FLIGHT HABITS OF THE PECAN WEEVIL, *CURCULIO CARYAE* (HORN), (COLEOPTERA: CURCULIONIDAE)

By

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FLIGHT HABITS OF THE PECAN WEEVIL, CURCULIO CARYAE (HORN), (COLEOPTERA: CURCULIONIDAE)

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PREFACE

At the time of these studies very little research had been done on biological control of the pecan weevil. Dr. Raymond D. Eikenbary, Associate Professor of Entomology at Oklahoma State University, brought to my attention the need of detailed research on flight habits to better understand how the weevils reach the tree. By understanding how the male and female weevils reach the pecan nuts on the tree, a better, more long-lasting means of control might be realized. A two-year study on flight habits of the pecan weevil soon became the primary objective of this research.

I am indebted to my major adviser, Dr. Raymond D. Eikenbary, for making this study possible, for his guidance, encouragement, suggestions, and assistance in the preparation of this manuscript.

Special appreciation is extended to Professors R. R. Walton and Nat Walker for their suggestions and criticism in reviewing this manuscript. The author wishes to express his appreciation to Dr. Robert D. Morrison, Professor of Mathematics and Statistics, for his help with the statistical portion of this paper.

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I would like to express my appreciation to my wife, Doris, for her patience, understanding and help throughout this graduate study.

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INTRODUCTION

The pecan weevil, Curculio caryae Horn, damages pecan crops nearly every year in Oklahoma. Much of the literature to date gives information on various control measures, along with life history, feeding, and ovipositional studies, but information is vague regarding the method by which pecan weevils reach and damage the nuts.

Regarding the pecan weevil's emergence habits, Moznette et al. (1931) stated that adult weevils emerged from the ground during the summer, and that immature pecan nuts were punctured by both sexes. Additional information provided by Hinrichs and Thomson (1955) indicated that they went to the trees to feed upon the kernels. Phillips et al. (1960) also noted the emergence habits reported by the above authors when they stated that emerging adults tended to go to the nearest tree, and if there were nuts on the trees, the insects remained there to feed and lay eggs. One must assume that Phillips et al. observed the method the emerging weevils used in reaching the nearest trees, but he failed to state this.

One of the first workers to record pecan weevil flight behavior was Swingle (1934), who reported that adult weevils emerged from the soil and immediately flew to the pecan trees to feed upon the nuts. In studies on other nut-infesting weevils Brooks (1910) reported that most of the weevils were very sluggish in their movements and were rarely seen in flight. Brooks and Cotton (1929) stated that the length of flight for acorn-infesting weevils had not been determined, but under

favorable conditions it seemed probable that weevils might be capable of flights of at least one mile. Gibson (1964) reported that acorn-infesting weevils emerged from the soil and crawled or flew to the tree.

Knowing how male and female weevils get to trees after emergence would facilitate control by chemical or biological means. A study on flight habits was undertaken to obtain this information.

METHODS AND MATERIALS

Simplified Cone Trap for Collecting Adult Weevils

Many pecan weevils, recently emerged from the soil, were needed daily. This required many collecting traps, since only a few weevils emerged each day under a given trap. A pink bollworm emergence trap (Schiller 1946) had been used in previous weevil collecting. This pyramidal trap (Fig. 1) consisted of a redwood frame covered with screen wire topped with a collecting jar. Although this is a very effective trap for collecting pecan weevils, it did not meet the needs of this study, due to its complexity and high cost of construction. A more satisfactory trap (Fig. 2) was constructed of a 6-ft strip of galvanized screen wire, 36 inches wide, a 30-inch piece of lath, and a fruit jar and ring. The wire was cut in a semicircle having a 36-inch radius. Sides A and B were overlapped and stapled to the same side of the lath to make the cone-shaped trap (Fig. 2). A space was left for the fruit jar ring at the top of the cone when attaching the lath. This ring was soldered to the wire and the jar screwed into the metal ring. An opening 1/4-inch in diameter was left in the top of the cone to allow the weevils to enter the jar. Adult pecan weevils are negatively geotropic. For this reason the weevils were easily trapped upon emerging from the soil, because they crawled up and entered the jar through the hole in the top of the cage and were confined until removed. The trap was made escape-proof by placing soil around the base of the cage. Three 8-inch pieces of No. 8 wire were bent into a "U" shape and used to

Figure 1. Comparison of pyramid trap to simplified cone trap used in flight habit studies.

