BIOLOGY AND NATURAL CONTROL OF THE WHITE PINE WEEVIL, *PISSODES STROBI* (PECK), IN VIRGINIA

by

Dan M. Harman

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APPROVED:

Chairman, Dr. H. M. Kulman

Dr. J. M. Grayson

Dr. S. E. Neff

Dr. E. C. Turner

Dr. R. G. Henderson

Dr. R. L. Pienkowski

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A. INTRODUCTION

Eastern white pine, Pinus strobus L., has been regarded as the most important sawtimber species in the Northeast (Jaynes, 1958). According to Connola and Wixson (1963), market prices for white pine lumber have more than tripled since 1939 and foresters continue to consider it the most desirable tree for reforestation in the Northeast. In recent years this species has been used rather extensively in plantings in Virginia and southward and may now be considered one of the more important plantation species in certain areas of the Southern Appalachians (R. J. Kowal, personal communication, 1963).

The white pine weevil, Pissodis strobi (Peck), has been a major factor in limiting the full potential of white pine as a lumber tree in the Northeast. Studes in New Hampshire in 1952 revealed losses of 13 percent (board foot volume) in sawlog portions, and 70 percent (cubic volume) in the portions above sawlog limits of merchantability in sawlog trees. These losses represent 35 million cubic feet of potential merchantable volume in pole timber trees, 2.16 billion board feet in the sawlog portions of sawtimber trees, and 116 million cubic feet for material other than sawlogs (Waters, McIntyre, and Crosby, 1955).

Belyea and Sullivan (1956) stated that the weevil first became a problem in the eastern United States in the middle of the nineteenth century, when fields cleared for agriculture were abandoned and seeded in by white pine. A similar situation presently exists in the Southern Appalachians. This suggests the possibility of increasing problems with the white pine weevil in this area, and emphasizes the need for early studies in controlling outbreaks in southern stands. Although much has been written on the white pine weevil, recent literature surveys indicate that little research has been done on it south of Pennsylvania.

B. BRIEF RESUME OF TAXONOMIC POSITION, LIFE HISTORY, HOSTS AND RANGE

The white pine weevil was first described by W. D. Peck (1817), professor of natural history and botany at Harvard University, who mentioned it as a forest pest of importance.

The following synonomy for *Pissodes strobi* were listed by Taylor (1929a): *Rhynchaenus strobi* Peck (1817), *Pissodes nemorensis* Say (1831), *Pissodes strobi* Say (1859), *Pissodes strobi* Gemm. and Har. (1871), *Pissodes strobi* Leconte and Harr. (1876), *Pissodes strobi* Hopk. (1911), *Pissodes strobi* Blatch. and Leng (1916). He also states that it has been confused with *P. webbi* Hopk. and *P. fiskei* Hopk. in catalogues. *Pissodes approximatus* Hopk., *P. affinis* Randal, and *Hylobius pales* Boh. have been mistaken for it in the literature and collections. There are 9 described species of *Pissodes* occurring in the Northeast (Anonymous 1959). The 2 most common of these are *P. strobi* and *P. approximatus*. Two others, *P. affinis* and *P. nemorensis*, are also found frequently in some places. The authors state that *P. strobi*, the white pine weevil, is rated the most important species of the group, and *P. approximatus* is rated as a secondary insect. The others are less numerous and are secondary pests. The white pine weevil is sympatric with the other 3 species. Both *P. strobi* and *P. approximatus* occur throughout the Northeast, with *P. affinis* found in the northern part of the range and *P. nemorensis* in the southern part. According to Taylor (1929a), the white pine weevil is found throughout the natural range of white pine in Canada, New England, the lake states, the Appalachian forest zone, and occasionally in Indiana, Illinois, Iowa and Ohio and westward to the Rockies. It is most important in New England, in states bordered by the great lakes, and in Maryland.

There are several accounts of the life history of P. strobi in the literature. According to Belyea and Sullivan (1956), it completes one generation per year, hibernating in the winter as an adult in the duff and litter at the base of the host tree. Emergence of adults from hibernation usually occurs in the latter half of April, depending upon the season and location. Feeding, copulation and oviposition occurs on the upper part of the terminal shoot. The eggs are placed under the outer layers of the bark in small chambers excavated at the base of normal feeding punctures. The eggs hatch in about 2 weeks, and the small larvae soon become arranged in a ring about the leader. They move downward as a group, feeding internally on the inner bark and leaving the outer bark intact. About 5 or 6 weeks are required to attain larval maturity. Transformation from mature larvae to adults occurs in pupal chambers constructed in the pith or in the dead leader. New-generation adults are formed in about 2 weeks but remain in the leaders until August or September. Thus activity at this time is limited to feeding on the host tree. With the beginning of unfavorable conditions, they move to the duff to hibernate. Tree injury results from the larvae killing the terminal leader, including 2 or more years' growth. Two or more laterals may compete for dominance, resulting in a crooked or forked stem.

MacAloney (1930) included the following tree species as hosts of the white pine weevil; white pine, Pinus strobus L.; Norway spruce, Picea abies (L.) Karst; pitch pine, Pinus rigida Mill.; jack pine, Pinus banksiana

Lamb.; Japanese red pine *Pinus densiflora* Sieb. and Zucc.; western white pine, *Pinus monticola* Dougl.; limber pine *Pinus flexilis* James; foxtail pine, *Pinus balfouriana* Murray; red spruce, *Picea rubra* Link., Scotch pine, *Pinus sylvestris* L.; western yellow pine, *Pinus ponderosa* Dougl.; Mugho pine, *Pinus montana mughus* (Scop.) Willk.; black spruce, *Picea mariana* (Mill.) B. S. P.; blue spruce, *Picea pungens* Englm.; white spruce, *Picea glauca* (Moench) Voss.; Douglas fir, *Pseudotsuga taxifolia* (La Marck) Britton; red pine, *Pinus resinosa* Ait.; Himalayan pine, *Pinus excelsa* Wall.

C. LITERATURE REVIEW

There is an extensive literature on the white pine weevil. However, a review of the literature indicates that little work has been conducted on parasites and predators in recent years. In many cases, the information on natural control agents consists of a mere mentioning of species involved, especially in recent references.

In table 1 are listed the natural enemies of the white pine weevil found in the literature, the authors who reported them, and additional information from the articles.

Sullivan (1961a) discussed natural control of the white pine weevil, and mentioned reports of birds, small mammals, and insect predators and parasites which have been listed by other workers. MacAloney (1930) and Taylor (1928; 1929) considered *Eurytoma pissodis*, *Lonchaea corticis*, and *Microbracon pini* to be the most important insect parasites of the weevil, the first 2 of which were relatively common over the entire range. Belyea (1956) briefly discussed biological means of control, and states that they do not appear promising. Taylor's (1929) studies were the most complete done on insect parasites and predators.

MacAloney (1932) reared 29 species of parasitic insects from leaders collected in various New England states. His list of the most important insect enemies includes *Lonchaea corticis*, *Eurytoma pissodis*, and *Microbracon pini*, which he states are external feeders, and *Doryctes* sp. and *Coeloides pissodis*, which are internal feeders. He placed infested leaders in containers which allowed the parasites to escape into plantations, but retained the weevils. He found no noticeable decrease in weevil attack resulting from these treatments. In 1930 he stated that the most important natural control factor is climate, and considered control by parasitic and predatory insects to be at best a very uncertain method. He added, however, that this influence has great value and cannot be excluded from consideration. He included a complete list of insects collected or reared from infected leaders by himself or other authors, listing parasites, hyperparasites, predators, and associated species separately (see table 1). Lonchaea corticis, Eurytoma pissodis, Microbracon pini and Doryctes sp. and C. pissodis were again stated to be the most important primary parasites. He considered L. corticis to be far the most important dipterous form and added that it should properly be considered a predator. He discussed several of the species separately and reported some life history information on L. corticis and others. Deleter undulatus, Pleurotropis sp., and Homoporus sp., and Berecyntus sp. were named as hyperparasites. The first 3 attacked dipterous insects and the fourth attacked associated Lepidoptera in the shoots.

A barrel with a screen on each end was suggested by Hopkins (1907) to allow the escape of insect enemies of the white pine weevil emerging from infested leaders in the barrel.

A comprehensive study of parasites was conducted by Taylor (1929a) in which he included biological information on many species which were parasitic on the white pine weevil, and listed species obtained by other workers. He points out that although parasites are of value, no one had attempted to measure their effectiveness. Taylor counted exit holes, pupal cells and other evidence in 3,000 weeviled leaders and showed that about 50 percent of the mature larvae and 5 to 10 percent of the eggs eventually emerged as adult weevils. He grouped natural control of the weevil into 12 categories which included egg infertility, parasitism, predation, pitch-drowning, and winter killing. He ranked the primary parasites in descending order of their percentage of effectiveness as follows: Eurytoma pissodis, Lonchaea corticis, Microbracon pini, Eupelmus pini, Rhopalicus pulchripennis, Coeloides pissodis, Calliephialtes nubilipennis, and Spathius sp..

Taylor (1929b) presented additional work on weevil parasites in which he included a list of parasites obtained by other workers (see table 1), and a list of European parasites of the genus Pissodes. Separate discussions were included for each of the more important parasites and predators.

In a discussion of natural control of the white pine weevil, Taylor (1930) listed the major mortality factors for each stage in the weevil life cycle, and included estimates of their effectiveness, methods of study, size of sample, and source of material. He also included data and a discussion on effectiveness of birds and insect parasites.

Plummer and Pillsbury (1929) considered natural controls to be vitally important in controlling the white pine weevil, but stated that since the weevil is an indigenous insect, it is improbable that natural checks can be artificially increased to any marked extent. They named Lonchaea corticis as the most important predator in New Hampshire, stating that it is responsible for about 50 percent reduction in the number of larvae. They considered the hyperparasitic chalcid, Pleurotropis sp., to be a factor in reducing the effectiveness of L. corticis. They mentioned various clerids as predators of the weevil.

An annotated bibliography of the white pine weevil was published by Mott in 1930 which covered the literature in chronological order from 1817 until that time. Each reference was studied and abstracted by the author and various aspects of the biology and control of the weevil were presented.

Barnes (1928a and b) reported on parasitism in addition to his studies on anatomy, flight, phenology, behavior and injury to trees. From his material he reported the following species, in order of their apparent importance; Lonchaea sp.; Pleurotropis sp. (Hyperparasitic on Lonchaea pupae); Eurytoma pissodis; Labena apicalis; Microbracon pini; Microbracon sp.; Rhopalicus pulchripennis; Calliephialtes comstockii; Eupelmus cyaniceps var. amicus; Coeloides pissodis; Eurytoma tylodermatis; E. tomici; and Spathius canadensis. He reared several other species for which the status was questionable and mentioned others of importance which were not obtained in his study (the complete list is contained in table 1). Taylor (1928) described Lonchaea corticis, and included taxonomic information on some other species of Lonchaea. He also described Eupelmus pini from reared material (Taylor, 1927b). A mite, Pediculoides ventricosus was reported as a predator on prepupae of Eurytoma pissodis, which is in turn a parasite of the white pine weevil (Taylor, 1927a). He observed that some braconid parasites of weevils reared in the same manner as E. pissodis were not attacked by the mite. Webber (1926) reported a case where Compsilura concinnata was found in a museum mount where it had evidently parasitized the white pine weevil, C. concinnata is a tachinid parasite of the gypsy and brown tail moths. Graham (1926) stated that Eurytoma pissodis was the most important parasite of the weevil in his studies. MacAloney (1926) considered Eurytoma pissodis and Lonchaea corticis to be the 2 most important insects destroying the weevil and stated that control by parasites is very tenuous. Britton (1920) suggested that Cyanopterus sp. may not be a parasite of the white pine weevil. Packard (1886) wrote of carnivorous grubs in the weevil mines, particularly Tennebrionid larvae. Dodge (1874) discussed an Ichneumon fly which deposited an egg in the weevil larvae. Along with the original description of the white pine weevil, Peck (1817) reported and described a species of Ichneumon which deposits its eggs in the body of the weevil larva.

In addition to insects as natural enemies of the white pine weevil, many workers have reported predation by birds, some considering them the most important of the natural control agents. MacAloney (1926; 1930; 1932) suggested that through protection of insectivorous birds, a greater degree of control could be gotten than by any other biological method. In one heavily infested plantation of 3 acres, he observed that 30 percent of the weeviled leaders had been stripped of bark and the weevil larvae destroyed. Taylor (1929a) stated that birds are of great importance in reducing the numbers of Pissodes strobi, and quoted other authors who named the nuthatches, chickadees and woodpeckers specifically. His figures of weevil larvae consumed in a count of 3,009 leaders totaled 17.62 percent of average effectiveness in all shoots. However, he found that larvae must reach a certain size before birds begin utilizing them for food, and that predation by birds on young larvae is almost non-existent (Taylor, 1930). The possibility of ground birds consuming adults in the duff was also considered. Mott (1930) reviewed several articles which included consideration of birds as predators.

The white breasted nuthatch, Sitta carolinensis, was observed feeding on larvae in an infested leader, (Plummer and Pillsbury (1929)). Graham (1926) mentioned nuthatches, chickadees, downy woodpeckers, chipping sparrows, and wrens as probable predators on weevil larvae in the leaders, and suggests the ground feeders, such as cheewinks, thrashers, grouse, and quail on the ground. He stated that domestic fowl may be of value in small plantations, and that chickens and turkeys have been used against the boll weevil in the South, with some success. He also related one instance in New York where chickens released in a plantation helped in partially checking the weevil.

Graham (1918) stated ..." the most important predaceous enemies are the birds. Such birds as the chickadee feed upon the weevil larvae, picking them out of the infested terminals, and the ground feeding birds, such as the ruffed grouse and the towhee, find adults in the litter about the trees". McAtee (1926) reported on the association of birds with woodlots, and discussed many different birds and their insect prey. Among the birds he listed as predators of the white pine weevil were the chickadee, Penthestes atricapillus L., and the bluebird, Sialia sialis L. Noting the work of other authors, he added the woodpecker, the yellow-billed cuckoo, and the English sparrow.

Britton (1920), Hopkins (1907), and Peirson (1922) mentioned birds, particularly woodpeckers, devouring weevil larvae, pupae and adults. Houser (1918) and Felt (1906; 1903) stated that a number of birds tear open the leaders and feed on the occupants.

The role of small mammals as predators of the white pine weevil has been discussed by several workers, although few detailed studies have been conducted to determine their actual value. In experiments to determine the value of small mammals in reducing the hibernating populations of the weevil, Jaynes and Godwin (1953; 1954a; 1954b) released weevils under 100 trees, 50 of which were protected from small mammals. They obtained results which indicated that mammals were not important. They also conducted a study to determine what species were present and their abundance in certain stand types. Using radioactive weevils, they found two specimens; one Peromyscus and one Blarina which had radioactive viscera, indicating they had consumed weevils.

MacAloney (1932, 1930) states that runways of field mice, wood mice and shrews found in the litter at the depth at which weevils hibernate indicate they are probable predators. Taylor (1930) does not consider these mammals to be of much importance in controlling the weevil because their feeding impact is diluted since there are many other insects present in the duff. The short tailed shrew is very common in the pine thickets, and lives entirely on insects (Graham, 1926). He adds, however, that compared to the birds, the mammals are of little importance in the destruction of weevils.

Several workers have mentioned nematodes, fungi, and bacteria in association with the weevils in the leaders. However, few have attached any importance to this subject and detailed studies of this nature are extremely rare.

Taylor (1929a) writes ..." Under natural conditions, very few weevil larvae or pupae covered with fungus mycellia were noted, and in the occasional case so noted, it was impossible to say definitely that the fungus was the cause of death. Species of the genera Aspergillus and Pennicillium, which were common in the cultures, are not usually regarded as entomophagous... it would seem probable that pathogenic microorganisms are responsible for some of the mortality of the weevil larvae but are probably not an important agent of control under the usual conditions that prevail in the leaders.' He states that in the frass behind the weevil ring, nematodes may be found in large numbers, especially when water is not entirely absent. Barnes (1928a) found nematodes on the weevil adults, in the adipose tissue of larvae and pupae, and in the bursa copulatrix of an adult female. He mentioned Diplogaster sp. and Rhabditolaimus sp. and added that there is no evidence that weevil larvae which die before maturity owe their death to nematodes. In 1930, Taylor stated that it is extremely doubtful that nematodes are a factor in control. Commenting on bacteria and disease, he stated that it is difficult to ascribe decaying larvae to any primary pathogenic organism. Barnes (1928a; 1928b) discussed his observations of Diplogaster sp., present on weevils, and believed that this case is similar to that reported by another worker who studied nematodes in the same genus living in a form of symbiosis with a species of Ips. Hopkins (1907) stated that some larvae apparently die from disease.

D. PROBLEM STATEMENT AND OBJECTIVES

A survey of the literature on the white pine weevil indicates that little research was conducted south of Pennsylvania, and few of the studies concerning its parasites, predators, and associated fauna have dealt with their relative abundance in different types of stands.

The present study started in 1963, and was designed to gain basic information on biological control possibilities in the southern Appalachians. The primary objectives were: (1) to determine the species of parasites, predators, and other organisms associated with the white pine weevil in Virginia; (2) to relate the abundance of these organisms to various white pine stand types; (3) to relate the abundance of the weevil and its associated fauna to ecological positions within plantations; (4) to obtain an estimate of the degree of predation and parasitism of the weevil; (5) to relate this mortality to the host stage attacked and to its occurrence at specific distances from the base of the leading shoot; and (6) to gain biological information on the white pine weevil and its associated fauna.

E. PROCEDURE, METHODS, AND MATERIALS

To determine the species of parasites and predators attacking the white pine weevil, collections of infested leaders were made at 10-day intervals from 13 different locations in Virginia (figure 1). Infested leaders were brought into the laboratory and placed in 12x24-inch polyethylene bags which were folded at the top and fastened with paper clips. The bags were checked every 2 days and the occurrence of insect emergence recorded from July 10 to September 19, 1963. In addition to the clipping of leaders for laboratory rearing, leaders were caged in 12x24-inch muslin bags in the field on June 1, June 10, and June 20. The caged leaders were clipped and taken into the laboratory on July 4. At this time the leaders were transferred to polyethylene bags for additional rearing. Organisms which had emerged in cloth bags were recorded. One final observation for insect emergences was made on December 30, 1963, to observe any insect emergence after September 19. Upon emergence, the insects were placed in vials and labeled. Later, each specimen was pinned and sent to specialists for identification or confirmation of identifications. Upon emergence, representatives of several of the important species were reared in glass vials on a diet of moist honey for longevity studies. The honey was kept moist by wetting it at intervals of 2 or 3 days.

Within the collection areas used, 5 different types of white pine stands were observed and classified as shown in table 2. Edge and inside positions were recorded separately for several of the plantations of stand types 1 and 2, and were represented by collections from Radford, Catawba, Hillsville, and Camp.

During the summer of 1964, a study was undertaken to determine the vertical distribution of emergences of the weevil and associated insects along the leaders. Infested leaders were collected from 3 different stands located at Catawba, Radford, and Deerfield. Separate records were kept for leaders collected at the edge and interior of stands at Catawba and Radford. Leaders were brought into the laboratory on July 4, clipped into 4-inch sections, and placed into large glass jars. Separate jars were used for the distal 4-inch section, next 4-inch section, etc. Earlier attempts to cage leader sections with organdy sleeves were unsuccessful because insects chewed through the cloth. In the fall, counts were made of weevils, parasites, predators, and associated organisms. Leader sections were dissected and counts were made of adult weevils which emerged, completely developed adults which failed to emerge, dead larvae, and artifacts indicating parasitism or predation.

<u>Parasite verification studies in 1965</u>. -- Beginning in late May, 1965, studies were undertaken to gain further information on insect species associated with weevil infestations. A total of 96 leaders were examined during the summer and early fall. All organisms observed within the weevil larval feeding areas were recorded for each inch downward from the base of the terminal shoots. All weevil larvae were examined for parasites. Immature parasitic forms were placed in gelatin capsules with records of number per host, position on or within the host, and distance from the terminal bud. Counts were made of <u>Lonchaea corticis</u> eggs, larvae, and pupae. All immature forms were kept for rearing to the adult stage or for development of hyperparasites. Mortality from parasitism and from

unknown causes was recorded separately for each inch along the leaders.[1/] To observe larvae actively feeding down leaders, a method was developed using polyethylene film to replace the thin outer layer of bark which normally excludes the larvae from view. The outer bark was shaved from the leader with a razor blade. Strips of thin polyethylene were then drawn tightly around the leader and secured with tape. Larvae were placed under the polyethylene at the top of the sleeve where they assumed a feeding formation and progressed downward. It was necessary to transfer the larvae as quickly as possible to avoid drying. The method was successful with late instar larvae, which could be easily observed until they burrowed into the stems. Much difficulty was encountered with the transfer of the early-instar larvae as they had difficulty orienting themselves into the feeding positions.

1/ Unfortunately, a fire destroyed a large number of the early summer parasites.

F. RESULTS

Throughout the summer of 1963, a total of 759 infested leaders were caged and observed for emergence of weevils and associated insects. Of these, 651 were clipped and brought directly to the laboratory on 6 different collection dates and 108 leaders were caged in the field from 10 to 30 days before being brought to the laboratory as shown in table 3.

During the course of the study, 48 species were identified and several others were found for which identifications could not be obtained. In table 4, the species reared are listed by family and numbers obtained in the 1963 rearings. Several species which were believed to be incidental to the study were omitted from table 4.

During other studies on natural control agents in summers following that of 1963, two additional species, Bracon sp. and Eurytoma crassineura, were reared and identified. Their numbers will be discussed in a separate section.

Actual numbers of the 5 species of Coleoptera listed in table 3 were not recorded, although samples of each apparent type were sent for identification. A few other species of Coleoptera were not identified. Two species of Drosophila, D. funebris (Sturt.) and D. buskii (Coq.), were found associated with infested leaders in the emergence bags, but were not included in the above list. The clerid, Enoclerus nigrifrons was present in certain groups of leaders in 1963, but was incidental to the main study.

Emergences according to stand type. -- The 13 stands used in the study were classified into 5 basic types, as previously stated. Emergences of organisms from the infested leaders were totalled for each stand type on the basis of average number of emergences per leader. Emergences of the white pine weevil (table 4) and associated fauna (table 5) are given with totals for each stand type on the basis of average numbers of emergences per leaders yielding. Only the leaders yielding the respective organisms were included in the averages. Of the associated species represented, _Lonchaea corticis_ greatly outnumbered all other associated fauna in emergences per leader and was therefore considered separately in the calculations in table 5. Tables 5 and 6 are presented to emphasize broad trends in emergences of organisms from the various stand types. All associated organisms other than _L. corticis_ are grouped together. A closer examination of emergences of the various species will be given later.

Stand type 1, comprised of young open plantations, produced more adult weevils than all other stands. From the 162 leaders in the collection, 134 leaders yielded 2461 weevils for an average of 18.36 individuals per leader yielding.

Lowest average emergences of weevils per leader yielding were found to occur in the naturally seeded stands growing under a hardwood overstory. Average emergences of weevils in stand types 1 and 2 were higher than for stand types 3, 4, and 5. The number of emergences from older, closed plantations (stand type 2) were twice as high as the number from the naturally seeded areas with a hardwood overstory (stand type 3) with averages of 13.04 and 6.00, respectively. Likewise, the average number of emergences from young, open plantations (stand type 1) are 3 times as large as the number of emergences in the naturally seeded areas with hardwood overstory with values of 18.36 and 6.0, respectively. Stand types 4 and 5, older trees growing in the open with crowns unclosed, had similar weevil yields per leader with averages of 7.75 and 7.68, respectively.

Emergences per leader of all associated species, including Lonchaea corticis was highest in stand type 2, averaging 12.99 individuals per leader yielding and lowest in stand type 4, with an average of 3.42 individuals per leader yielding (table 7). Other associated organisms, not including L. corticis, showed the greatest number of emergences per leader yielding from stand type 1 and the lowest from stand type 3.

In the entire study, 6046 weevils emerged from 491 leaders, averaging 12.31 weevils per leader yielding. A total of 3031 Lonchaea corticis emerged from 257leaders, averaging 11.79 individuals per leader yielding. Of the remaining species, 944 emerged from 297 leaders, averaging 3.18 per leader yielding. Combining L. corticis with the other associated species, (table 7), a total of 3975 individuals emerged from 423 leaders, averaging 9.40 per leader yielding. Sixty-five percent of the leaders observed in the study yielded weevils and 56 percent yielded other species. Thirty-four percent yielded L. corticis and 39 percent yielded associated species other than L. corticis. Considering the cumulative emergences of the white pine weevil and all other organisms, 10,021 specimens emerged during 1963 (table 7). Stand type 1 had the highest number of emergences per leader yielding and the greatest percentage of leaders yielding organisms. Stand type 5 had the lowest total emergences, lowest average emergences per leader yielding, and lowest percentages of leaders yielding.

Complexes of the individual insect species which emerged from each stand type are shown in table 8. Average emergences per leader in the entire collection and per leader yielding are shown for the more numerous species only. Stand type 2 yielded the most species, followed by stand types 1, 3, 4, and 5, respectively. *Coeloides pissodis* occurred in each stand type and emerged in greatest total numbers from stand type 1. It emerged from the highest percentage of leaders from stand type 1 and in highest average emergences per leader yielding from stand type 5. For *Bracon pini*, stand type 2 was highest in total emergences, percentages of leaders yielding, and average emergences per leader yielding. In descending order stand types 1, 3, 4, and 5 followed stand type 2 uniformly for all 3 items. *Rhopalicus pulchripennis* emerged in greatest numbers, percentages of leaders yielding, and emergences per leader yielding from stand type 5. Stand type 2 was second in total emergences of *R. pulchripennis* and lowest in percentage of leaders yielding. *Eurytoma pissodis* was reared in much higher numbers from stand type 1 than any other stand type. Percentages of leaders yielding were negligible in the other stand types which yielded this species. It was entirely absent from stand types 3 and 5. *Pseudeucoila* sp. was not recorded from stand types 4 and 5, and *Oscinella conicola* was absent from stand type 5. Stand type 2 yielded the greatest numbers of *Eupelmus pini* although it occurred from only 4 percent of the leaders collected. This was also the percentage of occurrence from standttypes 1 and 5. *Pseudeucoila* sp. was present in substantial numbers only from stand type 2, with 59 individuals emerging from 16 leaders which was 5 percent of the total number collected. In the other stand types it was rare or absent. Both Oscinella conicola and O. hinkleyi appeared in largest percentages of leaders and averages per leader yielding from stand type 2. Pediobius sp. was encountered in very low numbers in all except stand type 2, from which 16 individuals emerged. Table 9 summarizes data on emergences, percentages, and averages of the more numerous species according to stand type.

Emergences according to collection date, emergence date, and individual collection source. -- Collections of infested white pine leaders were made at about 10-day intervals from early May until July 10, 1963. A total of 6 separate collection dates is represented in the study. Unequal amounts of infested material in the various stands made it impossible to collect in equal numbers on each date and resulted in some stands not being represented in each collection.

Emergences of insects from the leaders taken on each collection date are shown in table 10. Pissodes strobi and Lonchaea corticis were considered separately. All remaining associated species were considered as a unit since they occurred in lower numbers.

The more frequently-occurring associated species emerged from most of the individual collection areas and stand types, although differences were observed. Table 11 shows emergences for specific areas and for the most abundant species. Lonchaea corticis was not included in table 11 since it was considered separately in table 10. The species treated in table 11 occurred in numbers of 20 or more.

Table 12 shows emergence data according to date of collection for the same species. This is done to confine periods of emergence of the different species within seasonal limits.

The May 6 collections yielded none of the species considered in table 12. Coeloides pissodis occurred from the greatest percentages of leaders in the June 20 collection. Greatest total numbers of individuals and of leaders yielding occurred on July 1. Bracon pini emerged from the greatest percentage of leaders and in highest numbers per leader yielding from the June 1 collections. In both of the above species, the number of emergences per leader yielding decreased from June 10 to July 10. Rhopalicus pulchripennis emerged from 10 percent of the leaders in the July 1 collection. This collection date exceeded the others in numbers per leader yielding, in percentages of leaders yielding, and in total numbers. Oscinella conicola, O. hinkleyi, Pediobius sp., Eupelmus pini, and Pseudeucoila sp. were absent from the May 15 collection at Radford. The highest percentage of leaders yielding O. conicola was 6 percent, which occurred from the July 10 collections. Oscinella hinkleyi emerged in its highest numbers per leader yielding from the June 1 collection. Pediobius sp. was not encountered in the June 1 collections. It had its highest averages per leader yielding from the July 1 collections and emerged from greater percentages of the leaders in these collections than in any other collection date. Eurytoma pissodis emerged from its highest percentages of leaders in the collections of May 15 and June 1. For Eupelmus pini and Pseudeucoila sp. highest percentages were in the collections of June 1 and June 20, respectively.

<u>Success of attack</u>. -- Observations on individual leaders throughout the season of weevil development revealed that many attacks yielded no weevils, although they succeeded in damaging or killing the leader. For the purpose of this analysis, infested leaders which yielded no weevils are considered cases of unsuccessful attack , although attacks resulting in the killing of leaders might be considered successful from the standpoint of the forester.

Other categories which also became apparent in this study involved the emergence of associated species from infested leaders. As shown on table 13, the 4 combinations are as follows: (1) emergence of no organisms; (2) emergence of associated species only; (3) emergence of weevils only; and (4) emergence of both associated species and weevils. The associated species which appeared in each case were included in table 13 which gives data separately for individual location, date of collection, and stand type. Percentages of leaders yielding these groups and average emergences per leaders yielding were used along with numbers of emergences to present the data in a meaningful manner.

Figure 2 shows a comparison of the 4 emergence categories according to stand type. In every stand type, the percentage of leaders yielding nothing was higher than the percentage yielding associated species only. All stand types except stand type 3 had higher percentages of leaders yielding weevils only than those yielding associated species only. For each stand type, except stand type 5, percentages of leaders yielding both weevils and associated species were greater than the percentage yielding either of these alone. The opposite trend was emphasized in stand type 5 due to the Prices Fork collection of May 6 which yielded only weevils, probably due to the early collection date. Likewise in the other collections for stand type 5 (Massanetta) a greater percentage of the leaders yielded weevils only than yielded both weevils and associated species. Comparatively, the percentage of leaders yielding no organisms was highest in stand type 4 (naturally seeded areas with no hardwood overstory). The order of stand types in percentage levels of leaders yielding both weevils and associated species was almost the reverse for that for leaders yielding no organisms.

On figure 3 are shown comparisons of average emergences per leader yielding. Weevils and associated species are considered for each stand type in separate and combined occurrence. Stand type 1 was highest in emergence of weevils in separate occurrence and in combination with associated species. In every stand type except stand type 5, more weevils and more associated insects emerged per leader yielding where they occurred in combination than where either occurred alone.

Weevil emergence per leader. -- In table 13, successful attack was defined as the emergence of 1 or more weevils. Actual numbers of weevils emerging per leader are shown in table 14. Within each stand type, leaders yielding one weevil are more numerous than those yielding any other number of weevils. A sharp decline in numbers of leaders yielding is apparent for leaders with 1 to 5 weevils per leader (figure 4). For leaders with 5 to 15 weevils per leader, the numbers of leaders yielding fluctuated but still followed a downward trend.

A total of 493 leaders yielded weevils. Of these, 19 percent yielded only one weevil, 51 percent yielded 1-5 weevils, 15 percent yielded 5-10 weevils, and 10 percent yielded 10-15 weevils. Twenty percent yielded more than 15 weevils per leader. The highest emergence for any one leader was 106 weevils.

Seasonal emergences of the weevil and associated species. -- Polyethylene bags containing infested material were observed every 2 days for emergences from July 9 until September 19. Organisms which emerged into the muslin bags in the field were recorded when the bags were brought to the laboratory. On December 30, a final examination of the polyethylene bags was made to record all emergences occurring after September 19.

On table 15 are shown emergences of the white pine weevil and associated species for each check date and collection date throughout the season. Since leaders from the earlier collection dates were exposed to laboratory temperatures longer than leaders from later dates, the former were more subject to a laboratory influence for the seasonal emergence data. On table 16, seasonal emergences were grouped into 6 categories as follows: (1) emergence in the field cages, occurring May 15-July 4; (2) the first examination of the polyethylene bags in the laboratory on July 9 which included cumulative emergence from May 6-July 9; (3) the remainder of July (July 10-31); (4) August 1-31; (5) September 1-19; and (6) the final examination of the bags on December 30 which included the period of September 19-December 30.

Emergence recorded in the first 2 categories listed above (field cages and July 9 check date) is considered to be early, since these categories include late spring and early summer. Only Bracon pini was recorded at a notably high level from the 2 early categories, issuing from more than 50 percent of the leaders. Coeloides pissodis, Rhopalicus pulchripennis, Eurytoma pissodis, Eupelmus pini, Pseudeucoila sp., and Pediobius sp. emerged in highest percentages in category 3 (July 10-31). The white pine weevil, Lonchaea corticis, Oscinella conicola, and Oscinella hinkleyi emerged in highest percentages in category 4 (August 1-31). Enoclerus nigripes emerged in highest percentages in category 5 (September 1-19).

In figure 5 seasonal emergence levels for the white pine weevil and Lonchaea corticis are presented in a graph. Peak emergences of the white pine weevil occurred on July 9 with 496 individuals. Peak emergence of Lonchaea corticis occurred on August 28 with 200 individuals.

Seasonal emergence for each species is shown according to stand type in table 17. On table 18, percentages of emergences are shown by stand type, individual species, and seasonal categories as previously described.

Emergence according to ecological position within stands. -- In some stands, mostly the plantations, edge and inside positions of trees were clearly defined. The amount of infested material was scarce in some areas, however, and equal numbers could not be taken at each collection. Edge trees were classified as those with one side exposed to the plantation edge. Inside trees were classified as those surrounded by other trees in the plantation. Since there were many more of the inside trees, more infested material was available for collection in this position than in the edge position. The stands at Radford, Catawba, Hillsville, and Camp were used for collections in the study of ecological position.

Table 19 includes individual data for each species according to ecological position, location, and date of collection. This data is summarized in table 20. A total of 90 leaders were collected for the edge position and 118 for the inside position. Within the edge position, 74 percent of the leaders yielded organisms. The white pine weevil averaged 8.15 individuals per leader yielding. Other species which occurred commonly were Lonchaea corticis, Bracon pini, Oscinella conicola, Coeloides pissodis, and Eupelmus pini.

Nineteen species of insects were recorded from the inside position, totalling 1971 individuals. The white pine weevil averaged 15.75 individuals per leader yielding. Most of the species commonly occurring from the edge position also occurred in the inside position. Pseudeucoila sp., however, was not recorded from the edge position although 19 individuals were obtained from the inside position.

Comparisons of stand types 1 and 2 for the edge and inside positions are shown in table 21. In both stand types, emergence of weevils from edge and inside positions was similar. Stand type 2 had a much lower average emergence of weevils per leader yielding than stand type 1 in both positions. Average emergence per leader of associated species was higher for both stand types in the inside position.

Longevity of adult organisms on a diet of moist honey. -- As adult insects emerged, specimens of 8 species were used for longevity studies. They were kept at room temperature in cotton stoppered vials and fed a diet of moist honey. As shown in table 22, only one specimen of Bracon pini and Eurytoma pissodis were included. Pseudeucoila sp. had the highest maximum longevity at 21 days. Maximum longevity for both Lonchaea corticis and Coeloides pissodis was 18 days. Of the 7 specimens of Rhopalicus pulchripennis, none died before 10 days nor lived longer than 17 days. Rhopalicus pulchripennis had the highest average longevity at 13.28 days.

Distribution of organisms along white pine leaders. -- Studies were conducted in 1964 to compare species and numbers of organisms at different horizontal levels in white pine leaders. Leaders were collected at Radford and Carvins Cove on June 1, June 20, and July 10.

Data on emergence and observed mortality of the white pine weevil according to collection location and position in stands is presented in table 23. Combined deaths of weevil larvae and adults are averaged in table 23 for leader sections yielding. Greatest total numbers of adult weevils were found in the sections 16-20 inches down the leader, including both the adults stuck in emergence holes and pupal chambers and those which successfully emerged. A total of 52 percent of all weevil forms emerged successfully, 9 were stuck in emergence, and 39 percent died in the larval stage. Only 0.5 percent of the successful weevil emergences occurred in the sections 1-4 inches down the leaders, although 8 adults were found stuck in emergence holes or pupal chambers within these sections. A total of 467 leader sections from 96 leaders were included in the study. Larval infestation down the leaders reached as far as 28-32 inches.

In table 24, emergence of parasites are shown according to the 4-inch sections. Nine species were recorded, all of which had been noted in the previous studies except Eurytoma crassineura. Emergences of parasites was greatest from the 8-12 inch sections. The most numerous of the parasite species was *Bracon pini*, with 95 individuals. It emerged in greater numbers from the 8-12 inch sections than from any other.

In addition to data presented in table 23 and 24, dissections revealed that many scolytids emerged from the top 4 inches of the leader. Sections 4-8 inches down the leaders yielded a few clerid larvae and larvae of *Lonchaea corticis*, both of which were common in lower parts of the leader.

Parasite verification and weevil development. -- Over 100 gelatin capsules containing parasite forms were destroyed in a fire before identifications were made. From the remaining material, however, several species were reared and identified. *Lonchaea corticis* was encountered in relatively large numbers in the dissections. Larvae were found on and in dead weevil larvae, sometimes 10 to 15 *L. corticis* larvae on one host. They were also found on and in larvae and cocoons of other species associated with the weevil. It was impossible to state definitely, however, whether the *L. corticis* larvae had killed a healthy host or whether it had attacked only weakened or dead individuals, as the hosts were already dead when observed.

Pseudeucoila sp. was found to be a solitary, pupal parasite of *L. corticis*. Pupal cases of *L. corticis* were placed in gelatin capsules for rearing of hyperparasites. Any pupal cases which were intact at the end of the season were broken open and examined for unemerged hyperparasites. From 96 leaders, 9 cases of hyperparasitism by *Pseudeucoila* sp. were observed in *L. corticis* pupae. Five of these individuals had failed to emerge from the pupal cases of the host. They were solitary and found only as parasites of L. corticis. All of the Pseudeucoila sp. were recovered within the range of 20-27 inches down the leaders.

Coeloides pissodis were noted as external, solitary parasites which spun cocoons next to the dead body of the host; the host larval skin and head capsule were usually attached to the outside of the parasite cocoon. C. pissodis cocoons were frequently found in host burrows. They occurred from 9-25 inches down leaders with their greatest numbers occurring at 23 inches.

Individuals of Bracon pini were reared from weevil larvae and appeared to be external, larval, gregarious parasites whose numbers per host varied from 1 to 5. The gregarious habit was assumed since groups of B. pini were found closely associated in areas where remains of only one host were present. Bracon pini occurred from 2-29 inches down the leader. Individuals which emerged from smaller hosts in the top portions of leaders were much smaller than from larger hosts farther down the leader.

Eurytoma pissodis was observed in 3 cases of parasitism as an external, solitary, larval parasite, and was found inside a host burrow each time.

At least 5 other species, not yet identified, were observed parasitizing weevil larvae. A number of parasites remained in the larval stage into the fall and winter. They were placed in a refrigerator in an attempt to break the diapause, which was not accomplished as of this writing.

In table 25 all organisms obtained in the dissections were included, wether or not they were identified. Cases of known parasitism without a positive identification of the organisms were categorized as "cases of parasitism", to be used in mortality counts. Incidental beetles and other forms of unknown status were enumerated under the category of unidentified organisms.

Mortality of weevils in all stages above the egg is shown on table 25. Percentages killed by parasites were as follows: 16 percent on the May 20 collection, 8.9 percent on June 10 collection, 6.6 percent on the June 20 collection, and 10.9 percent on the July 1-20 collections.

Measurement of head capsules in white pine weevil larvae. -- Head capsule widths were taken for all weevil larvae in the dissections. These measurements were taken with a binocular microscope and grid, and were measured to the nearest one-hundredth of a millimeter. The head capsules were measured at their widest points. On table 26 head capsule measurements, numbers and percentages are shown for each collection date. A graphic presentation of all head capsule measurements is shown in figure 6.

Table 27 shows head capsule measurements related to progressive development of the weevil forms throughout the season. For this purpose, only live larvae at the feeding front (the foremost 3 inches of the larval feeding area), healthy larvae which had burrowed into the stem centers, and live pupae and adults were included. Living but unhealthy larvae lagging more than 3 inches behind the feeding front were not included. Development was stopped by freezing the larvae collected at several intervals through the season. On May 20, the highest percentage of the larvae had head capsules below 0.7 mm in width. On June 10 and 20, the highest percentages of larvae had head capsules 1.26 mm wide. On July 1, eleven percent of the total living forms were in the pupal stage and by July 10 forty percent were pupae. By August 10 the majority of the living forms were adults.

The larvae started to burrow into the shoot to construct pupal chambers between June 10 and 20. Their head capsule width averaged 1.05 mm with 0.95 mm being the smallest recorded.

G. DISCUSSION

Studies on natural control agents. -- During the studies of 1963, a total of 48 insect species were reared from infested white pine leaders. A literature review (table 1) revealed that many of these have been previously recorded. In a detailed study on predators and parasites, Taylor (1929) listed species reared from infested leaders, including discussions on the biologies of *Eurytoma pissodis*, *Microbracon pini*, *Eupelmus pini*, *Rhopalicus pulchripennis*, *Coeloides pissodis*, *Calliephialtes nubilipennis*, *Spathius* sp., *Pleurotropis* sp., *Eucoila* sp., and *Hemiteles humeralis*. Except for Taylor's work, most of the reports on natural control agents gave no information other than that shown in table 1. Most of the studies include a long list of rarely-occurring species. These species were recovered in rearings, but little is known of their activities. For many of the parasites and hyperparasites, the host stages attacked are unknown. A thorough study of the fauna within infested leaders was difficult because the insects were in immature stages. Dissection of leaders was time-consuming and many of the leaders yielded only a few parasites. Also, dissection of the leaders disrupted the natural environmental conditions under the bark causing the death of many of the immature forms. Identification was impossible in most of these cases. Even with the most extreme care in dissection, some of the immature organisms were killed or injured. Therefore, many of the rarely-occurring forms remained unknown.

The 2 phases of this study were: (1) large-scale rearing of insects from infested leaders to obtain quantitative data and representatives of as many species as possible, and (2) dissection of infested leaders to authenticate the status of the insects and to obtain life history information. Secondary objectives will be discussed later.

From the large-scale rearings 48 species of insects were identified. The 15 most common species are included in table 4. All remaining species were obtained in such low numbers that they were grouped as rarely-occurring species.

Leader dissections yielded several of the species obtained in the large-scale rearings, along with several unidentified forms. Lonchaea corticis adults were recovered in large numbers in the rearings and their larvae were very common in dissected leaders. It was the most common associated insect recovered in this study.

From 759 leaders in the polyethylene bags, 3031 individuals of L. corticis were obtained. In comparison, 682 individuals were obtained from 2700 leaders in Taylor's study. He recovered both Bracon pini and Eurytoma pissodis in greater numbers than L. corticis. It is believed that the polyethylene bags used in the present investigation provided a moist, decaying environment favorable for the development of L. corticis. In 1964, 130 leaders reared in glass jars with 3 inch diameter tops covered with organdy yielded only 6 L. corticis adults, but Bracon pini emerged in larger numbers than any other associated species. This suggests that humidity was a limiting factor for rearing L. corticis in the laboratory. Taylor stated that L. corticis was able to complete its development on a diet of either frass or weevil larvae. Large numbers of eggs were deposited by L. corticis (table 25) but apparently only a small percentage reached the adult stage under natural conditions. Eggs were found under weevil feeding punctures and in punctures apparently made by L. corticis adults.

A small hyperparasite, Pseudeucoila sp., was obtained from both the mass rearings and the dissections. It occurred in relatively low numbers in the dissections and in 5 of the 9 cases the adults had failed to emerge from the host pupal cases. Its occurrence was concentrated in relatively few leaders.

Bracon pini, which was considered third in importance by Taylor, was the second most numerous species obtained in 1963. It was gregarious in many cases, with 1 to 5 individuals per host.

Eurytoma pissodis was considered first in effectiveness by Taylor. In the present study it occurred in numbers which were very low compared to B. pini and C. pissodis. However, this parasite overwinters as a larva within infested leaders, and its actual numbers were not recorded in the 1963 rearings since the leaders were discarded in December. Even with the immature overwintering habit, 42 specimens emerged before winter in 1963. The 37 insects that were in sufficiently good condition to be sexed were all females. Seventeen external, solitary, larval parasites which are believed to be E. pissodis were recovered in the dissections in 1965. They are still in the larval stage.

Coleoides pissodis, which was considered to be of negligible importance by Taylor, ranked third in numbers in the 1963 rearings. In dissections, it was found to be a solitary, external, larval parasite, and often occurred in burrows made by weevil larvae. Burrowing may have been a reaction on the part of the host, since stinging of the host by the adult before oviposition was reported by Taylor.

Eupelmus pini emerged from an Ichneumonid cocoon in one instance in this study, demonstrating that it may be secondary at times. Taylor stated that it was impossible to establish it conclusively as a primary parasite of the white pine weevil. He reared it from the weevil, but from no other species.

Most of the species recovered in the large-scale rearings were not obtained in the dissections. The activities of incidental species were grouped as follows: (1) associated plant feeders in the white pine leaders; (2) scavengers in the weevil feeding area or in the areas excavated by other plant feeders; (3) predators and hyperparasites attacking the primary parasites and predators.

Some of the less numerous insects recovered in the rearings were also listed by Taylor as parasites of Lepidoptera. Itoplectis conquisitor is known to have many hosts, and Calliephialtes comstockii is known to be a parasite of both Lepidoptera and Coleoptera. Several Lepidoptera were reared during this study, none of which were returned after being sent for identification.

Oscinella conicola has been reported as a larval parasite of the European pine shoot moth. However, Kulman (1966) found no indication that it adversely affected the shoot moth and reported it as an apparent scavenger. He added that more study was needed to determine the full scope of its feeding activities.

Emergence of insects according to stand type. -- Collections made in the 5 stand types showed that type 1 (young, open plantations without crown closure) had the highest emergence of weevils per leader yielding weevils followed by stand types 2, 4, 5, and 3. (table 5). A comparison of stand types for emergence of weevils is shown in table 28. It appears that emergence per leader yielding remained at a steadily high level for each collection date in stand type 1, but not in the other stand types. Possibly there was a larger quantity of food in the leaders of young, open plantation pines than in the other stand types. Stand type 1 is the only group which is restricted to young pines. In all other stand types older trees are included. If sufficient food material is available, weevils might feed for a longer time before pupation and greater numbers might survive, thus resulting in the emergence pattern shown in table 28 for stand type 1. For the other stand types insufficient food may result in earlier development of the larvae, and a lower survival. Leaders were noticeably smaller, especially in stand type 3 (naturally seeded with a hardwood overstory) than in stand type 1.

The largest emergence of associated species per leader yielding occurred in stand type 2 (older closed plantations) followed by stand types 3 and 1. Stand type 3, which was lowest in emergence of weevils, was higher than stand type 1 in emergence of associated insects per leader yielding and was second highest of all stand types. It was also second highest in percentage of leaders yielding associated species. This indicates that stand types producing the heaviest populations of weevils do not necessarily yield the greatest numbers of associated species. The activity of parasites and predators might have been intense enough to decrease weevil emergence. However, stand type 2 was relatively high in emergence of both weevils and associated species, indicating that another factor was probably responsible. Stand type 2 yielded associated species in numbers very high relative to the other stand types. Numbers of species recorded from stand types 1 to 5 were 16, 24, 14, 12, and 9, respectively. Stand type 2 yielded more species than the other stand types. This may be related to the larger collection of leaders from stand type 2 than from other stands. However, stand type 2 had more associated insects per leader yielding than the other stand types. This stand type therefore appears to be the most favorable for emergence of associated species. A large percentage of the emergence of associated species in both stand types 2 and 3 consisted largely of the dipterous predator, <u>Lonchaea corticis</u>. In stand type 3, it accounted for 88 percent of the associated insects. The shaded conditions in stand types 2 and 3 may have favored this species, as it was previously shown that it apparently survived better under humid conditions.

Stand types 2 and 5 (both plantations) could be considered as later successional stages of stand type 1 (young plantations with open crowns). As growth proceeds and crowns close the stand type 2 condition would occur. If tree mortality caused sufficient thinning, the plantation may remain open as in stand type 5.

Comparison of stand types 1, 2, and 5 reveals the following relationships: (1) in stand type 1 (young open plantations), weevil emergence was highest per leader yielding. Associated species emergence was second per leader yielding; (2) stand type 2 (older closed plantations), a possible latet successional stage of stand type 1, was second in emergence of weevils per leader yielding. It led all other stands by a considerable margin in the emergence of associated species per leader yielding; (3) stand type 5 (older open plantations), also a possible later successional stage of stand type 1, was third in emergence of weevils and of associated species per leader yielding. It appears that crown closure is beneficial, therefore, in encouraging parasite and predator populations. A numerical comparison of these 3 stand types is shown in table 29.

Stand type 3 was lowest of the 5 stand types in weevil emergence and second highest in emergence per leader yielding of associated insect species. Stand type 4 (naturally seeded, with no hardwood overstory) was slightly higher than type 3 in emergence of weevils and lower than stand type 3 in emergence of associated species per leader yielding. Stand types 4 and 5 would seem to parallel each other in growing conditions, although stand type 4, being naturally seeded, was more uneven-aged and would have been exposed to the insect populations of the parent natural stand.

Seasonal emergence of the various species. -- Collections of material at different dates throughout the season were made to roughly delineate insect emergence periods. Comparison of relative numbers of insects for successive collection dates should show the dates on which most of the insects were present in the leaders. To more accurately assess seasonal emergence, rearing containers were checked at 2-day intervals throughout the developmental period. These checks, however, did not begin until July 9, which was after the emergence of many of the earlier forms. Insects which overwintered in the larval stage were missed in the 1963 study, since the latest examination was made in December. Most of the individuals emerging during the summer, however, were recorded. Seasonal emergence of the more important species have been considered in the previous section.

Forty-two specimens of *Eurytoma pissodis*, which normally overwinters as a larva within the infested leaders, emerged in July and August in this study. Their emergence in the same season of development is interesting since the white pine weevil would probably not be a suitable host in mid summer. Only the white pine weevil and *Coeloides pissodis* are reported to be hosts of *E. pissodis* by Musebeck et al. (1951).

Analysis of success of attack. -- Attacks on leaders which produced no weevils are termed unsuccessful for the purposes of this study. Stands and stand types are compared against 4 different categories, which are percentages of leaders yielding (1) no insects, (2) no white pine weevils but yielding associated insects, (3) white pine weevils only, and (4) both weevils and associated insects (figures 2 and 3).

Stand type 1, which had the highest emergences of weevils per leaders yielding, had the lowest percentage of unsuccessful attack. Highest percentages of unsuccessful attack were from stand type 4 (naturally seeded, with no hardwood overstory). Stand type 3 (naturally seeded with a hardwood overstory) had the lowest average emergences of weevils per leader yielding, lowest percentages of leaders yielding weevils only, and the highest percentages of leaders yielding associated species only.

