting the sycomore figs, first of all I sharpen two similar knives. Then I climb the tree. As there are innumerable fruit on the tree, I must work quickly. I take therefore a knife in each hand, that is when the form of the branch offers a sufficient hold. . . ." In the same work, Keimer depicts the special knife used by the Egyptians for making these circular cuts (Fig. 1). Brief references to such treatment are found also in the writings of several other authors (1, 11, 12). The

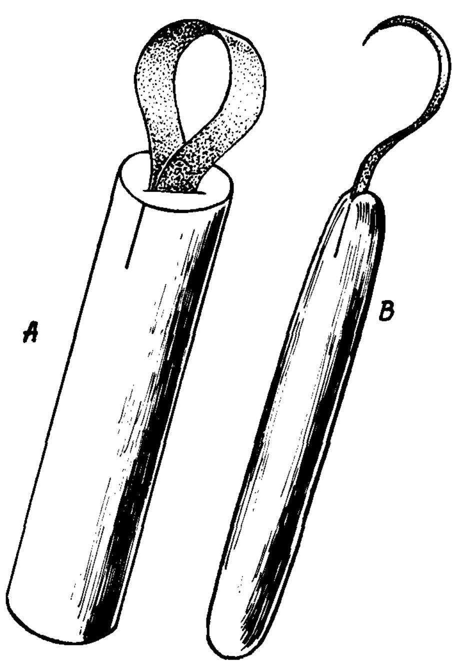

Fig. 1. Knives used for gashing of sycomore figs in Egypt (according to Henslow (A, B) and Keimer (A).

circular cuts have often been observed on dry sycomore fruit from ancient tombs or that depicted in old paintings and bas-reliefs (Fig. 2). Even contemporary Egyptian farmers employ the same technique, and on sycomore fruit sold in the suburbs of Cairo, dark, gaping circular cuts are prominent (Fig. 3). The physiology of fruit ripening has been extensively studied during the last decade (2). As a result, the role of ethylene gas in fruit ripening (3) and the effect of phytohormones on the production of ethylene (10, 19) have both been proved. It is now well known that in many cases wounding of the fruit has a marked effect on its rate of respiration and ethylene production, and consequently on its ripening (18). All these data are indispensable for understanding the gashing technique.

Descriptions of the cuts in sycomore fruit are widespread in botanical and Egyptological literature, but they are not backed up by sufficient knowledge of the biology of these figs and the physiology of fruit ripening. For this reason, the connection between the treatment described above and the small wasps inhabiting the figs has never been properly understood. The present paper contributes new and more complete information on this subject, in the light of recent advances in botany and zoology.

Materials and Methods

The developmental cycles of the sycomore figs and of the wasps inhabiting them were studied at the Botanical Garden of Tel-Aviv University. Observations on the gashing technique were made in Limassol, Cyprus. Sycomores growing in the suburbs of Limassol belong to a variety which necessitates gashing the figs for ripening, and the local Turkish peasants treat the fruit as do the Egyptians. The physiological experiments were conducted at the Botanical Garden of Tel-Aviv University. The figs were enclosed in cellophane bags while on the tree, and various substances—including solutions of phytohormones, ethylene gas and various plant parts—were tested for their effect on fruit ripening.

Observations

Inflorescence and fruit. The structure of the floral organs of the sycomore will be

