

SMYRNA FIG CULTURE IN THE UNITED STATES.

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INTRODUCTION.

That an article bearing this title should be prepared by an entomologist may seem at first glance unusual, not to say curious; but as is well known to those informed on the subject, and as will be readily seen by the readers of this article, the problem of establishing the Smyrna fig industry in the United States has been very largely an entomological problem.

Fig culture has never amounted to much as an industry in this country. Fig trees grow abundantly throughout the South and in California, having been introduced by the early French and Spanish settlers, and there have been more or less frequent importations since. As a domestic fruit, the fig is of considerable importance in all the Gulf and South Atlantic States. It is a common dooryard tree throughout this region. It has been grown with more or less success as far north as the lower Hudson River Valley, and where well cared for during the winter it will bear well for years, even at these northern limits. In the South figs are used almost entirely for household purposes. They are eaten fresh from the tree and are served on the table with sugar and cream. They are also stewed and made into puddings and pies, and are canned and preserved. In this section figs are occasionally, but seldom, dried for household use, as they ripen at the period of summer showers, which makes drying difficult. Much more of an effort to produce a salable dried fig has been made in California than in the South, especially during the last twenty years, and a greater success has been secured, probably on account of the drier climate. Fig trees were grown in California by the early Spanish padres, probably as early as 1710, and have flourished throughout the southern part of the State, one of the largest and most remarkable trees in America growing as far north as Chico (130 miles north of San Francisco), on the Bidwell place, where it was planted in 1856.¹

¹ The writer saw this tree in 1898, and it is certainly one of the great horticultural curiosities of the country. It is 11 feet in circumference near the base of the trunk; branches have grown down into the ground and sent up new shoots, and the process has been repeated until a ground space of 150 feet in diameter is covered by this one tree, giving a dense shade over a space big enough to accommodate a large picnic party.

ATTEMPTS TO GROW THE SMYRNA FIG.

After the early attempts to dry figs in California had progressed for some years it was gradually realized that with the varieties then growing it was impossible to arrive at a product which should compare in quality or commercial value with the Smyrna fig of commerce. As a result, in 1880 and 1882, Mr. Gulian P. Rixford, of the San Francisco Bulletin, imported into California, by the aid of E. F. Smithers, United States consul at Smyrna, and A. Sida, an American merchant in Smyrna, about 14,000 cuttings of the supposedly best varieties of Smyrna fig trees. These cuttings were widely distributed and were known as the "Bulletin" cuttings. This effort received wide newspaper notoriety, and much was expected of it, but when the trees came into bearing it was found that the fruit invariably dropped on or before reaching the size of a marble. Many explanations of this lack of success were made, the one generally accepted being that the Smyrna fig growers from whom the cuttings were purchased, fearing competition in the United States, had sent worthless varieties.

To test and remedy this matter, Mr. E. W. Maslin, of California, in 1885, planted Smyrna seeds taken from the best figs imported by the great wholesale grocery house of H. K. Thurber & Co., of New York, and presented to Mr. Maslin for experimental purposes. He grew in four years large and flourishing trees, the trunks of which had in 1889 reached a diameter of from 4 to 6 inches. These trees are still alive, and will be the subject of future study.

In 1886 Mr. F. Roeding, a banker in San Francisco and proprietor of the Fancher Creek Nurseries of Fresno, having become convinced that California could be made to grow as good a fig as could be grown in Smyrna, sent his foreman, Mr. W. C. West, to Smyrna for the purpose of investigating the fig industry on the spot. Mr. West remained in Smyrna four months and succeeded in securing several thousand Smyrna fig cuttings, as well as cuttings of wild figs and a few of such varieties as are grown for home consumption. He was watched by the people constantly. He was refused the sale of cuttings, and finally succeeded only by buying through a foreign resident, who was not suspected of any intention to export. After a journey of several months the cuttings arrived in Fresno in good condition and were planted in 1888 in the Fancher Creek Nursery, 20 acres being planted that year, 20 more in 1889, and in 1891 an additional 20 acres.

ATTEMPTS TO GROW THE CAPRIFIG.

The importation at this time of the wild, or caprifig, cuttings was the most important step which had yet been taken toward the solution of the problem. This importation was due to the tardy recognition of the fact that the Smyrna fig, the standard fig of commerce, owes its

peculiar flavor to the number of ripe seeds which it contains, and that these ripe seeds are only to be gained by the fertilization of the flowers of the Smyrna fig with pollen derived from the wild fig, or caprifig. Since time immemorial it has been known that in Oriental regions it has been the custom of the natives to break off the fruits of the caprifig, bring them to the edible fig trees, and tie them to the limbs. From the caprifigs thus brought in there issues a minute insect, which, covered with pollen, crawls into the flower receptacles¹ of the edible fig, fertilizes them, and thus produces a crop of seeds and brings about the subsequent ripening of the fruit. The careful investigations of Count Solms-Laubach and Fritz Mueller, in the early eighties, and later those of Dr. Paul Mayer, have shown that the varieties of the wild fig or caprifig are the only ones which contain male organs, while the varieties of the Smyrna fig are exclusively female. In the caprifig there is said to exist in Mediterranean regions three crops of fruit—the spring crop, known as “profichi,” the second, as “mammoni,” and the third, as “mamme,” the latter remaining upon the trees through the winter. The fig insects (the Oriental species being known as *Blastophaga grossorum* Gravenhorst) overwinter in the mamme, oviposit in the profichi, develop a generation within it, each individual living in the swelling of a gall flower (a modified and infertile female flower), and issue from it covered with pollen, enter the young flower receptacles of the Smyrna fig, which are at that time of the proper size, and make an attempt to oviposit in the true female flowers, fertilizing them at the same time by means of the pollen adhering to their bodies. The life history of the insect from that time on was not well understood, but the *Blastophaga* was known to occur again in the overwintering or mamme crop of figs.

In order to be certain that the right varieties of caprifigs and Smyrna figs had been imported and grown, Mr. George C. Roeding (the son of Mr. F. Roeding), in 1890, artificially fertilized his young Smyrna figs with pollen taken from the caprifig flowers, shaking the pollen out of the caprifigs and introducing it with a quill into the young Smyrna figs. Four Smyrna figs were produced as a result of this artificial fertilization, and in 1891 one hundred and fifty fruits were produced by using a glass tube drawn very fine at one end to introduce the pollen. After gathering a little of the pollen at the end of the tube Mr. Roeding inserted it into the orifice of the fig and then blew into it. As a result of this successful artificial fertilization, Mr. Roeding planted 20 more acres in 1892.

In the meantime Dr. Gustav Eisen, who as early as 1885 had published a pamphlet at Fresno entitled “The fig and its culture and growing, with especial reference to California,” had been experimenting and

¹ The fig is not a fruit in the ordinary sense, but a flower and seed receptacle.

corresponding with European experts, and was probably the first scientific man to fully realize the importance of *Blastophaga* fertilization at a time when it was generally frowned upon. He had obtained from Solms-Laubach cuttings of caprifigs and Smyrna figs as well, had established these in the large nurseries of Mr. John Rock, at Niles, Cal., and in 1891 produced the same artificial fertilization of the Smyrna fig that had been produced by Mr. Roeding at Fresno. At Mr. Rock's place at Niles there are now growing several Smyrna fig trees of large size and a number of caprifigs, and Mr. Rock has accomplished the interesting result of grafting several varieties of the Solms-Laubach cuttings of caprifigs upon a single Smyrna fig tree. Dr. Eisen prepared and published in 1896 an important paper entitled "Biological studies of figs, caprifigs, and caprification," in the Proceedings of the California Academy of Science, series 2, Vol. V, pages 897-1001.

From the beginning of the work the Department of Agriculture had been thoroughly alive to the importance of its possible practical outcome, and by the close of the eighties the subject had become so well understood that it was deemed desirable to establish Smyrna figs and caprifigs in a number of localities in California and the Southwestern States, with the ultimate view that so soon as the proper host plants in the best possible condition should have grown to the proper size the importation of *Blastophaga* would be attempted. Thus, after consultation between Prof. H. E. Van Deman, then Pomologist, and Prof. C. V. Riley, then Entomologist, of this Department, caprifig cuttings were secured from Turkey and were distributed by the Division of Pomology in the winter of 1889-90. Comparatively few of the plantings from this distribution resulted successfully, but there are at several points in California and New Mexico a few large trees now living which have grown from this introduction. Much credit is due to the Division of Pomology, however, for these introductions, and had the persons to whom they were sent taken a uniform interest in the sendings and given them the best of care, the new industry just established would experience a more rapid growth than is at present possible.

EARLY ATTEMPTS TO INTRODUCE BLASTOPHAGA.

The introduction of *Blastophaga* (fig. 1), the fig-fertilizing insect, was first attempted by private enterprise. Mr. James Shinn, of Niles, Cal., obtained the first specimens in July, 1891, but want of sufficient caprifigs for their propagation made the venture a failure. There was at that time only one caprifig tree on his place. The tree had just finished shedding, practically, all ripe caprifigs, and only a dozen ripe figs yet remained on the tree. There was absolutely no sign of a succeeding crop, and the hatching *Blastophaga* had no caprifigs in which to lay their eggs. As Dr. Eisen has remarked, "with only one caprifig

tree, and that one bearing only one crop a year, this importation could not possibly have been a success." These first Blastophagas were imported with the help of a missionary in Syria. In 1892 Mr. George C. Roeding secured several consignments of figs containing Blastophagas from Smyrna, most of which arrived in good condition. On cutting a fig open hundreds of the insects emerged, flying around in a large Mason jar, in which he placed the fruit, and these insects were afterwards placed in a covered tree to note the ultimate result. Mr. Roeding also tried two other interesting experiments, but which were foreordained to failure; the one was the introduction of native Blastophagas from Mexico and the other of native Blastophagas from Hawaii. In 1890 the writer remembers to have seen some caprifigs received by the Division of Pomology from Turkey which contained living Blastophagas, but there was at that time no place known to the Pomologist to which they could be sent. Mr. Roeding from year to year continued his artificial fertilization of Smyrna figs at his Fresno place, and in 1897 a box of figs fertilized in this way was sent by Mr. Roeding to the Division of Pomology. The writer was shown some of these figs by Mr. W. A. Taylor, then acting pomologist, and their flavor at once convinced him, if he needed conviction, that the true taste of the Smyrna fig was there.