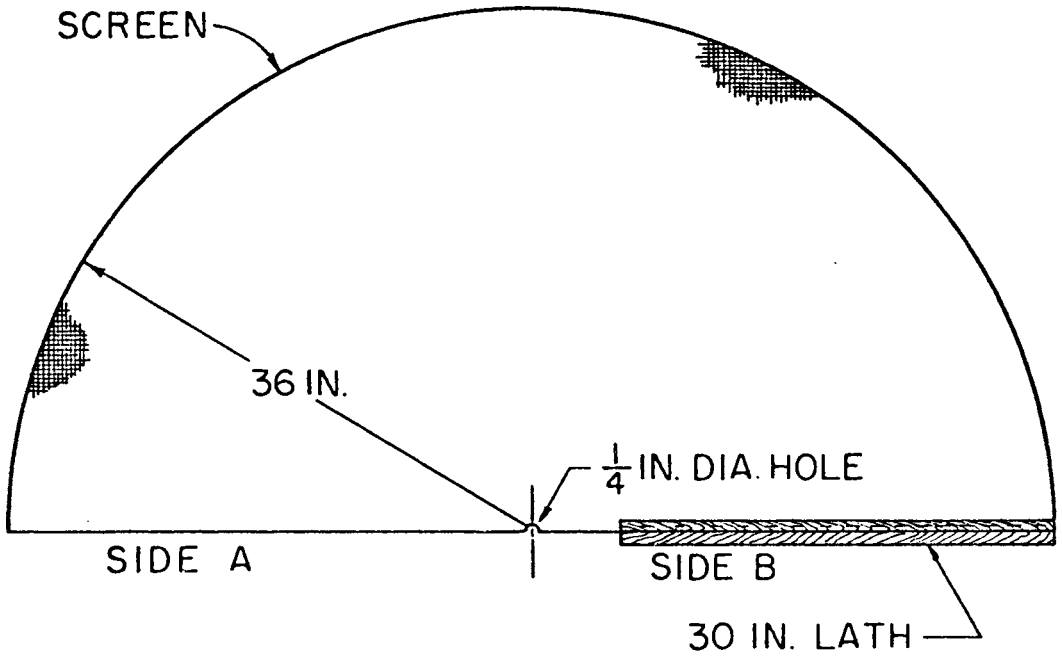

Figure 2. Dimensions of wire used in the construction of the simplified cone trap.

anchor each trap (Fig. 1). The trap withstood the elements with only an occasional disturbance by deer or livestock. After collection from these traps, the weevils were taken to the field for flight habit studies.

Flight Habit Studies

In the summer of 1966 several pecan trees located on the Oklahoma Agricultural Experiment Station were selected for flight habit studies. Ten males and 10 females were released, at 3-ft intervals on a line extending north from the base of the tree, and the movements of the weevil recorded. Each weevil was observed until it flew to the trunks or branches, crawled to the trunk, or failed to reach the tree within a period of about ten minutes. A total of 80 insects was observed at temperatures ranging from 88 to 95 F and with winds varying from 5 to 10 mph.

Flight studies were continued in 1967 on a larger scale to determine more accurately the height reached in the tree by the weevils. A pole with markings at 2-ft intervals was set against the pecan trees so that height flown could be recorded to the nearest 2 feet. Three-foot intervals were marked off on the soil surface away from the trunk to a distance of 21 feet. Ten males and 10 females were released at each 3-ft interval from the trunk. The same types of observations were recorded as in the 1966 tests, with a total of 420 observations in 3 replications. Temperatures ranged from 84 to 95 F and winds varied from 5 to 15 mph.

RESULTS AND DISCUSSION

The trap described in this paper was constructed at the rate of about 6/hr/worker. The cost of constructing this effective trap was approximately 1/10 of the cost of construction of the pink bollworm trap. The importance of the low cost of this trap is apparent when considering the large number needed to properly time insecticide applications for control of the pecan weevil. For instance, the emergence of weevils from the soil may be influenced by different soil types, cultivation, compaction, and unequal distribution of rainfall in the pecan grove (Hinrichs and Thomson 1955, Osburn et al. 1963). This trap was effective in collecting pecan weevils and might be of value in trapping other soil emerging insects.

