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INTRODUCTION

The genus *Heliothis* includes two well known species, *Heliothis zea* (Boddie), the bollworm and *Heliothis virescens* (F.), the tobacco budworm. These two species present an economic problem on a world wide scale. In the United States crops such as corn, cotton, tobacco, tomato, alfalfa soybeans, sorghum and many garden vegetables are attacked by one or both species. Many ornamentals including roses, chrysanthemum and snapdragons are also attacked, as well as a whole series of wild plants.

Both species in their southerly distribution are active from March or April until frost, a period which extends beyond the growing season of any single host plant species. Thus a continuous series of host plants are required to extend these species over their active period. Research in Northeast Mississippi was conducted during 1963 to determine the plant species involved in this succession as well as to determine their relative importance as hosts. Special emphasis was placed on occurrence on cotton.

COMMON NAMES

Heliothis zea is known under the common names of corn earworm, bollworm, or tomato fruitworm. All are approved by the Entomological Society of America. For the purposes of this publication *H. zea* will be called the bollworm.

Heliothis virescens, a congeneric species, bears the approved common name of tobacco budworm and will be referred to throughout this bulletin as such or more simply as the budworm.

REVIEW OF LITERATURE

Both *Heliothis* species have been reported as rather general feeders, having a wide variety of cultivated and wild host plants. In general the bollworm has been considered the more dependent on cultivated crops, turning to wild plants in periods when cultivated hosts were not available. On the other hand, the tobacco budworm has been generally considered as relying greatly on wild host species.

When the *Heliothis* complex is viewed from region to region the host relationships of these two species vary greatly. Wolcott (1933) reported that Cuba was the only West Indies Island where tobacco budworms occurred as a pest in tobacco although it was also present on other tobacco producing islands. In Jamaica, he reported bollworms as the typical tobacco pest which in other areas attacks tobacco only very early and again in late season. The bollworm is never found on cotton in Peru but is abundant on corn (Hambleton, 1944, Willie, 1951). In Peru, tobacco budworms are a major cotton pest and, in addition, attack corn. This species does not attack corn in the United States. Brazzel et al. (1953) suggested that these differences in food habits can be explained by regional differences in the availability of wild and cultivated host plants, or can possibly be attributed to the

presence of biological races.

Quaintance and Brues (1905) conducting one of the earlier and most extensive studies of the bollworm reported this species as occurring on 72 different species of plants which are included within 21 plant families. In this country bollworms have been collected from plants belonging to 9 families and the tobacco budworm has been recorded as occurring on plants representing 12 families (Chamberlin and Tenhet, 1926; Barber, 1937, Brazzel et al., 1953).

The most thorough previous host plant study of these species was conducted by Barber (1937) in eastern Georgia. He noted corn as the primary host for the bollworm but observed that both flax and tobacco were important prior to corn silking. Of the wild hosts, he reported toadflax as the first plant species attacked and this plant was cited as a very important host in that it provided food for the earliest occurring larvae. A species of "beggar ticks" *Desmodium (Meibomia) purpurea* was reported as the principle food plant beginning in August.

He found toadflax, as with the bollworm, served as the first important food source for budworms. From this host the budworm was reported as moving to *Rhexia alifanus* (Deergrass) on which two generations developed during June and July. He postulated that this species served to tide the budworm over from its common spring food, toadflax, until *Desmodium (Meibomia) purpurea*, its principle fall host, was available.

Brazzel et al. (1953) working in Louisiana and Arkansas collected larvae from 25 plant species. The bollworm was the only species reported on corn, grain sorghum, lima beans, cowpeas, snap beans, chrysanthemum, *Hibiscus rose-sinensis*, vetch, crotalaria, Korean lespedeza and bur clover. This species was dominant on tomato, soybean, alfalfa, white clover, rose, *Sida spinosa* and lupine. They reported the budworm as predominant on tobacco and *Abutilon theophrasti* while this was the only species recorded from snapdragon. Infestations were almost equal on crimson clover and *Jacquemontia tamnifolia*. Both species were recorded in large number from cotton. The tobacco budworm was the predominant species during June and July while the bollworm was predominant after August 1.

In the most recent study, Feunzig (1963) in eastern North Carolina found 10 species of wild plants serving as hosts. As previously reported by Barber (1934), toadflax was found to serve as an excellent early season host for both species. The bollworm was collected from this host continuously from mid-May until mid-June while the budworm was found from early May until the first week in June. During this four year study he found the earlier appearance of the budworm to be consistent. Several species of deergrass, *Rhexia mariana*, *R. mashii* and *R. alifanus* were found to be important mid-season hosts for the budworm. A species of *Desmodium* was reported as a host for both species but was of little importance in this area of North Carolina.

The bollworm has been recognized as a pest of cotton since 1820 (Quaintance and Brues, 1905). The first record of the budworm as a pest was made by Wilson in 1923 in the Virgin Isles. However, this insect was not reported as a cotton pest in the United States until Folsom (1936) in 1934 found large populations feeding on squares and bolls in Louisiana. He suggested that this species had undoubtedly been overlooked on cotton and that much of the damage attributed to bollworms was the result of this species. The seasonal relationship of these two species in cotton was greatly clarified by Brazzel and Newton in 1963. They found in Texas that the tobacco budworm during early season, until mid-June, was the predominant species giving way in July to bollworms, which represented over 90 percent of the total population. Following this period in August and September the budworm was again

reported as the dominant species representing approximately 60 percent of the population.

Snow (1964) during the same year, in Georgia, recorded essentially the same results. Tobacco budworms were predominant until the latter part of July. Following this period, large populations of bollworms were recorded but, unlike conditions in Texas, this species remained predominant throughout the remainder of the season. Young and Brazzel (1963) working in Mississippi, found essentially the same situation occurring in that state.

LARVAL COLLECTION METHODS

From March until October, 1963, collections of *Heliothis* larvae were made on cultivated and wild plants in the vicinity of Starkville, Mississippi. Efforts were made to collect from all previously cited hosts occurring in the area as well as other cultivated and wild plants with populations large enough to support either species. Special attention was given to plants belonging in families containing species which had been reported as hosts.

Most of the collections were made in a three county area including Oktibbeha, Lowndes and Clay counties. Collections were made on a weekly basis when possible but due to the large number of plant species involved, counts were often delayed for several days.

The method of collection was determined largely by the nature of the vegetation. In cases of pure stands and where injury to cultivated crops would not result, sweeping with a standard 15-inch insect net was employed. This method could not be used for larvae feeding within fruiting structures. In these cases whole plant or partial plant examinations were employed as the sampling method. With both methods, samples were collected in a random manner from a series of locations so that data would represent average occurrence within the area.

The total number of sweeps or whole plants examined weekly varied greatly, depending on such factors as host availability, infestation and time available for sampling. In the case of sweeping, efforts were made to collect only from uniform, pure stands and sweeps were kept as uniform as possible so that valid population density comparisons within a single species could be made. However, the reader should be warned that density comparisons among the various hosts should be made with extreme caution because of the several collection methods as well as factors such as plant density and nature of the vegetation. An example to illustrate this point may be made by considering sweep comparisons between a loosely branched species such as *Desmodium*, which has a large *Heliothis* feeding area, as compared with sweeps from black medic, which occurs in very thick stands and has a much smaller feeding area. While no sweeping system would collect all larvae within a sampled area, the efficiency in the first case would be much lower than in the case of black medic. For this reason, in comparisons between hosts, more emphasis should be placed on the rise and fall of populations rather than actual larval numbers.

