UNITED STATES DEPARTMENT OF AGRICULTURE
BULLETIN No. 231
Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. PROFESSIONAL PAPER August 2, 1915.

RECENT STUDIES OF THE MEXICAN COTTON BOLL WEEVIL

By

B. R. COAD, Entomological Assistant, Southern Field Crop Insect Investigations

CONTENTS

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CONTENTS.

INTRODUCTION.

The cotton season of 1913 was of great importance in the study of the boll weevil, *Anthonomus grandis* Boh., because of several opportune discoveries. Briefly, the events of the year were the discovery, by Mr. O. F. Cook, of the cotton boll weevil breeding upon a wild-cotton plant, *Thurberia thespesioides*, in Arizona; the establishment of breeding work at Victoria, Tex., for the purpose of studying any changes in the life history of the weevil; the discovery by the writer of important food adaptations of the weevil; explorations of southeastern Arizona by Dr. A. W. Morrill and Mr. W. D. Pierce in August, by Mr. Vernon Bailey later in the fall, and by Messrs.

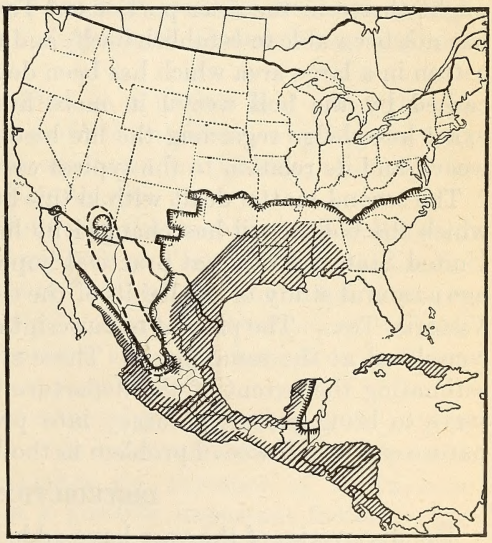

Fig. 1.—Distribution of the Mexican cotton boll weevil. The shading shows the infested area; the heavy lines, the limits of cotton production; the broken line, the probable distribution of the Arizona wild cotton weevil. (Original.)

Note.—This bulletin is of interest to entomologists in the cotton belt.

E. A. Schwarz and H. S. Barber in December, 1913. The results of the explorations and research work are quite fully treated in the body of this article.

Mr. Cook's announcement, which was published in February, 1913,[1] was followed by departmental press notices issued in October of the same year, and by a detailed article by Mr. W. D. Pierce describing the Arizona weevil as a new variety, *Anthonomus grandis* var. *thurberiæ*, issued November 10, 1913.[2]

A paper by the author on the food habits of the boll weevil in Texas has recently been published.[3]

This bulletin deals with a number of rather technical experiments and observations which have important bearings on the general boll-weevil problem. The principal matters dealt with are, first, the exact relation between the typical boll weevil, *Anthonomus grandis* Boh., and the form *A. grandis thurberiæ* Pierce, which has recently been found attacking a cottonlike plant in Arizona; and, second, the changes in the habits of the boll weevil which have taken place since it first entered the United States.

The importance of the first point mentioned lies in the fact that the western form of the boll weevil has adapted itself to life under extremely arid conditions, in which respect it differs conspicuously from the typical boll weevil. It therefore appears that the western weevil might thrive in the drier portions of Texas, where the typical weevil has not been able to establish itself, and thus reduce the production of cotton in a large area which has been depended upon to offset the loss caused by the boll weevil in more humid regions. Consequently, exact knowledge regarding the life history and habits of the Arizona weevil and its relation to the typical weevil are of importance.

The second matter dealt with in this bulletin, namely, the extent to which the boll weevil has changed its habits since it has been in the United States, is of great practical importance. More than 10 years ago a careful study of the habits of the typical boll weevil was made at Victoria, Tex. The present manuscript deals with similar studies just completed at the same place. These studies give an exact basis for estimating the extent of the departure from the original habits and serve to bring greater accuracy into predictions as to the ultimate nature of the boll-weevil problem in the United States.

DISTRIBUTION.

The discoveries of the year have added to the present knowledge of the distribution of the species. On the accompanying map (fig. 1)

[1] Cook, O. F. A wild host-plant of the boll weevil in Arizona. Science, n. s., v. 27, no. 946, p. 259-261, Feb. 14, 1913.

[2] Pierce, W. D. The occurrence of a cotton boll weevil in Arizona. U. S. Dept. Agr., Jour. Agr. Research, v. 1, no. 2, p. 89-96, Nov. 10, 1913.

[3] Coad, B. R. Feeding habits of the boll-weevil on plants other than cotton. U. S. Dept. Agr., Jour. Agr. Research, v. 2, no. 3, p. 235-245, June, 1914.

it will be seen that there are three apparent lines of distribution of the species, with Costa Rica as the apex. One line of distribution is along the Pacific slope, and although, according to present knowledge, the Arizona infestation is isolated from that of Sinaloa, Mexico, it is probable that the weevil occurs on *Thurberia thespesioides* in the mountains between these points. The Thurberia plant is known from Chihuahua and Guadalajara, Mexico, which latter locality is within a few miles of weevil-infested cotton.

The dispersion following the middle line is historic. Since 1880 this movement has been watched more or less thoroughly from Tamaulipas, Nueva Leon, and Coahuila, Mexico, until now (1914) it has reached the Georgia line (fig. 1).

The third line of distribution from Mexico through Yucatan to central Cuba is the cause of considerable speculation as to whether Cuba or the continent was the original source. There is also some speculation as to whether the Central American infestation furnished the nucleus for the dispersion or whether the weevil originated in southern Mexico and dispersed southward.

FOOD PLANTS.

The plant longest known as the food plant of the boll weevil is cotton, of which several species are now recorded as hosts—*Gossypium hirsutum*, *G. herbaceum*, *G. barbadense*, *G. brasiliense*, and also several Mexican species.

Mr. Cook's announcement added as a native food plant the so-called Arizona wild cotton, *Thurberia thespesioides*, which grows in a number of mountain ranges in southeastern Arizona, and also in parts of Mexico and probably New Mexico.

During the summer of 1913, following the discovery of a boll weevil feeding on cultivated *Hibiscus syriacus* at Victoria, Tex., the writer succeeded in rearing the species on buds of this plant, fed them for some time, and noted the partially complete development in buds of *Callirrhoë involucrata* and *C. pedata*, and kept them alive on *Sphæralcea lindheimeri* buds for a short period.

In the above series of experiments, by alternating foods it was found that the weevils have a wide range of hitherto unsuspected adaptability. This discovery makes the presence of malvaceous plants in the vicinity of cotton a possibly important factor in the ultimate control of the species. The greatest importance of this fact would arise in any attempted cessation of cotton planting as a control measure against the species.

CHOICE OF FOOD PLANT.

Two male and two female boll weevils reared from Thurberia buds imported from Arizona were placed with Thurberia buds and with cotton squares to test their food preference. They began feeding

immediately on both foods, but usually fed slightly more on the cotton squares than on the Thurberia buds. When egg deposition started the greater number of the eggs were deposited in cotton squares. These observations were continued for 15 days.

From these experiments it would appear that, when in captivity, weevils reared from Thurberia will feed on cotton squares just as readily as they will on Thurberia buds. The slightly greater amount of feeding on cotton squares in this experiment may or may not have any significance, and it was probably purely accidental.

These records made in the laboratory are in strong contrast with those made in the field. At Victoria the Thurberia plants under cultivation were within 50 feet of a small patch of cotton. This cotton was heavily infested by weevils throughout the season and not a boll was able to reach maturity. On the other hand, although the Thurberia plants were just as much exposed as the cotton, not a single indication of weevil work was found on the plants and not a weevil was found on them.

In Stone Cabin Canyon, Santa Rita Mountains, Ariz., Mr. W. D. Pierce was unable to find a weevil on cotton plants growing within 10 feet of Thurberia plants which were heavily infested with weevils. In December this same cotton was examined by Messrs. Schwarz and Barber and they were unable to find a sign of weevil work in the bolls.[1]

In this connection records made on the habits of larvæ of the cotton leafworm (*Alabama argillacea* Hübn.) are of interest. These larvæ are almost exclusively cotton feeders, but in the laboratory tests they fed on the Thurberia leaves as readily as on cotton when both were offered and were able to pupate and reach maturity on this food. In Stone Cabin Canyon this species was found feeding on Thurberia plants. The species was common on cotton at Tucson and Phoenix, Ariz. At Victoria, Tex., this species acted exactly as did the native weevils, with relation to the cotton and Thurberia patches. The cotton was heavily infested and only preserved from destruction by spraying, but not a single leafworm larva was ever found on the Thurberia plants. The moths were very numerous for a considerable period and eggs were abundant on the cotton, whereas careful examination failed to show an egg on the Thurberia plants.

CHARACTERISTICS OF THE ADULT.

DESCRIPTION OF THE SPECIES.

