To the Graduate Council:

I am submitting herewith a thesis written by Lavone Lambert entitled "Development Periods, Preoviposition Periods, and Oviposition Rates of the Cotton Boll Weevil, Anthonomus grandis Boheman." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Biology.

Charles D. Pless

Charles D. Pless, Major Professor

We have read this thesis
and recommend its acceptance:

Accepted for the Council:

Hilton A. Smith

Vice Chancellor
Graduate Studies and Research

DEVELOPMENT PERIODS, PREOVIPOSITION PERIODS, AND OVIPOSITION RATES OF THE COTTON BOLL WEEVIL, ANTHONOMUS GRANDIS BOHEMAN

A Thesis

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ABSTRACT

The study was conducted during the cotton growing seasons of 1973 and 1974 on the West Tennessee Experiment Station at Jackson, Tennessee. The purposes of the study were to determine the development periods, preoviposition periods, and oviposition rates of the boll weevil, Anthonomus grandis Boheman.

In 1973, equipment and techniques were developed for completing the studies.

Experiments were conducted in 1974 which determined the development periods from egg to the emergence of adult weevils. Determinations were made of the preoviposition periods and the oviposition rates for female weevils that emerged from cotton squares each week throughout the test period.

Development periods were found to vary with temperature. As temperatures decreased, development periods increased. Preoviposition periods were found to increase and oviposition rates were found to decrease as the season progressed.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The boll weevil, Anthonomus grandis Boheman, is the major insect pest of cotton in Tennessee. Both the larva and adult stages feed primarily on the floral bud (square) of the cotton plant. Adult boll weevils puncture unopened petals of the square and feed on the anthers. Eggs are deposited among the anthers through the feeding holes made by the female. Abscission of the square five to nine days after oviposition results from larval feeding and developing inside the square (Hunter and Pierce, 1912; Coakley, et al., 1912). The larva pupates inside the desiccated square and emerges as an adult by chewing its way to the outside. If squares are fed on heavily by the adults, abscission will result. The boll weevil overwinters in the adult stage in a state of diapause (Brazzel and Newsom, 1959).

Since the only effective means of control for this insect is through the use of insecticides on the adult, it is important to know development rates of the larvae and preoviposition periods and oviposition rates of the adults throughout the cotton growing season. This knowledge will allow establishment of control programs which coincide with the emergence of adults and with heavy damage periods. Also, knowledge of oviposition rates will make possible more accurate estimations of population levels since populations can be estimated from oviposition damage (E. P. Lloyd, U.S.D.A. Boll Weevil Research Laboratory, State College, Mississippi, personal communication).

Prior to this present study, no work had been done which provided data for a complete season. This study was undertaken to provide such data. An effort has been made to conduct the test under conditions that more nearly simulate field conditions than tests conducted by other researchers. Also, this is the first work of its kind to be carried out in the northern part of the cotton growing area.

CHAPTER II

REVIEW OF LITERATURE

I. DEVELOPMENT PERIODS

The early work on the development periods of the cotton boll weevil was done by Cushman (1911) in the Mississippi Delta region of Louisiana. To determine the development periods, Cushman allowed weevils to oviposit in cotton squares and then observed those squares for emergence of adults. The squares were picked from cotton plants and placed in small cages containing adult boll weevils. The cages were located on an open porch. Once each day the squares that had been exposed to the weevils were exchanged for fresh ones. Exposed squares which contained eggs were placed in cages. Squares from each day were kept in a cage separate from those of other days. A daily record of temperature and adult emergence was kept.

Cushman found that when temperatures averaged 79.11°F the development period averaged 14.25 days; as average temperature increased, the development periods decreased. When temperatures averaged 80.79°F the development period averaged 12.92 days. He concluded that the development period of the boll weevil is temperature dependent, since there was a close correlation between average temperatures and development periods.

A major problem which Cushman encountered in his work was desiccation of the cotton squares after eggs had been deposited into

them. Normally a square containing a developing larva will remain on the cotton plant seven days in mid-season, longer in late-season, before abscission occurs (Hunter and Pierce, 1912). Due to his collecting squares from the cotton plants before oviposition, they began to desiccate seven days before they normally would in a field situation. With the problem of early desiccation, Cushman could not be sure that a shortage of food or a lack of moisture did not affect the weevil's development period. Also, since squares were placed in cages on a porch they were removed from the environment to which they would normally have been exposed in a cotton field.

Harris, et al. (1966) conducted studies which dealt only with fall development periods of the boll weevil in northeast Mississippi. Their studies were carried out by implanting boll weevil eggs into cotton squares. They implanted eggs in cotton squares on plants in screened field cages and in collected cotton squares which were then placed in environmental control chambers. The fall environment was simulated for the test in the environmental control chambers. Their work was begun in early September. They found that as the season progressed, the development periods increased. The development periods averaged 19.7 days for eggs deposited in early September and 38 days for eggs deposited in late September. Eggs deposited on or after October 1 did not develop. The increase in the development periods was thought to be due to a decrease in average temperatures which occurred during the test period.