In figure 5, categories 1 and 2 could be combined to include unsuccessful attack since no weevils emerged within these categories. Categories 3 and 4 would therefore include successful attack, as shown on table 30. The descending order of stand types for percentages of leaders with unsuccessful attacks is 4, 3, 5, 2, 1 and for percentages with successful attack 1, 2, 3, 5, 4. Stand types 3 and 4 had about equal percentages of unsuccessful attack.

From the standpoint of natural control, the category of leaders yielding only associated species would be best. Next in preference would be the categories with no emergence and with emergence of both weevils and associated species. Emergence of weevils only without associated species would be the least desirable. Using this as a basis for assessing the favorability of stand types for the maintenance of weevil populations, stand type 3 appears to be least favorable to the weevil since (1) it yielded lowest numbers of weevils per leader yielding, (2) it had highest percentages of leaders yielding associated species only, and (3) it had lowest percentages of leaders yielding weevils.

The complexes of associated species involved in the specific cases might also be considered in evaluation. Complexes of known parasites and predatory species obviously are more meaningful than that of hyperparasites or forms of doubtful status. Also, actual numbers of all species must be considered in the evaluation.

Numerical comparisons of weevils and associated species where they occur together and where they occur exclusively is shown on table 13 and figure 2. Only in stand type 5 were there more weevils per leader yielding where weevils occurred alone than in combination with other species.

In cases where only weevils or only associated species emerge from a leader the advancing weevil larvae could have been killed by overheating, drowning in oleoresin or other causes. It seems apparent that continuation of weevil feeding is a factor in favor of the associated species. Where weevils emerged at the exclusion of associated species, the associated species may have been present and may have had their normal effects on the weevil larvae, but failed to emerge.

Weevil emergences per leader. -- Weevil emergences per leader are shown on table 14. Considering totals of all stands, leaders yielding 1 through 26 weevils per leader account for approximately one half of the total numbers of weevils. The highest numbers of weevils for any one category was 26 weevils, although the most frequent category was one weevil per leader. The higher weevil emergence per leader, though occurring more infrequently, accounts for a large share of the total emergence.

Ecological position within stands. -- Edge and inside positions were noted for several stands of types 1 and 2. Well-defined ecological positions were difficult to find in the other 3 stand types, where growth was scattered and the trees existed under similar conditions.

Average emergence per leader of all insects and for weevils alone was approximately twice as high for the inside as opposed to edge positions. For Lonchaea corticis, average emergences per leader were nearly equal in both positions. This may indicate that there is no oviposition preference by adults for humid locations, but that survival of larvae is the indicator of preference by this species. Since the leaders were kept in polyethylene bags in the laboratory the conditions after the time of collection was equal for both the edge and inside locations.

Many leaders were available in the inside positions, and although unintentionally, the leaders attacked heaviest and most successfully may have been selected in the collecting process. In the edge position, most of the material was collected, so that little selection was possible.

Longevity of adults on moist honey diet. -- An attempt was made to test longevity of the more commonly occurring insect species on a moist honey diet. Eight species were reared on this diet, and results are reported in table 22. It is believed that factors other than the honey diet were responsible for the relatively short average longevity figures. Specimens were found stuck to the honey in some instances, and it appeared that the material was not sufficiently restricted to a small area. Another factor was temperature, which probably reached levels too high for the insects inside the vials. In a separate study, an attempt was made to rear *Coeloides pissodis* adults on moist honey in large polyethylene bags, filled with air to allow for movement. Longevity of these adults was no greater than for those reared in vials.

Distribution of organisms at various horizontal positions in infested leaders. -- These studies were conducted to determine the activities of weevils and associated insects at various levels in the shoot and to obtain additional data on the biology and status of parasites and other species.

Table 23 shows data on mortality obtained by examination of the material after the developmental season. Difficulties were encountered in taking counts of dead larvae, especially in the 1-4 inch sections, because of pitch-soaking of the area and decay of dead larvae. Counts of dead larvae include deaths from all causes.

Examination of the data shows that the highest mortality of larvae occurred 8 to 12 inches down the leader. Highest mortality of fully developed adults which failed to emerge was found 16 to 20 inches down the leader. Only a few adult weevils emerged near the top of the leaders. In many of these cases, larvae had developed in the current year's elongating shoot and migrated down tothe previous year's growth where they burrowed for pupation.

In leader dissections, inadequate conditions of humidity were believed to be the most important reason for death of the immature forms. As was stated earlier, polyethylene provided a partial answer to this difficulty. Weevils which had developed to a certain degree required no more food to finish their development, and could be reared to the adult stage in polyethylene bags. These individuals were kept alive in the immature stage for weeks while they developed into adults.

Head capsule measurement in weevil larvae. -- Measurements of head capsules were made to determine the number of larval instars. However, individual larvae were not successfully reared through in this study. Therefore, measurements for each moulting stage could not be made. A total of 3274 measurements were made on weevil larva throughout the season. Figure 5 shows a summary of all measurements, both living and dead, which were taken during the leader dissections in 1965. Unfortunately, equal numbers of individuals could not be measured at each time interval throughout the season.

To correlate head capsule measurement with seasonal development of weevils and associated insects, only living forms in healthy condition were included. Table 27 includes only larvae which were developing in the field from the time of hatching until collection and dissection of the leader. The tables and the accompanying graphs on table 27 illustrate the progress of development of the healthy forms, including pupae, adults, larvae which had burrowed in the shoot, and larvae within 3 inches of the lowest point of feeding activity in the shoot.

The burrowing habit in weevil larvae was related to head capsule width although some larvae continued feeding after others with the same head capsule size had burrowed in the shoot for pupation. It was observed that some burrowing was done by last-instar larvae, since there was evidence of only one moult before pupation within the larval burrow.

H. CONCLUSIONS AND SUMMARY

1. The weevils, parasites, predators, and associated insects were studied by (1) large scale rearings in which 759 infested leaders were caged in polyethylene bags to obtain species, numbers, and time sequence of emergence, and (2) dissections of infested leaders to isolate parasitized hosts and to establish host-parasite relationships.
2. A total of 48 species of parasites, predators, and associated insects were reared from infested white pine leaders in Virginia. All but 15 were rarely-occurring species, recorded in numbers of 5 or less. Lonchaea corticis, a predatory fly, occurred in much higher numbers than any other associated species. The next 2 most abundant species were Bracon pini and Coeloides pissodis, respectively. In leader dissections additional information was obtained on several of the more common species. Eupelmus pini was reared from an Ichneumonid cocoon in one instance, indicating that it may be secondary as well as primary. Pseudeucoila sp. was a solitary pupal parasite of Lonchaea corticis.
3. Collections were made in 13 stands representing the following 5 stand types: (1) young open plantations, (2) older closed plantations, (3) naturally seeded white pines with a hardwood overstory, (4) naturally seeded white pines without a hardwood overstory, and (5) older open plantations. Emergence data on all insects were related to stand type.

Stand type 1 appeared to be the most favorable type for the development of weevil broods. Stand type 3 was considered to be the least favorable. Stand type 2 yielded the most associated species.

4. Seasonal emergences were shown for commonly-occurring species at 2-day intervals. *Bracon pini* appeared in highest percentages prior to July 9. *Coeloides pissodis*, *Rhopalicus pulchripennis*, *Eurytoma pissodis*, *Eupelmus pini*, *Pseudeucoila* sp., and *Pediobius* sp. emerged in highest percentages from July 10 to July 31. *Lonchaea corticis*, *Oscinella conicola*, and *O. hinkleyi* had highest percentages of emergence in August, as did the white pine weevil. *Enoclerus nigripes* occurred in largest numbers in September. Relative numbers of *Eurytoma pissodis*, the parasite considered to be most important by Taylor, were not obtained in the large-scale rearings, since they overwinter in a prepupal stage. However, 42 individuals emerged during the same summer that the weevil infestation occurred indicating that at least part of the population does not follow the usual over-wintering habit. All of the 37 specimens in suitable condition for sexing were females.

5. Success of attack was defined as attack which produced adult weevils. Lowest percentages of unsuccessful attack occurred in stand type 1, whereas highest percentages occurred in stand type 2.

6. Edge and inside positions were recognized for stand types 1 and 2. Higher emergence levels of weevils and associated species were found on leaders from the inside position than from the edge locations.

7. Adults of 8 species of associated insects were reared for longevity studies on a diet of moist honey. *Rhopalicus pulchripennis* had the highest longevity, averaging 13.28 days. The maximum longevity for any of the insects was 21 days for *Pseudeucoila* sp.

8. Occurrence of insects at various horizontal levels in the leaders was studied by rearing from cut 4-inch sections and by dissection. The largest emergence of associated species occurred at 8 to 12 inches from the base of the terminal bud. Greatest emergence of weevils occurred at 16 to 20 inches and the highest mortality of weevil forms occurred at 8 to 12 inches from the base of the terminal bud.

9. Head capsule measurements of weevil larvae were used in showing progressive weevil development through the season. By July 10, forty-four percent of the developing forms were pupae and adults. By July 20 and August 1, fifty-six and 90 percent, respectively, were pupae and adults. The burrowing habit in weevil larvae was observed in those with head capsule widths 0.95 mm and wider. Average head capsule width for burrowing forms was 1.30 mm, although the most commonly-occurring measurement was 1.26 mm.

Figure 1. Locations of stands used in periodic collections in Virginia in 1963

Legend

Number	Locality
1	Camp
2	Speedwell
3	Hillsville
4	Radford
5	Snowville
6	Willis
7	Prices Fork
8	Blacksburg
9	Floyd
10	Catawba
11	Deerfield
12	Rawley Springs
13	Massanetta

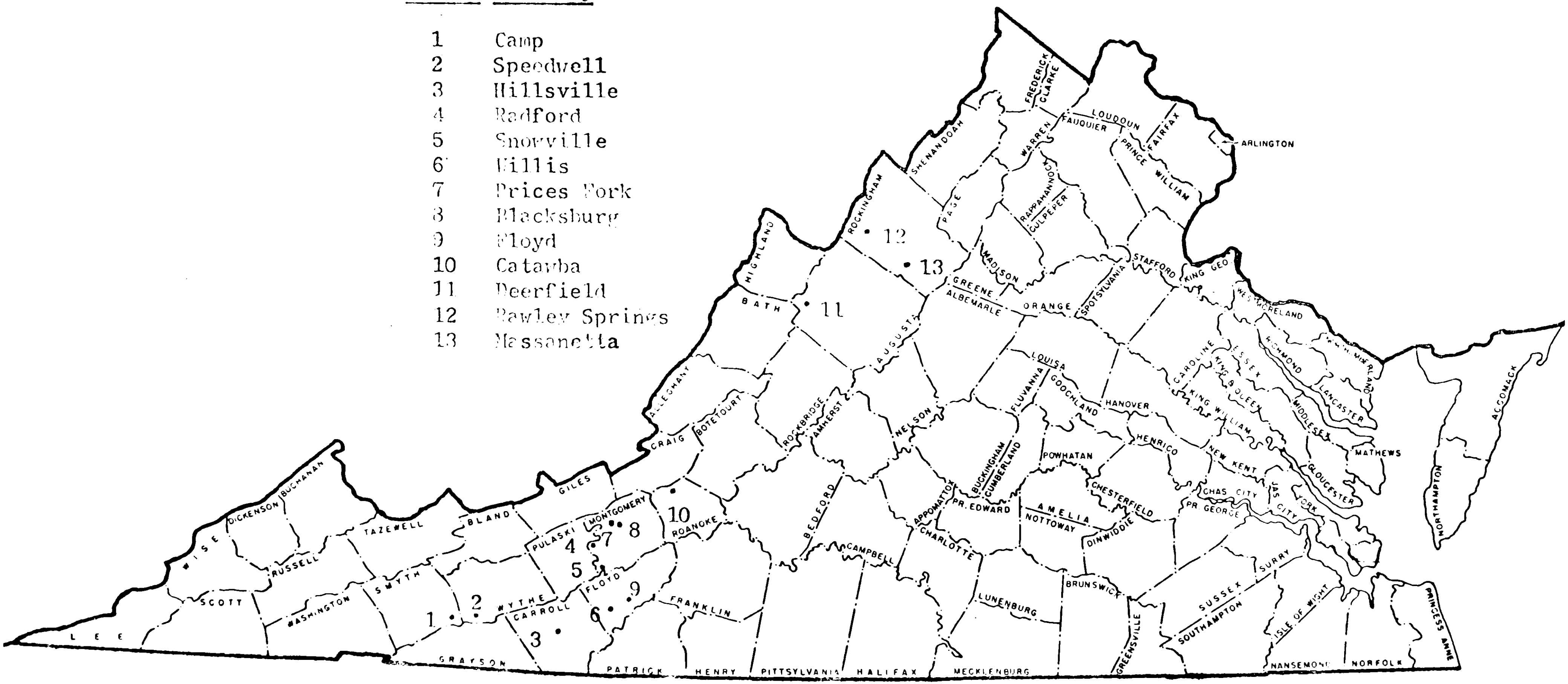
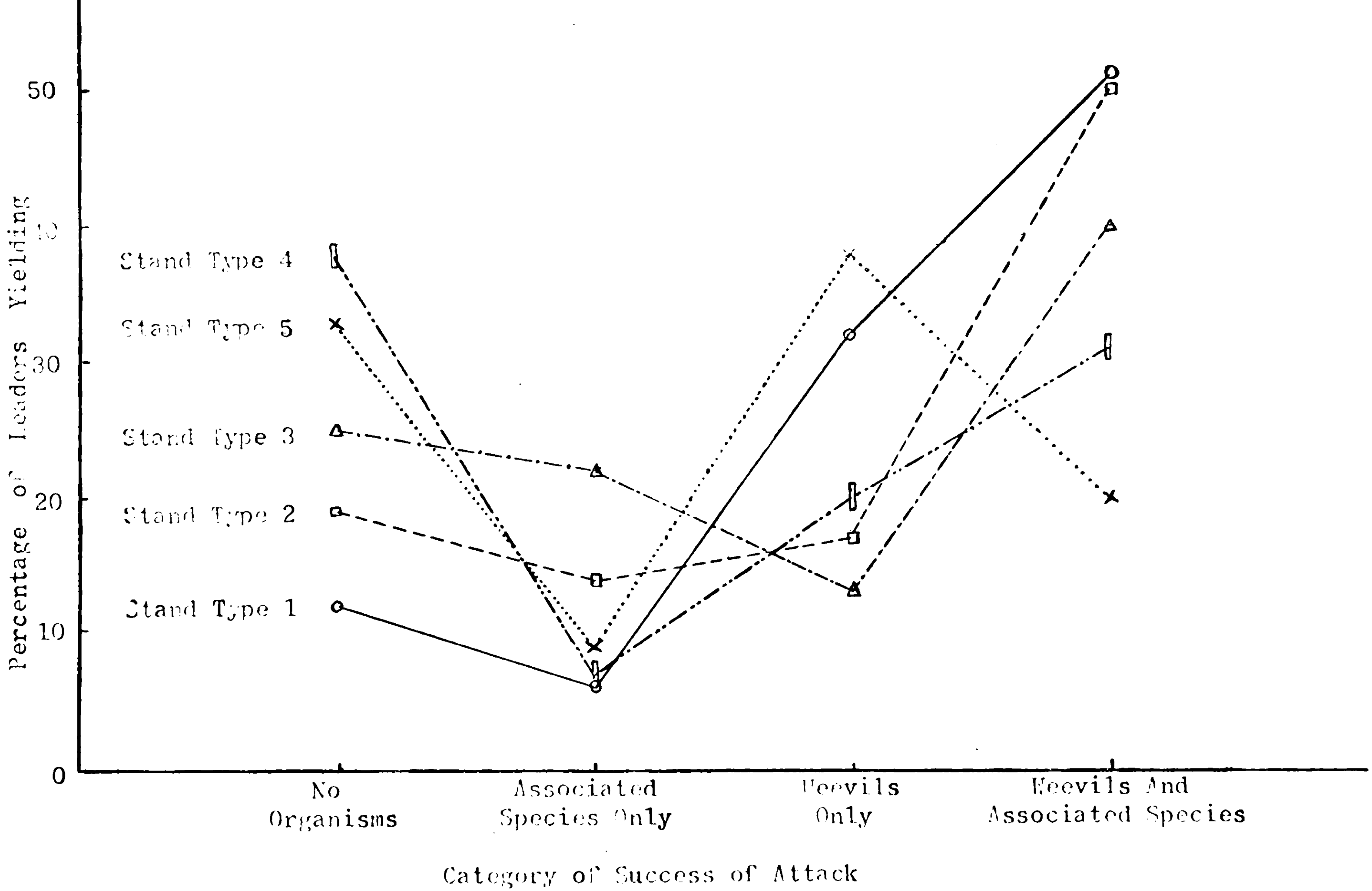


Figure 2. Percentages of leaders yielding the 4 emergence categories according to stand type



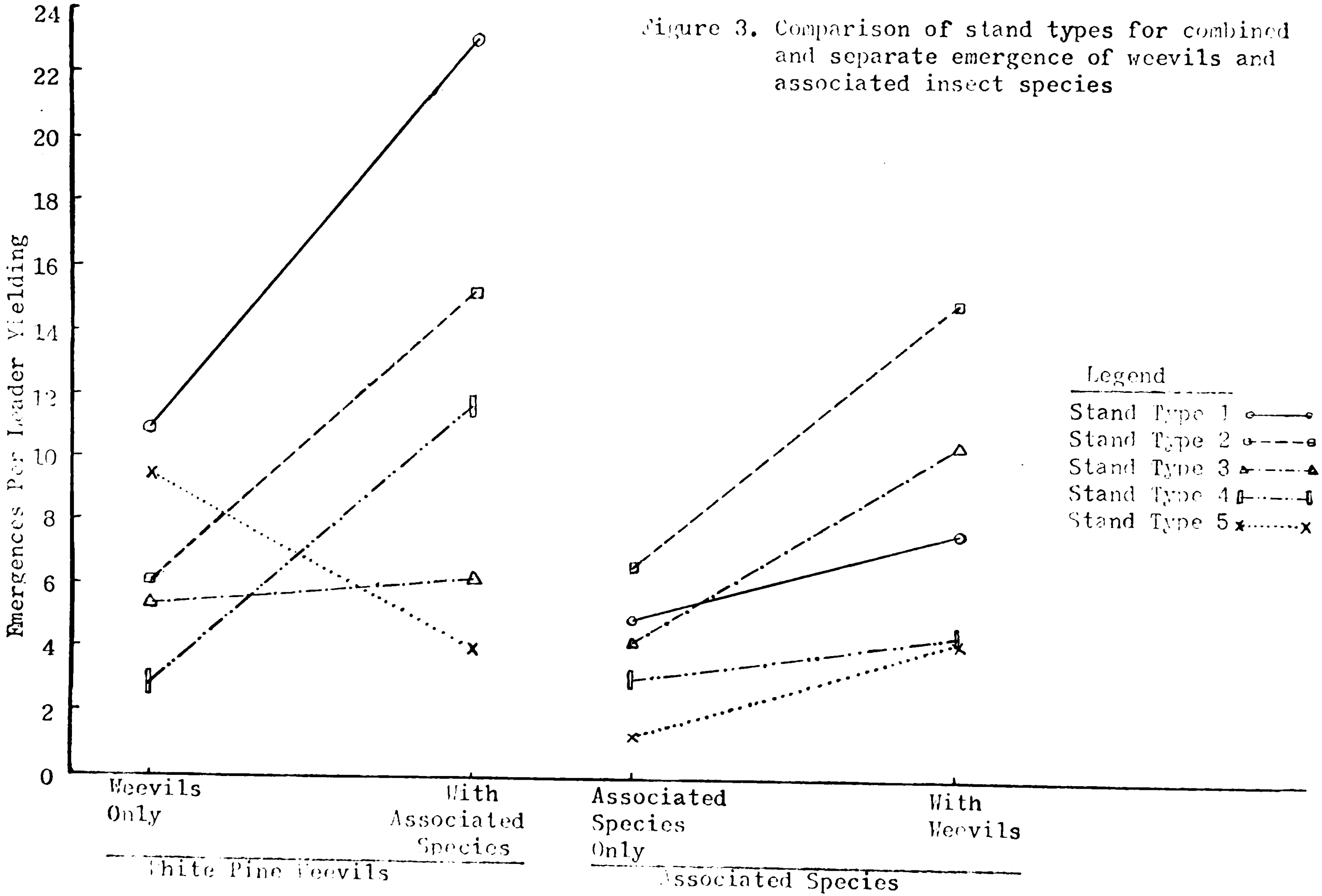
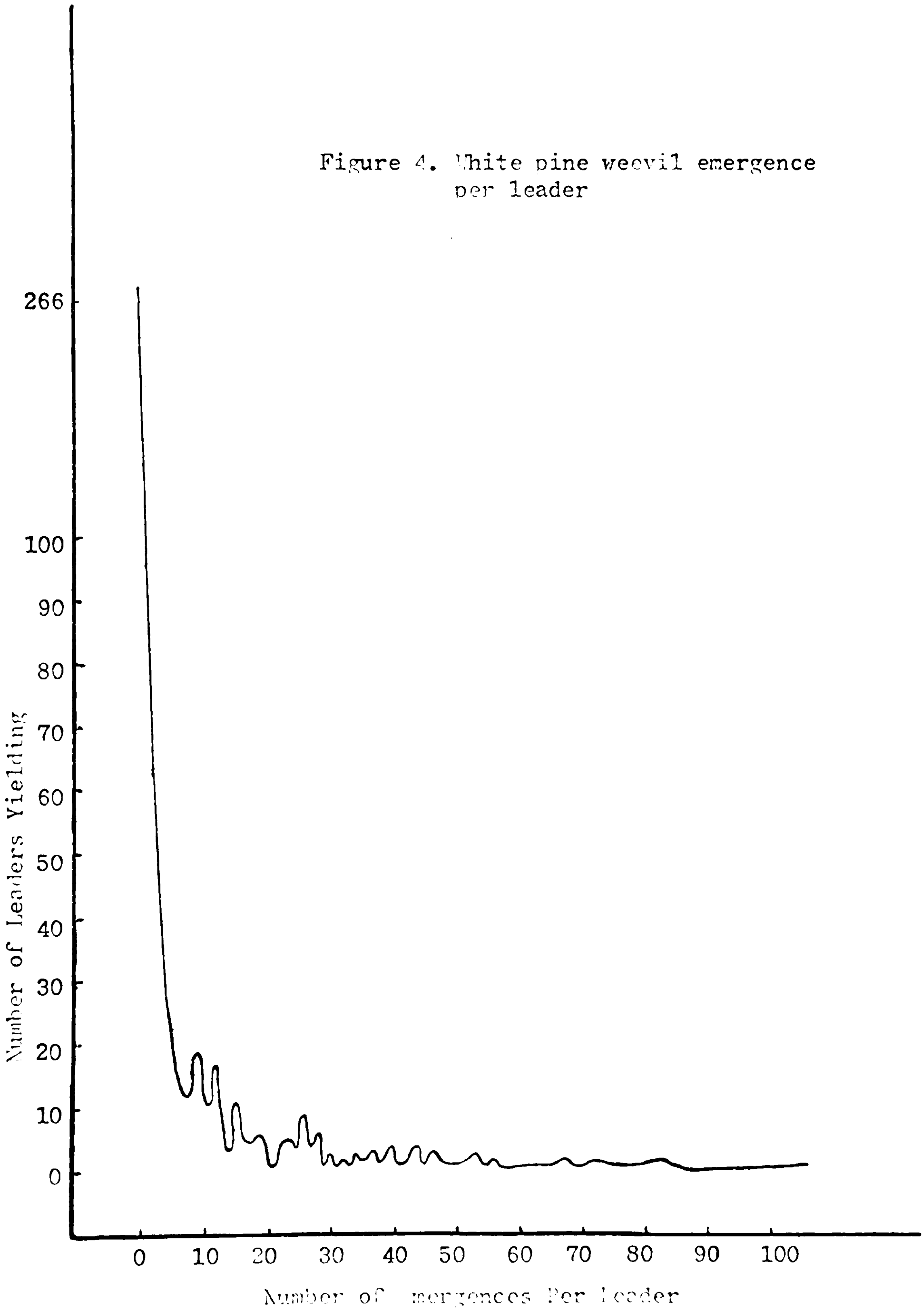


Figure 3. Comparison of stand types for combined and separate emergence of weevils and associated insect species

Figure 4. White pine weevil emergence per leader



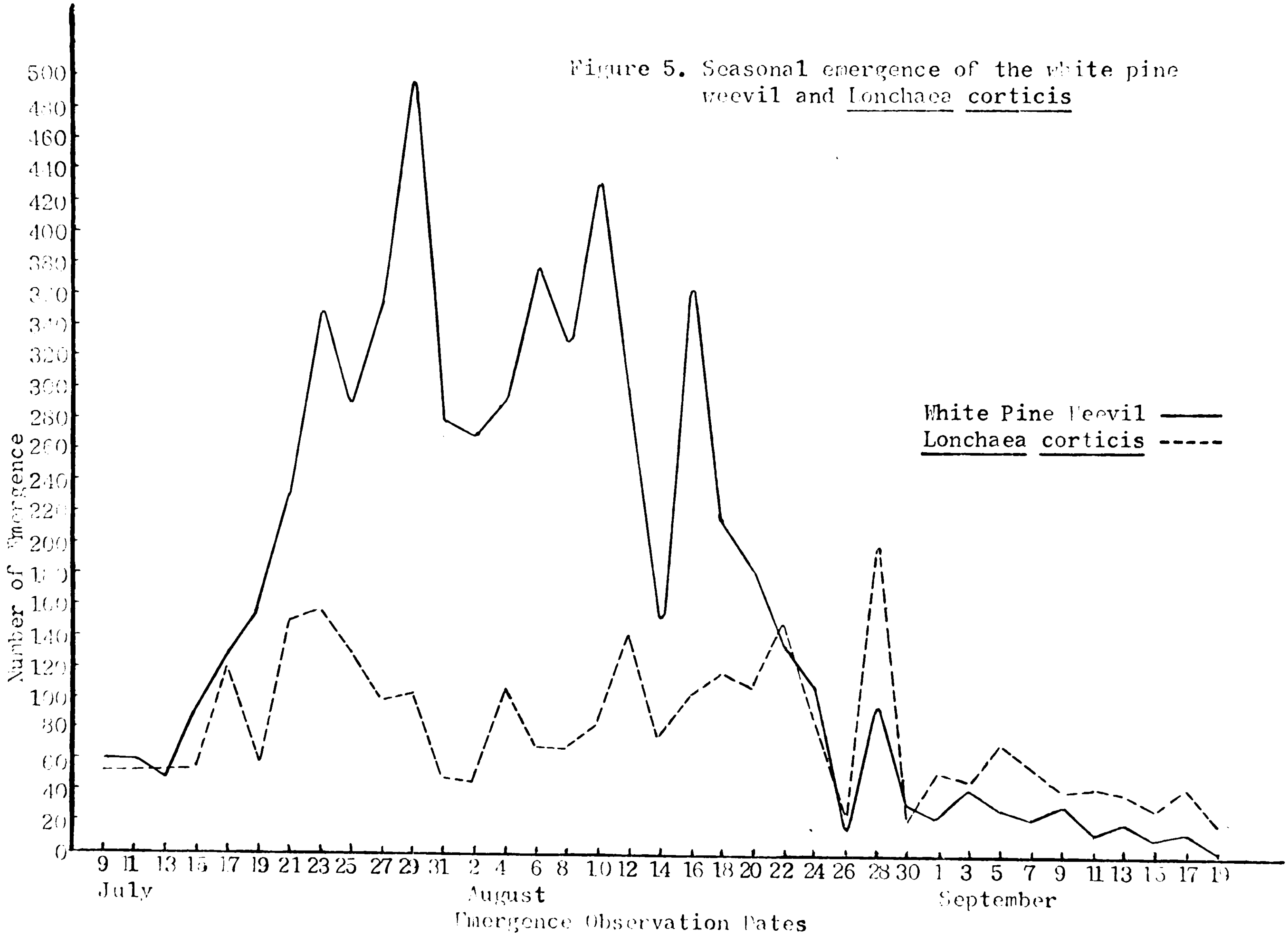


Figure 5. Seasonal emergence of the white pine weevil and Lonchaea corticis

Figure 6. Head capsule measurements of all white pine weevil larvae encountered in leader dissections in 1965

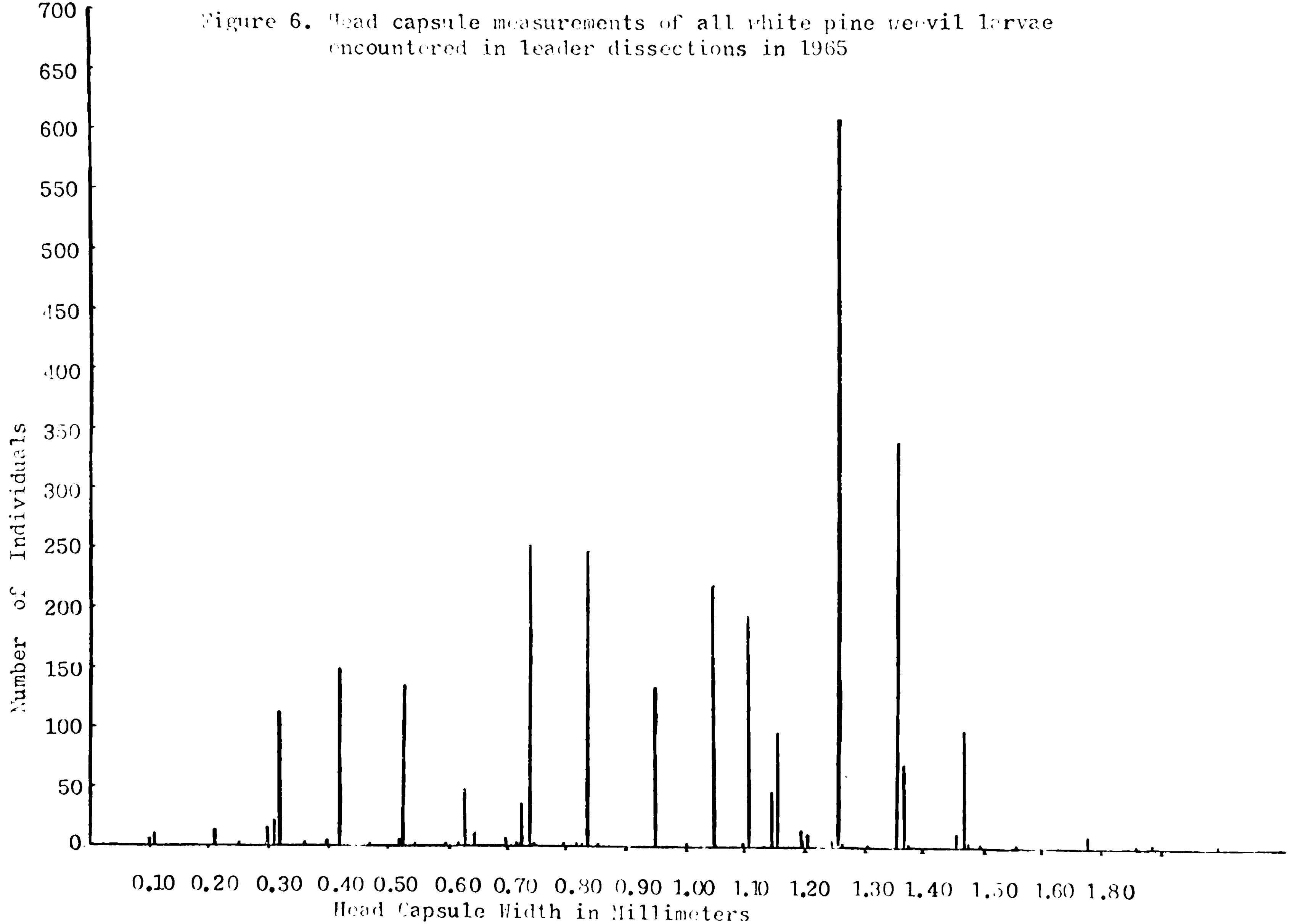


Table 1. Arthropods, birds, and mammals reported in the literature as enemies of the white pine weevil

Classification	Status[1/]	Classification Reference[2/]	Authority	Location
Insect parasites, predators and associated species.				
Insecta				
Hymenoptera				
Bethylidae				
<u>Scleroderma</u> <u>immigrans</u> (foreign sp.)	para	M	Taylor 1929a&b	NS
<u>Scleroderma</u> <u>macrogaster</u> (Ashm.)	para	M	Taylor 1929a&b	NS
Braconidae				
<u>Agathis</u> <u>annulipes</u> (Cress.)				
<u>Syn</u>.				
<u>Bassus</u> <u>annulipes</u> (Cress.)	assoc.-Lep.host	RS	Taylor 1929a&b[3/]	Pa
<u>Aphaereta</u> sp.	assoc.-Dipt.host	RS	Taylor 1929a&b	NY
<u>Bracon</u> <u>nanus</u> (Prov.)				
<u>Syn</u>.				
<u>Microbracon</u> <u>nanus</u> Prov.	NS (Natural checks)	M	Mott 1930	Conn
	para	M	Plummer & Pillsbury 1929	NS
	Assoc.	M	Taylor 1929a&b	Conn
	para	M	Barnes 1928a	NY
	para	M	Peirson 1922	NS
	para	M	Britton 1920	Conn

1/ para= parasitic; pred=predatory; assoc=associated species; unknown=status unknown; hyper= hyperparasitic; ext.=external; int.=internal; sol.=solitary; greg.=gregarious; NS = not stated

2/ RS= reared in the respective study; O=observed by the author; M=merely mentioned by the author

3/ These references are combined because they represent one paper, which appears in 2 parts

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Bracon pini (Mues.)					
Syn.					
Microbracon pini Mues.	para	M	Sullivan	1961a	NS
	para, ext	RS	MacAloney	1932	Pa, NY, Conn, Me, Mass.
	para, ext	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA, NH, NY, Mass
	para	RS	Taylor	1930	New Engld, Ohio, Mich
	para	RS	Plummer & Pillsbury	1929	NH
	para, ext, greg.	RS	Taylor	1929a&B	Vt, Mich, NH, NY, Pa, Conn, Mass, Me
	para, ext., greg, L	RS	Barnes	1928a	NY
	para, larval	RS	Barnes	1928b	NY
	para	M	Leonard	1928	NE USA
Bracon					
Syn.					
Microbracon	para	M	Mott	1930	Mass
	para, larval	RS	Barnes	1928a	NY
	para	RS	Peirson	1922	Mass
Coeloides pissodis (Ashm.)	para, int	RS	MacAloney	1932	Pa, NY, Conn, Mass, Me
	para, int	M	MacAloney	1930	NH
	para	M	Mott	1930	NY, Mass, Conn, NJ, NH, W.Va., Ohio, NE USA

Table 1. -- (continued)

Classification	Status[1]	Classification[2] Reference	Authority		Location
	para	RS	Plummer & Pillsbury	1929	NS
	para, sol, ext.	RS	Taylor	1929a&b	Pa, NH, Me, NY, RI, Mass
	para	RS	Barnes	1928a	NY
	para, larval	RS	Barnes	1928b	NY
	para	M	Leonard	1928	NS
Syn. *Microbracon pissodis* (Ashm.)	NS	M	Muesebeck	1925	NS
Syn. *Bracon pissodis* Ashm.	para	M	Peirson	1922	NS
	NS	M	Houser	1918	NS
	para	M	Smith	1910	NS
	para	M	Peirce	1907	Mass
	para	M	Felt	1906	Mass
	para	M	Felt	1903	W. Va.
	para	RS	Riley & Howard	1890	Mass
Syn. *Habrobraconidea bicoloripes* Vier. (Britton also mentions *C. pissodis*)	para	M	Britton	1920	Conn
Coeloides sp.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
Cyanopterus sp.	NS (Natural checks)	M	Mott	1930	Conn
	Assoc.	M	Taylor	1929a&b	Conn
	para	M	Barnes	1928a	NY
	Unknown	M	Britton	1920	Conn

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Doryctes sp.	para , int	RS	MacAloney	1932	Pa,NY,Conn,Mass, Me
	para, int	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
	para	M	Plummer & Pillsbury	1929	NS
	Assoc.[4/]	M	Taylor	1929a&b	Mass
Habrobracon bicoloripes Vier.[5/]	para	M	Barnes	1928a	NY
Meteorus vulgaris (Cress.)	Assoc. Host: some Noctuidae	M	Taylor	1929a&b	NS
	unknown	RS	Barnes	1928a	NY
Microtypus	Assoc.	M	Taylor	1929a&b	NY
Microtypus sp.	unknown	RS	Barnes	1928a	NY
Rogas aciculatus (Cress.)	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
	Assoc.	M	Taylor	1929a&b	Mass

4/ Taylor says the specimen so labelled was actually Coeloides pissodis

5/ This combination was not found in Meusebeck

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Spathius brachyurus Ashm.	para	M	Mott	1930	Ohio,Conn,NY,W Va
	para	M	Plummer & Pillsbury	1929	NS
	para	M	Taylor	1929a&b	W Va
	para	M	Barnes	1928a	NY
	para	M	Leonard	1928	NS
	para	M	Peirson	1922	NS
	para	M	Britton	1920	W Va
	NS	M	Graham	1918	NS
	para	M	Felt	1906	W Va
	para	M	Felt	1903	W Va
Spathius canadensis Ashm.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
	para. Host: Prob. scolytids	M	Taylor	1929a&b	NY, Mass
	para	RS	Barnes	1928a	NY
Spathius sp.	para	M	Mott	1930	Mass
	para, ext.	RS	Taylor	1929a&b	Mass
Ceraphronidae					
Megaspilus sp.	assoc.	M	MacAloney	1930	NH
	assoc.	M	Taylor	1929a&b	Conn
Chalcididae					
Brachymeris tarsata (D.T.)[6/]	assoc.	M	Taylor	1929a&b	NY
	unknown	RS	Barnes	1928a	NY

6/ This combination was not found in Muesebeck

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Colletidae					
Hylaeus sp.	assoc.	M	MacAloney	1930	NH
Cynipidae					
Eucoila sp.	para	M	Mott	1930	NH,Mass
	hyper. on Lonchaea	M	Plummer & Pillsbury	1929	NS
	hyper. host: L. corticis	RS	Taylor	1929a&b	NH,Mich,Vt,Me, Mass,NY,RI, Pa
	hyper., prob. host: L. corticis	RS	Barnes	1928a	NY
Diapriidae					
Prosynacra sp.	assoc.	M	MacAloney	1930	NH
	assoc.	M	Taylor	1929a&b	Mass
Encyrtidae					
Copidosoma bakeri bakeri (How.) Syn. Berecyntus bakeri How.	assoc.	M	Taylor	1929a&b	Mass
Copidosoma sp. Syn. Berencyntus sp.	hyper on Lepid	M	MacAloney	1930	NH
	hyper on Lepid	M	Mott	1930	NE USA
Eulophidae					
Elachertus pini Gah.	assoc. Hosts: Rhyacionia frustrana & Dioryctria n. sp.	RS	Taylor	1929a&b	Mich,Vt,Mass,Me
Elachertus	hyper on Dioryctria	RS	Barnes	1928a	NY

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Paracrias	para	M	Mott	1930	Mass
	para	M	Peirson	1922	Mass
Paracrias sp.	assoc.	M	Taylor	1929a&b	Mass
Pleurotropis sp.	hyper on Dipt	M	MacAloney	1930	NH
	hyper on L. corticis and Dipt	M	Mott	1930	NE USA, NY, NH, Mass
	hyper on L.corticis	RS	Plummer & Pillsbury	1929	NH
	hyper on L. corticis	RS	Taylor	1929a&b	Vt, Mass,Me,NY,RI, Pa,Conn,NH,Mich
	hyper on Lonchaea pupae	RS	Barnes	1928a	NY
	hyper on L. corticis	RS	Barnes	1928b	NY
Eupelmidae					
Eupelmus cyaniceps amicus Gir.	para, larval	RS	Barnes	1928a	NY
Eupelmus pini Say.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	Mass,NE USA, NY, NH
	para	M	Plummer & Pillsbury	1929	NS
	para, ext, sol	RS	Taylor	1929a&b	NY,Mass
	para, larval	RS	Barnes	1928b	NY
Eupelmus sp.	assoc., Host NS	RS	Taylor	1929a&b	Mass
Ptinobius sp.	assoc., Host Coleopt	RS	Taylor	1929a&b	Mass

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Eurytomidae					
Eurytoma	para	M	Mott	1930	Mass
	para	RS	Peirson	1922	Mass
Eurytoma cleri Ashm.	para	M	Mott	1930	W Va
Eurytoma cleri Ashm.	assoc.	M	Taylor	1929a&b	W Va
	para	RS	Hopkins	1899	W Va
Eurytoma pissodis Gir.	para	M	Sullivan	1961a	NS
	para, ext	RS	MacAloney	1932	Pa,NY,Conn, Me, Mass
	para, ext	M	MacAloney	1930	NH
	para, ext	M	Mott	1930	Conn, Mass,NY, NH,NE USA
	para	RS	Taylor	1930	New Engld, O,Mich
	para	RS	Plummer &	1929	NH
	para, ext, sol	RS	Taylor	1929a&b	Vt,O,NH,Mich,NY, Me,RI,Pa,Conn
	para, sol, larval & pupal	RS	Barnes	1928a	NY
	para, larval	RS	Barnes	1928b	NY
	para, ext	RS	Graham	1926	NY,Lake States
	para, ext	M	MacAloney	1926	NS
	para	M	Peirson	1922	NS
	para	M	Britton	1920	Conn
	para	M	Graham	1918	NS
Eurytoma sp.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA, Ohio
	associ, host NS	RS	Taylor	1929a&b	Mass
	para	RS	Houser	1918	NS

Table 1. -- (continued)

Classification	Status 1/	Classification Reference 2/	Authority		Location
Eurytoma tomici Ashm.	para of Tomicus	M	Taylor	1929a&b	NY
	para	RS	Barnes	1928a	NY
Eurytoma tylodermatis Ashm.	para of Eureulionids & Araeocerus	M	Taylor	1929a&b	NY
	para	RS	Barnes	1928a	NY
Formicidae					
Pheidole sp.	pred	M	MacAloney	1930	NH
	pred	M	Mott	1930	NE USA
Ichneumonidae					
Calliephialtes comstockii (Cress.)					
Syn.					
Ephialtes comstockii Cress.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	Ohio,NY, NH, NJ,NE USA
	para. Host:Lepid	RS	Plummer & Pillsbury	1929	NH
	para.Host:Lepid larvae on conifers	M	Taylor	1929a&b	NH,NY, Mass, Conn, Ohio
	para, larval	RS	Barnes	1928a	NY
	para, larval	RS	Barnes	1928b	NY
	para	RS	Houser	1918	NS
Calliephialtes nubilipennis (Vier.)	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA, Mass
	para, ext, sol	RS	Taylor	1929a&b	Me, Pa, Mich, Mass

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Cubocephalus annulatus (Cress.)					
Syn.					
Phygadeuon nitidulus Prov.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
	assoc	M	Taylor	1929a&b	Mass
Cubocephalus erythropus velox (Cress.)					
Syn.					
Chaeretymma velox (Cress.)[7/]	assoc. Host: sawfly?	RS	Taylor	1929a&b	Mass
Delomerista sp.	assoc. Host: prob. sawfly	RS	Taylor	1929a&b	Mass
Dicaelotus sp.	assoc. Host: prob. Lepid pupae	RS	Taylor	1929a&b	Mass
Hemiteles humeralis Prov.	para	M	Mott	1930	Mass
	hyper	RS	Taylor	1929a&b	Mass
Horogenes solenobiae (Ashm.)					
Syn.					
Limneria solenobiae Ashm.	assoc. Host: Solenobia	RS	Taylor	1929a&b	Mass

7/ This combination was not found in Muesebeck et al. (1951)

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Labena grallator (Say)					
Syn.					
Labena apicalis Cress.	assoc. Hosts: cerambycids & a eureulionid	M	Taylor	1929a&b	Pa
	para	RS	Barnes	1928a	NY
	para, larval	RS	Barnes	1928b	NY
	para	M	Mott	1930	NY
Mastrus hydrophilus (Ashm.)					
Syn.					
Hemiteles hydrophilus Ashm.	NS	M	Mott	1930	NH
	para	RS	Plummer & Pillsbury	1929	NH
	assoc. Prob Hyper	RS	Taylor	1929a&b	Mass, NH
Mesoleius sp.	assoc. Host: a sawfly	RS	Taylor	1929a&b	Mass
Orthocentrini	assoc. Host NS	RS	Taylor	1929a&b	Mass
Poemenia americana (Cress.)	assoc. Host: Prob. cerambycids	RS	Taylor	1929a&b	Mass
Rhorus varifrons (Cress.)					
Syn.					
Monoblastus varifrons (Cress.)	assoc. Host: sawfly	RS	Taylor	1929a&b	Maine, Mass
Scambus					
Syn.					
Epiurus	para	M	Mott	1930	Mass
	para	RS	Peirson	1922	Mass

Table 1. -- (continued)

Classification	Status[1/]	Classification[2/] Reference	Authority		Location
Scambus sp.					
Syn.					
Epiurus sp.	assoc.	M	Taylor	1929a&b	Mass
Schenkia	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
Schenkia sp.	assoc.	M	Taylor	1929a&b	Mass
Stenomacrus undulatus (Davis)					
Syn.					
Deleter undulatus Davis	hyper on Dipt	M	MacAloney	1930	NH
	hyper on Dipt	M	Mott	1930	NE USA
Syrphoctonus sp.					
Syn.					
Homoporus sp.	hyper on Dipt	M	MacAloney	1930	NH
	hyper on Dipt	M	Mott	1930	NE USA
	assoc. Host: Dipt?	M	Taylor	1929a&b	Conn
Pteromalidae					
Cecidostiba sp.	assoc. Host NS	RS	Taylor	1929a&b	Mass
Coelopisthia suborbicularis (Prov.)	NS	M	Mott	1930	NH
	para	RS	Plummer & Pillsbury	1929	NH
	assoc.	M	Taylor	1929a&b	NH
Habrocytus sp.	assoc. Host NS	RS	Taylor	1929a&b	Maine, Mass, Vt
	unknown	RS	Barnes	1928a	NY

Table 1. -- (continued)

Classification	Status[1/]	Classification[2/] Reference	Authority		Location
Heydenia unica Cook & Davis	para	M	Mott	1930	W Va
	para, prob of P. strobi	M	Taylor	1929a&b	W Va
	para, pupal	RS	Hopkins	1899	W Va
Norbanus sp.					
Syn.					
Arthrolysis sp.	assoc.	M	Taylor	1929a&b	NY
	unknown	RS	Barnes	1928a	NY
Rhopalicus pulchripennis (Cwfd.)	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA, Mass, NY, NH
	para	RS	Plummer & Pillsbury	1929	NH
	para, ext, sometimes greg	RS	Taylor	1929a&b	NY, Mass, Mich.
	para, larval	RS	Barnes	1928a	NY
	para, larval	RS	Barnes	1928b	NY
Rhopalicus tutela (Walker)					
Syn.					
Rhopalicus suspensus (Ratz.)	NS (Natural checks)	M	Mott	1930	NH, Conn
	para	RS	Plummer & Pillsbury	1929	NH
	assoc	M	Taylor	1929a&b	Conn, NH
	para	M	Barnes	1928a	NY
	para	M	Britton	1920	Conn

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Pyralididae					
Dioryctria sp.	pred	RS	Taylor	1929a&b	Mass, NH
Tenthredinidae					
Hemitaxonus dubitatus (Nort.)	assoc	M	MacAloney	1930	NH
Diptera					
Lonchaeidae					
Lonchaea sp.	facultative pred.	RS	Barnes	1928a	NY
Lonchaea corticis Taylor	para	M	Sullivan	1961a	NS
	NS - external	RS	MacAloney	1932	Pa, NY, Conn, Maine, Mass
	para, ext	M	MacAloney	1930	NH
	para, ext	RS	Taylor	1930	New England
	pred	M	Mott	1930	NY
	para	RS	Taylor	1929	New England
	pred	RS	Plummer & Pillsbury	1929	NH
	pred	RS	Barnes	1928b	NY
Syn.					
Lonchaea rufitarsus Macq.	NS ext	RS	MacAloney	1932	Pa,NY,Conn, Maine, Mass.
	pred	RS	Plummer & Pillsbury	1929	NH
	pred	M	Mott	1930	NY
	pred (facultative)	RS	Barnes	1928a	NY
	pred	RS	Graham	1926	NS
	para	M	Graham	1918	NS

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Lonchaea laticornis Mg.	NS	RS	MacAloney	1932	Pa,NY, Conn,Maine, Mass
	pred	RS	Plummer & Pillsbury	1929	NH
	facultative pred.	RS	Barnes	1928a	NY
	pred ext.	M	MacAloney	1926	NS
Lonchaea polita Say	pred	RS	Plummer & Pillsbury	1929	NH
Ceratopogonidae					
Forcipomyia specularis Coq.	assoc	M	MacAloney	1930	NH
Chloropidae					
Gaurax apicallis Mall.	para	M	MacAloney	1930	NH
	para	M	Mott	1936	NE USA
Hippelates sp.	assoc	M	MacAloney	1930	NH
Oscinella cocendix Fitch.	assoc	M	MacAloney	1930	NH
Crosophilidae					
Chymomyza amoena Liv.	assoc	M	MacAloney	1930	NH
Scaptomyza graminum Fall.	assoc	M	MacAloney	1930	NH
Empididae					
Tachydromia sp.	assoc	M	MacAloney	1930	NH
Milichiidae					
Madiza glabra Fall.	assoc	M	MacAloney	1930	NH
Muscidae					
Muscina stabulans Fall.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
Phoridae					
Aphiochaeta sp.	assoc	M	MacAloney	1930	NH

Table 1. -- (continued)

Classification	Status[1]	Classification Reference[2]	Authority	Date	Location
Sphaeroceridae					
<u>Leptocera</u> sp.	assoc	M	MacAloney	1930	NH
Tachinidae					
<u>Compsilura</u> <u>conncinnata</u> Meig.	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NH
	para(evidently)	M	Webber & Schaffner	1926	NH
Coleoptera					
Cleridae					
<u>Monophylla</u> <u>terminatus</u> Say	pred	M	MacAloney	1932	NS
	pred	M	Mott	1930	NY
<u>Syn</u>.					
<u>Elasmoserus</u> <u>terminatus</u> Say	pred	M	MacAloney	1930	NH
	preds	M	Mott	1930	NE USA
	pred	M	Plummer & Pillsbury	1929	NS
	pred	RS	Graham	1926	NS
<u>Enoclerus</u> sp.	pred	M	MacAloney	1930	NH
	pred	M	Mott	1930	NE USA
<u>Hydnocera</u> <u>unifasciata</u> Say	pred	RS	MacAloney	1930	NH
	pred	M	Mott	1930	NE USA
<u>Hydnocera</u> <u>verticalis</u> Say	pred	M	Mott	1930	NE USA
	pred	RS	LTaylor	1929	New England
<u>Phyllobaenus</u> <u>dislocatus</u> (Say)	pred	M	Mott	1930	New England
	pred	RS	Taylor	1929	New England
<u>Placopterus</u> <u>thoracicus</u> Oliv.	pred	M	Mott	1930	New England
	pred	RS	Taylor	1929	New England

Table 1. -- (continued)

Classification	Status[1]	Classification Reference[2]	Authority		Location
Thanasimus dubius Fabr.	pred	O	MacAloney	1930	New England
	pred	M	Mott	1930	NE USA
	pred	M	MacAloney	1930	NH
	pred	RS	Taylor	1929	New England
Lepidoptera					
Gelechiidae					
Eucordylea atrupictella Dietz.	assoc	M	MacAloney	1930	NH
Pyralidae					
Undetermined pyralid	para	M	MacAloney	1930	NH
	para	M	Mott	1930	NE USA
Dioryctria sp.	para	RS	Taylor	1929	New England
	pred	RS	Barnes	1928a	NY
Dioryctria abietella D and S.	Assoc	M	MacAloney	1930	NH
Pinipestis zimmermanni Grate	assoc	M	MacAloney	1930	NH
Arachnida					
Acarina					
Pediculoididae					
Pediculoides ventricosus Newport predatory on Eurytoma pissodis		RS	Taylor	1927a	NS

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority		Location
Natural enemies other than arthropods					
BIRDS					
Bluebird			MacAloney	1932	
Siala sialis L.			McAtee	1926	
Chewink			Graham	1926	
Chickadee			Sullivan	1961a	
			MacAloney	1932	
			MacAloney	1930	
			Taylor	1929a&b	
			Graham	1926	
			Graham	1918	
Parus atricapillus L.			Forbush	1907	
Penthestes atricapillus			McAtee	1926	
Chicken			MacAloney	1932	
			MacAloney	1930	
			Graham	1926	
Cuckoo- yellow-billed			MacAloney	1932	
			McAtee	1926	
Grosbeak, rose-breasted			MacAloney	1932	
			MacAloney	1930	
Grouse, ruffed			Graham	1926	
			Graham	1918	

Table 1. -- (continued)

Classification	Status[1/]	Classification Reference[2/]	Authority	Location
Nuthatch			Sullivan 1961a	
			MacAloney 1932	
			MacAloney 1930	
			Taylor 1929a&b	
			Graham 1926	
Sitta carolinensis			Plummer & Pillsbury 1929	
Quail			Graham 1926	
Sparrow				
English			MacAloney 1932	
			McAtee 1926	
Chipping			Graham 1926	
Thrasher			Graham 1926	
Towhee			MacAloney 1930	
			Graham 1918	
Turkey			Graham 1926	
Warbler			MacAloney 1932	
			MacAloney 1930	
Woodpecker			Sullivan 1961a	
			MacAloney 1930	
			Taylor 1929a&b	
			McAtee 1926	
			Peirson 1922	
			Britton 1920	
			Hopkins 1907	
Downy			MacAloney 1932	
			MacAloney 1930	
			Graham 1926	
Dryobatus pubescens medianus			Forbush 1907	

Table 1. -- (continued)

Classification	Status[1/]	Class-ification[2/] Reference	Authority		Location
MAMMALS					
Mole			Taylor	1930	
Mouse, field			MacAloney	1932	
			MacAloney	1930	
Peromyscus					
Mouse, wood			MacAloney	1932	
			MacAloney	1930	
			Taylor	1930	
			Taylor	1929a&b	
Blarina					
Shrew			MacAloney	1932	
			MacAloney	1930	
			Taylor	1930	
			Taylor	1929a&b	
Short-tailed			Grayam	1926	

Table 2. Type, description and location of stands used in collections of infested material

Stand Type	Description	Location in Virginia
1	Young open plantations	Radford, Snowville, Willis
2	Older closed plantations	Catawba, Camp, Hillsville
3	Naturally seeded with hardwood overstory	Deerfield area 2, Rawley Springs, Speedwell
4	Naturally seeded, no hardwood overstory	Deerfield 1, Floyd
5	Plantations of large trees, without stand closure	Massanetta, Prices Fork

Table 3. Leaders collected and caged for study in 1963

Leaders Taken Directly to Laboratory		Leaders Caged in Field	
Dates Collected (approximately)	Number of Leaders	Date Caged (approximately)	Number
May 6	9	May 15	15
June 1	23	June 1	36
June 10	88	June 10	26
June 20	74	July 20	25
July 1	288	July 1	6
July 10	169		
Total	651		108
Total Leaders 759			

Table 4. Insect species reared from infested white pine leaders in 1963-1964

Scientific Name	Numbers in 1963 Study	Observations[1/] on Status
Hymenoptera		
Braconidae		
1a. Bracon pini (Muesebeck)	266	External, gregarious, Larval parasites of the white pine weevil
1b. Bracon sp. (1964 only)		
2. Coeloides pissodis (Ashmead)	163	External, solitary, Larval parasites of the white pine weevil
3. Apanteles aristoteliae Viereck	7	
Pteromalidae		
1. Rhopalicus pulchripennis (Crawford)	93	
2. Habrocytus sp.	1	
3. Lampoterma sp.	2	
4. Cheiropachus sp.	1	
Cynipidae		
1. Pseudeucoila sp.	64	Hyperparasite on Lonchaea corticis. Solitary pupal
Eupelmidae		
1. Eupelmus pini Taylor	41	
Eurytomidae		
1a. Eurytoma pissodis Girault	42	External, solitary, Larval parasites of the white pine weevil
1b. Eurytoma crassineura (1964 only)		
2. Eurytoma sp.	6	

1/Status of parasites as given in the literature is included in table 1. Due to delay in identifications. Few of the observations done in this study can be presented here.