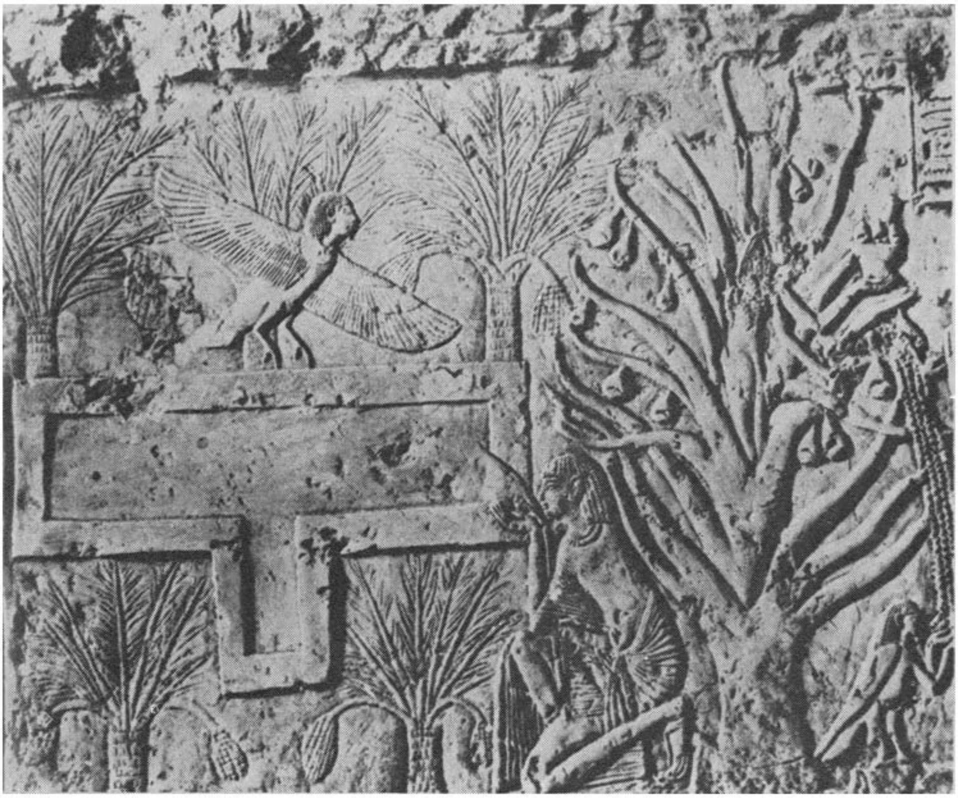

Fig. 2. Bas-relief showing a sycomore tree with gashed fruit. Found at Thebes, Egypt. According to Laurent-Täckholm, 1964 (courtesy of Natur och Kultur, Stockholm).

described briefly, as far as necessary for an understanding of the main aspects of the gashing technique. For further detail, the reader is referred to the paper of Galil and Eisikowitch (8).

In Israel, flowering and fruiting of the sycomore occur during the hot summer months. Up to six crops may be produced in one year by a single tree. The figs are found occasionally on trees even during winter

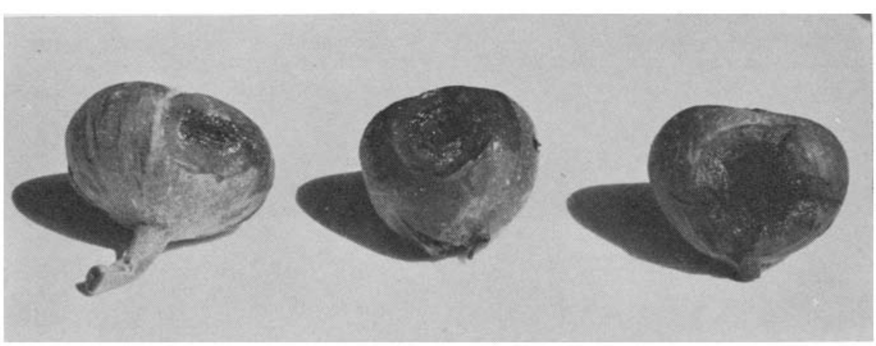

Fig. 3. Gashed sycomore fruit from Egypt. Collection of Schweinfurth. Museum of Natural Sciences, Dahlem, Berlin (courtesy of the management of the Museum).

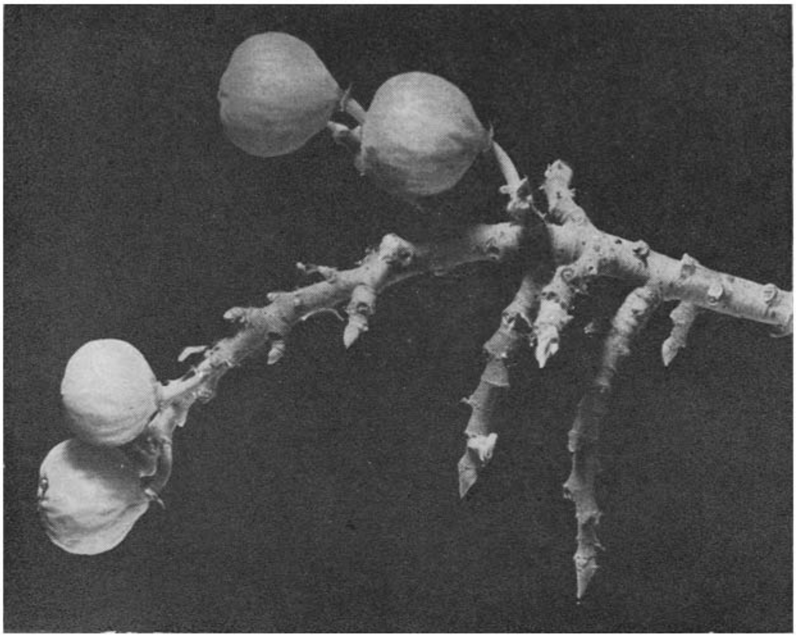

Fig. 4. Sycomore panicle bearing vegetative-parthenocarpic fruit (B′).