SUCCESSFUL IMPORTATION BY THE DEPARTMENT OF AGRICULTURE.

Up to this time the Department of Agriculture had made no serious effort to import Blastophagas, but being convinced by letters from Mr. Roeding, and from statements received from the San Francisco Board of Commerce, in the late autumn of 1897, that probably the time had arrived for such an attempt, the writer was authorized by the Secretary of Agriculture to take charge of the work, and to attempt the importation and the establishment of the insect. He at first thought of having Dr. Eisen, so well qualified by virtue not only of his scientific attainments, but also on account of his special interest in this subject and his well-known investigations and conclusions, commissioned to visit Mediterranean regions for the purpose of collecting additional varieties of caprifigs, of sending overripe gall figs, and of bringing to this country, if necessary, an entire transplanted and healthy caprifig tree. He corresponded with Dr. Eisen on the subject, the latter secured a provisional leave of absence from the California Academy of Sciences, where he was at that time employed, and the details of compensation were arranged. It happened, however, that just at that time Mr. W. T. Swingle, a competent botanist in the employ of the Division of Vegetable Physiology and Pathology, was in South Europe on leave of absence, and it happened also that while studying at the Naples station Mr. Swingle had become interested in the subject of the fig, its origin and botanical varieties, and

the phenomenon of caprification. This fact coming to the writer's attention, it was deemed advisable by utilizing Mr. Swingle's services to save for other purposes the funds which would have been required to send out a new man.

Another preliminary step undertaken by the writer was to visit California in the early spring of 1898 to inspect the points where Smyrna figs and caprifigs were supposed to be growing, so as to be able to decide upon the best point or points at which to attempt the establishment of the insect in the tolerably certain event of its successful introduction in living condition. Upon reaching Mr. Roeding's place near Fresno, the writer was at once assured, by the thriving condition of the trees and by their great number (nearly 5,000 in all, including 100

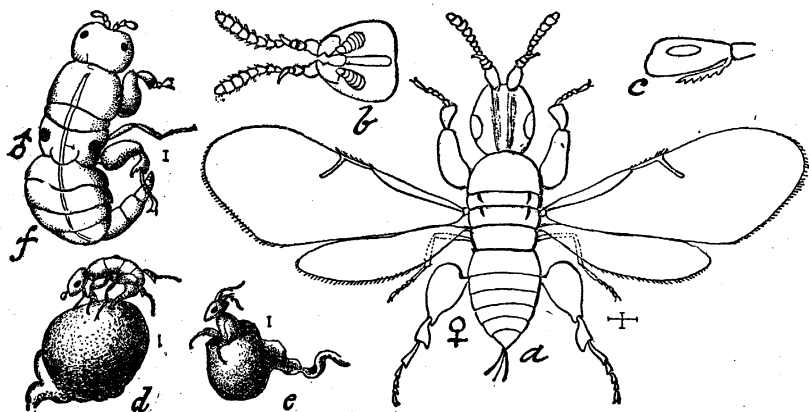
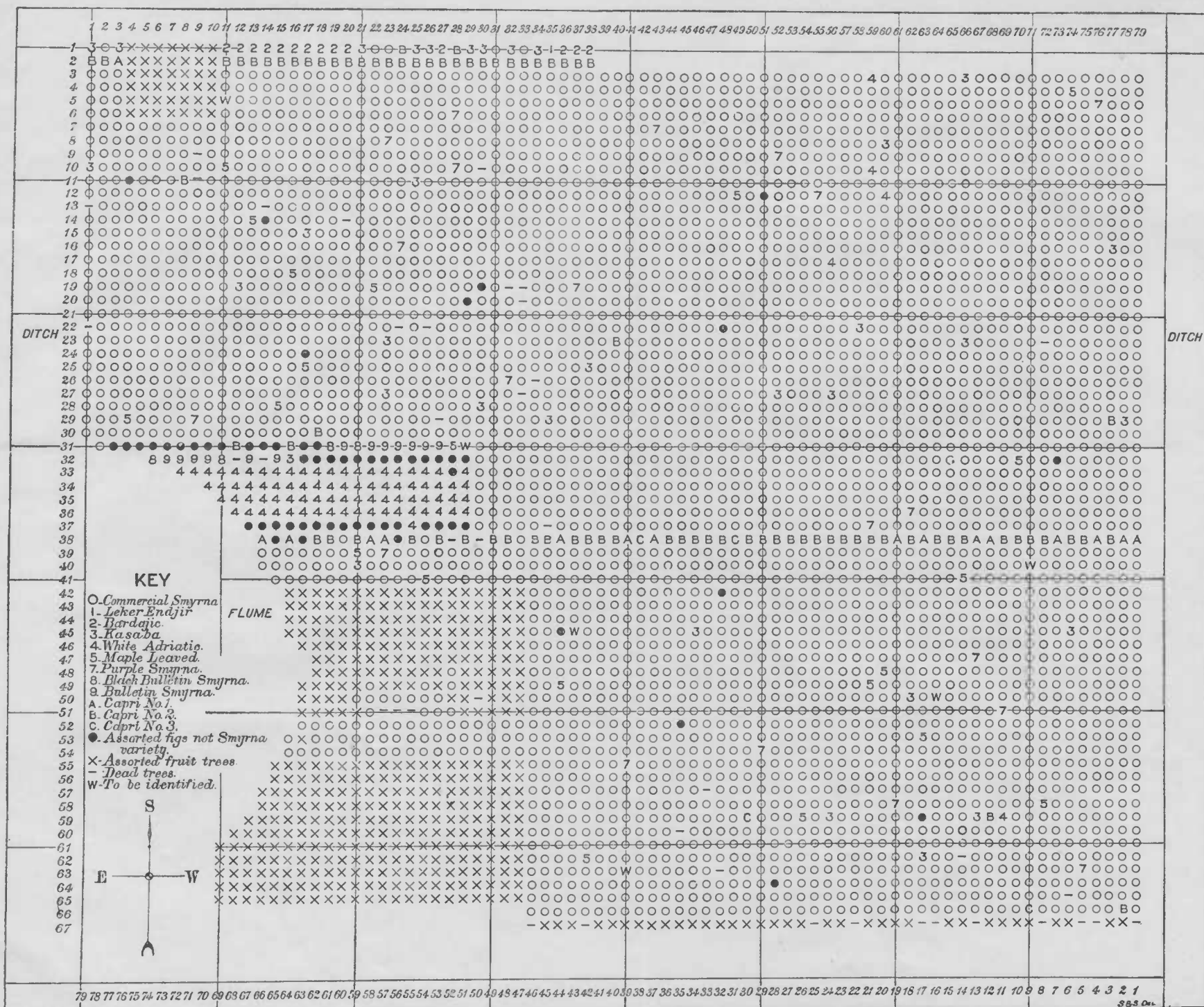


FIG. 1.—*Blastophaga grossorum*: a, adult female; b, head of same from below; c, head of same from side; d, male impregnating female; e, female issuing from gall; f, adult male—enlarged (after Westwood).

caprifigs), that no better place could possibly be found, or could be prepared in several years. A plat of this orchard is shown in Pl. I.

At some personal expense and on his own initiative, Mr. Swingle began in the spring of 1898 to send a number of caprifigs containing gall insects to the Department of Agriculture at Washington City for shipment to California, and made a careful study of the different varieties of caprifigs. The first shipment arrived at Fresno in April, 1898. It had been sent from Naples, the locality in which Dr. Paul Mayer had made his investigations. Mr. Swingle had adopted an ingenious and eminently successful method of packing. Each green caprifig was carefully and closely wrapped in tin foil, the end being covered with wax. On arrival at Fresno the female *Blastophagas* were seen to be emerging from the gall figs. In this first sending were quite a number of specimens of *Philotrypesis caricae*, a parasite of the *Blastophaga*. Mr. Roeding readily distinguished between the female *Blastophagas* and this parasite, and destroyed all the parasites noticed. A caprifig



PLAT OF THE ROEDING SMYRNA FIG ORCHARD NEAR FRESNO, CAL.

[Location of the various varieties of Smyrna trees (open circles and figures) and the disposition of the Capri trees (letters). All trees are planted 25 feet distant from each other, and the entire orchard occupies an area of about 62 acres.]

tree was inclosed in a thin cloth tent and subsequent sendings of caprifigs were placed in this inclosure, and the Blastophagas were liberated.

Then a year elapsed without result. Either none of the caprifigs on the inclosed tree was stung by the Blastophagas or no larvæ developed, so far as Mr. Roeding could observe.

In the meantime Mr. Swingle had been transferred to the Section of Seed and Plant Introduction of the Division of Botany and commissioned as an agricultural explorer to work at the introduction into the United States of desirable plants. In the course of his work he went to Greece, and from there sent additional varieties of caprifigs to this country, which were forwarded to Mr. Roeding and planted under differing conditions.

