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# Ecological Investigations of the BOLL WEEVIL

## Tallulah, Louisiana 1915–1958

*By R. C. Gaines*

Technical Bulletin No. 1208

Agricultural Research Service
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# Ecological Investigations of the BOLL WEEVIL

## Tallulah, Louisiana, 1915-1958

By R. C. Gaines, *entomologist, Entomology Research Division, Agricultural Research Service*

The boll weevil (*Anthonomus grandis* Boh.) has been studied intensively at Tallulah, La.,[1] since 1909. Although, through research, controls have been developed which have made it possible for farmers to grow cotton economically in most instances, the boll weevil is still the most important pest over much of the Cotton Belt. Because of the emphasis on developing satisfactory control measures, much of the ecological data accumulated through the years remains unpublished. In the course of obtaining data on the boll weevil, records on certain other cotton insects were made. Systematic studies were begun in 1915. This publication is a summary of the essential ecological and attractancy studies made at the Tallulah laboratory since then.

## Boll Weevil Survival Studies

### Survival in Spanish Moss

Spring examinations of Spanish moss were started in 1916, and fall examinations in 1925; both were discontinued after 1940. Spanish moss was collected from trees in woods adjacent to cotton fields. Samples were taken from a number of locations in Madison Parish near Tallulah, and brought to the laboratory where the moss was examined thoroughly for boll weevils. Information on the abundance of boll weevils in Spanish moss was made available to entomologists, cotton growers, and manufacturers of calcium arsenate. To a certain extent, arrangements for the manufacture and purchase of calcium arsenate were based on the number of boll weevils found in Spanish moss.

In the hibernation cages Spanish moss did not afford as much protection for boll weevils during the winter as certain other shelters. Many boll weevils were killed in Spanish moss under natural conditions before temperatures as low as 20° F. were encountered, and temperatures below 20° F. were fatal to most of the weevils in that shelter. Therefore, it was evident that boll weevils found in the cotton fields during May and June had found shelters that afforded more protection than Spanish moss. The number of boll weevils found in ground trash collected from woods adjacent to cotton fields was more closely related to the number found in cotton fields during May and June than the number found in Spanish moss. For this reason, the examinations of Spanish moss were discontinued. The results of Spanish moss examinations are given in table 1.

[1] The Tallulah, La., laboratory of the Entomology Research Division, United States Department of Agriculture, was established in 1909, and has been in operation continuously since that date.

TABLE 1.—*Summary of boll weevils entering hibernation, winter temperatures, and boll weevil survival, Tallulah, La., 1915–16 to 1957–58*

| Year | Weevils entering hibernation | | Days from September to March when temperature fell below— | | Minimum temperature for winter | Weevils surviving winter | | | | Weevils per acre on cotton plants during May and June |
|---|---|---|---|---|---|---|---|---|---|---|
| | Per ton of Spanish moss | Per acre of ground trash | 32° F. | 20° F. | | Per ton of Spanish moss | Per acre of ground trash | | In hibernation cages | |
| | *Number* | *Number* | *Number* | *Number* | *Degrees F.* | *Number* | *Number* | *Percent* | *Percent* | *Number* |
| 1915–16 | | | 32 | 0 | 20 | 24.0 | | | 6.14 | 346 |
| 1916–17 | | | 45 | 5 | 16 | 8.0 | | | .17 | 4 |
| 1917–18 | | | 60 | 14 | 1 | 1.7 | | | .05 | 51 |
| 1918–19 | | | 45 | 4 | 9 | 4.0 | | | .31 | 73 |
| 1919–20 | | | 39 | 2 | 18 | 9.5 | | | .48 | 81 |
| 1920–21 | | | 35 | 1 | 16 | 22.0 | | | 1.38 | 129 |
| 1921–22 | | | 30 | 0 | 22.5 | 127.0 | | | 4.22 | 133 |
| 1922–23 | | | 26 | 0 | 20 | 19.0 | | | 1.59 | 70 |
| 1923–24 | | | 51 | 5 | 10.5 | .5 | | | .11 | 10 |
| 1924–25 | | | 49 | 4 | 15 | .6 | | | .01 | 3 |
| 1925–26 | 280 | | 47 | 3 | 13 | 0 | | | .05 | 32 |
| 1926–27 | 242 | | 30 | 4 | 16 | 4.0 | | | | |
| 1927–28 | 21 | | 43 | 10 | 11 | 1.0 | | | .02 | 9 |
| 1928–29 | 240 | | 43 | 7 | 16 | 3.8 | | | .78 | 30 |
| 1929–30 | 189 | | 44 | 11 | 1.8 | .2 | | | .01 | 12 |
| 1930–31 | 49 | | 37 | 0 | 20 | 33.0 | | | 5.34 | 7 |
| 1931–32 | 724 | | 19 | 0 | 23 | 462.3 | | | 18.39 | 247 |
| 1932–33 | 881 | | 28 | 3 | 12 | 1.3 | | | .15 | 269 |
| 1933–34 | 365 | | 29 | 0 | 20 | 40.8 | | | 7.51 | 439 |
| 1934–35 | 192 | | 38 | 5 | 6 | 5.2 | | | .11 | 231 |
| 1935–36 | 19 | | 54 | 7 | 14 | 0 | 141 | | .17 | 14 |
| 1936–37 | 141 | 2,118 | 31 | 0 | 22 | 23.0 | 50 | 2 | 11.87 | 51 |
| 1937–38 | 51 | 519 | 35 | 6 | 14 | 1.4 | 186 | 36 | 1.13 | 97 |
| 1938–39 | 4 | 1,284 | 33 | 3 | 15 | 6.7 | 226 | 18 | 1.16 | 113 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1939–40 | 189 | 2, 243 | 59 | 12 | −8 | 0 | 190 | 8 | . 01 | 35 |
| 1940–41 | 23 | 721 | 31 | 2 | 17 | ---------- | 920 | 128 | 10. 36 | 263 |
| 1941–42 | ---------- | 1, 484 | 46 | 4 | 11 | ---------- | 327 | 22 | . 14 | 44 |
| 1942–43 | ---------- | 2, 916 | 29 | 4 | 14 | ---------- | 750 | 26 | 1. 40 | 200 |
| 1943–44 | ---------- | 2, 488 | 43 | 4 | 15 | ---------- | 625 | 25 | 1. 29 | 110 |
| 1944–45 | ---------- | 2, 435 | 34 | 0 | 20 | ---------- | 1, 512 | 62 | 15. 42 | 184 |
| 1945–46 | ---------- | 4, 199 | 31 | 3 | 16 | ---------- | 1, 065 | 25 | 9. 28 | 359 |
| 1946–47 | ---------- | 2, 698 | 34 | 2 | 18 | ---------- | 426 | 16 | 1. 84 | 170 |
| 1947–48 | ---------- | 1, 178 | 50 | 4 | −2 | ---------- | 177 | 15 | . 38 | 91 |
| 1948–49 | ---------- | 2, 146 | 27 | 1 | 10 | ---------- | 1, 710 | 80 | 4. 04 | 255 |
| 1949–50 | ---------- | 3, 231 | 31 | 0 | 21 | ---------- | 2, 202 | 68 | 17. 10 | 560 |
| 1950–51 | ---------- | 4, 586 | 48 | 8 | −12 | ---------- | 1, 742 | 38 | . 02 | 138 |
| 1951–52 | ---------- | 1, 367 | 37 | 5 | 15 | ---------- | 629 | 46 | . 94 | 123 |
| 1952–53 | ---------- | 1, 295 | 41 | 0 | 20 | ---------- | 1, 149 | 89 | . 60 | 83 |
| 1953–54 | ---------- | 5, 239 | 46 | 2 | 17 | ---------- | 1, 113 | 21 | 3. 54 | 318 |
| 1954–55 | ---------- | 2, 686 | 45 | 1 | 19 | ---------- | 2, 021 | 75 | 1. 32 | 132 |
| 1955–56 | ---------- | 13, 443 | 40 | 7 | 14 | ---------- | 3, 654 | 27 | 1. 42 | 290 |
| 1956–57 | ---------- | 2, 622 | 26 | 3 | 17 | ---------- | 1, 937 | 74 | . 88 | 218 |
| 1957–58 | ---------- | 6, 860 | 44 | 1 | 17 | ---------- | 1, 856 | 27 | 4. 34 | 33 |