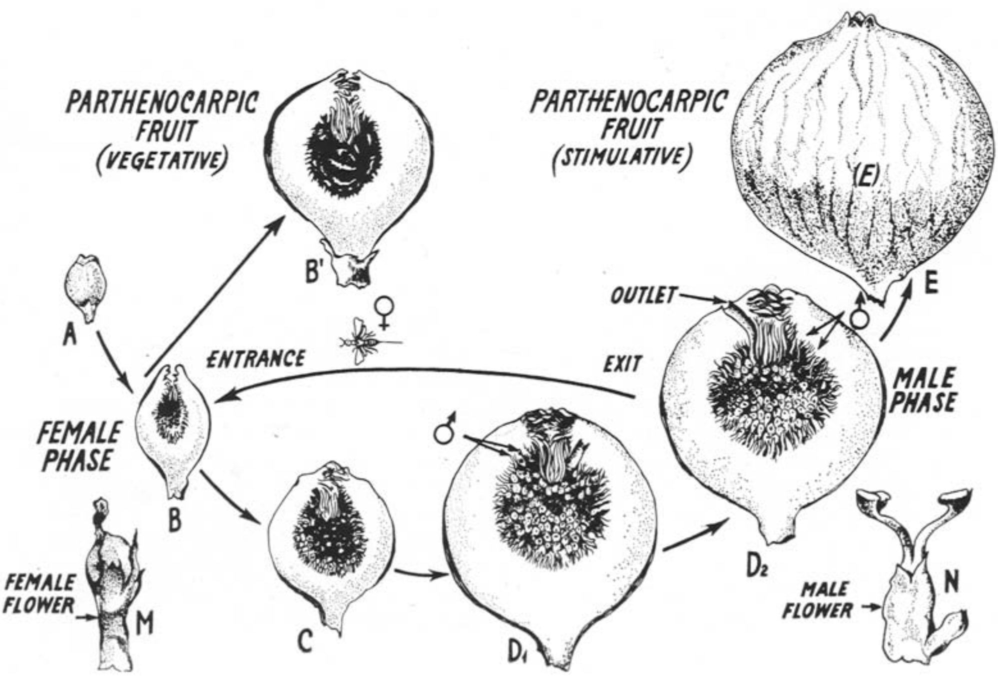

Fig. 5. Developmental cycle of sycomore fig in Israel.

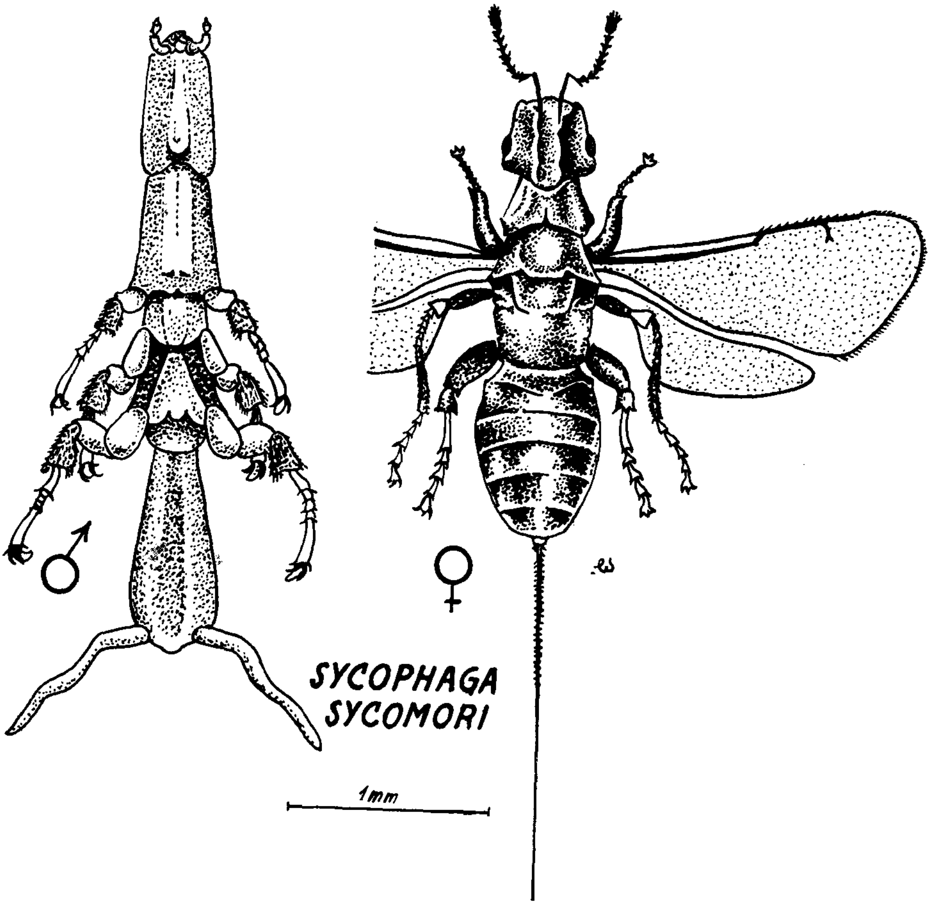

Fig. 6. Sycomore wasp, *Sycophaga sycomori*.

months, but their number is usually small, and development very slow. The figs develop in special panicles on the trunk and main branches (Fig. 4).