In the winter he went to Algeria and sent other cuttings and one large caprifig tree. As the spring opened Mr. Swingle again began his sendings of caprifigs, packed as before, and which as before were placed by Mr. Roeding under the artificial inclosure. This time, as before, Mr. Swingle adopted the innovation of sending the winter generation of caprifigs instead of the spring ("profichi") generation, and to this important change is doubtless due more than to any other cause the success of these sendings, since, so far as can be learned, all earlier importations had been of the profichi generation. On March 31, 1899, six boxes of caprifigs were received by the writer and forwarded to Mr. Roeding, on April 5 one more box, and on April 6 the eighth and last. On April 6 the first boxes were received by Mr. Roeding. The fruits seemed to be in excellent condition. He cut several open and found them full of Blastophagas in the pupa condition. All of the figs were cut open and placed under the covered tree.

It must here be said that most of the persons connected with the work had little hope of the establishment of the fig insect by this method, on account of previous failures. It was tried because the opportunity offered and because of the variations referred to in the method of packing and the careful tenting of the single tree, in the hope that some might succeed in finding fruits of the right size for entering and for oviposition. Mr. Roeding, in acknowledging the receipt of the sending of March 31, and promising to cut them open and put them under the covered tree, said: "But I anticipate no results, and I do not think a success will be made of this matter until fig trees with the figs attached are sent out here during the winter months." Most of the figs shipped from Washington, D. C., on the 5th and 6th of April arrived at Fresno in a decaying condition.

In view of previous failures and this lack of confidence on Mr. Roeding's part, the pleasure of every one concerned in the results which followed can readily be understood. In the latter part of June, 1899, one of Mr. Roeding's men was engaged in gathering caprifigs and extracting the pollen for the purpose of artificially pollenizing Smyrna

figs by means of the usual blowpipe process, and on the 23d of June he found one fig which contained evidences of the presence of the insect. On the 24th of June the tented tree was examined, and it was found that all the figs had dropped and shrivelled up with the exception of about 20, which were still green and plump, and which subsequent evidence showed contained developing *Blastophagas*. Other figs showing evidences of *Blastophaga* were found on outside trees, and by the end of June were found other wild fig trees upon which young figs, presumably the second crop, or mammoni, were beginning to develop. On the 30th of June a tree 1,500 feet away from the tented tree was found bearing two caprifigs containing galls and male insects.

About the middle of July Mr. Roeding found a few neighboring Smyrna trees which had been fertilized by the *Blastophaga* without any effort on his part.

About the end of August some of the caprifigs of the second crop (mammoni) had begun to come to maturity, but many young caprifigs were also present, and the insects entered them. By November 10, when Mr. Swingle visited Mr. Roeding's orchard, many swollen caprifigs were to be seen, which had been supposed to be the overwintering, or mamme, generation, but on that date and for a number of days subsequently thousands of the insects emerged, thus producing at least a partial fourth generation of the insect, a fact entirely unprecedented in the history of the species, so far as the writings of the European authors inform us. These entered at once the young individuals of this generation of figs, as could readily be observed at the end of November, when the writer visited the orchard, the minute wings of the insect being found adhering to the bracts on the outside of the fruit, while living males were still found in the older figs from which females had issued earlier.

CARRYING THE INSECT THROUGH THE WINTER.

In November, for the purpose of protecting a goodly number of overwintering figs containing insects from possible freezing weather, Mr. Roeding built a cloth house 28 by 17 by 16 feet high, in which three trees were inclosed, in all bearing fully a thousand figs. At the time of the writer's visit (November 23-25, 1899) the cloth house was found to have been admirably designed. There was a high square framework of joists (Pl. II), with the canvas buttoned on over nails, so that a free circulation of air could be allowed and the trees could be entirely uncovered with a minimum of trouble in fine weather when no frosts were anticipated. The estimate of about 1,000 gall figs was confirmed and other trees outside the tent were found to carry a few caprifigs of the overwintering generation. Although *Blastophagas* had issued on the 10th of the same month, and although November 24



FIG. 1.—A 10-YEAR-OLD CAPRI TREE (ROEDING'S CAPRI NO. 1).

[Tree, in prime condition, as seen on March 3, when the young foliage was not yet fully developed; had been protected during the winter by a canvas tent, and the illustration shows the framework of the tent.] (Reduced from an original photograph.)



FIG. 2.—A 10-YEAR-OLD CAPRI TREE (ROEDING'S CAPRI NO. 2).

[Tree, in prime condition, as seen on March 30, when the spring foliage was not yet fully developed. In the background are the rows of Smyrna trees.] (Reduced from an original photograph.)



A BRANCH OF A CAPRIFIG TREE (ROEDING'S CAPRI NO. 1).

[Photographed on March 30, showing two winter figs or mammie (the two nearest the right side of plate), from which the hibernated *Blastophagus* are about to issue, and a bunch of spring figs or profichi (near the tip of the branch), which are in the receptive stage, that is, ready to receive the *Blastophagus* issuing from the winter figs.] (Reduced from an original photograph.)

was a bright warm day, with a temperature of 83° F., there were no signs of any insects issuing. One of the larger figs, in which the eye had opened, showing that the insects had probably issued on the 10th, was opened and was found to contain 1 dead female and 3 living males, the latter very lively. At this time some extremely small caprifigs were seen, and with a warm winter promised to be receptive to any *Blastophagas* which might subsequently issue. On the terminal twigs the buds seemed almost ready to swell.

From this time on the winter was passed without any occurrence worthy of especial note. About December 15 there was a frost of 29° F., and there were several light frosts later. On January 1, 1900, some of the large figs dropped from the tree under the cover and were found to contain fully developed male and female insects.

AN ASSISTANT SENT TO FRESNO IN THE SPRING OF 1900.

As the time approached in the spring of 1900 for the issuing of the hibernating insects from the overwintering crop of caprifigs, the writer decided to station an expert assistant at Fresno during the entire season of 1900 to follow closely the biology of the insect, to watch and study carefully all conditions in order that, in case of possible emergencies, no opportunity should be lost through lack of expert entomological knowledge. Mr. E. A. Schwarz was chosen for this purpose, not only on account of the fact of his wide entomological knowledge and standing as a close observer, but also because he had been familiar with the subject of caprification for a number of years and was well posted in regard to the European literature. Mr. Schwarz arrived at Fresno March 11 and remained in California until early in November. He spent most of his days in the orchard, watched and assisted in all of the cultural features, made almost hourly observations upon the insects, and advised with Mr. Roeding and his assistants at all times. The following brief summary of the summer's work is drawn largely from Mr. Schwarz's correspondence and from an account which has been transmitted to the writer by Mr. Roeding:

Upon his arrival at Fresno, Mr. Schwarz found that two of the tented trees and some of the trees outside of the tent, all belonging to the same variety of capri trees,¹ bore about 400 apparently sound overwintering caprifigs. By March 18 many of the spring crop were seen to be as big as cherries, and with difficulty distinguishable from the smaller overwintering individuals. The larger overwintering

¹There are three varieties of caprifig trees on Mr. Roeding's place, which, for want of better names, have been called Capri No. 1, Capri No. 2, and Capri No. 3. Pl. II (fig. 1) shows a 10-year-old Capri No. 1, and (fig. 2) a Capri No. 2 of the same age, both trees being in prime condition. Pl. III shows a branch of a Capri No. 1, and Pl. V shows the upper parts of a Capri No. 3.

specimens continued dropping, and all were found to be more or less affected with rot. To Mr. Schwarz it seemed probable that these larger individuals, which are pulpy in their character and which still contained full-grown insects, were not true mamme, but simply hibernating mammoni of the mammoni crop of 1899. In Europe this phenomenon is known; the belated mammoni are said even to stay over winter on the trees, maturing in the spring, and thus hardly to be distinguished from the genuine mamme in general appearance. In these larger specimens, which were taken to be belated mammoni, the insect was found all through the winter in the pupal or adult conditions, whereas Mayer and Solms-Laubach state that in Europe in the mamme the *Blastophaga* hibernates in the egg or larval condition. The issuing of the insects from these figs had evidently been prevented by the presence of a large amount of saccharine matter, and the greatest hope at this time was that the smaller figs, evidently the true mamme, would contain the insect in the proper condition to issue at the proper time. This generalization held not only for the figs upon the tented trees, but upon the others outside.

THE EMERGENCE OF THE INSECTS IN THE SPRING.

The adult *Blastophagas* from these overwintering small figs began to issue March 28, and continued to do so for about five weeks. If the weather had been fair and warm this period would have lasted probably only three or four weeks, but bad days intervened, and the time was extended. Upon issuing, the adult female *Blastophagas* immediately entered the spring generation of caprifigs, which were in the proper receptive condition. Mamme, from which the *Blastophagas* were issuing or were about to issue, were transferred to other trees, with the result that on June 10 Mr. Schwarz wrote that at that time the total crop of good profichi was estimated at about 6,000. With knowledge gained later, a much larger number of good profichi figs could have been obtained if the transferring of mamme had been concentrated upon fewer trees, but since the orchard contained three varieties of capri trees, and since their qualifications were not well understood at the time, it was deemed best to distribute the insect over as many capri trees as possible. Some interesting practical information was thus gained—the *Blastophaga* emerging from the mamme oviposits preferably only in such profichi as are shaded, evidently not liking to work in the sun, and probably because the figs grown in the shade are cooler and fresher. The most valuable figs for this purpose seem to be those which grow on the small inner twigs which never reach the top nor the sides of the tree. Unfortunately, this inside growth in the orchard had been carefully trimmed out on most of the trees. This affords a cultural point of value for future experience. The average California horticulturist, judging from the writer's

experience, finds his ideal of a fruit tree in its symmetrical and beautiful outline, but while this may be good for other fruits, it apparently does away with the bearing capacity of a fig tree of the Smyrna class.