Table 4. -- (continued)

Scientific Name	Number in 1963 Study	Observations on Status
Torymidae		
1. Monodontomerus aereus Walker	17	
Eulophidae		
1. Pediobius sp.	21	
Ichneumonidae		
1. Exeristes comstockii (Cresson)	6	
2. Itoplectis conquisitor (Say)	1	
3. Phaeogenini	1	
4. Mesochorus sp.	1	
5. Labena grallator grallator (Say)	1	
6. Cremastus sp.	2	
7. Gèlis sp.	1	
Leucopsidae		
1. [illegible] sp.	2	
Tenthredinidae		
1. Leptocera sp.	1	
Cleptidae		
1. Cephalonomia sp.	1	
Chalcididae		
1. Spilochalcis igneoides (Kirby)	2	

Table 4. -- (continued)

Scientific Name	Number in 1963 Study	Observations on Status
Diapriidae		
1. <u>Psilus</u> sp.	1	
<u>Diptera</u>		
Lonchaeidae		
1. <u>Lonchaea</u> <u>corticis</u> Taylor	3031	Predatory on weevil larvae and other organisms under bark
Chloropidae		
1a. <u>Oscinella</u> <u>conicola</u> (Greene)	93	
1b. <u>Oscinella hinkleyi</u> (Mall.)	61	
1c. <u>Oscinella</u> sp.	1	
2. <u>Connioscinella</u> sp.	1	
Hyperscelidinae		
1a. <u>Scatopse</u> <u>fuscipes</u> Mg.	1	
1b. <u>Scatopse</u> sp.	1	
<u>Coleoptera</u>		
Cleridae		
1a. <u>Enoclerus</u> <u>nigripes</u> Say	10	
1b. <u>Enoclerus</u> <u>nigrifrons</u> Say (reared from an incidental leader)		

Table 4. -- (continued)

Scientific Name	Number in 1963 Study	Observations on Status
Ptinidae		
1a. Catorama sp. (no record of numbers)		
1b. Ernobius sp. (no record of numbers)		
Cerambycidae		
1. Eupogonius tomentosus Hald. (no record of numbers)		
Nitidulidae		
1. Colopterus truncatus (no record of numbers)		
Hemiptera		
Miridae		
1. Sericophanes heidimanni Poppius	1	

Table 5. Emergences of white pine weevils from infested leaders according to stand type

Stand Type	Description	Number of Leaders Collected	Individuals Emerged		Percent of Leaders Yielding	
			No.	Ave. for Leaders Yielding	No.	Total
1	Young, open plantations without crown closure	162	2461	18.36	134	82%
2	Older plantations (15-20 ft.) with crowns closed	276	2373	13.04	182	66%
3	Naturally seeded stands, growing in a shaded condition, with hardwood overstory	154	486	6.00	81	52%
4	Naturally seeded stands, with no hardwood overstory	101	434	7.75	56	55%
5	Plantations of larger trees (15-20 ft.) without crown closure	66	292	7.68	38	57%
	Total	759	6046	12.31	491	65%

Table 6. Emergences of associated organisms from infested leaders according to stand type.

Stand Type	Description	Number of Leaders Collected	*Lonchaea corticis*: Individuals Emerged No.	*Lonchaea corticis*: Individuals Emerged Ave. for Leaders Yielding	*Lonchaea corticis*: Leaders Yielding No.	*Lonchaea corticis*: Leaders Yielding Percent of Total	All other associated organisms: Individuals Emerged No.	All other associated organisms: Individuals Emerged Ave. for Leaders Yielding	All other associated organisms: Leaders Yielding No.	All other associated organisms: Leaders Yielding Percent of Total
1	Young, open plantations without crown closure	162	430	9.15	47	29%	267	3.87	69	42%
2	Older plantations (15-20 ft.) with crowns closed	276	1779	16.32	109	39%	481	3.36	143	52%
3	Naturally seeded stands, growing in a shaded condition, with hardwood overstory	154	696	9.80	71	46%	93	1.98	47	30%
4	Naturally seeded stands, with no hardwood overstory	101	125	4.31	29	29%	39	2.05	19	19%
5	Plantations of larger trees (15-20 ft.) without crown closure	66	1	1.00	1	1%	64	3.37	19	29%
	Totals	759	3031	11.79	257	34%	944	3.18	297	39%

Table 7. Total emergence of weevils and associated insects according to stand type

Stand Type	Total emergences, excluding *Pissodes strobi* — Individuals Emerged: Total Number	Individuals Emerged: Average for Leaders Yielding	Leaders Yielding: Total Number	Leaders Yielding: Percent of Total	Total emergences, including *Pissodes strobi* — Individuals Emerged: Total Number	Individuals Emerged: Average for Leaders Yielding	Leaders Yielding: Total Number	Leaders Yielding: Percent of Total
1	697	7.49	93	57%	3158	22.08	143	88%
2	2260	12.99	174	64%	4633	20.50	226	82%
3	789	8.05	98	59%	1275	10.80	118	77%
4	164	4.31	38	40%	598	9.64	62	61%
5	65	3.25	20	33%	357	8.30	43	65%
Totals	3975	9.40	423	56%	10,021	16.93	592	78%

Table 8. **Parasite, predator, and associated insect species complexes of the various stand types**

Stand Type	Species	Emergences for Entire Collection: Total	Emergences for Entire Collection: Average Per Leader	Leaders Yielding: Leaders: Number	Leaders Yielding: Leaders: Percent of Total	Leaders Yielding: Emergences Per Leader Yielding	Leaders Not Yielding: Number	Leaders Not Yielding: Percent of Total
	Species of more frequent occurrence							
1	*Lonchaea corticis* Taylor	430	2.65	47	29%	9.14	115	70%
	Coeloides pissodis Ashm.	70	0.41	27	17%	2.59	135	83%
	Bracon pini (Mues.)	95	0.59	29	17%	3.27	133	82%
	Rhopalicus pulchripennis (Cwfd)	21	0.12	10	6%	2.10	152	93%
	Eurytoma pissodis Girault	33	0.20	18	11%	1.83	144	88%
	Eupelmus pini Taylor	7	0.04	7	4%	1.00	155	95%
	Pseudeucoila sp.	2	0.01	2	1%	1.00	160	98%
	Oscinella conicola (Green)	3	0.01	2	1%	1.50	159	90%
	Oscinella hinkleyi (Mall.)	4	0.02	3	1%	1.33	158	97%
	Pediobius n. sp.	1	0.006	1	0.6%	1.00	161	99%
	Species with total occurrences of less than twenty individuals							
	Exeristes comstockii (Cress.)	5		3				
	Monodontomerus aeureus Walker	17		1				
	Leptocera sp.	1		1				
	Eurytoma sp.	3		2				
	Spilochalcis igneoides (Kirby)	2		2				
	Lampoterma sp.	2		2				
	Psilus sp.	1		1				
	Totals	697	4.30	93	57%	7.49	69	42%

Table 8 -- (continued)

Stand Type	Species	Emergences for Entire Collection: Total	Emergences for Entire Collection: Average Per Leader	Leaders Yielding: Leaders: Number	Leaders Yielding: Leaders: Percent of Total	Leaders Yielding: Emergences Per Leader Yielding	Leaders Not Yielding: Number	Leaders Not Yielding: Percent of Total
2	Species of more numerous occurrence							
	Lonchaea corticis Taylor	1779	6.44	109	39%	16.32	167	60%
	Coeloides pissodis Ashm.	47	0.17	32	11%	1.46	244	88%
	Bracon pini (Mues.)	139	0.50	51	18%	2.72	225	81%
	Rhopalicus pulchripennis (Cwfd.)	22	0.07	13	4%	1.69	263	95%
	Eurytoma pissodis Girault	8	0.02	5	1%	1.60	271	98%
	Eupelmus pini Taylor	24	0.08	13	4%	1.84	263	95%
	Pseudeucoila sp.	59	0.21	16	5%	3.68	260	94%
	Oscinella conicola (Green)	68	0.24	18	6%	3.77	258	93%
	Oscinella hinkleyi (Mall.)	39	1.14	24	8%	1.62	252	91%
	Pediobius n. sp.	16	0.05	7	2%	2.28	269	97%
	Species with occurrences of less than twenty individuals and others of doubtful significance							
	Apanteles aristoteliae Vier.	7	4					
	Habrocytus sp.	1	1					
	Connioscinella sp.	1	1					
	Leucopis sp.	1	1					
	Scatopsae	1	1					
	Drosophila funebris (Stuart)	5	4					
	Drosophila buskii (Coq.)	27	17					
	Scatopse fuscipes Mg.	1	1					
	Eurytoma sp.	2	2					
	Mesochorus sp.	1	1					
	Cremastus sp.	2	2					
	Sericophanes heidimanni Poppius	1	1					
	Gelis sp.	1	1					
	Enoclerus nigripes Say	8	7					
	Totals	2260	8.19	174	63%	12.99	102	37%

Table 8 -- (continued)

Stand Type	Species	Emergences for Entire Collection: Total	Emergences for Entire Collection: Average Per Leader	Leaders Yielding: Leaders Number	Leaders Yielding: Leaders Percent of Total	Leaders Yielding: Emergences Per Leader Yielding	Leaders Not Yielding: Number	Leaders Not Yielding: Percent of Total
3	Species of more numerous occurrence							
	Lonchaea corticis Taylor	696	4.52	71	46%	9.80	83	52%
	Coeloides pissodis Ashm.	13	0.08	9	5%	1.44	87	56%
	Bracon pini (Mues.)	27	0.17	14	9%	1.92	140	90%
	Rhopalicus pulchripennis (Cwfd.)	17	0.11	14	9%	1.21	140	90%
	Eupelmus pini Taylor	2	0.01	2	1%	1.00	152	98%
	Pseudeucoila sp.	3		3				
	Oscinella conicola (Green)	16	0.10	6	3%	5.33	148	96%
	Oscinella hinkleyi (Mall.)	9	0.05	7	4%	1.28	147	95%
	Pediobius n. sp.	1	0.006	1	0.6%	1.00	153	99%
	Species with occurrences of less than twenty individuals							
	Exeristes comstockii (Cress.)	1		1				
	Phaeogenini	1		1				
	Oscinella sp.	1		1				
	Cheiropachus sp.	1		1				
	Enoclerus nigripes Say	1		1				
	Totals	789	5.12	98	63%	8.05	56	36%

Table 8 -- (continued)

Stand Type	Species	Emergences for Entire Collection: Total	Emergences for Entire Collection: Average Per Leader	Leaders Yielding: Leaders Number	Leaders Yielding: Leaders Percent of Total	Leaders Yielding: Emergences Per Leader Yielding	Leaders Not Yielding: Number	Leaders Not Yielding: Percent of Total
4	Species of more frequent occurrence							
	Lonchaea corticis Taylor	125	1.23	27	26%	4.62	74	73%
	Coeloides pissodis Ashm.	6	0.05	5	4%	1.20	95	94%
	Bracon pini (Mues.)	4	0.03	2	1%	2.00	99	98%
	Rhopalicus pulchripennis (Cwfd.)	9	0.08	8	7%	1.12	92	91%
	Eurytoma pissodis Girault	1	0.09	1	9%	1.00	100	99%
	Eupelmus pini Taylor	2	0.01	2	1%	1.00	99	98%
	Oscinella conicola (Green)	6	0.05	3	2%	2.00	98	97%
	Oscinella hinkleyi (Mall.)	6	0.05	3	2%	2.00	98	97%
	Pediobius n. sp.	2	0.01	2	1%	1.00	99	98%
	Species with occurrences of less than twenty individuals							
	Itoplectis conquisitor (Say)	1		1				
	Leucopes sp.	1		1				
	Enoclerus nigripes Say	1		1				
	Totals	164	1.62	38	37%	4.31	63	62%

Table 8 -- (continued)

Stand Type	Species	Emergences for Entire Collection: Total	Emergences for Entire Collection: Average Per Leader	Leaders Yielding: Leaders: Number	Leaders Yielding: Leaders: Percent of Total	Leaders Yielding: Emergences Per Leader Yielding	Leaders Not Yielding: Number	Leaders Not Yielding: Percent of Total
5	Species of more frequent occurrence							
	Lonchaea corticis Taylor	1	0.01	1	1%	1.0	65	98%
	Coeloides pissodis Ashm.	27	0.40	10	15%	2.7	56	84%
	Bracon pini (Mues.)	1	0.01	1	1%	1.0	65	98%
	Rhopalicus pulchripennis (Cwfd.)	24	0.36	6	9%	4.0	60	90%
	Eupelmus pini Taylor	6	0.09	3	4%	2.0	63	95%
	Oscinella hinkleyi (Mall.)	3	0.04	2	3%	1.5	64	96%
	Pediobius n. sp.	1	0.01	1	1%	1.0	65	98%
	Species with occurrences of less than twenty individuals							
	Cephalonomia sp.	1		1				
	Eurytoma sp.	1		1				
	Totals	65	0.98	20	30%	3.25	46	70%
	Grand Total	3975	5.24	423	56%	9.40	336	44%

Table 9. Total emergences of the more common associated species according to stand type

Species	Stand Type	Lead-ers Coll-ected	Total Emer-gences	Leaders Yielding: Leaders: Number	Leaders Yielding: Leaders: Percent of Total	Leaders Yielding: Emergences Per Leader Yielding
Lonchaea corticis - Data presented separately on Table 5						
Coeloides pissodis	1	162	70	27	17%	2.59
	2	276	47	32	11%	1.48
	3	154	13	9	5%	1.44
	4	101	6	5	4%	1.20
	5	66	27	10	15%	2.70
	Totals	757	163	83	10%	1.96
Bracon pini	1	162	95	29	17%	3.27
	2	276	139	51	18%	2.72
	3	154	27	14	9%	1.92
	4	101	4	2	1%	2.00
	5	66	1	1	1%	1.00
	Totals	757	266	97	12%	2.74
Rhopalicus pulchripennis	1	162	21	10	6%	2.10
	2	276	22	13	4%	1.69
	3	154	17	14	9%	1.21
	4	101	9	8	7%	1.12
	5	66	24	6	9%	4.00
	Totals	757	93	51	6%	1.82
Eurytoma pissodis	1	162	33	18	11%	1.83
	2	276	8	5	1%	1.60
	3	154	0	0	0	0.00
	4	101	1	1	0.9%	1.00
	5	66	0	0	0	0.00
	Totals	757	42	24	3%	1.75
Eupelmus pini	1	162	7	7	4%	1.00
	2	276	24	13	4%	1.84
	3	154	2	2	1%	1.00
	4	101	2	2	1%	1.00
	5	66	6	3	4%	2.00
	Totals	757	41	27	3%	1.51
Pseudeucoila sp.	1	162	2	2	1%	1.00
	2	276	59	16	5%	3.68
	3	154	3	3	2%	1.00
	4	101	0	0	0	0.00
	5	66	0	0	0	0.00
	Totals	757	64	21	3%	7.00

Table 9 -- (continued)

Species	Stand Type	Lead-ers Coll-ected	Total Emer-gences	Leaders Yielding: Leaders: Number	Leaders Yielding: Leaders: Percent of Total	Leaders Yielding: Emergences Per Leader Yielding
Oscinella conicola	1	162	3	2	1%	1.50
	2	276	68	18	6%	3.77
	3	154	16	6	3%	5.33
	4	101	6	3	2%	2.00
	5	66	0	0	0	0.00
	Totals	757	93	29	4%	3.21
Oscinella hinkleyi	1	162	4	3	1%	1.33
	2	276	39	24	8%	1.62
	3	154	9	7	4%	1.28
	4	101	6	3	2%	2.00
	5	66	3	2	3%	1.50
	Totals	757	61	39	5%	1.56
Pediobius n.sp.	1	162	1	1	0.6%	1.00
	2	276	16	7	2%	2.28
	3	154	1	1	0.6%	1.00
	4	101	2	2	1%	1.00
	5	66	1	1	1%	1.00
	Totals	757	21	12	1%	1.75

Table 10. Emergence of *Pissodes strobi* and associated insect species

		Pissodes strobi				*Lonchaea corticis*			
		Leaders Yielding		Emergences		Leaders Yielding		Emergences	
Collection Date	Location of Collection	No.	Percent of Total	Total	No. Per Leaders Yielding	No.	Percent of Total	Total	No. Per Leaders Yielding
May 6	Prices Fork	6	66%	149	24.83	0	0	0	0
May 15	Radford	9	60%	185	20.55	2	13%	5	2.5
June 1	Radford	14	100%	440	31.42	1	7%	34	34.0
	Snowville	5	83%	58	11.6	1	16%	29	29.9
	Willis	4	66%	33	8.25	0	0	0	0
	(STAND TYPE 1)	23	88%	531	23.09	2	8%	63	31.50
	Catawba	17	85%	429	25.23	7	70%	76	10.85
	(STAND TYPE 2)								
	Deerfield 2	3	60%	47	15.66	2	40%	40	20.00
	(STAND TYPE 3)								
	Floyd (STAND TYPE 4)	8	100%	123	15.37	2	25%	32	16.00
	Total	51	61%	1130	22.15	13	15%	211	16.23
June 10	Radford	14	82%	287	20.50	1	5%	1	1.00
	Snowville	5	100%	58	11.60	2	40%	32	16.0
	(STAND TYPE 1)	19	86%	345	18.16	3	14%	33	11.00
	Catawba	22	92%	726	33.00	11	55%	146	13.27
	Camp	11	100%	174	15.81	9	81%	489	54.33
	Hillsville	13	81%	193	14.85	6	37%	51	8.50
	(STAND TYPE 2)	46	90%	1093	23.76	26	51%	686	26.38
	Deerfield 2	7	100%	87	12.43	5	71%	95	19.00
	Rawley Springs	8	61%	72	9.00	10	77%	102	10.20
	Speedwell	4	80%	24	6.00	5	100%	71	14.20
	(STAND TYPE 3)	19	76%	183	9.63	20	80%	268	13.40
	Deerfield 1	6	86%	69	11.50	5	71%	16	3.20
	(STAND TYPE 4)								
	Massanetta	2	22%	14	7.00	0	0	0	0
	(STAND TYPE 5)								
	Total	92	81%	1704	18.41	54	47%	1003	8.80

according to date and individual location

Associated Species, other than L. corticis				Total Associated Species				Total Emergences			
Leaders Yielding-		Emergences		Leaders Yielding		Emergences		Leaders Yielding		Emergences	
No.	Per-cent of Total	Total	No. Per Leaders Yield-ing	No.	Per-cent of Total	Total	No. Per Leaders Yield-ing	No.	Per-cent of Total	Total	No. Per Leaders Yield-ing
0	0	0	0	0	0	0	0	6	66%	149	24.83
3	20%	15	1.00	6	40%	20	3.33	9	60%	205	22.78
8	57%	75	9.37	10	71%	109	10.90	14	100%	549	39.21
5	83%	22	4.40	5	83%	51	10.20	6	100%	109	18.17
1	16%	3	3.00	1	16%	3	3.00	4	66%	36	9.00
14	54%	100	7.14	16	61%	168	10.19	24	92%	694	28.92
10	50%	49	4.90	13	65%	125	9.23	18	90%	554	30.78
4	80%	8	2.00	4	80%	48	12.00	4	80%	95	23.75
0	0	0	0	2	25%	32	16.00	8	100%	155	19.37
28	33%	157	5.60	35	42%	368	10.51	78	94%	1498	19.20
9	52%	55	6.11	9	52%	56	6.22	14	82%	343	24.50
0	0	0	0	2	40%	32	16.00	5	100%	90	18.00
9	41%	55	6.11	11	50%	88	8.00	19	86%	433	22.79
19	79%	47	2.47	16	66%	193	12.06	23	96%	919	39.96
7	63%	28	4.00	10	90%	517	51.70	11	100%	691	62.82
14	87%	40	2.87	14	87%	91	6.50	16	100%	284	17.75
40	78%	115	2.87	40	78%	801	20.02	50	98%	1894	37.88
2	28%	2	1.00	5	71%	97	19.40	7	100%	184	52.57
2	15%	6	3.00	11	85%	108	9.82	13	100%	180	13.85
2	40%	3	1.50	5	100%	74	14.80	5	100%	98	19.60
6	24%	11	1.83	21	84%	279	13.28	25	100%	462	18.48
4	57%	10	2.50	5	71%	26	5.20	7	100%	95	13.57
3	33%	4	1.33	3	33%	4	1.33	4	44%	18	4.50
62	54%	195	3.14	80	70%	1198	14.97	105	92%	2902	27.64

Table 10. -- (continued)

Collection Date	Location of Collection	*Pissodes strobi* Leaders Yielding No.	*Pissodes strobi* Leaders Yielding Percent of Total	*Pissodes strobi* Emergences Total	*Pissodes strobi* Emergences No. Per Leaders Yielding	*Lonchaea corticis* Leaders Yielding No.	*Lonchaea corticis* Leaders Yielding Percent of Total	*Lonchaea corticis* Emergences Total	*Lonchaea corticis* Emergences No. Per Leaders Yielding
June 20	Radford	12	80%	213	17.75	3	20%	10	3.33
	Snowville	5	100%	66	13.20	1	20%	11	11.00
	(STAND TYPE 1)	17	85%	279	16.41	4	20%	21	5.25
	Catawba	17	68%	161	9.47	6	30%	58	9.67
	Camp	10	100%	112	11.20	10	100%	318	31.80
	Hillsville	10	67%	73	7.30	7	47%	32	4.57
	(STAND TYPE 2)	37	74%	349	9.43	23	46%	408	17.74
	Deerfield 2	3	60%	9	6.0	4	80%	23	5.75
	Rawley Springs	7	70%	40	5.71	6	60%	70	11.67
	Speedwell	3	60%	7	2.33	5	100%	48	9.60
	(STAND TYPE 3)	13	65%	56	4.31	15	75%	141	9.40
	Deerfield 1 (STAND TYPE 4)	3	60%	55	18.33	2	40%	9	4.50
	Massanetta (STAND TYPE 5)	4	100%	39	9.75	0	0	0	0
	Total	74	75%	778	10.51	44	44%	579	13.16
July 1	Radford	29	91%	605	20.86	10	31%	33	3.30
	Snowville	7	64%	66	9.43	7	64%	124	17.71
	Willis	3	50%	14	4.67	2	33%	8	4.00
	(STAND TYPE 1)	39	79%	685	17.56	19	39%	165	8.68
	Catawba	31	57%	238	7.68	13	24%	92	7.08
	Camp	18	67%	161	8.94	15	55%	159	10.60
	Hillsville	13	52%	48	3.69	10	40%	142	14.20
	(STAND TYPE 2)	62	58%	447	7.21	38	36%	393	10.34
	Deerfield 2	6	31%	51	8.50	5	26%	39	7.80
	Rawley Springs	7	28%	28	4.00	12	48%	65	5.42
	Speedwell	16	80%	54	3.37	8	40%	26	3.25
	(STAND TYPE 3)	29	45%	133	4.59	25	39%	130	5.20
	Deerfield 1 (STAND TYPE 4)	29	57%	140	4.83	18	35%	66	3.67
	Massanetta (STAND TYPE 5)	16	66%	60	3.75	1	4%	1	1.00
	Total	175	59%	1465	8.37	101	34%	755	7.47

Associated Species, other than *L. corticis*				Total Associated Species				Total Emergences			
Leaders Yielding		Emergences		Leaders Yielding		Emergences		Leaders Yielding		Emergences	
No.	Per-cent of Total	Total	No. Per Leaders Yield-ing	No.	Per-cent of Total	Total	No. Per Leaders Yield-ing	No.	Per-cent of Total	Total	No. Per Leaders Yield-ing
3	20%	4	1.33	4	27%	14	3.50	12	80%	227	18.42
1	20%	1	1.00	2	40%	12	6.00	5	100%	78	15.60
4	20%	5	1.25	6	30%	26	4.33	17	85%	305	17.94
15	60%	41	2.73	17	68%	99	5.82	20	80%	263	13.15
8	80%	47	5.87	10	100%	365	36.50	10	100%	477	47.70
9	60%	28	3.11	14	93%	60	4.28	15	100%	133	8.87
32	64%	116	3.62	41	82%	524	12.78	45	90%	873	19.40
2	40%	3	1.50	4	80%	26	6.50	5	100%	35	7.00
2	20%	4	2.00	9	90%	74	8.22	9	90%	114	12.67
2	40%	6	3.00	5	100%	54	10.80	5	100%	61	12.20
6	30%	13	2.17	18	90%	154	8.55	19	95%	210	11.05
3	60%	7	2.33	3	60%	16	5.33	3	60%	71	23.67
3	75%	21	7.00	3	75%	21	7.00	4	100%	60	15.00
48	48%	162	3.37	71	72%	741	10.44	88	89%	1519	17.26
15	47%	33	2.20	19	59%	66	3.47	31	97%	671	21.64
3	27%	14	4.67	7	64%	138	19.71	9	82%	204	22.67
1	17%	1	1.00	3	50%	9	3.00	4	67%	23	5.75
19	39%	48	2.53	29	59%	213	7.34	44	90%	898	20.41
17	31%	29	1.70	29	54%	121	4.17	43	80%	359	8.35
13	48%	41	3.15	20	74%	200	10.00	22	81%	361	16.41
16	64%	59	3.69	17	68%	201	11.82	19	76%	249	13.10
46	43%	129	2.80	66	62%	522	7.91	84	70%	969	11.53
5	26%	12	2.40	8	42%	51	6.37	10	53%	102	10.20
7	28%	8	1.14	15	60%	73	4.87	17	68%	101	5.94
8	40%	14	1.75	14	70%	40	2.86	19	95%	94	4.95
20	31%	34	1.70	37	58%	164	4.43	46	72%	297	6.46
10	19%	20	2.00	24	47%	86	3.58	34	67%	226	6.65
9	37%	34	3.78	10	42%	35	3.50	16	67%	95	5.94
104	35%	265	2.55	166	56%	1020	6.14	224	76%	2485	11.09

Table 10. -- (continued)

Coll-ection Date	Location of Collection	Pissodes strobi: Leaders Yielding No.	Leaders Yielding Percent of Total	Emergences Total	Emergences No. Per Leaders Yielding	Lonchaea corticis: Leaders Yielding No.	Leaders Yielding Percent of Total	Emergences Total	Emergences No. Per Leaders Yielding
July 10	Radford	19	95%	391	20.58	10	50%	78	7.80
	Snowville	8	80%	45	5.62	7	70%	65	9.28
	(STAND TYPE 1)	27	90%	436	16.15	17	57%	143	8.41
	Catawba	13	38%	31	2.38	4	12%	16	4.00
	Hillsville	7	47%	24	3.43	11	73%	200	18.18
	(STAND TYPE 2)	20	41%	55	2.75	15	31%	216	14.40
	Deerfield 2	4	28%	5	1.25	0	0	0	0.00
	Rawley Springs	2	20%	9	4.50	2	20%	33	16.50
	Speedwell	11	69%	53	4.82	7	40%	84	12.00
	(STAND TYPE 3)	17	42%	67	3.94	9	22%	117	13.00
	Deerfield 1 (STAND TYPE 4)	10	33%	47	4.70	2	6%	2	1.00
	Massanetta (STAND TYPE 5)	10	50%	30	3.00	0	0	0	0.00
Total		84	50%	635	7.60	43	25%	478	11.12
Grand Total		491	65%	6046	12.31	257	34%	3031	11.79

SUMMARY OF TABLE 10

May 6	6	66%	149	24.83	0	0	0	0.0
May 15	9	60%	185	20.55	2	13%	5	2.5
June 1	51	61%	1130	22.15	13	15%	211	16.23
June 10	92	81%	1704	18.41	54	47%	1003	8.80
June 20	74	75%	778	10.51	44	44%	579	13.16
July 1	175	59%	1465	8.37	101	34%	755	7.47
July 10	84	50%	635	7.60	43	25%	478	11.12

Associated Species other than L. corticis: Leaders Yielding: No.	Per-cent of Total	Emergences: Total	No. Per Leaders Yield-ing	Total Associated Species: Leaders Yielding: No.	Per-cent of Total	Emergences: Total	No. Per Leaders Yield-ing	Total Emergences: Leaders Yielding: No.	Per-cent of Total	Emergences: Total	No. Per Leaders Yield-ing
15	75%	36	2.40	17	85%	114	6.70	20	100%	505	25.25
5	50%	8	1.60	8	80%	73	9.12	10	100%	118	11.80
5	15%	10	2.00	7	20%	26	3.71	17	50%	57	3.35
20	67%	44	2.20	25	83%	187	7.48	30	100%	623	20.77
5	15%	10	2.00	7	20%	26	3.71	17	50%	57	3.35
10	66%	62	6.20	7	47%	262	7.43	12	80%	286	23.83
15	31%	72	4.80	14	28%	288	20.57	29	59%	343	11.83
2	14%	3	1.50	2	14%	3	1.50	5	36%	8	1.60
2	20%	2	1.00	4	40%	35	8.75	5	50%	44	8.80
7	44%	22	3.14	12	75%	106	8.83	14	87%	159	11.36
11	27%	27	2.45	18	45%	144	8.00	24	60%	211	8.79
2	6%	2	1.00	4	13%	4	1.00	10	33%	51	5.10
4	20%	5	1.25	4	20%	5	1.25	13	65%	35	2.69
52	31%	150	2.88	65	38%	628	9.66	106	63%	1263	11.91
297	39%	944	3.18	423	56%	3975	5.24	616	81%	10,021	16.93
0	0	0	0	0	0	0	0	6	66%	149	24.83
3	20%	15	1.00	6	40%	20	3.33	9	60%	205	22.78
28	33%	157	5.60	35	42%	368	10.51	78	94%	1498	19.20
62	54%	195	3.14	80	70%	1198	14.97	105	92%	2902	27.64
48	48%	162	3.37	71	72%	741	10.44	88	89%	1519	17.26
104	35%	265	2.55	166	56%	1020	6.14	224	76%	2485	11.09
52	31%	150	2.88	65	38%	628	9.66	106	63%	1263	11.91

Table 11. **Emergence data for the more commonly occurring associated species according to their individual collection areas**

Location of Collection	Total Leaders Coll-ected	*Coeloides pissodis* Leaders Yielding No.	*Coeloides pissodis* Leaders Yielding Per-cent of Total	*Coeloides pissodis* Emergences Total	*Coeloides pissodis* Emergences No. Per Leaders Yield-ing	*Bracon pini* Leaders Yielding No.	*Bracon pini* Leaders Yielding Per-cent of Total	*Bracon pini* Emergences Total	*Bracon pini* Emergences No. Per Leaders Yield-ing	*Rhopalicus pulchripennis* Leaders Yielding No.	*Rhopalicus pulchripennis* Leaders Yielding Per-cent of Total	*Rhopalicus pulchripennis* Emergences Total	*Rhopalicus pulchripennis* Emergences No. Per Leaders Yield-ing
Radford	113	24	21%	63	2.6[illegible]	23	18%	84	3.65	7	6%	9	1.28
Snowville	37	4	8%	6	1.50	5	13%	8	1.60	3	8%	12	4.00
Willis	12	1	8%	1	1.00	1	8%	3	3.00	0	0	0	0.00
(STAND TYPE 1)	162	29	18%	70	2.41	29	18%	95	3.27	10	6%	21	2.10
Catawba	157	17	10%	26	1.23	22	14%	60	2.70	10	6%	13	1.30
Camp	48	8	16%	10	1.25	14	29%	33	2.35	2	4%	5	2.50
Hillsville	71	7	9%	11	1.57	15	21%	46	3.06	1	1%	4	4.00
(STAND TYPE 2)	276	32	11%	47	1.41	51	18%	139	2.72	13	5%	22	1.69
Deerfield 2	50	2	4%	2	1.00	3	6%	6	2.00	4	8%	7	1.75
Rawley Springs	58	0	0	0	0	1	1%	1	1.00	7	12%	7	1.00
Speedwell	46	7	15%	11	1.57	10	21%	20	2.00	3	6%	3	1.00
(STAND TYPE 3)	154	9	6%	13	1.44	14	9%	27	1.93	14	9%	17	1.27
Deerfield 1	93	5	5%	6	1.20	2	2%	4	2.00	8	8%	9	1.12
Floyd	8	0	0	0	0	0	0	0	0	0	0	0	0
(STAND TYPE 4)	101	5	5%	6	1.20	2	2%	4	2.00	8	8%	9	1.12
Massanetta	57	10	17%	27	2.70	1	1%	1	1.00	6	10%	24	4.00
Pricés Fork	9	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
(STAND TYPE 5)	66	10	15%	27	2.70	1	1%	1	1.00	6	9%	24	4.00
Total	759	85	11%	163	1.92	97	13%	266	2.74	51	7%	93	1.82

Table 11. -- (continued)

Location of Collection	Total Leaders Collected	Oscinella conicola: Leaders Yielding		Oscinella conicola: Emergences		Oscinella Minkleyi: Leaders Yielding		Oscinella Minkleyi: Emergences		Pediobius: Leaders Yielding		Pediobius: Emergences	
		No.	Percent of Total	Total	No. Per Leaders Yielding	No.	Percent of Total	Total	No. Per Leaders Yielding	No.	Percent of Total	Total	No. Per Leaders Yielding
Radford	113	1	0.008%	2	2.00	3	2%	4	1.33	0	0	0	0
Snowville	37	1	2%	1	1.00	0	0	0	0.00	1	2%	1	1.00
Willis	12	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
(STAND TYPE 1)	162	2		3		3		4		1		1	
Catawba	157	5	3%	9	1.80	10	6%	15	1.50	1	0.006%	1	1.00
Camp	48	1	2%	1	1.00	2	4%	4	2.00	3	6%	11	3.66
Hillsville	71	12	16%	58	4.83	13	18%	20	1.53	3	4%	4	1.33
(STAND TYPE 2)	276	18	6%	68	3.78	25	9%	39	1.56	7	2%	16	2.28
Deerfield 2	50	2	4%	6	3.00	3	6%	4	1.33	0	0	0	0.00
Rawley Springs	58	1	1%	4	4.00	3	5%	4	1.33	1	2%	1	1.00
Speedwell	46	3	6%	6	2.00	1	2%	1	1.00	0	0	0	0
(STAND TYPE 3)	154	6	4%	16	2.67	7	4%	9	1.28	1	.006%	1	1.00
Deerfield 1	93	3	3%	6	2.00	3	3%	6	2.00	2	2%	2	1.00
Floyd	8	0	0	0	0	0	0	0	0	0	0	0	0
(STAND TYPE 4)	101	3	3%	6	2.00	3	3%	6	2.00	2	2%	2	1.00
Massanetta	57	0	0	0	0.00	2	3%	3	1.50	1	1%	1	1.00
Prices Fork	9	0	0	0	0.00	0	0	0	0	0	0	0	0
(STAND TYPE 5)	66	0	0	0	0	2	3%	3	1.50	1	1%	1	1.00
Total	759	29	4%	93	3.21	40	5%	61	1.52	12	1%	21	1.75

Table 11. -- (continued)

Location of Collection	Total Leaders Coll-ected	Eurytoma bissodis: Leaders Yielding No.	Leaders Yielding Per-cent of Total	Emergences Total	Emergences No. Per Leaders Yield-ing	Eupelmus pini: Leaders Yielding No.	Leaders Yielding Per-cent of Total	Emergences Total	Emergences No. Per Leaders Yield-ing	Pseudeucoila: Leaders Yielding No.	Leaders Yielding Per-cent of Total	Emergences Total	Emergences No. Per Leaders Yield-ing
Radford	113	14	12%	22	1.57	5	4%	5	1.00	1	0.008%	1	1.00
Snowville	37	4	10%	11	2.75	2	5%	2	1.00	1	10%	1	1.00
Willis	12	0	0	0	0.00	0	0	0	0.00	0	0	0	0.00
(STAND TYPE 1)	162	18	11%	33	1.83	7	4%	7	1.00	2	1%	2	1.00
Catawba	157	6	4%	7	1.66	6	4%	12	2.00	0	0	0	0.00
Camp	48	0	0	0	0.00	2	4%	2	1.00	11	22%	44	4.00
Hillsville	71	1	1%	1	1.00	7	9%	10	1.42	5	7%	15	0.80
(STAND TYPE 2)	276	7	2%	8	1.42	15	5%	24	1.60	16	6%	59	3.687
Deerfield 2	50	0	0	0	0.00	1	2%	1	1.00	1	2%	1	1.00
Rawley Springs	58	0	0	0	0.00	0	0	0	0.00	1	1%	2	2.00
Speedwell	46	0	0	0	0.00	1	2%	1	1.00	0	0	0	0.00
(STAND TYPE 3)	154	0	0	0	0.00	2	1%	2	1. 00	2	1%	3	1.50
Deerfield 1	93	1	1%	1	1.00	2	2%	2	1.00	0	0	0	0.00
Floyd	8	0	0	0	0	0	0	0	0	0	0	0	0
(STAND TYPE 4)	101	1	1%	1	1.00	2	2%	2	1.00	0	0	0	0
Massanetta	57	0	0	0	0.00	3	5%	6	2.00	0	0	0	0.00
Prices Fork	9	0	0	0	0	0	0	0	0	0	0	0	0
(STAND TYPE 5)	66	0	0	0	0	3	4%	6	2.00	0	0	0	0
Total	759	26	3%	42	1.61	29	4%	41	1.41	20	3%	64	3.20

Table 12. Emergence data for the more common associated species according to individual date of collection

Date of Collection	Leaders Collected	Leaders Yielding: No.	Leaders Yielding: Percent of Total	Emergences: Total	Emergences: Ave. No. Per Leaders Yielding	Leaders Yielding: No.	Leaders Yielding: Percent of Total	Emergences: Total	Emergences: Ave. No. Per Leaders Yielding	Leaders Yielding: No.	Leaders Yielding: Percent of Total	Emergences: Total	Emergences: Ave. No. Per Leaders Yielding
		Coeloides pissodis				*Bracon pini*				*Rhopalicus pulchripennis*			
May 6	9	0	0	0	0	0	0	0	0	0	0	0	0
May 15	15	3	20%	7	2.33	2	13%	4	2.00	1	6%	1	0.06
June 1	59	6	10%	30	5.00	15	25%	59	3.93	3	5%	3	1.00
June 10	114	5	4%	11	2.20	26	23%	99	3.81	6	5%	12	2.00
June 20	99	16	16%	30	1.87	20	20%	43	2.15	6	6%	7	1.16
July 1	294	33	11%	49	1.48	25	8%	46	1.84	29	10%	63	2.17
July 10	169	22	13%	36	1.63	9	5%	15	1.67	6	3%	7	1.17
Total	759	85	11%	163	1.92	97	13%	266	2.74	51	6%	93	1.82
		Oscinella conicola				*Oscinella hinkleyi*				*Pediobius* n. sp.			
May 6	9	0	0	0	0	0	0	0	0	0	0	0	0
May 15	15	0	0	0	0	0	0	0	0	0	0	0	0
June 1	59	2	3%	6	3.00	3	5%	6	2.00	0	0	0	0
June 10	114	5	4%	9	1.80	19	17%	27	1.42	2	2%	3	1.50
June 20	99	2	2%	4	2.00	10	10%	19	1.90	1	1%	1	1.00
July 1	294	9	3%	28	3.11	4	1%	5	1.25	9	3%	17	1.89
July 10	169	11	6%	46	4.18	4	2%	4	1.00	0	0	0	0
Total	759	29	3%	93	3.21	40	5%	61	1.52	12	1%	21	1.75

Table 12 -- (continued)

Date of Coll-ection	Leaders Coll-ected	Eurytoma pissodis: Leaders Yielding No.	Eurytoma pissodis: Leaders Yielding Per-cent of Total	Eurytoma pissodis: Emergences Total	Eurytoma pissodis: Emergences Ave. No. Per Lead-ers Yield-ing	Eupelmus pini: Leaders Yielding No.	Eupelmus pini: Leaders Yielding Per-cent of Total	Eupelmus pini: Emergences Total	Eupelmus pini: Emergences Ave. No. Per Lead-ers Yield-ing	Pseudeucoila: Leaders Yielding No.	Pseudeucoila: Leaders Yielding Per-cent of Total	Pseudeucoila: Emergences Total	Pseudeucoila: Emergences Ave. No. Per Lead-ers Yield-ing
May 6	9	0	0	0	0	0	0	0	0	0	0	0	0
May 15	15	2	13%	2	1.00	0	0	0	0	0	0	0	0
June 1	59	8	13%	19	2.37	4	7%	7	1.75	1	2%	1	1.00
June 10	114	1	0.8%	1	1.00	1	0.8%	1	1.00	4	3%	5	1.25
June 20	99	1	1%	1	1.00	3	3%	6	2.00	7	7%	37	5.28
July 1	294	9	3%	11	1.22	10	3%	12	1.20	5	2%	18	3.60
July 10	169	5	3%	8	1.60	11	6%	15	1.36	3	2%	3	1.00
Total		26	3%	42	1.61	29	4%	41	1.41	20	3%	64	3.20

Table 13. Success of white pine weevil attacks according to

			Unsuccessful Attack							
			Leaders Yielding Nothing		Leaders yielding no white pine weevils but yielding associated species					
					Leaders Yielding		Emergences			
Location of Collection	Date of Collection	Leaders Collected	No.	Percent of Total	No.	Percent of Total	No.	Ave. Per Leaders Yielding	Number of Species	Species[1/] Represented
				%		%				
Radford	May 15	15	6	32	0	0	0	0	0	
	June 1	14	0	0	0	0	0	0	0	
	June 10	17	3	17	1	6	2	2.00	2	2, 20
	June 20	15	3	20	0	0	0	0	0	
	July 1	32	1	3	2	6	5	2.50	3	Lc, 6, 7
	July 10	20	0	0	1	5	3	3.00	1	Lc 6
	Total	113	13	11%	4	3%	10	2.50	5	Lc, 2, 6 7, 20
				%		%				
Snowville	June 1	6	0	0	1	17	2	2.00	2	2, 7
	June 10	5	0	0	0	0	0	0	0	
	June 20	5	0	0	0	0	0	0	0	
	July 1	11	2	18	2	18	32	16.00	1	Lc
	July 10	10	0	0	2	20	5	2.50	3	Lc, 8, 33
	Total	37	2	5%	5	13%	39	1.05	11	Lc, 2, 7, 8, 33
Willis	June 1	6	2	33	0	0	0	0	0	
	July 1	6	2	33	1	17	1	1.00	1	1
	Total	12	4	33%	1	17%	1	1.00	1	1
				%		%				
STAND TYPE 1		162	19	12	10	6	50	5.00	8	Lc, 1, 2, 6, 7, 8, 20, 33

1/ Associated species are given numerical designations as follows: (Lc) Lonchaea corticis, (1)Coeloides pissodis, (2)Bracon pini, (3) Exeristes comstockii, (4)Itoplectis conquisitor, (5)Phaeogenini, (6)Rhopalicus pulchripennis, (7)Eurytoma pissodis (8)Eupelmus pini, (9) Monodontomerus aereus, (10)Pseudeucoila, (12)Apanteles aristoteliae, (13)Habrocytus sp., (14)Oscinella conicola, (15)Connioscinella, (16)Leucopis, (17)Scatopsae, (18)Leptocera, (19)Oscinella sp., (20)Oscinella hinkleyi, (21)Drosophila funebris, (22)Drosophila buskii, (23)Pediobius n. sp., (24)Scatopse fuscipes, (25)Cephalonomia sp., (26)Eurytoma sp., (27) Mesochorus sp., source and date of collection

Successful Attack[2/]: Leaders Yielding White Pine Weevils Only — Leaders Yielding No.	Leaders Yielding Percent of Total	Emergences No.	Emergences Ave. Per Leaders Yielding	Leaders Yielding Weevils and Associated Species — Weevils — Leaders Yielding No.	Leaders Yielding Percent of Total	Emergences No.	Emergences Ave. Per Leaders Yielding	Associated Species — Emergences No.	Emergences Ave. Per Leaders Yielding	Number of Species	Species Represented
	%				%						
5	33	60	12.00	4	27	125	31.25	20	5.00	6	Lc,1,2,6,7,31
5	36	64	12.80	9	64	376	41.78	109	12.11	9	Lc,1,2,3,6,7,8,9,18
6	35	87	14.50	8	47	200	25.00	54	6.75	7	Lc,1,2,6,7,10,14
6	40	63	10.50	6	40	150	25.00	14	2.33	4	Lc,1,2,6
12	37	205	17.08	17	53	400	23.53	61	3.59	8	Lc,1,2,3,7,8,20,31
3	15	15	5.00	16	80	376	23.50	111	6.94	10	Lc,1,2,3,6,7,8,20,26,29
37	33%	494	13.35	60	53%	1627	27.12	369	6.15	14	Lc,1,2,3,6,7,8,9,10,14,18,20,26,29,31
1	17	2	2.00	4	67	56	14.00	49	12.25	5	Lc,1,2,7,26
3	60	7	2.33	2	40	51	25.50	32	16.00	1	Lc
3	60	18	6.00	2	40	48	24.00	12	6.00	2	Lc,2
2	18	16	8.00	5	45	50	10.88	106	21.20	4	Lc,2,6,23
2	20	5	2.50	6	60	40	6.67	68	11.33	5	Lc,1,8,10,14
11	30%	48	4.36	19	51%	245	12.89	267	14.05	10	Lc,1,2,6,7,8,10,14,23,26
3	50	21	7.00	1	17	12	12.00	3	1.00	1	2
1	17	3	3.00	2	33	11	5.50	8	4.00	1	Lc
4	33%	24	6.00	3	25%	23	7.67	11	3.67	2	Lc,2
52	32%	566	10.88	82	51%	1895	23.11	647	7.89	15	Lc,1,2,3,6,7,8,9,10,14,18,20,26,29,31

(28)Labena grallator, (29)Spibchalcis igneoides (30)Creamstus sp., (31)Lampoterma sp., (32)Cheiropachus, (33)Psilus sp., (34)Sericophanes heidimanni, (35)Gelis sp. (36)Enoclerus nigripes

2/ Unsuccessful attack for these purposes is defined as infestation of a leader from which no weevils emerged. Successful attack is designated if one or more weevils emerged from the leader.