Their study, however, is not representative of actual development

periods under normal field conditions. The eggs used in the tests were held at room temperature for 32 hours before being implanted in squares in the field cage. They were held 72 hours at room temperature before being placed in the environmental control chamber. They also covered the field cage with a sheet of plastic at night to retard the temperature drop inside it.

A study was conducted by Fye, et al. (1969) in which boll weevils were allowed to develop on an artificial diet under the influence of constant or fluctuating temperatures. The diet used was that described by Sterling and Adkisson (1966). Environmental control chambers were used to control the developmental environment. They found that the development period under the experimental conditions of 59°F averaged 88.5 days. The development period decreased to 17 days when temperatures were increased to 86°F. Temperatures above 86°F did not further decrease the development period. When tests were conducted using fluctuating temperatures it was found that the development period was correlated with average temperature. When fluctuating temperatures averaged 77°F the development period averaged 21 days, the same as under a constant temperature of 77°F.

Their studies substantiated what other workers had suggested, that development periods of the boll weevil are temperature dependent. They do not, however, indicate actual development periods for boll weevils which develop in, and feed on, cotton squares. Sterling, et al. (1965) conducted studies in which they demonstrated that diet affects development periods. In their studies, boll weevils were

allowed to develop under identical conditions except two different artificial diets were used. They found that the average development period differed by as much as four days, depending on the diet used.

II. PREOVIPOSITION PERIODS

Cushman (1911) reported on work to determine preoviposition periods for the cotton boll weevil. In his study, newly emerged adults were housed in large tubes with cotton squares and held on an open porch. The squares were exchanged each day for fresh ones. The ones that were removed from the tubes were dissected and inspected for eggs to determine if oviposition had occurred. He found that in early July the preoviposition period averaged six days. There was a gradual increase in this period to an average of 6.89 days by late August and to 12.89 days by mid-September.

The boll weevils on which Cushman's tests were conducted were those from the development period studies discussed above. Thus, the adults used were those that had developed on inadequate diet due to the early desiccation of the cotton squares in which they developed. He noted that these weevils were smaller than boll weevils normally found in cotton fields. Therefore, he could not be sure that the preoviposition periods which he determined were ones that normally occurred or if the developmental environment had influenced them in some way.

Preoviposition periods as reported by Harris, et al. (1966) averaged 9.8 days for boll weevils emerging in early September. For

boll weevils emerging in late September, they reported an average preoviposition period of 9.9 days and for boll weevils emerging in early October 12.8 days. They did not make studies of preoviposition periods in early or mid-season. Their studies were conducted by housing newly emerged adults with cotton squares in one-quart ice cream cartons with screen tops. These cartons were placed in a cotton field. They exchanged the squares each day for fresh ones. The squares that were removed were dissected and inspected for eggs to determine if oviposition had occurred.

III. OVIPOSITION RATES

Oviposition rates by first generation boll weevils were reported by Cushman (1911) for only a two day period in mid-July. He placed adults on fresh cotton squares in small cages. At the end of each one of the two days, he removed the squares and dissected them to determine the number of eggs that had been deposited. He found that the average was 5.4 eggs per day per female.

Mitchell and Cross (1969) made observations of female boll weevils ovipositing in squares on plants in cotton fields in Oktibbeha County, Mississippi. Since their data were taken by direct observation and weevils were not observed continuously, they were only able to project oviposition rates. Their report grouped all data obtained from May to August, 1965. Therefore, no seasonal data are available from their report.

Oviposition rates were reported by Vanderzant and Davich (1958). Their tests were conducted under laboratory conditions of constant darkness or constant light, each with constant humidity.

CHAPTER III

MATERIALS AND METHODS

I. PREOVIPOSITION PERIODS AND OVIPOSITION RATES

The tests were conducted in an outdoor insectary. The insectary was an 8 x 8 x 8-foot framed structure with a solid top and screened on all sides. A shelf was erected four feet from the floor around three sides of the interior.

Each week beginning July 18, infested cotton squares which had abscissed from plants were collected from cotton fields on the West Tennessee Experiment Station. The station is located at 35°37' latitude and 88°51' longitude. The collected squares were placed in emergence cages on the shelf in the insectary. The emergence cages were 1 x 1 x 1-foot with a solid top and screened on all other sides. They were located in such a way that the only time they received direct sunlight, if at all, was late afternoon.