## Survival in ground trash

Spring and fall examinations of ground trash were started in 1936. Ground-trash samples were taken from areas 3 feet by 6 feet, or 18 square feet, in woods adjacent to cotton fields, usually within 50 feet of the edge of a field. All of the ground trash down to the soil was removed, sacked, and carried to the laboratory for examination. Up to 10 samples were taken from areas adjacent to fields of cotton known to have had heavy, intermediate, and light infestations during the previous season. The areas selected were always within a radius of 20 miles of Tallulah.

In the laboratory, the trash samples were run through a machine, which divided each sample into several portions. The portion containing the boll weevils was then placed on a heated table for examination to determine the number of live and dead boll weevils. Table 1 gives the results of the fall and spring examinations, together with the percent of survival.

## Survival in hibernation cages

Studies of boll weevil survival and emergence were started in hibernation cages, 4 feet by 4 feet by 4 feet, during the fall of 1915. Gaines (1935) reported that the average survival in all cages was 1.22 percent from 1915–16 to 1930–31. Of the total number of weevils surviving, 15.7 percent emerged in March, 22.9 percent in April, 39.7 percent in May, 21.4 percent in June, and 0.3 percent in July. The emergence period for the various years ranged from 47 to 127 days, with a weighted average of 117 days. Of the different materials studied, cornstalks gave the highest average survival of any type of shelter, Spanish moss the second highest, and bare ground the lowest. To determine the effect of date-of-installation on survival, the cages were grouped by approximately 15-day periods. The highest survival occurred in cages installed during the latter half of October, and the next highest during the first half of November. It is during these 4 weeks that the first killing frosts usually occur, which may be one of the factors that cause weevils to enter hibernation under natural conditions.

With the completion in 1931 of certain phases of the hibernation studies, the number of cages was reduced in 1932, again in 1940, and again in 1944 until there were only 10 cages. The study that involved these 10 cages was started during the fall of 1931 and has been continued to date. Ground trash was used for hibernation shelter in one-half of the cages and Spanish moss in the others. The cages were located in woods from 1931–32 to 1948–49, in the laboratory yard from 1949–50 to 1956–57, and in woods during 1957–58. The average survival in all cages each year since 1915–16, with the exception of 1926–27, may be found in table 1. Flood water from the Mississippi River destroyed the cages in May of 1927.

The average boll weevil survival in ground trash from 1937 to 1958, inclusive, was 42 percent; in hibernation cages only 4 percent. L. D. Newsom and J. R. Brazzel of the Louisiana State Experiment Station, and N. W. Earle of the Entomology Research Division, United States Department of Agriculture (unpublished records) found that weevils taken from ground trash at various times during the summer, fall, winter, and spring were all in diapause. This indicates that only those weevils in diapause hibernate and survive the winter. Weevils placed in hibernation cages were collected from cotton fields. Examinations by Newsom *et al.* of field populations of weevils showed that a small proportion were in diapause as early as July, with the proportion increasing as the season progressed. The proportion in diapause varies from field to field and from time to time in a given field. Apparently, when weevils in diapause have accumulated maximum fat they leave the fields for hibernation quarters. This might explain the variations in the proportion of diapausing weevils in a given field at different times. The fact that many weevils confined in the cages were not in diapause may explain why the survival in cages was so much lower than that in ground trash.

### Survival under natural conditions as indicated by number found on cotton during May and June

During May and June of each year, starting in 1916, cotton in a large number of fields was examined to determine the number of boll weevils present. Examinations were started when cotton was in the seedling stage and continued until cotton squares were sufficiently large to attract the weevils away from the terminal buds. These surveys were started for the purpose of locating suitable fields for insecticide-control experiments. A suitable field was one with sufficient boll weevils to cause damage, a uniform stand of cotton, and cotton of uniform growth. After the records were made for a number of years it was evident that they might be correlated with other boll weevil-survival figures and with cotton yields. The number of weevils found on cotton during May and June since 1916, with the exception of 1927, may be found in table 1.

## Relation Between Winter Temperatures, Boll Weevil Survival, Summer Rainfall, and Cotton Yields

Discussions of some of the known boll weevil factors for the years 1915 to 1934 have been published (Gaines 1935, Young 1935). Gaines (1943) reported correlation studies for the years 1915 to 1941. Gaines (1953) reported further correlation studies which added the years 1942 to 1952. Tables 1 and 2 present the published records, with the addition of those for the years 1953 to 1958. Those statements published by Gaines (1953), based on correlation studies, were not changed (with the exception of two comparisons) by the inclusion of the years 1953 to 1958. Table 3 presents the correlation coefficients based on records for the entire period 1915 to 1958.