Owing to the recent studies on the variations of this species it becomes necessary to reconstruct the descriptions given by Boheman

[1] Experiments during 1914 in Arizona have proven that the Thurberia weevils will attack growing cotton.

and Dietz in order to include all variations. These descriptions are the joint work of Mr. W. D. Pierce and the writer:

Anthonomus grandis Boheman. [Redescribed.]—Stout, subovate to ovate, mahogany red to piceous and clothed with coarse baryta-yellow to raw sienna pubescence. Beak long, slender, shining, and sparsely pubescent at the base; more or less distinctly striate to about the middle; apical half finely and remotely punctured; the beak of the female is slightly longer and more slender than that of the male, more shining, and less coarsely punctured and striate. The female antennæ are inserted at about two-fifths of the distance from the apex of the beak to the eyes, while the male antennæ are inserted at one-third the distance from the apex. Antennæ slender; second joint of funicle longer than the third; joints 3–7 equal in length, but becoming gradually wider. The club may or may not be concolorous with the funicle and is more or less distinctly annulate. Head conical, pubescent, coarsely but remotely punctured, front foveate. Eyes moderately convex, posterior margin not free. Prothorax about one-third wider than long; base feebly bisinuate, posterior angles more or less rectangular; sides almost straight from base to middle, or slightly converging, strongly rounded in front; apex sometimes constricted and transversely impressed behind the anterior margin; surface moderately convex, densely and sometimes subconfluently punctured; punctures irregular in size, sometimes coarser about the sides; pubescence variable, often denser along the median line and on the sides. Scutellum variable. Elytra oblong, scarcely wider at the base than the prothorax; sides convex or subparallel for two-thirds of their length, thence gradually narrowed to and separately rounded at apex, leaving the pygidium moderately exposed; striæ deep, punctures large and approximate; interstices convex, rugulose, pubescence somewhat condensed in spots. Legs rather stout, femora clavate, anterior always strongly bidentate, inner tooth long and strong, outer one variable in shape but connected with former at base; middle and posterior femora unidentate or bidentate. Tibiæ moderately stout, more or less bisinuate internally; tarsi moderate, claws broad, blackish, and rather widely separated; tooth almost as long as claw. Length from 2.3 to 6.75 mm.; width from 1.1 to 3.6 mm.

Anthonomus grandis Boheman. [Typical variety.]—Stout, subovate, almost piceous, and clothed with coarse, baryta-yellow pubescence. Beak long, slender, shining, and sparsely pubescent at base; more or less distinctly striate to about the middle; apical half finely and remotely punctured; the beak of the female is slightly longer and more slender than that of the male, more shining, and less coarsely punctured and striate; the female antennæ are inserted at about three-fifths of the distance from the apex of the beak to the eyes, while the male antennæ are inserted at one-third of the distance from the apex. Antennæ slender, second joint of the funicle longer than the third; joints 3–7 equal in length, but becoming gradually wider; concolorous throughout, usually mahogany red; club rarely distinctly annulate and usually with only the faintest traces of whitish hairs on the apical margins of the first two joints. Head conical, pubescent, coarsely but remotely punctured, front foveate. Eyes moderately convex, posterior margin not free. Prothorax about one-third wider than long, base feebly bisinuate, posterior angles more or less rectangular; sides usually almost straight from base to middle, or slightly converging, strongly rounded in front; apex sometimes constricted and transversely impressed behind the anterior margin; surface moderately convex, densely and sometimes confluently punctured; punctures irregular in size, sometimes coarser on the sides; pubescence condensed in a sharply defined median vitta distinct from base to apex, also denser on sides. Scutellum narrow, elongate, convex, usually cylindrical, rounded oblong. Elytra oblong, scarcely wider at base than the prothorax; sides subparallel for two-thirds of their length, thence gradually narrowed to and separately rounded at apex, leaving the pygidium moderately exposed; striæ deep, punctures large and approximate; interstices convex, rugu-

lose, pubescence somewhat condensed in spots. Legs rather stout, femora clavate, anterior strongly bidentate, inner tooth long and strong, outer one variable but connected with former at base; middle femora unidentate in male, rarely with minute second tooth in female; posterior femora unidentate. Tibiæ moderately stout, more or less bisinuate internally; tarsi moderate, claws broad, blackish, and rather widely separated; tooth almost as long as claw. Length, from 2.3 to 6.75 mm.; width, from 1.1 to 3.6 mm.

Anthonomus grandis thurberiæ Pierce.—Stout, ovate, mahogany red, and clothed with coarse, raw sienna pubescence. Beak long, slender, shining, and sparsely pubescent at base; more or less distinctly striate to about the middle; apical half finely and remotely punctured; the beak of the female is slightly longer and more slender than that of the male, more shining and less coarsely punctured and striate; the female antennæ are inserted at about two-fifths of the distance from the apex of the beak to the eyes, while the male antennæ are inserted at one-third of the distance from the apex. Antennæ slender, second joint of funicle longer than the third; joints 3–7 equal in length but becoming gradually wider; the club piceous black, scape and funicle mahogany red; club with apical margins of the first two segments usually distinctly annulate with fine whitish hairs. Head conical, pubescent, coarsely but remotely punctured, front foveate. Eyes moderately convex, posterior margin not free. Prothorax about one-third wider than long; base bisinuate, posterior angles more or less rectangular; sides usually converging from near base to apical third and thence strongly convexly narrowed to apex; apex sometimes constricted and transversely impressed behind the apical margin; surface moderately convex, densely and sometimes subconfluently punctured, punctures irregular in size, sometimes coarser about the sides; pubescence evenly distributed; without sharply defined vittæ. Scutellum broad, subquadrate, rarely subtriangular, flattened. Elytra broad, scarcely wider at the base than the prothorax; sides slightly convex in basal two-thirds, thence strongly convexly narrowed and separately rounded at apex, leaving the pygidium moderately exposed; striæ deep, punctures large and approximate; interstices convex, rugulose, pubescence more regular but slightly condensed in spots. Legs rather stout, femora clavate, anterior always strongly bidentate, inner tooth long and strong, outer one variable in shape but connected with former at base; middle femora bidentate; posterior femora almost always unidentate. Tibiæ moderately stout, anterior and median bisinuate internally, posterior straight; tarsi moderate, claws broad, blackish, and rather widely separated, tooth almost as long as claw. Length, from 2.5 to 6.7 mm.; width, from 1.8 to 3.6 mm.

LONGEVITY OF ADULT WEEVILS.

Several series of experiments were conducted to determine the longevity of the weevils upon different foods. These experiments not only compare the two varieties of the weevil, but compare weevils from Tallulah, La., with those from Victoria, Tex.; various Malvaceæ with one another and with a diet of water only; different parts of the same plant; different seasons; and also the two sexes. The data obtained are presented in concise form in Table I.

The maximum record of longevity made in the 1913 work is based on a specimen of *Anthonomus grandis thurberiæ*, extracted from its hibernation cell August 27, after at least nine months in hibernation, which was still alive when the food supplies at Victoria gave out, October 29. This gives the maximum known period of hibernation as 270 days, and a total of over 333 days longevity. The maximum recorded length of life is 335 days for a hibernated weevil at Tallulah, La., in 1910.[1]

The maximum length of life of weevils after emergence from hibernation was 73 days for males and 71 days for females, both of which records are far below the highest previous records.

A true comparison of females fed on blooms of *Hibiscus syriacus* gives the average longevity of Arizona *A. g. thurberiæ* as 22.5 days, Texas *A. grandis* as 16 days, and Louisiana *A. grandis* as over 27 days.

The *grandis* males averaged 3.47 days on water, 5 days on *Sphæralcea lindheimeri*, 7.6 days on *Callirrhoë pedata*, 17.5 days on *Hibiscus syriacus*, 20 days on *Callirrhoë involucrata*, and 33.2 days on cotton, while the *thurberiæ* males averaged 27.6 days on *Hibiscus syriacus*.

The *grandis* females averaged 3.32 days on water, 5.4 days on both *Sphæralcea lindheimeri* and *Callirrhoë pedata*, 19.2 days on *Hibiscus syriacus*, and 34.3 days on cotton, while the *thurberiæ* females averaged 25.5 days on *Hibiscus syriacus*.

The greater longevity of weevils on the same food later in the season is very evident and is due to the advance of hibernation temperatures.

Although the records of life on cotton were shorter than those previously obtained when the totals are considered, it is noted that they agree quite well for any given season. It is evident that temperature and humidity exercise considerable control upon the length of life on any given food. The average longevity on cotton leaves was 11.9 days, on bolls 17.2 days, and on squares 42.1 days.

Adding these new records to those previously obtained 5,858 weevils fed on water only averaged 10.1 days; 16 weevils fed on cotton leaves only averaged 11.9 days; 226 weevils fed on miscellaneous malvaceous plants averaged 13.2 days; 92 weevils fed on cotton bolls averaged 19.9 days; 4,353 weevils fed on cotton foliage averaged 24.5 days; and 147 weevils fed on cotton squares averaged 59.5 days.

Comparing the sexes irrespective of food in all experiments hitherto conducted 4,226 males averaged 17.7 days, and 3,624 females averaged 18.5 days.

[1] The longevity records of 1913 have been greatly exceeded during 1914 in experiments conducted at Washington, D. C. Weevils have been kept in a dormant state for over a year, and give promise of living considerably longer.

TABLE I.—*Duration of life of boll weevils.*

VARIETY GRANDIS, WITHOUT NORMAL FOOD.

Season.	Sustenance provided.	Males.				Females.				Both sexes.		Notes on weevils.
		Number.	Weevil[1] days.	Average longevity.	Maximum longevity.	Number.	Weevil[1] days.	Average longevity.	Maximum longevity.	Maximum longevity.	Average longevity.	
				Days.	*Days.*			*Days.*	*Days.*	*Days.*	*Days.*	
June 22–July 2	Moist sand	19	66	3.47	6	21	70	3.32	5	6	3.3	Bred.
May 13–May 28	*Sphæralcea lindheimeri*, buds and blooms.	3	22	7.3	9	3	30	10.0	15	15	8.6	Hibernated.
June 13–June 29	do	10	43	4.3	8	10	41	4.1	7	8	4.2	Bred.
Total on Sphæralcea.		13	65	5.0	9	13	71	5.4	15	15	5.2	
May 16–June 11	*Callirrhoë pedata*, buds and blooms.	4	56	14.0	26	4	41	10.2	18	26	12.1	Hibernated.
June 13–July 6	do	11	58	5.3	21	11	40	3.6	6	21	4.4	Bred.
Total on *Callirrhoë pedata*.		15	114	7.6	26	15	81	5.4	18	26	6.5	
May 13–June 2	*Callirrhoë involucrata*, buds and blooms.	1	20	20.0	20					20	20.0	Hibernated.
June 26–July 1	*Hibiscus syriacus*, buds	5	16	3.2	5	5	21	4.2	5	5	3.7	Bred.
June 26–Aug. 5	*Hibiscus syriacus*, blooms	4	120	30.0	40	2	32	16.0	28	40	25.3	Do.
Sept. 1–Oct. 13	do	2	+66	+33.0	+33	2	+54	+27.0	+33	+33	+30.0	Bred. Tallulah weevils.[2]
June 16–July 22	*Hibiscus syriacus*, buds, blooms, and fruit.	6	92	15.3	23	6	101	16.8	36	36	16.0	Collected.
July 16–July 28	do	6	91	15.1	26	6	140	23.3	43	43	19.2	Bred.
Aug. 28–Sept. 23	do	3	27	9.0	13	3	58	19.3	26	26	14.1	Do.
Sept. 9–Oct. 13	do	3	+97	+32.3	+34	4	+133	+33.3	+34	+34	+32.8	Do.[2]
Total on Hibiscus		29	+509	+17.5	40	28	+539	+19.2	43	43	+18.3	
Total all *grandis*	Abnormal malvaceous foods.	58	+708	+12.2	40	56	+691	+12.3	43	43	+12.2	

[1] "Weevil days" is the term applied to the sum of the time periods experienced by the various individuals during the course of the observations.
[2] These weevils were alive on October 13 when the food supply ran out.