Table 13. -- (continued)

Location of Coll-ection	Date of Coll-ection	Leaders Coll-ected	Unsuccessful Attack: Leaders Yielding Nothing: No.	Leaders Yielding Nothing: Percent of Total %	Leaders yielding no white pine weevils but yielding associated species: Leaders Yielding: No.	Leaders Yielding: Percent of Total	Emergences: No.	Emergences: Ave. Per Leaders Yielding	Number of Species	Species Represented
Catawba	June 1	20	3	15	0	0	0	0	0	none
	June10	24	1	4	1	4	1	1.00	1	16
	June 20	25	4	16	4	16	16	4.00	6	Lc,1,2,6,20,22
	July 1	54	14	26	7	12	51	7.28	6	Lc,1,2,6,7,8
	July10	34	19	56	2	6	5	2.50	1	Lc
	Total	157	41	26%	14	9%	73	5.21	9	Lc,1,2,6,7,8,16 20,22
Camp	June10	11	0	0	0	0	0	0	0	none
	June20	10	0	0	0	0	0	0	0	none
	July 1	27	5	18	4	15	20	5.00	4	Lc,2,6,23 -
	Total	48	5	10%	4	8%	20	5.00	4	Lc,2,6,23
Hills-ville	June10	16	0	0	3	19	10	3.33	4	2,6,14,20
	June20	15	0	0	5	33	21	4.20	4	Lc,2,8,20
	July 1	25	5	20	7	28	30	4.28	9	Lc,1,2,8,14,20,23, 34,35
	July10	15	3	20	5	33	102	20.40	5	Lc,8,10,14,22
	Total	71	8	11%	20	28%	163	8.15	12	Lc,1,2,6,8,10,14, 20,22,23,34,35
STAND TYPE 2		276	54	19%	38	14%	256	6.74	14	Lc,1,2,6,7,8,10, 14,16,20,22,23, 34,35

Successful Attack											
Leaders Yielding White Pine Weevils Only				Leaders Yielding Weevils and Associated Species							
Leaders Yielding		Emergences		Leaders Yielding		Weevils Emergences		Associated Species Emergences			
No.	Per-cent of Total	No.	Ave. Per Leaders Yield-ing	No.	Per-cent of Total	No.	Aver. Per Leaders Yield-ing	No.	Ave. Per. Leaders Yield-ing	Number of Species	Species Represent-ed
4	25%	88	22.00	13	65%	341	26.23	125	11.36	10	Lc,1,2,6,7,8,14,17,20,27
4	17	16	4.00	19	79	710	37.37	192	10.67	10	Lc,1,2,6,14,20,21,22,36
5	20	35	7.00	12	48	129	10.75	83	6.92	9	Lc,1,2,6,7,14,20,22,36
16	30	43	2.69	17	31	195	11.47	70	4.12	11	Lc,1,2,6,7,8,14,20,22,23,26
8	23	20	2.50	5	15	11	2.20	21	4.20	5	Lc,1,2,7,8
37	23	202	5.46	66	42	1386	22.00	491	7.79	15	Lc,1,2,6,7,8,14,17,20,21,22,23,26,27,36
1	9	4	4.00	10	91	170	15.45	517	51.70	8	Lc,2,8,10,20,22,24,26
0	0	0	0	10	100	112	11.20	365	36.50	5	Lc,1,2,10,23
3	11	11	3.67	15	55	150	10.00	180	12.00	11	Lc,1,2,6,8,10,12,14,20,23,30
4	8%	15	3.75	35	73%	432	12.34	1062	30.34	14	Lc,1,2,6,8,10,12,14,20,22,23,24,26,30
2	12	48	24.00	11	69	145	13.18	81	7.36	7	Lc,2,20,21,22,23,36
3	20	22	7.33	7	53	51	7.28	39	5.57	7	Lc,1,2,8,10,20,36
2	8	4	2.00	11	44	44	4.00	171	15.54	10	Lc,1,2,7,8,10,12,13,14,21
0	0	0	0	7	47	24	3.43	160	22.86	9	Lc,1,8,10,12,14,15,20,22
7	9%	74	10.57	36	51%	264	7.33	451	12.53	15	Lc,1,2,7,8,10,12,13,14,15,20,21,22,23,36
48	17%	291	6.06	137	50%	2082	15.20	2004	14.95	21	Lc,1,2,6,7,8,10,12,13,14,15,17,20,21,22,23,24,26,27,30,36

Table 13. -- (continued)

			Unsuccessful Attack							
			Leaders Yielding Nothing		Leaders yielding no white pine weevils but yielding associated species					
					Leaders Yielding		Emergences			
Location of Collection	Date of Collection	Leaders Collected	No.	Percent of Total	No.	Percent of Total	No.	Ave. Per Leaders Yielding	Number of Species	Species Represented
						%				
Deerfield 2	June 1	5	0	0	2	40	45	22.50	6	Lc,1,10,14,20
	June10	7	0	0	0	0	0	0	0	none
	June20	5	0	0	2	40	9	4.50	3	Lc,2,6
	July 1	19	9	47	4	21	6	1.50	3	Lc,2,6
	July10	14	9	64	1	7	1	1.00	1	8
	Total	50	18	38%	9	18%	61	6.78	9	Lc,1,2,6, 8,10,14,20,36
				%						
R wley Springs	June10	13	1	8	4	31	28	7.00	1	Lc,20
	June20	10	2	20	1	10	1	1.00	1	Lc
	July 1	25	9	36	9	36	22	2.44	5	Lc,2,5,6,23
	July10	10	6	60	2	20	2	1.00	1	6
	Total	58	18	31%	16	27%	53	3.31	6	Lc,2,5,6,20 23
Speedwell	June10	5	0	0	1	20	11	11.00	2	Lc,2
	June20	5	0	0	2	40	9	4.50	2	Lc,20
	July 1	20	1	5	3	15	4	1.33	3	1,2,6
	July10	16	2	12	3	19	8	2.67	2	Lc,14
	Total	46	3	6%	9	19%	32	3.55	9	Lc,1,2,6,14,20
STAND TYPE 3		154	39	25%	34	22%	146	4.29	11	Lc,1,2, 5,6, 8,10,14,20, 23,36

Successful Attack											
Leaders Yielding White Pine Weevils Only				Leaders Yielding Weevils and Associated Species							
Leaders Yielding		Emergences		Leaders Yielding		Weevils Emergences		Associated Species Emergences			
No.	Percent of Total	No.	Ave. Per Leaders Yielding	No.	Percent of Total	No.	Ave. Per Leaders Yielding	No.	Ave. Per Leaders Yielding	Number of Species	Species Represented
1	20%	35	35.00	2	40%	12	6.00	3	1.50	2	Lc,20
2	28	29	14.50	5	71	58	11.60	97	19.40	3	Lc,2,20
0	0	0	0	3	60	9	3.00	17	5.67	1	Lc
2	10	6	3.00	4	21	45	11.25	45	11.25	4	Lc,1,6,14
3	21	3	1.00	1	7	2	2.00	2	2.00	1	6
8	16	73	9.12	15	30%	126	8.40	164	10.93	6	Lc,1,2,6,14,20
2	15%	4	2.00	6	46%	68	11.33	80	13.33	3	Lc,14,20
2	20	14	7.00	5	50	26	5.20	73	14.60	3	Lc,10,20
1	4	1	1.00	6	24	27	4.50	51	8.50	2	Lc,6
0	0	0	0	2	20	9	4.50	33	16.50	1	Lc
5	7%	19	3.80	19	33%	130	6.84	237	12.47	5	Lc,6,10,14,20
0	0	0	0	4	80%	24	6.00	63	15.75	2	Lc,2
0	0	0	0	3	60	7	2.33	45	15.00	2	Lc,2
5	25%	11	2.20	11	55	43	3.91	36	3.27	5	Lc,1,2,6,19
2	12	4	2.00	9	56	49	5.44	98	10.89	8	Lc,1,2,3,6,8,14,32
7	15%	15	2.14	27	59%	123	4.55	242	8.96	9	Lc,1,2,3,6,8,14,19,32
20	13%	107	5.35	61	40%	379	6.21	643	10.54	11	Lc,1,2,3,6,8,10,14,19,20,32

Table 13. -- (continued)

Location of Collection	Date of Collection	Leaders Collected	Unsuccessful Attack: Leaders Yielding Nothing No.	Leaders Yielding Nothing Percent of Total %	Leaders yielding no white pine weevils but yielding associated species: Leaders Yielding No.	Leaders Yielding Percent of Total %	Emergences No.	Emergences Ave. Per Leaders Yielding	Number of Species	Species Represented
Deerfield 1	June 10	7	0	0	1	14	9	9.00	3	Lc,2,20
	June 20	5	1	20	1	20	1	1.00	1	1
	July 1	51	17	33	5	10	12	2.40	6	Lc,6,8,14,16,23
	July 10	30	20	66	0	0	0	0	0	none
	Total	93	38	41%	7	7%	22	3.14	9	Lc,1,2,6,8,14,16,20,23
Floyd	June 1	8	0	0	0	0	0	0	0	none
STAND TYPE 4		101	38	38%	7	7%	22	3.14	9	Lc,1,2,6,8,14,16,20,23
Massanetta	June 10	9	5	55	2	22	3	1.50	1	20
	June 20	4	0	0	0	0	0	0	0	none
	July 1	24	6	25%	2	8	2	1.00	2	6,1
	July 10	20	8	40	2	10	3	1.50	2	1,8
		57	19	33%	6	10%	8	1.33	4	1,6,8,20
Prices Fork	May 6	9	3	33%	0	0	0	0	0	none
STAND TYPE 5		66	22	33%	6	9%	8	1.33	4	1,6,8,20

Successful Attack											
Leaders Yielding White Pine Weevils Only				Leaders Yielding Weevils and Associated Species							
Leaders Yielding		Emergences		Leaders Yielding		Weevils Emergences		Associated Species Emergences			
No.	Percent of Total	No.	Ave. Per Leaders Yielding	No.	Percent of Total	No.	Ave. Per Leaders Yielding	No.	Ave. Per Leaders Yielding	Number of Species	Species Represented
	%				%						
2	28	21	10.50	4	57	48	12.00	17	4.25	5	1,2,6,20,36
0	0	0	0	3	60	55	18.33	15	5.00	4	Lc,6,14,20
10	20	17	1.70	19	37	123	6.47	74	3.89	6	Lc,1,6,7,8,14
7	23	13	1.86	3	10	34	11.33	4	1.33	3	Lc,1,4
19	20%	51	2.89	29	31%	260	8.96	110	3.79	10	Lc,1,2,4,6,7,8, 14,20,36
6	75%	19	3.17	2	25%	104	52.00	32	16.00	1	Lc
25	25%	70	2.80	31	31%	364	11.74	142	4.58	10	Lc,1,2,4,6,7,8, 14,20,36
1	11%	9	9.00	1	11%	5	5.00	1	1.00	1	1
1	25	15	15.00	3	75	24	8.00	21	7.00	5	1,2,6,8,26
9	37	39	4.33	7	29	21	3.00	33	4.71	5	Lc,1,6,23,25
8	40	27	3.37	2	10	3	1.50	2	1.00	2	1,8
19	33%	90	4.74	13	23%	53	4.08	57	4.38	8	Lc,1,2,6,8,23,25, 26
6	66%	149	24.83	0	0	0	0	0	0	0	none
25	38%	239	9.56	13	20%	53	4.08	57	4.38	8	Lc,1,2,6,8,23,25, 26

Table 14. White pine weevil emergence per leader.

Radford			Snowville			Willis			Stand Type 1		
Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences
0	16	0	0	7	0	0	5	0	0	28	0
1	9	9	1	4	4	1	2	2	1	15	15
2	3	6	2	5	10	3	2	6	2	8	16
3	5	15	3	2	6	10	1	10	3	9	27
4	2	8	4	2	8	12	1	12	4	4	16
5	3	15	5	3	15	17	1	17	5	6	30
6	2	12	6	1	6				6	3	18
7	1	7	9	1	9				7	1	7
8	4	32	11	1	11				8	4	32
9	4	36	12	1	12				9	5	45
10	5	50	15	1	15				10	6	60
11	1	11	16	1	16				11	2	22
12	3	36	17	1	17				12	5	60
13	3	39	18	1	18				13	3	39
14	2	28	19	1	19				14	2	28
15	3	45	22	1	22				15	4	60
16	2	32	23	2	46				16	3	48
17	1	17	29	1	29				17	3	51
18	2	36	30	1	30				18	3	54
19	2	38							19	3	57
20	2	40							20	2	40
21	1	21							21	1	21
22	2	44							22	3	66
25	2	50							23	2	46
26	4	104							25	2	50
27	3	81							26	4	104
28	1	28							27	3	81

Table 14. -- (Continued)

Radford			Snowville			Willis			Stand Type 1		
Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences
30	1	30							28	1	28
32	1	32							29	1	29
33	1	33							30	2	60
34	2	68							32	1	32
36	2	72							33	1	33
37	2	74							34	2	68
40	1	40							36	2	72
41	1	41							37	2	74
44	1	44							40	1	40
46	1	46							41	1	41
53	2	106							44	1	44
54	1	54							46	1	46
55	1	55							53	2	106
59	1	59							54	1	54
68	2	136							55	1	55
69	1	69							59	1	59
72	1	72							68	2	136
83	2	166							69	1	69
84	1	84							72	1	72
									83	2	166
									84	1	84

Table 14. -- (Continued)

Catawba			Camp			Hillsville			Stand Type 2		
Number of Emergences	Number of Leaders Yielding	Total Emergences	Number of Emergences	Number of Leaders Yielding	Total Emergences	Number of Emergences	Number of Leaders Yielding	Total Emergences	Number of Emergences	Number of Leaders Yielding	Total Emergences
0	55	0	0	9	0	0	28	0	0	92	0
1	26	26	1	2	2	1	8	8	1	36	36
2	11	22	2	4	8	2	9	18	2	24	48
3	9	27	4	4	16	3	7	21	3	16	48
4	6	24	5	5	25	4	1	4	4	11	44
5	1	5	7	3	21	5	1	5	5	7	35
6	2	12	8	1	8	7	1	7	6	2	12
7	1	7	9	3	27	8	2	16	7	5	35
8	2	16	10	1	10	9	2	18	8	5	40
9	1	9	11	1	11	10	2	20	9	6	54
10	2	20	12	2	24	12	1	12	10	5	50
11	5	55	13	1	13	13	1	13	11	6	66
12	3	36	15	1	15	16	1	16	12	6	72
14	1	14	16	1	16	18	2	36	13	2	26
15	3	15	17	1	17	19	1	19	14	1	14
16	1	16	20	1	20	24	1	24	15	4	60
20	1	20	23	1	23	26	1	26	16	3	48
22	1	22	24	2	48	30	1	30	17	1	17
23	2	46	25	1	25	45	1	45	18	2	36
24	1	24	27	1	27				19	1	19
26	4	104	28	2	56				20	2	40
31	1	31	35	1	35				22	1	22
34	1	34							23	3	69
37	1	37							24	4	96
40	2	80							25	1	25
44	3	132							26	5	130

Table 14. -- (Continued)

Catawba			Camp			Hillsville			Stand Type 2		
Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences
53	1	53							27	1	27
54	1	54							28	2	56
56	2	112							30	1	30
57	1	57							31	1	31
61	1	61							34	1	34
63	1	63							35	1	35
71	1	71							37	1	37
72	1	72							40	2	80
75	1	75							44	3	132
106	1	106							45	1	45
									53	1	53
									54	1	54
									56	2	112
									57	1	57
									61	1	61
									63	1	63
									71	1	71
									72	1	72
									75	1	75
									106	1	106

Table 14. -- (Continued)

Deerfield Area 2			Rawley Springs			Speedwell			Stand Type 3		
Number of Emergences	Number of Leaders Yielding	Total Emergences	Number of Emergences	Number of Leaders Yielding	Total Emergences	Number of Emergences	Number of Leaders Yielding	Total Emergences	Number of Emergences	Number of Leaders Yielding	Total Emergences
0	27	0	0	34	0	0	12	0	0	73	0
1	5	5	1	4	4	1	9	9	1	18	18
2	3	6	2	8	16	2	5	10	2	16	32
3	2	6	3	2	6	3	7	21	3	11	33
4	3	12	4	1	4	4	3	12	4	7	28
5	1	5	5	1	5	5	1	5	5	3	15
6	1	6	7	2	14	6	2	12	6	3	18
9	1	9	9	2	18	7	2	14	7	4	28
12	1	12	11	1	11	8	1	8	8	1	8
13	1	13	12	1	12	9	1	9	9	4	36
17	1	17	13	1	13	12	1	12	11	1	11
20	1	20	46	1	46	13	2	26	12	3	36
25	1	25							13	4	52
28	1	28							17	1	17
35	1	35							20	1	20
									25	1	25
									28	1	28
									35	1	35
									46	1	46

Table 14. -- (Continued)

Deerfield Area 1			Floyd			Stand Type 4		
Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences
0	45	0	0	0	0	0	45	0
1	14	14	1	3	3	1	17	17
2	7	14	2	1	2	2	8	16
3	3	9	3	1	3	3	4	12
4	4	16	11	1	11	4	4	16
5	2	10	40	1	40	5	2	10
6	6	36	64	1	64	6	6	36
8	1	8				8	1	8
9	1	9				9	1	9
10	1	10				10	1	10
12	2	24				11	1	11
15	2	30				12	2	24
19	1	19				15	2	30
24	1	24				19	1	19
28	2	56				24	1	24
32	1	32				28	2	56
						32	1	32
						40	1	40
						64	1	64

Table 14. -- (Continued)

Massanetta			Prices Fork			Stand Type 5		
Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences
0	25	0	0	3	0	0	28	0
1	9	9	1	1	1	1	10	10
2	6	12	5	1	5	2	6	12
3	4	12	9	1	9	3	4	12
4	2	8	38	1	38	4	2	8
5	2	10	46	1	46	5	3	15
6	1	6	50	1	50	6	1	6
7	2	14				7	2	14
8	1	8				8	1	8
9	2	18				9	3	27
12	1	12				12	1	12
15	1	15				15	1	15
19	1	19				19	1	19
						38	1	38
						46	1	46
						50	1	50

Table 14. -- (Continued)

			Total for all Stands					
Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences	Number of Emer-gences	Number of Leaders Yielding	Total Emer-gences
0	266	0	21	1	21	45	1	45
1	96	96	22	4	88	46	3	138
2	62	124	23	5	115	50	1	50
3	44	132	24	5	120	53	3	159
4	28	112	25	4	100	54	2	108
5	21	105	26	9	234	55	1	55
6	15	90	27	4	108	56	2	112
7	12	84	28	6	168	57	1	57
8	12	96	29	1	29	59	1	59
9	19	171	30	3	90	61	1	61
10	12	120	31	1	31	63	1	63
11	10	110	32	2	64	64	1	64
12	17	204	33	1	33	68	2	136
13	9	117	34	3	102	69	1	69
14	3	42	35	2	70	71	1	71
15	11	165	36	2	78	72	2	144
16	6	96	37	3	111	75	1	75
17	5	85	38	1	38	83	2	166
18	5	90	40	4	160	84	1	84
19	6	114	41	1	41	106	1	106
20	5	100	44	4	176			

Table 15. Seasonal emergences of the white pine weevil and associated species

	Number of Emergences														
	White Pine Weevils								*Lonchaea corticis*						
	Collection Dates								Collection Dates						
Emergence Check Dates	May 6	May 15	June 1	June 10	June 20	July 1	July 10	Total	May 15	June 1	June 10	June 20	July 1	July 10	Totals
Field Bags		8	11	9	1			29		22	8				30
July	25		23	10		1		59		11	33	6	3		53
9															
11															
13	23		7	12	3	2		47		8	36	7	3		54
15	32		25	21	3	10		91		4	40	7	3	2	56
17	36		65	11	5	10		127		18	78	13	5	4	118
19	13	12	32	68	27	7		156		7	38	5	7	2	59
21	3	12	85	75	13	34	10	232		15	93	19	6	16	149
23	6	17	79	133	45	51	18	349		9	91	45	6	8	159
25	2	23	76	106	29	42	12	290		2	81	44	2	1	130
27	1	28	87	101	45	59	35	356		1	55	33	6	5	100
29		26	137	158	59	92	24	496		10	62	20	7	5	104
31	3	8	39	103	24	83	20	280	1	1	34	5	5	3	49
August															
2	1	1	50	107	46	30	35	270		3	25	17	2		47
4	1	9	62	118	23	52	32	297	1	3	61	4	14	24	107
6	2	6	41	109	51	120	49	378		1	18	31	17	11	78
8	1	5	63	71	42	103	45	330	1	6	21	15	20	6	69
10		11	59	141	71	107	43	432	1	7	22	24	20	10	84
12		2	29	68	63	86	53	301		12	28	42	43	18	143
14		6	8	41	29	36	33	153		7	23	12	24	11	77
16		5	52	83	68	115	42	365		8	17	18	42	19	104
18		3	22	34	45	68	44	216		7	13	32	35	31	118
20			27	48	31	49	27	182		4	15	25	39	26	109
22		1	13	36	20	43	21	134		13	14	14	65	45	151
24		1	17	13	16	53	8	108		4	9	20	37	18	88
26				6	1	9	1	17			5	7	5	10	27
28			12	1	10	63	11	97	1	11	24	30	80	54	200
30			1	6		12	14	33		2	4	7	14	5	32
Sept.															
1					1	15	8	24		2	5	7	19	22	55
3			5	1	1	27	8	42		3	5	5	27	8	48
5			1	3	2	20	5	31		1	7	7	41	17	73
		1	1	3	1	13	5	24				3	14	9	26
9				1	2	29		32			4	14	24		42
11				1		6	7	14			7	6	14	18	45
13			1	7		5	8	21		3	11		20	7	41
15				1	1	4	5	11		1	1	10	5	16	33
17				2		5	8	15			4	10	17	13	44
19							1	1			1	2	16	3	22
Dec. 30						4	2	6		5	10	13	48	31	107
Totals	149	185	1130	1704	778	1465	635	6046	5	211	1003	579	755	478	3031

Table 15. -- (continued)

Emergence Check Dates	Number of Emergences													
	Coeloides pissodis							Bracon pini						
	Collection Dates							Collection Dates						
	May 15	June 1	June 10	June 20	July 1	July 10	Totals	May 15	June 1	June 10	June 20	July 1	July 10	Totals
Field Bags			9	13	1		23		18	60	30			108
July														
9		1	1	4	4		10		7	7	12	10		36
11														
13		2		2	5		9		2	6		8		16
15				6	3	1	10	2		3		4	1	10
17		4	1	4	9	4	22		15	17		12	3	47
19	2	4			5	1	12	2	6			1	4	13
21	4	3			8	4	19		4	1		5	4	14
23	1	6			4	7	18		6	1				7
25		6			7	4	17		1		2	1	2	6
27		3			2	3	8						1	1
29		1			2	2	5							
31						1	1							
August														
2						4	4			3				3
4						2	2							
6										1				1
8						2	2							
10														
12						1	1							
14														
16														
18														
20														
22														
24														
26														
28														
30														
September														
1														
3														
5														
7														
9														
11														
13														
15														
17														
19														
Dec 30												4		4
Totals	7	30	11	29	50	36	163	4	59	99	44	45	15	266

Table 15. -- (continued)

Emergence Check Dates	*Rhopalicus pulchripennis*: May 15	June 1	June 10	June 20	July 1	July 10	Totals	*Eurytoma pissodis*: May 15	June 1	June 10	June 20	July 1	July 10	Totals	*Eupelmus pini*: June 1	June 10	June 20	July 1	July 10	Totals
Field Bags		1	11	5			17					1		1			1			1
July																				
9				1	3		4										1	2		3
11																				
13		1			1	1	3										1			1
15					9		9					1		1			3		1	4
17					11		11					1		1		1		3		4
19				1	12	3	16					1		1						
21					7		7		2					2						
23			1		7		8		1			1		2				3	3	6
25	1	1			7	1	10	1	8	1		2		12	2			1	4	7
27								1	7			2	4	14	1			1	2	4
29					2		2		1			1	3	5	3					3
31															1			1		2
August																				
2						1	1					2		2				1	1	2
4													1	1						
6																				
8						1	1												2	2
10																				
12					1		1												1	1
14																			1	1
16																				
18																				
20																				
22																				
24																				
26																				
28																				
30																				
September																				
1																				
3																				
5					3		3													
7																				
9																				
11																				
13																				
15																				
17																				
19																				
Dec 30																				
Totals	1	3	12	7	63	7	93	2	19	1	1	11	8	42	7	1	6	12	15	41

Table 16. Percentages of emergence of the white pine weevil and associated species for separate collection dates and seasonal categories

Emergence Check Groups	May 6	May 15	June 1	June 10	June 20	July 1	July 10	Totals	May 6	May 15	June 1	June 10	June 20	July 1	July 10	Totals
	Percentages of Emergences															
	Collection Dates								Collection Dates							
	White Pine Weevils								*Lonchaea corticis*							
Field Cages		4	.9	.5	.1			.4		[illegible]	10	.7				.9
July 9	17		2	.5		.6		.9		[illegible]	5	13	[illegible]	.3		2
July	80	68	56	46	32	27	19	40		20	35	64	34	7	10	32
August	3	27	40	52	66	64	72	55		80	42	30	51	60	60	47
Sept		.5	.7	1	1	8	7	4			5	4	11	26	24	14
Dec 30						.2	.3	.09			2	.9	2	6	6	3
	Coeloides pissodis								*Bracon pini*							
Field Cages				82	45	2	25	14			30	61	68			41
July 9			3	9	14	8		6			12	7	27	22		13
July		100	97	9	41	90	75	78		100	58	28	4	69	100	43
August								5				4				1
Sept																
Dec 30														9		1
	Rhopalicus pulchripennis								*Eurytoma pissodis*							
Field Cages			33	92	71			18					100			2
July 9					4	1		4								
July		100	67	8	14	92	71	71		100	100	100		82	87	90
August						1	28	3						18	12	7
Sept						5		3								
Dec 30																
	Eupelmus pini								*Pseudeucoila*							
Field Cages					17			1				20				1
July 9					17	17		7			100		8	5		8
July			100	100	67	75	67	76				80	69	74	33	69
August						8	33	15					22	21	67	22
Sept																
Dec 30																
	Oscinella conicola								*Oscinella hinkleyi*							
Field Cages				11				1								
July 9						18		5								
July			83	89	50	21	22	33			83	22	10	60	50	29
August			17		50	57	78	59			17	78	89	40	50	70
Sept																
Dec 30						3		1								

Table 16. -- (continued)

Emergence Check Groups	Percentages of Emergences															
	Collection Dates								Collection Dates							
	May 6	May 15	June 1	June 10	June 20	July 1	July 10	Totals	May 6	May 15	June 1	June 10	June 20	July 1	July 10	Totals
	Pediobius								Enoclerus nigripes							
Field Cages						6	6	5						33		20
July 9				67				9								
July				33	100	94		86			100					10
August														16		10
Sept												100		50		60
Dec 30																

Table 17. Seasonal emergence of the white pine weevil and associated species according to location and stand type

Emergence Check Dates	Numbers Emerged: White Pine Weevil	*Lonchaea corticis*	*Coeloides pissodis*	*Bracon pini*	*Rhopalicus pulchripennis*	*Oscinella conicola*	*Pseudeucoila* sp.	*Oscinella hinkleyi*	*Eupelmus pini*	*Eurytoma pissodis*	*Pediobius* sp.	*Enoclerus nigripes*	All Other Species	Totals
	Stand Type 1 - Radford, Snowville, Willis													
Field Bags	11		1	16			1						17	46
July														
9				10										10
11														
13				9										9
15		2	1	6	5		1							15
17	2	10	6	30					1	1			2	52
19	13	8	11	8	3	1								44
21	59	22	11	4				2		2			2	102
23	103	10	13	7	5	2		1		1	1		3	146
25	129	1	12	1	2			1	1	9			3	159
27	157	9	7						1	13			1	188
29	241	5	3		2				1	4				256
31	117	8							1				1	127
August														
2	92		4	3	1				2	2				104
4	151	20	1							1				173
6	221	20		1										242
8	212	8			1									221
10	254	21												275
12	168	24												192
14	63	15												98
16	202	23												225
18	87	18											1	106

Table 17. -- (continued)

Emergence Check Dates	Numbers Emerged: White Pine Weevil	Lonchaea corticis	Coeloides pissodis	Bracon pini	Rhopalicus pulchripennis	Oscinella conicola	Pseudeucoila sp.	Oscinella hinkleyi	Eupelmus pini	Eurytoma pissodis	Pediobius sp.	Enoclerus nigripes	All Other Species	Totals
						Stand Type 1 - Radford, Snowville, Willis								
20	57	20												77
22	41	30												71
24	24	16											1	41
26	3													3
28	18	53												71
30	5	6												11
September														
1	1	2												3
3	10	8												18
5	5	10												15
7	3	4			2									9
9	3	7												10
11	1	4												5
13	2	10												12
15	2	4												6
17	2	15												17
19		2												2
Dec 30	2	15												17
Totals	2461	430	70	95	21	3	2	4	7	33	1	0	31	3158
						Stand Type 2 - Catawba, Camp, Hillsville								
Field Bags	16	30	17	76	13	1			1	1		2	1	158
July														
9	21	50	2	20		5	4		3		2		8	115
11														
13	17	48	5	4	1		2						6	83
15	29	53	2	4		2	1		1	1	1		4	98

Table 17. -- (continued)

Emergence Check Dates	Numbers Emerged: White Pine Weevil	*Lonchaea corticis*	*Coeloides pissodis*	*Bracon pini*	*Rhopalicus pulchripennis*	*Oscinella conicola*	*Pseudeucoila* sp.	*Oscinella hinkleyi*	*Eupelmus pini*	*Eurytoma pissodis*	*Pediobius* sp.	*Enoclerus nigripes*	All Other Species	Totals
Stand Type 2 - Catawba, Camp, Hillsville														
17	54	97	7	15	5		8	2	3		1		4	196
19	104	44	1	5		5	4	3		1	1		5	173
21	133	107	5	6	1	2	3				3		1	261
23	192	132	2		2		8	1	4		3		2	346
25	135	104	2	4		2	10	1	5	3	2			268
27	157	67		1		2	4	1	1	1	3			237
29	225	72	1			4		1	2	1			2	308
31	131	32				1	1	1						165
August														
2	134	36					6							176
4	115	63	1			23	1	7					3	213
6	114	32						6					1	153
8	88	42	2			3			2					137
10	98	38				1		8						145
12	87	80						6					4	177
14	50	31				11	1	1	1					95
16	90	36					2							128
18	77	50				2							2	131
20	72	51				1		1						125
22	49	68				4	1						2	124
24	55	50					1						3	109
26	9	17					2						1	29
28	39	84						1				1	1	126
30	5	16												21
September														
1	10	33												43
3	18	27												45
5	13	33												46
7	14	15												29
9	5	20										1		26
11	8	23												31
13	3	13										1	17	17
15	4	13										3		20
17	1	11												12
19		11												11

Table 17. -- (continued)

Emergence Check Dates	White Pine Weevil	Lonchaea corticis	Coeloides pissodis	Bracon pini	Rhopalicus pulchripennis	Oscinella conicola	Pseudeucoila sp.	Oscinella hinkleyi	Eupelmus pini	Eurytoma pissodis	Pediobius sp.	Enoclerus nigripes	All Other Species	Totals
	Numbers Emerged													
Stand Type 2 - Catawba, Camp, Hillsville														
Dec 30	1	50		4									1	56
Totals	2373	1779	47	139	22	68	59	39	24	8	16	8	51	4633
Stand Type 3 - Deerfield Area 2, Rawley Springs, Speedwell														
Field Bags	1			11	1									13
July														
9			1	6			1							8
11														
13				3	1									4
15	2		1		1									4
17		4	4	2								1	1	12
19	1	1			6								1	9
21	5	13	1	4	1	3								27
23	14	11	1		1				1		1			29
25	2	23	2	1	4									32
27	18	21	1			2	2	3	1					48
29	8	22				1		1						32
31	10	9	1			2								22
August														
2	14	10												24
4	19	23						2					1	45
6	23	24												47
8	19	19				3								41
10	57	25												82
12	32	35	1		1	1		3						73
14	29	31												60
16	48	45												93
18	40	44												84
20	32	34				4								70
22	26	45												71
24	20	22											1	43
26	5	9												14
28	26	49												75
30	5	9												14

Table 17. -- (continued)

Emergence Check Dates	Numbers Emerged: White Pine Weevil	*Lonchaea corticis*	*Coeloides pissodis*	*Bracon pini*	*Rhopalicus pulchripennis*	*Oscinella conicola*	*Pseudeucoila sp.*	*Oscinella hinkleyi*	*Eupelmus pini*	*Eurytoma pissodis*	*Pediobius sp.*	*Enoclerus nigripes*	All Other Species	Totals
	Stand Type 3 - Deerfield Area 2, Rawley Springs, Speedwell													
September														
1	6	14												20
3	2	10												12
5	4	19			1									24
7	2	7												9
9	3	14												17
11	1	15												16
13	9	15												24
15	3	15												18
17		15												15
19		8												8
Dec 30		36												36
Totals	486	696	13	27	17	16	3	9	2	0	1	1	4	1275
	Stand Type 4 - Deerfield 1, Floyd													
Field Bags				4	3						1			8
July														
9	12	3			2									17
11														
13	2	6	1											9
15	17	1			1									19
17	26	7	2		2									37
19	12	5				1							1	19
21	24	7	1		1	1								34
23	18	6				1				1				26
25	15	2	1						1				1	20
27	17	3							1					21
29	21	5	1					1			1			29
31	16													16
August														
2	24	1				2								27
4	10	1												11
6	14	2												16

Table 17. -- (continued)

Emergence Check Dates	White Pine Weevil	*Lonchaea corticis*	*Coeloides pissodis*	Bracon pini	*Rhopalicus pulchripennis*	*Oscinella conicola*	*Pseudeucoila* sp.	*Oscinella hinkleyi*	*Eupelmus pini*	*Eurytoma pissodis*	*Pediobius* sp.	*Enoclerus nigripes*	All Other Species	Totals
						Stand Type - 4 - Deerfield 1, Floyd								
8	9													9
10	18													18
12	12	4						1						17
14	9							1						10
16	22							2						24
18	10	6						1						17
20	21	4												25
22	18	8												26
24	5													5
26	-	1												1
28	14	13												27
30	16	2												18
September														
1	7	5												12
3	11	4												15
5	8	11												19
7	4													4
9	9	1												10
11	3	3												6
13	2	3												5
15	2	1												3
17	4	3										1		8
19		1												1
Dec 30	2	6			1									9
Totals	434	125	6	4	9	6	6	6	2	1	2	1	2	598
						Stand Type 5 - Massanetta, Prices Fork								
Field Bags	1		5	1										7
July														
9	26		7		2								1	36
11														
13	28		3		1				1				1	34
15	43		6		2				3					54
17	45		3		4									52
19	26	1	1		7						1			35
21	11				4									16
23	22		2						1					25

Table 17. -- (continued)

Emergence Check Dates	White Pine Weevil	*Lonchaea corticis*	*Coeloides pissodis*	*Bracon pini*	*Rhopalicus pulchripennis*	*Oscinella conicola*	*Pseudeucoila* sp.	*Oscinella hinkleyi*	*Eupelmus pini*	*Eurytoma pissodis*	*Pediobius* sp.	*Enoclerus nigripes*	All Other Species	Totals
	Numbers Emerged													
	Stand Type 5 - Massanetta, Prices Fork													
25	9				4									13
27	7													7
29	1													1
31	6													6
August														
2	6													6
4	2							2						4
6	6													6
8	2													2
10	5													5
12	2							1	1					4
14	2													2
16	3													3
18	2													2
20														
22														
24	4													4
26														
28														
30	2													2
September														
1														
3	1													1
5	1													1
7	1													1
9	12													12
11	1													1
13	5													5
15														
17	8													8
19	1													1
Dec 30	1													1
Totals	292	1	27	1	24			3	6	0	1	0	2	357

Table.18. Percentages of emergence of the white pine weevil and associated species for the stand types and seasonal categories

Emergence Check Groups	White Pine Weevil	Lonchaea corticis	Coeloides pissodis	Bracon pini	Rhopalicus pulchripennis	Oscinella conicola	Pseudeucoila	Oscinella hinkleyi	Eupelmus pini	Eurytoma pissodis	Pediobius	Enoclerus nigripes	All Total Species	Total
	Percentages of Emergences													
Stand Type 1														
July	33	17	91	58	81	100	50	100	71	91	100		39	35
August	65	64	7	4	9				28	9			6	60
Sept	1	19			9									3
Dec 30	.08													0.5
Fld Bgs	11			v17			50						55	1
July 9				10										.3
Stand Type 2														
July	49	42	53	28	40	25	69	23	71	87	87		47	46
August	45	39	6			66	24	77	12			12	33	41
Sept	3	11										62		6
Dec 30	.04	3		3									2	1
Fld Bgs	.6	2	36	55	52	1			4	12		25	2	3
July 9	.8	3	4	14		7	7		12		12		16	2
Stand Type 3														
July	12	15	85	37	82	50	67	44	100		100	100	50	17
August	81	61	8		.6	50		55					50	65
Sept	6	19			.6									13
Dec 30		5												3
Fld Bgs	0.2			41	.6									1
July 9			8	22			33							.6
Stand Type 4														
July	39	34	100		44	50		17	100	100	50		100	28
August	46	34				33		83						42
Sept	11	26										100		14
Dec 30	.4	5				17								1
Fld Bgs				100	33						50			1
July 9	3	2			22									3
Stand Type 5														
July	68	100	55		92				83		100		50	68
August	12							100	17					11
Sept	10													8
Dec 30	.3													.2
Fld Bgs			18	100										[illegible]
July 9	9		26		8								50	10

Table 19. Emergence of the white pine weevil and associated species according to ecological position within stands.

Ecological Position	Collection location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing Number	Leaders Yielding Nothing Percent
Edge	Radford	2					0	0
	June 1		White Pine Weevil	18	2	8		
Edge	Radford July 1	7	White Pine Weevil	230	7	32.8	0	0
			Lonchaea corticis	15	3	5		
			Oscinella hinkleyi	2	1	2	—	—
			Totals	247	7	35.28		
Totals for Edge, Stand Type 1		9	TOTAL	265	9	29.44	0	0
			Associated Species	17	4	4.25		
Edge	Catawba	10					1	10
	June 20		White Pine Weevil	41	7	5.8		
			Coeloides pissodis	2	2	1		
			Bracon pini	10	2	2.5		
			Rhopalicus pulchripennis	1	1	1		
			Eurytoma pissodis	1	1	1		
			Oscinella conicola	2	1	2.0		
			Oscinella hinkleyi	1	1	1	—	—
			Totals	58	9	6.44		
			Associated Species	17	8	2.12		

Table 19. -- (Continued)

Ecological Position	Collection Location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing Num-ber	Leaders Yielding Nothing Per-cent
Edge	Catawba July 1	25					3	12
			White Pine Weevil	66	16	4.1		
			Lonchaea corticis	48	8	6		
			Coeloides pissodis	4	4	1		
			Bracon pini	2	1	2		
			Rhopalicus pulchripennis	3	3	1		
			Eurytoma pissodis	1	1	1		
			Eupelmus pini	1	1	1		
			Oscinella conicola	1	1	1		
			Pediobius	1	1	1		
			Totals	127	22	5.77	—	—
			Associated Species	61	9	6.78		
Edge	Catawba July 10	28					15	53
			White Pine Weevil	27	11	2.4		
			Lonchaea corticis	3	2	1.5		
			Coeloides pissodis	1	1	1		
			Bracon pini	1	1	1		
			Eurytoma pissodis	1	1	1		
			Eupelmus pini	4	1	4		
			Totals	37	13	2.85	—	—
			Associated Species	10	5	2.00		

Table 19. -- (Continued)

Ecological Position	Collection Location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing Num- ber	Leaders Yielding Nothing Per- cent
Edge	Camp	10					3	30
	July 1		White Pine Weevil	47	6	7.8		
			Lonchaea corticis	36	4	9		
			Coeloides pissodis	1	1	1		
			Bracon pini	6	3	2		
			Eupelmus pini	1	1	1		
			Oscinella hinkleyi	1	1	1		
			Cremastus sp.	1	1	1		
			Totals	93	7	13.28		
			Associated Species	46	7	6.57		
Edge	Hillsville	8					1	12
	July 1		White Pine Weevil	11	5	2.2		
			Lonchaea corticis	4	2	2		
			Bracon pini	2	1	1		
			Eupelmus pini	2	1	1		
			Apanteles aristoteliae	1	1	1		
			Habrocytus sp.	1	1	1		
			Oscinella conicola	12	2	6		
			Oscinella hinkleyi	1	1	1		
			Sericophanes heidimanni	1	1	1		
			Totals	35	7	5.0		
			Associated Species	24	7	3.43		
Totals for Edge, Stand Type 2		81		350	58	6.03	23	28
			Associated Species	175	40	4.37		
TOTALS FOR EDGE		90		615	67	9.18	23	26

Table 19. -- (Continued)

Ecological Position	Collection Location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing Number	Leaders Yielding Nothing Percent
Inside	Radford	12					0	0
	June 1		White Pine Weevil	440	14	31.4		
			Lonchaea corticis	34	1	34		
			Coeloides pissodis	25	4	6.2		
			Bracon pini	21	4	5.2		
			Exeristes comstockii	3	1	3		
			Rhopalicus pulchripennis	1	1	1		
			Eurytoma pissodis	5	2	2.5		
			Eupelmus pini	2	2	1		
			Monodontomerus aereus	17	1	17		
			Leptocera	1	1	1		
			Totals	549	12	45.75		
			Associated Species	109	9	12.11		
Inside	Radford	17					1	1
	June 10		White Pine Weevil	287	14	20.5		
			Lonchaea corticis	1	1	1		
			Coeloides pissodis	1	1	1		
			Bracon pini	48	7	6.8		
			Rhopalicus pulchripennis	1	1	1		
			Eurytoma pissodis	5	2	2.5		
			Pseudeucoila	1	1	1		
			Oscinella conicola	2	1	2		
			Oscinella hinkleyi	1	1	1		
			Totals	347	16	21.69		
			Associated Species	60	9	6.67		

Table 19. -- (Continued)

Ecological Position	Collection Location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing: Number	Leaders Yielding Nothing: Percent
Inside	Radford July 1	20					1	5
			White Pine Weevil	324	17	19		
			Lonchaea corticis	16	6	2.6		
			Coeloides pissodis	6	4	1.5		
			Bracon pini	4	4	1		
			Exeristes comstockii	1	1	1		
			Rhopalicus pulchripennis	3	1	3		
			Eurytoma pissodis	3	3	1		
			Eupelmus pini	1	1	1		
			Lampoterma	1	1	1		
			Totals	359	19	18.89	—	—
			Associated Species	35	13	2.69		
TOTALS-STAND TYPE 1		49	TOTAL	1255	47	26.70	2	4
			Associated Species	204	31	6.58		
Inside	Catawba June 20	10					1	10
			White Pine Weevil	118	8	14.7		
			Lonchaea corticis	40	4	10		
			Coeloides pissodis	1	1	1		
			Bracon pini	2	1	2		
			Rhopalicus pulchripennis	1	1	1		
			Oscinella hinkleyi	2	1	2		
			Enoclerus nigripes	3	2	1.5		
			Totals	167	9	18.55	—	—
			Associated Species	49	7	7.00		

Table 19. -- (Continued)

Ecological Position	Collection Location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing Number	Leaders Yielding Nothing Percent
Inside	Catawba	19					6	31
	July 1		White Pine Weevil	28	10	2.8		
			Lonchaea corticis	16	2	8		
			Bracon pini	1	1	1		
			Eurytoma pissodis	1	1	1		
			Eupelmus pini	1	1	1		
			Oscinella hinkleyi	1	1	1		
			Totals	48	13	3.69		
			Associated Species	20	5	4.00		
Inside	Catawba	6					3	50
	July 10		White Pine Weevil	4	2	2		
			Lonchaea corticis	13	2	6.5		
			Bracon pini	3	1	3		
			Totals	20	5	4.00		
			Associated Species	16	2	8.00		

Table 19. -- (Continued)

Ecological Position	Collection Location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing Num-ber	Leaders Yielding Nothing Per-cent
Inside	Camp	17					2	12
	July 1		White Pine Weevil	114	12	9.5		
			Lonchaea corticis	120	11	10.9		
			Coeloides pissodis	5	4	1.2		
			Bracon pini	1	1	1		
			Rhopalicus pulchripennis	5	2	2.5		
			Pseudeucoila	7	4	1.7		
			Apanteles aristoteliae	1	1	1		
			Oscinella conicola	1	1	1		
			Pediobius n. sp.	10	2	5		
			Cremastus sp.	1	1	1		
			Totals	265	15	17.67		
			Associated Species	151	13	11.61		
Inside	Hillsville	17						
	July 1		White Pine Weevil	40	9	4.4		
			Lonchaea corticis	138	8	17.2		
			Coeloides pissodis	4	2	2		
			Bracon pini	12	3	4		
			Eurytoma pissodis	1	1	1		
			Eupelmus pini	2	1	2		
			Pseudeucoila	11	1	1		
			Oscinella conicola	6	2	3		
			Pediobius n. sp.	1	1	1		
			Gelis sp.	1	1	1		
			Totals	216	15	14.40		
			Associated Species	176	12	14.67		

Table 19. -- (Continued)

Ecological Position	Collection Location and Date	Leaders Collected	Species	Total Numbers Emerged	Leaders Yielding	Emergences Per Leader Yielding	Leaders Yielding Nothing: Number	Leaders Yielding Nothing: Percent
Total Stand type 2 Inside		69		716	57	12.56	17	25
			Associated Species	412	39	10.56		
TOTALS FOR INSIDE		118		1971	99	19.91	19	16

Table 20. Summary of emergence data on ecological position

Ecological Position	Species	Emergences: Total Number	Emergences: Percent of Total	Emergences: Ave. Per Leaders Yielding	Leaders Yielding: Total Number	Leaders Yielding: Percent of Total
Edges	White Pine Weevil	440	71	8.15	54	80
	Lonchaea corticis	106	17	10.60	10	15
	Coeloides pissodis	8	1	1.14	7	10
	Bracon pini	21	3	2.62	8	12
	Rhopalicus pulchripennis	4	0.1	1.00	4	6
	Eurytoma pissodis	3	0.1	1.00	3	4
	Eupelmus pini	8	1	2.00	4	6
	Apanteles aristoteliae	1	0.1	1.00	1	1
	Habrocytus sp.	1	0.1	1.00	1	1
	Oscinella conicola	15	2	3.75	4	6
	Oscinella hinkleyi	5	1	1.25	4	6
	Pediobius n. sp.	1	0.1	1.00	1	1
	Cremastus sp.	1	0.1	1.00	1	1
	Sericophanes heidimanni	1	0.1	1.00	1	1
	Totals	615		9.18	67	74%
	Associated Species	175		3.64	48	53%
Inside	White Pine Weevil	1355	69	15.75	86	70
	Lonchaea corticis	378	19	10.80	35	30
	Coeloides pissodis	42	2	2.62	16	13
	Bracon pini	92	5	4.18	22	19
	Exeristes comstockii	4	0.20	2.00	2	2
	Rhopalicus pulchripennis	11	0.55	1.83	6	5
	Eurytoma pissodis	15	0.76	1.67	9	8
	Eupelmus pini	6	0.30	1.20	5	4
	Monodontomerus aereus	17	0.86	17.00	1	0.8
	Pseudeucoila	19	0.96	3.17	6	5
	Apanteles aristoteliae	1	0.05	1.00	1	0.8
	Oscinella conicola	9	0.45	2.25	4	3
	Leptocera sp.	1	0.05	1.00	1	0.8
	Oscinella hinkleyi	4	0. 20	1.33	3	2
	Pediobius n. sp.	11	0.55	3.67	3	2
	Cremastus sp.	1	0.05	1.00	1	0.8
	Lampoterma sp.	1	0.05	1.00	1	0.8
	Gelis sp.	1	0.05	1.00	1	0.8
	Enoclerus nigripes	3	0.15	1.50	2	2
	Totals	1971		19.91	99	83%
	Associated Species	616		8.80	70	59%

Table 21. Comparisons of stand types 1 and 2 for inside and outside ecological positions

Stand Type	Leaders Collected	Ecological Position	White Pine Weevil: Number	White Pine Weevil: Percent of Total	White Pine Weevil: Ave. Per Leader Yielding	Associated Species: Total Number	Associated Species: Percent of Total	Associated Species: Ave. Per. Leader Yielding	Leaders Yielding Nothing: Number	Leaders Yielding Nothing: Per cent
1	9	Edge	248	93	27.55	17	6	4.25	0	0
1	49	Inside	1051	84	23.35	204	16	6.58	2	4
2	81	Edge	192	55	7.38	158	45	4.05	23	28
2	69	Inside	304	42	7.41	412	57	10.56	17	25
		Totals	1795			791				

Table 22. Longevity of adult parasites on a diet of moist honey

Lonchaea corticis

Number of Insects	Days Lived	
1	2	
2	3	
2	4	
2	5	
3	7	
1	9	
1	10	
3	11	
2	12	
2	13	
1	14	
2	15	
2	16	
1	17	
1	18	
26	156	
Average	6.00	Days
Minimum	2	Days
Maximum	18	Days

Coeloides pissodis

Number of Insects	Days Lived	
1	2	
3	3	
1	4	
6	5	
3	11	
2	10	
4	12	
2	13	
3	14	
3	15	
1	16	
3	17	
2	18	
34	140	
Average	4.12	Days
Minimum	2	Days
Maximum	18	Days

Pseudeucoila

Number of Insects	Days Lived	
2	4	
1	5	
2	6	
1	8	
1	9	
2	11	
3	12	
2	13	
1	16	
1	18	
1	19	
1	21	
18	142	
Average	7.89	Days
Minimum	4	Days
Maximum	21	Days

Rhopalicus pulchripennis

Number of Insects	Days Lived	
1	10	
1	11	
1	12	
1	13	
1	14	
1	16	
1	17	
7	93	
Average	13.28	Days
Minimum	10	Days
Maximum	17	Days

Bracon pini

Number of Insects	Days Lived	
1	13	Days

Exeristes comstockii

Number of Insects	Days Lived	
1	1	
1	5	
2	6	
1	16	
5	28	
Average	5.6	Days
Minimum	1	Day
Maximum	16	Days

Eupelmus pini

Number of Insects	Days Lived	
1	6	
1	7	
2	13	
Average	6.5	Days
Minimum	6	Days
Maximum	7	Days

Eurytoma pissodis

Number of Insects	Days Lived
1	8

Table 23. Emergences and mortality of the white pine weevil from 4-inch sections down white pine leaders