## Effect of Season on the Toxicity of Calcium Arsenate to the Boll Weevil

Cages for confining boll weevils on cotton plants have been used for many years to determine the effectiveness of poisons. The results from such tests conducted prior to 1920 showed that poisons were less effective and weevil mortalities were more erratic as the season progressed from July to September. For this reason, cage tests were usually discontinued after August 31 or earlier. The results obtained

TABLE 2.—*Summary of summer rainfall, and cotton yields, Tallulah, La., 1916 to 1958*

| Year | Total precipitation June 21 to Aug. 19 | Days with 0.30 inch or more precipitation from June 21 to Aug. 19 | Increase in yield over checks in plots treated with insecticides | Yield in Madison Parish | |
|---|---|---|---|---|---|
| | | | | Pounds per acre [1] | 500-pound bales [2] |
| | *Inches* | *Number* | *Percent* | *Number* | *Number* |
| 1916 | 9.18 | 7 | | | 5,385 |
| 1917 | 6.17 | 6 | | | 11,217 |
| 1918 | 2.96 | 5 | | | 13,725 |
| 1919 | 9.61 | 10 | | | 4,766 |
| 1920 | 6.92 | 8 | 32.8 | | 5,716 |
| 1921 | 9.32 | 9 | 44.6 | | 7,406 |
| 1922 | 14.62 | 16 | 83.9 | | 4,475 |
| 1923 | 7.80 | 8 | 20.7 | | 6,385 |
| 1924 | 1.39 | 2 | 1.1 | | 12,550 |
| 1925 | 6.57 | 5 | 11.7 | | 22,682 |
| 1926 | 8.62 | 12 | 68.3 | | 15,449 |
| 1927 | 8.88 | 9 | 33.0 | | 2,812 |
| 1928 | 9.05 | 11 | 41.2 | 220 | 11,402 |
| 1929 | 5.98 | 5 | 11.7 | 299 | 19,671 |
| 1930 | 1.65 | 2 | 9.3 | 205 | 15,488 |
| 1931 | 8.53 | 8 | 31.8 | 300 | 19,402 |
| 1932 | 7.25 | 7 | 45.7 | 225 | 14,447 |
| 1933 | 16.33 | 12 | 46.0 | 209 | 9,243 |
| 1934 | 2.52 | 2 | 19.5 | 252 | 10,516 |
| 1935 | 4.03 | 2 | 11.3 | 252 | 11,658 |
| 1936 | 5.85 | 6 | 5.0 | 453 | 24,130 |
| 1937 | 1.86 | 2 | 3.3 | 469 | 28,992 |
| 1938 | 10.77 | 9 | 9.6 | 414 | 18,306 |
| 1939 | 7.05 | 6 | 11.3 | 410 | 19,325 |
| 1940 | 12.22 | 12 | 54.7 | 177 | 7,997 |
| 1941 | 6.87 | 8 | 46.3 | 238 | 10,925 |
| 1942 | 5.08 | 5 | 2.4 | 430 | 21,393 |
| 1943 | 3.46 | 6 | 13.8 | 478 | 22,959 |
| 1944 | 6.02 | 7 | 1.8 | 482 | 21,610 |
| 1945 | 4.28 | 4 | 36.5 | 228 | 10,260 |
| 1946 | 13.44 | 10 | 75.0 | 116 | 5,409 |
| 1947 | 4.81 | 5 | 15.5 | 331 | 16,212 |
| 1948 | 14.89 | 6 | 13.7 | 449 | 23,039 |
| 1949 | 9.42 | 12 | 39.0 | 276 | 15,273 |
| 1950 | 7.66 | 10 | 112.8 | 373 | 14,423 |
| 1951 | 3.24 | 6 | 85.3 | 401 | 18,675 |
| 1952 | 1.65 | 1 | 18.4 | 477 | 21,609 |
| 1953 | 5.13 | 4 | 19.7 | 551 | 37,000 |
| 1954 | 1.56 | 2 | 28.7 | 543 | 24,500 |
| 1955 | 15.08 | 12 | 16.8 | 551 | 22,600 |
| 1956 | 4.68 | 4 | 34.2 | 714 | 27,050 |
| 1957 | 9.22 | 9 | | 491 | 16,700 |
| 1958 | 12.01 | 12 | | | |

[1] Data from Agricultural Marketing Service.
[2] Data from Census Bureau and Agricultural Marketing Service.

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TABLE 3.—*Correlation coefficients showing the relation between winter temperatures, boll weevil survival, summer rainfall, and cotton yields, Tallulah, La., 1915–16 to 1957–58*

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | ------ | ------ | ------ | −0.50* | −0.19 | −0.37 | −0.55** | −0.56** | ------ | ------ | ------ | ------ | ------ |
| B | ------ | ------ | ------ | −.11 | −.16 | −.39 | −.52** | −.40** | ------ | ------ | ------ | ------ | ------ |
| C | ------ | ------ | ------ | +.38 | +.14 | +.28 | +.42** | +.28 | ------ | ------ | ------ | ------ | ------ |
| D | −0.50* | −0.11 | +0.38 | ------ | ------ | ------ | +.81** | +.32 | ------ | ------ | +0.31 | −0.20 | −0.05 |
| E | −.19 | −.16 | +.14 | ------ | ------ | +.37 | +.19 | +.54** | ------ | ------ | +.49* | +.32 | +.01 |
| F | −.37 | −.39 | +.28 | ------ | +.37 | ------ | +.37 | +.33 | ------ | ------ | +.27 | −.10 | −.04 |
| G | −.55** | −.52** | +.42** | +.81** | +.19 | +.37 | ------ | +.57** | ------ | ------ | +.40* | −.30 | −.13 |
| H | −.56** | −.40** | +.28 | +.32 | +.54** | +.33 | +.57** | | ------ | ------ | +.48** | −.07 | −.25 |
| I | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | | +0.84** | +.37* | −.23 | −.35* |
| J | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ | +0.84** | ------ | +.59** | −.28 | −.45** |
| K | ------ | ------ | ------ | +.31 | +.49* | +.27 | +.40* | +.48** | +.37* | +.59** | ------ | −.33 | −.45** |
| L | ------ | ------ | ------ | −.20 | +.32 | −.10 | −.30 | −.07 | −.23 | −.28 | −.33* | ------ | +.85** |
| M | ------ | ------ | ------ | −.05 | +.01 | −.04 | −.13 | −.25 | −.35* | −.45** | −.45* | +.85** | ------ |