VARIETY THURBERIÆ, WITHOUT NORMAL FOOD.

Season.	Sustenance provided.	Males.				Females.				Both sexes.		Notes on weevils.
		Number.	Weevil[1] days.	Average longevity.	Maximum longevity.	Number.	Weevil[1] days.	Average longevity.	Maximum longevity.	Maximum longevity.	Average longevity.	
				Days.	*Days.*			*Days.*	*Days.*	*Days.*	*Days.*	
Sept. 5–Oct. 18	*Hibiscus syriacus*, blooms					2	45	22.5	30	30	22.5	Bred.
Sept. 9–Oct. 13	*Hibiscus syriacus*, buds, blooms, and fruit.	5	+138	+27.6	+34	4	+108	+27.0	+34	+34	+27.3	Do.[2]
Total all *thurberiæ* on Hibiscus.		5	+138	+27.6	+34	6	+153	+25.5	+34	+34	+26.4	

VARIETY GRANDIS, WITH NORMAL FOOD.

June 9–July 24	Cotton, leaves	8	121	15.2	45	8	70	8.8	13	45	11.9	Bred.
June 18–July 20	Cotton, bolls	4	96	24.0	32	6	76	12.6	30	32	17.2	Do.
May 8–Aug. 1	Cotton, squares	10	497	49.7	73	13	556	42.8	71	73	45.6	Hibernated.
June 5–Oct. 10	do	9	318	35.3	52	32	1,325	41.4	74	74	40.0	Bred.
Total all *grandis* on cotton.		31	1,032	33.2	73	59	2,027	34.3	74	74	32.8	

[1] "Weevil days" is the term applied to the sum of the time periods experienced by the various individuals during the course of the observations.
[2] These weevils were alive on October 13 when the food supply ran out.

It is important to note that the maximum longevity on water was 6 days, on *Sphæralcea lindheimeri* 15 days, on *Callirrhoë involucrata* 20 days, on *C. pedata* 26 days, on *Hibiscus syriacus* 43+ days, and on cotton 74 days.

SEX OF ADULTS.

The material studied during the year was all sexed and the records have been tabulated to show the seasonal abundance and for comparison of the varieties (Table II).

TABLE II.—*Relative proportions of the sexes of boll weevils.*

Variety and description of material.	Male.		Female.	
	Number.	Per cent.	Number.	Per cent.
Grandis:				
Hibernated weevils	674	67.88	319	32.12
First generation collected	73	53.3	64	46.7
Collected in August	158	62.0	97	38.0
Bred	557	52.6	500	47.4
Total and average	1,462	59.8	980	40.2
Thurberiæ:				
Collected in August	21	51.3	20	48.7
Bred from Thurberia bolls in September	11	50.0	11	50.0
Bred from cotton in the fall	20	62.5	12	37.5
Extracted from Thurberia bolls, March, 1914	71	57.7	52	42.3
Total and average	123	56.9	95	43.1
Hybrids:				
♂ *Thurberiæ* × ♀ *grandis*	22	59.4	15	40.6
Second generation	21	42.0	29	58.0
Not positive crosses	135	51.0	130	49.0
♂ *Grandis* × ♀ *thurberiæ*	11	45.8	13	54.2
Second generation	15	57.7	11	42.3
Not positive crosses	20	51.3	19	48.7
Total and average	224	50.7	217	49.3
Total and average all weevils	1,809	58.3	1,292	41.7

Separating this material into hibernated and spring or summer bred weevils, there are in the hibernated material 777 males and 402 females, or 65.9 per cent males and 34.1 per cent females, while the spring and summer bred weevils numbered 1,032 males and 890 females, or 53.6 per cent males and 46.4 per cent females.

The total of all records to date gives 8,826 males and 6,710 females, or 56.7 per cent males and 43.3 per cent females.

It is noticeable that there is a larger percentage of females in the variety *thurberiæ* and in the hybrids than in the variety *grandis*.

REPRODUCTION.

RELATION OF FOOD TO COPULATION.

To test the period from emergence to copulation, a number of lots of males and females of the variety *A. grandis* were separated by sexes immediately after emergence and placed on either cotton

squares, leaves, or bolls. In each lot the weevils were paired off together for a few hours daily while under close observation. As soon as a pair copulated they were removed from the lot and the remainder tested until they either copulated or died. In this copulation series 23 pairs of weevils fed on squares, 2 pairs fed on bolls, and 1 pair fed on leaves copulated. These figures are of more value when taken in relation to the number of pairs of weevils that refused to copulate before death on the different foods. This relation is shown in Table III.

TABLE III.—*Relative proportion of boll weevils copulating on different foods.*

Food.	Number pairs of weevils carried to either copulation or death.	Number pairs copulated.	Percentage copulated.
			Per cent.
Cotton squares	38	23	60
Cotton bolls	8	2	25
Cotton leaves	8	1	12

From this table it is seen that copulation is unusual when the weevils are fed strictly on either cotton bolls or leaves.

AGE AT WHICH FERTILIZATION TAKES PLACE.

The length of the period before copulation depends in a large measure upon the temperature as well as upon the food. For square-fed weevils this period varied from 3 to 10 days, with a weighted average of 5.8 days.

In the series of boll-fed weevils only two records were made on this period. Both of these were in the latter part of June and were 6 and 8 days, respectively, giving an average of 7 days.

In the leaf-fed series only 1 pair copulated, and they gave a period of 5 days.

The records on boll-fed and leaf-fed weevils are too few in number to offer any comparison with the length of the period for square-fed weevils and serve only to emphasize the difficulty with which the life functions are performed on these unnatural foods.

The period from emergence to copulation was not determined exactly for the weevils fed only on buds and blooms of *Hibiscus syriacus*, but some idea of the period can be secured from the first date the weevils were observed in copula while making the daily examination. Two pairs of *A. g. thurberiæ* were first observed in copula in 6 and 14 days after emergence, while at the same time (September) two pairs of *A. grandis* were first observed in copula in 9 and 13 days after emergence. These records and the frequency with which the weevils were observed in copula later show that the proper element to stimulate copulation is present in the food.

PERIOD FROM FERTILIZATION TO OVIPOSITION.

The period from fertilization to oviposition was secured as a continuation of the experiments described under the period from emergence to copulation. After the females in this series copulated once they were placed on food and watched for the first egg deposited. In this manner the period was determined. In most cases the male was removed after the first fertilization, but in a few cases the male was placed with the female for a short period each day and the copulation noted. In this way as many as five copulations were noted for a female before a single egg was deposited. The periods determined are noted according to the food.

Weevils fed on cotton squares.—During June, July, and August this period was observed for 21 females fed only on squares. The period ranged from 1 to 7 days, with an average of 3.9 days.

Weevils fed on cotton bolls.—Three pairs of boll-fed weevils were observed from first copulation to oviposition. The period for these weevils ranged from 3 to 7 days, with an average of 5 days.

Weevils fed on cotton leaves.—Only one pair of weevils started copulating when fed only on cotton leaves from emergence. This female emerged July 7 and copulated the first time on July 11. She lived until July 24 and copulated 8 times in the interval. No eggs were laid.

PERIOD FROM EMERGENCE TO OVIPOSITION.

In the series of typical *grandis* the period from emergence to oviposition when on squares constantly varied from 3 days to 13 days, with an average of 6.1 days for the positive records.

With typical *thurberiæ* the three cases recorded ranged from 3 to 6 days, with an average of 4 days. These records are too few in number to allow a positive comparison with those for *grandis*, but the average is just about the same as for the latter during the same period (early September).

Two pairs of progeny of female *grandis* by male *thurberiæ* began to oviposit in 4 and 7 days each or an average of 5.5 days.

Two pairs of progeny of female *thurberiæ* by male *grandis* began to oviposit in 5 days each.

The period from emergence to oviposition was observed with six pairs of *grandis* fed only on buds and blooms of *Hibiscus syriacus* from maturity. Three of these pairs observed during early June varied from 5 to 6 days, and averaged 5.6 days. The other three pairs, observed during September, ranged from 11 to 18 days, with an average of 13.6 days.

This period was also observed with two pairs of *thurberiæ* on the same food. These began to oviposit in 12 and 16 days, or in an average of 14 days.

PERIOD FROM FIRST FEEDING ON SQUARES TO OVIPOSITION.

The period from first feeding on squares to oviposition is shown for hibernated *A. grandis* females in Table IV.

TABLE IV.—*Time from first feeding on squares to oviposition for hibernated females of A. grandis.*[1]

Collected, May—	First fed on squares, May—	First eggs deposited, May—	Period fed on squares to deposition.	Total period from first fed on leaves to deposition.
			Days.	*Days.*
8	14	22	8	14
8	14	19	5	11
8	15	20	5	12
8	17	19	2	11
10	24	25	1	15
Avg.			4.2	12.6
Max.			8	15
Min.			1	11

[1] These weevils were collected in the field before squares began to form and fed upon leaves until the dates noted above.