THE SPRING CROP OF CAPRIFIGS.

A natural spread of the insect was allowed to take place from two of the overwintering trees; but it was found that only a few neighboring trees could be caprificated in this way. The result of the transfer of the mamme to other trees was that a sprinkling of good profichi was gained, either good or poor, according to the variety or individuality of the trees, and of course also according to the number and quality of the suspended mamme. It appeared also that the mamme suspended previous to April 10 produced better results than those suspended afterwards, and it seemed that a caprifig tree in good condition requires at least 25 mamme to have a chance to be fully caprificated. This number, however, experience may lessen very greatly; in fact, at that time, while it was supposed that the method adopted of scattering the few mamme all over the row would not be favorable for a commercial purpose on account of the trouble in gathering the scattered crop, it has been found not to be so unfavorable after all. Many of the profichis, as above indicated, drop either by rubbing or by the action of severe winds, or by means of a disease which Mr. Schwarz terms "the ostiolum disease."¹ The insects themselves in this crop are, many of them, lost in numerous ways: They may issue as cripples and not be able to fly; they may be caught in spiders' webs; they may be caught in the sticky exudation from certain of the figs; they may lose their wings in attempting to penetrate, without success; they may die through entering figs which are too small, or several may enter the same fig; they may be blown away by the wind; they may enter figs which are too old. It was also noticed that the insects are very shy, and that when they issue from the mamme they drop to the ground on the slightest provocation. In these various ways, it was estimated that more than 50 per cent of all the *Blastophagas* issuing from the overwintering figs were lost, and of course in every subsequent generation the same thing occurred.

All of the profichi, or spring generation of figs, which had not been fertilized, continued to drop from the trees until June 3, and on June 10 for the first time there appeared to be a swelling up or puffing up of what appeared to be the ripest fertilized figs of this generation. These ripest figs within twenty-four hours became softer and assumed the pale olive-green color so characteristic of the ripening mamme. The characteristics of this generation of figs in different stages of growth are worth especial mention. When quite small they are globular,

¹Mr. Schwarz subsequently decided that this disease is due to the presence of female flowers.

pale green, and delicately pruinose. Just before fertilization they are bright green, shining, and long stemmed. After caprification some of them become gradually more rounded or even transversely oval, dark green, hard and firm, and very pruinose. Just before ripening, viz, just before the issuing of the insect, the ostiolum opens and gradually assumes a more decided yellow color, and shortly after the first issuing of the *Blastophagas* the outer layer of scales becomes erect and quite stiff. As soon as the first batch of *Blastophagas* issues, the figs commence to collapse and appear shriveled, but other insects continue to emerge for several days afterwards. (Fig. 2.)

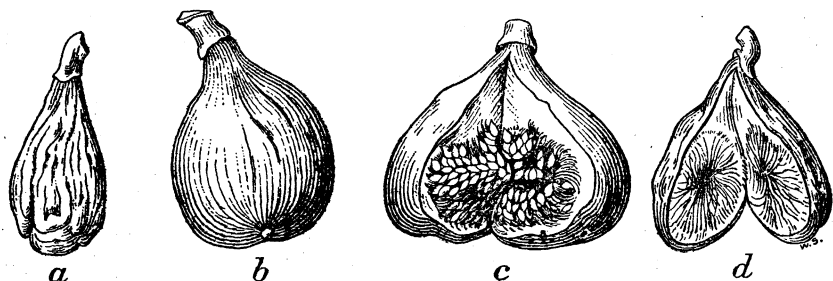


FIG. 2.—Caprificated and noncaprificated caprifigs (drawn from nearly dried-up specimens): *a*, outside appearance of noncaprificated fig; *b*, outside appearance of caprificated fig; *c*, interior of caprificated fig; *d*, interior of noncaprificated fig—all natural size (original).

THE SECOND GENERATION OF *BLASTOPHAGAS*.

Blastophagas began to issue on June 11. After that date the daily temperature increased, and the *Blastophagas* commenced to issue at an earlier hour every subsequent day, until on June 24 they began to issue at 6 o'clock in the morning. No *Blastophaga* was observed to issue in the afternoon or evening. A fig gives out insects only for a short time each day, commencing again the following day, and continuing for four or five days, and perhaps longer. The number of *Blastophagas* issuing from one fig each day is extremely variable, but reaches in some figs 50 or 60, perhaps more, which come out with a rush. The whole flight for each day does not last more than three or four hours, so that after 10 o'clock in the morning on June 24 very few specimens could be seen.

Although the issuing from the overwintering crop lasted over four or five weeks, fully 95 per cent of the profichi generation gave out all of their contained insects in two weeks.

CAPRIFICATION.

As soon as the first *Blastophagas* of the second generation were seen issuing on June 11, Mr. Schwarz commenced hand caprification, and succeeded in performing this function for about 20 trees.¹ The next day

¹ In Pl. V, at the lower left-hand side, is represented a twig of a *Smyrna* tree bearing young figs, which show the striking difference between specimens caprificated by

a number of workmen joined him, and by June 15 and 16 a force of 9 men was at work. The active work of caprification was carried on from the 11th to the 20th of June. It was early found that the estimate of 6,000 healthy profichi was altogether too small, and the entire force was kept very busy. An estimate was made that it would have taken at least 17 men, working assiduously for a week, to caprify one-half of the orchard of approximately 4,000 trees, namely, 10 men to do the picking and stringing, 5 to do the distributing and suspending, and 2 to carry the strung figs from headquarters to the distributors. The expense in wages for half the orchard would be in the neighborhood of \$125.

The appliances necessary for caprification were found to be a number of stepladders, especially small ones; fruit baskets, or light boxes, for the collection of the figs; shallow wooden trays, into which the picked figs are laid for inspection; harness needles and raphia fiber, for stringing; scissors and sharp knives, for cutting the ends of the raphia; gasoline, for washing the needles; a bucket of salt water, for the frequent washing of the hands; poles, short and long, for hanging the strings of caprifigs; hooks and crotches, to support the poles; flags, sticks, and labels, to mark the caprifigged areas on trees.

Finding only brief directions in the literature, Mr. Schwarz decided at first to devote 10 caprifigs to the average Smyrna tree, but the number was increased to 12, 14, 16, or even 20, wherever the trees were above the average in size. Recaprification with a smaller number of figs, varying from 2 to 10, was carried on at intervals of from three to five days, as far as the provision of profichi lasted. A second recaprification would be desirable; but for this purpose another variety of caprifigs, bearing either earlier or later figs, will be necessary. The system adopted was about as follows: At 6 o'clock in the morning all hands turned out and proceeded to pick over the caprifigs (either by hand or by pulling them off with a bamboo pole fruit picker), assembling finally at headquarters, where the figs were laid out in trays for inspection. This inspection was to eliminate the worthless figs, and to keep only those which were pretty sure to give out a good supply of insects. Doubtful ones were kept separate and were suspended on experimental

the Blastophaga (the two figs on the left side of the branch) and not caprifigged specimens (the three figs on the right side of the branch)—nearly natural size (photographed July 2).

The large figs along the right side of the plate are nearly ripe caprifigged Smyrna figs (reduced from natural size), the cut specimens representing that stage where the stems of the female flowers, greatly thickened, secrete the largest amount of saccharine matter (photographed August 20).

The small twig with figs at the upper left-hand corner of the plate represents the earlier mammoni crop of caprifigs (Roeding's Capri No. 1), the large fig at the tip of the twig being nearly ripe and about ready to give forth the winged Blastophaga females—natural size (photographed August 20).

trees. During this inspection the stringing of the figs began, and all hands joined in this tedious, dirty, and slow work. One or two figs at each end were strung with a strong needle upon a bit of the raphia fiber. After stringing 20 or 30 the needle and fingers become covered with the sticky, milk-like fluid which exudes from the stems, and the washing of fingers and needle becomes necessary. After stringing a couple of thousand of the figs each operator became aware that this milk possesses some poisonous quality. The tips of the fingers become sore and burn like fire. They aggravated this evil at first by washing the hands in concentrated salt water, so that they could proceed with the work only with considerable pain. The Japanese laborers simply rubbed their hands with dust, and probably this is the best way of getting temporarily rid of the milky stuff. Each string of raphia was then hung over a pole, which was suspended at some little distance from the stringers. The method of stringing and inspecting is illustrated in Pl. IV, fig. 1. After about 600 figs were strung the poles with their strings of figs were taken up, and the distributing party of five men started with the figs into the orchard, where the figs were suspended on the branches or wound about the twigs. This is illustrated in Pl. IV, fig. 2. Two rows of trees were thus caprifigged at a time, and the shaded portions of the trees were chosen. When the supply of figs was exhausted flags were planted on the row at the tree where the work stopped, and the distributors returned to headquarters to help the stringers until another batch was ready for distribution. In this large orchard the distributing party had to walk at least 10 miles a day, each row being almost half a mile in length. The plan of throwing the strings into the trees was tried, but was not very successful.

In this way about 18,000 profichi figs were distributed, and more than 1,300 Smyrna trees were successfully caprifigged. Then also to the number of trees which were caprifigged by the transfer of figs must be added an unknown number of trees from which a crop of Smyrna figs was to be expected by the natural spread of the *Blastophaga*. At this time the loss of *Blastophaga* by spider webs was observed to be very great. Mr. Schwarz estimated that several hundred thousand specimens were lost in this way.

The effect of caprifigation on the young Smyrna figs becomes readily visible within a few days, and is illustrated by the figure of a twig at the lower left side of Pl. V. Before the *Blastophaga* enters the fig the latter is transverse and strongly ribbed, as shown in the three figs on the right side of the twig. A few days after fertilization the fig swells up and becomes rounded and sleek, as shown by the two specimens on the left side of the twig. The figures along the right side of the plate represent (on a somewhat reduced scale) the "botanically"



FIG. 1.—CAPRIFICATION.