*Significant.
**Highly significant.
A Number of days from September to March when temperature fell below 32° F.
B Number of days from September to March when temperature fell below 20° F.
C Minimum temperature for winter ° F.
D Number of weevils per ton surviving the winter in Spanish moss.
E Number of weevils per acre surviving the winter in ground trash.
F Percent of weevils surviving the winter in ground trash.
G Percent of weevils surviving the winter in hibernation cages.
H Number of weevils per acre found on cotton plants during May and June.
I Total precipitation from June 21 to Aug. 19.
J Number of days with 0.30 inch or more precipitation from June 21 to Aug. 19.
K Percent of increase in yield over checks in plots treated with insecticides.
L Yield per acre in Madison Parish.
M Total yield in Madison Parish.

in cage tests from 1915 to 1930 are not available, but they are available from 1931 to 1947, inclusive. Cage tests were discontinued after 1947. Net mortalities (table 4) of boll weevils treated with calcium arsenate decreased significantly during each semimonthly period from July 16–31 to August 16–31.

TABLE 4.—*Net mortalities of boll weevils caused by calcium arsenate during three semimonthly periods*

| Date of tests (1931 to 1947) | Net mortality |
|---|---|
| | *Percent* |
| July 16–31 | 83 |
| Aug. 1–15 | 75 |
| Aug. 16–31 | 61 |

M.S.D. at 5% level, 5.
M.S.D. at 1% level, 7.

During the past 10 years, considerable data on the seasonal decline in the effectiveness of insecticides against the boll weevil have been published. Gaines and Mistric (1951) showed that considerably higher dosages of insecticides were required late in September and October than were required in August to give a comparable kill of boll weevils. Rainwater and Gaines (1951) reported that, in general, toxaphene, benzene hexachloride, aldrin, and dieldrin were approximately 50 percent as effective in October as in July, whereas undiluted calcium arsenate was approximately 67 percent as effective. Gaines and Mistric (1952) found that higher dosages of the insecticides were required to effect control of weevils late in the season than early in the season.

Factors other than environment affected the toxicity of organic insecticides to boll weevils. Mistric and Gaines (1953) reported that it required from two to three times as much of the various insecticides to kill comparable percentages of boll weevils late in the season as compared with early in the season. Since the climatic conditions did not vary sufficiently to account for such a difference, it is assumed that factors involving the physiology of the weevil are responsible for such varying susceptibility. Reiser *et al.* (1953) found (1) that the total lipid content of the boll weevil increased as the season progressed; and (2) that the fat content of the boll weevil is not directly related to its resistance to chlorinated hydrocarbon insecticides, as indicated by (a) increasing resistance to calcium arsenate during the season, and (b) the higher fat content of insects resistant to any insecticide tested, or of surviving controls. From the above, Reiser *et al.* suggested that the higher fat content, larger size, and increasing resistance of late-season weevils may be due to the nutritional advantage of boll-reared over square-reared insects.

## Boll Weevil Longevity Studies

Boll weevil longevity tests were conducted from 1934 to 1950, with the exception of 1947 and 1948, and in 1958. On July 24, 1947, the 12 weevils under observation were killed by benzene hexachloride which drifted into the insectary when the dust was applied to a wasp nest on the outside of the building. In 1948, all of the weevils were dead by the end of June. This was not in line with records made during previous years. It was possible that cotton used for weevil food may have been contaminated with toxaphene. The field where the squares were collected was adjacent to a cotton field which was dusted twice during June with 10-percent toxaphene applied by airplane. There could have been enough drift from that field to have contaminated the cotton used for food.

During May, June, and July, some of the over-wintered boll weevils taken from hibernation cages were used in the longevity studies. Those weevils were then carried to an insectary where they were placed in small screen-wire cages on dishes of sand. The sand was kept moist by applying water daily. Only one weevil was placed in each small cage. Each weevil was given fresh food daily. In all years except 1958, weevils were given seedling plants early, and terminals with squares after squares were available. In 1958, weevils were given parts of the cotton plant having no fruiting forms until July 31, and after that date, plant terminals with squares. A record was made of the date of death of each weevil, or the date in November when the weevil was placed in a cage with adequate hibernation shelter for possible survival a second winter.

Table 5 presents the longevity records, by years, for the 690 overwintered boll weevils used in this study. These records show that 87.4 percent of the weevils were alive on June 1, 48.0 percent on July 1, 30.2 percent on August 1, 17.0 percent on September 1, 5.4 percent on October 1, and 1.3 percent on November 1. The 1.3 percent (9 weevils) are of special interest because each of the weevils had been under observation for approximately one year, or longer. On November 2, 1934, the two surviving weevils were marked and then placed in a cage with cornstalks and Spanish moss for hibernation shelter. Fresh food was supplied as long as they were active.

One of the weevils came from a hibernation cage installed on November 16, 1933. This weevil was last observed on November 10, 1934, so it was in hibernation or active for a total longevity of 359 days. The other weevil came from a cage installed November 1, 1933, and was last observed on November 12, 1934. The longevity of this weevil was 377 days. These weevils apparently entered hibernation on November 10 and 12 because they were not observed to have been active after those dates. The hibernation cage was examined on May 7, 1935, and both weevils were found dead. Of the five live weevils on November 1, 1937, one died on November 2. The longevity of that weevil was 367 days. On November 18, the remaining four weevils were marked for identification and placed in a cage with cornstalks and Spanish moss for hibernation shelter, where they failed to survive the winter. The longevity of each of these four weevils was 383 days. In 1944, one weevil died on November 30, longevity unknown. In 1945, one weevil died on November 13, longevity 378 days. Their actual longevities were somewhat more because their ages were unknown when they were collected from cotton in the field and placed in hibernation cages during the previous fall.