As in all *Ficus* species, the inflorescence of the sycomore—i.e., the fig or syconium—is a hollow receptacle bearing the flowers on its inner surface and closed from the outside by several scales (Fig. 5). The sycomore is monoecious, each fig containing both female and male flowers. The former are numerous and cover most of the inner surface, while the latter number 20 to 30 and are situated at the upper part of the fig, close to the entrance scales. The female flowers consist of a few perianth scales and a central pistil; the male flowers, of two stamens within the perianth (Fig. 5). As usual in *Ficus,* the inflorescence is protogynic, the stamens maturing several weeks after the female flowers.

The sycomore wasps. Of the eight sycophilous wasp species inhabiting the fruit of the sycomore in its native country, only two have reached the Near East (8). The more important of the two is the sycomore wasp *Sycophaga sycomori* L. (Chalcidoidea, Agaonidae). Like other fig wasps, *Sycophaga* shows a distinctly pronounced sexual dimorphism (Fig. 6). The female is an agile, winged insect, 1.5—1.8mm in length. Its ovipositor is comparatively long—up to 2mm. The male is a wingless, crawling insect, characterized by two very long filaments at its widened posterior tip (9). The females of *Sycophaga sycomori* enter the young figs and oviposit there. The new generation develops within the ovaries of the female flowers. The grown males mostly do not leave their figs.

The life cycle. The developmental phases of the figs are as follows (Fig. 5):

Phase A (Pre-female). The fig appears as a small bud in the axil of a scale on the panicle. At first it is enveloped in several basal bracts. The entrance scales are adpressed.

Phase B (Female). The fig overgrows the basal bracts, and, when it reaches about 10-12mm in diameter, the female flowers mature. The receptacle is still green and hard. The entrance scales loosen slightly to admit a few female sycomore wasps that have emerged from the older figs (at Phase D). These wasps oviposit into the ovaries of the female flowers through the stigmata and the styles. They are not the effective pollinators of the sycomore and do not cause any seed setting. Due to their excessively long ovipositor, these wasps may occupy most of the ovaries of the fig; however, even when many ovaries remain unoccupied, no seeds are formed. In the occupied ovaries, a new generation of wasps starts developing, while the unoccupied ones shrivel. Once oviposition is over, the female wasps die inside the syconium. The entrance scales become closely appressed again.

Phase C (Interfloral). Wasp larvae develop from the eggs laid in Phase B. The larvae are concealed within the ovaries and feed on ovular tissues. Somewhat later, a fluid appears within the figs, and the ovaries, which by this time have become galls, grow in size and bulge into the cavity. This phase lasts several weeks and is the longest in the developmental cycle. Meanwhile, the fig grows slowly but remains green and hard (Fig. 5).

Phase D (Male). The male flowers mature, but the filaments remain short and the closed anthers are still within the perianth scales. The wasps reach maturity. As usual for fig-wasps, the males eclode first and fertilize the females while these are still within their galls. At this phase, the fig is filled with many small wasps. Contrary to what occurs in the common fig, in the sycomore the entrance scales do not loosen at phase D, and the male wasps cut a hole in the wall of the fig by means of their strong jaws (8). Such holes serve as an outlet for the female wasps.

Phase E (Post-floral). After the female wasps leave, the figs ripen quickly (Fig. 5). They increase in size (to 30-40 mm. in diameter), and become soft, rose-colored and sweet. As a general rule, the stamen filaments elongate at this phase only, and the ripe anthers protrude into the fig cavity.

It must be emphasized that the ripe fruit (of Phase E) is parthenocarpic: no embryos develop within it, and, consequently, it contains no seeds. In this instance, the oviposition within the ovaries prevents fig drop at Phase B, thus ensuring normal development to maturity both of figs and wasps. The wasp replaces the fig embryo also physiologically, and male flowers attain maturity just as if normal seeds were developing. Condit (5) names such fruit "stimulative parthenocarpic." The developmental phases are identical with those of figs in East Africa, where pollination takes place and viable seeds develop (see Fig. 7).

In local varieties growing in the coastal plain of Israel, only a small percentage of the figs completes an entire developmental cycle as described above. Most figs swell quickly at Phase B, either before or immediately after penetration of the female wasps. Within a few days soft, rose-colored, sweet and edible fruit are formed (Figs. 5, 7, 8).

In such instances, even if some oviposition does take place, the eggs hardly develop, and it is very difficult to detect them within the ovaries. As for the few female wasps which may gain entry into the figs at Phase B and subsequently die there, these do not spoil the fruit. The fruit, in fact, starts its development without any visible cause and is truly parthenocarpic or, to borrow Condit's (5) terminology for such fruit, "vegetative parthenocarpic."

