

Arizona

Commission of Agriculture  
and Horticulture

---

**FIFTH ANNUAL REPORT**

For the Year Ending June 30, 1913

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Phoenix, Arizona. December 24, 1913

LETTER OF TRANSMITTAL

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*To His Excellency, George W. P. Hunt, Governor of Arizona:*

SIR: In accordance with a provision of the Arizona Crop Pest Law, we submit herewith the Fifth Annual Report of the Arizona Commission of Agriculture and Horticulture, for the year ending June 30, 1913.

Very respectfully,

ANDREW KIMBALL, Thatcher  
*Chairman.*

W. K. BOWEN, Mesa,  
*Member.*

R. H. FORBES, Tucson,  
*Secretary-Treasurer.*

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PLATE I.—TWO DISEASES AFFECTING THE ROOTS OF NURSERY TREES

Upper figures.—Crown gall, hairy root type, on roots of apple trees from shipment into State of Arizona.

Lower figure.—Roots of mulberry infested with nematode worms producing condition known as root knot. From shipment into State of Arizona, condemned by inspector.

# ARIZONA COMMISSION OF AGRICULTURE AND HORTICULTURE

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## FIFTH ANNUAL REPORT

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*For the Year ending June 30, 1913*

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Horticulturally, the year has been one both of progress and of retrogression. At higher altitudes, and in deciduous districts generally, planting of apple trees, peaches, pears, plums, grapes and other deciduous species have been made in substantial numbers. In certain districts where cheap lands are available, and where climatic and soil conditions are favorable, olives are being planted, or are in contemplation, to a considerable extent.

In the dry-farming districts, particularly, a good many small orchards have been set experimentally in the effort to develop fruit production under conditions heretofore considered unfit for orchards. At higher altitudes small orchards are being planted and irrigated from springs, small streams, and wells with excellent success, much of the best fruit of the State being thus produced. These isolated small orchards are in many instances free from codling moth and other pests and are, therefore, very profitable to their owners.

The citrus districts of the State suffered a serious setback because of the cold weather of January 6 to 9, 1913. This season of severe frosts, during which the temperatures registered in some orange growing districts were as low as 14° to 16° F., prevailed generally throughout the Southwest, including Southern Arizona, Southern California and the San Joaquin Valley of California, and extended to an unknown distance southward into Sonora. As a result of this severe season the supply of nursery stock and the fruit crop were cut short in both Arizona and Southern California, excepting in a few favored locations in the foothills of the California citrus growing districts, and on the mesa near Yuma. The Yuma citrus district

appears to be distinctly favored in comparison with other southwestern localities, and the experience of the year promises well for the mesas adjacent to the lower Colorado River.

The extreme cold weather also resulted in cutting short certain other fruit and nut crops in Southern Arizona, as almonds, peaches, apricots and walnuts. The behavior of date palms under extreme cold was especially interesting. At altitudes of 1,000 feet and above, in southern Arizona, the foliage of the palms was nearly or quite all destroyed. The cold, however, did not succeed in penetrating the thick, succulent trunks sufficiently to kill the trees, which quickly put forth new crowns with the advent of warm weather, and six months later showed surprisingly little trace of damage. The orchards at Tempe and Yuma even produced small crops of dates, although many of the earlier buds beginning to put forth at the time of the freeze were destroyed. Date palms, indeed, have proved much better adapted to extreme conditions of heat, cold, and alkaline soils than citrus trees, and the experience of the year further establishes them in confidence and regard as a future horticultural asset of the region.

Infested districts, through inspectors, as well as through the good will of those resident therein, are making creditable efforts to meet the quarantine and other orders of the Commission, which are designed particularly to exclude infested nursery stock, to enforce spraying operations in orchards infested with codling moth, and to prevent sale and transportation of dangerous wormy fruit from point to point. It is true that these orders sometimes impose a temporary hardship. Local citrus nursery stock, for instance, was cut back by the freeze so that it could not be sold the following Spring. The temptation to throw the doors open to imported citrus stock from infested districts was therefore strong, but, fortunately, the good sense and self restraint of the orange growers themselves declared in open meeting for a strict maintenance of the quarantine. Likewise, the temptation to sell infested apples from the orchards in Graham County was great, but a reasonable statement of the objects of the order prohibiting such sale and distribution by the local inspector secured compliance to the order on the part of local growers. In Utah, several years' effort was required to secure a similar order, with the result that the infested orchards of that State have been purified and Utah is now famous for the excellence, beauty and value of her apple harvests. The contest with woolly aphis is proving to be a difficult one inasmuch as the root-infesting habits of this creature, and the several broods which may be produced during our long grow-

ing season, make it a difficult pest to combat. The discovery of San Jose scale in the State in a state of pernicious activity, in spite of our supposed climatic immunity from its ravages, further dispels the old superstition that Arizona is exempt from insect pests, and further attests the good fortune of the State thus early in its agricultural history, in having available an organized agency for the exclusion or extermination of these pests.

### OPERATIONS UNDER THE NEW LAW

The official work of the Commission, immediately following the initiation of the new crop pest law, has been, largely, one of organization and re-statement of orders and rulings made under the old law. Under the direction of the State Entomologist this work was completed early in the year and the machinery of the Commission, improved and extended, was inducted into early operation. With ampler funds and a larger personnel, a corresponding increase of inspection work has been accomplished, and a larger measure of safety accorded to the farmers and fruit growers of the State.

The codification of the laws of the State in connection with the work of the First State Legislature, resulted in slight changes in the Crop Pest Law passed May 24, 1912. These changes were mostly in phraseology. However, the Director of the Experiment Station was made *ex-officio* Secretary of the Commission, without qualification; and the emergency appropriation of \$1,500.00 to fight the alfalfa weevil in the event of its appearance was dropped. It has been found possible, however, to reserve this sum, from current appropriations, against future emergencies.

### OFFICIAL ACTS OF THE COMMISSION

Seven meetings of the Commission were held in the course of the year, as follows:

1. An informal meeting of the old Horticultural Commission occurred at Thatcher, August 20 and 22, 1912, the business of the meeting being to prepare for the opening of operations under the Arizona Crop Pest Law of 1912, in August. Tentative actions for subsequent confirmation by the Commission in legal meeting were taken relative to officers for the following year; the time of the annual meeting; the division of the State into agricultural and horticultural districts, inspectors for the same and their compensation; the appointment of an Entomologist and an Assistant Entomologist; and a

schedule of expenditures for 1912-1913. The official report of the Horticultural Commission for the quarter ending June 30, 1913, was read, signed and forwarded to the State Auditor; and the Annual Report of the Horticultural Commission for the fiscal year ending June 26, 1912, was approved and ordered printed, to include the Entomologist's report for the same period.

Tentative action was also taken in connection with publicity meetings to be held in those communities affected by operations of the Commission personnel at Phoenix during Fair week; and for convenient names applying to the Commission and its officers. Quarantine Orders Nos. 1, 2 and 3 were read and discussed in advance of their adoption by the Commission of Agriculture and Horticulture.

## 2. Annual meeting of the Commission of Agriculture and Horticulture, Commercial Hotel, Phoenix, September 3, 1912.

This was the first regular meeting of the Commission of Agriculture and Horticulture, the new law having gone into effect August 16, the members of the Commission having been duly appointed by the Governor August 28, bonds already on file continuing in effect, and oaths of office, dated September 3, 1912, being on file.

Andrew Kimball was elected Chairman and R. H. Forbes Secretary-Treasurer, for the ensuing year.

Measures informally approved August 20 and 22 by the old Commission were adopted as follows:

(1) The date of the annual meeting was set for Wednesday of State Fair week each year.

(2) The State was divided into the following agricultural and horticultural districts:

No. 1. Graham, Greenlee and Gila Counties.

No. 2. Maricopa and Pinal Counties.

No. 3. Yuma County.

No. 4. Yavapai, Mohave and Coconino Counties.

No. 5. Navajo and Apache Counties.

No. 6. Cochise County.

No. 7. Pima and Santa Cruz Counties.

(3) The following first-grade inspectors were appointed:

District No. 1.—R. E. L. Wixom, Thatcher, Arizona;

W. O. Wheatley, Clifton, Arizona.

District No. 2.—Geo. Acuff, Phoenix, Arizona;

F. H. Simmons, Tempe, Arizona;

Chas. Sellers, Mesa, Arizona.

District No. 3.—

District No. 4.—L. L. Bates, Prescott, Arizona.

District No. 5.—S. D. Smith, Holbrook, Arizona.

District No. 6.—E. P. Grindell, Douglas, Arizona.

District No. 7.—

(4) The compensation of first-grade inspectors was fixed at \$3.50 a day and expenses, limiting the number of hours to eight in each twenty-four. The compensation of second-grade inspectors was similarly fixed at \$2.50 a day.

(5) Dr. A. W. Morrill was appointed Entomologist of the Commission and officially designated the "State Entomologist of Arizona" with salary at \$2,200 per annum, and an additional salary of \$300 as Entomologist of the Agricultural Experiment Station.

The Assistant Entomologist was designated the "Assistant State Entomologist of Arizona."

The law creating the Arizona Commission of Agriculture and Horticulture, approved May 24, 1912, was designated the "Arizona Crop Pest Law of 1912."

Each inspector appointed by the Commission under the new law was designated a "Crop Pest Inspector" for his district.

A schedule of expenditures for 1912-1913 with a sum total of \$11,000.00 was adopted.

A meeting of inspectors and other members of the Commission personnel was ordered to be called at Phoenix during Fair week and a program arranged for the improvement of the service and a better understanding among those making up the Commission personnel. Excursion rate railroad fares were ordered refunded to all inspectors attending the program as arranged. Dr. O. C. Bartlett, of Northampton, Massachusetts, was offered the position of Assistant Entomologist, with the title of "Assistant State Entomologist" at \$1,400.00 per annum. This offer was subsequently accepted.

Quarantine orders were read, discussed, amended and adopted as follows:

No. 1. RELATING TO ALFALFA WEEVIL. This order prohibits the importation of certain materials from districts known to be infested with alfalfa weevil, and provides for restricted admission of live stock, merchandise, etc. from such districts.

No. 2. RELATING TO WHITE FLIES. Provides against the introduction into the State of Arizona of three species of white flies and their food plants.

No. 3. RELATING TO THE MEXICAN ORANGE MAGGOT. Provides against the admission into Arizona of guavas, mangoes and oranges grown in Mexico, and for their destruction when so imported.

It was declared that apple and pear growing districts of Arizona were endangered by the traffic in fruit infested with codling moth and the State Entomologist was advised to take such action as was practicable under the Crop Pest Law of 1912 to prevent further spread of the codling moth in the State.

3. Annual meeting of the Arizona Commission of Agriculture and Horticulture, Office of the Commission, Phoenix, Arizona, October 30 - November 1, 1912. The Commission met with the entomologists and inspectors in discussion of the provisions and workings of the Crop Pest Law of 1912, the meeting being well attended by those concerned.

Petitions, pro and con, relating to the work of the State Entomologist and of the Commission were received and discussed at length, and letters ordered forwarded to the petitioners by the Secretary of the Commission.

The following crop pest inspectors were appointed:

District No. 1.—J. W. Aker, Duncan, Arizona;

Ira Harper, Deputy, Clifton, Arizona.

District No. 2.—J. R. Sandige, Deputy, Tempe, Arizona.

District No. 3.—C. J. Wood, Yuma, Arizona;

Roy Hansberger, Deputy, Yuma, Arizona.

District No. 4.—Ross H. Blakeley, Kingman, Arizona.

District No. 6.—R. B. Henrich, Bowie, Arizona.

District No. 7.—Robt. E. Lee, Nogales, Arizona;

J. H. Barrett, Tucson, Arizona.

A motorcycle for the entomologists and inspectors of the Commission in District No. 2 was ordered purchased. A reference book on Insect Pests and one on Diseases of Economic Plants was ordered placed in the hands of inspectors at half price.

Quarantine orders were adopted as follows:

No. 4. RELATING TO GRAPE PHYLLOXERA. This provides against the introduction and dissemination of the grape phylloxera.

No. 5. RELATING TO THE COTTON BOLL WEEVIL. This provides against the introduction of cotton seed from districts known to be infested with the boll weevil.

No. 6. RELATING TO CALIFORNIA RED AND YELLOW SCALES. This provides against the introduction of these scales from California.

It was ordered that white fly food plants shipped into Arizona from other states or countries should be completely defoliated.

An importation of date suckers at Yuma was discussed, and its treatment by means of braucco spray was ordered.

4. Meeting of the Arizona Commission of Agriculture and Horticulture held at the University Main Building, Tucson, Arizona, November 14, 1912.

Quarantine Order No. 6, relating to citrus quarantine, was amended to exclude Tulare and Fresno Counties in California from the provisions of the order. A new office room was authorized to be secured.

5. Meeting of the Arizona Commission of Agriculture and Horticulture, Office of the Commission, Phoenix, Arizona, January 21, 1913.

The following quarantine order was adopted:

No. 7. RELATING TO DATE PALM SCALES. This provides for the admission of date palms to the State, or their transportation within the State after treatment with the blast torch.

Foul brood of bees was declared not to come under the authority of the Commission.

An open session was held with orange growers to discuss citrus quarantine in connection with the recent frosts. It was observed that the demand for nursery stock had been lessened by the frost and that the local supply of clean trees had also been cut down. The expediency under these conditions of modifying the quarantine order was discussed, but it was finally agreed that before taking such action members of the Commission should personally investigate the situation in Southern California.

The modification of Quarantine Order No. 1 against the alfalfa weevil was also discussed in open meeting, but such modification was denied, attention of alfalfa growers being called to the severe measures taken against alfalfa weevil in other states.

The following crop pest inspectors were appointed:

District No. 2.—P. B. Beville, Mesa, Arizona.