TABLE 5.—*Boll weevil longevity studies*

| Year | Removed from hibernation cages | Number of weevils | Number of weevils that died in— | | | | | | Number alive Nov. 1 |
|---|---|---|---|---|---|---|---|---|---|
| | | | May | June | July | Aug. | Sept. | Oct. | |
| 1934 | June | 30 | | 7 | 2 | 6 | 10 | 3 | 2 |
| 1935 | May, June | 35 | | 21 | 6 | 6 | 2 | | |
| 1936 | May, June | 41 | 3 | 28 | 6 | 4 | | | |
| 1937 | May, June, July | 76 | 5 | 17 | 19 | 5 | 23 | 2 | 5 |
| 1938 | May, June | 37 | 4 | 9 | 8 | 10 | 6 | | |
| 1939 | May, June | 36 | 7 | 16 | 4 | 7 | 2 | | |
| 1940 | May | 2 | 1 | | | 1 | | | |
| 1941 | May, June, July | 86 | 11 | 33 | 20 | 10 | 12 | | |
| 1942 | May, June | 26 | 12 | 8 | 3 | 2 | 1 | | |
| 1943 | May, June, July | 44 | 12 | 13 | 2 | 7 | 2 | 8 | |
| 1944 | May, June, July | 51 | 3 | 18 | 8 | 4 | 11 | 6 | 1 |
| 1945 | June, July | 28 | | 2 | 1 | 6 | 9 | 9 | 1 |
| 1946 | May, June, July | 44 | 4 | 16 | 15 | 8 | 1 | | |
| 1949 | May, June | 28 | 14 | 12 | 2 | | | | |
| 1950 | May, June, July | 69 | 4 | 36 | 14 | 14 | 1 | | |
| 1958 | May, June | 57 | 7 | 36 | 13 | 1 | | | |
| Total | | 690 | 87 | 272 | 123 | 91 | 80 | 28 | 9 |

Table 6 presents the minimum, maximum, and average longevity of over-wintered boll weevils for 7 years—1943 to 1946, 1949, 1950, and 1958. The records for 1934 to 1942 were destroyed. The minimum longevity ranged from 1 to 5 days, the maximum from 41 to 150 days, and the average from 18.3 to 77.5 days.

TABLE 6.—*Minimum, maximum, and average longevity of over-wintered boll weevils*

| Year | Number of days weevils lived after being removed from hiberation cages | | |
|---|---|---|---|
| | Minimum | Maximum | Average |
| 1943 | 2 | 149 | 48.2 |
| 1944 | 2 | 150 | 50.2 |
| 1945 | 5 | 136 | 77.5 |
| 1946 | 1 | 76 | 32.0 |
| 1949 | 5 | 41 | 21.0 |
| 1950 | 2 | 61 | 20.5 |
| 1958 | 3 | 41 | 18.3 |

## Flight Screen Studies

### Effect of size of mesh on number of insects taken

Four different sizes of screening were tested; namely, 16-mesh screen wire, and 8-, 4-, and 2-mesh hardware cloth. These tests were made from April 17 to November 30, 1931. Six screens, 3 feet by 5 feet, were constructed with each of the four meshes. The screens were placed in a vertical position with their bottom edges 3 feet above the ground. Twelve of the screens (three of each mesh) were placed some distance apart in a row running east and west with north and south exposures. Twelve screens were placed in a row running north and south with east and west exposures. A fresh coating of tanglefoot was applied at 15-day intervals. The number of insects collected on the north, south, east, and west sides of the screens will be discussed in another section.

Table 7 gives the total number of insects collected on all sides of all screens constructed of wire, or hardware cloth, of different size meshes. There were no significant differences in the number of insects collected on the four kinds of screen wire tested.

### Effect of kind of sticker and mesh size of wire on number of insects taken

Preliminary studies were conducted from September 1930 to March 1931 with heavy, medium, and light applications of four types of stickers—tanglefoot, tanglefoot plus 12½, 25, and 37½ percent of castor oil. Screens, 2 feet by 2 feet, covered with 16-mesh screen wire, were used in this test. The bottom edges of the screens were 3 feet above the ground. Heavy applications of the four types of stickers were more effective in collecting insects than medium and light applications.

TABLE 7.—*Number of insects taken on screens made of wire or hardware cloth of different meshes, Apr. 17 to Nov. 30, 1931*

| Insect | Screen wire | Hardware cloth | | |
|---|---|---|---|---|
| | 16-mesh | 8-mesh | 4-mesh | 2-mesh |
| *Anthonomus grandis* Boh. | 716 | 495 | 680 | 581 |
| *Alabama argillacea* (Hbn.) | 3 | 1 | 2 | 0 |
| Cutworm | 0 | 1 | 0 | 1 |
| *Conoderus vespertinus* (Fab.) | 1, 491 | 1, 586 | 2, 005 | 2, 112 |
| *Diabrotica undecimpunctata howardi* Barber | 415 | 410 | 453 | 490 |
| *Graphocephala versuta* (Say) | 1, 458 | 1, 209 | 1, 682 | 1, 304 |
| *Sticlocephala festina* (Say) | 100 | 61 | 114 | 122 |
| *Euryophthalmus succinctus* (Linn.) | 3 | 0 | 4 | 6 |
| *Adelphocorus rapidus* (Say) | 102 | 151 | 123 | 149 |
| *Lygus oblineatus* (Say) | 504 | 314 | 322 | 330 |
| *Lygus apicalis* Fieb. | 526 | 456 | 358 | 356 |
| *Psallus seriatus* (Reut.) | 2, 213 | 1, 543 | 1, 347 | 502 |
| *Homalodisca triquetra* (F.) and *Oncometopia undata* (Fab.) | 1, 009 | 895 | 1, 052 | 1, 261 |
| Total | 8, 630 | 7, 122 | 8, 142 | 7, 214 |

Tests with the above four types of stickers were conducted from April 7, 1931 to April 15, 1932. Heavy applications of the stickers were made at 15-day intervals throughout the year. The screens were 2 feet by 2 feet. Each sticker was applied to three screens, one of which was made with 16-mesh screen wire, one with 8-mesh, and one with 4-mesh hardware cloth. The bottom edges of the screens were 3 feet above the ground.

Table 8 presents results obtained with the four types of stickers. Tanglefoot plus castor oil was more effective in holding the insects on the screens than tanglefoot alone. The number of insects taken on the mixture of tanglefoot plus 37½ percent of castor oil was significantly greater than the number taken on either of the other three types of stickers. There were no other significant differences.