Each day at 9 a.m. and 11 a.m. the emergence cages were checked for adults that had emerged from the infested squares. Most boll weevils emerge between 9 a.m. and 11 a.m. (Beckham, 1963). When adults were found in the cages at the 9 a.m. inspection, they were removed and destroyed. Also, when they were not to be used in the test, they were collected and destroyed at the 11 a.m. inspection. On one day each week the emerged adults were collected at the 11 a.m. inspection and sexed using the method described by Little and Martin

(1942). This method of sexing required very little manipulation of the boll weevils and was easily performed without injury to newly emerged callow adults. Since the Little and Martin method of sexing is not 100 percent accurate, at the end of each test sex classifications were verified using the method described by Agee (1964). His method, which is 100 percent accurate, was done at the end of each test since it required more manipulation than could be performed on newly emerged adults without injury. The resexing was done to guard against the possibility that eggs deposited from two females, one missexed as a male, would be reported as eggs produced by one female.

To conduct the tests, one male adult and one female adult were placed in a 2 x 2 x 2-inch oviposition cage. The cage was a clear plastic utility box closed on all sides. The cages containing the pairs of boll weevils were numbered, dated, and placed on the shelf in the insectary. The cages were situated where they never received direct sunlight. A debracted cotton square was placed in each cage as food for the boll weevils and in which the female oviposited. The square in the cage was exchanged for a fresh one every 12 hours. This exchange was made at 8 a.m. and 8 p.m. each day until August 23 when, due to short days, the feeding times were changed to 7 a.m. and 7 p.m.

Squares for the test were collected at approximately 4 p.m. each day. They were debracted, washed, and placed in a refrigerator until the evening and morning feedings. During the early part of the season when field populations were low, fresh squares for the test were collected from the field. These squares were inspected and those with

boll weevil punctures or damage were discarded. Later in the season when field populations of boll weevils began to build up, fresh squares were collected from cotton plants in field cages where the boll weevil population had been excluded.

As the squares were replaced in the oviposition cages, each one that was removed was placed in a container labeled with a number and date corresponding to those on the oviposition cage from which it was removed. Each square was dissected and inspected microscopically to determine preoviposition periods and oviposition rates. The time that elapsed after emergence before each female deposited her first eggs was recorded. Also, a record was made of the number of eggs each female deposited over a 14-day period beginning at the time of emergence. In this way it was possible to determine the preoviposition periods and the oviposition rates for the first 14 days after emergence for boll weevils emerging each week throughout the test period.

A test was conducted to determine if viable sperm in the female's spermatheca was necessary for oviposition to occur. In mid-July, one infested cotton square was placed in each of 30 oviposition cages. When these boll weevils emerged, they were sexed. Twelve females were placed in separate oviposition cages and treated the same as weevils paired in the preoviposition study. By conducting the study in this way, it was impossible for any of the females to have mated.

A test was conducted to determine if the first egg deposited by a female was viable. The first egg deposited by a female was removed from the cotton square and placed on a piece of filter paper in a petri

dish. The paper and dish were four inches in diameter. The filter paper was moistened with approximately 14 drops of distilled water. A top was placed on the petri dish and it was sealed with tape. The dish was then placed in an environmental control chamber set at a constant temperature of 77°F. After 70 hours, the petri dish was removed from the chamber and the egg was inspected microscopically to determine if the egg had hatched. This check was performed on a total of 60 eggs.

A test to determine if the preoviposition period or the oviposition rate would be affected if newly emerged females were paired with older males. On August 29, eight newly emerged females were paired with eight newly emerged males and eight newly emerged females were paired with one-week old males. The one-week old males had been housed with females during that period. A record was kept of the preoviposition periods and oviposition rates of each of the females.

Ambient air temperatures for each hour during the entire test period were obtained from the United States Department of Commerce National Oceanic and Atmospheric Administration Environmental Data Service (USDCNOAAEDS), Jackson Station. This station was located four miles from the test site. These temperatures were analyzed for correlation with temperatures recorded by a thermograph inside the insectary during a three-week period in September 1973.

II. DEVELOPMENT PERIODS

During the early part of the season, adult boll weevils were collected with pheromone traps using the method described by Leggett and Cross (1971). The early season boll weevils taken in this manner were weevils emerging from diapause. Close monitoring was carried out to determine when first generation adults began emerging from squares in the cotton fields. As soon as first generation adults were available, they were incorporated into the study.

The boll weevils were maintained on the insectary shelf in a 12 x 12 x 3-inch cage which was a modification of that described by Gast (1966). The cage was equipped with six-inch legs, the top and sides were solid, and the bottom was screened. A 6 x 6 x 1-inch tray made from 1/4-inch mesh hardware cloth and equipped with one-inch legs was placed inside the cage to hold cotton squares. Between 50 and 75 boll weevils were maintained in the cage throughout the study period. Each week approximately one-half of them were removed from the cage and destroyed. In early season, the destroyed adults were replaced by adults captured in pheromone traps. As soon as boll weevils began to emerge from squares collected from the cotton fields, they were used to replace those that were destroyed. This was done in an attempt to approximate the same mixture of generations of boll weevils in the test as existed in the cotton fields during the same period.