District No. 4.—Eugene Neuman, Deputy, Prescott, Arizona.

District No. 5.—Ove E. Overson, St. Johns, Arizona.

District No. 6.—C. A. Taylor, Douglas, Arizona.

6. Adjourned meeting of the Commission, Office of the Commission, Phoenix, January 22, 1913.

Inspection Order No. 2, providing for Class A and B Stations and a mode of operation for the inspection service was adopted.

A report was received from the State Entomologist relating to a uniform plan of nursery inspections to be proposed for adoption by different states in common.

7. An open meeting of the Crop Pest Commission with the orange growers was held at the Board of Trade, Phoenix, February 12, 1913.

A report by Messrs. Bowen and Forbes relating to citrus conditions in California and Arizona was read. It was shown that the January freeze was a very general one, affecting the citrus districts in Southern California and in Fresno and Tulare Counties, as well as in Arizona, and the generally infested condition of California groves with various scale insects was attested.

After a spirited discussion of the report at length and after various expressions of those present, mostly in favor of Arizona quarantine measures, a resolution to maintain the quarantine as heretofore was moved, seconded and carried by a large majority.

### PERSONNEL OF THE COMMISSION

The personnel of the Commission and its appointees for the year is as follows:

Andrew Kimball, Thatcher, Arizona, Chairman.

R. H. Forbes, Tucson, Arizona, Secretary and Treasurer.

W. K. Bowen, Mesa, Arizona, Member.

Dr. A. W. Morrill, Phoenix, Arizona, State Entomologist.

Dr. O. C. Bartlett, Phoenix, Arizona, Assistant State Entomologist.

District No. 1.—R. E. L. Wixom, Thatcher, Arizona.

W. O. Wheatley,<sup>1</sup> Clifton, Arizona.

J. W. Aker, Duncan, Arizona.

Ira Harper, Deputy, Clifton, Arizona.

District No. 2.—Geo. Acuff, Phoenix, Arizona.

F. H. Simmons, Tempe, Arizona.

Chas. Sellers,<sup>2</sup> Mesa, Arizona.

J. R. Sandige, Deputy, Tempe, Arizona.

P. B. Beville, Mesa, Arizona.

District No. 3.—C. J. Wood, Yuma, Arizona.

Roy Hansberger, Deputy, Yuma, Arizona.

District No. 4.—L. L. Bates, Prescott, Arizona.

Ross H. Blakely, Kingman, Arizona.

Eugene Neuman, Prescott, Arizona.

District No. 5.—S. D. Smith, Holbrook, Arizona.

Ove Overson, St. Johns, Arizona.

District No. 6.—E. P. Grindell, Douglas, Arizona.

R. B. Hendrich, Bowie, Arizona.

C. A. Taylor, Douglas, Arizona.

District No. 7.—Robt. E. Lee, Nogales, Arizona.

J. H. Barrett, Tucson, Arizona.

<sup>1</sup> Resigned

<sup>2</sup> Deceased.

## FINANCIAL STATEMENT

The finances of the Commission under the new law have been much more adequate than formerly, the available resources having been increased from \$5,000.00 for the year ending June 30, 1912 to \$11,000.00 for the year ending June 30, 1913. This improvement in finances has made possible the addition of the Assistant State Entomologist and of several much needed inspectors in various parts of the State. It has been possible, also, to maintain a financial reserve of about \$1,500.00 with which to meet emergencies that may arise from time to time. Such a reserve would be essential if alfalfa weevil, cotton boll weevil or other malignant pests should unexpectedly be discovered in Arizona.

Following is a detailed statement of expenditures for the year ending June 30, 1913. This statement shows the amount of money devoted to inspection service in the various districts, as well as the general expenditures which apply to the benefit of all districts.

ANDREW KIMBALL, *Chairman.*

R. H. Forbes, *Secretary and Treasurer.*

W. K. Bowen, *Member.*

## CLASSIFIED EXPENDITURES FOR THE YEAR ENDING JUNE 30, 1913

SCHEDULE	General	District No. 1	District No. 2	District No. 3	District No. 4	District No. 5	District No. 6	District No. 7	Totals
1a Salaries.....	4688.18								\$4688.18
1b Scientific assistance.....	1.55		90.00						91.55
1c Inspection.....	15.75	369.65	898.26	60.88	253.08	80.85	66.76	151.48	1896.71
2 Labor.....	40.46		4.00	13.50		20.00			77.96
3 Publications.....	331.78	4.00							335.78
4 Postage and stationery....	423.83	15.30			6.60	5.09	3.60		454.42
5 Freight and express.....	138.22	.90							139.12
6 Heat, light, water.....	14.50								14.50
7 Scientific apparatus.....	150.99								150.99
8 Sundry supplies.....	418.86	1.65	13.60			50			434.61
9 Books, etc.....	111.06								111.06
10 Tools, implements, mchy.	75.98		1.45						77.43
11 Furn., fixtures., ofc. rent..	564.80								564.80
12 Traveling expenses.....	1383.00	98.62	68.50	20.50	53.65	18.00	16.80	67.90	1726.97
13 Miscellaneous.....	40.52								40.52
<b>Totals.....</b>	<b>\$3399.48</b>	<b>\$490.12</b>	<b>\$1075.81</b>	<b>\$94.88</b>	<b>\$313.33</b>	<b>\$124.44</b>	<b>\$87.16</b>	<b>\$219.38</b>	<b>\$10804.60</b>

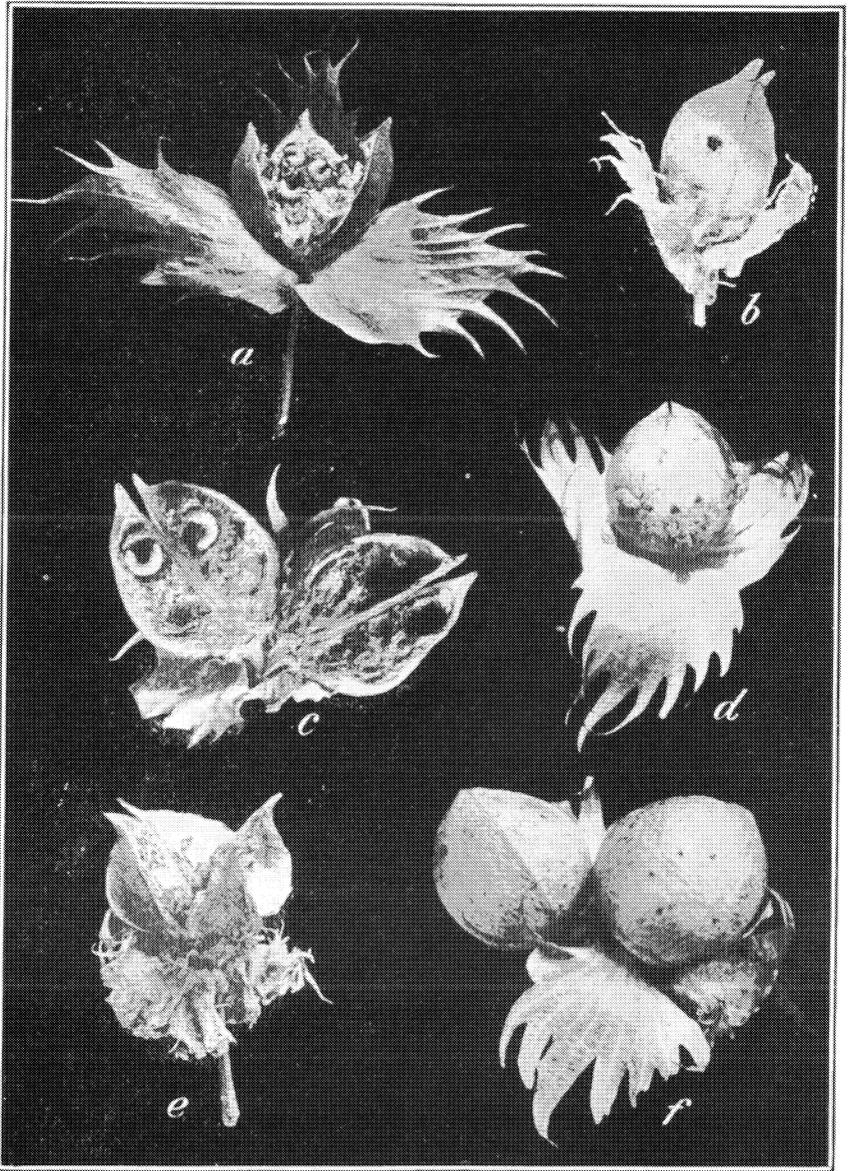


PLATE II.—INJURY BY MEXICAN COTTON BOLL WEEVIL TO BOLLS

*a.* Three larvae in boll; *b.* emergence hole in dry unopened boll; *c.* opened boll, with two locks injured by weevil; *d.* weevils puncturing boll; *e.* opened boll with two locks injured by weevils; *f.* large bolls severely punctured. (Hunter and Pierce, U. S. Dept. of Agr.)

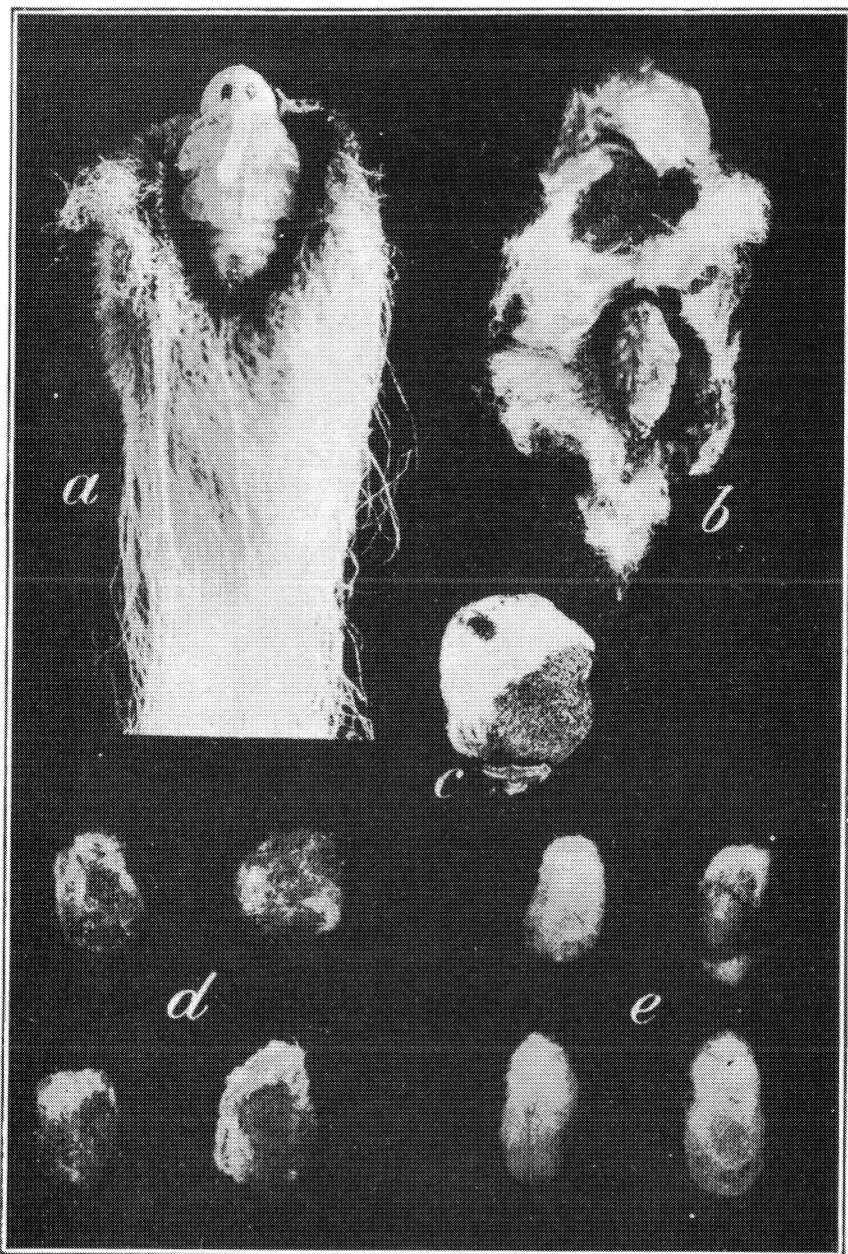


PLATE III.—RELATION OF MEXICAN COTTON BOLL WEEVIL CELLS TO SEED

a. Boll-weevil pupa found in cotton seed; b. boll-weevil in cell of lint from boll; c. weevil cell in dwarfed cotton boll containing live pupa taken among seed; d. weevil cells in bolls; e. cotton seeds. (Hunter and Pierce, U. S. Dept. of Agr.)