A slightly larger number of insects (total for the four types of stickers) was taken on 8-mesh screens than on either the 16- or 4-mesh screens. For this reason, and since it was easier to apply the tanglefoot to the 8-mesh wire, only this size was used in future studies.

## Effect of screen direction on number of insects taken

Six flight screens were located in each of three fields from June 1, 1932 to May 31, 1933. The screens, made of 8-mesh wire, were 3 feet by 5 feet, and were placed so that the bottom of each screen was 3 feet above the ground. They were placed in each field so that an equal number of screen sides faced the north, east, south, and west. A new coat of tanglefoot was applied every 15 days.

The total number of boll weevils taken on all sides of the 18 screens may be found in table 9. Peaks of movement occurred during August with general field dispersion, and during November with movement to hibernation quarters.

TABLE 8.—*Number of insects taken on screens coated with four types of stickers, Apr. 7, 1931 to Apr. 15, 1932*

| Insect | Tanglefoot | Tanglefoot plus castor oil, percent | | | M.S.D. at 5% level |
|---|---|---|---|---|---|
| | | 12½ | 25 | 37½ | |
| *Anthonomus grandis* Boh. | 88 | 75 | 94 | 107 | -------- |
| *Conoderus vespertinus* (Fab.) and *Drasterius elegans* (Fab.) | 604 | 672 | 676 | 702 | -------- |
| *Diabrotica undecimpunctata howardi* Barber | 220 | 201 | 216 | 281 | -------- |
| *Graphocephala versuta* (Say) | 255 | 237 | 263 | 320 | -------- |
| *Stictocephala festina* (Say) | 68 | 63 | 46 | 36 | -------- |
| *Adelphocoris rapidus* (Say) | 22 | 48 | 60 | 114 | -------- |
| *Lygus oblineatus* (Say) | 105 | 124 | 267 | 414 | -------- |
| *Lygus apicalis* Fieb. | 142 | 166 | 199 | 214 | -------- |
| *Psallus seriatus* (Reut.) | 151 | 164 | 214 | 250 | -------- |
| *Homalodisca triquetra* (F.) and *Oncometopia undata* (Fab.) | 168 | 130 | 152 | 202 | -------- |
| Total | 1,823 | 1,880 | 2,187 | 2,640 | 398 |

TABLE 9.—*Total number of boll weevils taken each month on all sides of the 18 screens, June 1, 1932 to May 31, 1933*

| Month | Number of boll weevils | Month | Number of boll weevils |
|---|---|---|---|
| *1932* | | *1933* | |
| June | 136 | January | 6 |
| July | 1,329 | February | 0 |
| August | 2,663 | March | 9 |
| September | 1,827 | April | 24 |
| October | 1,258 | May | 91 |
| November | 2,580 | | |
| December | 88 | Total | 10,011 |

Table 10 presents the number of insects taken on screens facing the north, east, south, and west. Although the differences between the total insects taken on the four different sides were not significant, a slightly larger number of boll weevils was taken on the screens with the western exposure. Previous studies indicated that the boll weevil moves against the wind. Since the prevailing wind was from approximately southeast, it was expected that the greatest number of boll weevils would be taken on the leeward side of the screens. Additional studies with revolving screens, which at all times faced the wind, showed conclusively that a much larger number of boll weevils was taken on the leeward side.

Table 10—*Number of insects taken on screens facing four different directions, June 1, 1932 to May 31, 1933*

| Insect | Side of screen | | | |
|---|---|---|---|---|
| | North | East | South | West |
| *Anthonomus grandis* Boh. | 2, 172 | 1, 623 | 2, 935 | 3, 281 |
| *Conoderus vespertinus* (Fab.) | 1, 113 | 545 | 706 | 800 |
| *Drasterius elegans* (Fab.) | 364 | 235 | 266 | 323 |
| *Graphocephala versuta* (Say) | 4, 103 | 4, 979 | 2, 909 | 4, 198 |
| *Stictocephala festina* (Say) | 258 | 407 | 210 | 423 |
| *Euryophthalmus succinctus* (Linn.) | 132 | 84 | 116 | 111 |
| *Adelphocoris rapidus* (Say) | 299 | 272 | 361 | 305 |
| *Lygus oblineatus* (Say) | 573 | 545 | 705 | 556 |
| *Lygus apicalis* Fieb. | 89 | 93 | 124 | 97 |
| *Psallus seriatus* (Reut.) | 56 | 55 | 71 | 61 |
| *Homalodisca triquetra* (F.) | 14, 704 | 9, 961 | 12, 555 | 13, 634 |
| *Oncometopia undata* (Fab.) | 839 | 593 | 528 | 707 |
| Total | 24, 702 | 19, 392 | 21, 486 | 24, 496 |

## Effect of screen height above the ground and screen direction on number of insects taken

In this study of the altitude at which insects fly, the screens were 3 feet by 5 feet, made with 8-mesh hardware cloth. The screens were coated with tanglefoot, which was removed and renewed every 15 days. The screens were placed on towerlike stairways with a 3-foot space between screens, thereby making the height above the ground as follows: 3, 9, 15, 21, 27, 33, 39, 45, 51, and 57 feet. The actual area of screen exposure above the ground was from 3 to 6 feet, 9 to 12 feet, etcetera. There were two stairways with a set of screens on each. The stairways and screens were placed so that each side faced a different direction—north-south and east-west.

Table 11 gives the total number of insects taken at each of the ten altitudes from August 6 to November 30, 1930. Glick (1939) reported that approximately one-fourth of the insects collected were taken from the screens with bottom edges 3 feet above the ground. This number was nearly twice as great as the number taken from the next screens, which were 9 feet above the ground, and more than five times as great as the number taken from the highest screens, which were 57 feet above the ground. The number of insects taken from the screens at the other elevations diminished gradually from the 9-foot elevation to the 57-foot elevation.

There was a significant correlation between altitude (3 to 57 feet) and the number of all insects collected.

Table 12 gives the number of insects (14 species) taken on screens facing four directions at all altitudes from 3 to 57 feet. Collections were made from April 16 to October 31, 1931. There were no significant differences in the numbers taken, whether screens were exposed to the north, south, east, or west.