Thus, in the Israeli sycomore varieties, development of the fruit may follow one of two courses (Fig. 5, 7, 8):

1. *The normal lengthy course*: The figs are inhabited by wasps, and both complete their developmental cycles. The figs reach Phase E. The male flowers reach maturity. As a result, a stimulative parthenocarpic fruit is formed, which is relatively large and highly

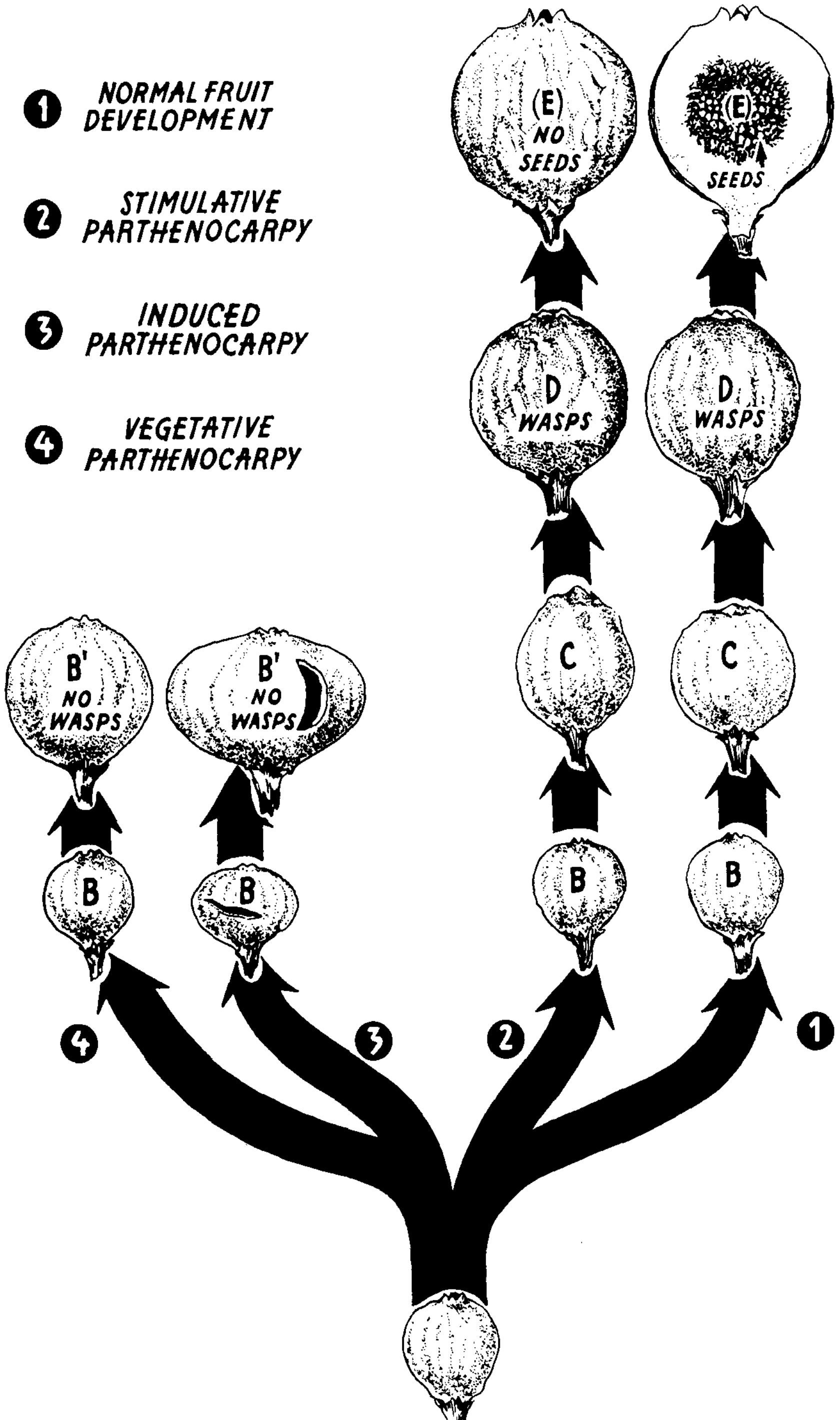

Fig. 7. Types of fruit developed in sycomore figs (1,2—lengthy cycles; 3,4—short cycles). A, B, C, D, E—developmental phases.