At 8 a.m. and 8 p.m. each day, 50 debracted cotton squares were placed in the cages and the squares that were there from the previous 12 hours were removed. The removed squares were destroyed except on

days when the eggs they contained were to be used in the test. Fresh squares were collected and prepared each day as described on page 10.

On one or two days each week, depending on oviposition rates, squares that had been collected from the field cages and exposed to the boll weevils for 12 hours, were taken into the laboratory. They were dissected and the eggs that had been deposited in them were removed with a small probe and floated in a dish filled with distilled water. The eggs were removed from the water by filtering. Surface sterilization was done by filtering over them approximately 100 milliliters of a 0.26 percent solution of sodium hypochlorite. They were immediately rinsed by pouring distilled water over them, transferring to clean filter paper, and pouring distilled water over them again. The eggs were held in the laboratory approximately one hour for this process. Finally, the eggs were taken to field cages for implantation in cotton squares.

A total of eight field cages were used in the study. They were 6 x 6 x 6-foot structures covered with green saran screen which supplied 43 percent actual shade. Each cage housed two rows of Deltapine-16 variety cotton which was planted on May 17. The six-foot rows averaged 20 plants each and were on 36-inch centers. The cages were erected over the cotton plants on July 1, soon after they began to produce squares. After the cages were in place, each plant in each cage was inspected. All boll weevils and all punctured squares that were found were removed and destroyed. After two days the plants in each cage were reinspected and again all boll weevils and punctured

squares were removed and destroyed. A third inspection was performed when boll weevil eggs were first implanted in each cage. The plants in each cage supplied an average of 75 squares per week throughout the test period.

Aphid populations built up to damaging levels in four of the cages by late August. On August 23 Thimet(R) 10G was added to the soil of all the cages at the rate of 10 pounds per acre. There was no noticeable reduction in the aphid populations as a result of this treatment.

Boll weevil eggs were implanted in cotton squares on plants in the field cages each week beginning July 8. The method used was that described by Davich, et al. (1965) which consisted basically of punching a small hole in a cotton square on the plant, placing one weevil egg into the hole, and sealing it with paraffin. The paraffin seal was not used until the week beginning August 12. As each egg was implanted, the square was dated using a small paper tag tied on with a string.

On the ninth or tenth day after each implantation, all the squares that had abscissed were collected and placed in an emergence cage. On the twelfth day after implantation in early season, longer in late season, all the squares that had abscissed since the tenth day, along with all the tagged squares remaining on the plants, were collected and placed in the emergence cage.

The emergence cages were the same as those described on page 10. One emergence cage was buried to a depth of approximately four inches

on one side of each field cage between the rows of cotton. Soil was placed inside it to approximately two inches above the soil level in the field cage.

The squares collected from the field cage egg implantations were scattered on the soil surface inside the emergence cage. The cage was labeled with the oviposition date of the eggs. Only squares with eggs from one oviposition date were placed in each emergence cage.

Beginning 14 days after the date the eggs were deposited, the emergence cage was checked each day at approximately 4 p.m. for emerged boll weevils. The date and number of emerged weevils were recorded. The emerged weevils were then collected and destroyed. Thus, it was possible to determine the development periods for boll weevils developing from eggs deposited each week throughout the study period.

Hourly temperature data were obtained from the USDCNOAAEDS, Jackson Station for the entire test period. These temperatures were analyzed to determine if they correlated with temperatures recorded inside a field cage by use of a thermograph during a three-week period in September 1973. The temperatures inside the field cage were recorded between the rows of cotton one foot above the ground.

CHAPTER IV

RESULTS AND DISCUSSION

I. CORRELATION OF AMBIENT AIR TEMPERATURES WITH TEMPERATURES RECORDED INSIDE THE INSECTARY

The temperatures recorded inside the insectary were found to average 1°F higher than ambient air temperatures recorded at the USDCNOAAEDS, Jackson Station during the three week test period (Table I). It was found that temperature changes inside the insectary lagged about two hours behind changes occurring in the ambient air temperature. However, during a period beginning at approximately 4 p.m. each day the temperature inside the insectary would surpass that of the ambient air (Table II). Based on the results of this study all average temperatures taken from data supplied by the USDCNOAAEDS, Jackson Station were adjusted upward 1°F for purposes of analysis when used to represent average temperatures occurring inside the insectary.

