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J. R. WATSON.....*Editor*
WILMON NEWELL.....*Associate Editor*
A. N. TISSOT.....*Business Manager*

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BIOLOGY OF THE MEXICAN COTTON BOLL WEEVIL. V.
Diurnal Observations of the Emergence of Boll Weevils From Their Hibernation Quarters[1]

By EDGAR F. GROSSMAN

Conflicting opinions relative to the time of day cotton boll weevils *(Anthonomus grandis* Boh.) emerge from their hibernation quarters led to experimentation to determine, as accurately as possible, whether the weevils quit their winter's resting place during the daytime, the night, or both. Consequently, by recording the exact time each of 1,910 boll weevils were observed to emerge from their hibernation quarters, sufficient data were accumulated to show that practically all of the weevils emerged during the day-time, and that three quarters of the weevils emerging during the day-time did so between 9:00 a.m. and 3:00 p.m. The weevils were observed to emerge from caged-in hibernation material consisting of Spanish moss hung about a branching tree trunk with corn stalks and similar debris packed about the base. The screened cage measured 8 x 8 x 8 feet and was located in a slightly shaded, light woody section of the Experiment Station grounds.

In 1928, observations were conducted inside the cage during the entire day-time of five days, May 12, 16, 18, 20 and June 2, recording the time as each weevil emerged from the moss or corn stalk debris. Twenty thousand boll weevils had been placed in the hibernation cage in October, 1927. By July, 1928, a total of 487 or 2.44% emerged. The number of weevils observed to quit

[1]Contribution from the Department of Cotton Investigations, Florida Agricultural Experiment Station.

TABLE 1.—NUMBER BOLL WEEVILS EMERGING FROM HIBERNATING QUARTERS DURING HOURLY PERIODS.

Hourly Periods	May 12 1928	May 16 1928	May 18 1928	May 20 1928	June 2 1928	Mar. 30 1929	Mar. 31 1929	Apr. 1 1929	Apr. 2 1929	Apr. 11 1929	Apr. 12 1929	Apr. 13 1929	Apr. 14 1929	May 21 1929	May 22 1929	May 31 1929	Totals
Before 6:00 a.m.	15	0	0	3	5	25	0	0	4	9	0	0	26	6	1	21	115
6:00-7:00 a.m.	0	0	0	0	2	4	2	0	0	6	1	1	18	1	1	0	36
7:00-8:00 a.m.	1	2	0	2	18	40	6	3	0	4	3	2	11	1	0	7	100
8:00-9:00 a.m.	4	0	1	0	18	10	7	1	1	25	9	8	3	0	0	4	91
9:00-10:00 a.m.	8	1	1	9	6	17	1	4	7	36	17	52	17	6	2	0	184
10:00-11:00 a.m.	20	0	7	13	24	38	6	7	2	41	27	52	13	10	3	3	266
11:00-12:00 a.m.	20	6	5	3	27	32	12	7	10	19	17	46	26	26	4	30	290
12:00-1:00 p.m.	6	3	0	6	25	49	3	6	7	13	5	24	18	58	4	54	281
1:00-2:00 p.m.	2	5	4	1	13	20	8	4	3	17	16	14	5	44	1	40	197
2:00-3:00 p.m.	2	1	2	0	4	14	10	1	0	5	11	10	20	62	5	9	156
3:00-4:00 p.m.	4	2	2	2	3	9	4	12	0	8	14	5	5	36	2	0	108
4:00-5:00 p.m.	3	3	1	5	0	2	7	3	0	6	9	3	0	10	0	0	52
5:00-6:00 p.m.	0	0	0	1	0	4	3	5	0	2	12	3	2	1	0	0	33
6:00-7:00 p.m.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Totals	86	23	23	45	145	264	69	53	34	191	141	220	164	261	23	168	1910

hibernation (322) was considered to be too small to be significant, though the curves drawn for each day's emergence agreed with each other in direction and slope.

In order to substantiate the emergence trend of 1928, observations were conducted in the cage for eleven additional days in 1929, March 30, 31, April 1, 2, 11, 12, 13, 14, May 21, 22 and 31. Of the 20,000 weevils placed in the hibernation cage in October, 1928, 5,736 or 28.68% emerged by August, 1929. Of this number 1,588 emerged during the eleven days the cage was under continuous observation. Combining the data secured in 1928, and 1929, a total record of sixteen days of observations was available. During this time 1,910 weevils were observed to emerge from hibernation.

Individual boll weevils emerging from their hibernation quarters have been grouped into hourly periods, starting at 6:00 a.m. and continuing until 7:00 p.m. Though the cage was first visited at 4:00 a. m. experience showed that searching for the weevils by the aid of a pocket flash-light was unsatisfactory and the cage was subsequently visited just before day-light and occupied until dark. Table I presents the number of weevils emerging hourly, and Table II presents the same data arranged, however, in cumulative percentages.