The weevils were collected in the field before any squares were formed and were fed only on cotton leaves until the dates given for placing on squares. It is seen that the period ranged from 1 to 8 days with an average of 4.2 days. An interesting point, however, is the fact that the time from the change from leaves to squares as food to the beginning of oviposition seems to vary inversely with the time fed on leaves. The totals of these two periods or, in other words, approximately the time from first feeding on the cotton plant to oviposition, are surprisingly similar. They vary from 11 to 15 days with an average of 12.6 days.

This period for female *thurberiæ* paired with male *grandis* was 12 and 15 days in the two cases tested in May and June. This gives an average of 13.5 days. In early September this period ranged from 2 to 5 days with an average of 3 days.

During the early part of September this period for typical *thurberiæ* varied from 1 to 3 days with an average of 2.2 days.

In all these series where female *thurberiæ* were used the individuals were extracted from their hibernation cells in Thurberia bolls and placed on cotton squares immediately.

The period from first feeding to oviposition of early hibernated females was observed in only one pair of weevils fed on the buds and blooms of *Callirrhoë pedata*. This female began depositing eggs 6 days after being placed on this food. As these weevils were collected during the early part of May they had probably fed very little, if at all, on cotton.

DURATION OF FERTILITY AND FECUNDITY.

Many experiments were conducted to test the duration of fertility and the fecundity of the various types of weevils. With *A. grandis* special experiments on this question were conducted in addition to the regular breeding series. Rather thorough data were obtained on the variety *thurberiæ* and the various crosses in the different breeding series of these.

Fecundity of females of A. grandis in copula only once.—The previous results on the exact duration of the fertility of females after copulation were very indefinite and there were no records of the fecundity resulting from only one copulation. In the course of the past summer's investigations the writer was able to secure considerable information on this point.

Eleven females were separated from the males immediately after emergence and only returned to them about 6 hours each day when under close observation. In this manner the first copulation of each female was determined and she was then placed alone on squares to test her fecundity with no more chances for fertilization. Of the 11 females so treated, five were fertile, four were infertile but deposited eggs, and two failed to deposit any eggs. Of the two that did not deposit eggs, one was in copula 25 minutes and the other 10 minutes. Each of these lived a short time and then died. The fecundity tests of the remainder gave the results found tabulated in Tables V and VI.

TABLE V.—*Fecundity of females of A. grandis in copula only one time and rendered fertile in that time.*

Duration of fertility.	Time in copula.	Oviposition.			Total eggs.	Eggs deposited.		Eggs per day.	
		Started.	Ended.	Period.		Externally.	Normally.	Average.	Maximum.
	Minutes.			*Days.*					
To end of oviposition..	24	June 28	Aug. 7	41	348	0	348	8.5	17
To Aug. 10.....	[1] 45	...do....	Aug. 27	61	456	9	447	7.4	21
To end of oviposition..	26	June 30	July 18	19	87	0	87	4.6	7
Do.....	[2] 31	July 12	Aug. 12	32	237	0	237	7.4	17
Do.....	29	Aug. 9	Sept. 4	27	32	0	32	1.2	3
Total.....	155	.....	.....	180	1,160	9	1,151	.....	.....
Average.....	31	.....	.....	36	235	.....	.....	.....	.....
Weighted average....	.....	.....	.....	.....	.....	.....	.....	6.4	.....
Maximum.....	45	.....	.....	61	456	9	447	8.5	21
Minimum.....	24	.....	.....	19	32	0	32	1.2	3

[1] Copulated twice (22 and 23 minutes respectively) with interval of 12.5 minutes between copulations.
[2] Copulated four times (7, 4, 2, and 18 minutes respectively) between 10:04 a. m. and 11:18 a. m. Remainder of the weevils were in copula only one time. These copulations were with so very little time between them that they were considered as one fertilization.

TABLE VI.—*Fecundity of females of A. grandis in copula only one time and not fertilized.*

Total, average, etc.	Time in copula.	Oviposition.			Total eggs.	Eggs deposited.		Eggs per day.		Time from last egg to death.
		Started.	Ended.	Period.		Externally.	Normally.	Average.	Maximum.	
	Min.			*Days.*						*Days.*
.....	3	June 29	June 29	1	1	0	1	1	1	4
.....	7.5	June 30	Aug. 26	58	67	51	16	1.1	6	1
.....	19	July 1	July 1	1	3	0	3	3	3	8
.....	37.5	...do....	July 3	3	3	0	3	1	1	35
Total...	67.0	.....	.....	63	74	51	23	.....	.....	48
Average.....	16.7	.....	.....	15.7	18.5	.....	.....	.....	.....	12
Weighted average.....	.....	.....	.....	.....	.....	.....	.....	1.1	.....	.....
Maximum....	37.5	.....	.....	58	67	51	16	3	6	35
Minimum.....	3	.....	.....	1	1	0	1	1	1	1

From Table V it is seen that the greatest fertility was with the longest period of copulation (45 minutes). Beyond this there seems to be very little relation between the time in copula and the resulting degree of fertility. In the infertile females it is seen that periods of 25 and 37.5 minutes in copula still failed to result in fertility.

The total eggs deposited by the fertile females ranged from 32 to 456 with an average of 235 each for the five females. This average is quite high, even in comparison with females having males present throughout life. The infertile females deposited from 1 to 67 eggs, with only one depositing more than 3 eggs.

The period of fertility of the fertile females ranged from 19 to 44 days with an average of 32.6 days. The average eggs per day ranged from 1.2 to 8.5 with a weighted average of 6.4. This is a rather high average when compared with the results secured in other deposition series.

A comparison of these results seems to indicate that the time in copula has very little influence on the resulting fertility of the female. One female was not rendered fertile during 37.5 minutes of copulation while four others were fertilized in less than this time. The shortest time in copula which resulted in fertility of the female was 24 minutes, but the writer thinks that this is not significant.

The high average of the eggs deposited by the females fertilized only once would seem to indicate that one fertilization is sufficient to produce the maximum fecundity of the female. While this may be true in certain rare instances, the writer believes that such cases will be very rare. In a different breeding series a few females were allowed to deposit eggs from one fertilization until they stopped deposition, then males were added and in every case the females began depositing again and continued for some time. The female with the highest deposition record in the one fertilization series discussed above quite evidently reached the limit of her fertility 17 days before death and she deposited 9 infertile eggs in this period.

From this evidence it seems clear that one copulation will often result in fertilization, but will not usually suffice for complete fecundity of the female.

Fecundity of females of A. grandis with complete record on copulation.—Since very little was known concerning the exact number of times a single female will copulate in the course of her life an attempt was made to secure some information on this point.

Nine females were separated from the males immediately after emergence and each was fed separately throughout life. A male was allotted to each female and each day the different pairs were placed together in dry glass tubes for a short time while under close observation and given a chance to copulate. The period spent in copula was noted each time and in this manner a complete record of the copulations of each female was secured. During the remainder of the day the females were kept on fresh squares and the daily egg deposition noted. The results secured in this series are shown in Table VII.

TABLE VII.—*Fecundity of females of A. grandis with complete record of time in copula.*

Total, average, etc.	Times in copula.	Total time in copula.	Average time per copula.	Oviposition.			Total number eggs.	Eggs deposited externally.	Average number eggs per day.	Maximum number eggs per day.
				Started.	Ended.	Period.				
		Min.	*Min.*			*Days.*				
	22	490.5	22.3	July 2	July 29	28	204	0	7.3	13
	30	667.5	22.2	July 4	Aug. 9	37	217	0	5.8	18
	33	786.5	23.8	...do.....	Aug. 24	52	302	4	5.8	15
	27	689.0	25.5	July 5	Aug. 4	31	112	0	3.6	10
	29	650.5	22.4	July 6	Aug. 12	38	126	2	3.3	10
	24	563.0	23.4	July 7	Aug. 6	31	126	1	4.0	10
	18	369.0	20.5	...do.....	Aug. 7	32	208	0	6.5	14
	13	291.5	22.4	July 9	Aug. 5	28	65	0	2.3	10
	9	196.0	21.7	July 11	Aug. 27	17	32	0	1.9	5
Total	205	4,703.5				294	1,392	7		
Average	22.7	522.6	22.9			32.7	154.7			
Weighted average									4.7	
Maximum	33	786.5	25.5			52	302	4	7.3	18
Minimum	9	196.0	20.5			17	32	0	1.9	5

The number of times a single female will copulate was found to be much higher than was anticipated. With these 9 females the number varied from 9 to 33, with 6 females copulating more than 20 times. The average per female was nearly 23 times.

In spite of the great number of copulations the number of eggs deposited by these females was not high in comparison with other series. It may be that the fact that the females were of necessity removed from their food for from 1 to 2 hours daily while with the males had some effect on the egg deposition. The total number of eggs per female varied from 32 to 302, with an average of 154.7 eggs per female. This average is considerably lower than that for the females fertilized only once The average number of eggs per female per day was 4.7, which is also lower than the average for the once fertilized females.

When the male and female weevils were placed together in the dry tubes daily they very rarely failed to copulate. They would usually unite within a few minutes after being being placed in the tube and it was very rarely that they copulated at all if they did not start almost immediately after having the opportunity. It was extremely rare for the two sexes to remain together without copulation for a half hour and then unite.

The various breeding series in which one pair of weevils were together on squares were examined only once daily and many pairs were found in copula day after day when making these daily examinations. In the field it was very noticeable that a pair usually united as soon as they were placed together on a plant. When weevils are collected in the field and placed in a tube it is the common occurrence for many pairs to unite as soon as dropped in the tube. Hence it seems probable that it is normal for a single female to be in copula many times and for the weevils to copulate almost whenever they meet in the course of their travels over the plants.

Three females deposited a total of 7 eggs externally. These eggs were deposited during the days when the same females deposited other eggs normally. As the females were certainly fertile, owing to the almost daily copulations, this shows that external deposition of eggs may be due to some cause other than infertility. The eggs deposited externally by these females were tested for viability and all hatched.