After collection larvae were transported to the laboratory and identified to species by the presence or absence of the mandibular process and microspines on the setigerous tubercles which first appear in the third instar (Brazzel et al. 1953). Larvae too small for identification were reared on artificial diet until they attained the third instar.

Data regarding all principle hosts with a few exceptions will be presented in tabular form as the total number of observations and larvae collected along with a computed value for occurrence per 100 sweeps or whole plants, depending on the

particular case. In the case of tobacco, results will be presented on a basis of 50 whole plants because of large larval numbers and on tomatoes in the same fashion since only 50 plants were examined during each weekly period. Occurrence on peanuts, *Desmodium rigidum* and *Haplopappus divaricatus* will be plotted graphically in that only 100 sweeps were taken during each weekly period.

POSITIVE HOST COLLECTIONS

Larvae were collected from a total of 32 species of plants representing 9 plant families.

A list of the plants utilized by bollworms is presented in Table 1. A total of 17 species of cultivated and 11 species of wild plants were recorded as supporting populations. Tobacco budworm larvae during the same period were collected from 8 species of cultivated and 11 species of wild plants (Table 2).

The degree of larval infestation varied greatly between the hosts, ranging from the collection of a single larva to continuous high infestations over an extended period. Host plants of sufficient importance utilized during this season will be discussed under separate headings.

A single bollworm larva was collected from bur clover and two larvae each from white clover, string beans and crotalaria. Three specimens were collected from eggplant and hop clover, while four were collected from Johnson grass and sorghum. Two tobacco budworm larvae were collected from *Hibiscus moscheutos* and three from sweet clover. Infestations were so light on these hosts that no further mention of them will be made.

Crimson Clover: Recently due to policy of the Mississippi Highway Department, vast acreage of this plant is available along roadsides early in the season for *Heliothis* development. In Mississippi, crimson clover blooms in April and May, and at this time of the year is extremely conspicuous in areas where it is common.

Larvae were not observed on this plant

Table 1. Cultivated and wild plants serving as hosts for bollworm larvae in Mississippi.

Common Name	Scientific Name
CULTIVATED PLANTS	
Alfalfa	**Medicago sativa** L.
Corn	**Zea mays** L.
Cotton	**Gossypium hirsutum** L.
Crimson Clover	**Trifolium incarnatum** L.
Crotalaria	**Crotalaria spp.**
Egg Plant	**Solanum melongena** L.
Lespedeza	**Lespedeza sericea** (Thumb.) Benth.
Okra	**Hibiscus esculentus** L.
Peanut	**Arachis hypogaea** L.
Sesame	**Sesamum indicum** L.
String Beans	**Phaseolus vulgaris** L.
Sorghum	**Sorghum vulgare** Pers.
Soybeans	**Glycine max** L.
Spider Flower	**Cleome spinosa** Jacq.
Tobacco	**Nicotiana tabacum** L.
Tomato	**Solanum esculentum** Mill
White Clover	**Trifolium repens** L.
WILD PLANTS	
Beggar's Lice	**Desmodium rigidum** (Ell.) DC.
Black Medic	**Medicago lupulina** L.
Buffalo Bur	**Solanum rostratum** Dunal
Bur Clover	**Medicago hispida** Gaertn.
Cocklebur	**Xanthium pensylvanicum** Wallr.
Hop Clover	**Trifolium procumbens** L.
Horse Nettle	**Solanum carolinense** (L.) Pers
Johnson Grass	**Sorghum halepense** (L.) Pers.
Perennial Pea	**Lathyrus latifolius** L.
Persian Clover	**Trifolium resupinatum** L.
Toadflax	**Linaria canadensis** (L.) Dumont

Table 2. Cultivated and wild plants serving as hosts for tobacco budworm larvae in Mississippi.

Common Name	Scientific Name
CULTIVATED PLANTS	
Alfalfa	**Medicago sativa** L.
Cotton	**Gossypium hirsutum** L.
Crimson Clover	**Trifolium incarnatum** L.
Lespedeza	**Lespedeza sericea** (Thumb.) Benth.
Okra	**Hibiscus esculentus** L.
Sesame	**Sesamum indicum** L.
Spider Flower	**Cleome spinosa** Jacq.
Tobacco	**Nicotiana tabacum** L.
WILD PLANTS	
Beggar's Lice	**Desmodium rigidum** (Ell.) DC.
Black Medic	**Medicago lupulina** L.
Buffalo Bur	**Solanum rostratum** Dunal
Cocklebur	**Xanthium pensylvanicum** Wallr.
Deergrass	**Rhexia** spp.
Haplopappus	**Haplopappus divaricatus** (Nutt.) Gray
Swamp-Rose	**Hibiscus moscheutos** L.
Horse Nettle	**Solanum carolinense** L.
Persian Clover	**Trifolium resupinatum** L.
Sweet Clover	**Melilotus alba** Desr.
Toadflax	**Linaria canadensis** (L.) Dumont

Table 3. Total number of sweeps and Heliothis larvae collected weekly from crimson clover in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
March 25-31	140	0	0	0.0	0.0
Apr. 1-7	140	0	0	0.0	0.0
Apr. 8-14	120	0	0	0.0	0.0
Apr. 15-21	160	13	0	8.1	0.0
Apr. 22-28	585	71	0	12.1	0.0
Apr. 29-May 5	250	17	4	6.8	1.6
May 6-12	105	73	1	66.4	0.9
May 13-19	100	104	16	104.0	16.0
May 20-26	100	60	4	60.0	4.0

until April 15-21 at which time clover was in early bloom. As shown in Table 3, the bollworm was the predominant species on this plant throughout the collection period. From the initial bollworm population of 8.1 larvae per 100 sweeps observed April 15-21, the infestation climbed for the next several weeks reaching a peak of 104.0 larvae per 100 sweeps during May 13-19.

At this time crimson clover was in late bloom stage. The following week the infestation had decreased to 60 larvae per 100 sweeps. Beyond this period, crimson clover was completely dead and unsuitable for larval development.

Tobacco budworm larvae were observed 2 weeks later on this host than the bollworm and infestations were always smaller. The first larvae were found during April 29-May 5 (average 1.6 per hundred sweeps) and the maximum population was reached during May 13-19 when an average of 16 larvae per 100 sweeps were counted.

The large bollworm population observed in the early spring demonstrates the importance of this crop as an early host in 1963. This crop facilitated the building up of large bollworm populations which served as a source of moths for later oviposition on economic crops. Even though budworm populations were low on this host it must be remembered that crimson clover's abundance makes this an equally important early spring host for this species.

Persian Clover: This legume is native to southeastern Europe and is natural-

ized, to a limited extent, in the southern United States. It is considered a minor forage crop (Isley, 1950), but has high feed value and may become more valuable in the future as an early spring pasture crop. In Mississippi this plant occurs to a small extent along roadways, and wet bottom land. The blooming period is in April and May.

Both species of *Heliothis* were recorded in the initial sweepings on this plant during April 29-May 5. At this time the clover was in full bloom. As shown in Table 4, an average of 5.2 larvae per 100 sweeps was recorded for both species on this date. Several of these larvae were in the advanced instars, indicating they were present at least a week prior to this time. The tobacco budworm seemed to prefer this host, reaching a population peak of 40 larvae per 100 sweeps during May 6-12. Bollworm populations had dropped to an average of 4 larvae for this weekly period. The following week Persian clover was in the final stages of development and both species were recorded in lower frequency. Persian clover had completely died by May 20-26 and no larvae were collected.