In both 1966 and 1967 tests, pecan weevils emerged from the soil and soon after flew, or crawled, to the tree. When released, the pecan weevils walked around on the ground, apparently trying to locate the highest point from which to initiate flight in much the same manner as reported by Hammer (1936) for the apple curculio, Tachyterellus quadrigilobus Say. The pecan weevils seemed to be sluggish and clumsy in finding this elevated point, and when disturbed they feigned death. Similar habits have been noted in studies on other weevils as reported by Brooks (1910), Hammer (1936), and Brooks and Cotton (1929). The latter observed that the larger chestnut weevil, Curculio proboscideus Fab., in feigning death dropped to the ground, remained motionless for a few minutes, after which they climbed some convenient stem or stone

and flew back to the tree. This same peculiarity was observed for the pecan weevils, except that they quite often feigned death for as long as 5 to 10 minutes.

Before attempting flight, the pecan weevil generally faced in the direction of the prevailing wind, which probably aided this clumsy flyer to become airborne. All weevils have not demonstrated this peculiarity. Hammer (1936) reported that there seemed to be no correlation between the direction of the prevailing wind and the dispersal direction of the apple curculio. The antennae of the pecan weevil appeared to be in motion during all of the preflight behavior, and this might indicate that they used olfaction to guide them in flight. Before flight, pecan weevils lowered the posterior abdomen, elevated the elytra and spread fully the flight wings. Female weevils succeeded more often than males in this initial process, probably because they are better fliers. In all cases, the flight wings had to be fully spread before flight could take place, which might take the weevil several tries. This observation is in agreement with the findings of Hagley (1965) when he reported that the palm weevil, Rhynchophorus palmarium (L.), walked on the soil surface with the tips of the wings extended beyond the ends of the elytra before flight.

Once airborne, pecan weevils were observed in several flight patterns to the pecan tree. Some weevils flew away from the point of launching, out past the drip-line of the tree, and then flew back and landed on the pecan tree. These wandering weevils covered a horizontal distance of approximately 70 ft. Other pecan weevils exhibited hovering flight. Hagley (1965) stated that hovering flights of palm weevils were observed most frequently in the presence of exposed, fermenting palm

tissue, with the weevils hovering in the same position for 20 to 30 seconds. Hovering flights of pecan weevils did not last that long, and they seemed to occur most often when the weevils had trouble in landing on a branch of the pecan tree. A few of the weevils were in flight for approximately one minute, covering a horizontal distance of 20 to 30 yards. In comparison, Hagley (1965) reported that the palm weevil was observed flying as far as 900 yards. A great many of the pecan weevils, mainly females, flew directly to the pecan tree from their point of origin.

Data on how the weevils reached pecan trees in 1966 are presented in Fig. 3. More females than males were observed flying to the branches or to the upper trunk. The males tended to fly to the lower portion of the tree, and more males than females were observed crawling to the trunk.

Fig. 4 presents data on how the weevils reached the tree in 1967. Again, more females than males flew to the higher branches or flew to the upper trunk, whereas a greater number of males than females were observed crawling to the tree. The highest percentages of male and female weevils were recorded flying to the lower levels of the tree.

To test the validity of a suspected difference in the tree height flown by the male and female pecan weevils and the distances released from the pecan tree, the data for 1967 were subjected to an analysis of variance (Table I). There was a highly significant difference between sexes and among replicates. Height flown by the weevils due to the distance released from the tree was significant at the 5% level. The coefficient of variation was 14.4%.