Collection Location and Ecological Position	Inches From Leader Tip	White Pine Weevil: Adults Emerged Number	Adults Emerged Per cent	Adults Stuck in Emergence Number	Adults Stuck in Emergence Per cent	Weevil Larvae Dead Number	Weevil Larvae Dead Per cent	Total Observed Mortality Number	Total Observed Mortality Per cent	Ave. Per Leader Yielding	Leader Sections Yielding Number	Leader Sections Yielding Per cent	Total Leader Sections Number	Total Leader Sections Per cent
Radford,	1-4	0	0	0	0	4	5	4	3	0.66	6	8	16	16
Edge	4-8	1	0.4	0	0	4	5	4	3	0.40	10	14	15	15
16 Leaders	8-12	9	4	0	0	25	33	25	20	1.78	14	20	15	15
	12-16	25	11	5	10	24	31	29	23	2.07	14	20	15	15
	16-20	43	20	12	25	9	12	21	17	1.91	11	16	14	14
	20-24	49	22	15	31	10	13	25	20	3.57	7	10	11	11
	24-28	68	31	11	23	0	0	11	9	1.83	6	8	14	14
	28-32	22	10	5	10	0	0	5	4	2.50	2	3	1	1
	Totals	217		48		76		124		1.77	70		101	
Percentages of Totals	------	64%		14%		22%		36%			70%			
Catawba,	1-4	3	1	0	0	73	26	73	21	5.21	14	26	23	21
Edge	4-8	3	1	0	0	66	24	66	19	4.71	14	26	23	21
23 Leaders	8-12	19	8	6	9	68	24	74	21	6.17	12	22	22	20
	12-16	36	15	9	14	50	18	59	17	6.55	9	17	19	17
	16-20	40	16	23	35	8	3	31	9	10.33	3	5	9	8
	20-24	24	10	16	25	14	5	30	9	15.00	2	4	7	6
	24-28	54	22	9	14	0	0	9	3	2.25	4	0	5	4
	28-32	67	27	2	3	0	0	2	1	1.00	2	0	2	2
	Totals	246		65		279		344		6.37	54		110	
Percentages of Totals	------	42%		11%		47%		58%			49%			
Total,	1-4	3	1	0	0	77	22	77	16	3.85	20	16	39	18
Edge	4-8	4	1	0	0	70	20	70	15	2.92	24	19	38	18
39 Leaders	8-12	28	6	6	5	93	26	99	21	3.81	26	21	37	17
	12-16	61	13	14	12	74	21	88	19	3.83	23	18	34	16
	16-20	83	18	35	31	17	5	52	11	3.71	14	11	23	11
	20-24	73	16	31	27	24	7	55	12	6.11	9	7	18	8
	24-28	122	26	20	18	0	0	20	4	3.33	6	5	19	9
	28-32	89	19	7	6	0	0	7	1	3.50	2	7	3	1
	Totals	463		113		355		468		3.77	124		211	
Percentages of Totals	------	50%		12%		38%		50%			59%			

Table 23 -- (continued)

Collection Location and Ecological Position	Inches From Leader Tip	White Pine Weevil: Adults Emerged Num-ber	Adults Emerged Per-cent	Adults Stuck in Emer-gence Num-ber	Adults Stuck in Emer-gence Per-cent	Weevil Larvae Dead Num-ber	Weevil Larvae Dead Per-cent	Total Observed Mortality Num-ber	Total Observed Mortality Per-cent	Ave. Per Lead-er Yield-ing	Leader Sections Yielding Num-ber	Leader Sections Yielding Per-cent	Total Leader Sections Num-ber	Total Leader Sections Per-cent
Radford,	1-4	0	0	7	17	31	9	38	10	3.16	12	11	27	18
Inside	4-8	1	0.3	0	0	73	21	73	19	3.48	21	19	26	17
27 Leaders	8-12	8	3	7	17	82	24	89	23	4.68	19	17	25	17
	12-16	53	18	5	12	82	24	87	23	3.95	22	20	25	17
	16-20	71	24	10	24	53	16	63	17	3.15	20	18	21	14
	20-24	71	24	8	19	7	2	15	4	1.87	8	7	14	9
	24-28	31	10	2	5	5	1	7	2	1.75	4	4	4	3
	28-32	64	21	2	5	5	1	7	2	1.40	5	4	6	4
	Totals	299		41		338		379		3.41	111		148	
Percentages of Totals ------		44%		6%		50%		56%			75%			
Catawba,	1-4	3	1	1	3	14	12	15	10	2.14	7	11	21	19
Inside	4-8	5	1	3	8	39	33	42	27	3.50	12	19	22	20
21 Leaders	8-12	50	15	10	26	22	19	32	21	2.00	16	26	19	17
	12-16	39	12	3	8	22	19	25	16	2.50	10	16	17	16
	16-20	107	32	11	29	4	3	15	10	2.14	7	11	12	11
	20-24	89	27	7	18	16	14	23	15	2.87	8	13	12	11
	24-28	27	8	3	8	0	0	3	2	3.00	1	2	4	4
	28-32	9	3	0	0	0	0	0	0	0.00	1	2	1	1
	Totals	329		38		117		155		2.50	62		108	
Percentages of Totals ------		68%		8%		24%		32%			57%			
Total,	1-4	3	0.4	8	10	45	9	53	10	2.79	19	11	48	19
Inside	4-8	6	1	3	4	112	25	115	21	3.48	33	19	48	19
48 Leaders	8-12	58	9	17	21	104	23	121	23	3.46	35	20	44	17
	12-16	92	15	8	10	104	23	112	21	3.50	32	18	42	16
	16-20	178	28	21	26	57	12	78	15	2.89	27	16	33	13
	20-24	160	25	15	19	23	5	38	7	2.37	16	9	26	10
	24-28	58	9	5	6	5	1	10	2	2.00	5	3	8	3
	28-32	73	12	2	2	5	1	7	1	1.17	6	3	7	3
	Totals	628		79		455		534		3.09	173		256	
Percentages of Totals ------		54%		7%		39%		46%			67%			

Table 23 -- (continued)

Collection Location and Ecological Position	Inches From Leader Tip	White Pine Weevil: Adults Emerged Number	Adults Emerged Percent	Adults Stuck in Emergence Number	Adults Stuck in Emergence Percent	Weevil Larvae Dead Number	Weevil Larvae Dead Percent	Total Observed Mortality Number	Total Observed Mortality Percent	Ave. Per Leader Yielding	Leader Sections Yielding Number	Leader Sections Yielding Percent	Total Leader Sections Number	Total Leader Sections Percent
Totals for all Locations and Positions	1-4	6	0.5	8	4	122	15	130	13	3.33	39	13	87	19
	4-8	10	1	3	1	182	22	185	18	3.24	57	19	86	18
	8-12	86	8	23	12	197	24	220	22	3.61	61	20	81	17
	12-16	153	14	22	11	178	22	200	20	3.64	55	18	76	16
	16-20	261	24	56	29	74	9	130	13	3.17	41	14	56	12
	20-24	233	21	46	24	47	6	93	9	3.72	25	8	44	9
	24-28	180	16	25	13	5	1	30	3	2.73	11	4	27	6
	28-32	162	15	9	5	5	1	14	1	4.67	8	3	10	2
	Totals	1091		192		810		1002		3.31	297		467	
Percentages of Totals ------		52%		9%		39%		48%			63%			

Table 24. Emergences of associated species from 4-inch sections down white pine leaders

Inches From Leader Tip	Radford Species	Radford Number	Catawba Species	Catawba Number	Total
1-4	Coeloides pissodis	1			1
	Bracon pini	5	Bracon pini	6	11
	Rhopalicus pulchripennis	2	Rhopalicus pulchripennis	2	4
	Eurytoma sp.	1	Eurytoma sp.	1	2
	Total	9	Total	9	18
4-8	Coeloides pissodis	1			1
	Bracon pini	8	Bracon pini	1	9
	Rhopalicus pulchripennis	5	Rhopalicus pulchripennis	9	14
	Eurytoma sp.	3			3
	Eupelmus sp.	1	Eupelmus sp.	1	2
	Enoclerus nigripes	1			1
			Eupelmus pini	1	1
			Eurytoma crassineura	1	1
	Total	19	Total	13	32
8-12	Lonchaea corticis	2			2
	Coeloides pissodis	2			2
	Bracon pini	19	Bracon pini	28	47
	Rhopalicus pulchripennis	2	Rhopalicus pulchripennis	2	4
	Eurytoma pissodis	1	Eurytoma pissodis	2	3
	Eupelmus sp.	2			2
	Total	28	Total	32	60
12-16	Lonchaea corticis	4			4
	Coeloides pissodis	5	Coeloides pissodis	11	16
	Bracon pini	13	Bracon pini	15	28
	Eurytoma pissodis	1			1
	Eupelmus sp.	1			1
			Rhopalicus pulchripennis	4	4
			Enoclerus nigripes	1	1
	Total	24	Total	31	55
16-20	Coeloides pissodis	7			7
	Eurytoma pissodis	8			8
	Eupelmus pini	1			1
	Total	16	Total		16
20-24	Coeloides pissodis	5			5
	Total	101		85	186

Table 25. Occurrence of organisms observed in inch-by-inch dissection

Distance Down Leaders (Inches)	White Pine Weevils 1/ - Eggs Number	Eggs Ave.	All Other Stages - Living Number	Living Ave.	Dead Number	Dead Ave.	Lonchaea corticis - Eggs Number	Eggs Ave.	Larvae Number	Larvae Ave.	Pupae Number	Pupae Ave. 2/
May 20 - 4 Leaders												
1	11	2.75	6	1.50	9	2.25	13	3.25	2	0.50	1	0.25
2	9	2.25	1	0.25	10	2.50	40	10.00	7	1.75		
3	6	1.50	28	7.00	5	1.25	41	10.25	9	2.25		
4	22	5.50	3	0.75	12	3.00	20	5.00	17	4.25		
5	13	3.25	8	2.00	17	4.25	17	1.75	11	2.75		
6	7	1.75	3	0.75	7	1.75	47	11.75	18	4.50		
7			6	1.50	7	1.75			22	5.50		
8	8	2.00	10	2.50	3	0.75	16	4.00	8	2.00		
9	4	1.00	10	2.50	4	1.00	30	7.50				
10			17	4.25	6	1.50			1	0.25		
11			1	0.25	1	0.25						
12			3	0.75								
13			64	16.00								
Total	80	20.00	160	40.00	81	20.25	224	56.00	95	23.75	1	0.25
June 10 - 4 Leaders												
1			1	0.25	9	2.25			4	1.00		
2	3	0.75	1	0.25	6	1.50						
3					11	2.75	3	0.75				
4					7	1.75	23	5.75	13	3.25		
5	4	1.00			11	2.75	21	5.25				
6	1	0.25			4	1.00						
7					4	1.00			10	2.50		
8					9	2.25	11	2.75	24	6.00		
9			4	1.00	13	3.25	4	1.00	9	2.25		
10					11	2.75						
11			9	2.25	6	1.50	3	0.75	13	3.25		
12			45	11.25	8	2.00			4	1.00		
13	3	0.75	2	0.50	6	1.50			12	3.00	5	1.25
14	4	1.00	1	0.25	6	1.50	2	0.50	1	0.25		

(continued next page)

1/ For entire table, E=egg; L=larva; P=pupa; A=adult

2/ Ave. designates average numbers of the subject per number of leaders dissected for that date(collection).

of leaders during 1965

Weevil Feeding Punctures Number	Ave.	Unidentified Forms, Not Definite Cases of Parasitism Number	Ave.	Unidentified Forms, Definitely Cases of Parasitism Number	Ave.	Identified Cases of Parasitism Number	Ave.	Species
41	10.25							
77	19.25			1P	0.25	1	0.25	*Bracon pini*
66	16.50	1L (clerid)	0.25	4P	1.00			
54	13.50			3P	0.75			
40	10.00					3	0.75	*Bracon pini*
26	6.50							
26	6.50							
30	7.50	1L (clerid)	0.25	1L	0.25			
24	6.00							
384	96.00	2L	0.50	9	2.25	4	1.00	
62	15.50			1P	0.25			
102	25.50			1P	0.25	1	0.25	*Bracon pini*
104	26.00	1A	0.25	1P	0.25			
94	23.50	(beetle)						
85	21.25	1A (Scolytidae)	0.25	3P	0.75			
89	22.25			2P	0.50			
77	19.25	1A	0.25	1P	0.25			
53	13.25							
56	14.00					1	0.25	*Bracon pini*
49	12.25					1	0.25	Alive, Jan. 20, larval stage
57	14.25							
24	6.00							
47	11.75							
32	8.00							

Table 25. -- (continued)

Distance Down Leaders (Inches)	White Pine Weevils: Eggs Number	White Pine Weevils: Eggs Ave.	White Pine Weevils: 1/ - All Other Stages: Living Number	Living Ave.	Dead Number	Dead Ave.	Lonchaea corticis: Eggs Number	Eggs Ave.	Larvae Number	Larvae Ave.	Pupae Number	Pupae Ave.[2]
June 10 - 4 Leaders (continued)												
15	4	1.00	11	2.75	2	0.50			2	0.50		
16			2	0.50					9	2.25		
17			3	0.75	2	0.50			5	1.25		
18			3	0.75					6	1.50		
19			3	0.75	2	0.50			5	1.25		
20			37	9.25	1	0.25			5	1.25		
21			30	7.50	16	4.00						
Totals	19	4.75	63	15.75	134	33.50	67	16.75	122	30.50	5	1.25
June 20 - 25 Leaders												
1	141	5.64	5	0.20	62	2.48	58	2.32	19	0.76		
2	124	4.96	4	0.16	39	1.56	86	3.44	11	0.44		
3	96	3.84	2	0.08	35	1.40	76	3.04	30	1.20		
4	108	4.32	4	0.16	28	1.12	70	2.80	14	0.56		
5	96	3.84	3	0.12	40	1.60	69	2.76	12	0.48		
6	67	2.68	6	0.24	32	1.28	95	3.80	27	1.08		
7	59	2.36	2	0.08	36	1.44	65	2.60	30	1.20		
8	47	1.88	49	1.96	35	1.40	76	3.04	63	2.52	3	0.12
9	10	0.40	10	0.40	27	1.08	17	0.68	91	3.64	2	0.08
10	12	0.48	11	0.44	44	1.76	76	3.04	92	3.68	1	0.04
11	9	0.37	34	1.36	81	3.24	97	3.88	151	6.04	4	0.16
12			32	1.28	38	1.52	8	0.32	66	2.64	3	0.12
13			60	2.40	44	1.76			95	3.80	9	0.36
14			43	1.72	48	1.92			72	2.88	1	0.04
15			61	2.44	17	0.68	2	0.08	28	1.12		
16			50	2.00	14	0.56			18	0.72		
17			22	0.88	11	0.44			6	0.24		
18			14	0.56	3	0.12			5	0.20		
19			12	0.48	9	0.37						
20			33	1.32	17	0.68			3	0.12		
21			30	1.20								
Totals	769	61.52	487	19.48	660	26.40	795	31.80	833	33.32	23	0.92

Weevil Feeding Punctures		Unidentified Forms, Not Definite Cases of Parasitism		Unidentified Forms, Definitely Cases of Parasitism		Identified Cases of Parasitism		
Number	Ave.	Number	Ave.	Number	Ave.	Number	Ave.	Species
14	3.50							
7	1.75							
952	238.00		0.75	9	2.25	3	0.75	
		3L-clerids, 3L						
502	20.08	7	0.28			1	0.04	2 *Bracon pini*
		1A, beetle						
546	21.84			1P	0.04			
478	19.12			1P	0.04			
414	16.56	3L	0.75 clerids					
442	17.68	1A	0.04	4	0.16	1	0.04	1 *Bracon pini*
		beetle						
373	14.92	2L	0.08	5	0.20			
		clerids						
200	8.00	2L clerids		4	0.16	1	0.04	1 *Bracon pini*
161	6.44	3	0.12	9	0.36			
		1A Scolytidae						
84	3.36	9L	0.36	2	0.08			
		clerids						
85	3.40	3L	0.75	4	0.16			
		clerids						
37	1.48	2L	0.08	2	0.08	1	0.04	1 *Bracon pini*
		clerids						
14	0.56	clerid		1	0.04			
11	0.44	1L	0.04	5	0.20			
8	0.32			1	0.04			
3	0.12							
				1	0.04			
				1	0.04			
7	0.28							
3365	134.60	31	1.24	41	1.64	4	0.16	

Table 25. -- (continued)

Distance Down Leaders (Inches)	White Pine Weevils[1] Eggs Number	Eggs Ave.	All Other Stages Living Number	Living Ave.	Dead Number	Dead Ave.	*Lonchaea corticis* Eggs Number	Eggs Ave.	Larvae Number	Larvae Ave.	Pupae Number	Pupae Ave.[2]
July 1-20 - 19 Leaders												
1	71	3.73			43	2.26	31	1.63	7	0.37		
2	78	4.10			34	1.79	11	0.58	13	0.68		
3	70	3.68			39	2.05	70	3.68	4	0.21		
4	66	3.47			32	1.68	27	1.42	3	0.16	9	0.47
5	44	2.31			19	1.00	25	1.31	5	0.26	1	0.05
6	53	2.79			29	1.53	35	1.84	5	0.26	7	0.37
7	48	2.53	2	0.10	28	1.47	27	1.42	1	0.05	7	0.37
8	32	1.68	6	0.31	45	2.37	4	0.21	16	0.84	9	0.47
9			10	0.53	41	2.16	14	0.74	8	0.24	5	0.26
10	41	2.16	12	0.63	18	0.95	4	0.21	2	0.10	10	0.53
11	11	0.58	16	0.84	24	1.26	1	0.05	12	0.63	6	0.31
12	7	0.37	16	0.84	9	0.47	17	0.89	20	1.05	12	0.63
13	9	0.47	18	0.95	7	0.37			25	1.31	11	0.58
14	5	0.26	19	1.00	9	0.47			30	1.58	9	0.47
15			21	1.10	9	0.47	[illegible]		30	1.58	7	0.37
16			41	2.16	25	1.31			20	1.05	5	0.26
17	4	0.21	22	1.16	32	1.68			6	0.31	2	0.10
18			56	2.95	26	1.37			6	0.31	6	0.31
19			37	1.95	27	1.42	7	0.37	8	0.42	1	0.05
20			34	1.79	38	2.00			12	0.63		
21			27	1.42	27	1.42			7	0.37		
22			49	2.58	22	1.16			9	0.47	5	0.26
23			34	1.79	15	0.79			2	0.10		
24			18	0.95	33	1.74			1	0.05		
25			2	0.10	22	1.16						
26					14	0.74						
Totals	539	28.37	440	23.16	667	35.10	273	14.37	252	13.26	112	5.89

Weevil Feeding Punctures		Unidentified Forms, Not Definite Cases of Parasitism		Unidentified Forms Definitely Cases of Parasitism		Identified Cases of Parasitism		
Number	Ave.	Number	Ave.	Number	Ave.	Number	Ave.	Species
		Scolytidae						
417	21.95	1	0.05	6	0.31	1	0.05	Sent for identification.
395	20.79			3	0.16			
400	21.05			6	0.31			
387	20.37			2	0.10			
		clerid						
297	15.63	1	0.05	5	0.26			
238	12.53	9	0.47					
199	10.47	5	0.26	(clerids 2)		1	0.05	1 *Coeloides pissodis*
176	9.26	9	0.47	1	0.05	1	0.05	1 *Pseudeucoila*, parasitizing a *Lonchaea corticis* pupa
		clerid						
		1	0.05	2P	0.10			
123	6.47			1	0.05	2	0.10	1 *Coeloides pissodis* 1 Sent for identification
58	3.05	2P	0.10					
50	2.63	2L	0.10					
10	0.53	2	0.10					
38	2.00	2L	0.10					
		clerids						
6	0.31	2L	0.10					
18	0.95	11 (1L, 10P)	0.58	1	0.05	2	0.10	Sent for identification.
13	0.68	12 (1L, clerid, 10P)	0.63			2	0.10	*Eurytoma pissodis*
		2P	0.10			2	0.10	1 *Coeloides pissodis* 1 *Bracon pini*
		1L	0.05	2	0.10	2	0.10	2 *Coeloides pissodis*
		clerid						
		2P	0.10	2P	0.10	3	0.16	3 *Coeloides pissodis*
						3	0.16	4 *B. pini*, 1 *C. pissodis*, 1 still alive, larva, Jan. 20
		2A	0.10	2P	0.10	3	0.16	2 *Coeloides pissodis*, 1 still live larva, Jan. 20
		scolytidae						
						7	0.37	6 *C. pissodis* (in burrows), (1 *C. pissodis* cocoon with live larva inside, Jan. 20)
						5	0.26	4 *B. pini*, 2 *C. pissodis*, 2 external, solitary parasite alive in larvae stage, Jan. 20
				2L	0.10	4	0.21	6 *B. pini*, 1 *C. pissodis*
2825	148.68	66	3.47	35	1.84	38	2.00	

Table 26. Head capsule measurements, numbers, and percentages for the various collection dates

Head Capsule Width (mm)	Living Number	Living Percent of Total	Dead Number	Dead Percent of Total	Total Number	Total Percent of Total
May 20						
0.11	10	6	2	2	10	4
0.21	10	6			12	5
0.30	15	9			15	6
0.31	19	12	3	4	22	9
0.32	8	5			8	3
0.40	4	2			4	2
0.42	19	12	17	21	36	15
0.50			1	1	1	0.4
0.51	1	1			1	0.4
0.52			3	4	3	1
0.53	5	3	12	15	17	7
0.54	1	1			1	0.4
0.60	4	2			4	2
0.63	18	11	10	12	28	11
0.70	2	1			2	1
0.73	1	1	2	2	3	1
0.74	8	5	4	5	12	5
0.80			2	2	2	1
0.84	8	5	13	16	21	9
0.95	2	1			2	1
1.00			1	1	1	0.4
1.05	9	5	2	2	11	4
1.10			1	1	1	0.4
1.16	7	4			7	3
1.21	2	1	5	6	7	3
1.26	1	1			1	0.4
1.31			2	2	2	1
1.37	1	1			1	0.4
1.48	3	2			3	1
1.58	2	1	1	1	3	1
1.89	1	1	—	—	1	0.4
Total	161		81		242	

Head Capsule Width (mm)	Living Number	Living Percent of Total	Dead Number	Dead Percent of Total	Total Number	Total Percent of Total
June 10						
0.21			1	0.7	1	0.3
0.32	2	1	6	4	8	3
0.42	3	2	2	1	5	2
0.52			2	1	2	1
0.53	6	4			6	2
0.63	5	3	12	9	17	6
0.70			4	3	4	1
0.73			30	22	30	10
0.74	15	10	21	16	36	12
0.84	19	12	17	13	36	12
0.95	10	6	4	3	14	5
1.05	22	14	10	7	32	11
1.11	6	4			6	2
1.15	2	1	2	1	4	1
1.20	1	0.6			1	0.3
1.21	2	1			2	1
1.26	32	21	17	13	49	17
1.36	16	10	2	1	18	6
1.47	12	8	4	3	16	5
Total	153		134		287	

Head Capsule Width (mm)	Living Number	Living Percent of Total	Dead Number	Dead Percent of Total
June 20				
0.32	7	0.7	72	7
0.34			1	0.1
0.36			2	0.2
0.42	24	3	56	6
0.47			1	0.1
0.52			2	0.2
0.53	19	2	109	11
0.54	1	0.1	1	0.1
0.63	28	3	112	11
0.64	12	1	5	0.5
0.73	1	0.1	2	0.2
0.74	49	5	115	12
0.75			1	0.1
0.80			1	0.1

(continued next page)

Table 26. -- (continued)

Head Capsule Width (mm)	Living: Number	Living: Percent of Total	Dead: Number	Dead: Percent of Total	Total: Number	Total: Percent of Total
June 20 (cont'd)						
0.83			1	0.1	1	0.05
0.84	46	5	75	7	121	6
0.95	47	5	51	5	98	5
1.05	68	8	104	10	172	9
1.11	87	10	46	5	133	7
1.15	24	3	8	0.8	32	2
1.16			1	0.1	1	0.05
1.20	8	0.9	4	0.4	12	0.6
1.21	2	0.2	1	0.1	3	0.1
1.25			1	0.1	1	0.05
1.26	300	34	135	14	435	23
1.27			1	0.1	1	0.05
1.36	115	13	73	7	188	10
1.37	2	0.2	1	0.1	3	0.1
1.46	4	0.4	2	0.2	6	0.3
1.47	30	3	5	0.5	35	2
1.57	2	0.2			2	0.1
pupae	1	0.1			1	0.05
	877		989		1866	[illegible]
June 25						
0.21			2	0.6	2	0.4
0.32			3	1	3	0.6
0.42	1	0.7	10	3	11	2
0.53	2	1	10	3	12	3
0.63	6	4	46	16	52	12
0.74	8	5	34	12	42	10
0.84	12	8	37	13	49	11
0.95	8	5	20	7	28	6
1.05	21	14	51	18	72	16
1.11	18	12	20	7	38	9
1.16	1	0.7	9	3	10	2
1.25	3	2	1	0.3	4	0.9
1.26	24	16	29	10	53	12
1.36	26	18	13	4	39	9
1.37	3	2	1	0.3	4	0.9
(cont'd)						
June 25 (cont'd)						
1.46	4	3	1	0.3	5	1
1.47	7.	5	2	0.6	9	2
1.57	1	0.7			1	0.2
1.58	1	0.7			1	0.2
pupae	1	0.2				
	147		289		436	
July 1						
0.53			8	6	8	5
0.63			19	14	9	114
0.73			1	0.7	1	0.6
0.74			23	17	23	14
0.84	1	3	12	9	13	8
0.95			13	10	13	8
1.05	1	3	20	15	21	13
1.11	5	16	17	13	22	13
1.26	11	34	11	8	22	13
1.36	8	25	10	7	18	11
1.47	1	3			1	0.6
pupae	5	16			5	3
	32		134		166	
July 10						
0.21			1	0.3	1	0.1
0.31			1	0.3	1	0.1
0.32			2	0.6	2	0.3
0.42			5	2	5	0.9
0.53			6	2	6	1
0.63			16	5	16	3
0.64			5	2	5	0.9
0.74			18	6	18	3
0.84			14	4	14	3

(continued next page)

Table 26. -- (continued)

Head Capsule Width (mm)	Living Number	Living Percent of Total	Dead Number	Dead Percent of Total	Total Number	Total Percent of Total
July 10 (continued)						
0.95	3	1	13	4	16	3
1.05	24	11	51	16	75	14
1.11	14	6	46	15	60	11
1.15			2	0.6	2	0.3
1.16	9	4	6	2	15	3
1.26	26	12	48	15	74	14
1.27			1	0.3	1	0.1
1.36	22	10	36	11	58	11
1.37	6	3	2	7	13	2
1.38			1	0.3	1	0.1
1.46	1	0.4	1	0.3	2	0.3
1.47	7	3	11	3	18	3
1.49			1	0.3	1	3
1.56	2	0.9	1	0.3	3	0.1
1.57	1	0.4			1	0.5
1.58	3	1	2	7	10	2
pupae	81	37			88	17
adults	17	8			18	3
Total	216		308		524	
July 20						
0.21	1	0.5			1	0.2
0.32	1	0.5	16	7	17	4
0.42			1	0.4	1	0.2
0.53	4	2	3	1	7	2
0.63			4	2	4	0.9
0.73			3	1	3	0.7
0.74	2	1	13	6	15	3
0.84			15	6	15	3
0.95			11	5	11	2
1.05	5	2	15	6	20	5
1.15	5	2	5	2	10	2
1.16			4	2	4	0.9
(continued)						
July 20						
1.26	25	13	75	33	100	23.
1.36	15	7	50	22	65	15
1.40			1	0.4	1	0.2
1.46			1	0.4	1	0.2
1.47	5	2	12	5	17	4
pupae	112	56	1	0.4	113	26
adults	23	12			23	5
Total	198		230		428	
August 1						
0.32	6	4	1	0.4	7	2
0.42	1	0.6	3	1	4	1
0.53			3	1	3	0.8
0.62	2	1			2	0.5
0.63			5	2	5	1
0.72	1	0.6			1	0.2
0.74			5	2	5	1
0.84			9	4	9	2
0.95			7	3	7	2
1.05	5	3	41	18	46	12
1.15			2	0.8	2	0.5
1.16	6	4	36	16	42	11
1.21	1	0.6			1	0.2
1.26	2	1	32	14	34	9
1.36			2	0.8	2	0.5
1.37			17	7	17	4
1.39	1	0.6			1	0.2
1.47			5	2	5	1
1.49			1	0.4	1	0.2
1.58	1	0.6	13	6	14	4
1.68			8	3	8	2
1.79			1	0.4	1	0.2
pupae	52	36	32	14	84	22
adults	67	46	7	3	74	20

Table 26. -- (continued)

Head Capsule Width (mm)	Living: Number	Living: Percent of Total	Dead: Number	Dead: Percent of Total	Total: Number	Total: Percent of Total
			August 10			
0.21	1	0.8			1	0.4
0.32			2	1	2	0.8
0.42			9	7	9	4
0.63			1	0.7	1	0.4
0.74			1	0.7	1	0.4
0.84	1	0.8	3	2	4	2
0.95	2	2	3	2	5	2
1.05	14	12	16	13	30	12
1.16	8	7	12	9	20	8
1.26	23	19	17	13	40	16
1.37	4	3	19	15	23	9
1.47	3	2	15	12	18	7
1.58			16	13	16	6
1.68			2	1	2	0.8
pupae	10	8	3	2	13	5
adults	54	45	7	5	61	25
Total	120		126		246	

Table 27. Healthy living stages of the white pine weevil occurring in material collected from May 20 through August 10 (including only live feeding larvae in the foremost 3 inches of the feeding formation, live burrowed larvae, pupae and adults)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent	Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
Eggs	14	9			0.73	1			
0.11	1	0.6			0.74	5			
0.15	1	0.6			0.84	4			
0.21	5	3			0.95	1			
0.30	15	9			1.05	10			
0.31	19	12			1.11	9			
0.32	3	2			1.16	7			
0.40	4	3			1.21	2			
0.42	10	6			1.37	1			
0.53	4	3			1.48	3			
0.54	3	2			1.58	2			
0.60	4	3			1.74	2			
0.63	18	12			1.84	2			
0.70	2	1			1.89	1			

May 20

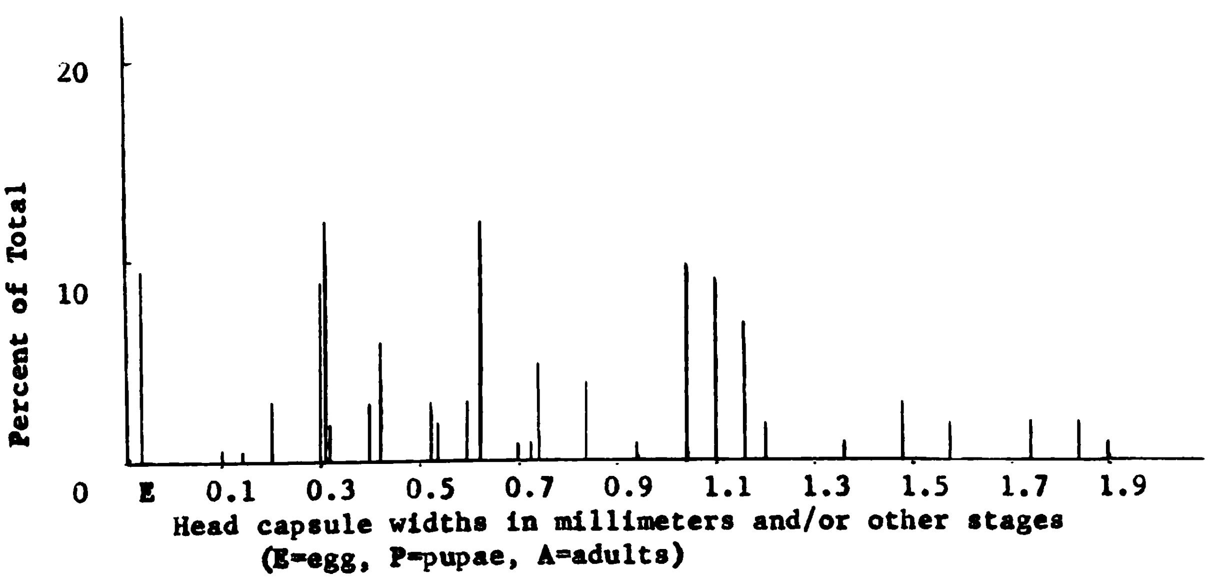
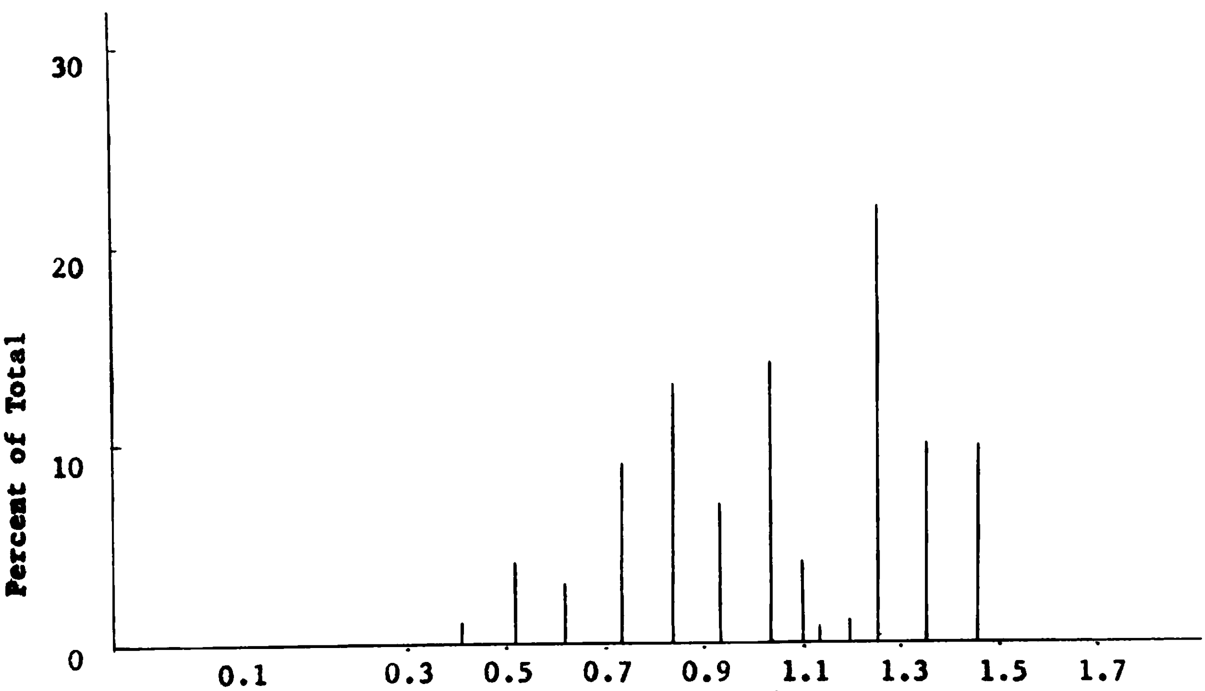


Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent	Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
0.42	2	1			1.11	6	4		
0.53	6	4			1.15	1	0.6		
0.63	5	3			1.21	2	1		
0.74	14	9			1.26	33	22		
0.84	20	13			1.36	16	10		
0.95	10	7			1.47	15	10		
1.05									
					Total	151			

June 10

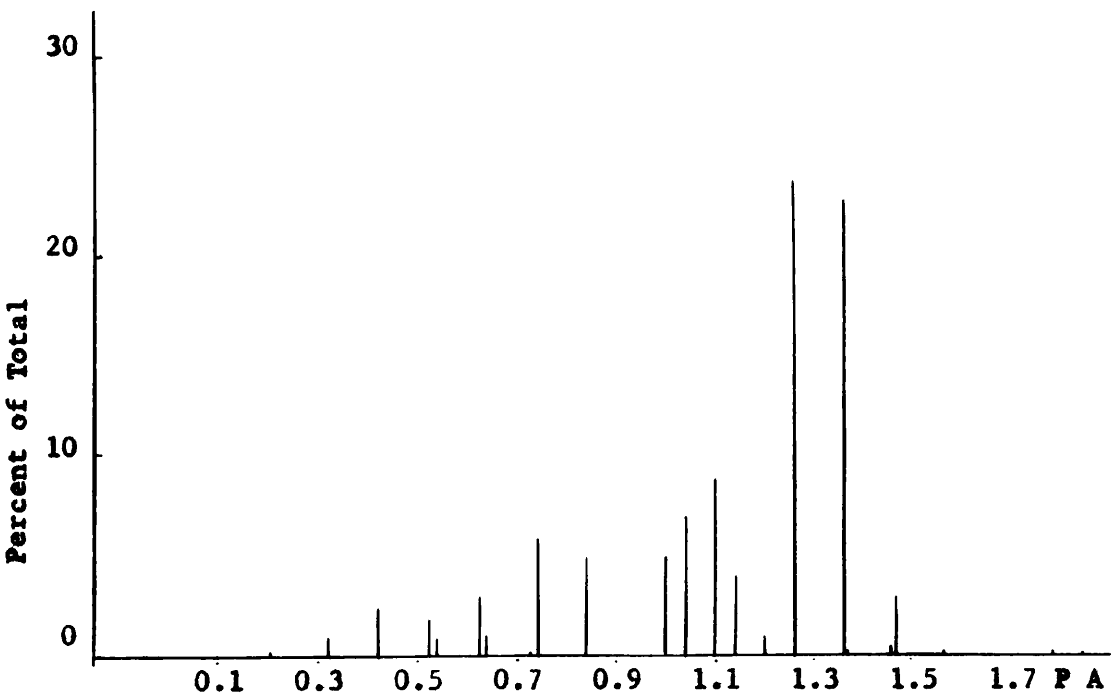


Head capsule widths in millimeters and/or other stages
(E=egg, P=pupae, A=adults)

Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent	Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
0.21	1	0.1			1.05	70	7	12	17
0.32	10	1			1.11	83	9	25	30
0.42	23	2			1.15	36	4	10	28
0.53	18	2			1.20	10	1	3	30
0.54	1	0.1			1.26	222	24	75	34
0.63	25	3			1.36	210	23	58	28
0.64	13	1			1.37	1	0.1		
0.73	1	0.1			1.46	4	0.4		
0.74	51	6			1.47	29	3	12	41
0.84	50	5			1.57	2	0.2		
0.95	46	5			pupae	2	0.2		
					Total	907		195	21.4

June 20

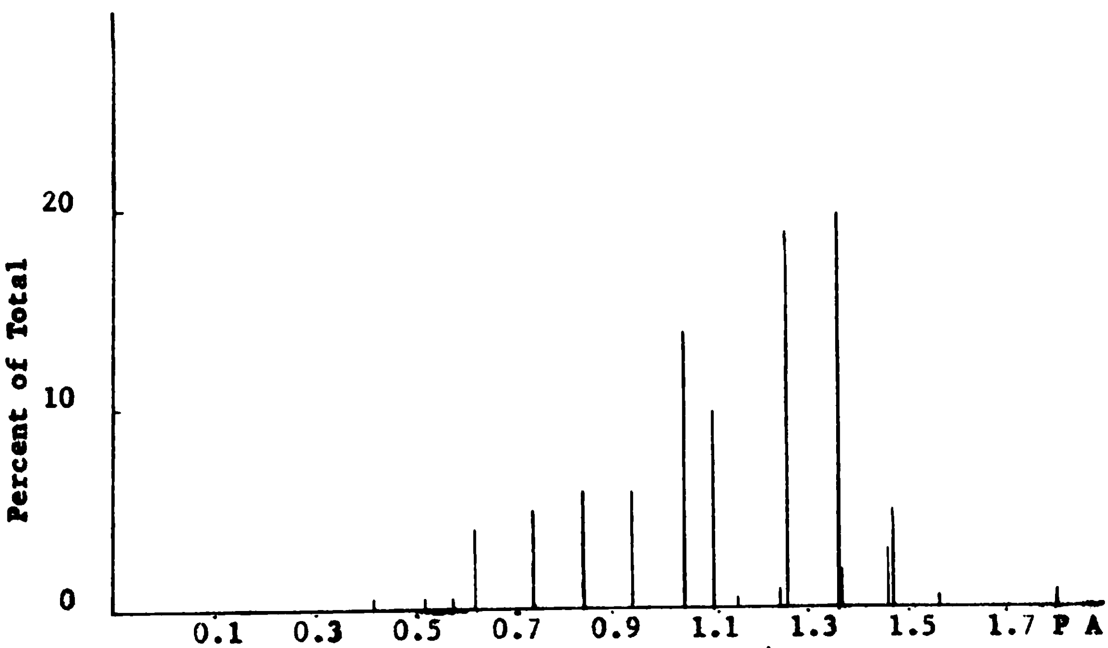


Head capsule widths in millimeters and/or other stages (E=eggs, P=pupae, A=adults)

Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent	Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
0.42	1	0.7			1.16	1	0.7	1	100
0.53	1	0.7			1.25	2	1	1	50
0.58	1	0.7			1.26	25	18	4	16
0.63	6	4			1.36	28	20	12	43
0.74	7	5			1.37	3	2		
0.84	9	6			1.46	4	3	1	25
0.95	9	6			1.47	7	5	3	43
1.05	20	14	4	20	1.57	1	0.7	1	100
1.11	15	10	4	27	pupae	2	1		
					Tota	142		31	22

June 25



Head capsule widths in millimeters and/or other stages
(E=eggs, P=pupae, A=adults)

Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
0.84	1	4	0	
1.11	4	15	3	75
1.26	9	35	8	89
1.36	8	31	7	87
1.47	1	4	1	100
pupae	3	11		
Total	26		19	73

July 1

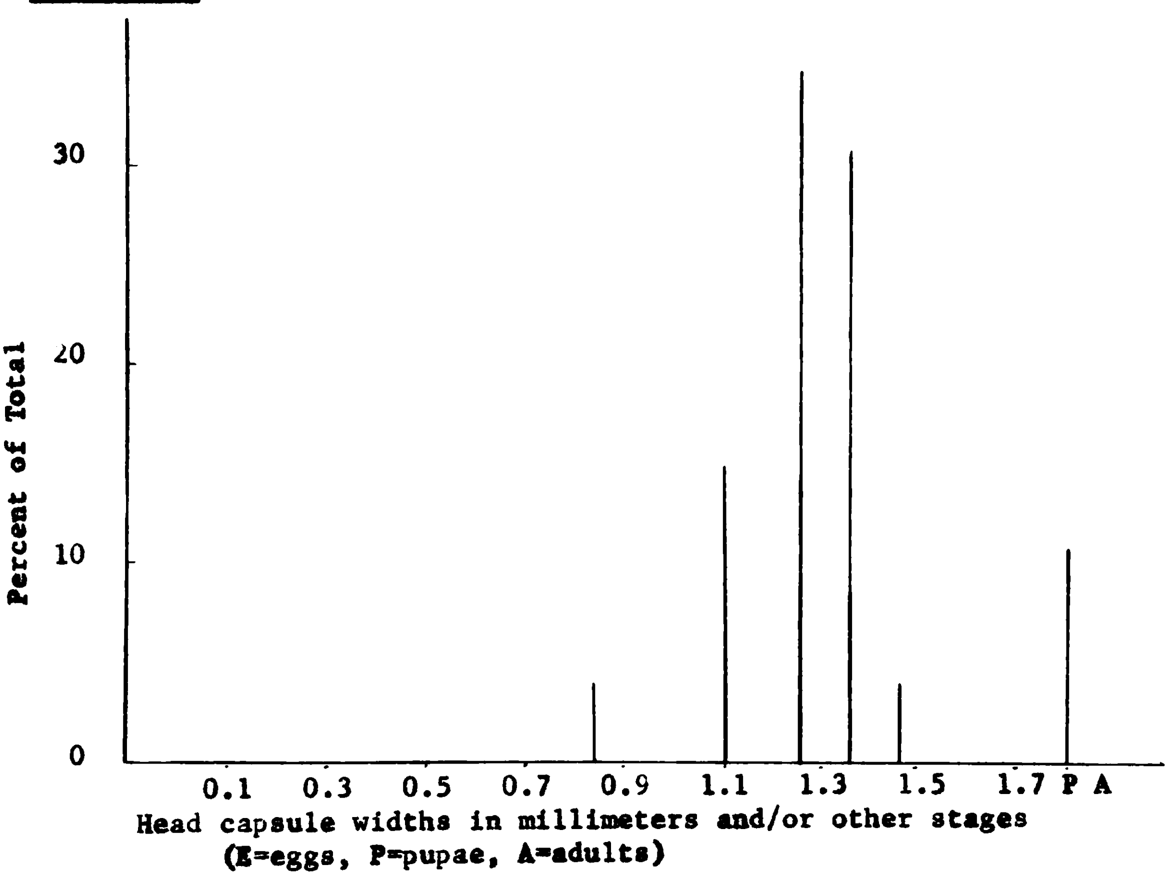
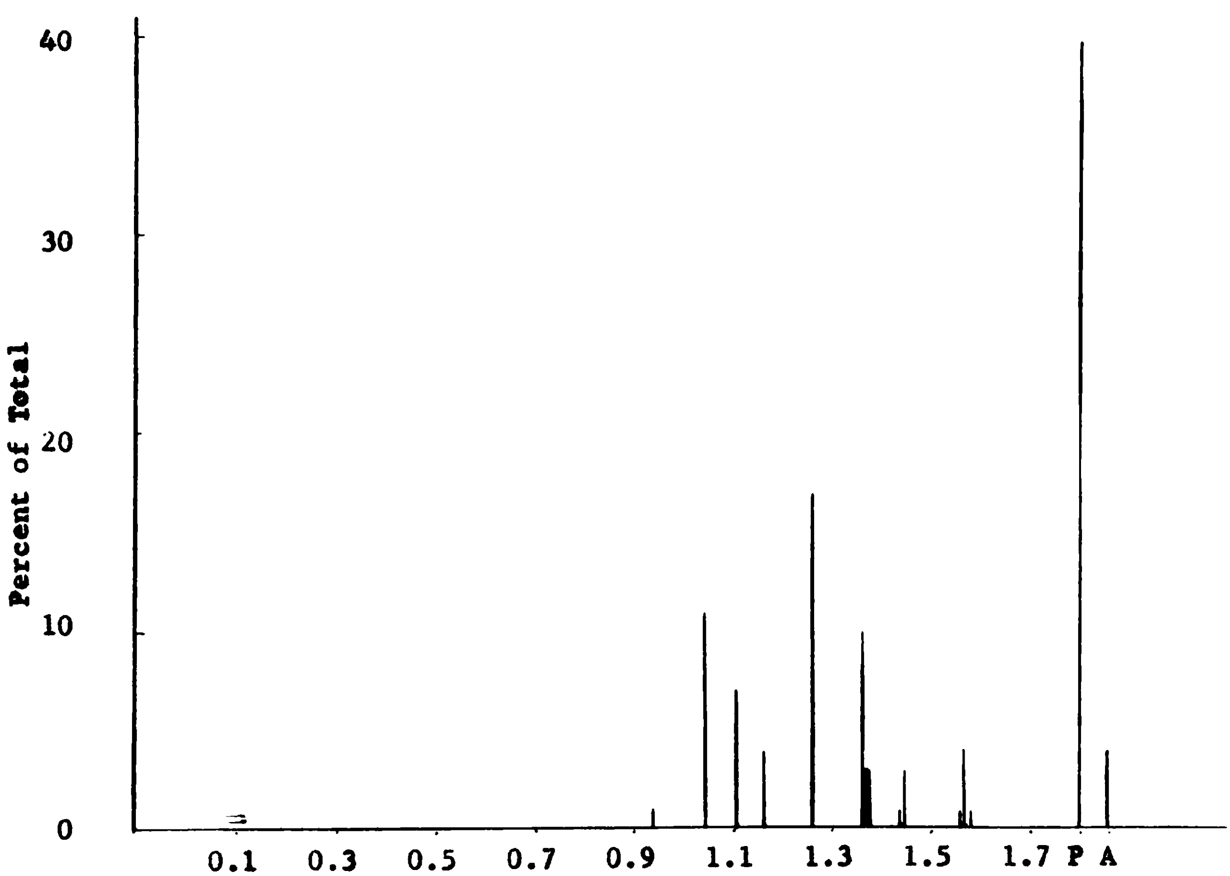


Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent	Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
0.95	2	1	2	100	1.46	1	0.4	1	100
1.05	23	11	16	69	1.47	7	3	6	86
1.11	14	7	9	64	1.56	2	1	2	100
1.16	9	4	6	67	1.57	1	4	1	100
1.26	22	17	11	50	1.58	3	1		
1.27	1	0.4			pupae	82	40		
1.36	20	10	15	75	adults	9	4		
1.37	7	3	4	57					
					Total	203		73	36 65% of all larvae

July 10

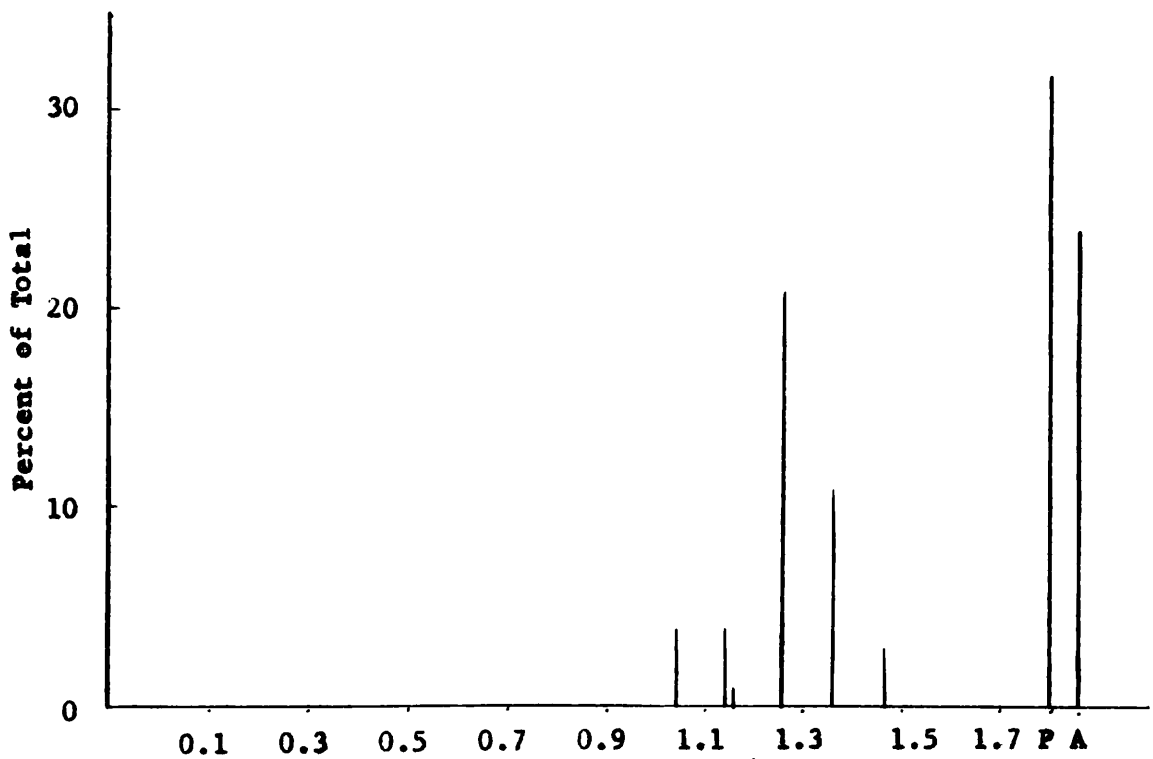


Head capsule widths in millimeters and/or other stages (E=eggs, P=pupae, A= adults)

Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
1.05	5	4	3	60
1.15	5	4	5	100
1.16	1	1		
1.26	25	21	22	88
1.36	13	11	9	85
1.47	4	3	3	75
pupae	38	32		
adults	29	24		
Total	120		42	79% of all larvae

July 20



Head capsule widths in millimeters and/or other stages (E=eggs, P=pupae, A=adults)

Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent	Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
1.05	5	3	4	80	1.58	1	1	1	100
1.16	5	3	5	100	pupae	55	36		
1.26	3	2			adults	84	54		
1.37	1	1							
					Total	154		10	67% of all larvae