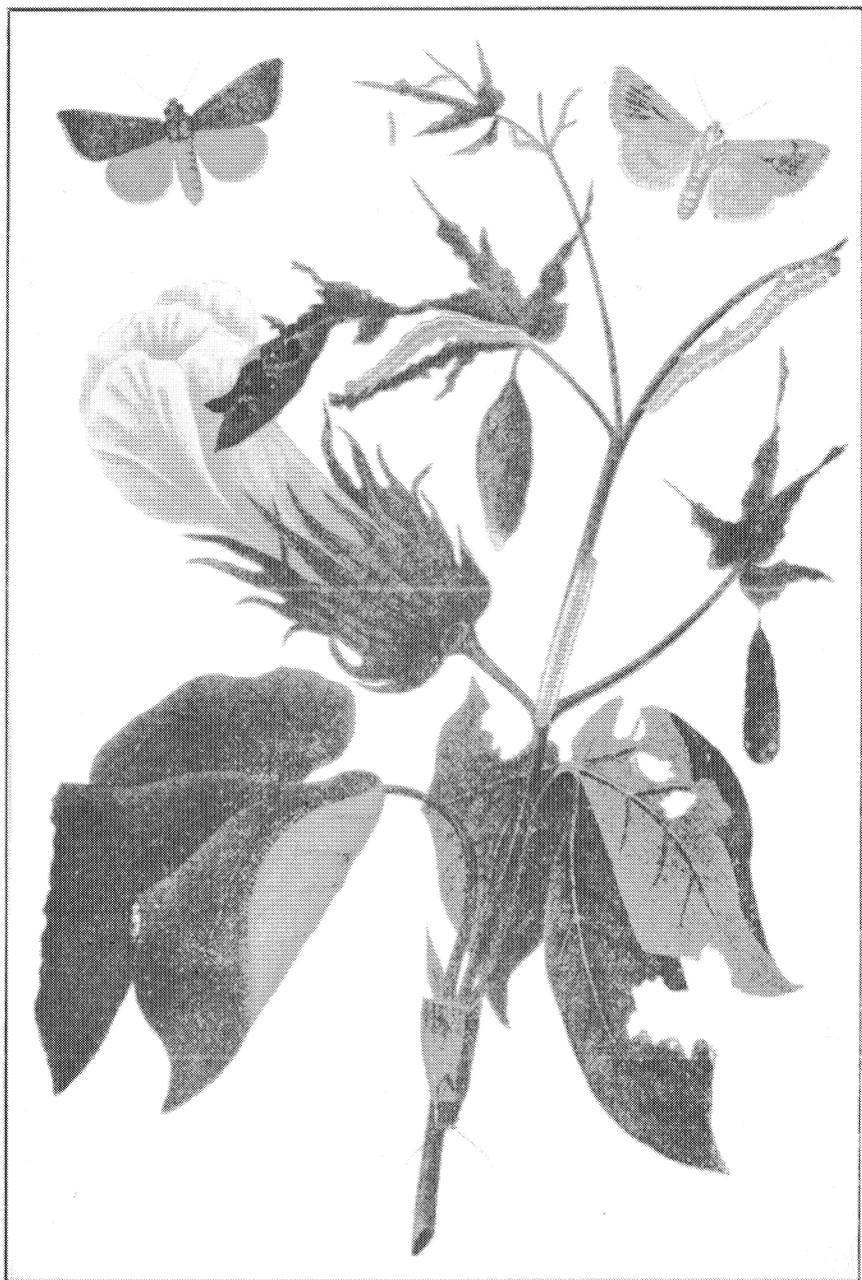


PLATE IV.—THE COTTON WORM

Young and full grown larvae or worms, pupae in natural position in folded leaves, one pupa exposed by feeding of worms and left hanging by thread, adult with wings folded in resting position and upper and lower views of adult with wings expanded. (Comstock, U. S. Dept. Agr.)

# REPORT OF THE ENTOMOLOGIST OF THE ARIZONA COMMISSION OF AGRICULTURE AND HORTICULTURE

*For the Year Ending June 30, 1913*

## INTRODUCTION

The work of the last fiscal year has proceeded in accordance with the general outline presented in the last report and the amount of work accomplished has been in proportion to the increase in funds made available by the amended law. While it is necessary to omit from our program many lines of work which are urgently brought to our attention it is believed that the State of Arizona is now as well protected against the importation of pests as any other state. Giving first attention to this matter, other lines of work receive consideration in accordance with our best judgment as to the comparative importance of each to the public.

In this report the first part is devoted to a general review of the work done in carrying out the provisions of the law. This relates strictly to the fiscal year ending June 30, 1913. The second part is devoted to the presentation of information which is of public interest in connection with notable insect pests of the past season or notable results of observations and investigations. In the adoption of a more logical and convenient method of treatment of the several subjects in this part of the report the period covered includes through the Summer and Fall seasons of 1913. A. W. M.

## PART I.

### INSPECTION OF PLANT, FRUIT AND SEED IMPORTATIONS

#### INSPECTION RECORDS

An attempt has been made by the means hereafter described, to arrange for the inspection of all shipments of living ornamental or fruit producing trees, shrubs and plants entering the State. Such shipments are reported by the inspectors to have numbered 1565

during the last fiscal year. This is an increase of 87 percent over the number inspected during the previous year. A large part of this increase has been due to the extension of the service, but a substantial growth of fruit interests is shown. A comparison of the records at the points covered by the inspection service during the past two fiscal years indicates an increase of 35 percent for the State at large, during the past year, in the amount of nursery stock and other plant importations.

The results of the inspection work during the past fiscal year are summarized in the following table:

TABLE I GENERAL SUMMARY OF INSPECTIONS

District Number	Release issued for entire shipment	Release issued for portion only of shipment	Release withheld for entire shipment	Total shipments inspected
1.....	73	4	6	83
2.....	726	27	3	756
3.....	140	2	5	147
4.....	236	6	1	243
5.....	39	5	0	44
6.....	193	1	0	194
7.....	96	1	1	98
Total.....	1503	46	16	1565
Percentage.....	96.0	3	1.	

The foregoing record, compared with the record of the previous fiscal year, shows practically the same percentage of shipments released as a whole,<sup>1</sup> the figures being 95.8 percent in the fiscal year 1911-12 and 96 percent in the fiscal year 1912-13. Considering that in previous years plant diseases were not recognized by the law, a marked improvement as regards the percentage found to be infested by insects, is to be noted, the records for the four years of the inspection service being successively 8.2 percent, 6.2 percent, 4.2 percent and 2.4 percent infested by insect pests. This gradual reduction in the percentage infested, or, in other words, the improvement in the condition of the imported plants, is a strong commendation for the system of inspecting shipments at destination regardless of the certificates of inspection which may accompany the goods.

The pests which were discovered by the inspectors in the several districts, in the inspection of plants imported into the State, are listed below:

<sup>1</sup> Fourth Annual Report, Arizona Horticultural Commission, page 16.

TABLE II.—RESULTS OF INSPECTION OF NURSERY STOCK AND OTHER LIVE PLANTS

Name of Pest	District							
	1.	2.	3.	4.	5.	6.	7.	
Florida red scale ( <i>Chrysomphalus aonidum</i> )		1						1
San Jose scale ( <i>Aspidiotus perniciosus</i> )		1						1
Purple scale ( <i>Lepidosaphes beckii</i> )	1							1
Soft brown scale ( <i>Lecanium hesperidium</i> )	2	4	1					7
Greedy scale ( <i>Aspidiotus rapax</i> )		1						1
Greenhouse orthezia ( <i>Orihezia insignis</i> )	1							1
Citrus mealy bug ( <i>Pseudococcus citri</i> )		1						1
Greenhouse mealy bug ( <i>Pseudococcus longispinus</i> )		1						1
Undetermined scales	1	1						2
White fly ( <i>Aleyrodes citri</i> )		1						1
Miscellaneous plant lice	2	4	5	1				12
Thrips (undetermined)							1	1
Red spider ( <i>Tetranychus mytilaspidis</i> )			1					1
Eastern peach borer ( <i>Sanninoidea exitiosa</i> )	1	3		2		1		7
Root knot ( <i>Heterodera radicolica</i> )		1		1				2
Crown gall ( <i>Bacterium tumefaciens</i> )	3	13		4	5			25

Quarantine order, number 3, directed against the importation of oranges, guavas and mangoes from Mexico, on account of the danger of introducing the Mexican orange maggot, was placed in effect on September 26, 1912, with the appointment of Mr. R. E. Lee as inspector at Nogales. On January 22, 1913, the Federal Horticultural Board adopted a quarantine measure against citrus fruits, guavas and mangoes from Mexico, and soon afterward Mr. Lee was appointed by the Federal Horticultural Board relieving the State Entomologist of further responsibility in the enforcement of the state quarantine. During the period when the quarantine was enforced by the State twenty-two lots of citrus fruit were intercepted and their transportation beyond the port of entry prevented.

Twenty-one shipments including 5 car lots of citrus fruit were received from California during the past fiscal year. Releases were granted in all but one instance, when a portion of a shipment of twenty boxes was infested with the California red scale. The uninfested fruit, about 19 boxes, was released from quarantine after the infested fruit had been so thoroughly sorted out by the owner that no further trace of infestation could be detected.<sup>1</sup>

<sup>1</sup> The danger of establishing scale insects from introduction on fruit is almost negligible as compared with the danger from introduction on trees and other living plants. The degree of danger does not justify such rigid rules governing the disposition of citrus fruits partly scale infested as are necessary in the case of nursery stock or other living plants for propagation.

No regular inspections of imported deciduous fruits were made during the past year with the exception of apples and pears, which were inspected at Clifton and Morenci, for the protection of valuable fruit orchards, free from the codling moth, located in Greenlee County. Seven shipments, consisting of 423 boxes were inspected and two shipments of 14 boxes each were refused a certificate of release and returned to the shipper, since the consignee preferred this disposition rather than to sort the fruit for reinspection. Owing to the fact that it is impracticable, if not impossible, to sort fruit infested with codling moth so thoroughly as to eliminate all infested specimens, an allowance of one percent has been made as the degree of infestation which is permissible.

Inspections of seed importations have been limited to the inspection of about a fourth of a ton of Egyptian cotton seed, originally imported direct from Egypt and sent gratis by the eastern importer to a cotton planter in the Salt River Valley. The result of this inspection was very important since the seed was found to be badly infested with the pink boll worm (*Gelechia gossypiella*) against which the Federal Horticultural Board has since adopted quarantine measures prohibiting the importation of cotton seed from the Hawaiian Islands and from all foreign countries with the exception of certain sections of Mexico. The entire lot of infested seed was burned. As far as is known this insect does not exist at the present time in the United States and the danger of further introduction is practically eliminated by the Federal quarantine mentioned.

#### INSPECTION PRACTICES

Suitable provisions for protecting the State as a whole against the importation of injurious pests, improvements in the law and the extension of the scope of the law to cover all agricultural and horticultural pests instead of insects alone, have necessitated the modification and extension of the rules followed by the inspectors in previous years and the working out of detailed plans for covering the State most economically and effectively and with the least possible interference with business. The principle of following practices which are useful and necessary rather than technical extremes in accomplishing the objects of the Crop Pest Law, has been closely adhered to as in former years. Equality of consideration accorded to shippers and importers of plants and a square deal in all details is the aim of the service. While numerous complaints have been received from shippers whose stock has been found to be infested or diseased, these complaints have been made in nearly all cases in attempted

justification of stock which first-class nurserymen or florists do not intentionally market. On the other hand numerous letters are on file from some of the heaviest shippers into the State of Arizona, commending the fairness of our inspection practices. In general, it may be said that plants of all kinds found to be infested or infected by any pest not known to exist in the State or not known to be prevalent in the section to which the shipment is made, are not released for delivery to the consignee under any circumstances. In certain cases not included in the foregoing, special provisions are in effect.

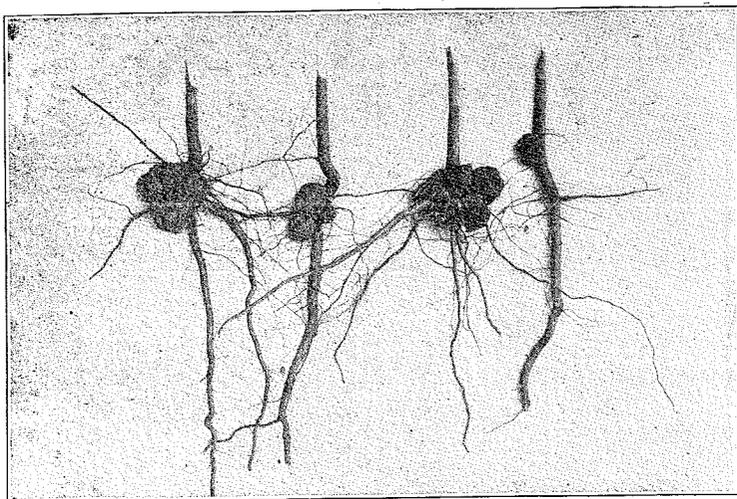


Fig. 1—Seedling almond trees diseased with crown gall. Nursery trees as badly affected as the second and fourth from the left have occasionally been found by Arizona inspectors in nursery stock shipments into the State (Toumey, Bul. 33. Ariz. Exp. Sta.)

With authority from the Commission the State Entomologist has instructed the inspectors in districts Nos. 2 and 3 to require complete defoliation and the destruction of all leaves of plants subject to attack by the citrus white fly, received from all outside sources, as a condition to issuance of certificates of release. This order supplements Quarantine Order No. 2 in citrus white fly protection. The quarantine order prohibits the importation of citrus, privets and cape jessamine from the states of the southeast where the citrus white fly thrives out of doors throughout the year. The insect however is occasionally met with in eastern and northern states in greenhouses and may temporarily infest certain susceptible ornamental and fruit nursery stock out of doors. The danger of such imported plants being shipped into citrus growing sections of Arizona, while comparatively slight, is worthy of recognition. Since the citrus white

fly has never been known to reach maturity on any other part of its food plants than the leaves, the defoliating requirement mentioned above together with the protection afforded by the quarantine order seems to provide for all the protection it is practicable to give against the importation of this insect.