[The process of sorting, examining, and stringing the profichi figs, preparatory to their distribution upon the Smyrna trees. For further details, see page 92.] (Reduced from a photograph taken June 13.)



FIG. 2.—CAPRIFICATION.

[Distributing the profichi figs upon the branches of the Smyrna trees. For further explanation, see page 92.] (Reduced from a photograph taken June 13.)



CAPRIFICATED AND NONCAPRIFICATED FIGS.

[For explanation of plate, see footnote, pages 90 and 91; also page 92.]

ripe Smyrna fig, the cut specimens showing that stage where the female flowers secrete the largest amount of saccharine matter.

The first figs were caprified on June 11, and the first ripe one dropped to the ground on August 2. By August 8 quite a number had dropped, but what may be termed real dropping did not begin until August 15, and ripening continued from that time on well into September, the whole period covering from four to five weeks. This gradual ripening is the most serious drawback, since the figs must be gathered every other day. This is an expensive affair in California, even with the cheap Chinese laborers employed.

HARVESTING AND DRYING.

As just stated, as the figs dropped they were collected every other day by laborers who went through the orchards provided with receptacles for collecting. This continued from August 8 for four or five weeks. No fertilized Smyrna figs were observed to drop to the ground prematurely. A great loss of insects, however, is occasioned by two or more (as many as five) Blastophagas entering the same fig, whereas only one is necessary for thorough fertilization. Another loss was from the Blastophagas entering the figs which were beyond the receptive stage, and which were found dead between the scales of the ostium. As the figs ripened another loss became apparent, many specimens turning orange yellow and a small area remaining hard and wrinkled. The bright orange color renders such figs easily recognizable, and if the defective spot is small, no great injury results. Moreover, during the expansion period of the figs many of them crack. The expansion due to the abundant secretion of saccharine matter is so powerful that the delicate skin of many figs, and, unfortunately, among the finest and largest, can not stand it, and the fig splits in two, usually across the ostium. Sometimes it splits into three parts and opens like a rose. If the split does not extend very far the fig is not rendered worthless, but if it extends across the surface the fig is lost. The loss caused by birds is also very great, especially by the California house finch or linnet (*Carpodacus mexicanus obscurus*). Mr. Schwarz found that these birds never nest on the fig trees, but on the shade trees along the roads, on the garden trees in the vicinity, and on the willows and cottonwoods along the ditches. They do not fly far away from their nesting places, and there was consequently little damage done in the central part of the fig orchard. Along the borders, however, hardly a single good fig was harvested on account of these birds. He advises, therefore, that a Smyrna fig orchard should not be planted in the vicinity of large shade trees or orange groves. Souring of the figs was not noticed in the early part of the season, but began later to a limited extent when showers occurred. When the Smyrna figs

ripen the ostiolum opens wide and remains open so that a match can easily be inserted and often moderate-sized insects can enter and feed on the sugar. Some of them are caught in the sticky sap and die within the fig. When the figs are ripe and fall, ants and beetles of the genera *Notoxus* and *Carpophilus* enter in this way. Wasps and other insects, notably among them a species of *Blapstinus*, eat holes through the skin if the figs are allowed to remain on the ground longer than a day or two.

On account of these and other losses, only about one-half of the crop of Smyrna figs was gathered this year in Mr. Roeding's orchard. The entire crop was estimated by Mr. Schwarz at from 12 to 15 tons of good figs on the trees, all resulting from the inhabitants of less than 450 winter figs!

It was found then that there are not less than seven or eight well-distinguished races or varieties of Smyrna fig trees in the Roeding orchard. Caprificated figs of all these varieties were obtained, and while that variety which has been called the "Commercial Smyrna" fig proved to be better adapted for drying than the other varieties, few would deny that some of the latter were of more delicate flavor than the commercial variety. Whether or not practical methods of drying these figs can be found must remain for later experience. Some of the more striking of these varieties are shown on the accompanying plates.

Pl. VI, fig. 2, illustrates the "Black Bulletin," which is one of the Smyrna figs introduced by the editor of the San Francisco Bulletin.

Pl. VII, fig. 1, represents the "Purple Smyrna" fig, a tree of the most beautiful shapely outline, closely resembling from a distance the Chinese umbrella tree. Fig. 2 of this plate shows the White Bardajic Smyrna, the most readily distinguishable variety on account of its pear-shaped fruit. This may prove to be of exceptional value.

Pl. VIII, figs. 1 and 2, represent 10-year-old "Commercial Smyrna" trees in full bearing, the fruit, however, showing very indistinctly in the illustration on account of its color.

It may also be of interest to state that the second crop of the San Pedro figs has been successfully caprificated by the *Blastophaga*.

After the collection of the figs they were transferred to the drying ground, dipped into a boiling brine made by dissolving 3 ounces of salt to a gallon of water, and then placed on trays, the time of drying varying from two to four days, according to the weather. The dipping of the fig is supposed to bring the sugar into the skin, hasten the drying, and make the skin pliable. After the figs were dried they were placed in sweat boxes holding about 200 pounds each, where they were allowed to remain for two weeks, to pass through a sweat. The only other treatment they received before packing was to wash



FIG. 1.—UPPER PART OF CAPRIFIG TREE (ROEDING'S CAPRI NO. 3), SHOWING ABUNDANT CROP OF CAPRIFICATED SPRING FIGS (PROFICHI).

[The photograph taken on May 23, and Blastophagas commenced to issue from the figs about June 11.] (Reduced from an original photograph.)

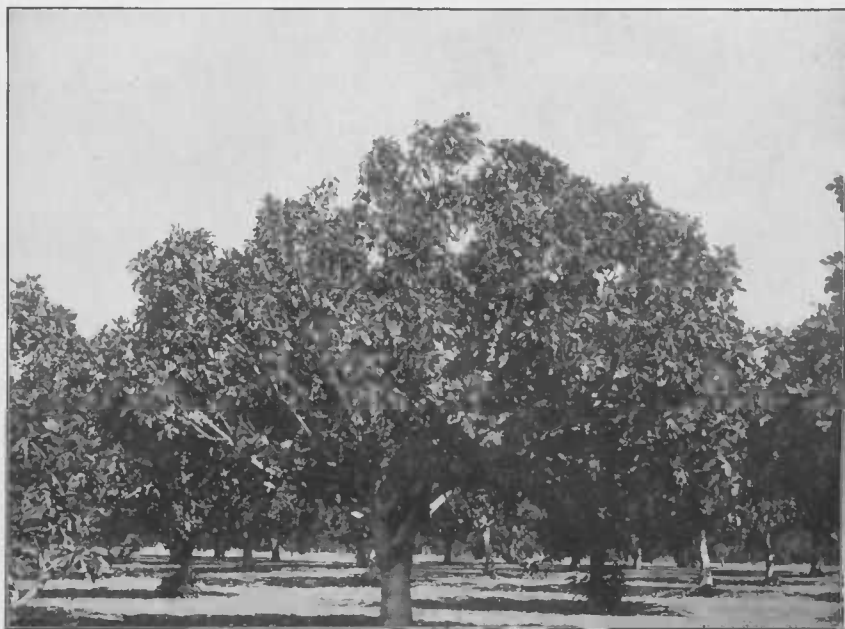


FIG. 2.—THE "BLACK BULLETIN" FIG TREE (15 YEARS OLD).



FIG. 1.—THE "PURPLE SMYRNA" FIG TREE (10 YEARS OLD).

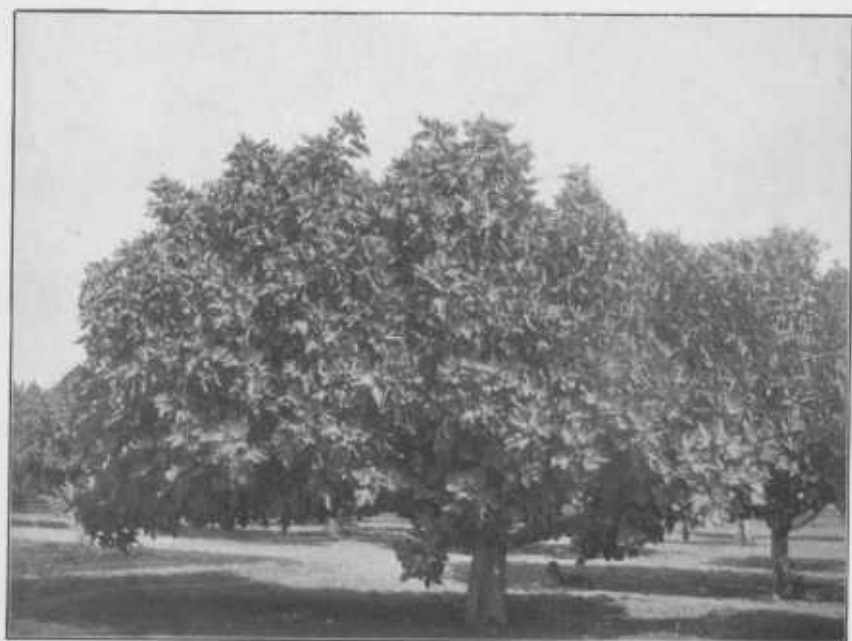


FIG. 2.—THE WHITE "BARDAJIC" SMYRNA TREE (15 YEARS OLD).