Fecundity of A. grandis females after hibernating.—Twelve females were collected in the field at Victoria, Tex., May 8 to 10, shortly after emergence from hibernation, and fed on cotton leaves until squares became available. Then each was placed with a male and given fresh squares daily for oviposition. These females were all observed until their normal death. The results secured are shown in Table VIII:

TABLE VIII.—*Fecundity of females of A. grandis after hibernating.*

Number of females.	Total eggs laid.	Average eggs per female.	Approximate oviposition period per female.	Eggs per day.	
				Average.	Maximum.
			Days.		
2	144	72	12	6.0	14
2	673	336.5	32	10.5	[1] 20
1	302	302	53	5.7	12
2	336	168	25	6.7	11
2	715	357.5	55	6.5	12
2	701	350.5	46	7.6	19
1	100	100	13	7.6	11
Total, 12	2,971		406		
Average		247.6	33.8		
Weighted average				7.3	
Maximum		358	55	10.5	20
Minimum		72	12	5.7	11

[1] The 2 females in this lot deposited 39 eggs in 1 day. Therefore one of them laid at least 20 eggs.

Unfortunately 10 of these females were placed 2 to a breeding cage, and consequently the records for each of these cages give the activities of 2 females instead of 1. Therefore complete individual records of these females can not be given.

The total number of eggs deposited by these weevils is very high. The average per female in the different lots ranged from 72 to 358 eggs. The average for the 12 females is 247.6 eggs. These averages are considerably higher than those of the reared weevils of the later generations. It was previously supposed that, owing to the vitality used in passing the winter, hibernated females would deposit less eggs than weevils emerged during the summer, but this is shown not to be the case.

The previously recorded maximum number of eggs deposited by a single female was 304. It is of considerable interest to note that 6 out of these 12 hibernated females evidently exceeded that number. The average number of eggs per day ranged from 5.7 to 10.5, with an average of 7.3. This also is greater than the average of any of the later generations.

Fecundity of summer-reared weevils.—Although the greater part of the females used in the various generation series of *A. grandis* during the season were not allowed to complete oviposition, 7 of them were continued to completion. The activities of these females are shown in Table IX.

TABLE IX.—*Fecundity of females of A. grandis in various breeding series throughout the season.*

Source of weevils.	Oviposition—			Total eggs.	Eggs per day.	
	Started.	Ended.	Period.		Average.	Maximum.
			Days.			
First generation adults	June 18	July 12	25	205	8.2	14
Third generation adults	July 26	Sept. 30	67	141	2.1	10
Do	...do	Aug. 10	16	83	5.2	12
Do	...do	Sept. 23	60	205	3.4	12
Last adults of first generation	Aug. 3	Sept. 30	59	233	3.9	11
Fourth generation adults	Aug. 18	...do	44	153	3.5	12
Do	...do	...do	44	45	1.0	5
Total				1,065		
Average			45	152.1		
Weighted average					3.3	
Maximum			67	233	8.2	14
Minimum			16	45	1.0	5

Considering the fact that these females were with males constantly, were given fresh squares daily and were less disturbed than any others, it is surprising that their oviposition was so low. The maximum did not equal the average of the once copulated weevils and the average is nearly 100 less than the average for the hibernated females.

The average number of eggs per day ranged from 1 to 8.2, with an average of 3.3 eggs. This is also much less than the average for either the hibernated or once copulated weevils. The maximum number of eggs per day ranged from 5 to 14. In fact these weevils showed a surprisingly low degree of fertility in all points.

Fecundity of females of A. grandis in experiments not continued to completion.—Many of the females in the various *grandis* generation series were allowed to oviposit only a short time and then stopped because of lack of squares. Some interesting data were secured from some of these weevils, as is shown in Table X.

TABLE X.—*Fecundity of females of A. grandis in experiments not continued to completion.*

Oviposition started.	Experiment closed.	Oviposition.	Total eggs.	Eggs per day.	
				Average.	Maximum.
		Days.			
June 16	June 20	5	20	5.0	7
June 17	July 2	16	147	9.2	15
Do	July 11	25	318	12.7	26
July 7	July 12	6	45	7.5	11
Do	...do	6	99	16.5	21
July 9	...do	4	31	7.7	11
Sept. 8	Sept. 21	14	53	3.7	8
Sept. 9	...do	13	73	5.6	10
Maximum				16.5	26
Minimum				3.7	7

This information is of principal value in giving maximum and minimum records. One female in this lot gave the season's maximum record for eggs deposited in one day. This was 26 eggs. Incidentally this is the highest number of eggs deposited by a single female in one day on record. This female was allowed to continue deposition only 25 days, but in this time she deposited a total of 318 eggs, or an average of 12.7 per day.

Fecundity of typical A. g. thurberiæ fed on cotton squares.—Three pairs of pure *thurberiæ* were mated on cotton squares in June, but for some reason only one female deposited any eggs. This one deposited 7 eggs with a maximum of 4 in 1 day and an average of 0.3 per day. These eggs were probably all fertile, as most of them, at least, hatched. It is very hard to account for the fact that two of these females laid no eggs and the other deposited so few. The females of *thurberiæ* placed with *grandis* males at this same time deposited a normal number of eggs.

The fall series of pure *thurberiæ* mated on cotton squares gave much better results, as is shown in Table XI.

TABLE XI.—*Fecundity of typical A. g. thurberiæ.*

Number of females.	Oviposition.			Total eggs.	Eggs per day.		Mean temperature for period.
	Started.	Ended.	Period.		Average.	Maximum.	
			Days.				° *F.*
1[1]	Sept. 7	Sept. 7	1	1	1.0	1	
1	Sept. 3	Oct. 6	34	173	5.1	17	77.6
1	Sept. 2	Oct. 1	30	73	2.4	11	77.3
1	...do....	Oct. 2	31	90	3.0	8	77.4
1	Sept. 4	Oct. 6	33	76	2.3	8	77.4
Total			128	412			
Average			32	103			
Weighted average					3.2		77.4
Maximum			34	173	5.1	17	
Minimum			30	73	2.3	8	

[1] Owing to the fact that this female deposited only one egg, the record is not included in the averages and summary given.

Five pairs were mated, and while four females deposited fairly well, the other deposited only one egg and is not considered in the following discussion. The total number of eggs deposited by these females ranged from 73 to 173, with an average of 103. The average per day ranged from 2.3 to 5.1, with an average of 3.2, and the maximum in one day was 17. All of these records are very low in comparison with the results of practically all other series. On the other hand, the *thurberiæ* females mated with *grandis* males at this time gave better deposition records.

Results of the mating of male of A. g. thurberiæ and female of A. grandis.—In June two hibernated *grandis* females collected in the field were placed with male *thurberiæ* on cotton squares. As these females were undoubtedly fertilized by *grandis* males before being isolated, this series did not result in positive proof of cross breeding, but, as the weevils copulated freely, the later progeny were quite probably hybrids.

These two females deposited 192 and 387 eggs, respectively, with an average of 7.1 and 7.9 each per day. The average total number of eggs per female was 289.5 and the daily average was 7.6. The maximum number of eggs per day was 16 for each female. On the whole this fecundity is quite high and the females were surely refertilized by the new type of males.

In September three known infertile females of *grandis* were mated with male *thurberiæ* on cotton squares immediately after emergence. This resulted in the positive crossing of the two. The results of these matings are shown in Table XII.

TABLE XII.—*Fecundity of positive crosses of male of thurberiæ and female of grandis.*

Total, average, etc.	Number of females.	Oviposition.			Total eggs.	Eggs per day.		Average temperature for period.
		Started.	Ended.	Period.		Average.	Maximum.	
				Days.				°*F.*
	1	Sept. 7	Oct. 24	48	115	2.4	7	74.4
	1	Sept. 4	Sept. 11	38	43	1.1	4	77.8
	1	Sept. 5	Sept. 17	13	69	5.3	8	78.9
Total	3			99	227			
Average				33	75.6			
Weighted average						2.3		76.3
Maximum				48	115	5.3	8	
Minimum				13	43	1.1	4	

The total oviposition of these females was surprisingly low, ranging from 43 to 115 and averaging 75.6 eggs per female. The average number of eggs per day was only 2.3 and the maximum number of eggs in one day was only 8.

Results of the mating of male of A. grandis and female of A. g. thurberiæ.—In June two of the female *thurberiæ* received were mated on cotton squares with male *grandis* collected in the field. As these females had been shipped with *thurberiæ* males, there was a possibility of their being fertile at the time of placing with *grandis* males, but refertilization probably occurred.

These females deposited 115 and 130 eggs respectively, with an average of 122.5 each. The average per day was 3.4 and 3.9 eggs, making an average of 3.6 each for the two females. The maximum in one day was 7 eggs.

In the fall three females of *thurberiæ* reared from Thurberia bolls received from Arizona were mated with the males of *grandis* on cotton squares immediately after emergence. Thus positive crosses were secured. The activities of these females are shown in Table XIII.

TABLE XIII.—*Fecundity of positive crosses of female of thurberiæ by male of grandis.*

Total, average, etc.	Number of females.	Oviposition.			Total eggs.	Eggs per day.		Mean temperature for period.
		Started.	Ended.	Period.		Average.	Maximum.	
				Days.				°*F.*
	1	Sept. 6	Oct. 27	52	95	1.8	8	73.9
	1	Sept. 3	Oct. 2	30	146	4.8	13	77.3
	1	...do....	Oct. 8	36	102	3.0	8	80.2
Total	3			118	343			
Average				39.3	114.3			
Weighted average						2.9		76.7
Maximum				52	146	4.8	13	
Minimum				30	95	1.8	8	

Here again the total eggs deposited was quite low and the average eggs per day was likewise low. However the fecundity was quite high enough to equal many of the *grandis* females depositing at the same time; consequently there seems little reason to believe that the fecundity of *thurberiæ* is less than that of *grandis*.