II. OVIPOSITION BY VIRGIN FEMALES

Of the 12 virgin females in this test, none deposited an egg during the 14 day period in which they were monitored. These results established that viable sperm must be present in the female's spermatheca for oviposition to occur at a rate that would have affected the results of these studies. A much more extensive study would be required to establish that oviposition by virgin females never occurs.

TABLE I

AVERAGE TEMPERATURES OF AMBIENT AIR, INSECTARY, AND FIELD CAGE OCCURRING AUGUST 27 THROUGH SEPTEMBER 16, 1973

Ambient Air Temperature	Insectary Temperature	Field Cage Temperature
76°F[1]	77°F[1]	76°F[1]

[1]Average of temperatures recorded every two hours.

TABLE II

TEMPERATURES OF AMBIENT AIR, INSECTARY, AND FIELD CAGE OCCURRING DURING A REPRESENTATIVE 24 HOUR PERIOD

Date and Time Temperature Was Recorded	Ambient Air Temperature (°F)	Insectary Temperature (°F)	Field Cage Temperature (°F)
August 31			
10 a.m.	81	74	80
12 noon	86	82	86
2 p.m.	89	88	89
4 p.m.	91	92	92
6 p.m.	90	91	89
8 p.m.	83	86	84
10 p.m.	79	81	79
September 1			
12 midnight	76	79	76
2 a.m.	74	76	74
4 a.m.	72	74	72
6 a.m.	71	73	71
8 a.m.	74	72	71
24 hour average	80	81	80

Walker and Bariola (1964) found that virgin females that had overwintered in a state of diapause would oviposite at a very low rate.

III. VIABILITY OF THE FIRST EGG DEPOSITED BY A NEWLY EMERGED FEMALE

Of the 60 first eggs deposited by a newly emerged females that were tested, all were found to be viable. This test determined that the end of the preoviposition period was the beginning of the reproductive period. This result indicates that the newly emerged males were able to produce viable sperm in the same period required for newly emerged females to produce eggs.

IV. PREOVIPOSITION PERIODS

The preoviposition period was found to increase as the season progressed. It was found to average 2.95 days for weevils emerging July 25. For weevils emerging August 15, the preoviposition period had increased to 7.06 days. In Table III are listed the preoviposition periods for boll weevils emerging each week throughout the test period.

The variability of the preoviposition period increased as the average preoviposition period increased (Table III). For weevils emerging July 25, two standard deviations from the mean preoviposition period for the test group was ±0.95 days. For weevils emerging August 15, two standard deviations from the mean of the test group had increased to ±1.66 days. By August 29, two standard deviations from the mean was ±5.02 days.

TABLE III

PREOVIPOSITION PERIODS FOR BOLL WEEVILS EMERGING EACH WEEK THROUGHOUT THE TEST PERIOD

Date of Emergence	Number of Pairs in Test	Mean Period of Preoviposition	Two Standard Deviations from Mean
July 25	22	2.95 days	±0.95 days
August 1	9	3.22 days	±1.58 days
August 7	11	3.58 days	±1.98 days
August 15	11	4.18 days	±1.66 days
August 22	12	4.90 days	±2.74 days
August 29	16	7.06 days	±5.02 days
September 5	12	9.25 days[1]	±5.18 days[1]

[1] In this test group four females had not oviposited at the end of the 14-day monitoring period and were not included in the computations of these values.

A correlation analysis of preoviposition periods and day of year females emerged produced a correlation coefficient (r) of 0.928. A table of significant values of r indicates that the significance of r with the value 0.928 is greater than 99 percent. Therefore, there is an almost perfect correlation between preoviposition periods and day of year of emergence of female weevils. Seasonal decrease in photoperiod, seasonal changes in temperature, or seasonal change in cotton plants are a few of the things that could bring about this close correlation. More research is needed to determine causal relationships.

Figure 1 illustrates the increase in the preoviposition period as well as the increase in variation as it relates to emergence date.

V. OVIPOSITION RATES

Oviposition rates were found to decrease as the season progressed. Female boll weevils that emerged July 25 deposited an average of 4.47 eggs per day per female during the 14-day monitoring period. Weevils emerging September 5 deposited an average of 0.53 eggs per female per day. In Table IV are listed the average oviposition rates for female weevils emerging each week throughout the test period.