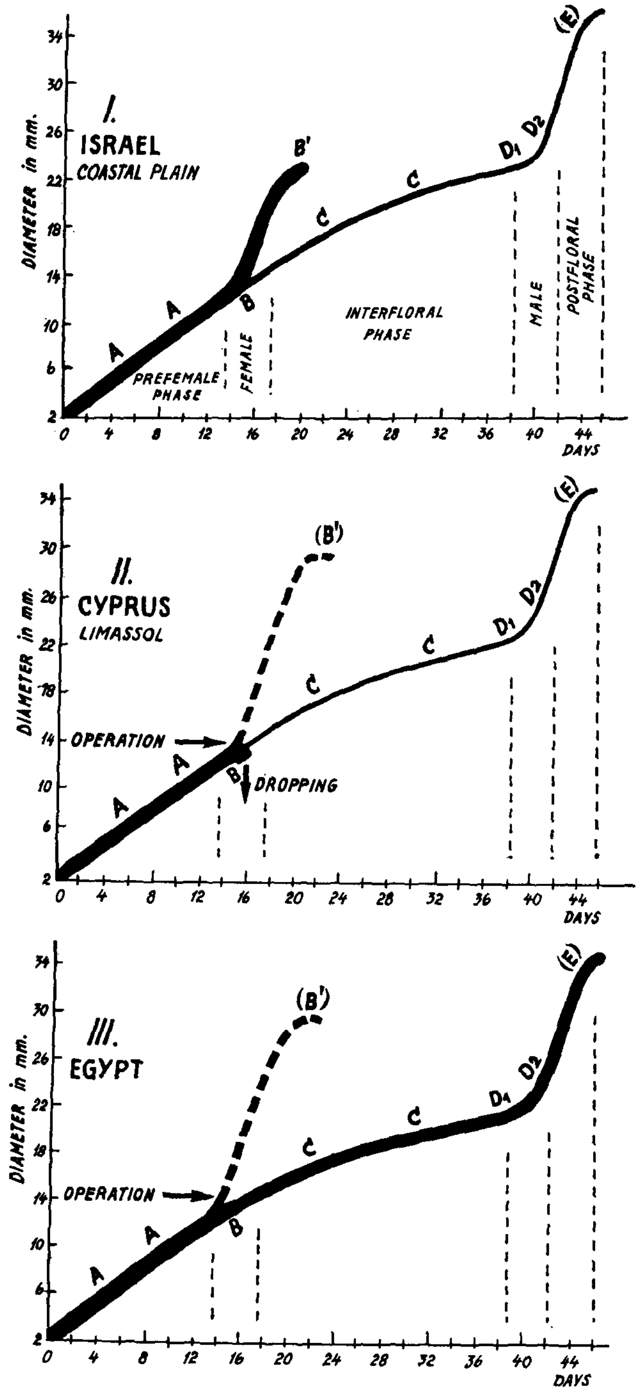

Fig. 8. Growth curves of the various types of sycomore fruit in Israel (coastal plain); Cyprus (Limassol); and Egypt (based on various authors). Thickness of curve shows relative quantity of figs.

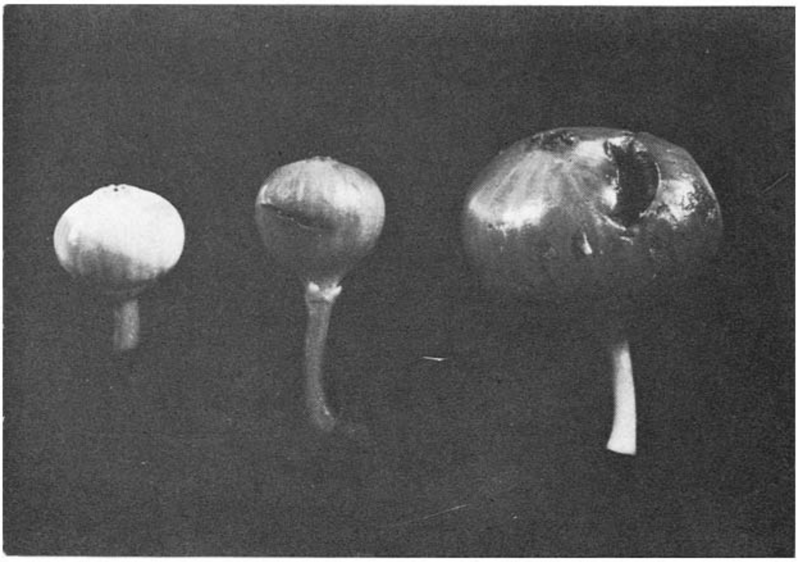

Fig. 9. Effect of gashing on ripening of sycomore figs. 1—Phase B fig, before gashing; 2—immediately after gashing; 3—ripe induced-parthenocarpic fruit, after four days.

colored, but upon ripening, it contains many wasps and is not edible.

2. *The short course*: The figs swell rapidly at Phase B. Male flowers are still at a very early stage—small buds enclosed within perianth scales. The vegetative-parthenocarpic fruit eventually produced is smaller than in the lengthy course, but quite edible and much more tasty. Until recently, this fruit was collected in large quantities on the coastal plain of Israel and even marketed or dried for later use.

Gashing of figs in Cyprus. Since sycomore varieties growing in Israel are fully parthenocarpic and produce edible fruit without the help of man, the technique of fig-gashing is not practiced. The variety growing in the vicinity of Limassol, Cyprus, however, is quite different in that it may produce stimulative parthenocarpic but not vegetative parthenocarpic fruit. Figs at phase B which have not been occupied by sycomore wasps always drop to the soil (Fig. 8) under the tree and may then be found as small, shrunken balls. In Limassol, however, as in Egypt, the peasants know a way to induce ripening of figs without the help of wasps—namely, by the gashing technique.