Fig. 5 gives the mean height flown by male and female weevils when

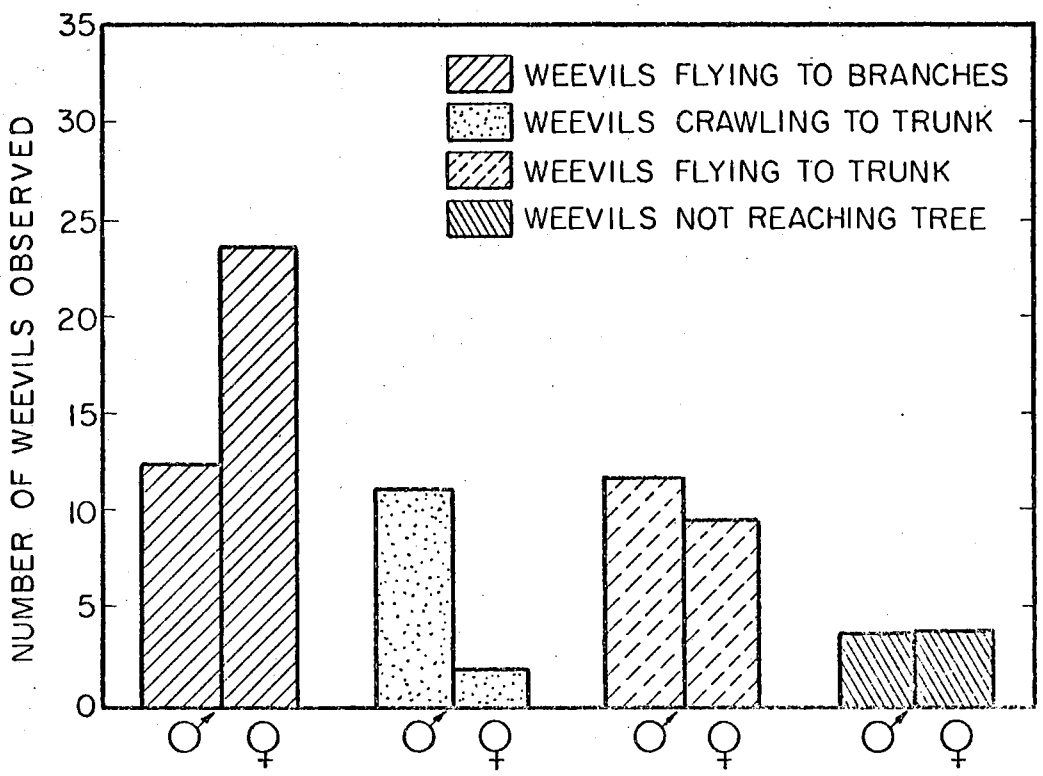

Figure 3. Method of movement of male and female weevils from soil to pecan tree, 1966.

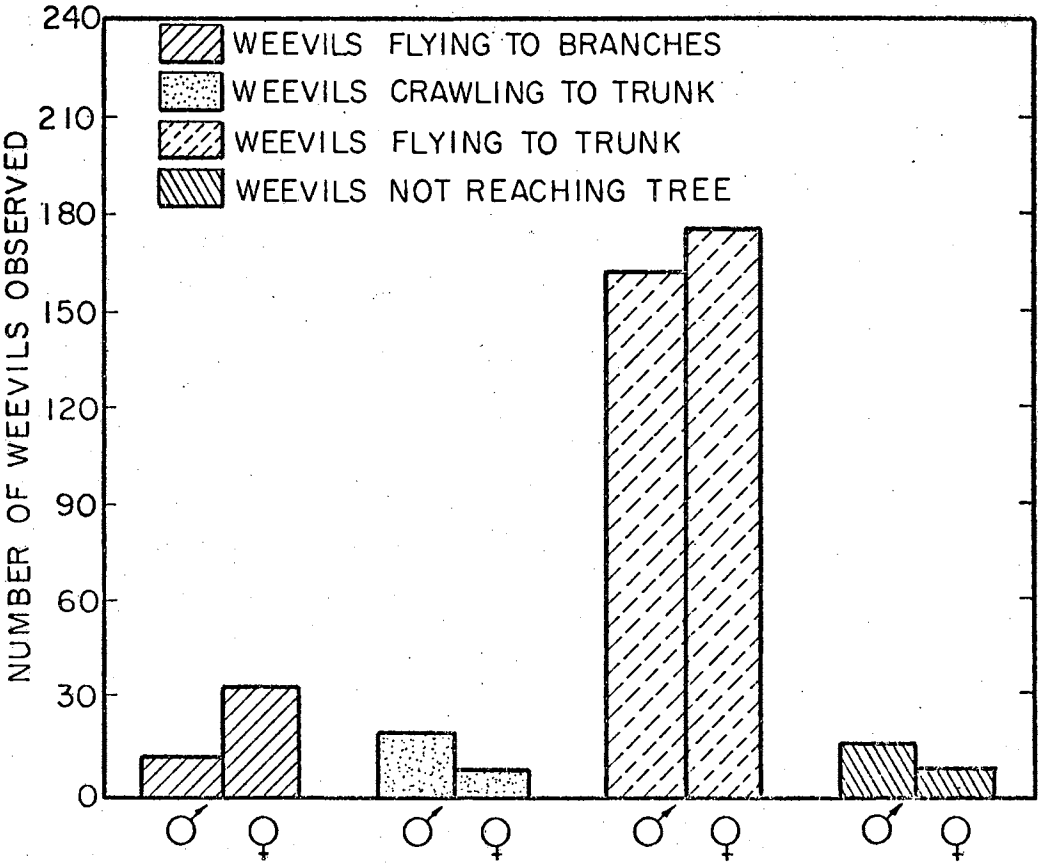

Figure 4. Method of movement of male and female weevils from soil to pecan tree, 1967.