It is obvious from these results that Persian clover is an adequate host, capable of supporting large populations of both species of *Heliothis*. Its importance in the area under discussion is limited because of sparse occurrence but it is evident that this crop is a potentially important early spring host in areas where it is common.

Lespedeza: This legume is found throughout the South, commonly serving as a hay and forage crop. This plant has also escaped from cultivation and is common along roadways and open land. It commonly blooms during May and June.

Larvae of both species were first swept from this plant feeding on foliage during May 6-12. As shown in Table 5, infestations continued over a period of about one month. Although infestations were low, all lespedeza swept in the area had populations of both species. The peak occurrence for bollworms was during May 13-19, while peak abundance of budworms occurred 2 weeks later (May 27-June 2). After June 3-9, no larvae were found until September 2 when two budworm larvae were collected.

Table 4. Total number of sweeps and Heliothis larvae collected weekly from Persian clover in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
Apr. 29-May 5	210	11	11	5.2	5.2
May 6-12	200	8	80	4.0	40.0
May 13-19	100	1	4	1.0	4.0
May 20-26	100	0	0	0.0	0.0

Table 5. Total number of sweeps and Heliothis larvae collected weekly from lespedeza sericea in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
Apr. 29-May 5	75	0	0	0.0	0.0
May 6-12	300	3	3	1.0	1.0
May 13-19	350	8	5	2.3	1.4
May 20-26	300	3	7	1.0	2.3
May 27-June 2	240	1	10	0.4	4.2
June 3-9	700	0	8	0.0	1.1
June 10-16	100	0	0	0.0	0.0
		Zero during this period.			
Sept. 2-8	100	0	2	0.0	2.0

Table 6. Total number of whole plants examined and Heliothis larvae collected weekly from tobacco in 1963.

Week	Number Plants	Total No. Collected		Average No. per 50 Plants	
		Bollworm	Budworm	Bollworm	Budworm
Apr. 29-May 5	88	0	6	0.0	3.4
May 6-12	88	0	2	0.0	1.1
May 13-19	88	0	4	0.0	2.3
May 20-26	88	0	0	0.0	0.0
May 27-June 2	50	0	4	0.0	4.0
June 3-9	76	5	189	3.3	124.3
June 10-16	60	9	105	7.5	87.5
June 17-23	60	4	56	3.3	46.7
June 24-30	50	0	90	0.0	90.0
July 1-7	50	0	99	0.0	99.0
July 8-14	60	0	144	0.0	120.0
July 15-21	60	0	138	0.0	115.0
July 22-28	50	0	156	0.0	156.0
July 29-Aug. 4	60	3	111	2.5	92.5
Aug. 5-11	60	0	78	0.0	65.0
Aug. 12-18	50	10	50	10.0	50.0
Aug. 19-25	60	4	36	3.3	30.0
Aug. 26-Sept. 1	50	2	39	2.0	39.0

Lespedeza apparently served as a host for one generation of both species early in the season when other hosts were not available. The absence of larvae during most of June and all of July and August even though this plant was available in a succulent condition indicates that it was not a preferred host but served adequately when other plants were not available.

Corn: In Mississippi corn is commercially planted from the middle of March to the last week in May. Bollworms were first observed in May feeding in the tassels. From mid-June until late August silking corn was available in a condition suitable for oviposition and during these months almost the entire bollworm population was found on this host. No plant seemed capable of competing with corn in attractiveness. All corn in the area had ear infestations in excess of 90 percent. Multi-larval infestations were common but confined primarily to the earlier instars because of the cannibalistic nature of the older larvae. Data regarding occurrence on this host are not presented because infestations were at such high levels that data would reflect levels of cannibalism, disease etc. rather than actual fluctations in the seasonal population.

As will be discussed later, absence of this species from other hosts during this period serves as an indicator of the importance of corn as a host.

Tobacco: This is a cultivated crop of several southern states but is not cultivated commercially in Mississippi. Small plantings were grown during 1963 for research purposes. Larval counts were made by individual examination of the whole plants. As shown in Table 6, with the exception of a single collection period, constant populations of tobacco budworms were observed during the entire growing season. In the weeks following May 27-June 2 populations of this species were extremely high, at times averaging over 3 larvae per single plant, (Table 6). During this period plant terminals and upper leaves were covered with eggs. As shown in Table 6, two peaks of abundance for this species may be observed. However, it appeared that variations in weekly populations were more greatly influenced by parasitism than by actual changes in the population. Parasitism was primarily by a species of Braconidae, *Cardiochiles nigricepes* Vier., which appeared to be highly effective in reducing the population in late stages of larval development.

Bollworm larvae were collected during two different periods but populations were always small. Of special significance is that the earlier bollworm infestations preceded corn silking while larvae were not observed again until early August, a time when corn was not available for oviposition.

Spider-Flower: This ornamental, a previously unreported host for the *Heliothis* complex, belongs in the family Capparidaceae, and is a common shrub found in and around yards. Gray's manual (Fernald, 1950) lists the distribution of this plant as Florida to Texas, and north to Massachusetts, Indiana and Ohio. This plant is common in Mississippi, being prized for its beautiful rose or white colored petals and long blooming period, which lasts from June until frost.

Observations were begun on this plant during June 24-30 at which time it was blooming well. Counts were based on the number of larvae per flower head including that area beneath the bloom which contained developing pods. Larvae were never observed below this point, confining their feeding within the flower heads and seed pods.

Table 7 demonstrates the acceptance of spider-flower as a host by the tobacco budworm. A continuous population was observed from June 24-30 until the last count was made during October 14-20. Four definite population peaks may be observed spaced at exact 5 week intervals. These may be interpreted as distinct generations which indicate that spider-flower is a preferred host. Several advanced instar larvae were found among the 42 specimens of tobacco budworm collected in the initial observation which indicates that larvae were present prior to the first collection period.

Bollworms were not observed on spider-flower until August 19-25. Populations of this species were continuous but low for the remainder of the season, never averaging over 5.3 larvae per 100 flower heads. As in the previous case, infestations did not occur until corn was lost as a host.

Okra: This cultivated crop is an introduction from Africa and is commonly found in small home gardens. It begins blooming in late May or early June and provides an excellent host for both species of *Heliothis* until late October.

Whole plants examinations were begun on this plant in early May when it was up to stand. The weekly seasonal occurrence data for both *Heliothis* species are shown in Table 8. No larvae were observed until after blooming had begun during June 3-9 at which time a single bollworm specimen

Total 7. Total number of flower heads examined and Heliothis larvae collected weekly from spider-flower in 1963.

Week	Number Heads	Total No. Collected		Average No. per 100 Heads	
		Bollworm	Budworm	Bollworm	Budworm
June 24-30	125	0	42	0.0	33.6
July 1-7	115	0	10	0.0	8.7
July 8-14	170	0	4	0.0	2.4
July 15-21	100	0	1	0.0	1.0
July 22-28	100	0	2	0.0	2.0
July 29-Aug. 4	150	0	16	0.0	10.7
Aug. 5-11	100	0	7	0.0	7.0
Aug. 12-18	100	0	8	0.0	8.0
Aug. 19-25	100	1	7	1.0	7.0
Aug. 26-Sept. 1	300	2	29	0.7	9.7
Sept. 2-8	125	3	15	2.4	12.0
Sept. 9-15	75	3	5	4.0	6.7
Sept. 16-22	75	4	4	5.3	5.3
Sept. 23-29	300	15	35	5.0	11.7
Sept. 30-Oct. 6	100	4	17	4.0	17.0
Oct. 7-13	100	3	19	3.0	19.0
Oct. 14-20	100	1	15	1.0	15.0

Table 8. Total number of whole plants examined and Heliothis larvae collected weekly from okra in 1963.