Results of the mating of progeny of male of thurberiæ and female of grandis.—In the latter part of June three pairs of weevils reared from eggs deposited by doubtful crosses of male *thurberiæ* and female *grandis* were mated on cotton squares. Two pairs were placed together in one jar and allowed to continue deposition until the normal cessation. These two females deposited a total of 100 eggs and averaged 4.3 per day. The maximum number in one day was 14 eggs. The other female was allowed to continue oviposition for 18 days, and in this time she deposited a total of 143 eggs at the rate of 8 eggs per day. The maximum number for one day was 15 eggs.

Results of the mating of progeny of male of grandis and female of thurberiæ.—In July two pairs of weevils reared from eggs deposited by doubtful crosses of male *grandis* and female *thurberiæ* were mated on cotton squares. Owing to the shortage of squares these weevils were stopped after having deposited for 17 and 5 days, respectively. The first female deposited a total of 131 eggs at the rate of 7.3 per day, with a daily maximum of 15, and the second deposited 48 eggs at the rate of 9.6 per day, with a daily maximum of 14.

MAXIMUM NUMBER OF EGGS PER DAY.

The maximum number of eggs deposited in 1 day by any female was 26. A first generation *grandis* female emerging June 8 deposited this number of eggs in cotton squares July 2. The mean temperature was 81.1° F. and the mean humidity was 68 per cent for the oviposition day involved. The previous record for 1 day's deposition (20 eggs) was exceeded many times by quite a number of females.

The maximum number of eggs deposited by typical *thurberiæ* on cotton squares was 17. This number was deposited September 8 at a mean temperature of 86.4° and a mean humidity of 78 per cent for the oviposition day.

The maximum for the mating of infertile female *thurberiæ* and male *grandis* was 13 eggs. This number was deposited September 10 at a mean temperature of 81.4° and a mean humidity of 83.5 per cent for the oviposition day.

The maximum for the mating of infertile female *grandis* and male *thurberiæ* was 8 eggs. This number was deposited September 16 at a mean temperature of 76° and a mean humidity of 77.5 per cent for the oviposition day.

The maximum number for females fed only on buds and blooms of *Callirrhoë involucrata* was 3 eggs.

The maximum for females fed only on the buds and blooms of *Hibiscus syriacus* was 8 eggs.

RATE OF OVIPOSITION.

The daily rate of oviposition has already been shown in the discussion of the general fecundity of the weevils, but the rate by fractions of the oviposition period of the different females is also of interest. In the following studies the oviposition period of each female has been divided into thirds and the results tabulated accordingly. This is shown in Table XIV.

TABLE XIV.—*Rate of oviposition of the boll weevil obtained in all experiments.*

Nature of weevils.	Number of females.	Season.	Rate of oviposition.					
			First third of period.		Middle third of period.		Last third of period.	
			Total eggs.	Daily average.	Total eggs.	Daily average.	Total eggs.	Daily average.
Hibernated *grandis* females.	2	May to July	136	6.5	161	7.3	105	4.6
Once fertilized *grandis* females.	5	June to September	521	9.0	484	8.2	155	2.5
Grandis females with a complete record on copulation.	9	July to August	492	5.2	590	6.0	310	3.0
Various breeding series of *grandis*.	6	June to September	415	4.7	386	4.3	219	2.3
Pure *thurberiæ*	4	September to October.	234	5.5	130	3.1	46	1.0
Positive crosses of male *thurberiæ* and female *grandis*.	3	do	77	2.4	83	2.5	67	2.0
Doubtful crosses of male *thurberiæ* and female *grandis*.	2	May to July	142	5.6	283	9.5	189	7.2
Positive crosses of male *grandis* and female *thurberiæ*.	3	September to October.	155	4.0	127	3.2	61	1.5
Doubtful crosses of male *grandis* and female *thurberiæ*.	2	June to July	81	3.9	101	4.4	63	2.7
Total			2,253		2,345		1,215	
Average				5.2		5.4		2.9

Here it is seen that the maximum rate of oviposition in the average of all series is reached in the middle period and the minimum is in the last period. However, there are several exceptions to this in the averages of the different types of females. It is interesting to compare the results of the spring and fall series. In the former the average of the middle third is much higher than the first and the last is only slightly lower, while in the fall series there is generally a great decrease in the latter part of the period. This difference is of course due to the temperature increasing from spring to summer and decreasing in the fall.

IS THE FECUNDITY OF THE WEEVIL DECREASING?

In previous bulletins on the boll weevil this question was put, but not answered because of insufficient data. A comparison of the total number of eggs laid by weevils at Victoria and the rate per day for 1902 to 1904 with 1913 gives the following results:

In 1902 to 1904 at Victoria 132 weevils laid 11,863 eggs at the rate of 89 eggs each, or 2.8 eggs each per day with a maximum of 135 eggs per female. In 1913 at Victoria 19 weevils in various seasons laid 4,036 eggs at the rate of 212 eggs each, or 5.9 eggs each per day with a maximum of 358 eggs. In one of the fecundity series in 1913 a female *grandis* exceeded even this maximum and laid a total of 456 eggs. This evidence seems to indicate that if there has been any change in the fecundity of the species it is in the nature of an increase rather than a decrease.

OVIPOSITION PERIOD.

During the summer a total of 47 females were observed through the complete oviposition period. The results of these observations are summarized in Table XV.

TABLE XV.—*Oviposition period of the boll weevil obtained in all experiments.*

Source of weevils.	Season.	Number of females.	Maximum period.	Minimum period.	Average period.
			Days.	*Days.*	*Days.*
Once fertilized *grandis* females	June to September	5	61	19	36
Grandis females with complete record on copulation.	July to August	9	52	17	32.7
Hibernated *grandis* females	May to July	12	55	12	33.8
First generation *grandis*	June to July	1			25
Third generation *grandis*	July to September	3	67	16	47.7
Last of first generation *grandis*	August to September	1			59
Fourth generation *grandis*	do	2	44	44	44
Pure *thurberiæ*	September to October	4	34	30	32
Positive crosses of male *thurberiæ* and female *grandis*.	do	3	48	13	33
Doubtful crosses of male *thurberiæ* and female *grandis*.	May to June	2	49	27	38
Positive crosses of male *grandis* and female *thurberiæ*.	September to October	3	52	30	39.3
Doubtful crosses of male *grandis* and female *thurberiæ*.	June to July	2	38	29	33.5
Total		47			
Weighted average					35.8
Maximum			67		
Minimum				12	

Here it is seen that the period ranged from 12 to 67 days with an average of 35.8 days for all females. The number of females of the different classes is too small to permit anything like an accurate comparison of results. While the pure *thurberiæ* and the crosses containing females of this variety averaged a slightly shorter time for the period than the native *grandis*, this difference is not great enough to indicate that there is any special significance in it.

Although the 1913 records on the oviposition period did not in any case approach the maximum recorded period, the average length was almost 5 days longer than the average of all previously recorded experiments.

EXTERNAL DEPOSITION OF EGGS.

In all types of breeding series and at all times during the season females were observed to deposit eggs externally. Usually, when the eggs were deposited externally, the female was either infertile or about through ovipositing but not infrequently fertile eggs were deposited externally by females on the same day they deposited a number normally. A few observations were made of fertile females depositing eggs in empty glass tubes. Every time this happened the female would turn and immediately eat the egg. This habit of eating eggs deposited externally was observed many times and undoubtedly greatly reduced the number found.

The eggs deposited externally were found in all manner of positions on the calyx and bracts of squares, some even being found on the outside of the bracts. When covered with a moist cloth and placed on damp sand several of the eggs hatched. In one case an egg hatched within 24 hours after deposition and two others hatched within 48 hours. As eggs in squares at this time were taking 3 and 4 days to hatch it seems evident that the period for those deposited externally was shortened by the greater exposure to the heat at the time. The tissue of the squares surrounding those deposited normally probably reduces the temperature affecting the eggs.

A number of larvæ were observed after hatching from eggs deposited externally. Although several of these larvæ were very near punctures in the square not one was observed to make its way into the square. They all moved around considerably but died within about one day after hatching. In one case a larva hatched from an egg placed about half inside a puncture and died without entering the square.

Some of these larvæ were taken immediately after hatching and placed in an incision in a square. These larvæ lived and matured. One larva hatched from an egg deposited on the petal of a Hibiscus bloom was placed in an opening in a Hibiscus bud and reached pupation safely.

Many of the eggs deposited externally were not observed for hatching, so no record can be given on the percentage of these eggs that were infertile, but in one series of females that were depositing fertile eggs all eggs deposited externally were kept and records made on the number hatching. A total of 20 eggs was deposited externally in this series and, of these, 3 hatched, or only 15 per cent. From this and the general observations made during the season it seems evident that by far the greater part of the eggs deposited externally are infertile, but occasionally fertile eggs are deposited in this manner.

NUMBER OF EGGS DEPOSITED FIRST DAY OF OVIPOSITION.

The number of eggs deposited the first day of oviposition by each female in all series varied from 1 to 12 with an average of 3 eggs for the 58 females observed during the season.

For typical *grandis* the number varied from 1 to 12 with an average of 3 eggs.

For typical *thurberiæ* the number varied from 1 to 10 with an average of 3.4 eggs.

The number for the mating of infertile female *thurberiæ* and male *grandis* varied from 1 to 2 with an average of 1.6 eggs. The number for the mating of infertile female *grandis* and male *thurberiæ* varied from 1 to 4 with an average of 2 eggs.

PERIOD FROM THE DEPOSITION OF LAST EGG TO DEATH.

The period from the deposition of the last egg to the death of the female in all series varied from 10 days to death on the same day that the last egg was deposited. This death on the last day of deposition was observed 5 times during the season. The average of the 42 cases observed was 3.1 days.

For the different series of typical *grandis* this period varied from 10 days to death on the last day of deposition. The average was 3.2 days.

For typical *thurberiæ* this period varied from 3 to 7 days with an average of 5.2 days.

For the mating of female *grandis* and male *thurberiæ* the period varied from 1 to 5 days with an average of 2.4 days.