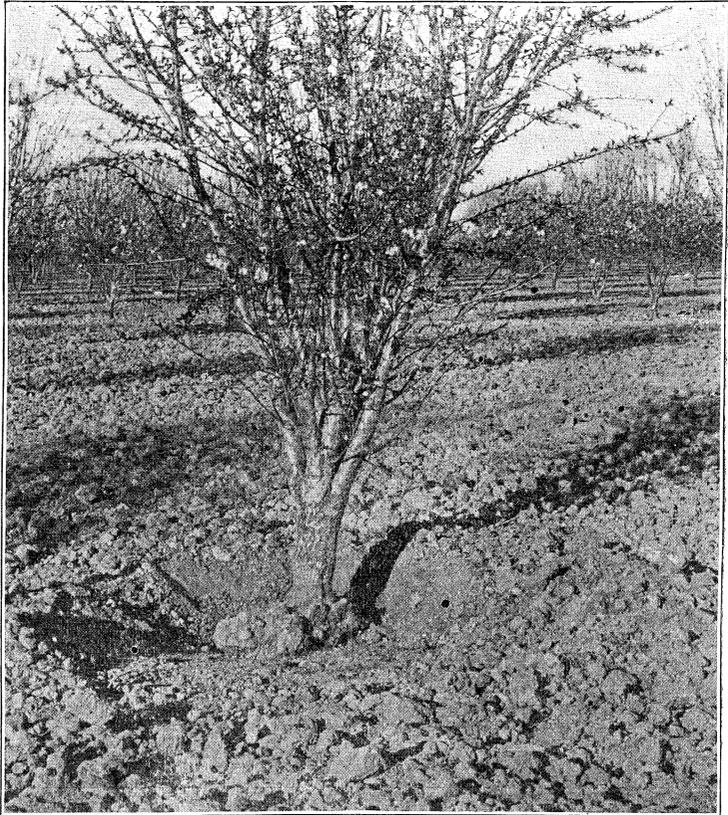


Fig. 2.—A result of planting a diseased tree. Five-year-old almond tree showing large galls almost completely surrounding the crown a few inches below the surface. Earth removed to expose the galls. (Toumey, Bul. 33, Ariz. Exp. Sta.)

Crown gall (Plate I), a widespread and troublesome bacterial disease affecting fruit trees, has necessitated the adoption of definite inspection standards for the guidance of Arizona inspectors in order to insure uniformity and reasonableness in dealing with this problem. In consideration of facts discussed in Press Circular No. 4 this standard was placed at one percent for all except apple trees for which a standard of 5 percent has been adopted. Whenever the trees of any kind, (apple or peach for instance) shows more than this amount of crown

gall disease all of the infected kind have been ordered burned or returned to the shipper by inspectors as a condition of the issuance of the certificate of release on the balance of the stock. Where only one kind of trees are included this rule necessitates withholding the release on the entire shipment when more than the allowance are infected. When the infection does not exceed the allowance every infected tree or plant is burned as a condition of the issuance of the certificate of release on the balance of the stock. Since the detection of crown gall is often difficult and in many cases there is a chance for differences of opinion even among those most experienced, the inspectors have been definitely instructed not to count questionable instances of crown gall infection, in connection with the standards. Furthermore, it is required that samples of the infected stock or diseased parts be submitted to the office of the state Entomologist. As an additional provision against doing injustice to any shipper a series of apple nursery trees showing various degrees of crown gall infection (hairy root type) have been referred to the U. S. Department of Agriculture where they have been examined and returned with comments by Mr. M. B. Waite, Pathologist in charge of Fruit Disease Investigations of the Bureau of Plant Industry. This has verified the decisions of the State Entomologist and the specimens afford valuable standards for comparison and reference.

One of the most difficult problems in connection with the inspection service during the past year has been the working out and placing in effect of plans for inspecting shipments for the many points in the interior of the State where it is not practicable to arrange for local inspectors to examine shipments of plants at destination. Such shipments constitute less than five percent of the total importations of plants. The plans approved by the Commission were published for the guidance of agents of common carriers, crop pest inspectors and others concerned as Inspection Order No. 2. This order constituted two classes of quarantine and inspection stations: Class A comprising entrance point stations where shipments of plants are inspected which are routed through in each case and not destined for any other regular inspection station; and Class B, interior inspection points covered by local inspectors and comprising with the Class A stations nearly all of the important points in the State where shipments of plants are received. Although the trouble involved in the inspection of shipments destined for others than Class A or Class B stations is out of proportion to the number of shipments concerned it is fully justified in view of the isolation of the points to which such shipments are frequently destined and of the possibilities of future

development of fruit growing in some of the sections. The practices followed during the past year will require modification from time to time as experience and the future growth of the different sections of the State may necessitate.

#### INSPECTIONS IN CONNECTION WITH POSTAL SHIPMENTS OF PLANTS

The regulations of the Post Office Department require (Order No. 6675) that packages containing nursery stock or other live plants be refused admittance to the mails unless accompanied by a certificate of inspection from an authorized official dated within one year. It is further provided by a recent order (No. 6696) that all postmasters when requested to do so by state inspection officials notify such officials of the arrival of packages containing plants, but they are especially instructed not to delay the delivery of such shipments to the addresses.

In connection with the above regulations postmasters in the State at points to which inspectors have been assigned have been advised to whom applications for inspections and certificates should be made by persons desiring to ship plants through the mails. Requests have also been made to notify the inspector concerning the arrival of plants in accordance with the second of the above mentioned regulations. Although the practical futility of these practices in the protection against the spread of pests soon became apparent every possible effort has been made to meet the situation.

Two hundred and twenty-seven certificates have been issued by the State Entomologist, Assistant State Entomologist and crop pest inspectors for packages containing plants to be shipped by mail. The inspection of packages of plants brought into the State by mail led to the discovery of one lot of trees badly diseased with crown gall and one lot of citrus trees infested with two different species of mealy bugs including the more destructive of the citrus infesting species (*Pseudococcus citri*), and the long spined mealy bug (*Pseudococcus longispinus*).

The experience of the past season, with the increasing use of the mails for shipping live plants, has demonstrated the utter failure of

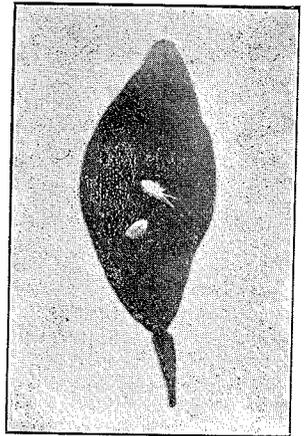


Fig 3.—Mealy bugs, two species, on citrus leaf from nursery tree shipped into Arizona by mail

the facilities offered by the Post Office Department to State inspection officials for protection against the importation of pests. Although written requests have been filed with the postmasters in every section where it is possible to follow up and inspect plant importations after delivery to addressee, notifications are given as provided in postal order No. 6696 for only a small percentage of the packages of plants delivered. The Phoenix post office probably receives and delivers more packages containing plants than any other ten post offices in the State combined, yet more notifications are given from the Glendale office than from the Phoenix office. Information concerning more plant shipments delivered through the Phoenix office is received from outside unofficial sources than through the post office officials who are expected to furnish the information. The citrus trees mentioned in the preceding paragraph were inspected upon request of the addressee and were not learned of through any official report.

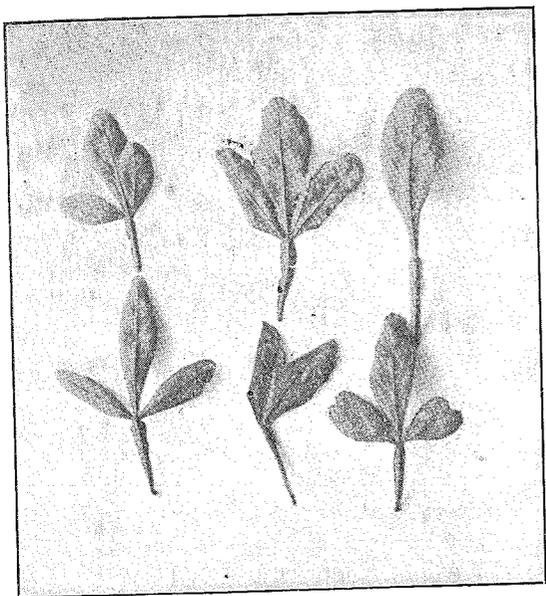


Fig 5—Citrus white fly on leaves of trifoliate orange (*Citrus trifoliata*) shipped into Arizona by express in bundle of size commonly sent by mail.

inspect the plants after delivery.

From the inspection so far made of packages received through the mails and of packages of plants to be sent by mail it is evident that mail shipments are the most dangerous of all classes as regards the transportation of insect pests and plant diseases.

The foregoing statement is not made in criticism of the local post office officials as the writer is convinced that the system itself is at fault. In small offices it appears to be practicable to notify inspectors in accordance with the postal order. In large offices it appears to be impracticable. Even if notifications were duly given in all cases it would be impracticable, on account of the expense, for an inspector to follow up each package and

The situation may be summarized as follows:

1. Post Office Department Order No. 6675 is of comparatively little value since experience has shown that nearly ten percent of the plant shipments which are accompanied by nursery inspection certificates are actually infested with insect pests or infected with plant diseases.
2. Post Office Department Order No. 6696 is of no appreciable value to the State as a whole in the protection against the introduction of pests.

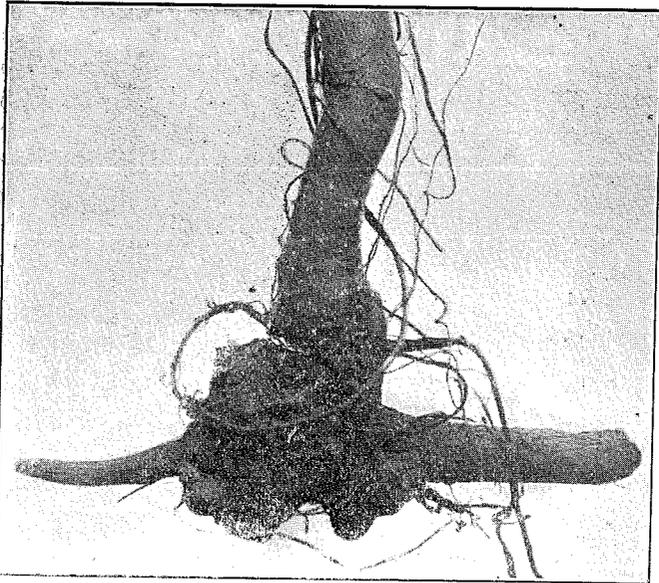


Fig. 5.—Crown gall on nursery tree shipped into Arizona by mail.

3. Dangerous insect pests and plant diseases are being sent with plants through the mails and as a class postal shipments are more dangerous than freight or express shipments.
4. State quarantine orders, particularly those relating to the citrus white fly and the cotton boll weevil, are rendered ineffective in-so-far as plants infested with the former and seed harboring the latter may be sent through the mails without adequate restrictions or without any restrictions whatever.

## INSPECTIONS OF NURSERIES AND ORCHARDS

The following nurseries in the State have been inspected during the past year:

R. A. Smith & Son, (deciduous fruit trees and ornamentals) Safford.

Graham County Nurseries, (deciduous fruit trees and ornamentals) Safford.

Mesa City Nursery (citrus), Mesa.

Carpenter & Helm (citrus, olives and date palms), Phoenix.

Riverside Nurseries (deciduous fruit trees and ornamentals), Phoenix.

Rogers and Rockwell (citrus and olives), Phoenix.

Salt River Valley Nurseries (citrus, date palms and ornamentals), Phoenix.

Ward & Billson (citrus), Phoenix.

E. Buzick (citrus) Yuma.

The only pests found which are likely to be transported on nursery stock were woolly apple aphid on apple stock and crown gall diseases affecting deciduous fruit trees. These pests were handled in accordance with customary practices elsewhere, the roots of apple stock treated with kerosene emulsion, and all trees visibly infected with crown gall separated out and destroyed when the stock was dug up. All citrus stock growing in the State is believed to be free from scale insects and white fly pests although the citrus thrips (*Euthrips citri*) can usually be found in citrus nurseries during its active season. This latter pest is not given consideration with nursery stock since in the section of Arizona named it has not so far injured trees in the nursery as far as observed and is already too prevalent for it to be practical to restrict its distribution in orchards by action against citrus nursery stock or otherwise.

The discovery of San Jose scale infesting rose bushes in door yards in Yuma and infesting certain orchards near Safford in Graham County and Concho in Apache County has necessitated considerable inspection work to determine the extent to which the pest is distributed. The occurrence of this insect in Arizona, the work so far done and plans for its future control and extermination are discussed elsewhere.

A lot of 2720 date offshoots imported from Africa during the preceding fiscal year have been held in quarantine near Yuma to determine the extent to which the date palm scales (*Parlatoria blanch-*

*ardi* and *Phoenicococcus marlatti*) had survived the dipping treatment with the Braucco insecticide. A thorough inspection about five months after the treatment and admission of the offshoots showed approximately 99 percent apparently free from live scales. A second treatment was given all of the date palms with the same insecticide, November 11-15, 1913, under the supervision of the Assistant State Entomologist. A second lot of about a dozen date palms of bearing age, more or less badly infested with both of the above mentioned scales, have also been placed in quarantine pending the successful eradication of the pests.

Nearly all of the bearing and many of the non-bearing citrus orchards in the Salt River Valley have been visited by either the State Entomologist or Inspector George Acuff; and the Assistant State Entomologist and Inspector Hansberger have visited the only commercial citrus orchard in the Yuma Valley. Aside from the citrus thrips no important citrus pests have been found although no tree by tree inspection has been made. Of more importance as indicating the probable freedom of Arizona citrus orchards from scale insect and white fly pests which are so destructive in the Gulf Coast states and in California, is the inspection of local grown citrus fruits at the packing houses during the shipping season. The extensive examinations of this kind by Inspector Acuff at Phoenix, following similar inspections for three previous seasons, almost amount to a guarantee of the freedom, so far, of the Salt River Valley citrus orchards from such pests.

The discovery and subsequent extermination of the California red scale thriving on rose bushes in the city of Phoenix in June 1912 emphasizes the necessity for continued watchfulness, as far as the resources of the Commission will permit, in order to quickly locate any colonies of citrus pests which may be introduced into and become established in the State.