Week	Number Plants	Total No. Collected		Average No. per 100 Plants	
		Bollworm	Budworm	Bollworm	Budworm
June 3-9	60	1	0	1.7	0.0
June 10-16	100	3	0	3.0	0.0
June 17-23	25	1	0	4.0	0.0
June 24-30	100	5	0	5.0	0.0
July 1-7	50	1	0	2.0	0.0
July 8-14	75	0	0	0.0	0.0
July 15-21	50	1	0	0.5	0.0
July 22-28	200	3	4	1.5	2.0
July 29-Aug. 4	100	3	20	3.0	20.0
Aug. 5-11	100	1	15	1.0	15.0
Aug. 12-18	250	2	25	0.8	10.0
Aug. 19-25	100	0	8	0.0	8.0
Aug. 26-Sept. 1	100	2	22	2.0	22.0
Sept. 2-8	100	3	18	3.0	18.0
Sept. 9-15	100	6	9	6.0	9.0
Sept. 16-22	200	11	14	5.5	7.0
Sept. 23-29	225	6	9	2.7	4.0
Sept. 30-Oct. 6	100	1	9	1.0	9.0
Oct. 7-13	100	3	13	3.0	13.0
Oct. 14-20	75	3	17	4.0	22.7
Oct. 21-27	100	4	17	4.0	17.0

Table 9. Total number of sweeps and Heliothis larvae collected weekly from alfalfa in 1963.

Week	Number Plants	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
May 20-26	250	13	1	5.2	0.4
May 27-June 2	175	4	1	2.3	0.6
June 3-9	300	2	1	0.7	0.3
June 10-16	150	8	1	5.3	0.7
June 17-23	100	0	0	0.0	0.0
June 24-30	50	0	0	0.0	0.0
		All alfalfa cut during this period.			
July 15-21	100	0	0	0.0	0.0
July 22-28	100	0	0	0.0	0.0
		All alfalfa cut during this period.			
Aug. 12-18	100	6	0	6.0	0.0
Aug. 19-25	200	16	0	8.0	0.0
Aug. 26-Sept. 1	100	35	1	35.0	1.0
Sept. 2-8	100	23	0	23.0	0.0
Sept. 9-15	100	15	0	15.0	0.0
Sept. 16-22	100	19	0	19.0	0.0
Sept. 23-29	100	35	0	35.0	0.0
Sept. 30-Oct. 6	100	20	0	20.0	0.0
Oct. 7-13	100	9	0	9.0	0.0
Oct. 14-20	100	1	0	1.0	0.0

was collected. Bollworm populations, although fairly constant, were low throughout the season. However, in viewing Table 8, 4 distinct generations may be observed peaking on the weeks beginning June 24, July 29, September 9 and October 14.

The tobacco budworm was not collected until the week July 22-28. Infestations by this species were much higher than for the bollworm. Three distinct generations reaching densities of 20 or more larvae per 100 whole plants were observed during the weeks beginning July 29, August 26 and October 14.

This host appears to be preferred by both species of *Heliothis*. Although infestations were rather continuous throughout the growing period, this host probably is more important in building up overwintering populations than actually sustaining populations during early and mid-

season because of the practice of removing pods for table consumption. Plantings are usually abandoned in late season, however, which provides an opportunity for undisturbed generations.

Alfalfa: This legume is common in the area discussed both in cultivation and as an escape along roadsides and in waste areas. It blooms in early summer unless continually cut for hay or silage.

Sweeping was begun early in the spring and continued throughout the season. Weekly occurrence data are shown in Table 9. Budworm populations were insignificant on this plant. In all 5 larvae were collected, 2 in late May, 2 in early June and a single specimen during the week of August 26-September 1.

Bollworm larvae were not recorded until May 20-26 when an average of 5.2 larvae per 100 sweeps was recorded (Table 9). Populations were present but low for the following 3 week period. Larvae were not found again until August 12-18 when an average of 6.0 larvae per 100 sweeps was recorded. The population climbed rapidly for the next 2 weeks, reaching an average of 35 larvae per 100 sweeps during August 26-Sept. 1. Populations declined for the next 2 weeks, reaching a low of 15.0. From this point the population again reached an average of 35.0 larvae per 100 sweeps during September 23-29. From this point the population dropped, reaching a low of 1.0 larvae per 100 sweeps during the last positive collection period of Oct. 14-20.

The effect of cutting alfalfa for hay places some doubt on the value of this plant as a host for bollworms in northeast Mississippi. In a well managed field the first cutting is normally made toward the middle of April with cuttings following approximately every 28 days, depending on temperature and moisture (Meredith, W. R., 1964, personal communication). Certainly if the practice is followed great mortality could be expected in early instars. Late season management however, is much more conducive to large populations. Normally in the late fall, alfalfa is allowed to stand longer in the field and is cut just prior to the date of frost. This is done to prevent tender regrowth before frost, but this practice also provides ample time for a large brood of bollworms to enter the soil and pupate.

Cotton: Particular attention was given to Heliothis occurrence on this crop because of the monetary loss suffered by cotton farmers each year from the feed-

Table 10. Total number of whole plants examined and Heliothis larvae collected from cotton in 1963.

Week	Number Plants	Total No. Collected		Average No. per 100 Plants	
		Bollworm	Budworm	Bollworm	Budworm
May 6-12	300	0	1	0.0	0.3
May 13-19	500	0	0	0.0	0.0
May 20-26	500	0	0	0.0	0.0
May 27-June 2	1000	0	0	0.0	0.0
June 3-9	1038	2	14	0.2	1.4
June 10-16	1100	14	30	1.3	2.7
June 17-23	1006	10	30	1.0	3.0
June 24-30	1595	23	42	1.4	2.6
July 1-7	1676	2	24	0.1	1:4
July 8-14	1305	1	18	0.1	1.4
July 15-21	1231	7	41	0.6	3.3
July 22-28	1024	13	41	1.3	4.0
July 29-Aug. 4	1192	18	28	1.5	2.4
Aug. 5-11	1060	72	30	6.8	2.8
Aug. 12-18	1266	231	27	18.3	2.1
Aug. 19-25	1080	189	6	17.5	0.6
Aug. 26-Sept. 1	1100	54	10	4.9	0.9
Sept. 2-8	700	38	4	5.4	0.6
Sept. 9-15	925	29	4	3.1	0.4
Sept. 16-22	950	21	4	2.2	0.4
Sept. 23-29	500	16	0	3.2	0.0