August 1

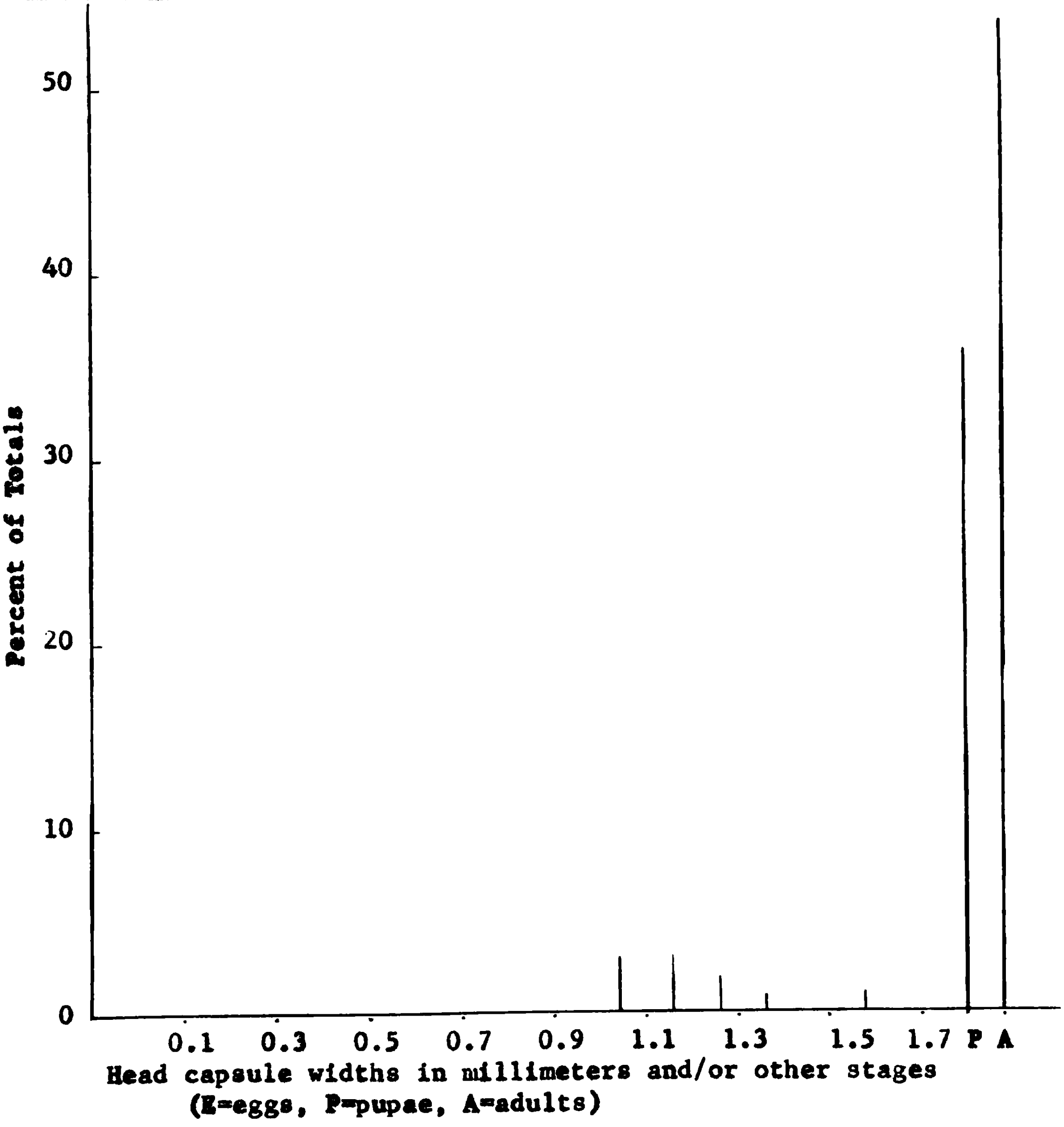
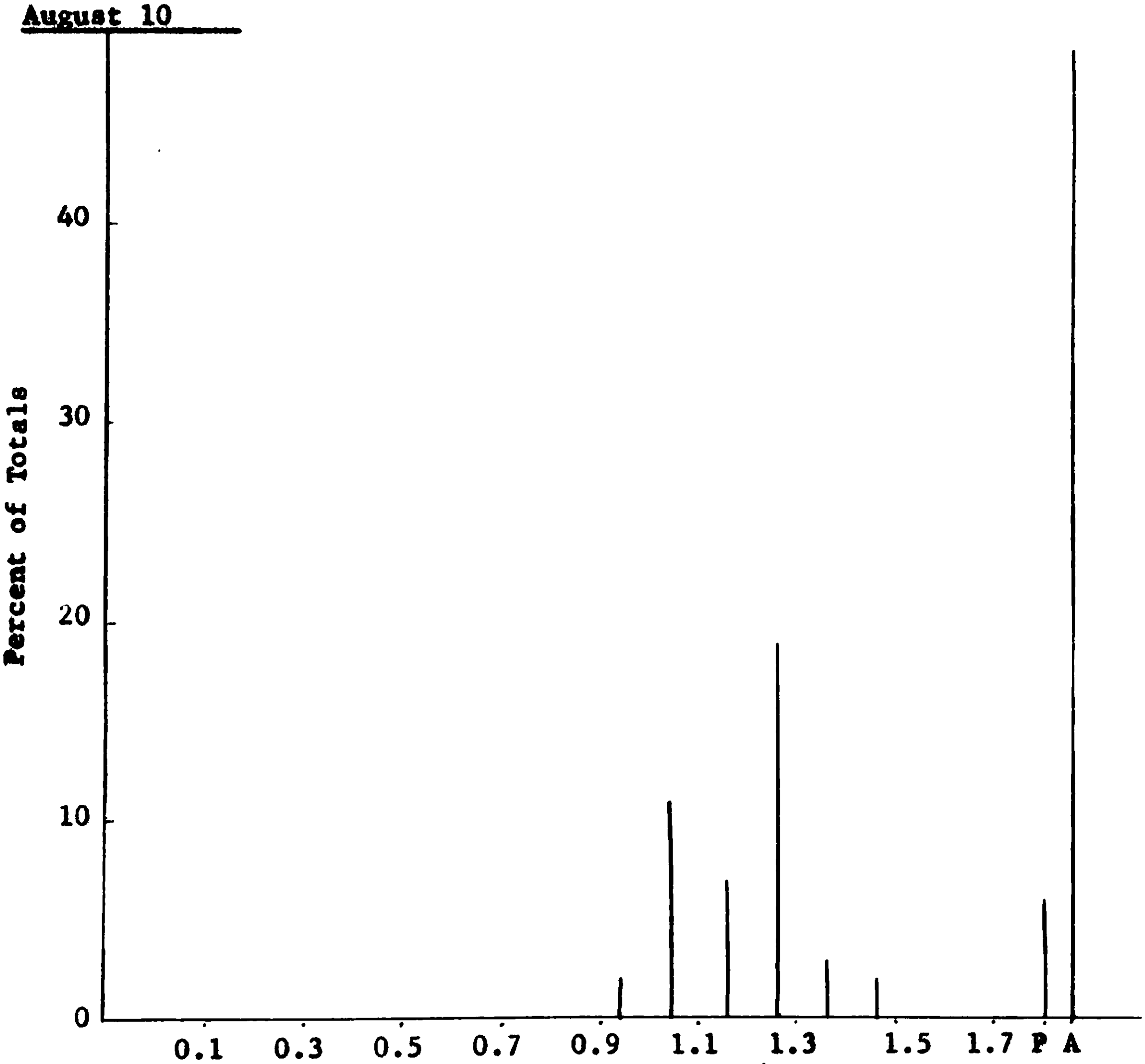


Table 27 -- (continued)

Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent	Head Capsule Width (mm)	Number	Percent of Total	Larvae Burrowing Number	Larvae Burrowing Percent
0.95	2	2	1	50	1.37	4	3	4	100
1.05	14	11	14	100	1.47	3	2	3	100
1.16	9	7	9	100	pupae	8	6		
1.26	23	19	23	100	adults	60	49		
					Total	123		54	98% of all larvae present

August 10



Head capsule widths in millimeters and/or other stages
(E=eggs, P=pupae, A=adults)

Table 28. Comparison of emergences of *Pissodes strobi* for each stand type and collection date

Collection Date	Emergences of Pissodes strobi per leader yielding Stand Type 1	2	3	4	5
June 1	23.09	25.23	15.66	15.37	
June 10	18.16	23.76	9.63	11.50	7.00
June 20	16.41	9.43	4.31	18.33	9.75
July 1	17.56	7.21	4.59	4.83	3.75
July 10	16.15	2.75	3.94	4.70	3.00

Table 29. Comparisons of emergences of white pine weevils and associated species for stand types 1, 2 and 5

	Emergences Per Leader Yielding		
	Stand Type 1	Stand Type 2	Stand Type 5
Weevils Per Leader Yielding	18.36	13.04	7.68
Associated Species Per Leader Yielding	7.49	12.99	3.25

Table 30. Comparison of success of attack for stand types 1-5

Stand Type	Percentages of Leaders: Unsuccessful Attack	Percentages of Leaders: Successful Attack
1	18	83
2	33	67
3	47	53
4	48	51
5	42	58

II. Studies on development and diapause in the white pine weevil

A. INTRODUCTION AND LITERATURE REVIEW

The white pine weevil pupates and transforms to the adult stage in the center of the infested stem. After a period of 10 to 30 days the adults emerge, mostly during July, August, and September. Activities of the new adults are not well known, although it has been commonly stated that members of the new adult population do not mate and oviposit in the fall. Their fall activity is limited to feeding on the old growth and on the matured growth of the current year (Belyea and Sullivan, 1956).

Hopkins (1911) illustrated the organs of reproduction of a newly emerged female weevil, and stated that young adults must attain the age of several months before the ovaries are sufficiently matured for the development of eggs. He also stated that one copulation may suffice for a long period. Graham (1926) caged over 100 newly emerged adults in the laboratory from August until November and observed only one pair in copulation. He observed a weevil coming directly out of the duff and depositing fertile eggs. MacAloney (1932) reported that weevils taken from hibernation may produce viable eggs. Neither author stated the age of these adults. MacAloney also observed frequent copulation among new generation adults in the fall. Barnes (1928a) dissected weevils to observe the reproductive system and illustrated a dissection of a weevil taken from the duff in March showing fully developed ovaries. He also showed intermediate ovariole development in an adult weevil taken from the duff in January.

Since the female reproductive system is in a state of arrested growth and development in the fall, it has been considered to be in diapause. Marquis (1963) stated that the diapause is obligatory, and that it can be shortened by laboratory manipulation of temperatures. Obligatory diapause implies that when reared under varied conditions, virtually every individual enters diapause in each generation (Lees, 1955).

Many contradictions in the literature probably stemmed from failure to distinguish between current year and older weevils. The present study was designed to investigate certain phases of weevil development and activity using individuals for which the age was known.

B. OBJECTIVES AND PROBLEM STATEMENT

The present investigation was conducted during 1964 and 1965 on new generation adults and those of previous generations. The objectives were as follows:

1. To study fall oviposition by adults [illegible] one year old or older.
2. To follow ovariole development of current year adults from an undeveloped condition until viable eggs are deposited and to relate this to time of mating.
3. To study conditions required for breaking of diapause.

C. PROCEDURE

To study ovariole development in adults of the current season, a series of dissections were made on weevils exposed for varying lengths of time under natural conditions. New adults reared from infested material were placed in 5-foot high wire screen cages around small unattacked white pines in mid-August. To assure against the presence of old generation weevils, trees were selected which had sparse foliage, no evidence of weevil attack or feeding, and which were growing on bare mineral soil. Before caging, the trees were closely examined for the presence of weevils at any place on the tree or on the ground at the base of the tree. Pine needles, closely examined to avoid introducing any other weevils to the cages, were placed on the soil beneath the trees. Soil was packed around the base of the cages to prevent the escape of the enclosed weevils or the entry of others. The cages were not disturbed in the winter except for the removal of weevils for dissection in the ovariole development studies.

Individuals of the overwintered generation were collected in early spring of 1964 and caged in a similar manner to avoid mixing with newly emerged adults. Dissections and photographs of weevils were used in showing ovariole development at various times in the season.

With each collection of weevils from the field cages, one dissection was done immediately and others were made at 5-day intervals. Weevils were maintained at room temperature in the laboratory with white pine boughs as feeding material. Branches were changed every 5 days and examined for oviposition. If larvae were found later in any of this material, it was correlated with the appropriate photograph which showed ovariole development.

Late oviposition by old generation adults was studied by caging them on white pine twigs in the laboratory and on freshly cut white pine stumps in the field. Weevils were left on this material for varying lengths of time and the material was checked later for the presence of larvae.

Oxygen consumption for adults of current and old generation weevils were made with a standard Warburg apparatus. Readings were taken for adults of known age, using 5 individuals per flask. Reading were taken at 5-minute intervals, but only the longest readings (30 minutes) were used in the calculations. This data was recorded at intervals from April to September, to be used in determining trends of activity in the weevil.

Old generation weevils used in this study were maintained in field cages. The new generation adults were known to have emerged between July 10 and 19 and were caged in the laboratory. For the calculation of flask constants, weights of every group of 5 individuals were used as a total. Readings taken per flask were averaged to determine the oxygen consumption per individual.

D. RESULTS

Ovarioles development. -- To study the development of ovarioles in the white pine weevil, adults were brought into the laboratory from the field cates at intervals for dissection. Photographs of the dissections are shown in figures 7 through 34. Adults from the overwintered and new generation were confined separately in field cages throughout late summer and early fall. By November the caged weevils were hibernating just above the mineral soil and were observed clinging to pine needles in the duff and in crevices very low on the trees. Most of the weevils were within an 8-inch radius of the tree trunk. The weevils were inactive when first collected (November 4) and in the subsequent winter collections. Upon exposure to warmer temperatures, however, they became active. There was no indication of activity in the cages until spring, although observations were made on some days in winter when air temperatures were 60 degrees F or higher.

Weevils of the old and new generations were taken into the laboratory for dissection. Figure 7 shows ovariole development of an old generation adult in November. This weevil produced viable eggs in the laboratory during the 5-day period prior to dissection on November 4. The dissection shown on figure 13 was done immediately on a new generation adult collected on November 4. Another new adult, also collected on November 4, was kept at temperatures between 70 and 80 degrees F until December 4, at which time it was dissected (figure 14).

During the period in the laboratory this weevil deposited viable eggs which emerged as adults in December. The exact time at which egg laying began was not known, but evidently the reproductive organs were sufficiently developed long before the end of the 30-day period. This demonstrated that the requirements for breaking diapause were met by early November for the current summer's generation.

Concurrently with experiments on adults exposed to natural conditions, others of the new generation were kept at a constant room temperature of approximately 75 degrees F after emergence. At the beginning of this series, a callow adult was taken from a white pine stem just after transformation from the pupal stage and prior to tanning. Immediately after tanning occurred, it was dissected (figure 8). Another adult was allowed to remain in the adult stage in the white pine material for the normal length of time. It was dissected directly upon natural emergence (figure 9). Comparisons of figures 8 and 9 show that considerable enlargement of the ovarioles evidently occurred during the period spent in the pine stem as an adult.

A number of new individuals which emerged between July 10 and July 19, 1964, were kept separately for study since their approximate emergence date was known. Members of this group were maintained at room temperature. The first dissection was made on August 28 after 40 days at room temperature. Dissections were made on others after 70 days (September 23, figure 11), and after 93 days (October 20, figure 12). By October 20, weevils in the field had gone into hibernation. Another adult from the same group, kept at room temperature, was dissected on November 22. Its degree of development was similar to that of the individual dissected on October 20 (figure 12). No evidence of egg laying was found for any of the adults reared at the constant room temperature and ovariole development was similar to that of the new generation adult brought from field conditions on November 4 (figure 13).

Further studies were conducted to test (1) length of time required for development of ovarioles after exposure to warm temperatures, (2) differences in time required for development as the winter progressed, and (3) oviposition by new adults without copulation after entry into warm temperatures.

In other studies, new adults were taken into the laboratory on December 4 and 30, February 10, March 1, and April 1 and 15. On December 4, mid-day air temperatures were about 60 degrees F although temperatures had recently been lower. Weevils in the duff were inactive, but they were able to make slight movements of appendages. Ice crystals were present in the duff, and the underlying soil was moist. The ovaries of one of the females dissected on December 4 is shown in figure 15. Ovariole development by December 15 and 30 in weevils brought in on December 4 are shown in figures 16 and 17, respectively.

On December 30, eleven adults were collected when air temperatures were about 50 degrees F. Some weevils were able to crawl very slowly in the duff, although others did not move. All weevils taken in after

December 4 were kept away from other weevils to avoid any possibility of copulation in the laboratory. The white pine twigs were changed every few days to determine whether eggs had been deposited. The immediate dissection of a weevil from the December 30 group is shown in figure 18. Dissections made at 5-day intervals in the laboratory are shown in figures 19, 20, and 21. The female dissected on January 14 (figure 21) had deposited viable eggs during the period of 10-15 days at room temperature although no copulation could have occurred after collection from the field.

For the February 10 group, dissections were made the day of collection from the field cages (February 10, figure 22), and at 3 subsequent 5-day intervals (figures 23, 24, and 25). In this group the female dissected on February 25 (figure 25) had deposited viable eggs between February 15 and February 25.

Individuals dissected from the March 1 collection are shown in figures 26, 27, 28, and 29. The first (figure 26) was dissected the day of collection and the other 3 at subsequent 5-day intervals. The female dissected at 15 days had produced viable eggs all of which were deposited at 10 to 15 days. When collections were made on March 1, the air temperature was 50-65 degrees F and the surface of the duff was dry and warm. Most of the weevils, however, were in the cold, damp area just above the mineral soil. One weevil was on the tree base near the level of the mineral soil. This was the first weevil found on the tree stem since hibernation. The remaining weevil were inactive.

The ovaries of weevils collected on April 1 after 5 and 13 days are shown in figures 30, 31, and 32, respectively. The ovaries of the weevil dissected after 5 days (figure 21) were well developed, but no eggs were deposited by weevils dissected at either 5 or 13 days.

On April 7, one weevil was observed feeding on the underside of a lateral branch in the field and signs of feeding were seen on 2 other trees. On April 12, several weevils were observed and collected near Lexington, Virginia. On April 15 the last collections were made from the field cages. Some weevils in the cage were clustered at the base of the tree stem and others were in the duff, still inactive. None were present on the leaders. The ovaries were not fully developed at this time (figure 33). After 5 days a rather high degree of development was observed, although no eggs were deposited.

Notes on late summer oviposition by overwintered adults. -- After leaving the white pine leaders, the old generation adults are difficult to find. Searches were conducted prior to emergence of the new generation to learn more about the activities of the old adults in late summer. They were usually found low on tree stems, although a few were found singly at bud bases. In some cases, solitary weevils were observed ovipositing in current leading shoots late in the summer. No more than 3 weevils per tree were found in late summer and most were inactive when observed. If weevils were present, evidence of feeding usually occurred in the lower trunk of the trees. Hardened areas were present beneath the bark surface around the feeding punctures, but there was no evidence of larval activity.

Ovarioles of old-generation adults in late summer were well developed, and viable eggs were deposited by weevils caged in the laboratory.

Concurrent with laboratory studies, old-generation adults were caged in the field around 4 white pine stumps 1 to 2 inches in diameter and 24 to 30 inches high. Each stump was exposed for about 20 days, beginning on July 10, August 1, August 20, and September 10, respectively. At the end of respective exposure periods stumps were examined for feeding punctures and weevil larvae, as shown on table 31. Several lateral whorls were present on each stump and the branches were clipped near the stem. Feeding punctures were concentrated around the whorls with noticably few in the areas between. Whorls higher on the stumps generally had greater numbers of feeding punctures than lower ones. Several of the 13 weevils were lost during the first 2 exposure periods, leaving only 5 weevils for the last 2 periods. Additional old-generation adults could not be obtained to replace the losses. After every exposure period, however, healthy larvae were present in the stumps, indicating that the capability for egg production exists into the fall.

Measurement of oxygen consumption. -- Measurements of oxygen consumption at various dates throughout the period of April to September, 1965, are shown on table 32. Weevils that overwintered had a steadily decreasing trend in oxygen consumption from May through June, with the lowest points occurring on June 20 for males and July 1 for females (figure 35). Old-generation males consumed oxygen at rates generally below that of females. An apparent leveling-off in the curve occurred through July and August for males although some very high readings occurred in August for females.

Newly-emerged adults were taken from a group which were known to have emerged between July 10 and July 19. In the first reading, taken July 19 and July 21, rates for females were higher than for males. After the second reading, however, the males gave higher readings than females except on one date (August 30).

The 3 readings on pupae in groups of 5 per flask were as follows: for 30 minutes exposure: 4.73, 4.80, and 3.99 microliters of oxygen per individual.

Size differences in white pine weevils were apparent. Although females in general appear to be larger than males, both sexes vary considerably in size. Weevils used in the respirometry studies were weighed in groups of 5 (table 33) on the same dates as the Warburg studies. The overwintered adult females had higher average weights than males and newly emerged females. Overwintered males weighed least, averaging almost 1 mg less than any other category shown on table 33. Newly emerged males weighed more than newly emerged females (15.42 mg as compared to 15.03 mg).

Weevil pupae, also weighed in groups of 5, averaged 18.02, 20.54, and 25.74 mg per individual in 3 respective readings. These weights were decidedly greater than for adults of either generation. Callow adults taken from the stem averaged 15.78 mg per individual, which was comparable with older adults.

E. DISCUSSION

In studies on development of ovarioles in the white pine weevil, 7 collections were made throughout the season and dissections were made at equal intervals after each collection. Age of the weevils was emphasized, since this factor seems to have been neglected in most past studies.

Considerable difficulty was encountered in evaluating the development of the reproductive organs. In similar studies measurements were made on the size of the ovarioles and averages were used. Since small samples were taken in this study, measurements could not be effectively used. Development sufficient for oviposition, however, was one factor which could be presented objectively, along with the photograph of the weevil in which it occurred. Comparison of complete and very early stages of development may be used as guides in evaluating development within a particular individual.

Dissection and laboratory rearing of the old-generation adults collected in November demonstrated that these individuals may deposit viable eggs within 5 days after collection. Accordingly, if these adults live until spring, they could produce viable eggs soon after emergence from hibernation without capulation.

Comparison of a callow adult taken from the stem (figure 8) and one which was allowed to spend the normal length of time within the pupal chamber (figure 9) shows that a considerable amount of thickening of the ovarioles takes place during this period.

The photographs of weevils kept at warm temperatures (figures 10, 11, and 12) show enlargement and lengthening of the ovariole, but no development comparable to that in an ovipositing female. All dissections of weevils constantly exposed to warm temperatures indicated restricted ovariole development. However, a hibernating weevil of the same age brought into the laboratory on November 4, deposited viable eggs during November (figure 14). This indicates that diapause may be broken very early in the winter. Interesting continuations of this study would be to determine exact temperature exposures required to break the diapause, and to determine whether prolonged exposure at constant warm temperatures will break the diapause.

All weevils dissected immediately after collection from the field cages exhibited a restricted state of ovariole development which was similar throughout the winter. There was no direct evidence of progressive development of the ovarioles during the hibernating season. However, from observations and dissections it seems likely that some individuals which hibernate at more exposed positions experience early exposure to warm temperature and complete their development sooner than weevils deeper in the duff. The dissection done on April 5 (figure 31) shows ovarioles highly developed after 5 days at room temperature. No viable eggs were produced, however.

Godwin and Bean (1956) reported on temperatures in relation to upward and downward movement of the white pine weevil on trees and stated that upward movement in the spring began within the range of 35 to 40 degrees F. In the present study observations in early April showed that some weevils were active in movement on the tree stems while others in the duff were inactive.

In 3 separate instances in this study, oviposition in the laboratory occurred although females were not allowed in contact with males at any time after collection from the field. Other workers have reported the occurrence of fall mating. In one study 84 percent of the females isolated from male weevils in early November produced viable eggs in the spring (Jaynes, 1958).

Studies in which old-generation adults were caged to small white pine stumps in the field and to white pine twigs in the laboratory showed that oviposition may occur late in the season. At this time of year caging many individuals together may have had some influence on their behavior, since they were never found crowded together under natural circumstances. Late egg-laying is probably of little importance in nature. In examination of large numbers of feeding punctures on tree stems, no evidence of larval feeding was found. Survival of the larvae in the tree stumps in the present study may have been due to the weakened condition in the stumps and to the concentrated feeding and ovipositing in small areas. Both of these conditions are abnormal for the weevil, since they are usually found on healthy trees in few numbers. The capability for oviposition in late summer is of interest, however, since it is not lost after the weevils leave the leaders. Also, some late feeding and oviposition occurs in the current summer's buds long after the main egg-laying activity has ended.

Studies on oxygen consumption. -- Although changes in weevil behavior are evident at the termination of oviposition, feeding, and mating on the leaders, a qualitative evaluation of this change is difficult to obtain. The measurements of oxygen uptake reported in this study are intended for use in following trends, comparing the sexes, and supplementing mere observations rather than in showing precise data from the standpoint of the physiologist.

A steady drop in the oxygen consumption curve indicates a decrease in activity in both males and females of the overwintered generation. During the period from April 25 to June 25, readings for males were below that of females in all except 2 dates (July 1 and July 5). Short term dips and peaks would be difficult to explain, and no explanation will be attempted here. Ovipositing females were expected to have a higher metabolic rate than males,and since these females retain the egg-laying ability, it might account for their higher rates of oxygen consumption throughout the summer.

The newly emerged adults followed a different pattern,with males generally exceeding females in oxygen uptake. If a true diapause exists in the white pine weevil, this could account for the decrease in oxygen consumptionin the new females. Lees (1955) mentioned reduced oxygen consumption rates associated with diapause in some insect species.

Compensations were made for size differences in weevils by using weights in calculation of flask constants. The equation of 1 gram = 1 ml was used in converting weight to volume. Greater weights were expected to correspond to higher oxygen consumption, since weight indicates the amount of living tissue present. This was essentially true with adults in the respirometry studies, since roughly the groups with greater average weights exhibited a higher curve than those with lower weights. With pupae, however, the greater weights were accompanied by a relatively low rate of oxygen consumption.

Many difficulties were encountered in the Warburg tests on white pine weevils. Gas exchanges were usually seen to occur in spurts, which made it necessary to use the longest readings (30 minutes) and discard the shorter ones. In many cases unknown gases entered the system in the flasks, and since extreme care was taken to seal the flasks, these gases were assumed to have been emmited by the insects. The nature and sources of the gases were unknown.

F. CONCLUSIONS AND SUMMARY

1. Some aspects of the diapause in white pine weevils were studied by dissection and photography of adult female ovaries. Emphasis was placed on knowledge of the age of the individuals used.

2. A noticable degree of ovariole development was found to occur during the period spent as an adult within the pupal chamber prior to emergence. Newly emerged weevils exposed to constant room temperatures maintained a restricted degree of development from July through November. New weevils of the same age kept in the field from July until November 4 were taken to the laboratory where they produced viable eggs during November. New adults immediately after collection from the field exhibited a state of restricted ovariole development which was similar on each of 7 dates throughout the winter. There was no evidence of progressive development of ovarioles during the hibernating season.

3. An overwintered weevil taken from a field cage on November 4 deposited viable eggs within 5 days after collection. In laboratory and field experiments, old-generation adults deposited viable eggs through October 1. Current summer's adults taken from field cages in winter deposited viable eggs after 10 to 15 days at room temperature, varying with the individual. In each of 3 cases studied, current summer's adults which were collected from field cages in winter and given no opportunity for copulation after collection produced viable eggs in the laboratory.

4. Oxygen consumption measurements were taken on old and new generation adults at intervals from April to September. Old generation males consumed oxygen at rates generally below that of old generation females. Both sexes exhibited a decreasing trend in oxygen consumption from April 25 to June 20. New generation adults were used whose emergence dates were known within 10 days. New females consumed oxygen at rates generally below males in the fall.

Figure 7 -- . Old-generation adult. Brought directly into the laboratory from field cage on October 30, kept for 5 days at room temperature, and dissected on November 4, 1964. During the 5 days in the laboratory, this female deposited viable eggs which emerged as adults in December, 1964.

Figure 8 -- . Callow adult, taken from the center of a white pine stem; dissected immediately after tanning, summer, 1964.

Figure 7

Figure 8

Figure 9 -- . New adult, just after emergence from a white pine stem. This individual was allowed to spend the normal period of time as an adult within the stem prior to emergence. Summer, 1964.

Figure 10 -- . New adult, emerged between July 10 and July 19, 1964. Kept at room temperature until dissected on August 28, 1964.

Figure 10

Figure 9

Figure 11--. New adult, emerged between July 10 and July 19, 1964. Kept at room temperature until dissected on September 23, 1964.

Figure 12--. New adult, emerged between July 10 and July 19, 1964. Kept at room temperature until dissected on October 20, 1964.

Figure 12

Figure 11

Figure 13--. Current summer's adult. Reared in cage in the field from soon after emergence in the summer until dissected on November 4, 1964.

Figure 14--. Current summer's adult. Reared in field cage from a few days after emergence in the summer until November 4. Reared in the laboratory at room temperature from November 4 until it was dissected on December 4, 1964. During the period from November 4 until December 4, this female deposited viable eggs in white pine twigs in the laboratory.

Figure 14

Figure 13

Figure 15--. Current summer's adult. Reared in field cage from a few days after emergence in the summer until it was dissected on December 4, 1964.

Figure 16--. Current summer's adult. Reared in field cage from a few days after emergence in the summer until December 4. Reared in the laboratory at room temperature from December 4 until it was dissected on December 15, 1964.

Figure 16

Figure 15

Figure 17--. Current summer's adult. Reared in field cage from a few days after emergence in the summer until December 4. Reared in the laboratory at room temperature from December 4 until it was dissected on December 30, 1964.

Figure 18--. Current summer's adult. Reared in field cage from a few days after emergence in the summer until it was dissected on December 30, 1964.

Figure 18

Figure 17

Figure 19 -- . Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until December 30. Reared in the laboratory at room temperature from December 30 until it was dissected on January 4, 1965.

Figure 20 -- . Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until December 30. Reared in the laboratory at room temperature from December 30 until it was dissected on January 9, 1965.

Figure 20

Figure 19

Figure 21 -- . Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until December 30. Reared in the laboratory at room temperature from December 30 until it was dissected on January 14, 1965, during which time no contact with any other weevils was allowed. During the period from December 30 until January 14, however, this individual deposited viable eggs in white pine material in the laboratory.

Figure 22 -- . Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until it was dissected on February 10, 1965.

Figure 22

Figure 21

Figure 23 -- . Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until February 10, 1965. Reared in the laboratory at room temperature from February 10 until it was dissected on February 15, 1965.

Figure 24 -- . Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until February 10, 1965. Reared in the laboratory at room temperature from February 10 until it was dissected on February 20, 1965.

Figure 24

Figure 23

Figure 25 -- . Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until February 10, 1965. Reared in the laboratory at room temperature from February 10 until it was dissected on February 25, 1965 during which time no contact was allowed with another weevil. This adult deposited viable eggs in white pine material in the laboratory between February 15 and February 25.

Figure 26 -- . Current adult for summer, 1964. Reared in field cage from soon after emergence in the summer until it was dissected, March 1, 1965.

Figure 26

Figure 25

Figure 27--. Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until March 1, 1965. Reared in the laboratory at room temperature from March 1 until it was dissected, March 5, 1965.

Figure 28--. Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until March 1, 1965. Reared in the laboratory at room temperature from March 1 until it was dissected, March 10, 1965.

Figure 28

Figure 27

Figure 29--. Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until March 1, 1965. Reared in the laboratory at room temperature from March 1 until it was dissected, March 15, 1965, during which time no contact was allowed with other weevils. This individual, however, deposited viable eggs in the laboratory between March 10 and March 15.

Figure 30--. Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until it was dissected, April 1, 1965.

Figure 30

Figure 29

Figure 31--. Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until April 1, 1965. Reared in the laboratory at room temperature from April 1 until it was dissected, April 5, 1965.

Figure 32--. Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until April 1, 1965. Reared in the laboratory at room temperature from April 1 until it was dissected, April 13, 1965.

Figure 32

Figure 31

Figure 33--. Current adult for summer, 1964. Reared in field cage from a few days after emergence in the summer until it was dissected, April 15, 1965.

Figure 34--. Current adult for summer, 1964. Reared in cage from after emergence in the summer until April 15, 1965. Reared in the laboratory at room temperature from April 15 until it was dissected, April 20, 1965. By this date, spring activity of weevil adults had begun in the field.

Figure 34

Figure 33

Figure 35. Oxygen consumption in adult male and female white pine weevils of newly emerged and old generations

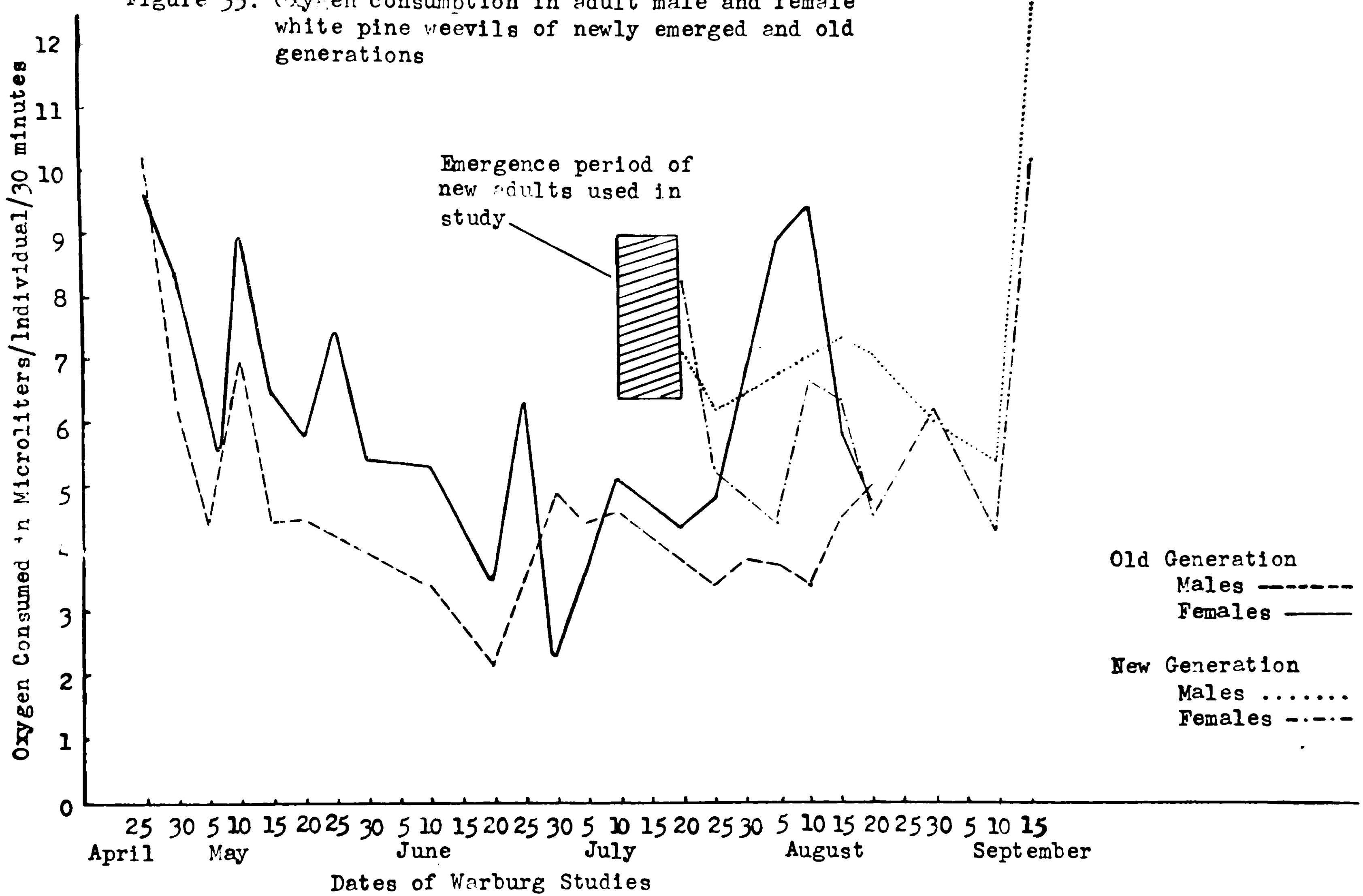


Table 31. Feeding and oviposition by overwintered white pine weevils in late summer

Period of Exposure	Whorl	Height Above Ground Level (inches)	Number of Feeding Punctures	Number of Larval Present
July 10-August 1 (13 weevils)			508	53
August 1-20 (9 weevils)	3	20.0	244	6
	2	10.5	115	19
	1	5.0	17	6
August 20-September 10 (5 weevils)	4	26.0	20	
	3	15.5	12	
	2	10.0	7	2
	1	6.5	4	
September 10-October 1	5	29.0	28	
	4	25.5	65	10
	3	13	41	
	2	8	8	
	5	6	20	

Table 32. Oxygen consumption measured in white pine weevil adults during April-June, 1965

Dates of Measurement	Oxygen Consumed (Microliters / Individual / 30 Minutes)			
	Newly-Emerged Adults (Emerged July 10-19)		Overwintered Adults	
	Females	Males	Females	Males
April 25			9.66	10.25
May 2			8.45	6.30
May 7			7.52	4. 41
May 10			9.01	7.00
May 15			6.54	4.48
May 20			5.86	4.51
May 25			7.50	5.97
May 30			5.46	3.99
June 10			5.35	3.46
June 20			3.50	2.20
June 25			6.39	6.19
July 1			2.37	4.93
July 5			3.71	4.41
July 10			5.15	4.62
July 19	8.31	7.14	4.43	4.42
July 21	8.41	6.54	5.77	5.35
July 25	5.32	6.25	4.83	3.46
July 30		4.88		3.89
August 5	4.47	6.83	8.96	3.78
August 10	6.70		9.48	3.46
August 15	6.48	7.40	5.84	4.51
August 20	4.58	7.14	4.83	5.03
August 30	6.28	6.08		
September 10	4.33	5.46		
September 15	10.20	12.68		

Table 33. Average weights of white pine weevil adults taken at intervals from May-September, 1965

Dates of Measurement	Newly-Emerged Adults (Emerged July-10-19) Females	Newly-Emerged Adults (Emerged July-10-19) Males	Overwintered Adults Females	Overwintered Adults Males
	Average Weights in Milligrams per Individual 1/			
May 10			15.41	13.74
May 15			14.40	12.60
May 20			16.64	13.84
May 25			17.46	14.22
May 30			16.61	14.05
June 10			16.72	13.90
June 20			14.72	14.14
June 25			16.16	14.98
July 1			14.38	13.68
July 5			15.40	13.70
July 10			14.90	13.50
July 19	13.36	13.32	15.44	13.04
July 21	14.84	15.28	16.10	15.04
July 25	15.10	15.36	16.26	14.24
July 30	15.06	15.06	16.47	13.20
August 5	15.08	16.16	16.73	15.08
August 10	14.72	15.84	16.06	13.96
August 15	16.54	17.32	17.30	15.96
August 20	15.58	14.32	16.27	15.72
August 30	14.28	15.88		
September 10	15.38	15.24		
September 15	15.42	15.84		
Total Average Weights	15.03	15.42	15.97	14.14

1/ - Weights were measured and averages taken in groups of usually five insects, with males and female weevils weighed separately.

III. Studies on weevil flight and dispersal

A. INTRODUCTION AND LITERATURE REVIEW

Several studies have been conducted on dispersal and flight of the white pine weevil. Barnes (1928a) studied flight in relation to direction, height, temperature, humidity, and wind. He stated that temperature is the most significant factor influencing flight activity and found that flights were not made at temperatures under 70 degrees F. He did not find a relationship between relative humidity and flight, but found that weevils would not take flight during high winds. He added, however, that weevils will fly if wind subsides for a moment. He reported that most of the weevils flew in the general direction of the breeze, but that they faced the breeze before flying.

Godwin, Jaynes and Davis (1957) studied dispersion of 1600 radioactively tagged white pine weevils in plantations. They supported Barnes' findings that weevils fly frequently when temperatures are favorable. They observed little movement of weevils from the release trees in the fall, but in April flights of 300 to 400 feet occurred. Dirks (1964) studied weevil dispersal by releasing marked weevils and collecting at various distances from the release point. He stated that much of the short distance travel was evidently accomplished by crawling, but that short flights also occurred. He found a considerable number of weevils at distances of 300 to 500 feet, but none farther than 500 feet.

B. PROBLEM STATEMENT AND OBJECTIVES

The objectives of this study were as follows:

1. To study the dispersal of the white pine weevil adults through a white pine plantation.
2. To study concentrations of weevils per tree and numbers of trees attacked at various distances and directions from the release point.
3. To compare males and females in respect to distance and frequency of flight, numbers per tree, and duration of stay on each tree.
4. To study weevil attraction by presence of either sex and by feeding activity.
5. To investigate success of attack from the standpoint of brood development, and to relate this to weevil dispersal data.

C. PROCEDURE, METHODS, AND MATERIALS

To study dispersal of weevils through a white pine plantation, weevils were collected from several plantations between April 12 and 21, 1965 and placed in polyethylene bags with white pine twigs. The weevils were sexed and marked on the elytra with Day-Glo paint followed by Day-Glo powder on the wet surface. Special care was taken to avoid getting paint between the elytra, as it may have interfered with normal flight. Males were marked with red and females with green. A total of 409 weevils (233 males and 176 females) were marked.

On April 23 the weevils were released under one tree located in the center of a 1431-tree plantation. All trees in the plantation were examined at 5-day intervals from April 24 to July 25 and the numbers of males, females, and unmarked weevils were recorded. Since the plantation had been excavated several years prior to planting, part of the plantation floor consisted of bare mineral soil, but in other areas pine duff had accumulated beneath the trees. The trees were about 6 years old and due to the diverse soil conditions, tree heights varied from about 1 to 10 feet. Leader length and diameter were also extremely variable. The crowns were not closed, but a few pines were shaded by a hardwood overstory. Since the trees were in well-defined rows, individual trees could be identified by row and number. The plantation, surveyed with a field compass and tape, was separated into 30 foot wide sectors along the radii outward from the release point. The cardinal directions were plotted from the release tree and the plantation was divided into 4 quadrants in addition to the 30 foot sectors. Individual trees were categorized by quadrant and distance from the release point.

In June each tree was measured for height, leader length, and leader diameter one inch up from the base of the leader. At the end of the season each tree was observed for status of attack (table 37). Attacks were classified according to the 5 categories described by Kulman and Harman (1965).

Studies on weevil attraction to trees were conducted in the early spring in 1963, 1964, and 1965. Several replications of 5-tree groups were selected at various points throughout the plantation. Five different treatments were given, one to each tree in the groups. The treatments, randomly assigned, were:

1. one male caged to a leader;
2. one female caged to a leader;
3. one mating pair caged to a leader;
4. puncturing of the leader with a pin to resemble weevil feeding;
5. no treatment.

The trees were checked daily. Any weevils which were present were sexed and released again at a central point in the plantation. Five replications were used in 1963 and 10 in 1964 and 1965. In 1963 and 1964 organdy cages were used, but in 1965 wire screen cages were used since a few weevils chewed holes in the organdy and escaped. The cages were placed around the leader at the upper portions near the normal feeding area and were wired at both ends to enclose the insects. The cages allowed the weevils to move about freely and feed.

D. RESULTS

The 409 marked weevils were released at midday on April 23, 1965 by placing them on the ground beneath the release tree. The sun was shining, the air temperature was about 80 degrees F and there was a fluctuating wind from the southwest.

Immediately after release, the weevils began crawling to elevated points and flying. Fifty to 100 weevils were observed taking flight, mostly in the direction of the prevailing wind. The flight activity of males and females was similar. By sundown it appeared that most of the released weevils which had not taken flight had crawled from the ground into the release tree and were feeding, copulating, and walking on the branches. No flights were observed in the evening.

On April 24 a preliminary check was made of some trees, but the first complete examination of the plantation was on April 27. Several weevils remained on the ground. Although there was bare soil beneath the trees, weevils were not observed crawling on the ground to nearby trees. By April 30, about 30 weevils remained on the release tree. Many weevils were observed crawling to elevated points, presumably in preparation for flight. On May 5 there were 26 weevils on the release tree, one of which was unmarked, but after May 10, weevils did not appear on the release tree.

The number of trees for the sectors and quadrants varies as shown in table 34. Since tree numbers varied, the data was calculated on the basis of numbers of weevils per tree as well as total numbers. Weevil presence by sector throughout the season is shown in table 35. Using number of weevils per tree, figure 36 shows weevil presence for the sectors of 0-30 feet and 30-60 feet, the 2 sectors nearest the release point. All sectors farther than 60 feet were similar to or less than the 30-60 foot sector and were not included in figure 36. In the second sector (30-60 feet), marked and unmarked weevils occurred in about equal numbers. The unmarked weevils were present in consistantly higher numbers per check date in the first sector than in the second, although the differences were not large.

Relative numbers of marked and unmarked weevils per attacked tree (figure 37) were similar in the first 2 sectors to the numbers on a per-tree basis. Curves for the sectors not shown in figure 37 were similar to that of the 30-60 foot sector. Numbers per tree and per attacked tree remained higher for marked weevils in the 0-30 foot sector than in the 30-60 foot sector, although a sharp drop in the curve began with the May 20 check date and reached a low leveling-off point by June 10. Few weevils were on the trees in either sector by June 10.

In comparing the data for males and females, the initial abundance of the males (56.9 percent of the total release) must be considered. More males than females were observed on most check dates, as shown on table 35. In figure 38, comparisons of the sexes are shown for the first 2 sectors. Percentage (of the number released) recovered per check date are used in figure 38 to compare males and females. The highest percentage of males observed for a single check date was on April 30, and the highest for females was on May 5.

Weevil numbers for the 4 quadrants are shown in table 36 according to total number and number per tree. In figures 39 and 40, numbers of marked and unmarked weevils are shown for the first sector (0-30 feet) in each quadrant. A concentration of released weevils occurred in the first sector of the northeast quadrant (figure 39), although no similar concentration of unmarked weevils occurred in this area (figure 40). Total numbers of weevils are used in figures 39 and 40 because almost equal numbers of trees occurred in each quadrant of the first sector (the southwest quadrant had one more tree than the other 3).

For the entire plantation, total numbers of weevils recorded throughout the season are shown in table 36 and figure 41. Numbers present on the leaders increased rapidly from April 26 to May 5, after which a sharp decrease in numbers occurred. This decrease continued until June 15, at which time only 16 weevils were observed on the leaders. Curves for males, females, and unmarked weevils are roughly parallel to the total (figure 41).

No more than 178 of the 409 released weevils were recorded on any check date. The highest recovery occurred on May 5, at which time 96 of the 233 males and 78 of the 176 females were observed on the leaders. These figures represent 41 and 44 percent recovery of males and females, respectively.

Measurements of tree height, leader length, and leader diameter one inch up from the base of the leader were made in early June for every tree in the plantation. At the end of the season, this data was correlated with weevil presence and attack, as shown in table 37. Damage categories were used approximately as described by Kulman and Harman (1965), although it was necessary to add a number of sub-categories. Table 37 includes data from approximately half of the plantation (NE and NW quadrants). Category G, trees with no attack visible in late summer, included approximately 82 percent of the trees in the plantation. About 15 percent were visited by weevils but not attacked, or attacked so slightly that no damage could be detected later. About 18 percent were attacked visibly (categories A-F), with only 1-4 percent yielding weevils. About 9 percent of the trees had dead leaders (categories A and B).

The number of trees visited by weevils are shown in figures 42, 43, and 44 for leader diameter, leader length, and tree height. Progressively larger measurements were accompanied by increasingly higher percentages of attack. A slight drop in percentages occurred with leader diameters greater than 0.69 inches.

Difficulties were encountered in attempting to detect individual weevil movement. However, counts at 5-day intervals were taken to determine increase or decrease in weevil numbers on individual trees. This data is presented on table 38 for the first sector (0-30 feet) of the northeast quadrant only, since this area had the highest concentration of marked weevils. Every tree within the quadrant-sector was included in table 38. Arrivals and departures were combined to obtain figures on total movement. Highest total movement for an individual tree was 46 for males, 33 for females, and 6 for unmarked weevils. Weevil movement from the leaders could have been due to a variety of reasons and do not necessarily indicate flight in every case.

Unmarked weevils native to the plantation were present on certain trees prior to release of the marked weevils. When marked weevils were released, therefore, they could have flown to uninhabited trees or to trees with the native weevils already present. Likewise, unmarked weevils could be attracted to trees with marked weevils present. Where marked and unmarked weevils occurred on the same trees, flight and attraction factors could have been involved. Table 39 shows separate and combined occurrence of marked and unmarked weevils on trees. Data on total numbers are compared graphically in figures 45 and 46. Weevil numbers were generally highest in combined occurrence of marked and unmarked individuals (figure 45). However, more trees had marked and unmarked weevils separately than in combined occurrence (figure 46).

All trees in the plantation were examined for presence of weevil attack in 1965 (current year), 1964, and prior to 1964. Attacks were classified as described in table 37, and the information is presented in table 40. For each damage category the majority of the trees attacked in 1965 were unattacked previously.

Table 41 shows the damage categories related to presence of weevils on individual trees. Approximately one half of the plantation was included in the analysis, and trees which were attacked and those merely visited by weevils are considered separately. Of the 100 trees visited, 38 percent had no visible evidence of attack by the end of the season. As many as 6 weevils per check date were observed on some trees. A total of 62 percent of the trees visited were visibly attacked.

Studies on weevil attraction were conducted in early spring in 1963, 1964, and 1965, and each covered a period of less than 12 days. Table 42 shows the recovery of weevils from the treated trees. Of the 47 weevils recorded, 24 were males, 10 were females, and 13 were not sexed. Studies on attraction in 1965 were conducted concurrently with weevil flight and dispersal studies, in which more males were released than females. Of the 15 marked weevils recovered in 1965, eleven were males and 4 were females. These figures represented 4.7 percent of the males released as compared to 2.2 percent of the females released. Higher numbers of weevils appeared on the trees with the caged female, the mating pair, and the artificial wound than with the caged male and the check tree. The latter 2 were similar, with 4 and 3 weevils, respectively.

E. DISCUSSION

Weevil dispersal in a plantation was studied by releasing weevils at a central point and examining all trees at 5-day intervals for their presence. The plantation was isolated from other white pine plantations by several hundred yards of hardwoods. Weevils flying out of the plantation would be leaving a continuous growth of white pine. However, marked weevils were observed on scattered white pine trees 200-300 yards from the plantation across the hardwood barrier.

Since more males than females were collected, the data was presented as percentages (figure 38). The data indicated that females remained on the leaders slightly longer than males since higher percentages of females were recorded on June 5, 10, and 15. Direct observations at the time of release revealed a readiness for flight in many of the weevils. Temperatures were favorable at the time of release and the period of captivity and crowding prior to release may have had an accelerating effect on flight. Likewise, in release, the weevils were still in a crowded situation under the tree. Although many weevils climbed into the tree before flight, a large number flew from elevated points on the ground.