A correlation analysis of oviposition rates and day of year females emerged produced an r of -0.989. An r of this value has a significance greater than 99 percent. There is an almost perfect negative correlation between oviposition rates and day of year females emerged. The regression line shown in Figure 2 illustrates the decrease in average oviposition rates as the season progressed. Any of

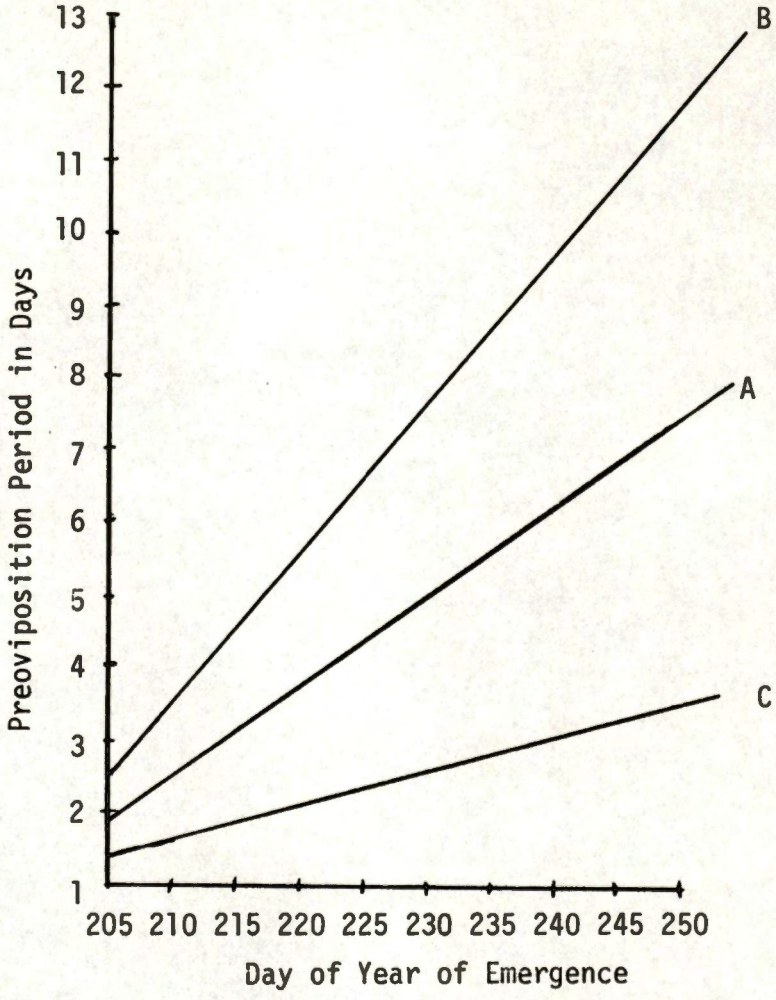

Figure 1. Average preoviposition period and the increase in deviation from the mean correlated with day of year of female emergence.

[A]Mean preoviposition period.

[B]Plus two standard deviations.

[C]Minus two standard deviations.

TABLE IV

AVERAGE OVIPOSITION RATES OF BOLL WEEVILS EMERGING EACH WEEK THROUGHOUT THE TEST PERIOD

Date Weevils Emerged	Number of Pairs in Test	Average Number of Eggs Deposited Per Female Per Day for 14 Days	Average Temperature for Test Period
July 25	22	4.47	77°F
August 1	9	3.82	76°F
August 7	11	2.92	77°F
August 15	11	2.79	79°F
August 22	12	1.61	77°F
August 29	16	0.88	72°F
September 5	12	0.53	71°F

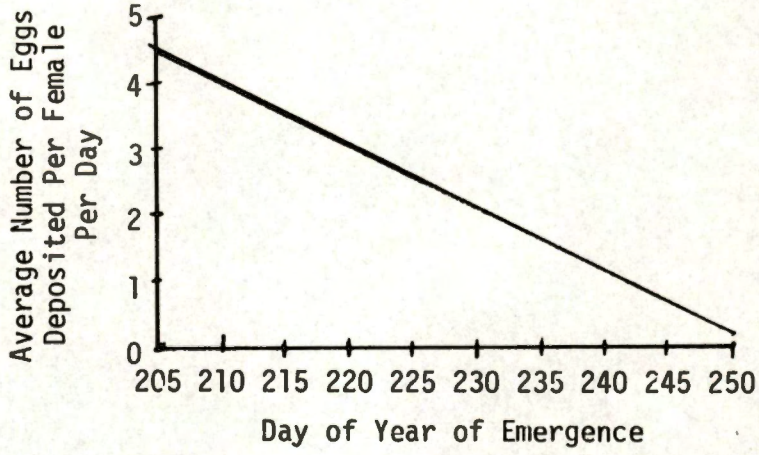

Figure 2. Average oviposition rates per female per day during first 14 days after emergence correlated with day of year female emerged.

the same factors listed under "Preoviposition Period" could be the causal factors in this correlation. More research is needed to determine causal relationships.

Maximum oviposition rates occurred on the average five days after the end of the preoviposition period. Figure 3 illustrates the average number of eggs deposited per female during each day of the monitoring period. The data have been grouped for weevils emerging the first three weeks and the second three weeks of the test period. Of the 22 females that emerged July 22, single females deposited seven or more eggs in a 24-hour period on one-fourth of the days monitored. The maximum number of eggs deposited in a 24-hour period by a single female was 14.