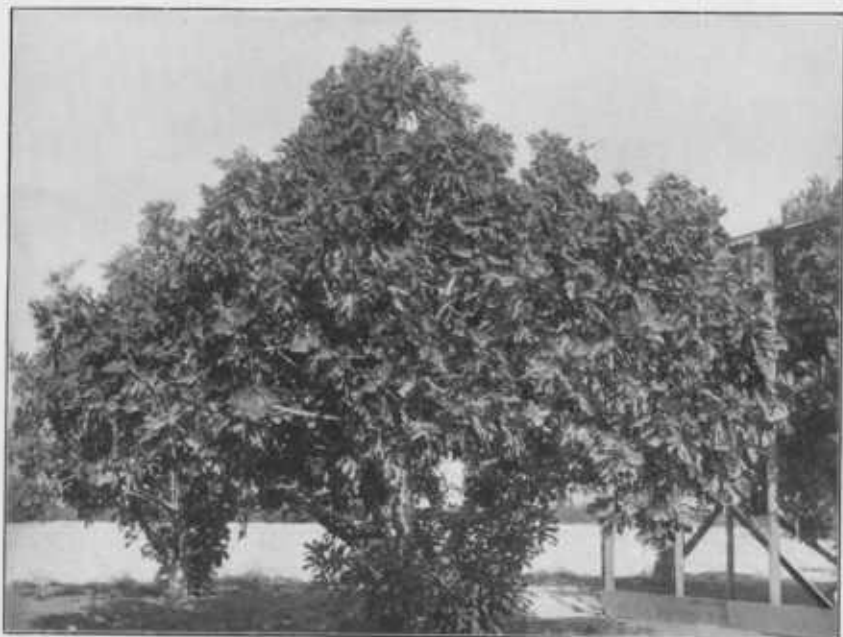


FIG. 1.—THE "COMMERCIAL SMYRNA" FIG TREE IN FULL BEARING (10 YEARS OLD).



FIG. 2.—PARTIAL VIEW OF THE "COMMERCIAL SMYRNA" FIG TREE IN FULL BEARING (10 YEARS OLD).

them in cold salt water, for the purpose of removing all dirt, and figs which were overdried or improperly fertilized (called "dummies" by Mr. Roeding) rose to the top when placed in the solution.

PACKING.

More than 6 tons of the product, dried in the manner just described, were put up in half-pound, 1-pound, and 10-pound boxes in layers, and 1-pound cartons. They were taken to one of the leading packing houses in Fresno in sweat boxes, the same size as is used for raisins and other dried fruits in California. In the height of the season from 200 to 300 hands are employed in this packing house. The neat appearance of the women and girls, and the cleanliness observed in the handling of the fruit are features of California packing houses, which are certainly not equaled in similar institutions in Smyrna.

The figs were first graded by machinery, a long tray with small holes in one end, which increased in size toward the other end, being used for this purpose. The three largest sizes were packed, the smaller grades being simply pressed in 50-pound boxes without packing. After grading, the figs were passed through a closed trough of boiling hot water, an endless chain with buckets attached being used for this purpose. This thoroughly cleansed the figs and softened them so that they could be easily handled. The work of packing was done exclusively by women and girls, and the splitting of the figs was practiced as in Smyrna, a short-bladed knife being used for that purpose.

The layer figs were packed in 10-pound boxes with three and four layers in a box, these layers being the finest and largest figs. The cartons consisted of 1-pound packages wrapped in waxed paper and packed 10 to the box. The largest figs in this mode of packing are known to the trade as 6-crown, the next in size 4-crown, and the smallest size 3-crown. Each brick of figs, as it is called, is neatly wrapped with colored ribbons, making when finished a very attractive package.

QUALITY OF THE PRODUCT.

Chemical analysis made by Professor Hilgard, of the University of California, showed that figs submitted to him by Mr. Roeding contained 1.42 per cent more sugar than the best imported Smyrna figs. Samples which the writer has received are of exceptional edibility. The flavor is delicious and precisely comparable to that of the imported figs, except for the lack of the slight acidity noticed in those ordinarily bought on the market, and which is of a rather disagreeable quality. Wholesale grocers to whom the writer has shown samples speak with strong approval of their quality, and there seems little doubt that a great and profitable trade in figs of this grade can readily be gained in the United States.

THE SECOND CROP OF CAPRIFIGS.

When the caprification of the Smyrna figs began, about the beginning of the second week in June, the second crop of caprifigs, in which only could the life round of the *Blastophagas* be maintained, was just beginning to appear, but in such small numbers as to cause a real break in the succession of crops. The advance individuals were readily entered by the second generation of *Blastophagas*, but it was deemed rash to depend solely upon the chances that when a goodly number of the second crop should be ready there would still be enough issuing *Blastophagas* to enter them; so a trip to Niles was undertaken early in July, and six profichi were carried back to Fresno. At this place a colony of *Blastophagas* had been successfully established in April, eighteen overwintering caprifigs having been taken there from Fresno. Between July 21 and 27, *Blastophagas* issued from two of these Niles caprifigs at Fresno. At Niles, however, they did not hatch out until the first week in August, and at the latter place very few of the second crop (mammoni) figs had developed. Thus, in case the break between the spring and second crops at Fresno becomes so marked another year that *Blastophagas* issuing from profichi figs are unable to find mammonis in which to oviposit, the later issuing *Blastophagas* may be brought in their profichi from Niles, and the succession of generations maintained. Thus all caprifigs of the second crop at Fresno, which developed from the buds subsequent to July 5 (the issuing period of the profichi generation of *Blastophagas* having been June 11 to July 5) did not get any insects (disregarding here the artificial importation from Niles). They kept on developing, vigorously, however, on into September, but in the meantime the first mammoni generation of *Blastophaga* developed from the comparatively few mammoni figs which were in a receptive condition between June 11 and July 5, began issuing August 13, and continued to issue on into September. This practically means that there were two generations of *Blastophaga* covered by one generation of caprifigs. Judging by the observations of last year (and it will be remembered that the *Blastophagas* issued in great numbers the second week in November), there are unquestionably four generations of *Blastophaga* at Fresno, contrary to preconceived ideas. Moreover, Mr. Schwarz writes that from a study of the dates given by Dr. Paul Mayer he has not the least hesitation in asserting that at Naples, Italy, there are also two mammoni generations of *Blastophaga*. Mayer's dates, September 4 and October 28, when he observed the mature insects, plainly indicate two generations, for it is very improbable, judging by Mr. Schwarz's careful observations the past summer, that the period of issuing of one generation of *Blastophaga* should occupy eight weeks. Dr. Mayer came near assuming two mammoni generations of *Blastophaga*, but preferred to cling to the three-generation theory, and tried to

explain away the difficulties by the assumption of early and late trees. At Fresno there is no such thing as early and late trees. One variety of caprifig is five or six days later than the other, but there is no greater difference.

These second-crop figs, which were not entered by the *Blastophaga*, dropped just as did the noncaprifiged Smyrna figs, most of them dropping when very young. The changes which take place in the second-crop figs which have been stung are practically the same as in the Smyrna figs. The final expansion is not very marked, but is accompanied by a noticeable change of color, from a rather dark olive green to a beautiful sea green. At the time of issuing of the insects the ripening mammoni are globular or very slightly elongate, white, and not particularly soft, but they turn quite soft and yellowish on the second day after the issuing of the first insects. On the fourth day they usually drop, having acquired a dirty ochreous color. From the majority of them a few female *Blastophagas* still issue when the fig is on the ground. All of these figs are of remarkably small size, only a few specimens being a little larger than a large cherry. In consequence of their small size, the number of *Blastophagas* issuing from each is correspondingly small. No exact count was made, but there are hardly more than 100 galls in the largest figs and less than 50 in the smallest. The females issue, as with the profichi generation, in the forenoon. At first they come out about 10 o'clock and continue until nearly noon, but as more figs become active the insects come out earlier, and by the 1st of September they commence to issue at 7.30 and continue until about 10 o'clock.

The time occupied in the development of this early generation of *Blastophagas* in the second crop of figs was practically two months, since from June 11 to July 5 the issuing profichi generation of *Blastophagas* were ovipositing in the advanced second crop of figs, and the issuing of their offspring occupied the interval from August 13 to about September 15.

FOURTH GENERATION OF BLASTOPHAGAS.

The later generation of *Blastophagas* in the second crop of figs, that is, the fourth generation, beginning from the overwintering mamme, proved to be a mere repetition of the first mammoni generation, taking place in what is unquestionably the same crop of figs. The first set of figs of this crop came just in time to catch the profichi *Blastophagas* (June 11 to July 5). The next set did not get any of the insects (July 5 to August 13). That which was receptive subsequent to August 13 caught the early mammoni generation of *Blastophaga*, and the figs becoming receptive after September 12 did not get any insects. The interesting point about the later mammoni generation of *Blastophaga* is that it consists of what may be termed a recuperation of the

Blastophaga to a larger number of specimens after the great breakdown suffered by the scarcity of available second-crop figs during the first mammoni generation. On September 16 Mr. Schwarz found that he had many thousands of inhabited figs of the later mammoni generation of *Blastophaga* (fourth generation). On September 13 he cut open two average-sized mammoni and found the interior of normal form, pale yellowish in color, and crammed full of well-developed galls, in which the *Blastophaga* larvæ were already plainly visible without a magnifying glass.

On September 17 the offspring of the profichi *Blastophagas* brought down from Niles commenced to issue. The duration of the first mammoni generation commencing on July 21 was therefore only fifty-eight days, a trifle shorter than the average duration of the Fresno insects. By September 24 almost every available fig in proper condition had been taken possession of by these insects, thus forming a second mammoni generation four and one-half weeks later than that formed by the Fresno *Blastophagas*.