#### INSPECTION OF FRUIT PRODUCTS OF THE STATE

The inspection of citrus fruits grown in the Salt River Valley, in connection with citrus thrips records, and the inspection of apples and pears grown in Graham County and offered for sale in Greenlee County, are the only activities in this line worthy of note. The results of the citrus fruit inspections are mentioned in connection with orchard inspections.

## ALFALFA WEEVIL PROTECTION

In Arizona, no one pest is to be more feared than the alfalfa weevil, which infests the alfalfa fields of Utah and adjoining sections of Wyoming and Idaho. In the isolation of our farming districts and in the absence of direct railroad communication with the sections at present infested Arizona possesses advantages of incalculable value in protecting against the importation and establishment of this pest. This natural protection has been supplemented during the past year by the quarantine order adopted by the Commission of Agriculture and Horticulture, which it is confidently believed eliminates fully nine tenths of the danger of the pests' introduction into the State. Since a quarantine of this kind cannot be perfect in its operation and since there are possibilities of introduction of the pest which are recognized as unavoidable it is of great importance that alfalfa growing districts be kept under careful observation so that if our protection against the importation of the alfalfa weevil fails, the pest may be discovered before it becomes too widespread to make extermination impracticable.

This work of inspecting alfalfa fields has been conducted during the past year in the Gila and Salt River Valleys. Particular attention has been given to visiting and inspecting alfalfa fields located near the residences of settlers who have come from the infested states, near railroad stations, and along railroad lines within one half mile on each side. In Graham County this inspection work has been conducted by Inspector Wixom, and in Maricopa County by Special Inspector John R. Sandige in the summer of 1912 and by Special Inspector Ernest Russell during the summer of 1913. In the Yuma Valley Inspector Wood was instructed to begin alfalfa weevil inspection work on July 1, 1913. In addition to the regular work above mentioned the State Entomologist has inspected several alfalfa fields in Yavapai County and in the Little Colorado Valley in Apache County.

For the information of both the alfalfa growers and their employees, warning notices in English and Spanish, with illustrations of the different stages of the weevil, have been printed for posting in public places and at random where inspections are made. These posters are similar to those previously printed and mentioned in the Fourth Annual Report of the Horticultural Commission.

## INSECT CONTROL AND ERADICATION

## CODLING MOTH

As in previous years a strong effort was made to encourage thorough work in controlling the codling moth. On February 5, Press Circular No. 3 was issued particularly for the benefit of fruit growers of Navajo and Apache Counties. In a modified form this was published in the newspapers of Graham County. Three subsequently issued press circulars, Nos. 5, 6, and 8, covered all phases of the codling moth control and mimeograph copies were extensively distributed among the fruit growers of the State as well as given wide circulation through the columns of the newspapers.

Two trips were made to Navaho and Apache Counties during the fiscal year, by the writers in connection with the codling moth control work, and one visit was made to Graham County. A field demonstration was made of spraying methods at St. Johns. The Chairman of the Commission with Inspector S. D. Smith of Agricultural and Horticultural District No. 5, held a series of conventions in Navaho and Apache Counties, on which occasions codling moth control work was discussed. Inspector R. E. L. Wixom has, as usual, been active in codling moth control work in his district, giving advice to fruit growers through the newspapers by posted notices and personal visits. In addition, the State and the Assistant State Entomologist devoted much time to codling moth control instruction to fruit growers when accompanying the Farmers' Demonstration train run by the Arizona Agricultural Experiment Station.

Before the time for the first application of spray the fruit growers throughout the State were notified in regard to the provision of the Crop Pest Law, which makes it unlawful to sell, transport or give away wormy apples or pears. Every possible effort was made, as shown above, to give information and advice to protect the fruit crops from injury. Nevertheless a great deal of badly timed and indifferent spraying was done during the spring of 1913. As has been repeatedly advised satisfactory results cannot be expected when the spraying apparatus is not suitable for the size of the orchard, when poison is not ordered in time to be on hand when needed for the first and most important spraying period and when, in general, the details of the rules for successful codling moth spraying are not observed. It is satisfying to note that several orchardists in different sections of the State, have proceeded with spraying in the same businesslike way that they conduct other matters of orchard management,

with the result that their wormy fruit is negligible in quantity. Even in the midst of the worst codling moth conditions found anywhere in the State, 90 percent of the apple crop has been saved by well timed and careful spraying.

The regulation for the sale of fruit from infested orchards, in accordance with the provision of the amended Crop Pest Law apparently will solve the codling moth problem in Arizona quicker and more satisfactorily than the methods previously tested. A beginning was made in this month in the Fall of 1912 and plans for extending the system during 1913, as far as available funds permit, are in operation at this writing.

#### SAN JOSE SCALE

The existence of the San Jose Scale in Arizona was reported by Prof. J. W. Toumey in a bulletin of the Agricultural Experiment Station published in 1895<sup>1</sup>; and Prof. T. D. A. Cockerell in a later bulletin published in 1899<sup>2</sup> reported having found it on peach trees at Glendale and on apple trees in Phoenix. The observations made led the last named writer to the conclusion that the San Jose Scale "will flourish in Arizona only when shaded from the direct rays of the sun; and, as in New Mexico, it spreads very slowly." However, Prof. Cockerell advised that "it will ruin the trees if left alone."

Following the above report, several years of drouth, shortage of irrigation water and unfavorable fruit marketing conditions resulted in many orchards in the Salt River Valley being abandoned and the trees pulled out in some cases. The pest does not seem to have survived these unfavorable conditions, although it is difficult to conceive of the insect once established being absolutely exterminated by unfavorable conditions of the kind mentioned. The fact remains, however, that during the past four years, with extensive inspections by state inspectors in the Salt River Valley and with a wide interest in insect pests no San Jose Scale has been found or reported from that section of the State.

Under the date of February 26, Crop Pest Inspector Hansberger of Yuma, sent in specimens of rose cuttings infested with what he suspected to be the San Jose scale. The cuttings were from a rose garden located in town. Examinations at the office of the State Entomologist showed Mr. Hansberger's identification to be correct and instructions for beginning the work of eradicating the pest were

1 Bul. 14, *Ariz. Agr. Exp. Sta.*, pp. 33-34.

2 Bul. 32 *Ariz. Agr. Exp. Sta.*, p. 284.

immediately sent. On April second the Assistant State Entomologist visited Yuma and spent several days investigating the situation and following up the preliminary work of eradication in a thorough manner.

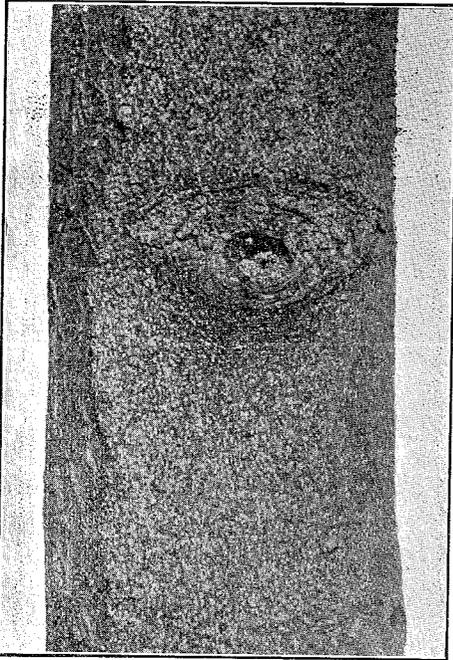


Fig. 6.—San Jose scale on bark of apple tree dying from effects of this pest. Specimen from Graham County, Arizona. Slightly reduced

The infestation was centered on a single town lot (a) with one badly infested rose bush found growing on an adjoining lot (b) while several rods distant on a third town lot (c) a few were found infested which were grown from cuttings from the rose bushes in the first lot (a). It was found upon inquiry that the several rose bushes growing on town lot (a) and the infested bush on lot (b) were shipped from California in one order several years ago, before inspection of imported plants was provided for by the State.

The pest seemed to be confined to rose bushes, although other trees and shrubs subject to its attack were growing on the premises where the infestations occurred. This circumstance is especially noteworthy inasmuch as the important citrus pest, the California red scale, which was discovered in Phoenix nearly a year previously, was also confined to rose bushes.<sup>1</sup> In each case food plants ordinarily more preferred by the insects were near at hand. In each case the insects were crowded closely upon the infested bushes and appeared to have become thoroughly adapted to withstand exposure to the hot sun of southern Arizona's leading agricultural districts. Nevertheless, it appears, as observed by Professor Cockerell several years ago, that the San Jose scale spreads slowly in the arid Southwest. The same may be said concerning the California red scale.

<sup>1</sup> Fourth Ann. Rpt., Ariz. Hort. Com., pp. 20-21.

More serious than the San Jose scale infestation discovered at Yuma is the discovery of the pest in fruit orchards in the Gila Valley in eastern Arizona. Sections of infested apple limbs were sent to the office of the State Entomologist by Crop Pest Inspector Wixom, on April 30, 1913. This infestation was investigated by Dr. Bartlett early in May during a ten day visit to the section mentioned. The scale was found in ten orchards between Solomonville and Pima. In two or three orchards the insect was doing considerable damage. The situation evidently called for control rather than eradication treatment and, since summer treatments are impracticable owing to the danger of injuring the trees with sprays strong enough to kill the scale, the owners of infested orchards were advised to wait until the winter months, when the trees were without foliage, before starting to combat the pest. Thorough spraying with lime sulphur solution will be required in all infested orchards before the trees start growth in the Spring.

#### MISCELLANEOUS INSECT PESTS

The exterminative methods used against the colony of California Red Scale discovered in June 1912 in Phoenix, appear to have been entirely successful. No new colonies of the insect have been discovered. The soft brown scale (*Lecanium hesperidium*) mentioned in previous reports, was unable, as far as observed, to withstand the unusually low temperatures of January 1913, and according to the results of inspections since made, the pest is now nearly extinct in the Salt River Valley, and probably also throughout the state. At Phoenix the examination of numerous oleanders which were heavily infested with the soft scale has resulted in no live specimens being found, but it is possible that under certain conditions of protection this scale survived and will be discovered later. For the present, however, it will be assumed that the pest has been eradicated and its further importation will be guarded against.

#### COOPERATION WITH FEDERAL HORTICULTURAL BOARD

In the Fall of 1912, in carrying out the provisions of Mexican Orange Maggot Quarantine Order (No. 2) the State Entomologist visited Nogales and investigated the local conditions on both sides of the international line as regards importations of citrus fruits subject to infestation by the orange maggot. Mr. Robert E. Lee of Nogales was appointed inspector on September 26, 1912. The work

of enforcing the above mentioned quarantine was conducted by Mr. Lee in the capacity of state inspector until March, 1913, when he was appointed collaborator of the Federal Horticultural Board to serve as inspector at Nogales particularly in the enforcement of the orange maggot quarantine declared by the Federal Horticultural Board on January 22, 1913. Arizona Quarantine Order No. 2 is now practically inoperative owing to its objects being effectively accomplished by the Federal quarantine.

On March 6, 1913, the State Entomologist was appointed collaborator of the Federal Horticultural Board in order to act as Federal inspector in connection with date palms imported from foreign countries or transported from one quarantine district to another in the United States.

### ENTOMOLOGICAL INVESTIGATIONS

The important subjects of investigations during the past fiscal year were the following: Woolly apple aphid, codling moth, harvester ants, green fruit beetle and the alfalfa seed chalcis fly. In addition to these, more or less attention has been given to numerous insect pests as occasion demanded. The results and progress with the more important subjects of investigation will be reported in the Annual Report of the Agricultural Experiment Station, which institution the State Entomologist serves in addition to the Commission of Agriculture and Horticulture. With the improvement of the organization of the inspection service resulting from the experience secured from the work of the previous four years, more time is now available for entomological investigations than ever before and proportionally better results may be looked for. There is need, however, for more attention being given to insect investigations than can be given at present. In order to meet the present demand on the part of the farmers of the state for information, which can be secured only by means of investigations, one or two additional assistants would be required. This fact is mentioned in explanation of the inability of the office of the State Entomologist to give adequate attention to more than a very limited number of the numerous insect problems of recognized importance.

### PLANT DISEASES

Injuries to crops from fungus and bacterial diseases are brought to the attention of the State Entomologist with greater frequency each year. Among the more important troubles of this kind, during the past year, have been diseases affecting the Irish potato, the Mexi-

can bean, tomato, watermelon, squash, alfalfa, cotton, oats and various fruit trees. Several of these have been readily recognized, but others have been of such a nature as to require special study for the determination of the cause. In the absence of facilities for this work specimens of unknown diseases have been referred to the plant pathologists of the U. S. Department of Agriculture at Washington, to whom acknowledgements are due for the assistance given in this connection. Two agents of the Department of Agriculture, Mr. Roland McKee and Mr. C. O. Townsend, have visited Arizona during the past year in connection with plant disease investigations and have given practical advice concerning their specialties. In this connection it should be mentioned that since the end of the fiscal year covered by this report, the appointment of Prof. W. H. Lawrence as Horticulturist of the Experiment Station has fortunately provided for the expert attention to diseases affecting horticultural crops, Professor Lawrence being an experienced Plant Pathologist as well as a Horticulturist.

#### PUBLICATIONS AND ADDRESSES

The State Entomologist and the Assistant State Entomologist gave 47 public lectures during the last fiscal year. In connection with the Farmers' Demonstration Train feature of the Farmers' Institute work, the State Entomologist gave 14 lectures upon the following subjects: Citrus Thrips and Its Control, Vegetable Crop Pests, Deciduous Fruit Pests, and Insecticides and Their Use. In the same connection the Assistant Entomologist gave 19 lectures upon the subjects of Deciduous Fruit Pests, Vegetable Crop Pests, and Insecticides and Their Use. Aside from the Demonstration Train work the following special addresses have been given during the year:

The Codling Moth and Woolly Aphis, by A. W. Morrill, Thatcher, Arizona, August, 1912, at the Fruit Growers' Convention, under auspices of the Arizona Commission of Agriculture and Horticulture.