For the mating of female *thurberiæ* and male *grandis* the period varied from 3 days to death on the last day of oviposition. The average was 1.8 days.

CESSATION OF OVIPOSITION BY HIBERNATED WEEVILS.

In connection with the discussion of early or late planting to escape the attack of the weevil it is interesting to note the time of cessation of oviposition by early hibernated weevils. The accompanying table (Table XVI) shows the date of the last egg deposited by each of the first twelve hibernated females collected in the spring. Here it is seen that the last egg ranged from May 29 to July 22.

TABLE XVI.—*Dates of cessation of oviposition of first hibernated females of the boll weevil.*

Date collected.	Date stopped ovipositing.	Date collected.	Date stopped ovipositing.
May 8	May 29	May 20	July 12
Do	June 4	Do	July 22
Do	June 19	Do	July 8
Do	June 22	Do	Do.
Do	July 10	May 10	June 14
May 20	June 14	Earliest date stopped	May 29
Do	June 15	Latest date stopped	July 22

DEPENDENCE OF REPRODUCTION UPON FOOD.

The studies of the feeding habits of the weevils in relation to malvaceous plants other than cotton and Thurberia have served to throw some further light on this subject. Many weevils were kept on cotton leaves only from emergence to death, but only one pair was observed in copula and not a single egg was found; but shortly after such females were transferred to squares or bolls they would start ovipositing more or less normally. The possibility of the shape of the square or boll being a mechanical stimulus to oviposition was considered for some time, but later in the season this idea was discarded. A female which had been fed only on the blooms of *Hibiscus syriacus* from emergence deposited a fertile egg on an open petal of a bloom. Then shortly after this several females were observed to oviposit in empty glass tubes. So it seems that oviposition is simply a question of food and fertility, although the element or elements needed for sexual maturity are not limited to cotton squares and bolls. This element is evidently not present in cotton foliage in sufficient quantities, but is present in varying amounts in cotton squares, bolls, and blooms, *Hibiscus syriacus* blooms, and also blooms of *Callirrhoë involucrata* and *C. pedata*.

DEVELOPMENT.

Only a few observations were made on the individual stages of development, although much work was done upon the whole period of development. The length of the stages was obtained by repeated examinations to learn the dates of transformation.

Incubation period.—The data on the egg stage are summarized in Table XVII.

TABLE XVII.—*Incubation period of the boll weevil.*

Date of oviposition.	Number of individuals.	Egg days.	Period.			Mean temperature.
			Minimum.	Maximum.	Average.	
Deposited normally:			*Days.*	*Days.*	*Days.*	° *F*
Aug. 23	9	18	2	2	2.0	88.5
24	8	17.6	2	3	2.2	87.6
28	20	53.8	2	3	2.69	86.8
29	17	48.28	2	4	2.84	86.1
Sept. 19	11	55.0	5	5	5.0	74.1
19	23	131.1	5	6	5.7	73.1
20	24	139.2	5	6	5.8	71.9
21	9	50.4	5	6	5.6	70.9
22	17	81.6	3.5	5.5	4.8	72.9
Total and average	138	594.9	2	6	4.3	.....
Deposited externally:						
May 20	1	1	1	1	1	77.4
Aug. 20	2	4	2	2	2	86.4
Total and average	3	5	1	2	1.6	.....

By this table it is noted that normally deposited eggs developed in 2 days at 88.5° and in 5.8 days at 71.9°, while eggs deposited externally and therefore directly exposed to the changes of air temperature developed in 1 day at 77.4° and in 2 days at 86.4°.

One weevil fed on flowers of *Hibiscus syriacus* deposited an egg externally on September 21. This egg hatched in 4 days at a mean temperature of 71.1°.

Larval period.—Only 26 larvæ were observed through this stage and they averaged 6 days with a minimum of 5.1 days and a maximum of 7.1 days at a mean temperature of 84.7°. One greatly retarded individual not observed to pupation required over 10 days for the period.

Pupal period.—Only 7 observations of the pupal period were made. The average period was 4.63 days, with a minimum of 4.38 days and a maximum of 5.38 days, at a mean temperature of 83.6°.

TOTAL DEVELOPMENTAL PERIOD.

The data for the total developmental period are presented in Table XVIII. Records of the development of 1,513 individuals indicate a very slightly shorter period for the females than the males. These various records are not strictly comparable until correlated with the climatic records.

TABLE XVIII.—*Data on the developmental period of the boll weevil.*

TEXAS WEEVILS.

Nature of weevils.	Larval food.	Period of oviposition.	Males.			Females.			Total number bred.	Total weevil days.	Average period.
			Number bred.	Weevil days.	Average period.	Number bred.	Weevil days.	Average period.			
					Days.			*Days.*			*Days.*
First generation	Cotton squares.	May 19–31	54	884	16.3	50	804	16.0	104	1,688	16.2
Do	...do	June 1–5	72	1,206	16.7	75	1,249	16.6	147	2,455	16.7
Do	...do	June 6–10	57	895	15.7	44	700	15.9	101	1,595	15.7
Do	...do	June 11–15	48	729	15.1	33	493	14.9	81	1,222	15.0
Do	...do	June 16–20	27	379	14.0	34	470	13.8	61	849	13.9
Do	...do	June 21–25	36	477	13.2	40	526	13.1	76	1,003	13.1
Do	...do	June 26–30	33	447	13.5	32	418	13.0	65	865	13.3
Do	...do	July 1–16	12	176	14.6	13	184	14.1	25	360	14.4
Second generation	...do	June 17–30	41	552	13.4	42	562	13.3	83	1,114	13.4
Offspring single pair.	...do	June 25–July 12	13	178	13.7	10	134	13.4	23	312	13.5
Second generation	...do	Aug. 19–Sept. 26	8	128	16.0	5	81	16.2	13	209	16.0
Third generation	...do	July 7–10	3	39	13.0	5	68	13.6	8	107	13.3
Fourth generation	...do	July 27–30	4	52	13.0	4	56	14.0	8	108	13.5
Fifth generation	...do	Aug. 20–Sept. 9	8	133	16.6	5	72	14.4	13	205	15.7
Sixth generation	...do	Sept. 9–17	3	56	18.6	3	57	19.0	6	113	18.8
Do	...do	Oct. 3				1	21	21.0	1	21	21.0
Seventh generation	...do	Oct. 11–14	2	43	21.5	1	21	21.0	3	64	21.3
Miscellaneous series	...do	July 3–Aug. 2	118	1,544	13.1	91	1,170	12.8	209	2,714	13.0
True *grandis*.	...do	May–Oct	539	7,928	14.7	488	7,086	14.5	1,027	15,014	14.6

TABLE XVIII.—*Data on the developmental period of the boll weevil*—Continued.

ARIZONA WEEVILS.

Nature of weevils.	Larval food.	Period of oviposition.	Males.			Females.			Total number bred.	Total weevil days.	Average period.
			Number bred.	Weevil days.	Average period.	Number bred.	Weevil days.	Average period.			
					Days.			*Days.*			*Days.*
First generation	Cotton squares.	Sept. 2–24	20	353	17.6	12	207	17.2	32	560	17.5
Do	do	May 27	2	38	19.0	....	.....	.....	2	38	19.0
Do	do	Sept. 20	1	18	18.0	....	.....	.....	1	18	18.0
Do	do	Sept. 3–10	3	55	18.3	2	37	18.5	5	92	18.4
Do	Cotton bolls.	Sept. 12–15	2	49	24.5	3	76	25.3	5	125	25.0
True *thurberiæ*.	Cotton forms.	May, Sept	28	513	18.3	17	320	18.8	45	833	18.5
Male *grandis* by female *thurberiæ*:											
First generation.	Cotton squares.	Sept. 7–Oct. 2	11	218	19.8	13	228	17.5	24	446	18.5
Do	do	June 6–July 3	20	270	13.5	19	257	13.5	39	527	13.5
Second generation.	do	July 2–15	15	212	14.1	11	157	14.2	26	369	14.1
Total			46	700	15.2	43	642	14.9	89	1,342	15.0
Male *thurberiæ* by female *grandis*:											
First generation.	Cotton squares.	Sept. 5–Oct. 4	22	387	17.5	15	265	17.6	37	652	17.6
Do	do	May 30–June 15	83	1,415	17.0	73	1,049	14.3	156	2,464	15.7
Do	do	June 16–30	35	453	12.9	39	510	13.0	74	936	13.0
Do	do	July 1–7	17	208	12.2	18	226	12.5	35	434	12.4
Second generation.	do	June 24–July 6	21	293	13.9	29	389	13.4	50	682	13.6
Total			178	2,756	15.4	174	2,439	14.0	352	5,195	14.7
Total of all varieties.		1913	791	11,897	15.0	722	10,487	14.5	1,513	22,384	14.7

The total developmental period was also tested in the buds of *Hibiscus syriacus* during September and October. Three *thurberiæ* varied from 15 to 17 days, with an average of 16 days, and 2 *grandis* gave a period of 17 and 18 days, or an average of 17.5 days.

GENERATIONS.

In order to determine definitely the possible number of generations of weevils in one season two series were carried through the breeding season. These were to determine the maximum and minimum number of generations in cotton squares from the first hibernated females to emerge in the spring.

In the maximum series the first eggs from the first hibernated females found were saved for the emergence of the adults. The first of these adults to emerge were mated, their first eggs saved, and so on through each generation. Table XIX shows the results of this series.

TABLE XIX.—*Number of generations of the boll weevil—maximum series on squares.*

[First generation from first eggs of females that emerged from hibernation May 8 to 10.]