On the 29th of September Mr. Schwarz visited Niles and examined the situation there. He concludes that there is every reason to suppose that the *Blastophaga* can be permanently established at that point, and that as a station for stocking or restocking other places with *Blastophaga* the importance of Niles can not be overestimated. The value of the ability to transfer the insect to localities having another climate can not fail to be very great. Thus, the importation of the Niles profichi to Fresno resulted in a mammoni generation of *Blastophagas* which is intermediate between the two Fresno mammoni generations, and this no doubt will increase or did increase the chances of producing a greater supply of healthy wintering figs. The value of a similar transfer of winter figs in April, or even later, will be still more important, as it will produce later profichi insects at Fresno.

POSSIBLY ONLY TWO TRUE CROPS OF CAPRIFIGS.

As the autumn advanced it was noticed that no break could be seen in the fig crops between the mammoni and the expected mamme, such as undoubtedly occurred between the profichi and the mammoni. Solms-Laubach says that in Europe there is no sharp distinction between mammoni and mamme, and that those of the former crop which do not mature in the fall remain as mamme over winter. The question arises, then, Are there two separate crops of figs or are the hibernating figs, known as the mamme crop, simply all late developing and overwintering mammonis? Mr. Schwarz observed that there is not the slightest difference in the mode of growth and location on the twigs between the mammoni and the mamme, which both develop on the new growth of the season. The first crop of figs develops on the old growth, and is accompanied by a liberal sprouting of leaves.

Toward the end of May the appearance of the second crop is also accompanied by the appearance of a set of leaves, but after that time no new leaves sprout and the leaf buds on the trees in October plainly belong to the first crop of the next year. If there were a third crop of figs would there not also be a third crop of leaves?

ISSUING PERIODS OF BLASTOPHAGA.

To sum up, the issuing periods of *Blastophaga* during the season, both in California and in Naples, Italy, are shown in the following table, which will doubtless make perfectly clear the somewhat complicated conditions described in previous paragraphs:

Dates showing the issuing periods of Blastophaga.

Generation.	Issuing periods of <i>Blastophaga</i> in California.			Issuing periods of <i>Blastophaga</i> in Italy.	
	Fresno.	Fresno, imported from Niles.	Niles.	Naples. (According to P. Mayer.)	Dates given by Eisen.
Mamme	Mar. 28-Apr. 25	.....	.....	End of March to April.	April.
Profichi	June 11-July 5	July 21-July 27	Aug. —Sept. 3	June 22-July 27	June.
First mammoni.	Aug. 13-Sept. 12.	Sept. 17-Sept. 28.	.....	Sept. 4	
Second mammoni.	Oct. 5 .....	.....	.....	Oct. 28	October.

Dates of issuing are of great value when we consider the question of the practical handling of the insect. Those above given may be modified by subsequent experience or by differing weather conditions, but they will probably remain approximately constant.

ABSENCE OF PARASITES.

A very fortunate aspect of the situation in California at the present time is the absolute absence of parasites of the *Blastophaga*. Elsewhere the *Blastophaga* has its parasites, and the very important one in South Europe, *Philotrypesis*, although introduced in the original importations which Mr. Swingle sent from Naples in the spring of 1898, and present in great numbers, was killed off so far as possible by Mr. Roeding, and in fact the whole importation failed. The Algerian importations in the spring of 1899, from which the success of the experiment dates, appeared to contain no parasites whatever, and in the whole course of his summer's work at Fresno Mr. Schwarz never saw one, so he feels sure that it does not exist there. Nor did he see any trace of the work of the Nematode, which is said by Italian writers to be a constant inhabitant of caprifigs and edible figs. Unless, therefore, parasites of *Blastophaga* are introduced with wild figs from Lower California, Mexico, or Florida, it is unlikely that *Blastophaga*

grossorum will have parasites in California. It has, however, other unimportant natural enemies like the Chrysopa and ladybird larvæ, but its greatest natural enemies are found in spiders. Webs constructed across the surface of a leaf or between the figs and the nearest leaves, geometrical webs between branches, simple runways spun along branches or between branches, all catch many *Blastophagas*. Those across the surface of the leaf seem the most destructive, and Mr. Schwarz found frequently from 100 to 150 specimens of *Blastophaga* caught in one of these webs. One little wolf spider was observed to catch *Blastophagas* as they emerged from the figs. Certain birds extracted the galls from ripening caprifigs.

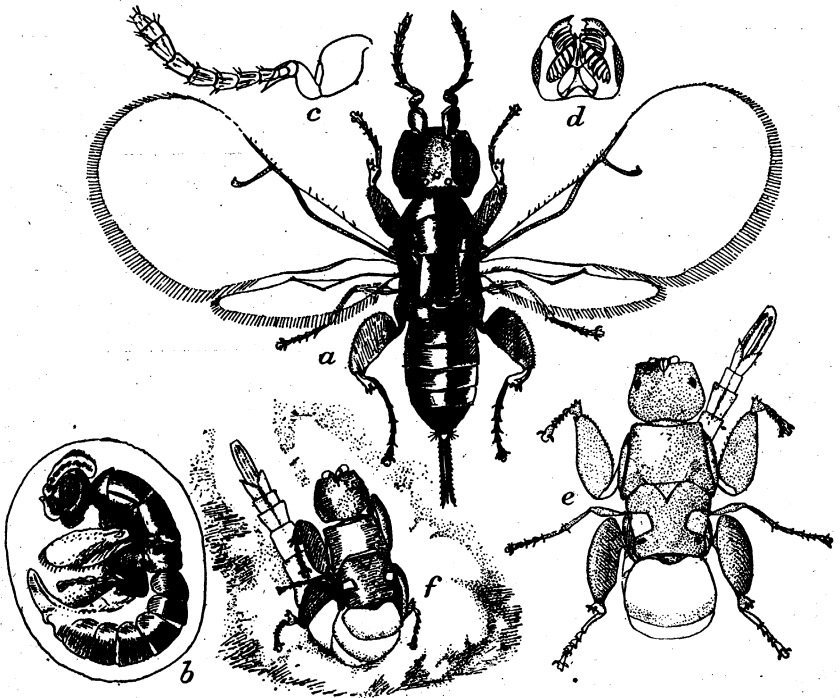


FIG. 3.—*Blastophaga grossorum*: a, adult female with wings extended, seen from above; b, female not yet entirely issued from pupal skin and still contained in gall; c, antenna of female; d, head of female from below; e, adult male; f, the same—all greatly enlarged (original).

LIFE HISTORY OF BLASTOPHAGA.

So far, we have referred to the life history of the fig-caprifying insect only in the most general terms. The illustration (fig. 1) which is given of the insect in the early part of this article is a copy of an old one drawn by the famous English entomologist, Prof. J. O. Westwood, and which was published in the Transactions of the Entomological Society of London, 1882, plate iv, in part. It is an interesting figure, and illustrates rather well the difference between the male

and the female. It shows the peculiar mouth parts of the female, which enables her to gnaw her way through the tough seed-like gall, and shows also the male in the act of fertilizing the female and the female in the act of issuing from the gall. It is, however, incorrect in some of the rather important structural details, as will be seen by comparing it with fig. 3, here given, which has been drawn under the writer's supervision from living specimens reared at this office and in Cali-

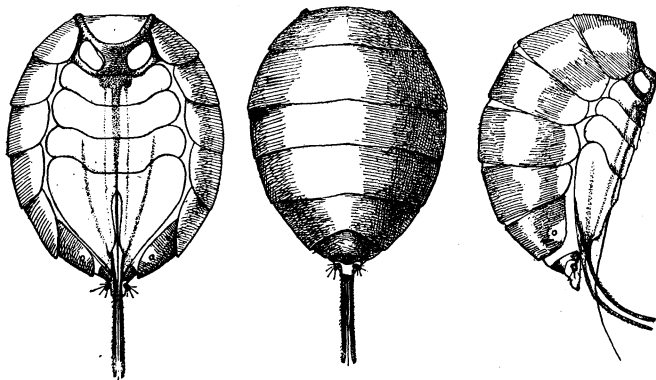


FIG. 4.—Abdomen of *Blastophaga*, female, viewed from beneath, from above, and from the side—enlarged (original).

fornia. The entomologist will at once note especially the difference in the details of the thorax in both males and females, and especially will the difference in the length of the abdomen of the male be seen. (Figs. 4 and 5.)

The male is always wingless. It has no ocelli, and its compound eyes are greatly reduced in size. The fact that the male rarely leaves the fig in which it has hatched might almost be inferred from these facts of winglessness and partial blindness. When this wingless male issues from the seed-like gall in which it is contained, it seeks a female gall in the interior of the same fig, gnaws a small hole through its cortex, inserts its extremely long, almost telescopic, abdominal extremity through the hole, and fertilizes the female. The female subsequently, with her powerful jaws, gnaws the top of the gall off and emerges, crawling around the interior of the fig and eventually forcing her way through the ostium, almost immediately seeking for young figs, which she enters, and should the fig entered prove to be a caprifig, lays her eggs at the base of as many male flowers as she can find, and then dies. Should the fig entered, however, be a Smyrna fig, either through the fact of the caprifig from which she issued having

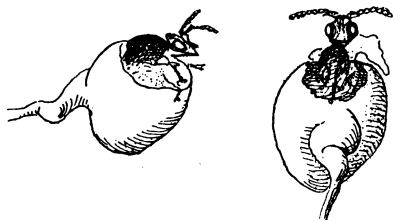


FIG. 5.—Female *Blastophagas* issuing from the galls—greatly enlarged (original).

been hung in the branches of a Smyrna fig tree, or from the fact that she has flown to an adjoining Smyrna fig tree, she walks around among the female flowers seeking for a proper place to oviposit, discovering eventually that she has made a mistake, but, nevertheless, probably trying to find a proper place for oviposition by thrusting her ovipositor in here and there. It is this futile, wandering search, covered as her body is with pollen from the caprifigs, that produces the extensive and almost perfect fertilization of the entire number of female flowers.