House Flies and Their Control, by A. W. Morrill, Phoenix, Arizona, January 16, 1913, before the Arizona Congress of Mothers.

Deciduous Fruit Insects, by O. C. Bartlett, Camp Verde, Arizona, January 21; Cornville, Arizona, January 22; and Cottonwood, Arizona, January 23, at Farmers' Institutes, University of Arizona.

Insecticides and Their Use, by O. C. Bartlett, Camp Verde, Arizona, January 21; and Cottonwood, Arizona, January 23, at Farmers' Institutes University of Arizona.

The Melon Louse and Its Control, by O. C. Bartlett, Phoenix, Arizona, February 26, 1913, at Maricopa County Farmers' Institutes.

Alfalfa Pests, by O. C. Bartlett, Palo Verde, Arizona, March 7, 1913, at Farmers' Institutes, University of Arizona.

Insecticides and Their Use, by O. C. Bartlett, Palo Verde, Arizona, March 7, 1913, at Farmers' Institutes, University of Arizona.

The House Fly as a Civic and Household Problem, by A. W. Morrill, Phoenix, Arizona, April 15th, 1913, at Phoenix Woman's Club.

The House Fly and Its Control, by A. W. Morrill, Phoenix, Arizona, May 15, 1913, at the Filmore School Mothers' Circle.

Some American Insects and Arachnids Concerned in the Transmission of Disease, by A. W. Morrill, Globe, Arizona, May 21, 1913, before the Arizona Medical Association.

Nurserymen's Problems In Plant Diseases, by A. W. Morrill, Portland, Oregon, June 19, 1913, before the American Association of Nurserymen. (Read by the secretary.)

During the past year nine press circulars were issued from the office of the State Entomologist and sent to each newspaper in the State. These were quite generally reproduced by the state papers and through their cooperation timely information concerning insect pests and plant diseases was placed before many more persons than could have been reached by other means. The following is the list of circulars issued during the year:

- No. 1. Arizona's Crop Pest Protection under the Amended Law  
—A. W. Morrill, October 29, 1912.
- No. 2. Plant Quarantine Measures Adopted by the Arizona Commission of Agriculture and Horticulture. —A. W. Morrill, November 11, 1912.
- No. 3. Preparing for Fighting the Codling Moth, in Apache and Navajo Counties.  
—A. W. Morrill, February 5, 1913.
- No. 4. Arizona Inspection Practices Relating to Crown Call.  
—A. W. Morrill, February 8, 1913.
- No. 5. Directions for Spraying for the Codling Moth in Arizona.  
—A. W. Morrill, March 31, 1913.
- No. 6. Neglected Orchards and Codling Moth Control.  
—A. W. Morrill, April 5, 1913.
- No. 7. Protecting the Citrus Trees. —A. W. Morrill, April 19, 1913.
- No. 8. Besides Spraying, what can be done to Control the Codling Moth.  
—A. W. Morrill, May 31, 1913.
- No. 9. Treatment of the Woolly Apple Aphid. —A. W. Morrill, June 7, 1913.

Twenty-two special articles and papers have been prepared by the State Entomologist and published, as shown in the following list:  
A Lady Bug Injurious to Beans.

—Southwestern Stockman-Farmer, September 6, 1912.

**Efforts to Protect Against the Codling Moth.**

- Southwestern Stockman-Farmer, September 27, 1912.
- Report of the Entomologist of the Arizona Horticultural Commission for the Year ending June 30, 1912.**
- Fourth Annual Report, Ariz. Hort. Com., pp. 15-43, October 1, 1912.
- The Mexican Orange Maggot.** —The Arizona Democrat, October 7, 1912.
- Concerning the White Woolly Substance Commonly Observed on the Twigs of Citrus and Other Fruit Trees.**
- Southwestern Stockman-Farmer, October 18, 1912.
- Experiments in Ripening of Navel Oranges.**
- Southwestern Stockman-Farmer, November 8, 1912.
- Mistaken Ideas Concerning the Effects of Climate upon Insects.** (Revised from previously published article, see Fourth Annual Report, Arizona Horticultural Commission.)
- California Fruit Grower, November 9, 1912.
- The National Plant Quarantine Act.**
- Southwestern Stockman-Farmer, November 15, 1912.
- The Relation of the Arizona Crop Pest Law to the Citrus Fruit Industry of the State.**
- Arizona Republican, December 5, 1912.
- Arizona Experiment Station Publications.**
- Southwestern Stockman-Farmer, December 6, 1912.
- Advice to Importers of Nursery Stock**
- Southwestern Stockman-Farmer, December 27, 1912.
- Entomology.**
- Twenty-third Ann. Rept., Agr. Exp. Sta., pp. 692-695, Dec. 31, 1912.
- Citrus Fruits in Arizona.**
- Southwestern Stockman-Farmer, January 10, 1913.
- The Citrus Outlook in Arizona.**
- The Progressive Farmer and Home Builder, March, 1913.
- Insect Pests and Plant Diseases.**
- Southwestern Stockman-Farmer, March 7, 1913.
- The Fig in Arizona.** —Arizona Gazette, March 26, 1913.
- How to Control Rose Aphis and Rose Mildew.**
- Timely Hints for Farmers, No. 99.—Agr. Exp. Sta., April 15, 1913.
- Entomological Pioneering in Arizona.**
- Journal of Economic Entomology, Vol. 6, No. 2, pp. 185-195, April, 1913.
- Cooperation Between State Horticultural Inspection Officials.**
- Journal of Economic Entomology, Vol. 6, No. 2, pp. 261-265, April, 1913.
- Red Spiders on Citrus—An infested tree discovered at Yuma in a shipment from Los Angeles.**
- Southwestern Stockman-Farmer, May 2, 1913.
- The Alfalfa Seed Chalcis Fly.** —Buckeye News, May 1, 1913.
- The Pink Boll Worm of Cotton.**
- Southwestern Stockman-Farmer, May 30, 1913.

## STATE FAIR AND DEMONSTRATION TRAIN EXHIBITS

The exhibit at the State Fair in 1912 was much more extensive than in previous years and included numerous new features. By almost constant attendance upon the exhibit the State Entomologist and Assistant Entomologist gave verbal advice and information concerning insect pests and plant diseases to a large number of farmers and fruit growers. Immediately after the State Fair the exhibit was transferred to the Farmers' Demonstration Train run cooperatively by the University of Arizona and the Santa Fe, Southern Pacific and El Paso and Southwestern railroads. The train was accompanied in turn by the State Entomologist and the Assistant State Entomologist over the northern and southern routes respectively.

A. W. MORRILL,

*State Entomologist.*

O. C. BARTLETT,

*Assistant State Entomologist.*

## PART II.

## NOTES ON IMPORTANT INSECTS OF THE YEAR

## DECIDUOUS FRUIT PESTS

The discovery of the San Jose scale in two districts in Arizona is the most notable feature of the year in connection with deciduous fruits. The earlier record of this insect in the Salt River Valley and its subsequent disappearance, as far as our present knowledge goes, has been noted on page 24 of this report. The fact that in Graham County several trees were actually killed by the San Jose scale before its presence was discovered illustrates well the need for tree to tree inspection in order to discover such pests while the infestation is still in the incipient stage.

A grape leaf skeletonizer (*Harrisina brilliana* B. & McS.)<sup>1</sup> was reported as doing damage to grapes near Tucson as early as May 29, and in the Salt River Valley was more common during the season of 1913 than in any of the four preceding seasons. Hand picking of the infested leaves when the worms first appear is recommended as the most important control measure. To be successful in this it is necessary to examine the vines carefully every few days from the time the first leaves are developed in the Spring up to the time when the fruit is picked. After picking the fruit, spraying the vines with arsenite of zinc or arsenate of lead is advised in case the worms continue to appear in injurious numbers. Experiments conducted with these poisons during the past summer by Mr. George Acuff, Crop Pest Inspector at Phoenix, show that arsenite of zinc (40% arsenious oxide<sup>2</sup>) should be used at the rate of one ounce per gallon of water and that powdered arsenate of lead (30-33% arsenic oxide<sup>3</sup>) should be used at the rate of one and one-third ounces per gallon of water. If arsenate of lead in paste form is used the amount of poison to each gallon of water should be doubled.

Leaf cutting bees, mentioned in the last annual report seem to be present in about the same numbers in some sections of Southern Arizona each year. While no unusual damage has been reported recently the State Entomologist has been fortunate in securing from a correspondent at Salome, Arizona, specimens of a species which has been doing considerable damage to young fruit trees near that point.

1 Determined by Dr. H. G. Dyar, U. S. Nat. Mus.

2 Equivalent to about 30% metallic arsenic

3 Equivalent to about 20-22% metallic arsenic

These proved to be a species previously found in New Mexico and known by the scientific name *Megachile lippiae* Ckll.<sup>1</sup>

The green fruit beetle (*Allorhina mutabilis*), more commonly known by the rather confusing name of "green June bug," was observed doing unusual injury to an apple orchard at Thatcher on one occasion during the past year. Ripe apples on the trees were attacked with the same avidity that the insect exhibits in the case of figs and peaches. The scarcity of peaches is supposed to be the cause for the attack upon the apples.

Injury to grape vines by a cane borer (*Apate punctipennis*)<sup>2</sup> related to the eastern grape cane borer (*Apate bicaudatus*) was reported from near Clarkdale in the Verde Valley. This is the first record of this insect in the State. The remedies applicable to the eastern species are recommended for this one. Since it probably breeds like the eastern relative in dying wood and diseased canes and never in vigorous live growth, all dead wood should be cut out of orchard trees and vines and the prunings burned in early Spring before the time for the emergence of the adult. In the vineyard they may some times be collected by hand when abundant.

The presence of a species of *Phylloxera* on wild grapes near Prescott and on a few vines in a commercial vineyard in the same locality was noted nearly two years ago. Specimens have been sent to the Department of Agriculture and compared with the common grape phylloxera (*Phylloxera vastatrix*) by Mr. Theo. Pergande, who has pronounced the Arizona specimens as belonging to the same species. In August, 1913, the State Entomologist discovered the same insect on wild grape vines in Stone Cabin Canyon of the Santa Rita mountains, located 200 miles southwest of Prescott, where there is no likelihood of it having been introduced. The circumstances related to its occurrence and distribution near Prescott lead to the conclusion that the insect is native, and the discovery of the insect in another section of the State under similar conditions confirms this beyond question. Fortunately the insect has not exhibited any tendency to seriously infest commercial vineyards although several vines in the vineyard mentioned above have suffered temporarily. The injury, as far as observed, both to wild and cultivated grapes has been to the foliage, only a few specimens being found upon the roots. In California, on the other hand, in commercial grape growing sections, the insect confines its attack to the roots exclusively. In their leaf-infesting habits the Arizona insects resemble the habits exhibited by the grape phylloxera in the Eastern states. The discovery

1 Determined by Dr. T. D. A. Cockerell, Jour. Economic Entomology, Vol. 6, No. 5, pp. 425.

2 Determined by C. H. Popenoe, U. S. Dept. Agr.

of the grape phylloxera in this State under the conditions noted, adds a reason for maintaining the present strict quarantine (No. 4) against the importation of rooted grape vines from the section of California where phylloxera exists and has already done so much damage. The insect is now known to be capable of doing damage to the foliage of the grape in certain sections of the State and a comparison of climatic conditions of sections of Arizona with the sections of the state of California where injury has been done by the insect, indicates that a large part of Arizona comes within the climatic range in which the insect is now known as injurious in the arid districts of the Western states.

#### CITRUS PESTS

The average injury done by the citrus thrips (*Euthrips citri*) during the season of 1912 was considerably less than during the preceding year. Comparisons for the two seasons showed certain unexpected results in one case. In this instance an orange grove which ranked highest as regards the percentage of thrips scarring in 1911, having twice as much as the average grove, showed very little damage in 1912, although no remedial measures were adopted. The reduction in the amount of fruit in the citrus orchards for the season 1913 would be expected to result in the thrips scarring being concentrated upon the smaller crop with serious results provided the insect itself occurred in its usual abundance. A general inspection of all the bearing groves, however, by Crop Pest Inspector Acuff resulted in finding only a small amount of thrips scarring. It appears therefore, that the citrus thrips were even more seriously effected by the cold wave in January, 1913, than were the orange trees.

The apparent extermination of the soft scale (*Lecanium hesperidium*) by the low temperatures of the winter of 1912-13 has already been mentioned. For the present, therefore, even this insect, which has never been of importance in commercial orchards in Arizona, is of no interest as a citrus pest.

#### FIELD CROP PESTS

The variegated cut worm (*Peridroma margaritosa saucia*) was destructive to alfalfa and garden crops near Prescott, Snowflake and St. Johns in the Summer of 1912. In 1913 it was in evidence in the last two localities, but its injury was very limited. In the Salt River

Valley this insect has never been observed since the outbreak in the Spring of 1911.<sup>1</sup>

Reports of serious injury to grains were received from the Yuma Valley in the Spring of the present year. Mr. E. L. Crane of Somerton, under the date of April 12, reported "a total failure of all grains planted since Feb. 1 this year, and very great damage to all grains planted previously, from effects of barley aphid. There has never been anything equal to it within my recollection here. And this following the coldest winter ever recorded." Crop Pest Inspector C. J. Wood, a few days later, sent specimens of aphid which he wrote were "doing considerable damage to wheat and barley in the valley especially on late sowings; in some fields they are almost destroying the crop." The specimens proved to consist of two species which are well known throughout the country, particularly in the middle west, for their injury to grains—the Spring grain aphid or "green bug" (*Toxoptera graminum*) and the corn leaf aphid (*Aphis maidis*) Hymenopterous parasites of the aphid<sup>2</sup> accompanied the specimens sent in by Mr. Wood. The aphid thrive in lower temperatures than the parasites and the outbreak was doubtless due to climatic conditions being unfavorable to the latter until after the damage had been accomplished. The Spring grain aphid was the more destructive of the two species. In the Eastern states it has been found that volunteer oats and wheat are largely responsible for the outbreaks of this insect and the destruction of all volunteer oats in the early Fall is therefore recommended. It is further recommended that the grain fields be closely watched and colonies of the aphid destroyed by spraying with an insecticide such as a solution of whale oil soap, one pound to ten gallons of water, before they have gained headway. Oats should be planted late in the Fall as a measure against permitting the pest to get an early start.<sup>3</sup>

The corn flea beetle (*Chaetocnema ectypa*) was reported during the Spring of 1913, as injurious to corn in the Yuma Valley and also appeared in unusual abundance in some localities in the Salt River Valley.