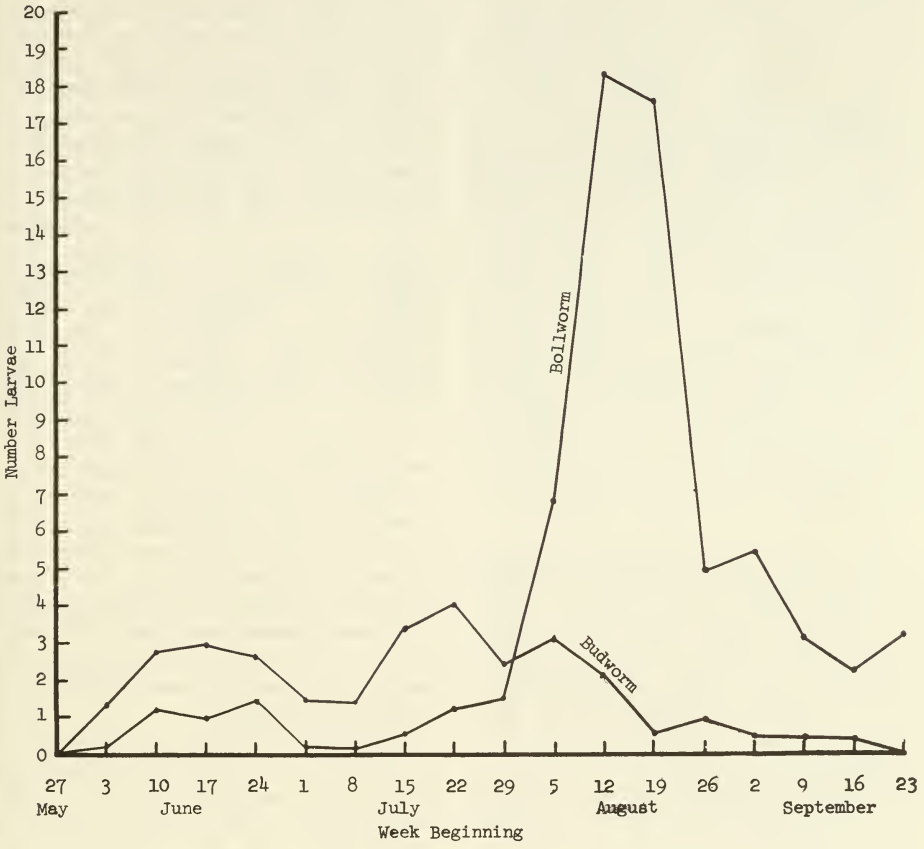

Figure 1. Seasonal abundance of Heliothis larvae on cotton per 100 whole plants in 1963.

ing of both species in squares and bolls.

Collections on this plant were made weekly in 500 acres of cotton scattered throughout Oktibbeha, Lowndes, and Clay counties. Counts were made by individual examination of whole plants. The fields were planted for commercial production and standard practices and procedures popular in this area were used. However, in all cases, no insecticides were used until early August when high infestations of bollworms forced their use.

Observations began when cotton was up to a stand and continued until killing frost. Both species were collected during this period. The total number of whole plants examined and number of larvae collected is shown in Table 10. The seasonal average occurrence of these species based on the number of larvae per 100 whole plants is shown graphically in Figure 1.

A single tobacco budworm larva was collected in May when cotton was in the two leaf stage. Larvae were not observed for the next several weeks until June 3-9 at which time both species were collected. Cotton during this period was just beginning to square. On this date the budworm

population averaged 1.4 larvae per 100 whole plants while the bollworm population was only 0.2 larvae per 100 whole plants (Table 10). From this period the tobacco budworm population increased reaching a peak of 3.0 larvae per 100 whole plants during July 17-23. For the next 3 weeks the population declined reaching a low of 1.4 larvae per 100 whole plants. From this point the population climbed for the next several weeks reaching a seasonal high of 4.0 larvae during July 22-28. After this week the population declined for 4 weeks, reaching a low of 0.6 larvae per 100 whole plants. For the remainder of the season populations never reached over 0.9 larvae per 100 whole plants. No tobacco budworm larvae were observed after September 16-22, although counts were continued until frost.

Two definite population peaks may be seen for this species (Figure 1) during the weeks June 17-23 and July 22-28. In both cases, egg counts prior to these low points ranged from 5 to 20 eggs per 100 terminals. In these untreated fields, larval populations remained below economic levels and no real yield loss could be attributed to this species. However, in adjacent cotton fields where applications of insecticides had been made in anticipation of Heliothis infestations, populations reached higher levels and economic damage resulted. This can be attributed to the insecticidal reductions in the predator and parasitic populations which were highly effective in reducing *Heliothis* in the untreated fields.

Bollworms were a much more serious pest in cotton fields in the 3 county area than was the budworm. From the initial level of 0.2 larvae (Table 10) per 100 whole plants observed during June 3-9 infestations remained below an average of 2 larvae per 100 plants until August 5-11 when population levels reached an average of 6.8 larvae per 100 whole plants. A peak of 18.3 larvae per 100 whole plants was reached the following week. This count was based on a total of 1266 whole plants and infestations were uniform throughout the collection area. The use of insecticides was necessary during this period to bring infestations below an economic level. During this period egg counts were extremely high, ranging from 40 to several hundred per 100 whole plants. The eggs were commonly placed on all areas of the plant including bolls, squares and blooms. Eggs from these 3 sites were collected and hatching larvae were placed on media and reared to identification size. In all cases larvae were identified as bollworms. In the field, larvae hatching from these positions were extremely difficult to control with chemicals.

Following this period of high numbers of both eggs and larvae, populations declined for the next several weeks to a low of 2.2 larvae per 100 whole plants during September 16-22. Populations increased slightly to an average of 3.2 larvae the following week. After this period most cotton fields had terminated and harvest had begun but counting was continued in fields of late cotton or slow

Table 11. Total number of sweeps and Heliothis larvae collected weekly from black medic in 1963.

Week	Number Sweeps	Total No. Collected		Average No. per 100 Sweeps	
		Bollworm	Budworm	Bollworm	Budworm
May 6-12	150	3	0	2.0	0.0
		Zero during this period.			
June 10-16	75	2	4	2.7	5.3
June 17-23	100	0	8	0.0	8.0
June 24-30	100	0	3	0.0	3.0
		Plants not available during this period.			
July 15-21	200	0	70	0.0	35.0
July 22-28	325	3	76	0.9	23.4
July 29-Aug. 4	200	1	16	0.5	8.0

maturing fields. Large populations of bollworms were encountered in these fields up to the first killing frost indicating that another population peak occurred. Data for this period are not presented, however, because infestations were spotted and occurrence data by necessity would be biased. However, the point that no budworms were collected during this period should be made.

Black Medic: This legume is established throughout most of the United States and is commonly found in Mississippi as a weed along roadsides and in waste places. It may be seen blooming throughout the summer.

A total of 9 bollworm larvae were swept from this plant during May, June and July of 1963 (Table 11). Populations of this species were always low and during 1963 must be considered a minor host. Tobacco budworms on the other hand, were found in much larger numbers. The first positive collection for this species was June 10-16 when an average of 5.3 larvae per 100 sweeps was collected (Table 11). The following week 8.0 larvae were collected which dropped to an average of 3 larvae per 100 sweeps during June 24-30. Counts were not taken for the next two weeks because available black medic had been cut by highway crews. Populations were again found on July 15-21 when an average of 35 larvae per 100 sweeps was recorded. For the next two weeks smaller populations were recorded but all larvae were in advanced instars indicating that oviposition had occurred during a few days period and the sweeping had recorded the same brood of larvae in different stages of development.

During 1963, two generations of budworms developed on black medic. The first generation in June was rather small with the second in July and August reaching much greater proportions. Larvae were collected from several locations in the area, apparently black medic was rather generally infested. In view of the wide spread abundance of this host, it must be considered an excellent host for continuing the species during mid-season.