THE EGG.

The egg when seen in the ovary is very long and slender, but when found in the fig it is less than three times as long as broad, almost regularly elliptical in shape, white and slightly shining, with a delicate petiole of about $1\frac{1}{2}$ times its length. On dissecting a male flower into which the egg has been inserted by the female *Blastophaga*, it will be found to have been pushed in transversely to the axis of the flower

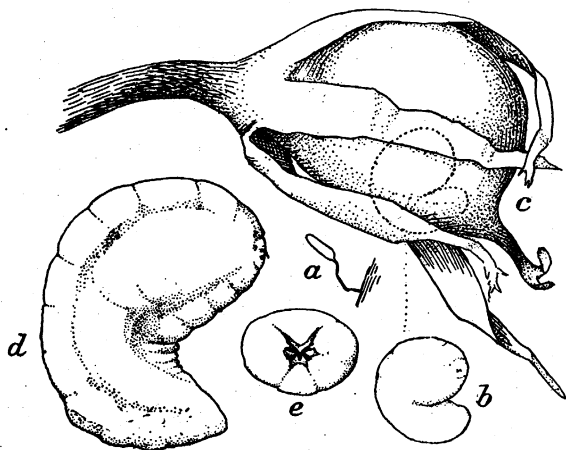


FIG. 6.—*Blastophaga grossorum*: a, egg; b, young larva; c, outline of same in gall; d, full-grown larva; e, mouth of same—enlarged (original).

nearly to the center, with the petiole reaching out to the cortex. Its dimensions are, length, exclusive of petiole, 0.092 mm.; width, 0.046 mm.

THE LARVA.

The young larva is a delicate little creature curved upon itself and showing no visible segmentation, much as indicated in fig. 6, *b*. It takes many days development of the caprifig before the larva becomes visible with certainty without the most careful observation under a strong lens. The first sign which indicates that one is watching the larva and not the sap in the gall is the visibility of two brownish spots, which are without doubt the mandibles of the larva. When these spots become visible, with a very powerful hand lens (one-fourth inch Tolles triplet), the larva is more than two-thirds grown and the segmentation of the body has become noticeable. It is a very difficult thing to dissect the larva out of the gall without crushing it, but it can be accomplished with care by the aid of dissecting needles. No casting of the skin has been observed. The full-grown larva presents the appearance indicated in fig. 6, *d*, and occupies the position in the gall shown by the

dotted lines in fig. 6, *c*. With the growth of the larva the gall at the base of the male florets becomes hard, and greatly resembles a seed, turning light brown in color.

THE PUPA.

The male and the female pupæ each occupies a greater portion of the interior of the gall, and the advanced female pupa, almost ready to emerge, presents the appearance indicated in fig. 7.

DURATION OF THE EARLY STAGES.

This is a point upon which it is very difficult to secure exact data. From the table of dates of the issuing periods printed on page 99, the duration of a generation, excepting, of course, the hibernating generation, seems to average between sixty and sixty-eight days, say, sixty-four days. It seems certain that more than fifty days are given to the larval stage. Oviposition takes two days, or perhaps longer, and the last larval stage

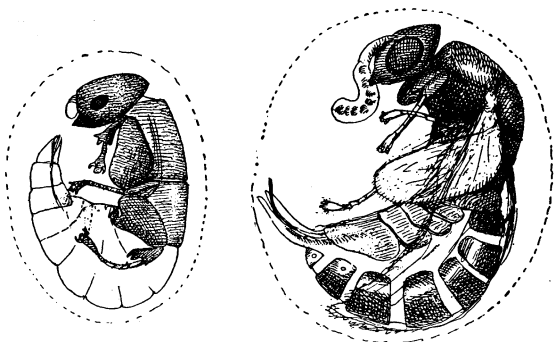


FIG. 7.—*Blastophaga grossorum*: Male and female pupæ in galls—enlarged (original).

with the pupa stage, and what may be termed the immature imago stage, lasts only a few days. All of the long intermediate period is occupied by the immature larval stages unless there should prove to be a prolonged egg state, which is very improbable. These three stages seem paralleled by the three outwardly visible changes undergone by the fig, and which have been described in preceding paragraphs. The first swelling of a freshly stung fig, about four days after the entering of the insect, probably marks the hatching of the egg. The long intermediate stage of slow almost imperceptible growth is identical with the duration of the larval stage, and includes also the pupal stage. The final and sudden expansion of the fig always marks the issuing from the galls (but not from the fig) of the male imagos. In the hibernating generation the duration of the final stage is greatly prolonged. On March 15 Mr. Schwarz found the insect in fallen overwintering figs as larva, pupa, immature imagos, and occasionally mature male imagos, and this lasted until March 28 or later. The same state of affairs was found in figs sent to the writer by Mr. Roeding as early as February. It seems probable that before a sudden drop in temperature occurred at any time subsequent to the middle of October the insect would hibernate in all of the different

stages in which it might happen to be at the time, because it is the presence of the insect which makes the fig adhere to the branch during the winter.

THE OUTLOOK FOR THE NEW INDUSTRY.

The success of the present season's work at Fresno indicates that in very many localities in the interior valleys of California good crops of Smyrna figs can be raised, and there is little doubt that many persons will at once start orchards of Smyrna fig trees, with the proper sprinkling of caprifigs. This statement holds not only for California, but unquestionably for good fruit-growing regions in New Mexico, Arizona, and Texas. Mr. A. M. Gildea, at Del Rio, Tex., for example, has now several 10-year-old caprifig trees in good condition, growing from the Department of Agriculture seedlings of 1890. This experience, however, does not enable us to make any predictions of value regarding the Gulf region. Experiment stations in Louisiana and more Southeastern States, and fruit growers in those States who can spare the land and the time to conduct the experiment, should by all means try it on a small scale. We possess very little information which will enable us to predict with any certainty the outcome of such experiments. The climate of these regions differs so radically from that of the Roeding place at Fresno that unquestionably not only will the caprifigs and Smyrna figs have different seasons, but the insect will be considerably altered in its life-history periods, even if it should flourish in such parts, and that itself is a fact of which we can not be absolutely certain. It is for these reasons that we earnestly advise that the experimental work at first should be done upon a small scale. A few trees only of several varieties of caprifigs and of Smyrna figs should be started, so that much valuable land need not be occupied. After these trees come into bearing the work of a season or two will indicate the probabilities of success, and then, if the results warrant further outlay, more trees can be started. We are sure that the insect will flourish in a dry climate where there is little frost. Persons residing in such locations can begin planting at once with a reasonable certainty of a profitable outcome. In all other regions planting should be done experimentally and in a small way. The work which has been done so far in California will be followed up by this Department. Further observations upon the *Blastophaga* will be made, and its habits will be carefully followed during succeeding generations, while the Section of Seed and Plant Introduction promises to secure cuttings of all possible varieties of caprifigs, and to distribute them at proper points, so that in the emergency of the dying out of the insect at one place it can be reestablished at another point within our own territory.

Aside from the manipulations connected with the operation of caprificating the Smyrna trees (see pp. 90-93), it may safely be assumed that the management of the *Blastophaga*, for the propagation of the species, will not cause any trouble throughout the year, provided that a sufficient number of capri trees are planted in the proper way. Each of the three Asiatic varieties of capri tree represented in the Roeding orchard has peculiar advantages and disadvantages, all of them, however, being valuable varieties. The mode of planting them in two long rows (as shown in the plat of the orchard in Pl. I) caused considerable work as often as the *Blastophaga* made its appearance outside of the figs. For the present, it is recommended that the capri trees be planted in a grove by themselves, so that the insect will have the greatest possible chance of spreading by natural means.

The Smyrna fig stands in the same relation to other varieties of figs as the Washington navel orange stands to ordinary varieties of oranges, and its superiority as a dried product over all other varieties which develop without caprification can no longer be questioned. The annual output of Smyrna figs is estimated to be from 12,000 to 15,000 tons, and these figs sell at wholesale in the New York market at from 10 to 20 cents per pound, while the best grade of California figs, as hitherto raised without the assistance of the *Blastophaga*, does not bring more than 75 cents for a 10-pound box, and when the Smyrna figs arrive it is difficult to sell California figs at any price. The successful production of the Smyrna fig described in the foregoing pages practically awakens a new industry for the United States.

In 1894 we imported 13,440,604 pounds of Smyrna figs, the valuation of which was \$698,894. After the adoption of the tariff law of 1897, which fixed an import duty of 2 cents per pound, shipments to this country decreased, and the importations for 1898 amounted to 7,992,544 pounds, the valuation of which was \$382,784. The following year the importations increased to some extent, and the price was higher. In that year we imported 8,535,967 pounds, and the valuation was \$504,800. It seems very probable that in the near future these importations will practically be stopped, as our whole country will be supplied with home-grown dried figs. The transportation charges from California, before the construction of a trans-isthmian canal, will keep the prices high in the Eastern States, but it is safe to say that with the better character of the product the total consumption of dried figs will increase. But this feature by no means comprises all the possibilities of the industry. America will compete with the Mediterranean countries in the open markets of the world. The character of the product, even of this first year's crop, shows it to be superior to the Oriental product, both from chemical analysis and from expert opinion. Experience gained this year assures a much better result next year,

not necessarily in the quality of the fruit itself, but in methods of drying and packing and of producing an attractive product for the market. Cleanliness in packing, prevention of the disgusting worms so often found in the imported Smyrna figs, and other similar points will be carefully attended to by American packers. At present there are by no means enough trees growing in California to bring about this result; but the right varieties will be planted by the thousands during the coming year, and in four or five years will be producing substantial crops.