#### VEGETABLE PESTS

Reports from Coconino County and information secured by the State Entomologist while on the "Farmers' Demonstration Train," indicate that the Colorado potato beetle (*Leptinotarsa decimlineata*) is spreading slowly in the important potato growing sections near

<sup>1</sup> Third Annual Report, Arizona Horticultural Commission, pp. 25-27.

<sup>2</sup> Determined by Mr. R. N. Wilson of the U. S. Dept. of Agr. as *Aphidius testicipes*.

<sup>3</sup> Circ. 93, Bureau of Entomology, U. S. Dept. Agr.

Williams and Flagstaff. This insect is also present near Prescott but has not so far been recorded from other sections of the State. Small acreages of potatoes have been grown for many years in the Salt River Valley and during 1913 a greatly enlarged acreage was grown, amounting approximately to five hundred acres; but the Colorado potato beetle has not so far been reported or observed in that section. Spraying with arsenical poisons is the standard remedy for this insect. Arsenate of lead powder should be used at the rate of two pounds in 50 gallons of water, arsenate of lead paste at the rate of four pounds, or Paris green at the rate of about one and a half pounds. If Paris green is used, an equal amount of freshly slacked lime should be added. Arsenate of lead adheres to the foliage better than Paris green and on this account is to be preferred.

At the present time the most important potato pests in the State are certain species of blister beetles which have been noted near Prescott and in the southern part of the Sulphur Spring Valley near McNeal. At Prescott two of these, a greenish gray blister beetle (*Marcobasis albida* Say) and a gray spotted blister beetle (*Epicauta pardalis* Lec.), appear early in July and after feeding for a few weeks disappear for the most part and are followed by a black blister beetle (*Epicauta Corvina* Lec.).<sup>1</sup> Spraying the potato vines with arsenate of lead (powdered) at the rate of one ounce in one gallon of water destroyed many of the blister beetles and the remainder left the poisoned vines in the course of a few days.

The harlequin cabbage bug (*Murgantia histrionica*) has never been reported in Arizona until the past summer, 1913, when they were sent in from McNeal with a report of injury to cabbage. Later they were observed in the Verde Valley and also in the Salt River Valley, attacking cabbage and other cruciferous crops, and were reported by Crop Pest Inspector Wixom as injuring cabbage in the Gila Valley, near Central. In the Verde Valley, near Camp Verde, the insects were found on a common cruciferous weed known as cleoma, a valuable honey producing plant, but they did not attack the garden crops as far as known. In this locality inquiry led to the conclusion that the insect was less abundant than ordinary, but in the other sections of the State mentioned, the reports and observations undoubtedly show an unusual abundance of it.

The green pea louse (*Macrosiphum pisi*) was reported as unusually destructive to garden peas in two localities, near Phoenix and near Gila Bend. In both cases fumigating with a nicotine fumigating paper<sup>1</sup> was recommended. Sections of the rows ten feet long

<sup>1</sup> Determined by C. H. Popenoe, U. S. Dept. Agr.

<sup>1</sup> Nico Fume Paper, manufactured by the Kentucky Tobacco Products Co., of Louisville, Ky.

were covered by canvas supported by wooden frames. The nicotine fumes obtained by lighting small strips of the paper and allowing it to smoulder under the cover, gave perfect killing results. The treated vines produced a full crop whereas in other gardens in the neighborhood peas were a total failure from the effects of the aphid. This treatment is entirely practical for use in home gardens, costing for material less than 10 cents for a 50 foot row of pea vines. The fumigating outfit can be used for treating other vegetable crops in-

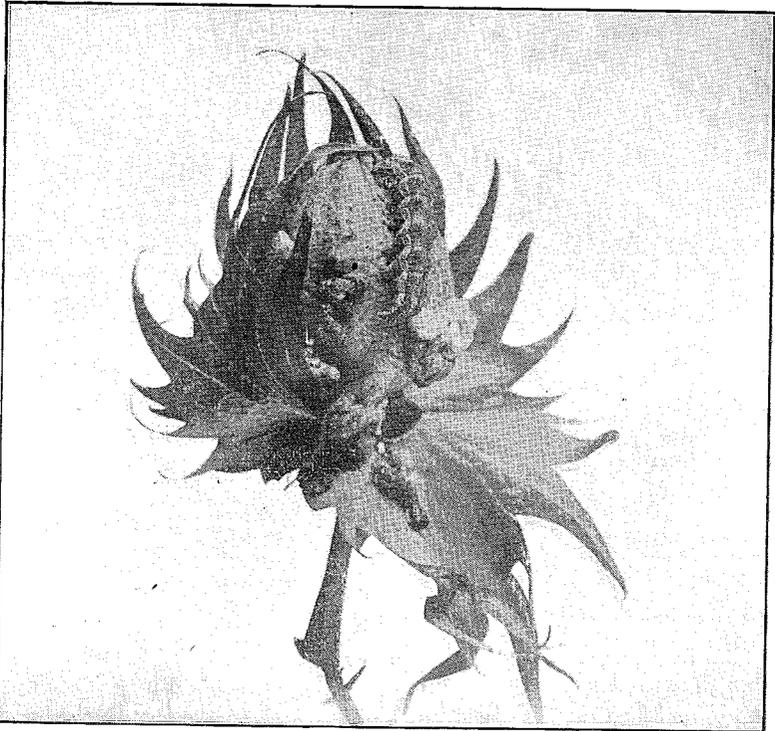


Fig. 7.—Boll of cotton showing worm entering. (After Quaintance and Brues, U. S. Dept. Agr.)

festated by aphid and is a desirable addition to the garden equipment. Spraying the vines with nicotine solutions<sup>1</sup> combined with soap, is a more quickly applied remedy and may be preferred where large patches require protection<sup>2</sup>.

#### COTTON INSECTS

It is generally recognized in cotton growing sections that successful cotton crops are more dependant upon the extent of the dam-

<sup>1</sup> "Black Leaf 40", "Nikoteen", "Tobacine", etc.

<sup>2</sup> For directions for mixing and applying see Timely Hints for Farmers, No. 99, Ariz. Exp. Sta.

age, or the absence of damage, from insect pests and plant diseases than upon any other factor. If there are no insect, bacterial or fungus enemies of the cotton plant to interfere, the success of the crop is practically assured when planting, cultivating, irrigating and other cultural operations are attended to more or less as routine procedure and in accordance with fairly well defined rules. In recognition of the importance of the matter considerable effort has been given to the acquiring of information concerning cotton pests in the State, including those actually to be found attacking cultivated cotton, those which attack wild cotton and also those which are known to be capable of damaging cultivated cottons but which have not so far been found in Arizona cotton fields. In this work we have had the cooperation of the Bureau of Entomology, U. S. Department of Agriculture.

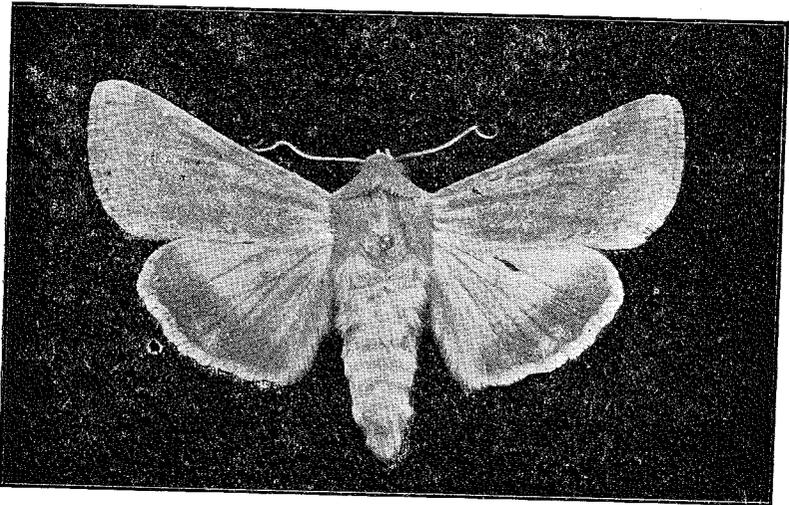
The more important cotton pests which have been found so far attacking cotton in the Salt River Valley are the following: Cotton boll worm (*Heliothis obsoleta*); cotton leaf worm (*Alabama argillacea*); salt marsh caterpillar (*Estigmene acraea*); cotton boll cut worm (*Prodenia ornithogalli*) and two species of grasshoppers of the genus *Schistocerca*. Among the insects of the Salt River Valley which have been known to attack cotton and probably will be found in cotton fields in greater or less numbers in the course of time, are the following: The Mexican "Conchuela" (*Pentatoma ligata*); the grain bug (*Pentatoma sayi*); the leaf footed plant bug (*Leptoglossus zonatus*); the bordered plant bug (*Largus succinctus*); the cotton melon aphid (*Aphis gossypii*) and the cotton red spider (*Tetranychus bimaculatus*). In addition a very minute species of thrips should be mentioned. This species, known by the scientific name of *Microthrips piercei*,<sup>1</sup> has been found in sufficient abundance to stunt the growth of young Egyptian cotton plants growing in our experimental gardens. It is an insect not heretofore known as an enemy of cotton.

Of the foregoing list, the boll worm, the cotton leaf worm, the grasshoppers and the cotton red spiders are of the most immediate interest.

The cotton boll worm ranks first in the amount of injury done to the cotton crop in the Salt River Valley. This insect is also known as the corn ear worm, green tomato worm and other names, according to the plant which it attacks. The adult is a moth which deposits her eggs on fresh corn silks in preference to cotton when the former is available. Upland or short staple cotton is preferred over Egyptian cotton in the ratio of about 6 to 2<sup>2</sup>. If, therefore, upland cotton

<sup>1</sup> Determined by Mr. H. M. Russell, U. S. Bureau of Entomology.  
<sup>2</sup> Fifty-six to twenty are the actual results of the tests reported by Quaintance and Brues. Bul. 50, Bur. Ent. U. S. Dept. Agr., pp. 71-72.

varieties were grown in Arizona proportionally greater injury from this insect would be expected than is now done by the insect to Egyptian cotton. The control of the boll worm consists in fall and winter plowing and harrowing of cotton and corn fields to break up the pupal cells in which the insects spend the winter in the pupal stage, and the planting of corn and cow peas with the cotton to serve as "trap crops." The pupal cells are made from 2 to 5 inches below the surface of the ground and are easily broken or displaced by winter plowing so that the insect is likely to be destroyed by frosts or birds, or buried so deeply as to be unable to reach the surface if it should succeed in developing into the moth stage. The use of trap crops



F.g. 8.—Boll moth worm enlarged about two times. (After Quaintance and Brues. U. S. Dept Agr.)

is for the purpose of attracting the moths away from the cotton and providing an attractive place for egg laying. If not managed properly, however, the growth of corn near the cotton fields may be attended with injurious effects upon the cotton crop. At the time of planting the cotton seed, strips should be left across the field at intervals of 250 or 300 feet, sufficiently wide to plant about ten or twelve rows of corn and cow peas. The corn should not be planted until late in May and not later than the first of June, so that it will be in silking condition and attractive to the moths as a place for egg laying about a month later. The cow peas should be in alternate rows with the corn, but should be planted about a week later. The blossoms of the cowpeas provide attractive food for the moths and tend to prevent the insect from going to the cotton blooms for nectar.

The corn can be harvested in the usual way, having served its purpose in protecting the cotton during the period when the greater part of the crop is being developed. Early corn growing in fields adjoining cotton fields is a disadvantage since the insects which breed in the corn, when they reach maturity, will not find fresh silks and will go to the cotton fields to lay their eggs.



Fig. 9.—Boll worm pupa in burrow in soil. (After Quaintance and Brues, U. S. Dept. Agr.)

Many boll worms may be destroyed by poisoning the cotton plants with Paris green or arsenate of lead, but unless the insects prove likely to do much more damage than has so far been noted, the control measures which have been described should prove sufficient protection.

The cotton leaf worm is one of the best known cotton insects of the southeastern United States. It has no other food plant than cotton (including the Arizona wild cotton) as far as known and its discovery in the cotton fields of the Salt River Valley and near Tucson during the past summer was unexpected. It did not, however, do any appreciable damage, nor is it likely to prove destructive in the future unless it is possible for it to hibernate in Southern Arizona. The adults are capable of flying hundreds of miles and the few worms found during August near Glendale and Tucson were with little doubt hatched from eggs laid by moths which had flown from Southern Mexico or Central America. It is only when the generations of the leaf worm begin early in the season, that damage need be feared. This is possible only in case the insects succeed in surviving the winter here. Protection of the cotton, when necessary, is a simple matter and not very expensive. It consists in applying Paris green to the plants after the worms have put in their appearance in threatening numbers. The full grown worms are nearly an inch and a half long, slender, bluish green in color, with black spots and frequently with black stripes along the back. They walk by looping and when disturbed drop from the plant. When full grown the worms spin light silken cocoons on the cotton plant, usually within a fold of a leaf, and transform to brown pupae. The moth, which is of an olive gray color, develops from the pupa in between one and four weeks according to temperature conditions. Cotton growers should watch for the appearance of these insects in their fields and be prepared to use poison if the young caterpillars are discovered in numbers which threaten to result in the defoliation of the plants. An average of even a single caterpillar to a plant as early as the first of August is likely to result in the stripping of the leaves with serious effects before the crop is matured.