Generation.	Date.	Mean temperature for period.[1]	Period from maturity to maturity (about).
		°F	*Days.*
First generation:			
Eggs laid	May 19–24		
Generation mature	June 4– 8	78.2	28
Second generation:			
Eggs laid	June 17–22		
Generation mature	July 1– 4	80.1	26
Third generation:			
Eggs laid	July 7–10		
Generation mature	July 20–22	84.3	19
Fourth generation:			
Eggs laid	July 27–30		
Generation mature	Aug. 9–11	87.5	20
Fifth generation:			
Eggs laid	Aug. 19–22		
Generation mature	Sept. 3– 5	85.2	25
Sixth generation:			
Eggs laid	Sept. 8–10		
Generation mature	Sept. 27–29	76.5	24
Seventh generation:			
Eggs laid	Oct. 7–11		
Generation mature	Nov. 2– 4	69.8	36

[1] The period referred to here is that from the average time of emergence of a generation to the same time in the next generation.

The weevils were very unusually late in emerging from hibernation at Victoria in the spring of 1913, the first being found on May 8. This is at least two or three weeks later than the usual time. As a result, nearly one complete generation was cut off the first of the season. The last generation secured in the breeding series was the seventh. The adults of this generation emerged November 2 to 4. At this time the cool weather had practically stopped all breeding in both cages and field, and this was considered to be the last generation. However, the weather became warmer in the latter part of November and December, and on the 26th of December Mr. J. D. Mitchell found breeding in progress in the field. This was evidently a case of an extra generation caused by the unusually warm weather after the starting of hibernation. The maximum number of generations in squares at Victoria in a normal season is evidently seven or eight.

The minimum generation series was conducted quite differently. The last eggs were secured from the hibernated females used in starting the maximum series. The last adults reared from these eggs were mated and their last eggs secured. The results of this series are shown in Table XX. The last adults of the second generation did not mature until October 13 to 15, and as these certainly would enter hibernation this was considered as the minimum number of generations from the first hibernated females. As the last females to emerge from hibernation in the spring would continue ovipositing much longer and the last weevils of the first reared generation would mature much later in the season, it seems quite possible for weevils of the first generation to enter hibernation in the fall.

TABLE XX.—*Number of generations of the boll weevil—minimum series on squares.*

[First generation from last eggs of females that emerged from hibernation May 8 to 10.]

Generation.	Date.	Period from maturity to maturity (about).	Mean temperature for period.
		Days.	°*F.*
First generation:			
Last eggs laid	July 14–16		
Generation mature	July 29–30	81	80.7
Last generation:			
Last eggs laid	Sept. 26–30		
Generation mature	Oct. 13–15	78	80.7

HIBERNATION.

The hibernation of variety *thurberiæ* in bolls of Thurberia is longer than any other phase of this phenomenon for the species. The adults mature in their cells before December, but remain therein until August or later around Tucson, Ariz. When removed from the cells they begin activity immediately.

NATURAL CONTROL.

Parasitism.—The parasitism of native weevil stages at Victoria during the season was very slight. In spite of the large numbers of infested squares and bolls collected in the field and held for the emergence of weevils, not a single parasite was reared. Several hundred infested squares and bolls were opened during the season and only one parasite larva was found.

Late in the season two lots of squares were sent to the writer from Tallulah, La., by Mr. G. D. Smith. These were placed in cages for the emergence of adults and five species of parasites emerged. These were: *Bracon mellitor* Say; *Catolaccus incertus* Ashm.; *Catolaccus hunteri* Cwfd.; *Cerambycobius cyaniceps* Ashm.; *Eurytoma tylodermatis* Ashm. Of these Bracon was much the more abundant.

From the *thurberiæ* imported from Arizona only one parasite was reared at Victoria. This was a specimen of *Eurytoma* sp. which had parasitized a weevil larva.

During September what threatened to be a serious outbreak of a mite (probably *Pediculoides* sp.) appeared in the various breeding series. This infestation spread rapidly over many of the shelves where immature stages of weevils were being reared and soon killed a considerable number of these. This infestation was evidently controlled by the cool weather and no further trouble was experienced.

Messrs. Schwarz and Barber found in Thurberia bolls two individuals parasitized by Ichneumonoidea.

Disease.—During the latter part of the season a curious epidemic of deaths of newly emerged weevils occurred in one breeding series.

Little attention was paid to the deaths at first, but in about three days nearly all weevils in this series had died. It was then noted that instead of presenting the usual appearance of death the weevils became very dark in color, almost black, in fact. On touching these weevils it was found that they were very soft and the body contents were liquified. This liquid had the usual dark color and characteristic odor of flacherie of lepidopterous larvæ. The source of the seemingly diseased weevils was investigated, and it was found that all came from squares kept in a California breeding box which had contained lepidopterous larvæ infected with flacherie only a short time previously. Two of the dead weevils were submitted to Dr. G. F. White, of this bureau, for bacteriological examination, and he reported as follows:

> In the examinations made the findings in the two specimens are the same. The direct examination shows the presence of a very large number of microorganisms, which seem to be bacteria. The appearances suggest that most of these organisms belong to one species. Comparatively few colonies appeared in plate cultures made from the material. There is some indication, therefore, that the trouble is bacterial in origin. These results can be interpreted, of course, only as suggesting the possibility.

While the results secured by Dr. White are by no means conclusive, they do, as he says, suggest the possibility of a bacterial disease of the boll weevil. Although it is but a mere possibility, there is evidently an opportunity for considerable profitable investigation of the subject.

BEHAVIOR OF LOUISIANA WEEVILS AT VICTORIA.

Late in the season a number of infested squares were imported from Tallulah, La., in order to test the weevils emerging from them in their various life functions in comparison with Texas weevils. As the work was interrupted by the cool weather very little was learned from the series, but some results of interest were secured. Four pairs of weevils were mated on cotton squares immediately after emergence and tested for fecundity. These weevils emerged on September 18 and on September 20 one female deposited 1 egg and another deposited 2. The latter female deposited another egg on September 22, and then neither of these two deposited any more eggs before the series was closed on October 29. The third female lived through the same period and did not deposit an egg. The fourth female emerged September 20, deposited 1 egg on September 22, and then waited 14 days before depositing another. Then deposition started normally and 37 eggs were laid in the next 23 days. These results are very peculiar, especially the fact that three out of the four females began deposition on the second day after emergence and then stopped; two of them permanently and one for a period of 14 days.

The eggs deposited were tested for the maturing of adults, but none emerged, possibly owing to the cold weather. Native weevils were maturing in small numbers under the same conditions at this time, but as the number tested was so small there may not be any significance in this fact.

These weevils were also tested for their ability to subsist on a diet of *Hibiscus syriacus*. The detailed results of this test have been published in the paper on the feeding habits of the weevils. As only blooms were available no tests were made of the ability of these weevils to breed in the buds of this plant, but they seemed as well adapted to the plant as the native and Thurberia weevils.

DEVELOPMENT OF THURBERIA THESPESIOIDES.

On May 21 a supply of seeds of Thurberia from the Santa Rita Mountains, Ariz., were planted at Victoria. A bed of rather sandy soil was selected in a well-drained situation. On May 26 the first seedling appeared above the ground and 11 plants were visible by June 1. Although over 100 seeds were planted only these 11 sprouted.

These plants grew rather rapidly for a couple of months but formed no lateral branches of any consequence. The growth was entirely upward and the stems were very thin, causing the plants to require staking to prevent drooping. About August 20 a number of fruiting branches appeared near the top of the plants and these developed very rapidly. At this time the larger plants were 3½ feet in height. On August 26 the first bud was observed and many more appeared daily for a period of about three weeks. Then fruiting was discontinued for a couple of weeks followed by the production of more fruiting branches. These plants continued to grow with intermittent formation of buds until the observations were discontinued on November 6. At this time several of the plants were more than 4 feet in height.

At Batesburg, S. C., Mr. E. A. McGregor planted about 100 of these seeds in a sandy bed. Not a single one of these appeared above the soil.

At Tallulah, La., Mr. G. D. Smith planted a number of seeds and only one sprouted. This plant lived through the season.

EXAMINATION OF THURBERIA BOLLS.

On March 10, 1914, the writer examined part of a lot of infested Thurberia bolls which had been collected by Messrs. Schwarz and Barber at from 4,500 to 5,000 feet altitude in Stone Cabin Canyon, Santa Rita Mountains, Ariz., on December 6, 1913. These bolls were shipped to Washington shortly after collection and placed in a cool cellar there until the day of examination. Seventy-seven of

the bolls yielded a total of 84 live weevils; one containing 3, 5 others containing 2 each, and the remainder containing 1 each. One boll had been completely eaten out by a bollworm, and another showed signs of weevil injury and a braconid parasite cocoon. Two dead pupæ and 2 dead larvæ were found in 4 other bolls. Their deaths were in all probability due to climatic causes. The remaining boll contained signs of weevil larval work, but no insects, either dead or alive, were found. One boll which contained a weevil adult also contained a tiny, light-green lepidopterous larva.

Of the 84 weevils found in the bolls, 52 were males and 32 were females. One additional male was found crawling among the bolls when the bag was opened. Those in the bolls were all tightly sealed in the pupal cells and were usually quiet when first opened. As soon as the weevils were exposed to the air they became quite active and remained that way.

The peculiar feeding habit of the larvæ of these weevils is certainly well adapted to destroying the maximum number of seeds in a boll. They do practically all their feeding in the center of the boll and form the pupal cells in this same place. Owing to the arrangement of the seeds this location of the larva enables it to injure practically every seed in the boll instead of injuring those of one lock as is usual with the cotton weevils.

On March 12, 1914, another lot of infested Thurberia bolls were examined. These were collected by Mr. Schwarz in a small canyon between Stone Cabin and Sawmill Canyons, Santa Rita Mountains, Ariz., on December 7, 1913, at about 3,900 feet altitude. The bolls were sent to Washington soon after collection and had been in a cool cellar from that time until examined.

Examination of 39 of the bolls showed 2 clean and the remainder infested. Thirty-three bolls yielded 36 live weevils, 3 bolls containing 2 each. Three dead adults (2 females and 1 male) were found in as many bolls. These deaths were probably due to climatic causes. One boll was found which showed signs of larval injury but the larva was not to be found. No signs of parasitism were found. One lepidopterous larva like the one noted in the preceding lot was found in a boll with a weevil. The live weevils consisted of 18 males and 18 females.

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