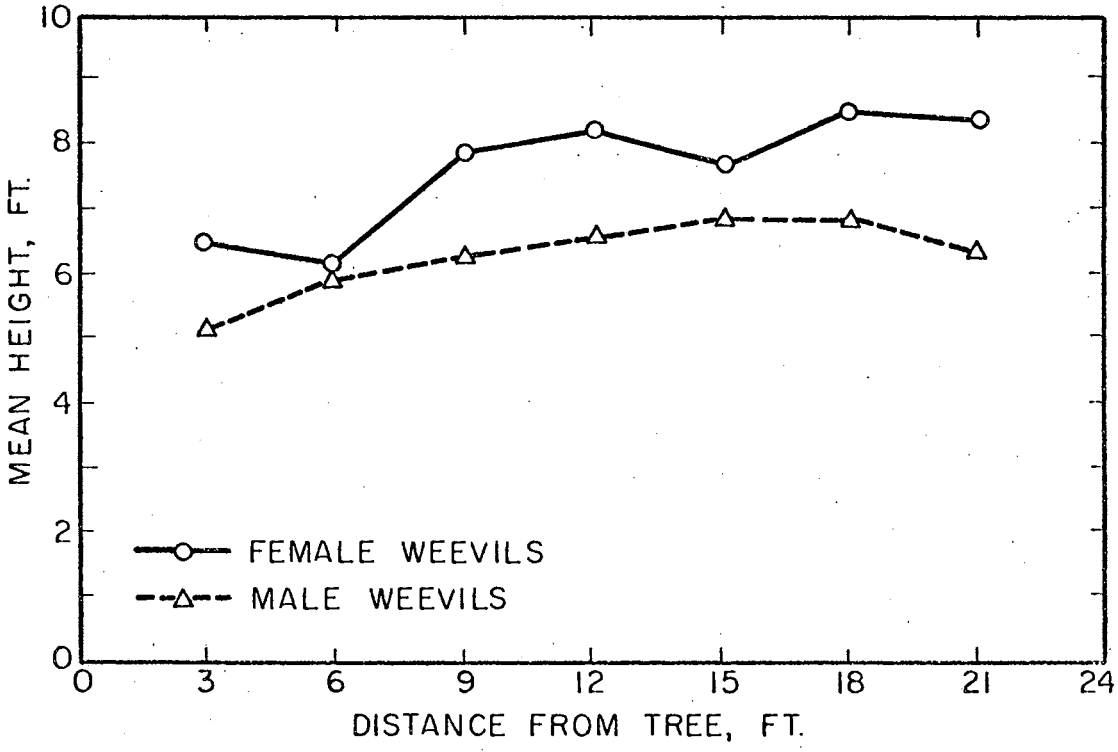

Figure 5. Average height on tree by male and female weevils flying from various distances under the pecan tree, 1967.

placed at various distances from the base of the tree. All mean heights for females were higher at each distance from the tree than for the males. At the 18-ft distance, the mean heights flown by both sexes decreased. The heights flown by female and male weevils ranged from 4 to 20 and 2 to 16 ft, respectively, with more females than males recorded in the 10 to 12-ft height range. These data are further evidence of the better flying ability by the females.

SUMMARY

The studies in 1966 and more detailed studies in 1967 indicated that the female weevils tended to fly to the higher parts of the pecan tree and that male weevils tended to crawl to the tree more frequently than female weevils.

Because male weevils crawled or flew to lower heights on the trees, it could be concluded that the male is the weaker flyer. Pecan weevils do have definite habits in reaching the tree, and this study seems to indicate that further investigations might be conducted to establish a method of control for the less mobile male weevils, as well as for the higher flying females.

Since the highest percentage of weevils were observed to fly to the lower levels of the trees in 1967, better control might be obtained by concentrating insecticides in that area of the trees.

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APPENDIX

TABLE I

ANALYSIS OF VARIANCE OF THE HEIGHT FLOWN BY WEEVILS DUE TO DIFFERENCE IN SEX AND THE DISTANCE RELEASED FROM THE PECAN TREE (1967)

Source of Variation	Degrees of Freedom	Mean Square
Replication	2	12.23**
Sex	1	17.81**
Distance	6	3.10*
AB	6	0.51
Error	26	1.16
Sampling	339	1.26
Total	380	

* Significant at the 5% level

** Significant at the 1% level

VITA

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Master of Science

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