The trees in Limassol are not large, and the lower, spreading branches are within reach of hand. For the higher branches, a ladder is used. The gashing consists of cutting the hard, green figs with an ordinary kitchen knife. No specific area need be gashed, but rather the cut is made at random, wherever the hand reaches the fruit. In figs so treated the female flowers are ripe, whereas the male flowers are still in bud form. The figs are at Phase B, i.e., the stage at which the Israeli figs start swelling and forming a vegetative parthenocarpic fruit. Figs of the Limassol variety, however, cannot ripen at this stage without human help.

Gashing induces very speedy growth, and in three to four days the figs increase about seven times in weight and volume. The cut—a mere slit at the beginning—later becomes a gaping gash (Figs. 9, 10). It is interesting to note that no sycomore wasps were encountered in the course of these observations, neither inside nor outside the figs.

In fact, these Limassol figs are very similar to the vegetative-parthenocarpic variety in that both follow the short developmental course and are essentially quick-swollen female inflorescences (Fig. 7). Since, however, the Limassol figs do not ripen by themselves

Fig. 10. Ripe induced-parthenocarpic fruit on the tree in Limassol (Cyprus).

but require external inducement, they should be considered as induced or artificial rather than vegetative-parthenocarpic (Fig. 7).

Gashing of figs in Egypt. Information on Egyptian fig varieties is not detailed enough, yet a fairly clear picture can be obtained, chiefly from the studies of Brown and Walsingham (1). It seems evident that the main features of these figs are essentially the same as those of the Israeli and Limassol varieties (Fig. 8).

In the Egyptian plants, there is no vegetative parthenocarpy. On the other hand, invasion by sycomore wasps is much greater than in the coastal plants of Israel. The untreated inhabited figs follow the long developmental course and become ripe but inedible fruit, full of insects. According to Henslow (12), there are three main crops of figs, but the farmers gash the fruit of the first two only (in August-September); when the third crop develops, they are too busy to give it attention. The untreated figs develop by the long route and become large but inedible fruit, full of wasps, which are abandoned to birds and dogs. In summer, the developmental phases are of the same duration as in Israel (1), namely, about 15 days from early bud to penetration and oviposition by female wasps (Phase B), and four weeks from oviposition to eclosion of the new generation (Phase D). Gashing of the figs is undertaken on the 15th to 20th day, i.e., at an age when Israeli figs are in Phase B. The gashed figs follow the short developmental course and give rise to induced parthenocarpic fruit, as in Limassol (Fig. 7).

The structure of the ripe induced-parthenocarpic fruit is quite similar to that of the vegetative-parthenocarpic fruit in Israel, both representing female influorescences which have swollen in a few days. In both, the male flowers are mere buds rather than degenerated organs, as maintained by Brown and Walsingham (1). Evidently the cut is of a different shape than that made on the fruit in Limassol, in view of the special round knife used in Egypt.

Fig-gashing in ancient Israel. An interesting sidelight on the topic of fig-gashing is the riddle of prophet Amos's occupation. The Bible (Amos 7, 14) quotes him as saying: "I was no prophet, neither was I a prophet's son; but I was a herdsman and a gatherer of sycomore fruit." There is some controversy concerning the translation. In the Hebrew version of the Bible, the occupation of Amos is given as "Boless Shikmim." "Shikma" is sycomore, but "Boless" appears only once in the Bible and its meaning is obscure. In the Septuaginta, the well known translation of the Bible into Greek (made in Alexandria about 200 B. C.), "Boless Shikmim" is translated as "Knizon Sycamina" (χνίζων συχαμινα), namely a "piercer of sycomore figs," and not "gatherer." Keimer (13), who examined the pertinent data on this subject, concluded that "grower" or "gatherer" does not indicate a specific action of the sycomore grower. He considers "Boless Shikmim" to be some special activity in connection with the sycomore, possibly the gashing technique long practiced in the Near East. Loew (16) is of the same opinion.

There is certain difficulty in accepting this view, since the contemporary Israeli plants produce edible fruit without gashing and the practice is not known in Israel now. In spite of that, the translation of "Boless" as "piercer" seems logical, in view of the fact that Israeli sycomores are descended from the Egyptian and in ancient times were undoubtedly of the same varieties as in Egypt.

It seems reasonable to assume, therefore, that new varieties of sycomore should have evolved in Israel, apparently by continuous selection under Mediterranean climatic conditions. Conceivably, in the days of Amos (8th Century B.C.), the old varieties may have still existed, to be replaced later on by new ones with vegetative parthenocarpic fruit. Thus, argument around this purely Biblical subject does perhaps throw some light on the evolution of sycomore varieties in the Near East.