May 12, 1928, March 30, April 2, 14, and May 31, 1929, show a considerable percentage of weevils emerging during the night, i. e., after 7:00 p.m. and before 6:00 a.m. Though the night of May 11, was warmer than the three preceding nights and though there was a trace of rainfall on May 11, following two dry days, neither the rainfall nor temperature can be held attributable to any great extent for the night emergence occurring before 6:00 a.m., May 12, 1928. It is possible that some of the weevils were overlooked and consequently not removed when the cage was examined late in the evening of the previous day. Thereafter care was taken to avoid repetition of this possibility.

The night emergence reported on March 30, followed a relatively warm March night, minimum temperature 63° Fahrenheit, and a smaller range of maximum-minimum temperatures, 21 degrees, than had occurred during the five previous days. Any outstanding effect the temperature or rainfall had on this night emergence is questionable. The over-night emergence recorded for April 2 followed a minimum temperature of 65° Fahrenheit, seven degrees higher than that of the preceding night. There had been no rainfall. April 14 showed a still greater correlation

TABLE II.—SAME DATA AS THOSE PRESENTED IN TABLE I, ARRANGED, HOWEVER, IN CUMULATIVE PERCENTAGES.

Hourly Periods	May 12 1928	May 16 1928	May 18 1928	May 20 1928	June 2 1928	Mar. 30 1929	Mar. 31 1929	Apr. 1 1929	Apr. 2 1929	Apr. 11 1929	Apr. 12 1929	Apr. 13 1929	Apr. 14 1929	May 21 1929	May 22 1929	May 31 1929	Avge.
Before 6:00 a.m.	17.44	0	0	6.67	3.45	9.47	0	0	11.76	4.71	0	0	15.85	2.30	4.35	12.50	6.02
6:00-7:00 a.m.	17.44	0	0	6.67	4.83	10.98	2.90	0	11.76	7.85	0.71	0.45	26.83	2.38	8.70	12.50	7.90
7:00-8:00 a.m.	18.60	8.70	0	11.11	17.24	26.13	11.60	5.66	11.76	9.94	2.84	1.36	33.54	3.06	8.70	16.67	13.14
8:00-9:00 a.m.	23.25	8.70	4.35	11.11	29.65	29.92	21.74	7.55	14.70	23.03	9.22	5.00	35.37	3.06	8.70	19.05	17.90
9:00-10:00 a.m.	32.55	13.05	8.70	31.11	33.79	36.36	23.19	15.10	35.29	41.88	21.28	28.64	45.74	5.36	17.40	19.05	27.53
10:00-11:00 a.m.	55.81	13.05	39.13	60.00	50.34	50.75	31.89	28.31	41.17	63.35	40.43	52.28	53.67	9.19	30.44	20.84	41.46
11:00-12:00 a.m.	79.07	39.14	60.87	66.67	68.96	62.87	49.28	41.52	70.57	73.30	52.49	73.19	69.52	19.15	47.83	38.74	56.64
12:00-1:00 p.m.	86.05	52.18	60.87	80.01	86.20	81.43	53.63	52.84	91.16	80.11	56.05	84.10	80.50	41.37	65.22	70.88	71.35
1:00-2:00 p.m.	88.38	73.92	78.26	82.23	95.17	89.01	65.22	60.39	100.00	89.01	67.40	90.46	83.55	58.23	69.57	94.68	81.66
2:00-3:00 p.m.	90.71	78.27	86.96	82.23	97.93	94.31	79.72	62.28	.....	91.63	75.20	95.01	95.74	81.98	91.31	100.00	89.83
3:00-4:00 p.m.	95.36	86.97	95.66	86.67	100.00	97.72	85.52	84.92	.....	95.82	85.13	97.28	98.79	95.77	100.00	.....	95.48
4:00-5:00 p.m.	98.85	100.00	100.00	97.78	.....	98.48	95.66	90.58	.....	98.96	91.51	98.84	98.79	99.60	.....	.....	98.20
5:00-6:00 p.m.	98.85	.....	.....	100.00	.....	100.00	100.00	100.00	.....	100.00	100.00	100.00	100.00	100.00	.....	.....	99.93
6:00-7:00 p.m.	100.00	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100.00

between warm nights and night emergence. The minimum temperature during the night did not fall below 67° Fahrenheit, thirteen degrees higher than that of the preceding night. There was no rainfall. May 31, on the other hand, indicated that, with a period of fairly constant minimum night temperatures (66° to 68° Fahrenheit) rainfall occurring during the previous day tended to stimulate night emergence. These five cage days indicate that warm nights and rainfall following drought might possibly stimulate night emergence. The other eleven days spent in the hibernation cage showed but little, if any, night emergence. These days were not preceded by temperature changes nor by rainfall, with the exception of March 31, and May 22, 1929, which were preceded by 0.09 and 0.34 inches rainfall and no emergence and a small percentage emergence respectively. Of the number weevils emerging, a total of but 115 weevils or 6.02% emerged, however, during the night-time.