VI. EFFECTS OF PAIRING OF NEWLY EMERGED FEMALES WITH ONE-WEEK OLD MALES ON PREOVIPOSITION PERIODS AND OVIPOSITION RATES

There was no significant difference between the preoviposition period or the oviposition rate for newly emerged females paired with one-week old males and those paired with newly emerged males.

VII. CORRELATION OF AMBIENT AIR TEMPERATURES AND TEMPERATURES RECORDED INSIDE A FIELD CAGE

The temperatures recorded inside the field cage were found to average the same as those recorded at the USDCNOAAEDS, Jackson Station (Table I, page 18). This result is in agreement with the findings of Hand and Keaster (1967) from studies they conducted on the environment

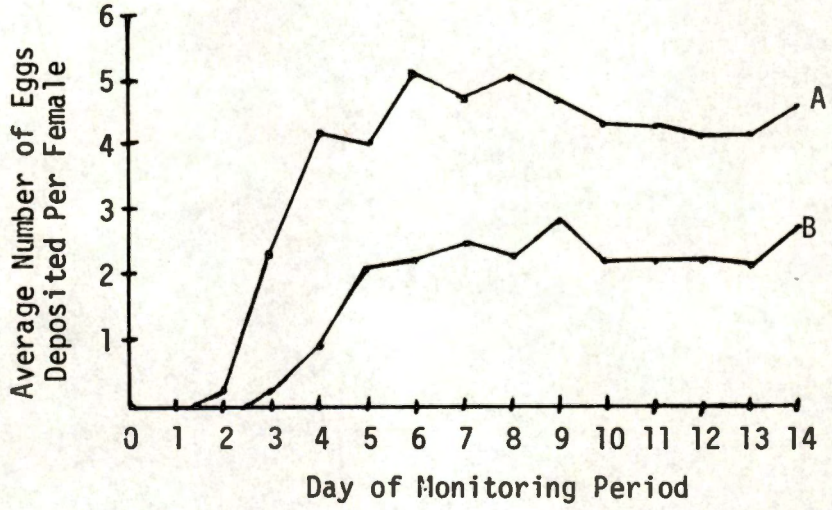

Figure 3. Average number of eggs deposited per female during each day of the monitoring period.

[A]Daily average for boll weevils emerging July 25, August 1, and August 2.

[B]Daily average for boll weevils emerging August 15, 22, and 29.

of a field cage. Table II, page 19, presents temperatures recorded during a representative day of the test period.

VIII. DEVELOPMENT PERIOD

The average development period from egg to emerged adult was found to vary with average temperature. The shortest development period was 16.14 days when temperatures averaged 80.81°F for eggs oviposited July 7. The longest development period was 28.28 days when temperatures averaged 69.21°F for eggs deposited August 25. Table V lists the average development periods and average temperatures that occurred during the development period for eggs oviposited each week.

The variability in length of the development period was found to increase as average temperatures decreased (Table V). When temperatures averaged 80.81°F two standard deviations from the mean development period of the test group was ±1.84 days. When temperatures averaged 69.21°F, two standard deviations from the mean development period of the test group was ±7.30 days.

A correlation analysis of development period and average temperatures occurring during the development period produced an r value of -0.981. An r of this value has a significance greater than 99 percent. There is an almost perfect negative correlation between development periods and average temperatures. Figure 4 illustrates the increase in development periods correlated with average temperatures as well as the increase in the variability in development periods.

TABLE V

AVERAGE DEVELOPMENT PERIODS AND AVERAGE TEMPERATURES
THAT OCCURRED DURING THE DEVELOPMENT PERIODS

Date of Egg Oviposition	Number of Individuals Emerging	Average Development Days	Two Standard Deviations from Mean	Average Temperature
July 8	35	16.14	±1.84 days	80.81°F
July 15	19	18.55	±2.62 days	79.74°F
July 22	23	19.77	±3.22 days	76.65°F
July 29	44	21.89	±3.04 days	76.05°F
August 5	122	21.09	±2.84 days	76.76°F
August 12	85	19.77	±2.76 days	77.50°F
August 18	135	22.60	±3.86 days	73.78°F
August 25	91	28.28	±7.30 days	69.21°F