Grasshoppers have attacked cotton in the Salt River Valley in seriously injurious numbers in at least one instance during the past season, according to observations of Mr. E. E. Russell, temporary entomological assistant. Two species were found in the field after most of the damage had been accomplished, both belonging to the genus *Schistocerca* (*S. vega* and *S. shoshone*).<sup>1</sup> At that time the latter was much the more abundant of the two. These insects are rather large, the male measuring about  $1\frac{3}{4}$  inches from the front of the head to the tip of the wings and the females about  $2\frac{5}{8}$  to  $2\frac{3}{4}$  inches. The former is light brown with black markings on the head, body and wing covers, while the latter is nearly uniformly green with red tibiae and tarsal segments of the hind legs. Both specimens have

<sup>1</sup> Determined by Mr. A. N. Candell of the U. S. National Museum.

been found in alfalfa fields and are occasionally troublesome to garden crops and young fruit trees. In the cotton field where their injury was noted, the plants were not only defoliated but the bark was completely eaten off from the stalks to a large extent. The use of poisoned bran mash is the usual means of destroying grasshoppers in cotton fields, but if the insects are excessively abundant poisoning of plants may also be advisable. The poisoned bran may be prepared with 25 pounds of wheat bran, two pounds of Paris green and one gallon of molasses. Cheap strong smelling molasses is the best grade for the purpose. Good results have been obtained with only one pound of Paris green. White arsenic is cheaper than Paris green and may be substituted for it if available. The bran and poison are mixed dry and the molasses with water mixed in to make a thick mash. The addition of two finely ground oranges or lemons to the mixture greatly increases its attractiveness to grasshoppers, according to experiments recently conducted at the Kansas Experiment Station. This mixture will poison poultry. It should be spread in heaps of a tablespoonful each and not over two or three feet apart along the side of the field, if the object is to check an invasion of the insects from alfalfa or other fields. If the grasshoppers are already widely scattered through the field the poison will likewise have to be widely scattered. It is advisable, however, to place the poisoned bran mixture in rows so that after the water has dried out it can be easily moistened, again, if necessary, by means of a hand sprayer. Very early in the morning, while the humidity is highest, is probably the best time to spread the poisoned bran in the field.

Within the past ten years the two spotted red spider, or cotton red spider, has become quite prominent among the cotton pests of the southeastern United States. In the spring of 1913 a species of red spider, was observed on violets in the city of Phoenix and upon examination it proved to be the above mentioned species.<sup>1</sup> Subsequent examinations have resulted in the discovery of the pest on violets elsewhere in the Salt River Valley, making it evident that attempts to eradicate would be futile. As already stated the cotton red spider has not so far been reported as infesting cotton in Arizona. Nevertheless, information concerning it is of timely interest.

The red spider is a true mite rather than an insect, having eight legs instead of six in the adult stage, lacking antennae and otherwise differing from true insects. The adult female is only 1-50 of an inch in length and the adult male is only about half as large as the female. Infested cotton leaves turn deep red on the upper surface, producing

1 This determination was verified by Mr. Nathan Banks of the Bur. of Ent. U. S. Dept. Agr.

a condition sometimes called "rust." An examination of the under surfaces of the leaves, however, reveals the presence of the minute red mites. Badly infested leaves become distorted and finally drop. The pest develops very rapidly, producing in a single season as many as 17 generations. It is of special interest in the arid Southwest on account of its belonging to a group notoriously fond of hot, dry weather and in this connection the following statements are quoted from a report of an investigation of the cotton red spider conducted in the

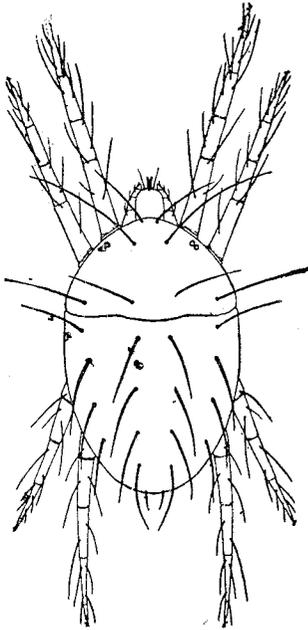


Fig. 10.—The two spotted red spider, greatly enlarged. (After Banks, U. S. Dept. Agr.)

Southeastern states<sup>1</sup>: "The influence of weather on breeding activity is very noticeable. Hot, dry conditions greatly favor and hasten development, while cool, wet weather correspondingly retards it. A female laying normally about 6 to 7 eggs per day, will often, upon the occurrence of a very hot day, suddenly increase the number to 15 or even more eggs per day, or upon a chilly day may drop as suddenly to 1 or 2 eggs."

In view of the probability of this red spider appearing in Arizona cotton fields sooner or later, preventive measures should be closely observed. The violet plant is probably the most likely means of spreading and maintaining this pest. In the Eastern states serious damage to cotton is frequently traceable to the presence of the red spider on violets growing near the cotton fields. All violets in the Salt River Valley are not infested with the red spider and it is prob-

ably also true that there are other kinds of plants which are infested. It is advisable, however, for cotton growers either not to permit these plants to grow near to cotton fields or else to examine them carefully to detect the first trace of infestation should the red spider appear. Weeds or other plants supposed to be infested with red spiders should be submitted to the office of the State Entomologist for examination. While the preventative measures suggested above are of leading importance in protecting the cotton fields against the pest here discussed, spraying with potassium sulphide at the rate of three pounds

1 E. A. McGregor, Circ. 172, Bur. Ent., U. S. Dept. Agr. p. 5, 1913

dissolved in 100 gallons of water is recommended as an effective remedy when the simpler and less expensive preventives fail.

A species of wild cotton (*Thurberia thespesiodes*) which grows in certain sections of Southern Arizona has become of great interest during the past year owing to the discovery of a weevil closely related to the Eastern boll weevil, attacking its squares and bolls<sup>1</sup>.

An investigation of the weevil and of other insects found associated with Arizona wild cotton was made during the season 1913. Much information of practical and scientific interest was secured. The full report under joint authorship of Mr. W. D. Pierce of the Bureau of Entomology, U. S. Department of Agriculture, and the Arizona State Entomologist, will be published in an entomological periodical and only a brief summary of the practical results of the investigation are here given.

The wild cotton weevil, which has been determined by Mr. Pierce as a variety of the eastern form and given the scientific name *Anthonomus grandis* var. *thurberiae* Pierce, will attack cultivated cotton as well as its natural food plant. It is distinguished by

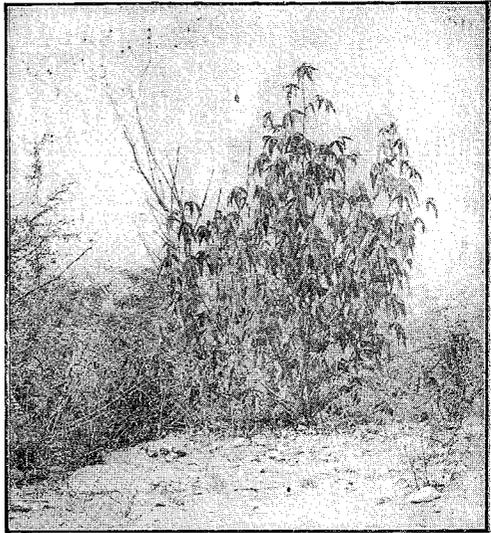


Fig. 11.—Arizona wild cotton plant, showing previous season's bolls.

certain structural details, being as a rule slightly larger and more robust than the Mexican cotton boll weevil which occurs in the eastern cotton states. In general, the habits and life history of the two forms are identical. The wild cotton weevil, however, so far as known, exists at present only between elevations of 3500 and 5000 feet, while the eastern form, so far as known, only at elevations below 2000 feet. The first remains in hibernation inside the bolls of the wild cotton until August and even up to the first of September, whereas the latter emerges from hibernation in the early spring before June first. Observations have been made, however, which indi-

1 O. F. Cook, Science, Feb. 14, 1913, p. 259-261.

cate that the time of emergence of the adults is not a fixed feature of the insect's habits but that under the warmer temperature conditions found at lower elevations the emergence period would be changed to early in the season. If the weevil which infests Arizona wild cotton is not adaptable in this respect it could not accomplish any appreciable damage to cotton even if it were to become established in cotton growing sections. It is by no means impossible that the insect is so thoroughly adapted to its natural food plant and to the conditions under which this food plant grows that it would not injuriously infest cultivated cotton. It is well known that some insects are restricted in their distribution by altitude and that outside of their natural range they are incapable of existing or are not harmful. As an example the corrupted or bean lady bug (*Epilachna corrupta*) may be referred to. In Arizona this insect occurs and is injurious to beans in nearly every locality where this crop is grown above an elevation of 2500 feet. Below this elevation the insect has never been found.

The Arizona boll weevil has been found attacking wild cotton in the canyons of the Santa Catalina and the Santa Rita mountains, located northeast and southwest of Tucson respectively at distances of about 15 and 30 miles. It presumably also exists east of Tucson in the Tanque Verde and Rincon mountains, in both of which ranges the food plant has been found. The wild cotton plant grows as near to the Salt River Valley as Fish Creek on the Roosevelt Road, but the weevil has not been found in that locality. Arizona wild cotton in all probability does not occur in any of the mountain ranges immediately surrounding the Salt River Valley. From our present information it seems probable that the weevil does not exist inside of 60 miles of the Salt River Valley.

There is likelihood of the Arizona boll weevil appearing sooner or later in fields of cultivated cotton if this crop is grown in the Rillito and Santa Cruz Valleys near Tucson. The insect can be carried down to lower elevations by flood waters or it can no doubt reach the cotton fields by flight. In Sawmill canyon of the Santa Rita mountains on August 26, 1913, six live weevils were found hibernating in wild cotton bolls on a single plant. Such a plant in the Santa Catalina mountains washed down to the valley by a freshet could easily carry the insect to the neighborhood of cotton fields. Spread of the eastern boll weevil is known to occur within a radius of about 40 miles. Such flights have been found invariably to be in connection with a shortage of food supply. The short breeding season of the Arizona weevil in its natural habitat, beginning, as it appears, in

August, and the great prolificacy of the Arizona wild cotton in producing squares (flower buds) and bolls, are distinctly favorable circumstances and a shortage of food supply is evidently an event which rarely, if ever, occurs.

If either the Arizona boll weevil or the Mexican boll weevil should make its appearance in cotton fields in Arizona the discontinuance of cotton culture for one year in the district infested, with the destruction of volunteer cotton stalks will be an effective and practical means of completely eradicating the pest. The danger of the first named insect infesting the cotton fields near Tucson and permanently injuring the industry there, is not considered by the writer to be great enough to be allowed to interfere with any plans for the development of the cotton growing industry in that locality. In the Salt River Valley the danger appears to be of even less consequence. Of far greater danger as far as the Salt River Valley is concerned is the likelihood of the Mexican boll weevil being introduced from the eastern states in cotton seed. The failure of the boll weevil quarantine to cover shipments by mail has already been mentioned in this report. This danger can be counteracted to a large extent by the maintenance of a strong sentiment against the importation of cotton seed from the Southeastern States and by the cotton growers and others interested notifying the office of the State Entomologist concerning any cotton seed importations which should be investigated.

In addition to the Arizona boll weevil three other pests of especial interest were discovered upon the wild cotton plant in the Santa Catalina and Santa Rita mountain canyons. The finding of a single specimen of the cotton leaf worm strengthens the belief that the moths which produced the infestation in fields of cultivated cotton near Glendale and Tucson came in from points in Mexico, hundreds of miles southward, or from Central America. A worm, which may be called the wild cotton boll worm, was found in both the Santa Catalina and Santa Rita mountains infesting the bolls and squares. The injury is similar to that done by the cotton boll worm although the insects, aside from belonging to the same family of moths, *Noctuidæ*, are not closely related. The wild cotton boll worm is more likely than is the boll weevil to appear in fields of cultivated cotton in Arizona, particularly in the Santa Cruz and Rillito Valleys. While it is attacked by parasites which hold it in check to a certain extent it is fully as destructive as the Arizona boll weevil to the squares and bolls of the wild cotton. The third pest of interest among those



found on the wild cotton is a mite which attacks the leaves, stems and squares. This is a new species of the genus *Eriophyes*<sup>1</sup> to which the rust mite of the orange and the pear blister mite also belong. This pest produces a fuzzy brown appearance on the infested parts of the plant, and many plants in the Ventana Canyon of the Santa Catalina mountains were found to be seriously damaged by it. Fortunately, this pest, being wingless, is unable to spread from the mountain canyons to the valleys by direct means and there seems to be slight danger of its being carried indirectly to cultivated cotton.

#### GRANARY AND MILL INSECTS

Attention has been called to granary and mill insects during the past year by specimens of a small grain infesting beetle (*Rhizopertha minuta*)<sup>2</sup> being sent in from Safford. An examination of a flour mill at that point by the Assistant Entomologist resulted in the discovery of an abundance of the Mediterranean flour moth (*Ephestia kuehniella*) and also of the rice weevil (*Calandra oryza*). The means for controlling granary and mill pests are now so well and thoroughly demonstrated that there is no longer any necessity for serious losses from this source. For the benefit of mill owners and seed and grain dealers a circular of information concerning the control of pests of this class will be issued in the near future.

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*State Entomologist.*

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1 Determined by Mr. Nathan Banks of the U. S. Dept. of Agr.

2 Determined by C. H. Popenoe, U. S. Dept. Agr.