Although flights were commonly observed in early spring, no flights were observed in old generation adults later in the season. Weevils which were released were known to have overwintered, but their actual age was unknown. Adults more than one year old may have behaved much differently in respect to flight, mating, and other factors than those which emerged the previous year.

A heavy concentration of weevils was found to occur within the first zone (0-30 feet) of the northeast quadrant. Since there was no corresponding concentration of unmarked weevils in the same area, apparently no attractive quality in the trees was involved. Prevailing winds were from the southwest and observations of weevil flights after release indicated that most of the weevils flew with the wind. The concentration of weevils within the 0-30 foot sector and northeast quadrant could thus be accounted for possibly in terms of short distance flights with the wind current. In the sectors past 30 feet the distribution of marked weevils was uniform, being similar to the native population. Figure 40 shows a decrease in total numbers of weevils observed on the leaders after May 5. Weevils which left the leaders could have flown to a different area or crawled to the lower portions of the tree.

Less than half of the total numbers released were recorded on any one check date. Weevils not recovered may have died, left the plantation, been missed by the observer, or migrated to lower portions of the trees. Some may have been recorded on the leaders alternately with other weevils which also moved up and down the tree stem.

The data on tree attributes was correlated with weevil visits and unsuccessful attack. The greater the dimension in tree height, leader length, and leader diameter, the higher the percentage of trees visited and attacked. Since trees were checked only at 5-day intervals, short visits could have occurred which were not recorded. Weevils could have approached small trees and departed within a very short time. There is no indication of this in the data, however, and weevil visits were apparently less frequent and attacks less successful on shorter trees with smaller leaders than on larger ones. Sullivan (1961b) stated that weevils exhibit a preference for thick leaders irrespective of length. In this study, larger measurements in all 3 characteristics often occurred in the same trees.

Frequency of movement was shown for one quadrant within 30 feet of the release point. Changes in weevil numbers may not have been due to flight in every case. Also, some movements probably occurred between observations. The analysis of marked and unmarked weevils occurring on the same trees supplies additional proof of movement and of attraction by weevils already on the trees.

Damage classification data was related to numbers of weevils present on leaders and to duration of stay. In many cases, numbers and duration of stay were as great on trees without successful brood development as on those with it. This could have been due to egg infertility, mortality, or low numbers eggs deposited. Some cases of successful brood development resulted in trees on which only one weevil was ever observed at a time, indicating that large numbers of weevils are not always required to produce a successful brood. The qualities of trees which are heavily visited but which produce no successful broods should be of interest to workers in tree resistance.

Caged weevils were used in studies to determine whether either sex attracted the other and to what extent. Weevil occurrence on leaders in varying numbers could be evidence in itself that attraction exists between weevils. As shown in table 42, more males than females were attracted to each treatment. Of the total numbers recovered, occurrence of males was more than double that of females (51 percent as compared to 21 percent). Although more males than females were released in 1965, higher percentages of the released males were recovered than the released females (4.9 percent as compared to 2.2 percent). The caged female, the mating pair and the artificial wound appeared to be more attractive to flying weevils than the caged male and the check tree.

F. CONCLUSIONS AND SUMMARY

1. Weevil flight and dispersal through a white pine plantation were studied by releasing marked weevils at a central point within the plantation and checking every tree at 5-day intervals. Concentrations of marked weevils occurred in the first (0-30 foot) sector of the northeast quadrant. This was believed to have resulted from short flights with the wind current.

2. Weevils flew readily at the time of release. Marked weevils were recorded in every 30-foot sector throughout the plantation. A few marked weevils were recovered 200-300 yards from the release point, completely away from the original plantation beyond a hardwood barrier.

3. Since slightly higher numbers of males were released than females, percentages of numbers released were used to compare the sexes in the 2 sectors nearest the release point. Higher percentages of females than males were observed on the leaders after May 25, indicating that males tend to leave the leaders sooner than females.

4. Total numbers of weevils on the leaders increased from April 26 to May 5, after which numbers steadily decreased. By June 15, only 20 weevils were recorded on the leaders within the entire plantation. The highest recording per check date occurred on May 5 with a 42.5 percent recovery of marked weevils. The highest recovery for males was 41 percent and 44 percent for females.

5. The attributes of tree height, leader length, and leader diameter one inch up from the base of the leader were related to percentages of

trees visited by weevils. Higher numerical dimensions for each of these characteristics was accompanied by higher percentages of trees visited and attacked.

6. Studies on weevil attraction were conducted by using the following 5 treatments in 5-tree groups and observing for presence of weevils: (1) one male caged to a leader; (2) one female caged to a leader; (3) one mating pair caged to a leader; (4) artificial wounding with a pin to simulate weevil feeding; (5) no treatment. Total recoveries indicated that weevils were attracted to the presence of other weevils and/or wounding as 4, 15, 14, 11 and 3 weevils were recovered for treatments 1 to 5, respectively. Higher numbers and percentages of males than females were obtained from all treatments, indicating that male weevils may fly more frequently than females.

7. Weevil movement was studied for a small segment of the plantation. A high of 79 movements were recorded for an individual tree.

8. Weevil visits were related to success of attack at the end of the season. Of the trees visited by weevils, 8 percent were successfully attacked (producing one or more weevils), 54 percent were visibly attacked but produced no weevils, and 38 percent had no visible evidence of attack by the end of the season.

Figure 36. Weevils per tree observed for the 2 sectors nearest the release point

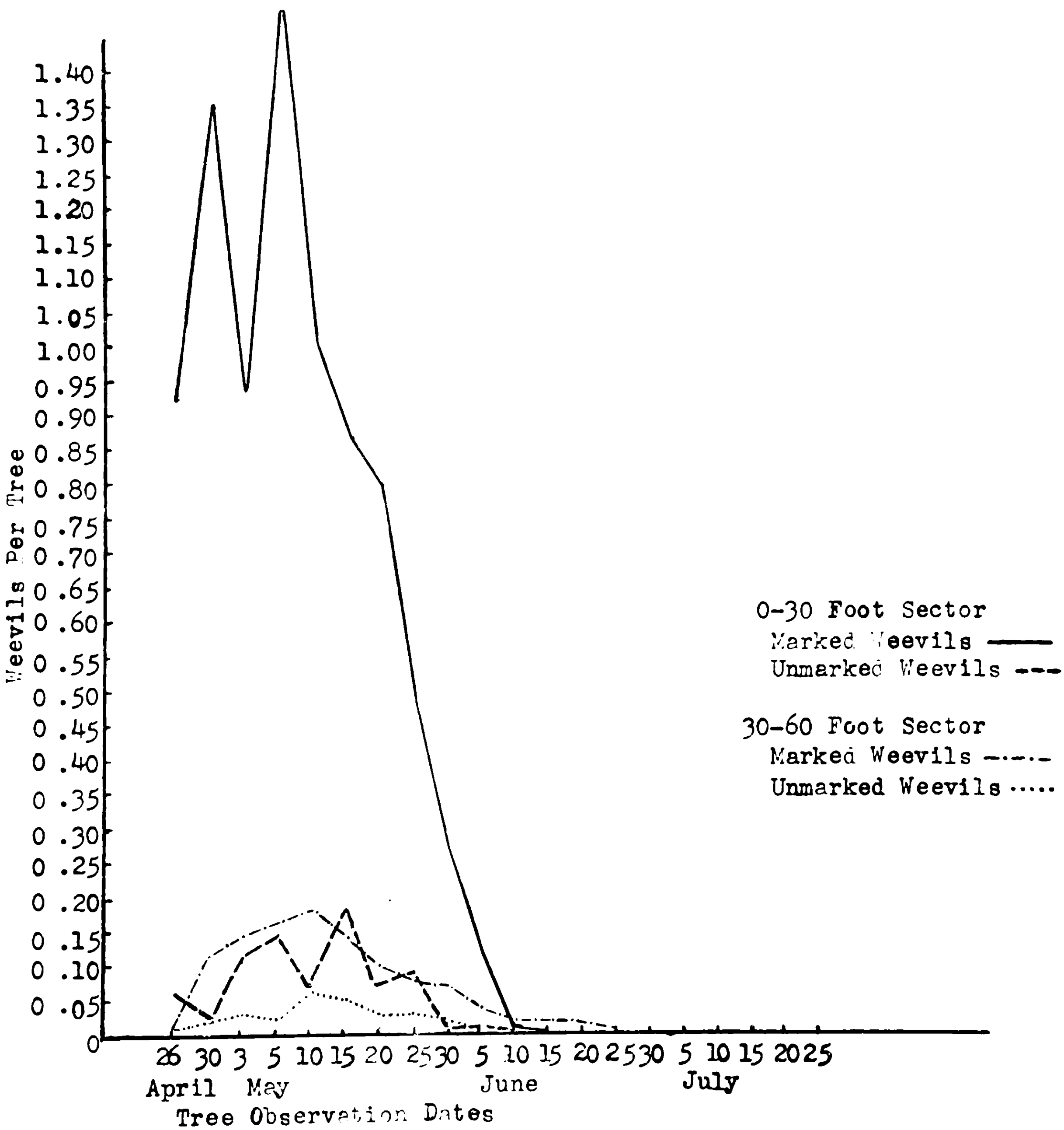


Figure 37. Weevils per attacked tree observed for the 2 sectors nearest the release point

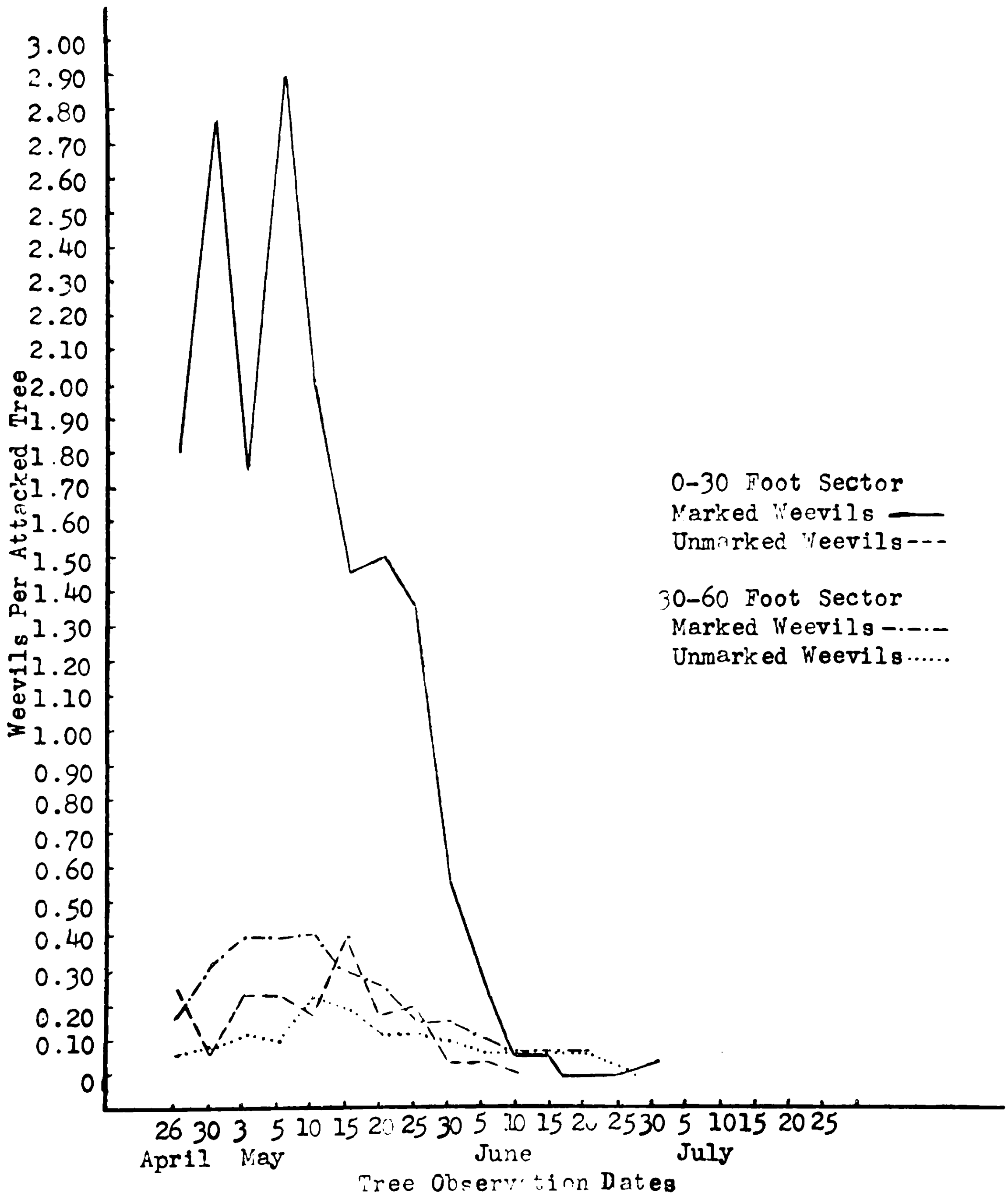


Figure 38. Comparison of numbers of male and female white pine weevils observed in the 2 sectors nearest the release point

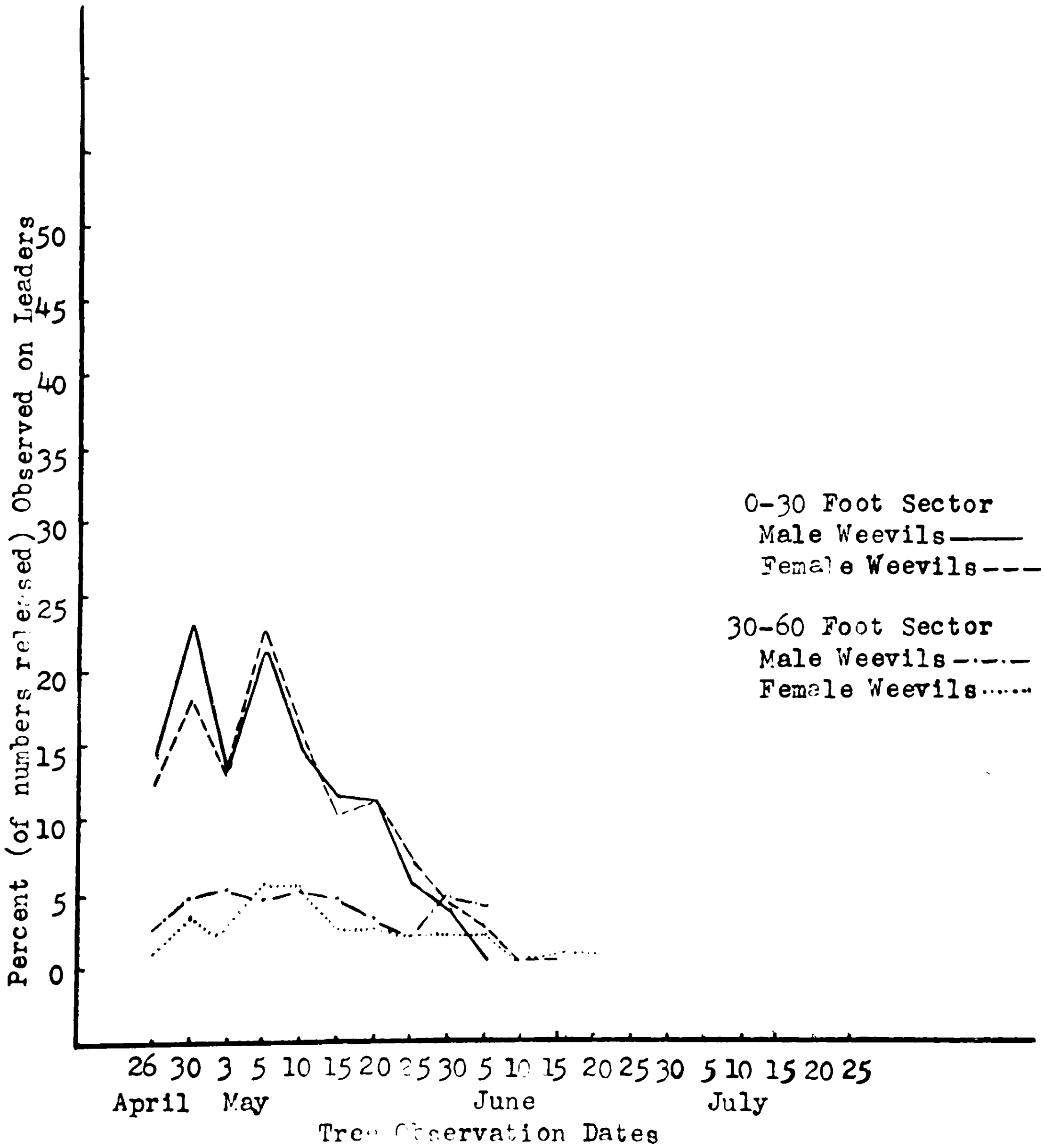
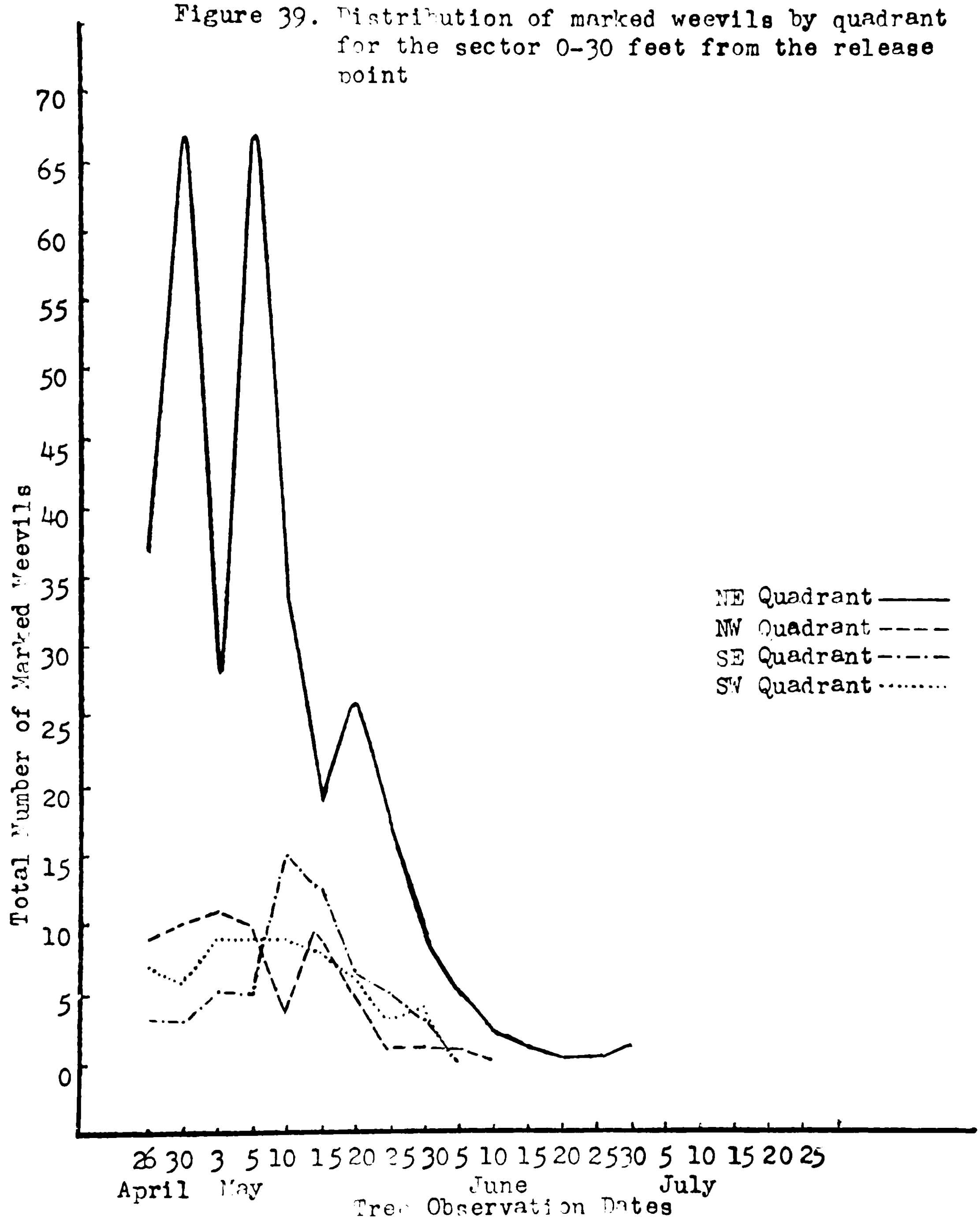


Figure 39. Distribution of marked weevils by quadrant for the sector 0-30 feet from the release point



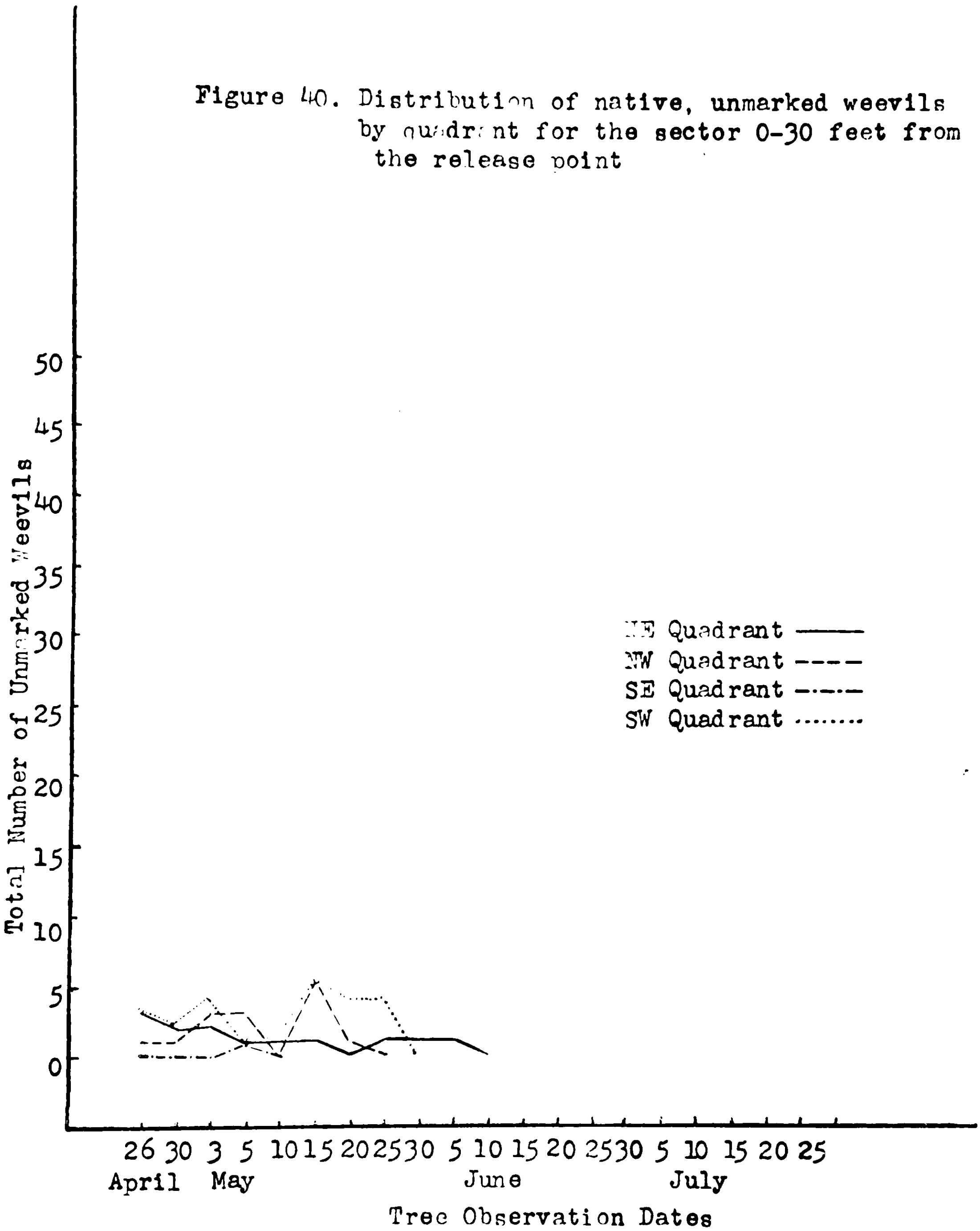


Figure 40. Distribution of native, unmarked weevils by quadrant for the sector 0-30 feet from the release point

Figure 41. Total weevils present on leaders on each observation date

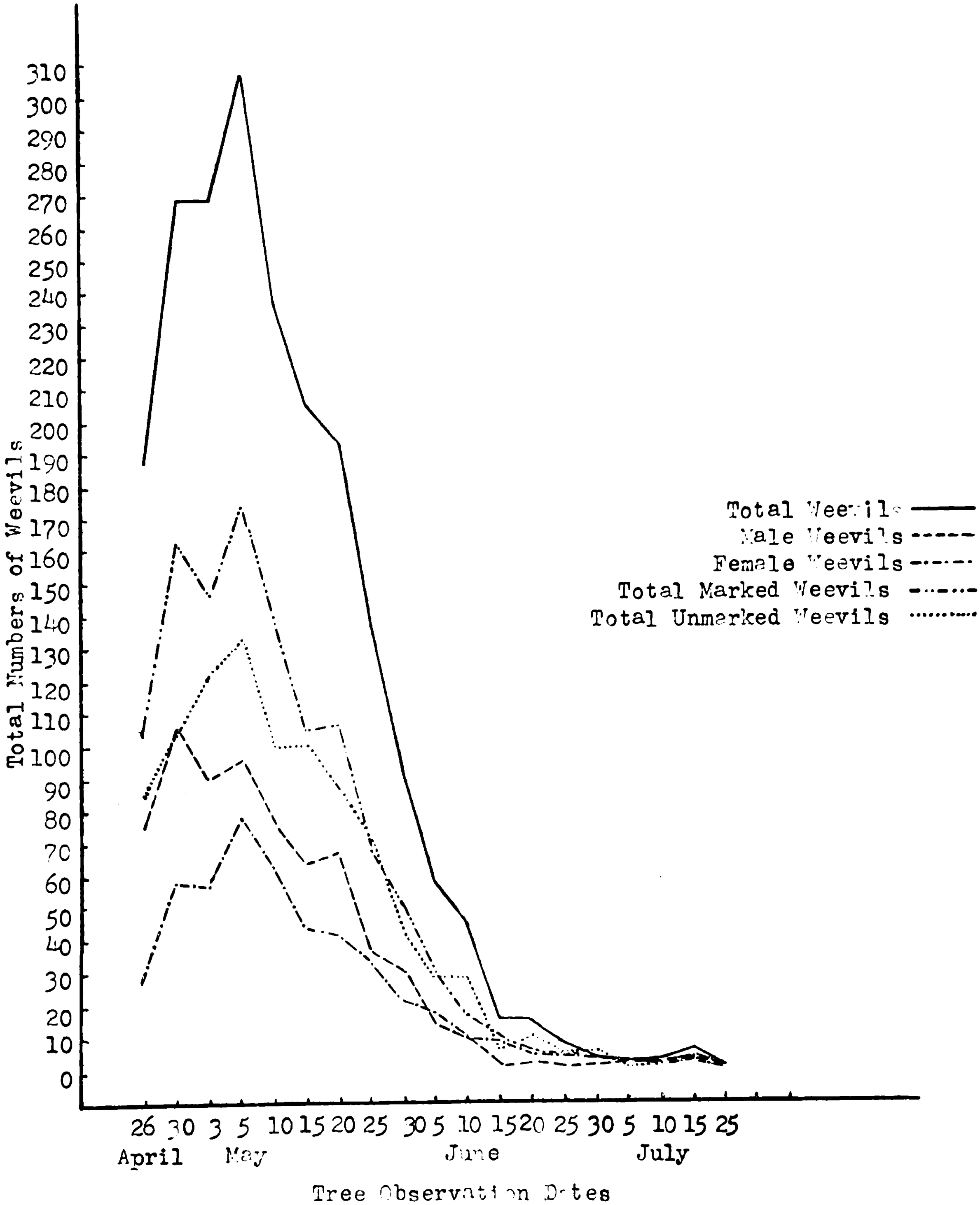


Figure 42. Weevil visits in relation to leader diameter

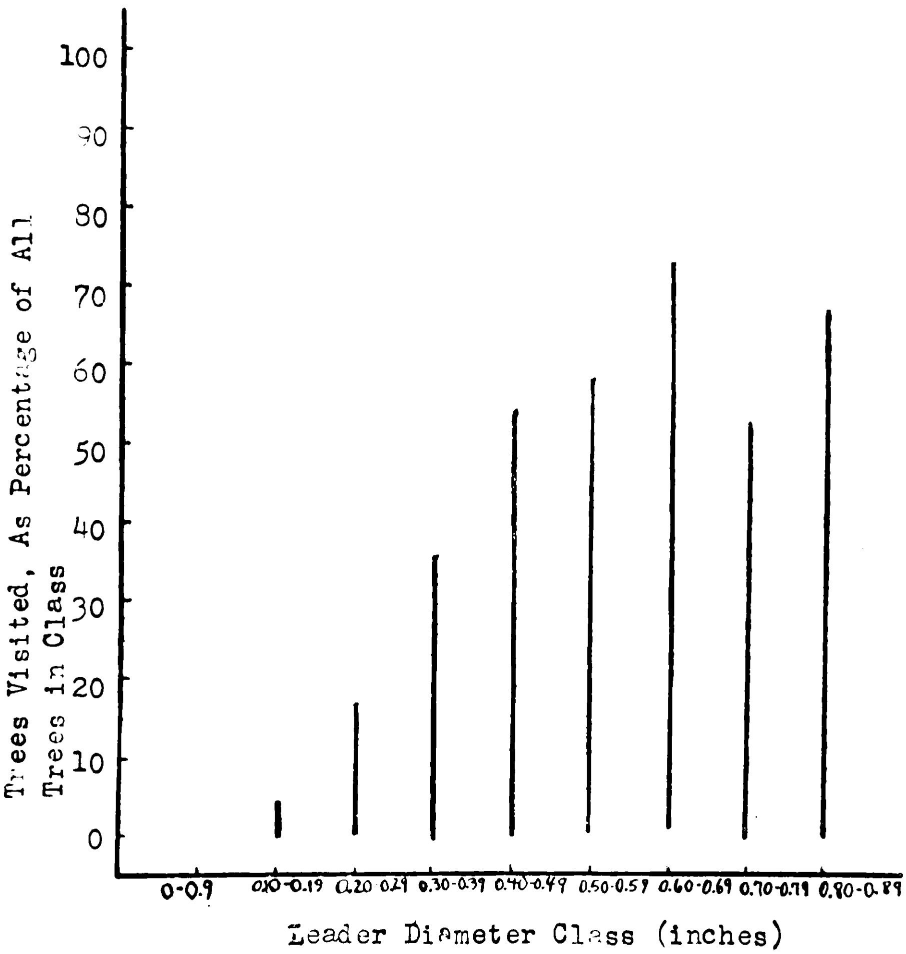


Figure 43. Weevil visits in relation to leader length

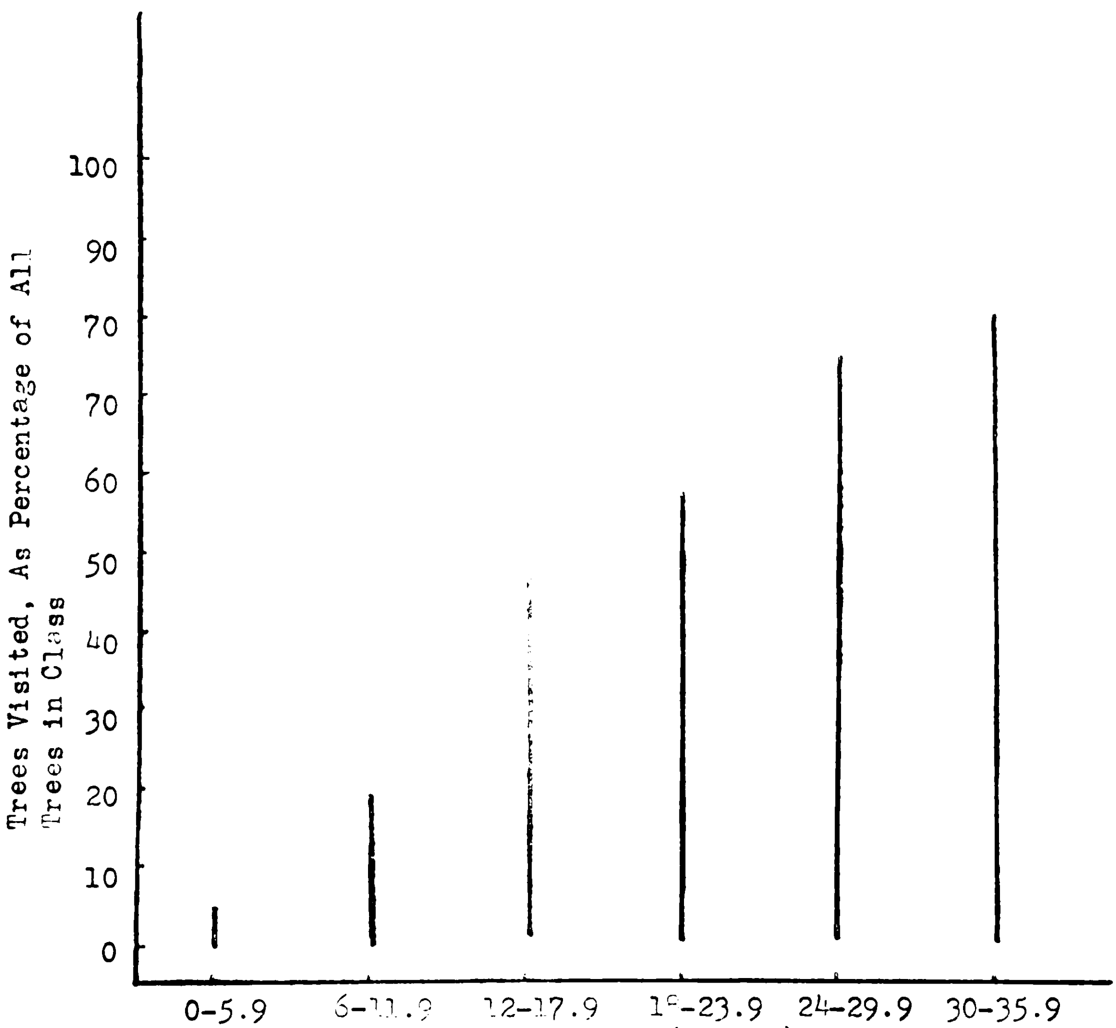


Figure 44. Weevil visits in relation to tree height

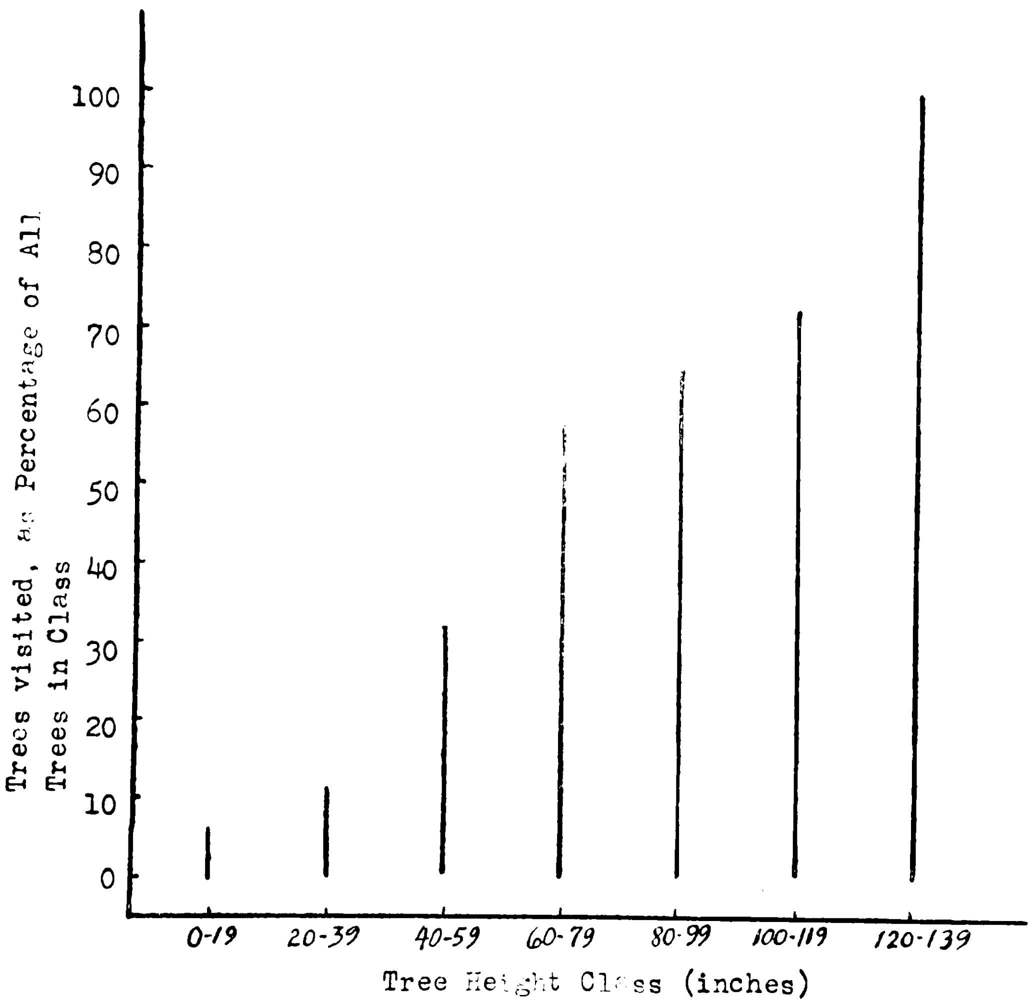


Figure 45. Marked and unmarked weevil occurrence in combination and separately on trees

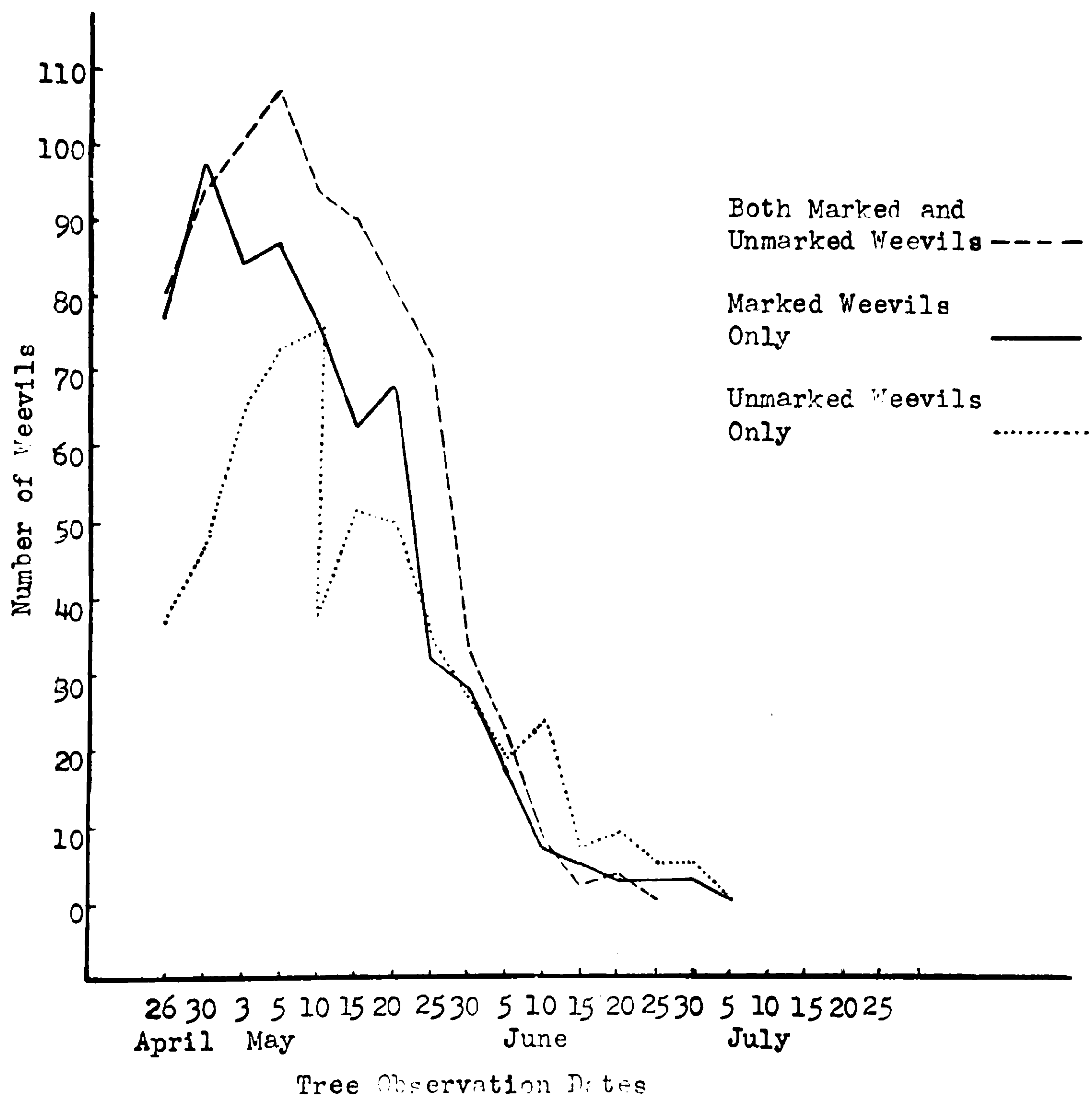


Figure 46. Numbers of trees with combined and separate occurrence of marked and unmarked weevils

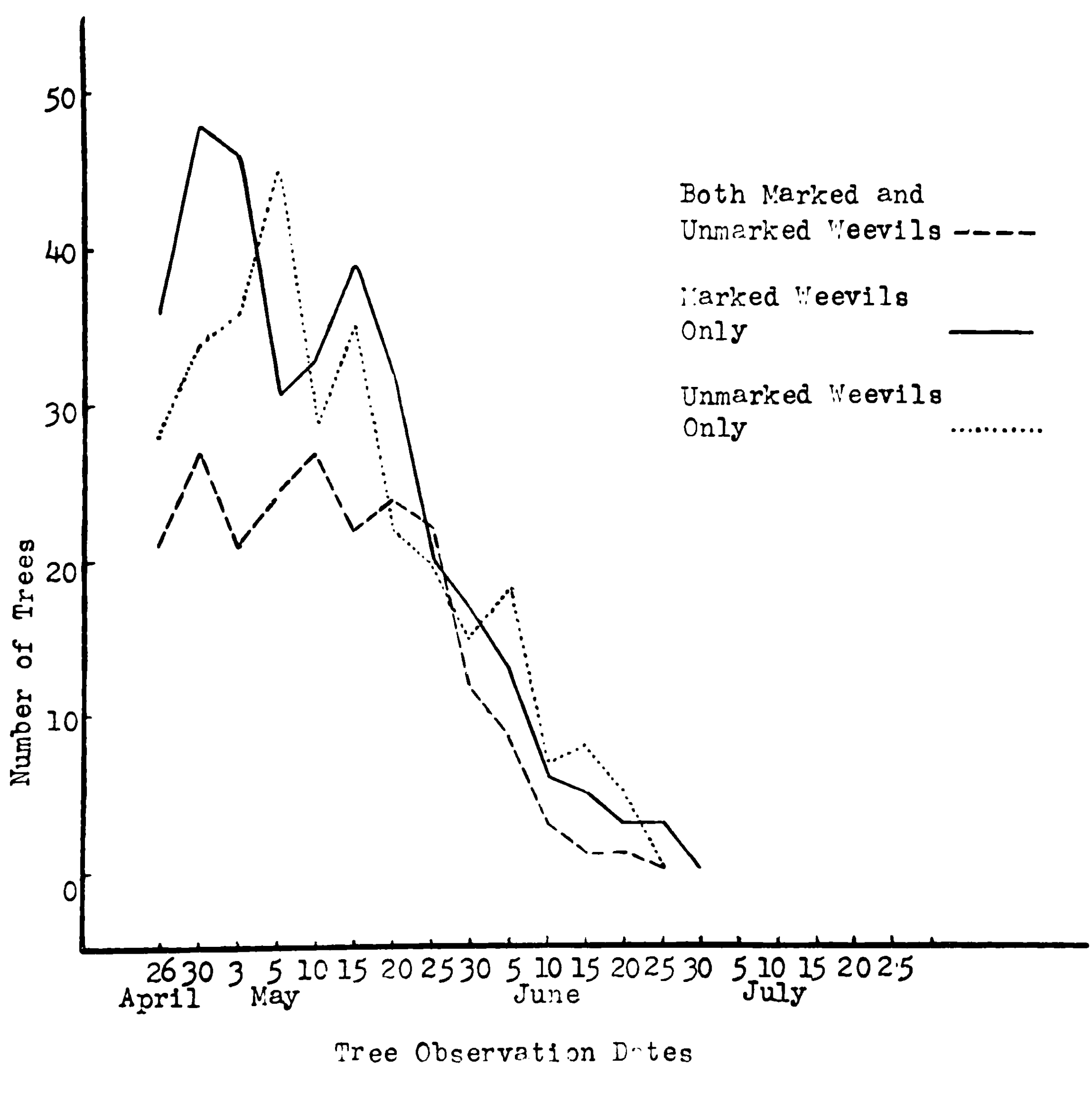


Table 34. Number of trees per sector and quadrant

Sector Radii From Release Point (feet)	Quadrant NE	NW	SE	SW	Total
0-30	16	16	16	17	65
30-60	47	51	47	39	184
60-90	56	75	66	65	262
90-120	75	76	48	53	252
120-150	48	66	20	57	191
150-180	25	56	1	31	113
180-210	32	57		38	127
210-240	21	42		32	95
240-270	12	41		24	77
270-300	1	26		35	62
300-330	—	—	—	3	3
Totals	333	506	198	394	1431

Table 35. -- Weevil distribution through the plantation by 0-30 foot sector

Field Check Dates		Total Weevils Observed: Un-marked	Marked: Male	Marked: Female	Total	Weevils Per Tree: Un-marked	Marked: Male	Marked: Female	Total
		Sector 0-30 feet (65 trees)							
April	26	4	34	22	60	0.0615	0.5230	0.3384	0.9230
	30	2	54	32	88	0.0307	0.8307	0.4923	1.3538
May	3	7	31	23	61	0.1076	0.4769	0.3538	0.9384
	5	7	50	40	97	0.1076	0.7692	0.6153	1.4923
	10	5	34	28	67	0.0769	0.5230	0.4307	1.0307
	15	12	27	18	57	0.1846	0.4153	0.2769	0.8769
	20	5	27	20	52	0.0769	0.4153	0.3076	0.8000
	25	6	13	13	32	0.0923	0.2000	0.2000	0.4923
	30	1	9	8	18	0.0153	0.1384	0.1230	0.2769
June	5	1	2	5	8	0.0153	0.0307	0.0769	0.1230
	10	0	1	1	2	0	0.0153	0.0153	0.0307
	15	0	0	1	1	0	0	0.0153	0.0153
	20	0	0	0	0	0	0	0	0
	25	0	0	0	0	0	0	0	0
	30	0	0	1	1	0	0	0.0153	0.0153
July	5								
	10								
	15								
	20								
	25								
		Sector 30-60 feet (184 trees)							
April	26	3	6	2	11	0.0163	0.0326	0.0108	0.0597
	30	4	11	6	21	0.0217	0.0597	0.0326	0.1141
May	3	6	12	9	27	0.0326	0.0652	0.0489	0.1467
	5	5	11	10	26	0.0271	0.0597	0.0543	0.1413
	10	12	12	10	34	0.0652	0.0652	0.0543	0.1847
	15	10	11	5	26	0.0543	0.0597	0.0271	0.1413
	20	6	8	5	19	0.0326	0.0434	0.0271	0.1032
	25	6	5	4	15	0.0326	0.0271	0.0217	0.0815
	30	5	4	4	13	0.0271	0.0217	0.0217	0.0706
June	5	2	2	4	8	0.0108	0.0108	0.0217	0.0434
	10	3	1	1	5	0.0163	0.0054	0.0054	0.0271
	15	2	0	2	4	0.0108	0	0.0108	0.0217
	20	2	0	2	4	0.0108	0	0.0108	0.0217
	25	1	0	0	1	0.0054	0	0	0.0054
	30	0	0	0	0	0	0	0	0
July	5	0	0	0	0	0	0	0	0
	10	0	1	0	1	0	0.0054	0	0.0054
	15	0	0	1	1	0	0	0.0054	0.0054
	20								
	25								

Table 35. -- (Continued)

Field Check Dates		Total Weevils Observed: Un-marked	Marked: Male	Marked: Female	Total	Weevils Per Tree: Un-marked	Marked: Male	Marked: Female	Total
Sector 60-90 feet (262 trees)									
April	26	24	13	5	42	0.0916	0.0496	0.0190	0.1603
	30	30	12	10	52	0.1145	0.0458	0.0381	0.1984
May	3	31	17	9	57	0.1183	0.0648	0.0343	0.2175
	5	18	9	8	35	0.0687	0.0343	0.0305	0.1335
	10	14	7	3	24	0.0534	0.0267	0.0114	0.0916
	15	14	4	5	23	0.0534	0.0152	0.0190	0.0877
	20	11	5	5	21	0.0419	0.0190	0.0190	0.0801
	25	10	3	6	19	0.0381	0.0114	0.0229	0.0725
	30	8	7	3	18	0.0305	0.0267	0.0114	0.0687
June	5	3	1	0	4	0.0114	0.0038	0	0.0152
	10	4	2	3	9	0.0152	0.0076	0.0114	0.0343
	15	1	0	4	5	0.0038	0	0.0152	0.0190
	20	1	0	2	3	0.0038	0	0.0076	0.0114
	25	0	0	1	1	0	0	0.0038	0.0038
	30	0	0	0	0	0	0	0	0
July	5	0	0	1	1	0	0	0.0038	0.0038
	10	0	0	0	0	0	0	0	0
	15	1	2	1	4	0.0038	0.0076	0.0038	0.0152
	20	0	0	1	1	0	0	0.0038	0.0038
	25	0	0	0	0	0	0	0	0
Sector 90-120 feet (252 trees)									
April	26	14	7	1	22	0.0555	0.0277	0.0039	0.0873
	30	22	9	7	38	0.0873	0.0357	0.0277	0.1507
May	3	25	9	4	38	0.0992	0.0357	0.0158	0.1507
	5	34	11	7	52	0.1349	0.0436	0.0277	0.2063
	10	16	5	6	27	0.0634	0.0198	0.0238	0.1071
	15	15	6	6	27	0.0595	0.0238	0.0238	0.1071
	20	17	8	4	29	0.0674	0.0317	0.0158	0.1150
	25	7	4	3	14	0.0277	0.0158	0.0119	0.0555
	30	7	3	3	13	0.0277	0.0119	0.0119	0.0515
June	5	8	1	4	13	0.0317	0.0039	0.0158	0.0515
	10	8	0	0	8	0.0317	0	0	0.0317
	15	3	0	0	3	0.0119	0	0	0.0119
	20	2	0	0	2	0.0079	0	0	0.0079
	25	0	0	0	0	0	0	0	0
	30	1	0	0	1	0.0039	0	0	0.0039
July	5								
	10								
	15								
	20								
	25								