TABLE 11.—*Total number of insects taken on screens at different heights above the ground, Aug. 6 to Nov. 30, 1930*

| Height above ground (feet) | Insects collected | |
|---|---|---|
| | *Number* | *Percent* |
| 3 | 105, 629 | 25. 1 |
| 9 | 57, 812 | 13. 7 |
| 15 | 47, 393 | 11. 3 |
| 21 | 36, 871 | 8. 8 |
| 27 | 38, 070 | 9. 1 |
| 33 | 32, 983 | 7. 8 |
| 39 | 27, 851 | 6. 6 |
| 45 | 27, 560 | 6. 6 |
| 51 | 26, 613 | 6. 3 |
| 57 | 19, 686 | 4. 7 |
| Total | 420, 468 | 100. 0 |

TABLE 12.—*Insects taken on screens facing four directions, Apr. 16 to Oct. 31, 1931*

| Insect | Number of insects taken | | | | |
|---|---|---|---|---|---|
| | North | South | East | West | Total |
| *Anthonomus grandis* Boh | 22 | 35 | 32 | 41 | 130 |
| *Alabama argillacea* (Hbn.) | 2 | 1 | 1 | 0 | 4 |
| *Strymon melinus* (Hbn.) | 1 | 1 | 1 | 1 | 4 |
| *Drasterius elegans* (Fab.) | 730 | 420 | 308 | 371 | 1, 829 |
| *Diabrotica undecimpunctata howardi* Barber | 174 | 123 | 74 | 124 | 495 |
| *Graphocephala versuta* (Say) | 426 | 286 | 327 | 355 | 1, 394 |
| *Stictocephala festina* (Say) | 18 | 18 | 20 | 25 | 81 |
| *Dysdercus suturellus* (H.-S.) | 1 | 3 | 1 | 1 | 6 |
| *Adelphocorus rapidus* (Say) | 12 | 10 | 27 | 43 | 92 |
| *Lygus oblineatus* (Say) | 60 | 26 | 43 | 57 | 186 |
| *Lygus apicalis* Fieb | 72 | 48 | 85 | 46 | 251 |
| *Psallus seriatus* (Reut.) | 230 | 147 | 1, 084 | 477 | 1, 938 |
| *Homalodisca triquetra* (F.) | 66 | 39 | 28 | 62 | 195 |
| *Oncometopia undata* (Fab.) | 414 | 423 | 346 | 396 | 1, 579 |
| Total | 2, 228 | 1, 580 | 2, 377 | 1, 999 | 8, 184 |

Table 13 gives the number of insects (14 species) taken on all screens at 10 altitudes from 3 to 57 feet. Collections were made from April 16 to October 31, 1931. A significantly greater number of insects was taken on the screens that were 3 feet above the ground than on screens at altitudes of 9 to 57 feet.

## Boll weevil activity during the normal period of hibernation

Gaines (1936) showed that a surprisingly large number of boll weevils become active during the normal period of hibernation.

TABLE 13—*Numbers of insects taken at different heights above the ground, Apr. 16 to Oct. 31, 1931*

| Insect | Feet above ground | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 9 | 15 | 21 | 27 | 33 | 39 | 45 | 51 | 57 | Total |
| *Anthonomus grandis* Boh | 42 | 12 | 11 | 13 | 11 | 10 | 3 | 6 | 8 | 14 | 130 |
| *Alabama argillacea* (Hbn.) | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 4 |
| *Strymon melinus* (Hbn.) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 4 |
| *Drasterius elegans* (Fab.) | 821 | 407 | 198 | 158 | 82 | 59 | 37 | 34 | 23 | 10 | 1, 829 |
| *Diabrotica undecimpunctata howardi* Barber | 78 | 25 | 45 | 59 | 48 | 33 | 55 | 42 | 66 | 44 | 495 |
| *Graphocephala versuta* (Say) | 841 | 134 | 68 | 66 | 52 | 50 | 50 | 60 | 47 | 26 | 1, 394 |
| *Stictocephala festina* (Say) | 27 | 5 | 3 | 5 | 8 | 7 | 5 | 6 | 11 | 4 | 81 |
| *Dysdercus suturellus* (H.-S.) | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 2 | 0 | 6 |
| *Adelphocoris rapidus* (Say) | 60 | 9 | 5 | 8 | 0 | 6 | 1 | 1 | 1 | 1 | 92 |
| *Lygus oblineatus* (Say) | 143 | 11 | 5 | 6 | 4 | 2 | 5 | 5 | 2 | 3 | 186 |
| *Lygus apicalis* Fieb | 130 | 13 | 18 | 19 | 14 | 17 | 12 | 16 | 7 | 5 | 251 |
| *Psallus seriatus* (Reut.) | 1, 838 | 68 | 16 | 6 | 8 | 1 | 0 | 0 | 1 | 0 | 1, 938 |
| *Homalodisca triquetra* (F.) | 37 | 20 | 19 | 21 | 11 | 14 | 10 | 16 | 21 | 26 | 195 |
| *Oncometopia undata* (Fab.) | 675 | 291 | 164 | 111 | 65 | 63 | 62 | 60 | 61 | 27 | 1, 579 |
| Total | 4, 693 | 996 | 554 | 472 | 305 | 262 | 242 | 247 | 251 | 162 | 8, 184 |

Under artificial cage conditions 1 percent of the total boll weevil activity occurred when maximum temperatures ranged from 36° to 45°, 7.6 percent from 46° to 55°, 20.1 percent from 56° to 65°, 36.9 percent from 66° to 75°, and 34.4 percent from 76° to 81° F. The flight screen records indicated that maximum temperatures of 62° F., or higher, are necessary before actual flight takes place. Of the 385 weevils taken on the screens during four winter periods (1931–32 to 1934–35), 2.3 percent were taken with maximum temperatures ranging from 62° to 65°, 32.0 percent with temperatures from 66° to 75°, and the remaining 65.7 percent with temperatures from 76° to 83° F.

### Chemotropic studies with trimethylamine and ammonium hydroxide

Chemotropic studies were begun in 1931, in all of which, flight screens, 3 feet by 5 feet, made with 8-mesh hardware cloth, and coated with tanglefoot, were used. The bottom edge of each screen was 3 feet above the ground. During 1931 and 1932 the chemicals trimethylamine and ammonium hydroxide, diluted with distilled water, were applied daily at the rate of 20 cc. per screen on four ordinary sponges attached to the borders of the screen. This method was not very satisfactory. In 1933 and 1934 the chemical mixtures were released in an atmometer bulb. The mixture was fed by gravity from a bottle reservoir to the bulb as fast as volatilization occurred. Hence, the odor of the chemicals was around the screens continuously.