A graph of the total number of weevils emerging during the sixteen days of observations conducted in the hibernation cage is presented in figure 1. The curved line indicates a cumulative percentage record of the observed hourly rate of the emergence of the boll weevils from their hibernation quarters. This line becomes more significant when compared with the straight line which represents an uninfluenced theoretical rate of emergence, namely, the same percent emergence during each of the twenty-four hours per day. It is interesting to note that, of the 1,910 weevils observed, 1,795, or 94%, emerged during the day-time and that 1,374, or 76.5% of the weevils emerging during the daytime did so between 9:00 a.m. and 3:00 p.m. Narrowing the period of emergence to four hours, 10:00 a.m. to 2:00 p.m., 57.6% of the day-time emerged weevils quit hibernation.

It was thought that sunshine might have stimulated the emergence between 9:00 a.m. and 3:00 p.m., and that more intense sunshine activated the increased emergence rate noted to occur between 10:00 a.m. and 2:00 p.m. Experiments were designed, therefore, to determine whether or not sunshine affected boll weevil emergence.

Groups of one hundred hibernating boll weevils were placed in the center of each of a number of closely packed Spanish moss balls. The individual balls measured about four inches in diameter and weighed about ten ounces. The weevil-containing balls were then placed into a low temperature incubator for several days, the temperature being held at 55° Fahrenheit. This was