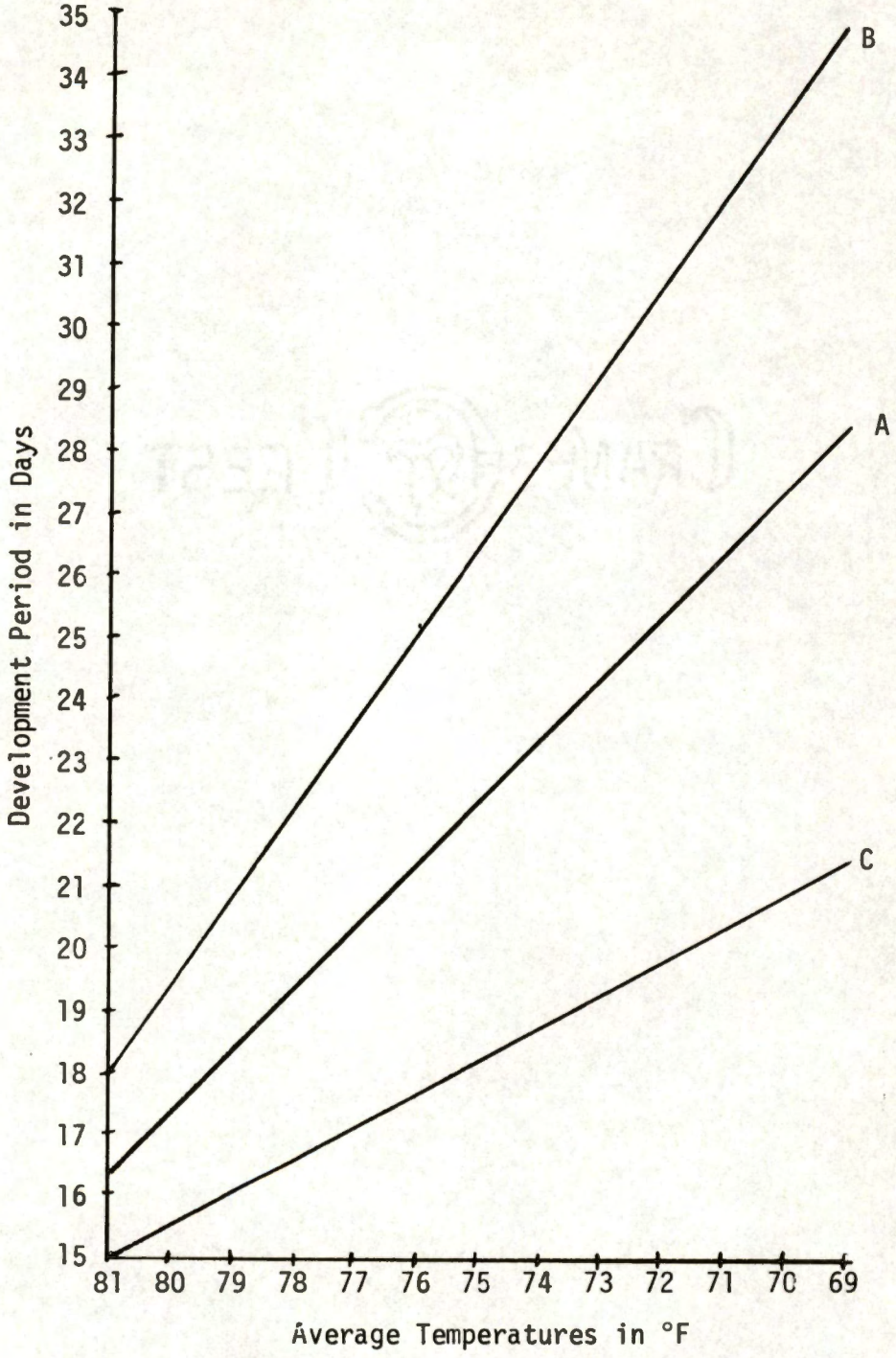

Figure 4. Average development periods and increase in deviation from the mean correlated with average temperatures.

[A]Mean development period.

[B]Plus two standard deviations.

[C]Minus two standard deviations.

CHAPTER V

CONCLUSIONS

1. Virgin females did not oviposit under the conditions of this test, but additional research is needed before one can say that mating is required for oviposition.

2. The first egg deposited by a newly emerged female is viable.

3. The preoviposition period increases as the season progresses.

4. The length of the preoviposition period becomes more variable as the season progresses.

5. The oviposition rate decreases as the season progresses.

6. Peak oviposition rates occur approximately five days after the onset of oviposition.

7. Pairing one-week old males with newly emerged females has no effect on the preoviposition period or oviposition rate when compared to pairing with newly emerged males.

8. Development periods vary with temperature. They increase as temperature decreases.

9. Length of development periods become more variable as temperatures decrease.

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VITA

Lavone Lambert was born in Jackson County, Alabama, on June 22, 1937 and was farm reared. He was graduated from Pisgah High School of the same county in 1956. In August of the same year he moved to Chattanooga, Tennessee, where he worked in private industry and attended night school at The University of Chattanooga. He studied Industrial Engineering and has held positions as Work Methods Analyst and Research and Development Project Engineer.

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