Table 14 gives the number of boll weevils taken on the screens from May 12 to November 15, 1931 and during February, March, and April 1932. In 1931, in the presence of cotton, there was an average increase of 3.1 percent and 9.9 percent, respectively, in the number of weevils taken on screens treated with trimethylamine, and ammonium hydroxide, over the number taken on untreated screens. In 1932, in the absence of cotton, there was an average increase of 18.8 percent and 16.7 percent, respectively.

Table 15 gives the number of boll weevils taken on the screens from June 1 to December 31, 1932. The untreated screens showed an average increase in number of boll weevils taken of 16.8 percent over the trimethylamine-treated screens, and 8.8 percent over the ammonium-hydroxide-treated screens.

From these results it appears that in the presence of growing cotton, the higher concentrations (4, 2, and 1 1/3 percent) of chemicals used in 1931 may have caused a slight positive reaction in the boll weevil, but the lower concentrations (1/3 of 1 percent and 1/6 of 1 percent) used in 1932 were negative in effect on the boll weevil. The same concentrations used from June 1 to December 31, 1932 were used during May 1933. The results were again negative.

Beginning June 1, 1933, a new setup of screens was inaugurated. Nine fields were used, with two screens in each field, so that each concentration (1/6, 1/3, and 2/3 of 1 percent) of chemical could be compared with distilled water in each field. The number of weevils collected from the treated and untreated screens during June 1933, and March, April, and May 1934 are given in table 16. A total of 315 boll weevils was collected on all screens. Of this number, 150 were taken on the treated screens and 165 on the distilled-water or

TABLE 14.—*Number of boll weevils taken on screens in 1931 and 1932 treated with chemotropic attractants as compared with untreated controls*

| Treatment | Number of boll weevils taken on two screens | |
|---|---|---|
| | May 12 to Nov. 15, 1931 | Feb., Mar., and Apr. 1932 |
| Trimethylamine, 4% | 366 | 75 |
| Ammonium hydroxide, 4% | 479 | 66 |
| Untreated | 382 | 57 |
| Trimethylamine, 2% | 580 | 117 |
| Ammonium hydroxide, 2% | 693 | 115 |
| Untreated | 628 | 101 |
| Trimethylamine, 1 1/3% | 806 | 77 |
| Ammonium hydroxide, 1 1/3% | 674 | 71 |
| Untreated | 739 | 59 |
| Trimethylamine, 1% | 414 | 79 |
| Ammonium hydroxide, 1% | 462 | 90 |
| Untreated | 352 | 76 |

TABLE 15.—*Number of boll weevils taken on screens treated with chemotropic attractants, as compared with cotton dew and untreated controls, from June 1 to Dec. 31, 1932*

| Treatment | Number of boll weevils taken on three screens |
|---|---|
| Trimethylamine, 1/3 of 1% | 1, 498 |
| Ammonium hydroxide, 1/3 of 1% | 1, 416 |
| Trimethylamine, 1/6 of 1% | 1, 598 |
| Ammonium hydroxide, 1/6 of 1% | 1, 907 |
| Cotton dew | 1, 653 |
| Untreated | 1, 808 |

check screens. Evidently these weak concentrations of chemicals caused no reaction in the boll weevil, either in the presence or absence of growing cotton.

## Summary

Ecological and attractancy studies on the boll weevil (*Anthonomus grandis* Boh.) were conducted at Tallulah, La., during the period 1915–1958. Records on winter survival in Spanish moss were made from 1916 to 1940 and in ground trash from 1937 to 1958. Temperatures below 20° F. were fatal to most of the weevils hibernating in Spanish moss. Survival from ground trash was more closely related to the number of weevils in the field during May and June. Hibernation cages did not provide a reliable estimate of winter survival. High correlations between winter temperatures, weevil survival,

TABLE 16.—*Boll weevils collected from screens treated with synthetic cotton dew, distilled water, and varying concentrations of trimethylamine and ammonium hydroxide, 1933 and 1934*

| Treatment | Number of weevils collected | | |
|---|---|---|---|
| | June 1933 | Mar., Apr., and May 1934 | Total |
| Trimethylamine, ⅛ of 1% | 8 | 5 | 13 |
| Distilled water | 9 | 2 | 11 |
| Ammonium hydroxide, ⅛ of 1% | 0 | 9 | 9 |
| Distilled water | 1 | 6 | 7 |
| Synthetic cotton dew | 7 | 15 | 22 |
| Distilled water | 4 | 10 | 14 |
| Trimethylamine, ⅓ of 1% | 0 | 6 | 6 |
| Distilled water | 1 | 11 | 12 |
| Ammonium hydroxide, ⅓ of 1% | 0 | 5 | 5 |
| Distilled water | 1 | 10 | 11 |
| Mixture of trimethylamine and ammonium hydroxide—⅓ of 1% of each | 1 | 26 | 27 |
| Distilled water | 1 | 23 | 24 |
| Trimethylamine, ⅔ of 1% | 8 | 10 | 18 |
| Distilled water | 3 | 41 | 44 |
| Ammonium hydroxide, ⅔ of 1% | 2 | 32 | 34 |
| Distilled water | 5 | 27 | 32 |
| Mixture of trimethylamine and ammonium hydroxide—⅔ of 1% of each | 6 | 10 | 16 |
| Distilled water | 5 | 5 | 10 |

summer rainfall, and cotton yields were found. The insect was more tolerant to calcium arsenate late in the season than earlier. Longevity records of 690 overwintered weevils during the period 1934–58 show that some live longer than 383 days. Flight screen studies showed that 8-mesh hardware cloth, coated with a mixture of tanglefoot plus 37½ percent of castor oil, on a stationary wooden frame, the bottom of which was 3 feet from the ground, provided a satisfactory method for collecting the boll weevil and other insects in flight. Screen direction had little effect on the total number of insects caught. Studies with revolving screens, which at all times faced the wind, showed that more boll weevils were taken on the leeward side. A greater number of insects was taken on screens 3 feet above the ground than at higher altitudes. Boll weevils became active during the hibernation period and took to flight when the temperature reached or exceeded 62° F. Chemotropic studies of trimethylamine and ammonium hydroxide on flight screens indicated that these chemicals had some attraction for the boll weevil in the absence of cotton.

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