Tomato: Observations were begun as soon as tomatoes became established in the fields and were continued until midsummer. During this period a total of 50 whole plants were examined weekly. The total number of larvae collected is shown graphically in Figure 2. Only the bollworm was recorded as attacking this plant. A total of 23 second and third instar larvae was collected during June 3-8. The tomatoes at this time were blooming and a few young fruits were present which, along with foliage, served as the source of food. The following week (June 10-16) 10 fourth and fifth instar larvae were collected. Only 2 larvae were found the following week. No larvae were collected after the month of June and no second or third instar larvae were collected after the initial week. This indicates that oviposition occurred only during a very short period and that this plant served as a host for only one generation of larvae prior to corn silking.

Peanuts: Peanuts are not commercially grown in Mississippi but are commonly found in small plots in rural sections of the state where they are grown for home consumption. This crop is normally planted in April but infestations by the bollworm were not recorded until August 5-11. On this date 20 second and third instar bollworm larvae were recorded in 100 sweeps, (Figure 2). The following week 13 larvae were collected in 100 sweeps and an additional 8 larvae the following week. Peanuts were harvested before additional counts were made.

Although peanuts in Mississippi are available as a host only to a limited extent the timing of infestations makes this an interesting host. No larvae were recorded during the peak vegetative or flowering period of this plant. Infestations occurred only in late stages of development and

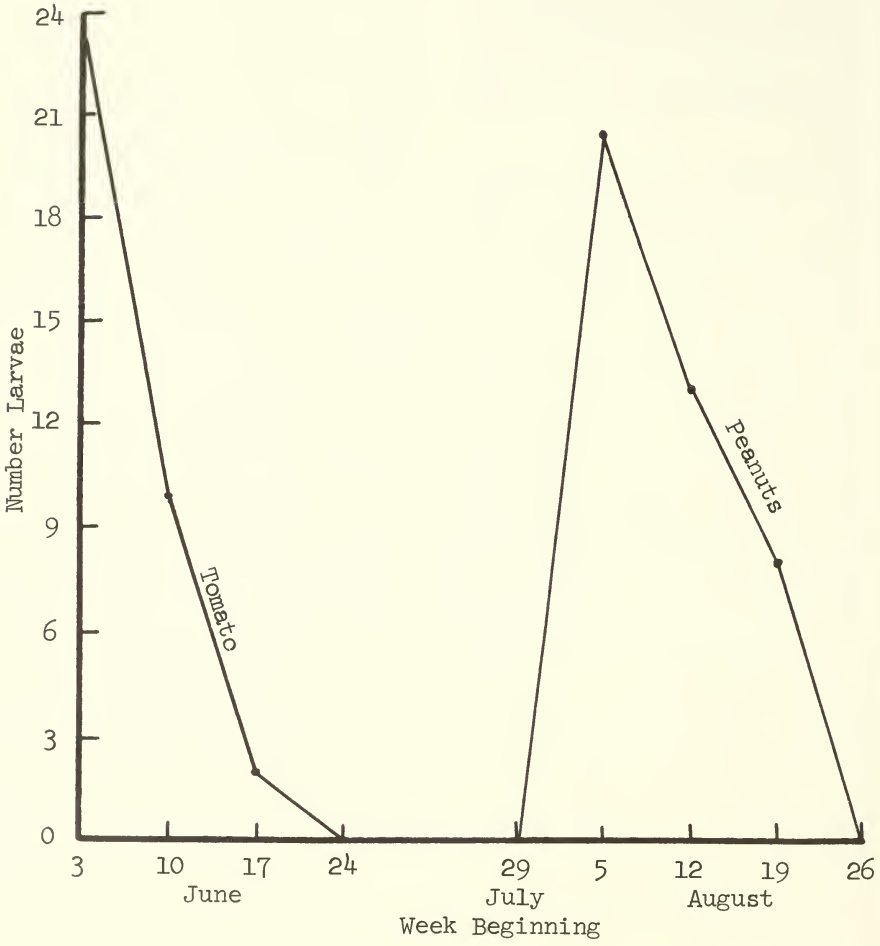

Figure 2. Seasonal abundance of bollworm larvae on tomato per 50 whole plants and per 100 sweeps on peanuts in 1963.

at a time when the plants should have been less, rather than more, attractive. This case provides excellent evidence of the inability of plant species to compete with corn in attractiveness to the bollworm.

Desmodium Rigidum: Members of the genus *Desmodium Desv.*, commonly called tick-trefoil, tick-clover or beggar's ticks are commonly found throughout the world except the western United States, Europe and New Zealand. In this area

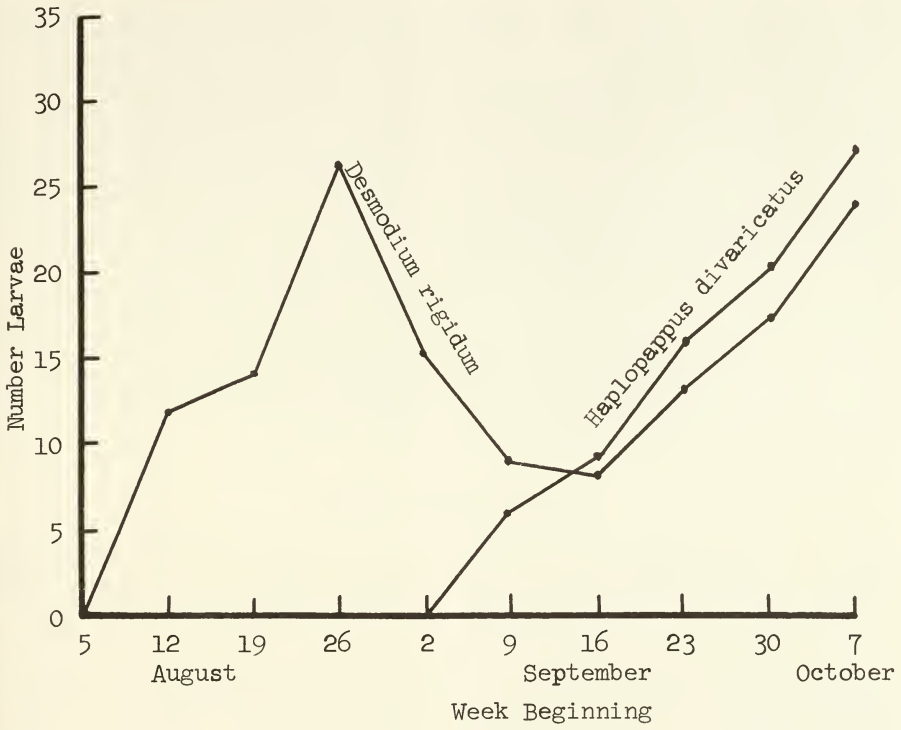

Figure 3. Seasonal abundance of tobacco budworm larvae per 100 sweeps on Desmodium rigidum and Haplopappus divaricatus in 1963.

of Mississippi a number of species occur but only one, *Desmodium rigidum*, was found supporting *Heliothis* populations. According to Grays Manual (Fernald, 1950) this species is found from Massachusetts to south Michigan and Indiana, south to South Carolina, Florida and east Texas. This plant is common in dry sandy or sandy loam soil, often occurring in rather thick stands 3 to 5 feet tall. It begins blooming and maturing seeds in late July and from then on throughout the season it becomes increasingly plentiful reaching its greatest abundance during September. By the first of October most of the seeds are ripe and too hard for larval food.