On the Purport of the Gashing Technique

What effect does gashing have on development of the sycomore fig in Cyprus and Egypt, and exactly how does this treatment cause ripening? There is little information on the subject in the botanical literature. Since in Egypt the ripe fruit is generally full of insects and not edible unless it had been gashed in due time, it was only natural for most authors to assume that the main reason for gashing was to rid the figs of wasps. Henslow (12) and others believed that this was accomplished by escape of the insects through the cuts. On the other hand, Brown and Walsingham (1) maintained that air entering the figs through the cuts "caused the female flowers to dry," thus stopping egg-laying by the female wasps and, at the same time, preventing the further development of eggs already laid.

Both opinions are incorrect. Gashing and subsequent ripening of the fruit take place when the figs are still young (at Phase B), at least several weeks before maturation of the wasps. Consequently, no adult insects are found within the figs upon gashing, except for a few females which hardly matter. Then again, the cuts do not cause drying of the flowers; quite on the contrary, the figs absorb water and become progressively more juicy, and any contained eggs or larvae are not harmed at all.

Finally, the fact that gashing is practiced also in Limassol, where most figs are free of wasps, indicates that basically fig-gashing has nothing to do with insects and that it makes no difference whether or not the figs harbor wasps.

The primary purpose of gashing is to ripen the figs in as short a time as possible, before the insects inside are sufficiently developed to cause any harm. Gashing thus shortens the lengthy developmental course of the fig and yields an induced parthenocarpic fruit.

There is still one major question to be answered; namely, the question as to how gashing of the figs effects their ripening. Recent investigations have provided the answer to this question.

A series of experiments have been carried out to determine the effect of ethylene and several synthetic growth substances on the ripening of sycomore figs at various phases of development. Only undetached fruit were used, since, in the case of the sycomore fig, the ripening process is accompanied by a very great increase in weight and the connection of the growing fig to the mother plant must be maintained throughout. The experiments were run on panicles with several figs at Phase B, each panicle enclosed in a separate cellophane bag. The findings may be summarized here as follows:

1. In bagged panicles, the gashing of a single fig was enough to cause ripening of all the rest.

2. The presence of even one detached and gashed fig within the bag sufficed to induce ripening of all figs.

3. Spraying with dilute solutions of synthetic phytohormones (such as 2.4.D, P.C.P.A.) induced ripening in both bagged and unbagged figs.

4. The introduction of a sprayed fig into the bag caused ripening of all figs within.

5. Ripening of untreated figs was effected by the introduction of ethylene gas into the bag.

6. Tests for presence of ethylene confirmed the production of this gas by gashed figs.

The above data show clearly that ethylene plays an integral part in the ripening process and that figs at Phase B, although merely young female inflorescences still far from the normal ripening stage, are already very sensitive to this gas.

Ripening of the treated figs is thus shown to result from the increased ethylene production brought about by gashing. In other words, the ancient practice of fig-gashing, as applied to *F. sycomorus,* is indeed a unique method of ripening figs through traumatization of the undetached fruit. The elimination of the insects is merely secondary, resulting from the acceleration of ripening.

Concluding Remarks

Since the early dawn of human civilization and for many centuries thereafter, sycomore trees had been of high economic and cultural significance in the Near East. The first specimens, introduced from the south, were undoubtedly similar to the spontaneous plants now growing in the tropics, the fruit of which is of inferior quality. In the Nile Valley, the sycomore was improved, and, with the development of a fruit-gashing technique, its juicy berries gained much in importance and popularity. The tree thus became a horticultural success, highly valued by the ancient world. From Egypt, the sycomore was introduced into neighbouring countries and later on—probably due to the more humid eastern Mediterranean climate—new vegetative parthenocarpic varieties evolved.

Over the years, the fruit of the sycomore has lost its importance. Other high-quality fruit trees have come into the region, and the sycomores are now gradually disappearing. The sycomore trees are not liked by the contemporary farmer. They are too wild and do not suit the modern environment. Their dropping fruit and leaves litter the ground, and their strong roots warp and may even burst water pipes. Consequently, the trees are gradually being cut down and are disappearing from the landscape. In the islands of the eastern Mediterranean, only a few trees remain. In Israel, their number is diminishing from year to year, and, even in Egypt, they are losing their former importance.

It is amazing that the very ancient horticultural practice of fruit gashing should have survived, seemingly without change, up to the present time, the more so in view of the hard and even hazardous labor involved. Evidently, only the very low standard of living in the Nile Valley could have accounted for its persistency. Is it not a behavioral relict of ancient times, an archeological remain involving action rather than structure?

Nowadays, the practice of gashing is actually superfluous, even in areas where no edible sycomore fruit develops spontaneously. Recent advances in plant physiology have shown that sycomore figs may be ripened simply by spraying them with dilute solutions of phytohormones, and that this can be done even without climbing the tree.

Acknowledgments

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