Table 35. -- (Continued)

Field Check Dates	Total Weevils Observed: Un-marked	Marked: Male	Marked: Female	Total	Weevils Per Tree: Un-marked	Marked: Male	Marked: Female	Total
				Sector 120-150 feet (191 trees)				
April 26	18	7	5	30	0.0942	0.0366	0.0261	0.1570
30	18	6	1	25	0.0942	0.0314	0.0052	0.1308
May 3	21	5	4	30	0.1099	0.0261	0.0209	0.1570
5	24	3	6	33	0.1256	0.0157	0.0314	0.1727
10	13	7	7	27	0.0680	0.0366	0.0366	0.1413
15	9	7	4	20	0.0471	0.0366	0.0209	0.1047
20	12	10	6	28	0.0628	0.0523	0.0314	0.1465
25	12	6	5	23	0.0628	0.0314	0.0261	0.1204
30	9	3	2	14	0.0471	0.0157	0.0104	0.0732
June 5	5	5	2	12	0.0261	0.0261	0.0104	0.0628
10	5	1	2	8	0.0261	0.0052	0.0104	0.0418
15	0	0	1	1	0	0	0.0052	0.0052
20	3	0	0	3	0.0157	0	0	0.0157
25	0	0	2	2	0	0	0.0104	0.0104
30	1	0	2	3	0.0052	0	0.0104	0.0157
July 5	0	1	0	1	0	0.0052	0	0.0052
10	1	0	1	2	0.0052	0	0.0052	0.0104
15	1	0	0	1	0.0052	0	0	0.0052
20								
25								
				Sector 150-180 feet (113 trees)				
April 26	2	3	1	6	0.0176	0.0265	0.0088	0.0530
30	10	6	0	16	0.0884	0.0530	0	0.1415
May 3	6	3	3	12	0.0530	0.0265	0.0265	0.1061
5	16	2	2	20	0.1415	0.0176	0.0176	0.1769
10	13	3	3	19	0.1150	0.0265	0.0265	0.1681
15	12	0	2	14	0.1061	0	0.0176	0.1238
20	10	0	1	11	0.0884	0	0.0088	0.0973
25	9	0	1	10	0.0796	0	0.0088	0.0884
30	4	0	0	4	0.0353	0	0	0.0353
June 5	3	0	1	4	0.0265	0	0.0088	0.0353
10	2	1	0	3	0.0176	0.0088	0	0.0265
15	2	0	0	2	0.0176	0	0	0.0176
20	1	0	0	1	0.0088	0	0	0.0088
25	3	0	0	3	0.0265	0	0	0.0025
30	2	0	0	2	0.0176	0	0	0.0176
July 5								
10								
15								
20								
25								

Table 35. -- (Continued)

Field Check Dates		Sector 180-210 feet (127 trees)							
		Total Weevils Observed				Weevils Per Tree			
		Un-marked	Marked Male	Marked Female	Total	Un-marked	Marked Male	Marked Female	Total
April	26	8	3	1	12	0.0629	0.0236	0.0078	0.0944
	30	9	4	1	14	0.0708	0.0314	0.0078	0.1102
May	3	9	5	3	17	0.0708	0.0393	0.0236	0.1338
	5	6	3	2	11	0.0472	0.0236	0.0157	0.0866
	10	8	4	1	13	0.0629	0.0314	0.0078	0.1023
	15	7	1	1	9	0.0551	0.0078	0.0078	0.0708
	20	5	2	0	7	0.0393	0.0157	0	0.0551
	25	7	1	1	9	0.0551	0.0078	0.0078	0.0708
	30	3	1	1	5	0.0236	Q0078	0.0078	0.0393
June	5	1	0	0	1	0.0078	0	0	0.0078
	10	2	1	1	4	0.0157	0.0078	0.0078	0.0314
	15	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0
	25	1	0	0	1	0.0078	0	0	0.0078
	30								
July	5								
	10								
	15								
	20								
	25								

Field Check Dates		Sector 210-240 feet (95 trees)							
		Un-marked	Marked Male	Marked Female	Total	Un-marked	Marked Male	Marked Female	Total
April	26	4	1	1	6	0.0205	00051	0.0051	0.0307
	30	3	1	1	5	0.0153	0.0051	0.0051	0.0256
May	3	8	3	1	12	0.0410	0.0153	0.0051	0.0615
	5	6	4	3	13	0.0307	0.0205	0.0153	0 .0666
	10	8	3	3	14	0.0410	0.0153	0.0153	0.0717
	15	2	1	1	4	0.0102	0.0051	0.0051	0.0205
	20	5	1	0	6	0.0256	0.0051	0	0.0307
	25	0	1	0	1	0	0.0051	0	0.0051
	30	2	2	0	4	0.0102	0.0102	0	0 .0205
June	5	3	0	1	4	0.0153	0	0.0051	0.0205
	10	3	1	1	5	0.0153	0.0051	0.0051	0.0256
	15	0	0	0	0	0	0	0	0
	20	1	1	0	2	0.0051	0.0051	0	0.0102
	25								
	30								
July	5								
	10								
	15								
	20								
	25								

Table 35. -- (Continued)

Field Check Dates		Total Weevils Observed: Un-marked	Total Weevils Observed: Marked Male	Total Weevils Observed: Marked Female	Total Weevils Observed: Total	Weevils Per Tree: Un-marked	Weevils Per Tree: Marked Male	Weevils Per Tree: Marked Female	Weevils Per Tree: Total
Sector 240-270 feet (77 trees)									
April	26	5	1	0	6	0.0649	0.0129	0	0.0779
	30	6	2	0	8	0.0779	0.0259	0	0.1038
May	3	7	4	1	12	0.0909	0.0519	0.0129	0.1558
	5	15	3	0	18	0.1948	0.0389	0	0.2337
	10	10	1	1	12	0.1298	0.0129	0.0129	0.1558
	15	17	4	1	22	0.2207	0.0519	0.0129	0.2857
	20	13	2	0	15	0.1688	0.0259	0	0.1948
	25	8	2	0	10	0.1038	0.0259	0	0.1298
	30	1	0	0	1	0.0129	0	0	0.0129
June	5	1	1	0	2	0.0129	0.0129	0	0.0259
	10								
	15								
	20								
	25								
	30								
July	5								
	10								
	15								
	20								
	25								
Sector 270-300 feet (62 trees)									
April	26	3	0	0	3	0.0483	0	0	0.0483
	30	0	1	0	1	0	0.0161	0	0.0161
May	3	2	1	0	3	0.0322	0.0161	0	0.0483
	5	2	0	0	2	0.0322	0	0	0.0322
	10	1	0	0	1	0.0161	0	0	0.0161
	15	2	1	0	3	0.0322	0.0161	0	0.0483
	20	3	2	0	5	0.0483	0.0322	0	0.0806
	25	2	0	0	2	0.0322	0	0	0.0322
	30	1	0	0	1	0.0161	0	0	0.0161
June	5	1	1	0	2	0.0161	0.0161	0	0.0322
	10								
	15								
	20								
	25								
	30	1	0	0	1	0.0161	0	0	0.0161
July	5								
	10								
	15								
	20								
	25								

Table 35. -- (Continued)

Field Check Dates		Sector 300-330 feet (3 trees)							
		Total Weevils Observed				Weevils Per Tree			
		Un-	Marked			Un-	Marked		
		marked	Male	Female	Total	marked	Male	Female	Total
April	26	0	0	0	0	0	0	0	0
	30	1	0	0	1	0.3333	0	0	0.3333
May	3								
	5								
	10								
	15	0	1	0	1	0	0.3333	0	0.3333
	20	0	1	0	1	0	0.3333	0	0.3333
	25	1	1	0	2	0.3333	0.3333	0	0.6666
	30	1	1	0	2	0.3333	0.3333	0	0.6666
June	5	0	0	0	0	0	0	0	0
	10	1	0	0	1	0.3333	0	0	0.3333
	15								
	20								
	25								
	30								
July	5								
	10								
	15								
	20								
	25								

Table 36 . Weevil distribution through the plantation by quadrant

Field Check Dates		Total Weevils Observed: Un-marked	Marked: Male	Marked: Female	Total	Weevils Per Tree: Un-marked	Marked: Male	Marked: Female	Total
		NE Quadrat (333 trees)							
April	26	32	40	19	91	.0960	.1201	.0570	.2732
	30	56	62	37	155	0.1681	0.1861	0.1111	0.4654
May	3	62	35	28	125	.1861	0.1051	0.0840	0.3753
	5	65	57	47	169	0.1951	0.1711	0.1411	0.5075
	10	45	35	35	115	0.1351	0.1051	0.1051	0.3453
	15	45	24	23	92	0.1351	0.0720	0.0690	0.2762
	20	42	35	21	98	0.1261	0.1051	0.0630	0.2942
	25	23	19	16	58	0.0690	0.0570	0.0480	0.1741
	30	10	10	8	28	0.0300	0.0300	0.0240	0.0840
June	5	9	4	8	21	0.0270	0.0120	0.0240	0.0630
	10	4	2	2	8	0.0120	0.0060	0.0060	0.0240
	15	2	0	3	5	0.0060	0 0	0.0090	0.0150
	20	3	1	1	5	0.0090	0.0030	0.0030	0.0150
	25	2	0	1	3	0.0060	0 0	0.0030	0.0090
	30	2	0	2	4	0.0060	0	0.0060	0.0120
July	5	0	0	0	0	0 0	0	0 0	0 0
	10	0	0	0	0	0	0	0	0
	15	1	1	0	2	.0030	.0030	0	.0060
	20					0	0		0
	25								
		NW Quadrat (506 trees)							
April	26	14	15	10	39	.0276	.0296	.0197	.0770
	30	18	21	11	50	0.0355	0.0415	0.0217	0.0988
May	3	25	28	14	67	0.0494	0.0553	0.0276	0.1324
	5	21	15	14	50	0.0415	0.0296	0.0276	0.0988
	10	18	11	6	35	0.0355	0.0217	0.0118	0.0691
	15	21	12	7	40	0.0415	0.0237	0.0138	0.0790
	20	15	9	8	32	0.0296	0.0177	0.0158	0.0632
	25	15	4	8	27	0.0296	0.0079	0.0158	0.0533
	30	14	11	5	30	0.0276	0.0217	0.0098	0.0592
June	5	6	5	6	17	0.0118	0.0098	0.0118	0.0335
	10	4	3	2	9	0.0079	0.0059	0.0039	0.0177
	15	3	0	1	4	0.0059	0 0	0.0019	0.0079
	20	0	0	0	0	0 0	0	0 0	0 0
	25	1	0	0	1	.0019	0	0	.0019
	30	1	0	0	1	0.0019	0	0	0.0019
July	5	0	0	0	0	0 0	0	0	0 0
	10	0	1	0	1	0	.0019	0	.0019
	15						0		0
	20								
	25								

Table 36 -- (continued)

Field Check Dates		Total Weevils Observed: Un-marked	Marked: Male	Marked: Female	Total	Weevils Per Tree: Un-marked	Marked: Male	Marked: Female	Total
SE Quadrat (198 trees)									
April	26	27	10	5	42	.1363	.0505	.0252	.2121
	30	24	12	5	41	.1212	.0606	.0252	.2070
May	3	21	13	5	39	.1060	.0656	.0252	.1969
	5	28	13	7	48	.1414	.0656	.0353	.2424
	10	18	19	10	47	.0909	.0959	.0505	.2373
	15	15	12	7	34	.0757	.0606	.0353	.1717
	20	9	8	4	21	.0454	.0404	.0202	.1060
	25	14	5	8	27	.0707	.0252	.0404	.1363
	30	1	1	3	5	.0050	.0050	.0151	.0252
June	5	9	1	1	11	.0454	.0050	.0050	.0555
	10	9	1	2	12	.0454	.0050	.0101	.0606
	15	1	0	2	3	.0050	0	.0101	.0151
	20	2	0	0	2	.0101	0	0	.0101
	25	0	0	2	2	0	0	.0101	.0101
	30	0	0	1	1	0	0	.0050	.0050
July	5	0	0	1	1	0	0	.0050	.0050
	10	0	0	0	0	0	0	0	0
	15	0	0	1	1	0	0	.0050	.0050
	20								
	25								
SW Quadrat (394 trees)									
April	26	12	10	4	26	.0304	.0253	.0101	.0659
	30	7	11	5	23	.0177	.0279	.0126	.0583
May	3	14	14	10	38	.0355	.0355	.0253	.0964
	5	19	11	10	40	.0482	.0279	.0253	.1015
	10	19	11	11	41	.0482	.0279	.0279	.1040
	15	19	15	6	40	.0482	.0380	.0152	.1015
	20	21	14	8	43	.0532	.0355	.0203	.1091
	25	16	8	1	25	.0406	.0203	.0025	.0634
	30	17	8	5	30	.0431	.0203	.0126	.0761
June	5	4	3	2	9	.0101	.0076	.0050	.0228
	10	11	2	3	16	.0279	.0050	.0076	.0406
	15	2	0	2	4	.0050	0	.0050	.0101
	20	5	0	3	8	.0126	0	.0076	.0203
	25	2	0	0	2	.0050	0	0	.0050
	30	2	0	0	2	.0050	0	0	.0050
July	5	0	1	0	1	0	.0025	0	.0025
	10	1	0	1	2	.0025	0	.0025	.0050
	15	1	1	1	3	.0025	.0025	.0025	.0076
	20	0	0	1	1	0	0	.0025	.0025
	25								

Table 36 -- (continued)

Field Check Dates		Totals for Entire Plantation (1431 trees): Total Weevils Observed: Un-marked	Marked: Male	Marked: Female	Total	Weevils Per Tree: Un-marked	Marked: Male	Marked: Female	Total
April	26	85	75	28	188	.059	.052	.019	.131
	30	105	106	58	269	.073	.074	.040	.187
May	3	122	90	57	269	.085	.062	.039	.187
	5	133	96	78	307	.092	.067	.054	.214
	10	100	76	62	238	.069	.053	.043	.166
	15	100	63	43	206	.069	.044	.030	.143
	20	87	66	41	194	.060	.046	.028	.135
	25	68	36	33	137	.047	.025	.023	.095
	30	42	30	21	93	.064	.020	.014	.064
June	5	28	13	17	58	.040	.009	.011	.040
	10	28	8	9	45	.031	.005	.006	.031
	15	8	0	8	16	.011	0	.005	.011
	20	10	1	4	15	.010	.001	.002	.010
	25	5	0	3	8	.005	0	.002	.005
	30	5	0	3	3	.005	0	.002	.002
July	5	0	1	1	2	0	.001	.001	.001
	10	1	1	1	3	.001	.001	.001	.002
	15	2	2	2	6	.001	.001	.001	.004
	20	0	0	1	1	0	0	.001	.001
	25	0	0	0	0	0	0	0	0

Table 37. Weevil damage related to leader diameter, leader length, and tree height for all sectors within the northeast and northwest quadrants

Leader Diameter																
Leader Diameter Class (Inches)	Trees Within Numerical Class: Number	Trees Within Numerical Class: Percent	Trees Visited: Number	Trees Visited: Percent Within class	Percent of Total Trees Within Each Class in Damage Category[1/]: A	B	A-B	C	D	E	F	G: G1	G2	G3	G4	Total G
0.00-0.09	26	3.4	0	0	0	0	0	0	0	0	0	100	0	0	0	100
0.10-0.19	141	18.6	6	4.2	0	0	0	0	0	0	0	95.0	2.8	2.1	0	100
0.20-0.29	165	21.7	28	16.9	0.61	4.2	0	0	1.2	0	0	82.4	4.8	5.4	1.2	93.9
0.30-0.39	145	19.1	52	35.8	2.06	6.9	2.7	2.7	6.2	2.1	0.7	62.7	6.2	6.2	1.4	76.5
0.40-0.49	150	19.7	82	54.6	1.33	80.0	4.7	0.7	6.0	4.7	0.7	44.6	9.3	10.6	9.3	74.0
0.50-0.59	65	8.5	38	58.4	1.53	13.8	7.7	1.5	1.5	7.7	0	41.5	6.1	9.2	9.2	66.1
0.60-0.69	45	5.9	33	73.3	4.44	11.1	13.3	2.2	6.7	4.4	0	26.6	13.3	13.3	4.4	57.7
0.70-0.79	17	2.2	9	52.9	0	5.9	5.9	0	17.6	0	0	47.0	5.9	0	17.6	70.5
0.80-0.89	3	0.3	2	66.6	33.3	33.3	0	0	0	0	0	33.3	0	0	0	33.3
0.90-0.99	1	0.1	0	0	0	0	0	0	0	0	0	100	0	0	0	100
Totals	758		250		1.3	5.9	3.0	0.9	3.5	2.2	0.2	66.3	6.0	6.4	3.8	82.5

1/ -- Categories of attack approximately as listed by Kulman and Harman (1965)

A -- Successfil attack, with one or more weevils emerging as adults

B -- Unsuccessful attack, with terminal shoot dead

C -- Unsuccessful attack, terminal shoot alive, but so badly damaged that a lateral shoot has assumed the terminal position

D -- Unsuccessful attack, with shoot alive but with conspicuous reduction in terminal shoot elongation in the year of weevil damage

E -- Unsuccessful attack, with terminal shoot alive but conspicuously damaged

F -- Unsuccessful attack, with terminal shoot alive but with minor feeding scars

G -- Trees not attacked; G1 -- No evidence of weevils or damage at any time; G2 -- Weevils observed on tree, but no damage present later; G3 -- Feeding damage recorded early in summer, but no longer evident by late summer; G4 -- Weevils and feeding damage recorded early in summer, but no longer evident by late summer

A-B -- Damage either in A or B, but unknown because weevil forms were destroyed by birds

Table 37 -- (continued)

Leader Length Class (Inches)	Trees Within Numerical Class: Number	Trees Within Numerical Class: Percent	Trees Visited: Number	Trees Visited: Percent Within class	A	B	A-B	C	D	E	F	G1	G2	G3	G4	Total G
Leader Length					Percent of Total Trees Within Each Class in Damage Category 1/											
0-5.9	156	20.5	7	4.4	0	0	0	0	0	0	0	95.5	3.2	1.3	0	100.0
6-11.9	222	29.2	41	18.4	0.9	3.6	0.4	0.9	1.3	0.4	0	80.1	2.7	6.3	2.2	91.4
12-17.9	213	28.0	99	46.4	1.4	8.0	3.7	0.5	7.0	2.8	0.9	52.5	9.4	8.9	4.7	75.5
18-23.9	112	14.7	64	57.1	3.6	10.7	5.3	3.6	3.6	7.1	0	42.8	6.2	8.9	8.0	66.0
24-29.9	51	6.7	38	74.5	2.0	13.7	13.7	0	7.8	3.9	0	25.4	13.7	11.7	7.8	58.8
30-35.9	5	0.6	4	80.0	0	20.0	20.0	0	20.0	0	0	20.0	20.0	0	0	40.0
Totals	759		253	33.3	1.3	5.9	3.0	0.9	3.5	2.2	0.2	66.0	6.0	6.7	3.6	82.4
Tree Height																
Height Class (Inches)																
0-19	51	6.7	3	5.9	0	0	0	0	0	0	0	94.1	2.0	3.9	0	100.0
20-39	209	27.7	23	11.0	0	1.4	1.0	0.5	0	0	0	88.9	2.9	4.8	0.5	97.1
40-59	237	31.5	76	32.0	2.1	5.9	1.7	0.4	5.1	0.8	0.4	67.9	8.0	4.6	2.9	83.5
60-79	183	24.3	106	57.9	3.3	10.3	3.8	2.2	6.0	7.1	0.5	42.0	7.1	8.7	8.7	66.6
80-99	60	7.9	39	65.0	1.7	10.0	13.3	1.7	5.0	5.0	0	35.0	5.0	5.0	5.0	63.3
100-119	11	1.4	8	72.7	0	18.1	9.1	0	0	0	0	27.2	27.2	18.1	18.1	72.7
120-140	1	0.1	1	100.0	0	0	0	0	100	0	0	0	0	0	0	0
Totals	752		256	34	1.5	5.8	2.6	0.9	3.5	2.3	0.2	65.9	5.9	6.5	3.8	82.4

Table 38. Movement of weevils recorded within the northeast quadrant, 0-30 feet from release point

Check Dates		Weevil Arrivals (+) and Departures (-)								
		Tree 1			Tree 2			Tree 3		
		Males	Females	Unmarked	Males	Females	Unmarked	Males	Females	Unmarked
April	26	1	0	0	release tree					
	30	+3			21	11				
May	3	-3			-16	- 7				
	5		+1		+ 9	+ 3	+1			
	10	-1	-1		-14	- 7	-1	+1	+1	
	15									
	20							+1	+1	
	25							-1	-1	
	30							-1	-1	
Total		7	2	0				4	4	
		Tree 4			Tree 5			Tree 6		
April	26	20	11	0	0					0
	30	- 4	+ 2							
May	3	-10	- 4	+ 1		+ 1				
	5	+13	+ 9	- 1						
	10	-10	-10	+ 1	+1		+1	+1	+3	
	15	- 7	- 7	+ 1			-1		-1	
	20	- 2	- 1	- 2	-1			+4	+1	
	25					-1		-2		
	30							-1	-2	
June	5							-1		
	10							-1	-1	
Total		46	33	6	2	2	2	10	8	
		Tree 7			Tree 8			Tree 9		
April	26	1	1	0	0	0	0	0	0	0
	30	- 1	- 1							
May	3									
	5	+ 1	+ 2						+1	
	10		+ 1		+1			+1	-1	
	15	+ 1	- 2					+1	+1	
	20	+ 1	+ 2		+1	+2		+1		
	25	- 2	- 2		-2	+2			+2	+2
	30							-1	-1	-1
June	5	- 1	+ 1	+1				-2	-2	-1
	10		- 2	-1				+1	+1	
	15							-1	-1	
Total		7	13	2	4	4		8	10	4

Table 38 -- (continued)

Check Dates	Weevil Arrivals (+) and Departures (-)								
	Tree 10			Tree 11			Tree 12		
	Males	Females	Unmarked	Males	Females	Unmarked	Males	Females	Unmarked
April 26	2	1	0		0			0	
30	-1								
May 3									
5			+1						
10	+1		-1						
15	-1								
20	-1	-1							
25								+1	
30								-1	
June 5					+1				
10					-1				
15					+1				
20					+1				
25									
30								+1	
July 5								-1	
Totals	4	1	2		4			4	

Table 39. Presence on trees of the native, unmarked weevils and those marked and released into the plantation

Check Date	Trees with Marked Weevils Only: Males Only: Number of Trees	Males Only: Number of Weevils: Total	Males Only: Number of Weevils: Per Tree	Females Only: Number of Trees	Females Only: Number of Weevils: Total	Females Only: Number of Weevils: Per Tree	Both Males and Females: Number of Trees	Both Males and Females: Number of Weevils: Total: Males	Both Males and Females: Number of Weevils: Total: Females	Both Males and Females: Number of Weevils: Per Tree	Total: Number of Trees	Total: Number of Weevils: Total: Males	Total: Number of Weevils: Total: Females	Total: Per Tree
April 26	21	21	1.00	5	5	1.00	10	30	21	5.10	36	51	26	2.14
30	22	26	1.18	8	8	1.00	18	34	29	3.50	48	60	37	2.02
May 3	15	16	1.07	13	13	1.00	18	30	25	3.05	46	46	38	1.83
5	6	6	1.00	13	13	1.00	12	36	32	5.67	31	42	45	2.81
10	9	9	1.00	8	9	1.12	16	25	33	3.62	33	34	42	2.30
15	15	15	1.00	11	11	1.00	13	21	16	2.85	39	36	27	1.61
20	11	12	1.09	8	8	1.00	13	27	21	3.69	32	39	29	2.12
25	7	7	1.00	6	6	1.00	7	9	10	2.71	20	16	16	1.60
30	6	7	1.17	5	6	1.20	6	8	7	2.50	17	15	13	1.65
June 5	3	3	1.00	7	8	1.14	3	3	3	2.00	13	6	11	1.31
10	1	1	1.00	3	3	1.00	2	2	1	1.50	6	3	4	1.17
15	0	0	0	5	5	1.00	0	0	0	0	5	0	5	1.00
20	1	1	1.00	2	2	1.00	0	0	0	0	3	1	2	1.00
25	0	0	0	3	3	1.00	0	0	0	0	3	0	3	1.00
30	0	0	0	3	3	1.00	0	0	0	0	3	0	3	1.00

Table 39 -- (continued)

Check Dates	Trees with Both Marked and Unmarked Weevils													Total Numbers				
	Unmarked Weevils with Marked Males 1/				Unmarked Weevils with Marked Females				Unmarked Weevils with Marked Males and Females									
	Number of Trees	Number of Weevils			Number of Trees	Number of Weevils			Number of Trees	Number of Weevils				Number of Trees	Number of Weevils			
		Total		Per Tree		Total		Per Tree		Total			Per Tree		Total			Per Tree
		U	M			U	F			U	M	F			U	M	F	
April 26	12	22	17	3.25	5	14	6	4.00	4	11	6	4	5.25	21	47	23	10	3.81
30	18	35	23	3.22	7	17	7	3.43	2	3	4	5	6.00	27	55	27	12	3.48
May 3	13	22	17	3.00	1	2	1	3.00	7	18	17	8	6.14	21	42	34	9	4.05
5	13	26	18	1.44	6	13	6	3.17	5	15	16	13	8.80	24	54	34	19	4.63
10	15	23	19	2.80	7	21	10	4.43	5	8	7	6	4.20	27	52	26	16	3.48
15	11	18	17	3.18	7	19	8	3.86	4	12	11	5	7.00	22	49	28	13	4.09
20	15	23	21	2.93	7	8	7	2.14	2	3	3	3	4.50	24	34	24	10	2.83
25	13	22	16	2.92	8	17	9	3.25	1	2	3	3	8.00	22	41	19	12	2.55
30	6	7	9	2.67	3	3	3	2.00	3	3	5	4	4.00	12	13	14	7	2.67
June 5	5	6	5	2.20	2	2	3	2.50	2	2	2	3	3.50	9	10	7	6	2.00
10	1	1	1	1.00	1	1	1	2.00	1	2	1	1	4.00	3	4	2	2	3.00
15					1	1	1	2.00						1	1		1	
20					1	2	1	3.00						1	2		1	
25																		

1/ -- M= male weevils; F= female weevils; U= unmarked weevils

Table 39 -- (continued)

Check Dates	Trees with Unmarked Weevils Only		
		Number of Weevils	
	Number of Trees	Total Number	Number per Tree
April 26	28	37	1.32
30	34	47	1.38
May 3	36	64	1.78
5	45	73	1.62
10	29	38	1.31
15	35	52	1.48
20	35	50	1.43
25	22	34	1.55
30	20	27	1.35
June 5	15	19	1.27
10	18	24	1.33
15	7	7	1.00
20	8	9	1.12
25	5	5	1.00
30	5	5	1.00

Table 40. Classification of current (1965) and past weevil damage

Number of Trees	Damage Classification 1/ 1965	1964	Prior to 1964
1	A	A	D
1	A	D	G
	(bird predation)		
1	A-B	A	G
1	A-B	G	A
1	A-B	G	B
25	A-B	G	G
3	B	A	G
1	B	B	B
1	B	B	A
1	B	B	G
1	B	C	B
1	B	C	G
1	B	D	A
3	B	D	G
2	B	G	A
2	B	G	B
81	B	G	G
1	C	B	C
1	C	C	C
1	C	G	A
1	C	G	D
11	C	G	G
1	D	A	G
2	D	B	G
1	D	D	G
1	D	D	D
1	D	G	A
33	D	B	G
1	E	B	A
1	E	B	G
1	E	G	A
23	E	G	G
1	F	G	A
8	F	G	G
21	G	A	G
1	G	B	B
21	G	B	G
2	B	C	G
1	G	D	D
6	G	D	G
3	G	E	G
17	G	G	A
5	G	G	B
1	G	G	D

1/ -- Damage categories as used in table 31

Table 41. Damage classification related to weevil presence on individual trees

Weevils Observed on Leaders on Check Dates from April-July[2/] (April 26 – May 15)

Tree	Damage[1/] Category	April 26 M	April 26 F	April 26 U	April 30 M	April 30 F	April 30 U	May 3 M	May 3 F	May 3 U	May 5 M	May 5 F	May 5 U	May 10 M	May 10 F	May 10 U	May 15 M	May 15 F	May 15 U
1	A																1		
2	A			3			1	1		3	1		3	2		2	2		1
3	A	1		3						5									1
4	A	1	2		1	1		3	2										
5	A																		
6	A	2		1	2		1	1						1	1			2	2
7	A	1		1	1			2	1	3	2	1	1	2	1	2			
8	A	1	1		1	2		2	1		3	2	1	6	4		4	2	
9	B														1				
10	B							1			1								
11	B													1	1		1		
12	B														1			1	
13	B														1				
14	B																		
15	B	1	1	1		1	4	1	1	4						1			1
16	B								1			1							
17	B																	1	
18	B						1			2									
19	B											1			1			1	1
20	B						2			2			2						1
21	B	1																	
22	B																		
23	B	1			1	1	1	1	3	1	2					2	2	2	2
24	B						1			1						2			2
25	B			1															

Weevils Observed on Leaders on Check Dates from April-July[2/] (May 20 – July 5)

Tree	Damage[1/] Category	May 20 M	May 20 F	May 20 U	May 25 M	May 25 F	May 25 U	May 30 M	May 30 F	May 30 U	June 5 M	June 5 F	June 5 U	June 10 M	June 10 F	June 10 U	June 15 M	June 15 F	June 15 U	June 20 M	June 20 F	June 20 U	June 25 M	June 25 F	June 25 U	June 30 M	June 30 F	June 30 U	July 5 M	July 5 F	July 5 U
1	A	1			1		1	1		1																					
2	A	1				2	4				1		2																		
3	A																														
4	A																														
5	A	1	1		1	2		1	2																						
6	A	2		1	3		4	2	1																						
7	A																														
8	A					1																									
9	B																														
10	B					1																									
11	B			1																											
12	B		1																												
13	B					1			1			1																			
14	B								1				2		4	4															
15	B		1	1									1																		
16	B																														
17	B		1																												
18	B							1																							
19	B		1																												
20	B			1																											
21	B		1					1	1	1		2			1	1					1	2			1						
22	B					1	1		1							1															
23	B	1	2	1																											
24	B			1			3																								
25	B																														

1/ -- Damage classifications as used in table 31

2/ -- M=males; F=females; U=unmarked weevils

Table 41 -- (continued)

Weevils Observed on Leaders on Check Dates from April-July[2]

Tree	Damage Category[1]	April 26			30			May 3			5			10			15			20			25			30			June 5			10			15			20			25			30			July 5		
		M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U
26	B	2		3	2		2	1			1		2																											2									
27	B												2			2			1			1																											
28	B												1															2																					
29	B		1			1			1						1	1		1	1	2	1					1																							
30	B														1			1																															
31	B													1	1	1	2	1		1			1	1																									
32	B							2	1		2	1		1	1		1			1																													
33	B			2	21	11		5	4		14	7	1																																				
34	A-B			2						2			3									1	1		2																								
35	A-B			1						1			1			1																																	
36	C												2			1			3																														
37	C													1			1		1																														
38	C						2	1		2			2	1		2																																	
39	C					1			1																																								
40	C																1			2		1	2		1	1		1		1	1					1										1	1		
41	C												1				2					2																											
42	C															1																																	
43	C													1	2						1																												
44	C																	1			1			1																									
45	D																		1			1			1																								
46	D														1					1			1																										
47	D						1			1			1		1	2			1																														
48	D	1			2	1							1			1			1																														
49	D												1						1		2				2			11	1		1																1		
50	D				1	1			1			1																																					
51	D																									1				1																			
52	D	1	1		1	1		1	1		2	1					1	1		1	1																												
53	D							2					1				1	1	2	2			1																										

Table 41 -- (continued)

Tree	Damage Category [1]	April 26			30			May 3			5			10			15			20			25			30			June 5			10			15			20			25			30					
		M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U
54	E	1	1	2	3		2	3	2	3	2	1	4	3	1	3		1				1										1		1															
55	E																				1	1			1			1																					
56	E																1																																
57	E																							1						1																			
58	F																																		1														
59	F			1																																													
60	F															1						1			1																								
61	G																								1																								
62	G	2		1	1																																												
63	G						1																																										
64	G																										1																						
65	G																														2																		
66	G	1		1																																													
67	G								1																																								
68	G																															1																	
69	G	1	1		1																																												
70	G	1		6	1		5		1																																								
71	G																					1																											
72	G									1																																							
73	G							1	1	1	1				1					2	1	2	1		1	1		1	1		1																		
74	G																										1																						
75	G			4			2			3		5	1			3	1		2	1		2		1	3						1																		
76	G																					1																											
77	G			1						4		4				2			3			2			1			2																					
78	G									1							1																																
79	G			1				1		1																																							
80	G																											1																					
81	G			1																																													

Column heading: Weevils Observed on Leaders on Check Dates from April-July [2]

Table 41 -- (continued)

Tree	Damage[1/] Category	Weevils Observed on Leaders on Check Dates from April-July [2/]																																									
		April						May																				June															
		26			30			3			5			10			15			20			25			30			5			10			15			20			25		
		M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U	M	F	U
82	G			1			1																																				
83	G																		1																								
84	G	1								1			1			2			2						1						1			1									
85	G																						1																				
86	G							1			1																																
87	G							3																																			
88	G												1																														
89	G												1	1		1																											
90	G													1																													
91	G	1		1																																							
92	G																					1																					
93	G												1																														
94	G	1												1			1			1																							
95	G	1			1																	1																					
96	G					1																																					
97	G	1			4			1			1																																
98	G				2																																						
99	G																1																										
100	G																																	1									

Table 42. **Attraction of flying weevils to treated trees**

Year	Number of Observations	Number of Replications	Number of Visits by Flying Weevils 1/ — Treatment Applied: Caged Male	Caged Female	Caged Male and Female	Artificial Wounding	Check Tree; no treatment	Totals
1963	3	5	1(U)	5(U)	2(U)	0	0	8
1964	6	10	0	7(5M) (2F)	2(M)	7(4M) (3F)	3(2M) (1F)	19
1965	11	10	3(M)	3(M)	10(3M) (3F) (4U)	4(2M) (1F) (1U)	0	20
Totals	20	25	4	15	14	11	3	47
Totals for Sexes		M	3	8	5	6	2	24
		F	0	2	3	4	1	10
		U	1	5	6	1	0	13

1/ M= Male Weevils; F=Female Weevils; U= Unmarked; sex unknown

IV. A Technique for Sexing Live White-Pine Weevils, *Pissodes strobi*

A. INTRODUCTION

Although the male and female anatomy of the white-pine weevil, *Pissodes strobi* (Peck), has been intensively studied, there has been no published account of a method by which live, adult weevils may be easily sexed without injuring the insect. In certain field and laboratory studies, it is necessary to determine the sex of the weevils without causing damage which may later affect experimental results.

Hopkins (1911) presented discussion and detailed illustrations of the anatomy and sexual characters of several members of the genus *Pissodes*, and MacAloney (1930) presented a method for sexing live weevils, based on the characters found by Hopkins. Although accurate, this method was difficult to perform without harming the insects. Some workers have developed their own methods for sexing weevils, but these techniques have not been published. Sexing live white-pine weevils has therefore remained an obstacle for beginning workers.

B. PREVIOUS SEXING TECHNIQUES

Hopkins (1911) illustrated both male and female reproductive systems in the genus *Pissodes*. He compared reproductive systems in various members of the genus, including *P. strobi*. His illustrations show that in male weevils, 8 abdominal tergites are visible dorsally, but in females only 7 tergites are visible. In the female, the eighth tergite is covered by the seventh. According to Torre-Bueno (1950), the pygidium is the tergum of the last segment of the abdomen, regardless of its numerical designation. Therefore, the pygidium is the eighth tergite in males and the seventh tergite in females. MacAloney (1930) used the pygidium in sexing weevils, but found that it could not be seen without opening the hind wings and the elytra. This operation was difficult to perform without injuring the weevil. He noted also that in the females, as compared with males (1) the beak was shorter, rougher, and less slender; (2) the seventh sternite was usually shorter than the preceding sternites; and (3) the inner apical tooth of the tibia was smaller.

The authors have sexed weevils by collecting them in the act of copulation. Although accurate, this method is tedious since the weevils must be observed in actual copula, as male weevils frequently mount male weevils.

C. THE NEW SEXING TECHNIQUE

The technique presented in this paper consists of prying down and forcing open the posterior end of the abdomen. To hold the insects fast during the operation, they were placed in a weevil-sized cavity carved on the upper surface of a convex paraffin block. The weevil was placed on its dorsum in the cavity with the abdomen extending upward at a 30-50° angle. A rubber band was placed around the block, crossing the weevil between the meso- and metathoracic legs. The prying instrument was a minuten pin attached to a small wooden handle. The pin was bent at a right angle, with the elbow 1 mm from the tip of the pin.

The tip of the pin was inserted between the elytra and the abdomen, entering from the right rear side (figure 47). The point of the pin was directed dorsally against the underside of the elytra (figure 48). The instrument was worked gently in as far as the elbow of the pin, with care being taken to keep the point of the pin against the elytra to avoid puncturing the abdomen. A slight rotation to the left brought the elbow of the pin against the posterior hypopleurite (figure 48). Slight pressure in this manner bent the abdomen ventrally, exposing the posterior dorsal surface of the abdomen or pygidium (figures 49A, 49B). This operation also opened the anogenital vestibule of the female for an internal view (figure 50B). To open the anogenital vestibule in the male (figure 50A), the pin was inserted slightly farther and rotated to the left. This operation brought the elbow of the pin ventrally against the anterior of the pygidium (eighth tergite). During the operation, the point of the pin was held against the underside of the elytra.

Bending the pygidia forward exposed them as they are shown in figures 49A (♂) and 49B (♀). After considerable experience, females could usually be distinguished from the males at this stage by the larger size and characteristic shape of the pygidium, as shown in figures 49A and 49B. Additional characters and the sexual apparatus could be seen by exposing the anogenital vestibule (figures 50A, 50B). In female weevils, the last tergite was no longer exposed on the dorsum (figure 50B), but was directly beneath the seventh and was heavily sclerotized. The fork of an apodeme arising from the eighth sternite was visible under the eighth tergite (figure 50B).

Males could be recognized by the obvious absence of the female structures mentioned, and the characteristic appearance of the anogenital vestibule (figure 50A). A small projection, which was evident in the center edge of the pygidium of males only (figure 50A), was not shown in the morphological studies by Hopkins (1911) and MacAloney (1930).

Attempts to expose the anogenital vestibule by direct prying resulted in immediate puncturing of the weevils and emission of fluids which obscured all characters. Straight minuten pins were inefficient for applying inward pressure to the anterior portion of the pygidium in males, and frequently resulted in puncturing the abdomen.

In the sexing procedure described, the weevils were separated by definitive characteristics. Therefore, there was no statistical chance for error as with characteristics having relative values. However, 20 weevils were dissected to determine the sex by the presence of the appropriate internal genital organs as a check on the method. In every instance the external method correctly indicated the sex.

More than 400 weevils were sexed by the characters and method described. They were marked with paint dots on the elytra to distinguish sexes and released in field-study plots. Their behavior of feeding, copulating, and dispersing in the field appeared similar to unmarked white-pine weevils native to the study area. The weevils used in the study were collected from leaders of white pine trees and were kept in polyethylene bags with several pine twigs.

Twenty weevils that were lightly wounded in the sexing process were kept separately in a polyethylene bag with fresh pine twigs. These weevils fed and copulated normally.

Weevils preserved in alcohol also can be sexed by this method. It is quicker, and equal in accuracy to the other methods.

Figures 47-50 -- . Diagramatic illustration of techniques for exposing sex characters. Figures 47, 48. -- Angle of approach and entry of probe, keeping needle point against ventral surface of elytra. Figures 49A, 49B. -- Bending abdomen forward, exposing pygidia of male (8th tergite) and female (7th tergite), respectively. Figures 50A, 50B. -- Opening of anogenital vestibule, showing characteristic views of male and female, respectively.

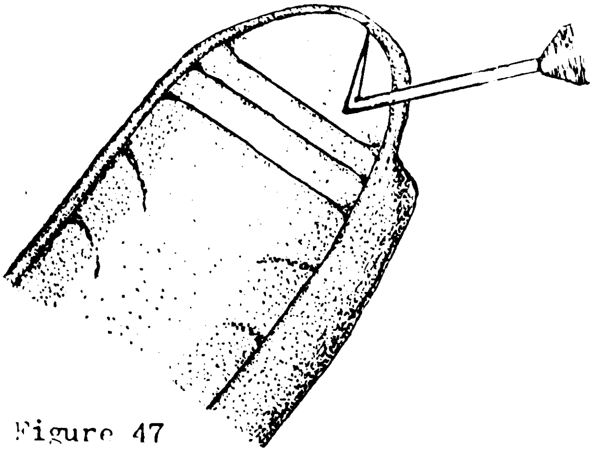


Figure 47

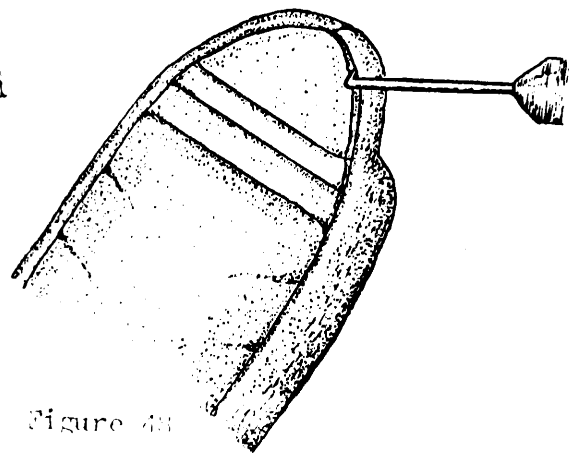


Figure 48

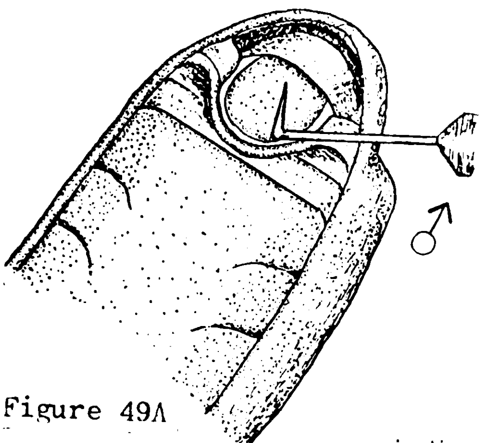


Figure 49A

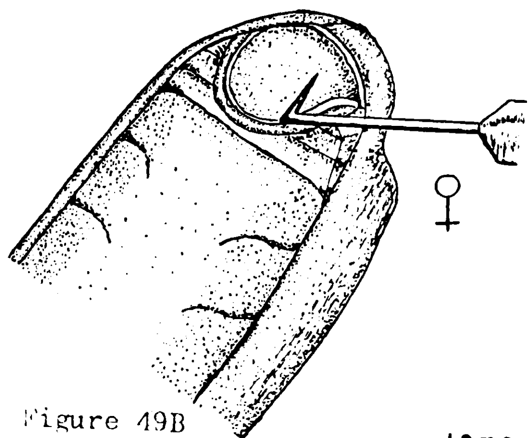


Figure 49B

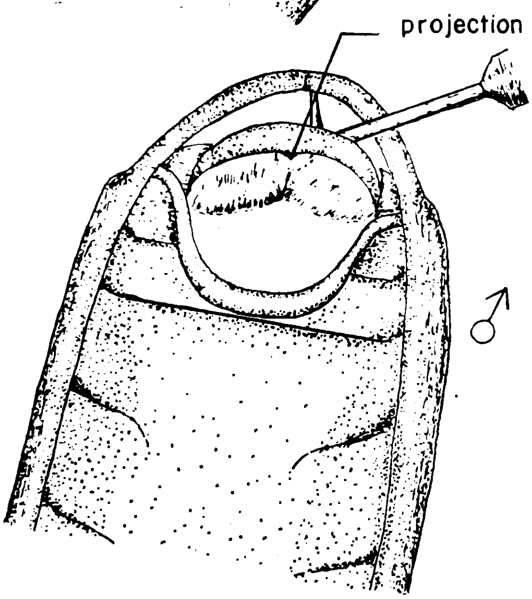


Figure 50A

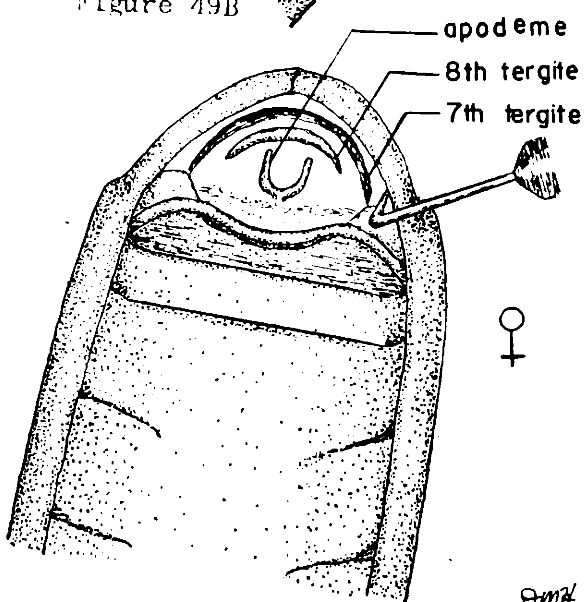


Figure 50B

V. ACKNOWLEDGMENTS

I wish to express my sincere appreciation to my graduate advisor, Dr. H. M. Kulman, for his guidance and assistance throughout the study; to the many landowners in western Virginia whose cooperation made the study possible; to Dr. W. H. Anderson and staff, of the parasite identification division of the Agricultural Research Service, United States Department of Agriculture, Dr. J. F. McAlpine of the Entomology Institute, Canada Department of Agriculture, and Dr. N. M. Downie of Lafayette, Indiana, for services rendered in identification of parasites and associated insect species; to Dr. P. A. Godwin of the Northeastern Forest Experiment Station, United States Department of Agriculture, for positive identification of *Pissodes strobi* by karyotype analysis; to Drs. J. L. Bishop and S. E. Neff for photography of insect specimens; to the Cooperative Extension Service of VPI for help with photographs; to Dr. D. G. Cochran for his cooperation and advice in the respirometry studies; to Mrs. E. F. Thompson, Mrs. R. W. Rhoades, Mrs. R. R. Gerhardt, and Mr. James Auld for assistance in the laboratory; to Mr. C. W. Berisford for helpful comments and critical reading of the manuscript; to Miss Sarah A. Duncan and Mrs. Josephine Proco for typing the manuscript; to my wife, Amy, for encouragement, patience and assistance throughout the research and writing of this thesis.

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VII. VITA

The author of this paper was born March 25, 1938, at Van, West Virginia, the son of Snyder S. and Ann[a] (Myers) Harman. He attended the Public schools at Harman, West Virginia and Broadway, Virginia from 1944-1952, and graduated in June 1956 from Harman High School, Harman, W. Va. He attended Potomac State College of West Virginia University, Keyser, W. Va. during 1957-1958, and West Virginia University, Morgantown, W. Va. from 1958-1962. He obtained a B.S. degree in forestry (1961) and an M.S. degree in forest entomology (1962) from West Virginia University. He attended Oregon State University, Corvallis, Ore. from 1962-1963, and Virginia Polytechnic Institute, Blacksburg, Va. from 1963 until the present time.

He married Amy Susan Litten, of Burlington, N. C. on December 14, 1963, at Christiansburg, Virginia.

He is a member of the following professional and honorary societies: Xi Sigma Pi Forestry Honorary; Phi Sigma Society; Entomological Society of America; Entomological Society of Canada, Society of American Foresters. In 1961 he received the A. D. Hopkins scholarship in entomology at West Virginia University.

Dan M Harman

ABSTRACT

The white pine weevil and its parasites, predators, and associated insect species were studied in 13 areas in Virginia by (1) large scale rearing of organisms from 759 infested white pine leaders in polyethylene bags and (2) dissection of infested white pine leaders. Forty-eight insect species were reared, of which only 15 were considered common. The white pine weevil emerged in highest total numbers, followed by *Lonchaea corticis* Taylor, *Bracon pini* (Mues.), and *Coeloides pissodis* (Ashm.). *Eupelmus pini* Say was reared from an ichneumonid cocoon in one instance, indicating that it may be secondary as well as primary. *Pseudeucoila* sp. was found to be a solitary pupal parasite of *Lonchaea corticis*.

Collections were made from 5 types of white pine stands. Young open plantations appeared to be most favorable for weevil brood development, whereas naturally seeded stands appeared to be least favorable. Highest numbers of associated species were obtained from older, closed plantations.

Emergence of insects from caged leaders was observed at 2-day intervals. *Bracon pini* emerged in highest percentages prior to July 9. *Coeloides pissodis*, *Rhopalicus pulchripennis*, *Eurytoma pissodis* Gir., *Eupelmus pini*, *Pseudeucoila* sp., and *Pediobius* sp. emerged in highest percentages from July 10 to 31. The white pine weevil, *Lonchaea corticis*, *Oscinella conicola* (Greene), and *Oscinella hinkleyi* (Mall.) had highest percentages of emergence in August. *Enoclerus nigripes* Say emerged in highest percentages in September.

Ovariole development and termination of diapause in the white pine weevil were studied by dissecting weevils at various intervals throughout the winter. Old-generation adults brought into the laboratory in early November produced viable eggs within 5 days. New generation adults brought into the laboratory on November 4 produced viable eggs during November. Viable eggs were deposited by other new-generation adults after 10 to 15 days at room temperature in winter. On each of the 3 collection dates studied, new generation adults produced viable eggs without copulating after collection from hibernation indicating that capulation occurs in the fall. There was no evidence of progressive ovariole development throughout the winter. New generation adults which were isolated as soon as they emerged from the shoots and maintained at constant room temperature had poorly developed ovarioles by November 20 and produced no eggs.

Weevil flight and dispersal through a white pine plantation was studied by releasing 409 marked weevils at a central point within a 1431-tree plantation and checking every tree at 5-day intervals. Weevils flew readily at the time of release. Marked weevils were recorded throughout the plantation, which extended as far as 330 feet from the release point. A few weevils were observed on scattered white pines 200-300 yards from the release point beyond a hardwood barrier. Total numbers of weevils present on the leaders increased from April 26 to May 5, after which numbers steadily decreased. By June 15, only 20 weevils were observed on the leaders.

Increasingly higher dimensions in tree height, leader diameter, and leader length were accompanied by higher percentages of trees visited and attacked by weevils. Weevil visits were related to success of attack at the end of the season. Of the trees visited by weevils, 8 percent were successfully attacked (producing one or more weevils), 54 percent were visibly attacked but produced no weevils, and 38 percent had no visible evidence of attack by the end of the season.

A method was devised for determining the sex of live white pine weevils without harming the insect. Weevils were held venter up and observed under a binocular microscope. The last abdominal tergite was pulled down and the anogenital vestibule opened with a mounted minuten insect pin bent at a right angle. Key characters used in sex determination were: (1) the pygidium (8th tergite of the male, 7th tergite of the female), (2) posterior view of the opened anogenital vestibule, which exposed the displaced 8th abdominal tergite and the apodeme fork of the 8th sternite in the female or a small projection of the 8th abdominal tergite in the male.