The tobacco budworm was first collected by sweeping on this plant during the week of August 5-11. From this initial population of 12 larvae in 100 sweeps, a peak of 26 larvae in 100 sweeps was recorded during August 26-September 1 (Figure 3). Populations decreased for the next 3 weeks reaching a low of 8 larvae in 100 sweeps during September 16-22. Populations again rose beyond this period reaching a high of 24 larvae in 100 sweeps during the week Otober 7-13. Most of these larvae were in advanced instars.

Two distinct generations of the tobacco budworm may be noted as utilizing this plant as a source of food. A total of 138 larvae was collected and it becomes apparent that this plant serves as a primary

host of great importance in late season. Only 3 bollworm larvae were collected from this plant in August.

Haplopappus Divaricatus: This plant is a loosely branched annual occurring very commonly in lands that have been recently cultivated. Gray's Manual (Fernald, 1950) lists the distribution from Florida to south Texas, north to southeast Virginia, Arkansas and Kansas. The blooming period is in September and October. It is a member of the family Compositae.

The tobacco budworm was first observed September 9-15 feeding on the leaves, flower buds and unripe seed pods. On this date a total of 6 larvae in 100 sweeps was collected (Figure 3). These larvae were all in early stages of development. For the following weeks the population gradually increased reaching a peak of 27 larvae in 100 sweeps on October 7-13. All larvae were in advanced instars and beyond this period no larvae were collected because of host termination. In all a total of 78 tobacco budworms was collected. No bollworms were recorded.

Only one large generation occurred on this host but like *Desmodium*, it serves as an important late food plant and probably has great significance in the overwintering of this species.

OCCASIONAL HOSTS

Larvae of one or both species were collected on a series of plants during 1963 in which infestations were short-termed or low. These plants have been designated as occasional hosts but it should be remembered that the lack of extensive infestations is probably due to the presence of more favorable food plants. In the absence of these plants these occasional hosts would probably play a greater role in the seasonal biology of these species. These hosts with the total number of larvae collected during 1963 are shown in Table 12.

Horse Nettle is abundant from May to August principally on cultivated ground or soil that has been cultivated within the past few years. It also occurs rather commonly in pastures which are not cut regularly. Larvae of both species were observed feeding on the flower buds, tender foliage and unripe fruit.

Positive collections of the budworm were recorded during the last week of May and the first two weeks of June. During this period a total of 9 larvae was collected. A single bollworm was collected on May 22 but no others were recorded again until August 14 when 5 larvae were collected.

Although larvae were not found in large numbers, the abundance of the plant in the area makes this plant serve as a potentially important host.

Buffalo Bur is native to our Western Plains and has become an aggressive weed through most of the northern and eastern states. This plant is in the same genus as

Table 12. Collections of Heliothis larvae from plants serving as occasional hosts during 1963.

Host	Months Collected	Number Larvae Collected	
		Bollworm	Budworm
Buffalo bur	May, June, July	12	12
Cockle bur	May and August	6	1
Deergrass	July and August	0	9
Horse nettle	May, June, August	6	9
Perennial pea	June	13	0
Sesame	June, August, September	7	207
Toadflax	May and June	4	8
Soybeans	May	7	0

horse nettle but is much less abundant in northeast Mississippi. Both *Heliothis* species attacked this plant in equal numbers feeding primarily on leaves and flowers. The bollworm confined its attack to a short period in late May and early June. The tobacco budworm was found only in late June and early July. In both cases a total of 12 larvae was collected.

Cockle Bur is an inhabitant of bottom land, low ground, cultivated and waste places throughout the southeastern United States. It is very common in northeast Mississippi and was found to be infested with a total of 6 bollworms and one tobacco budworm in May and August. The burs, buds and leaves to a lesser extent, were utilized as food.

Five of the bollworms were collected on August 21 within an infested peanut field. In this case oviposition may have occurred on peanuts with larval migration to cockle bur.

Deergrass is an inhabitant of moist lowland soils or along water-filled or moist ditches. Green seed capsules become available between July and August and small populations of tobacco budworms were found feeding on them. This plant has been reported in North Carolina (Feunzig, 1963) and Georgia (Barber, 1934) as a principal food plant of both bollworms and budworms but appeared to be of a secondary nature in Mississippi as a host for budworms.

Toadflax has been reported as the principle spring host for both *Heliothis* species in eastern Georgia (Barber, 1937) and eastern North Carolina (Feunzig, 1963). In northeast Mississippi this plant is fairly common as a weed in recently cultivated fields and waste places. Blooming usually occurs in May and June. Infestations by both species in 1963 were small, a total of 8 tobacco budworms and 4 bollworms larvae being collected in May and June.

Perennial pea has escaped from cultivation and is found along roadsides and waste places in Mississippi. It commonly occurs in association with vetch and has similar blooming habits. A total of 13 bollworm larvae was collected in the first 3 weeks of June. This plant apparently has some importance as a temporary host, serving between crimson clover, the most common spring host, and corn, the primary mid-season host.

Sesame, a cultivated crop of certain parts of Texas, is grown primarily for seed which are sold commercially as bird food. This crop was grown during 1963 in Stoneville, Mississippi, for research purposes. During a trip to that area on June 21, the writer observed that almost every terminal contained a young first instar larvae. Seventy such larvae were collected and brought to State College and reared to identification size. Of these 36 lived to be identified and all were tobacco budworms.

Seeds were planted at this time at State College but the plants did not bloom until late August and early October. During this period sesame was severely attacked by tobacco budworms comparing to infestations on tobacco. During this short period a total of 171 tobacco budworm and 7 bollworm larvae was collected.

Soybeans are widely grown in Mississippi and upon occasions are severely damaged by bollworm larvae. Infestations may occur in early summer and feeding is limited to foliage but the plants are most suitable as hosts in August and September when pods are available as larval food.

Damage to soybeans in northeast Mississippi was almost non-existent during 1963. A total of 7 bollworm larvae was collected during the month of May. No late damage occurred, primarily because soybeans had terminated by early August before severe damage usually occurs.

RELATIONSHIP OF HOST TO BOLLWORM

In order to demonstrate the host sequence of the bollworm as it relates to time during 1963, its occurrence on the various hosts is shown in silhouette form in Figure 4. The various silhouette sizes are based on the average occurrence units used under the separate discussion of each host. For this reason the reader should recall the limitation and example given in the methods section regarding comparisons among the various hosts. Occurrence on many of the plants classed as occasional hosts are also shown but in these cases the plot has relationship only to time of infestation and not to any sample unit.

Based on larval records, bollworm moths first emerged from overwintering pupae during late March or early April. In the area under discussion crimson clover and to a lesser extent Persian clover and lespedeza provided the principle early hosts for this species. Toadflax, reported by Barber (1937) and Feunzig (1963) as an important early spring host in other areas was found with only light infestations even though fairly abundant. Small populations of first generation bollworms were also recorded on black medic, soybeans, and alfalfa.

The extremely high infestations recorded on crimson clover demonstrates the preference exhibited for this species by the bollworm. In the ecological situation of 1963 crimson clover may be considered as the principle source of second generation moths. Vetch, an often reported spring host, was never found infested.