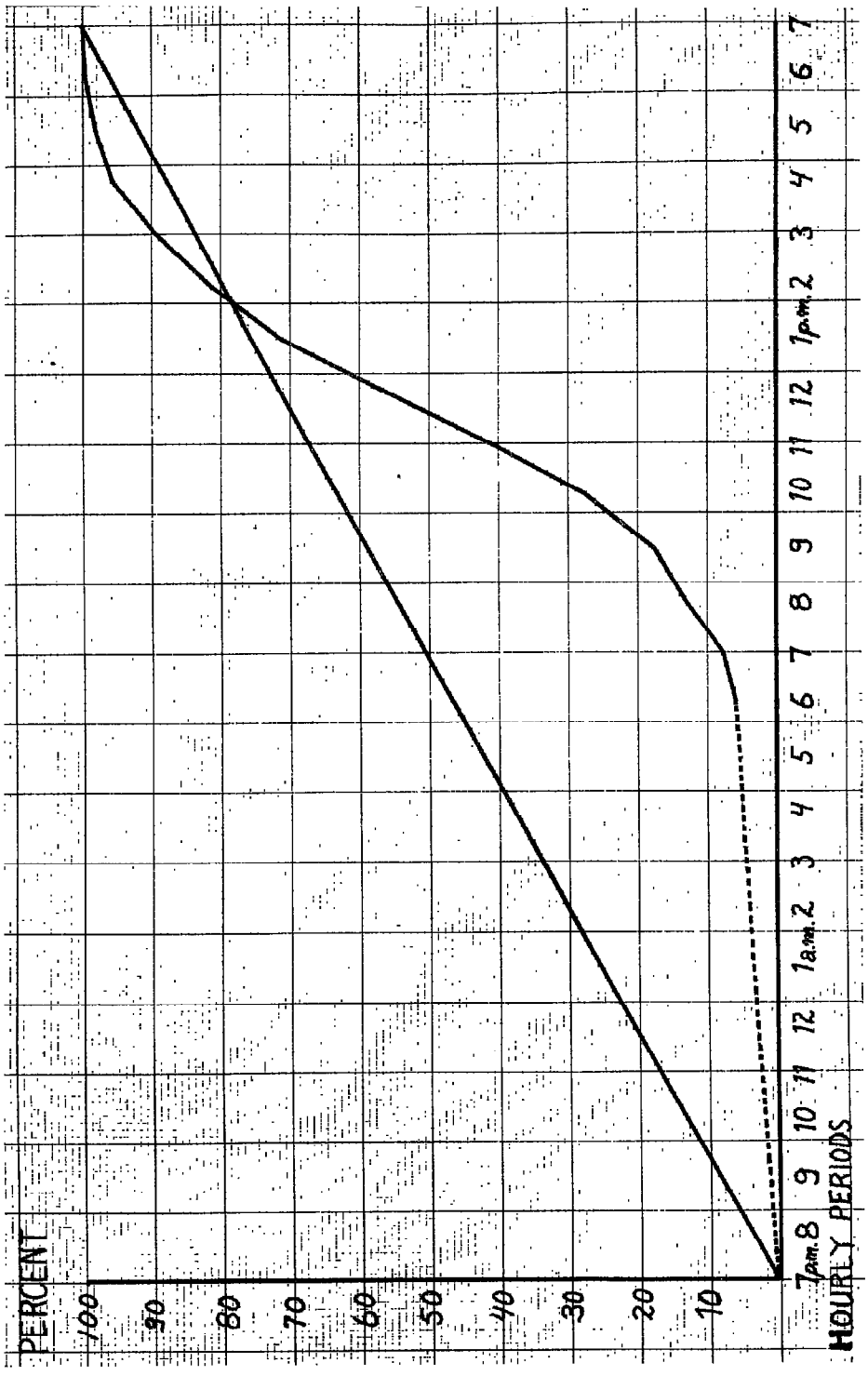

Figure 1.—Graph comparing the observed hourly rate of the emergence of boll weevils from hibernation, the curved line, with an uninfluenced theoretical emergence rate, the straight line.

done to insure a return to hibernation, which condition was necessarily interrupted while transferring the weevils to the moss balls.

The balls were removed from the incubator in pairs, and were placed in screened 4 x 4 x 5 foot cages, one cage being shaded and the other exposed to sunshine. As the weevils emerged from the moss balls they were recorded, the records being summarized in Table III. A total of 2,357 weevils were used for observing

TABLE III. — COMPARISON OF BOLL WEEVIL EMERGENCE FROM SPANISH MOSS BALLS PLACED IN THE SHADE AND IN THE SUN RESPECTIVELY.

Moss Balls	Days Kept at 55° F.	No. Weevils Used	Average Emergence Temperature	Percent Weevils Alive	Percent Weevils Emerged
In Shade	12	75	70° F.	71.42	62.50
In Sun	12	75	70° F.	54.05	80.95
In Shade	11	71	75° F.	54.92	77.14
In Sun	13	75	75° F.	64.38	61.53
In Shade	7	100	77° F.	83.87	31.57
In Sun	7	100	77° F.	85.56	38.46
In Shade	8	104	79° F.	42.30	100.00
In Sun	8	100	79° F.	47.00	92.85
In Shade	3	100	82° F.	94.94	38.50
In Sun	3	100	82° F.	90.00	56.81
In Shade	4	100	82° F.	100.00	68.00
In Sun	4	100	82° F.	88.88	78.94
In Shade	9	100	82° F.	50.00	59.25
In Sun	9	100	82° F.	27.58	82.60
In Shade	11	89	82° F.	67.04	84.21
In Sun	11	100	82° F.	51.00	86.20
In Shade	10	100	82° F.	35.55	78.94
In Sun	10	100	82° F.	48.00	100.00
In Shade	10	100	84° F.	38.14	83.33
In Sun	10	100	84° F.	65.00	69.44

the rate of emergence from twenty-seven moss balls. The condition of the weevils used for these tests is indicated by that column in Table III which presents the percent weevils alive at the end of each test.

At times weevils emerged faster from the shaded moss ball than from the one exposed to sunlight. As often, however, emergence from the moss ball in the sun was faster than from the shaded ball. Though a greater number of weevils, 74.78%, emerged from the sun-exposed moss balls than from the shaded ones, 68.34%, the difference is not significant enough to indicate that sunshine is a direct means of stimulating boll weevil emergence.

When, in addition to the information presented in this paper, one considers that, of 20,000 boll weevils placed in hibernation quarters, individuals emerge from hibernation daily from March 1 to the middle of July every year regardless of the variable temperature, periods of rainfall and drought, it appears that when the boll weevil is physiologically prepared to quit hibernation, it does so, daylight, temperature increases, and rainfall hastening the process but slightly.

A NEW FOOD PLANT OF THE BUCKEYE BUTTERFLY

A. N. TISSOT

This very pretty butterfly *(Junonia coenia,* Hubner), is now rather numerous in the vicinity of Gainesville. Holland in his "Butterfly Book" mentions that the larvae feed on various species of *Plantago, Gerardia* and *Antirrhinum.* A review of the available literature failed to reveal mention of any other food plants of the butterfly so it is of interest to note that numerous larvae of this species have been found during the month of August feeding on one of the wild asters, *Aster* sp. Two collections of the larvae were taken from localities about fifteen miles apart and in opposite directions from Gainesville. *Antirrhinum* grows only under cultivation and as no larvae of *coenia* were observed on *Gerardia* it seems quite probable that the asters play the role of principal host plant for this species of butterfly in central Florida where the plantains are almost entirely absent at this time of the year and are never abundant.