The second generation in early and mid-June was passed primarily on whorl stage corn, tomato, tobacco, alfalfa, okra and cotton. Tomato was severely attacked with infestations up to 23 larvae per 50 whole plants. Buffalo bur, horse nettle and perennial pea were occasionally infested. The lack of populations on these hosts after mid-June clearly demonstrates the preference exhibited by bollworms for corn which begins to silk at this time. This is particularly evident when considering that all the hosts were in the early stage of growth and should have become more, rather than less, attractive for oviposition. Two generations were passed on corn which silks continuously from mid-June to late July depending on the planting date. Data for corn occurrence is not shown for reasons already stated but the absence or lowness of populations on other hosts indicates activity on this crop.

From early August, with the loss of corn as a suitable host, the fifth generation turned to a series of hosts. In this case plants in late stages of development, actually less suitable from the standpoint of succulence and fruiting structures than they had been previously, were found infested. Peanuts, well beyond their active growing period, were found to support relatively large populations. Populations were again recorded on alfalfa and tobacco which had been negative during the entire period of corn silking. Infestations were particularly high on alfalfa reaching an average of 35 larvae per 100 sweeps. Smaller infestations were noted on okra and spider-flower. This generation was extremely important from an economic standpoint on cotton. As already discussed, applications of insecticides became necessary and in cases of poor control losses were suffered at a time when cotton could not replace destroyed bolls. It is obvious that corn served as the primary host in building up large populations of bollworm moths which utilized cotton for oviposition.

The final generation in late September and early October was passed essentially on the same hosts. Cotton in most fields had terminated and larvae were absent in these cases but were present in the few fields remaining in a fruiting condition. Other peaks were noted on alfalfa, spider flower and okra.

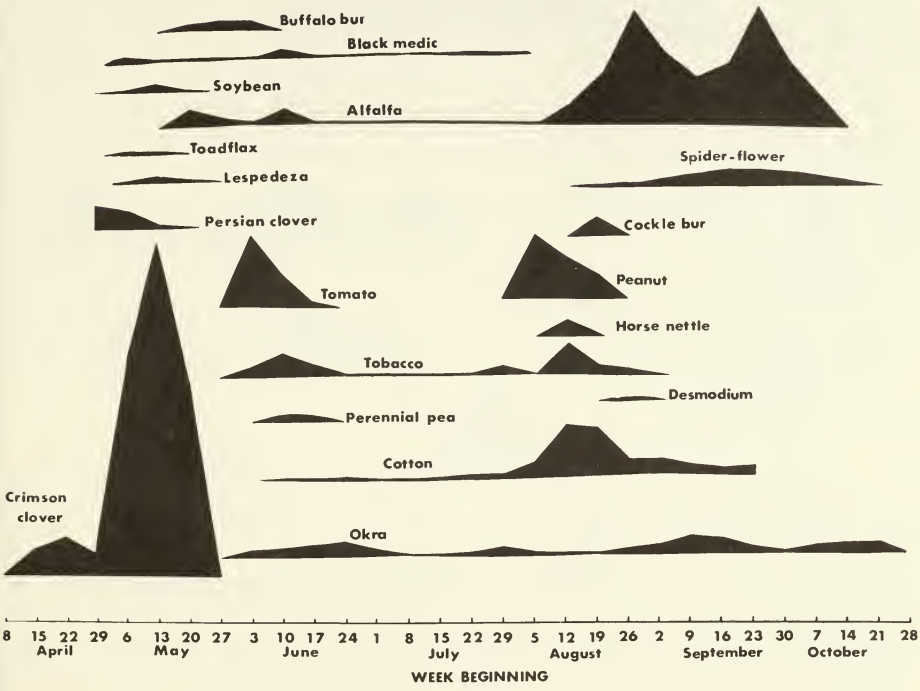

Figure 4. Seasonal host sequence of bollworm larvae on hosts during the entire 1963 season.

RELATIONSHIP OF HOST TO TOBACCO BUDWORM

Data pertaining to seasonal host sequence of this species is presented in Figure 5 in a similar manner as for the bollworm. In this case generations are less distinct in that much overlapping existed making different interpretations possible. It is the view of the writers that 5 complete generations occurred with the first and last taking longer because of the cooler temperatures.

Based on larval records, moths began emerging from overwinter pupae one to two weeks later than recorded for the bollworm. Eggs from this generation were deposited primarily on Persian and crimson clover. Larvae were found on both hosts during the same week but the presence of several advanced instar larvae on Persian clover indicates an earlier occurrence on this plant and places some doubt on the time of first adult emergence. The tobacco budworm showed a preference for Persian clover, infestations reaching a maximum of 40 larvae per 100 sweeps. Seedling tobacco and lespedeza were found to have low but consistent populations of this species. Lespedeza appeared to have the role of a plant suitable as host but not preferred in that only one generation utilized it as a host, even

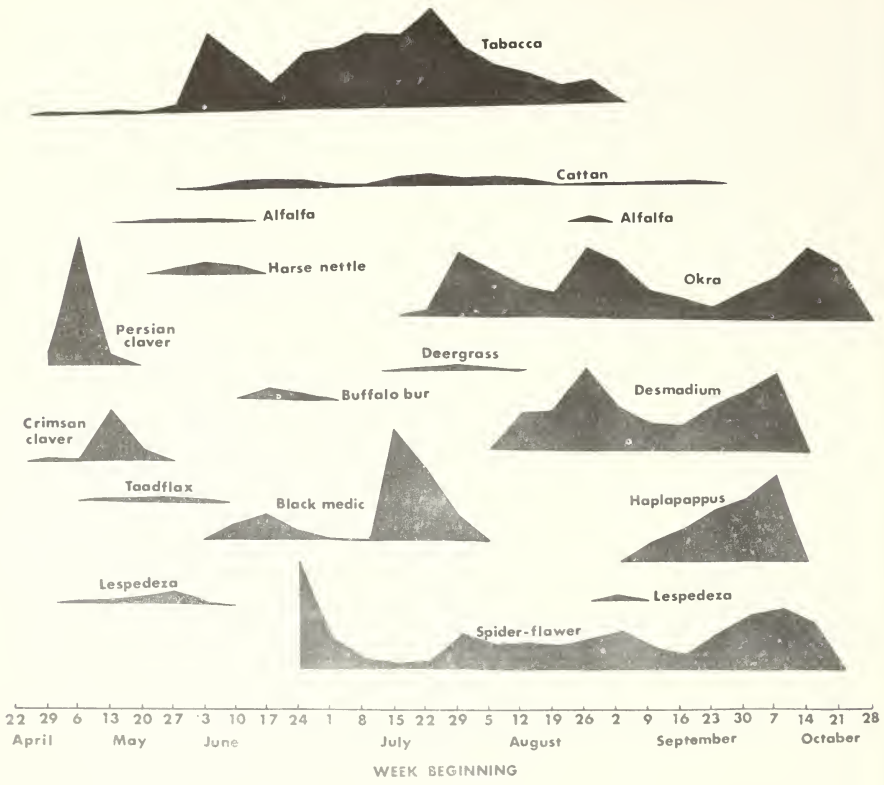

Figure 5. Seasonal host sequence of tobacco budworm larvae on hosts during the entire 1963 season.

though it remained available until late summer. Several plants classed as occasional hosts including buffalo bur, horse nettle and toadflax were utilized during this period. In addition several larvae were collected from alfalfa.

The second generation in June was passed primarily on spider-flower, black medic and cotton. Infestations on cotton and black medic were of low magnitude. Spider flower, first observed during June 24-30 probably had infestations prior to this period. Several of the occasional hosts including buffalo bur, horse nettle and toadflax which were infested in May continued to have small populations in June. Despite the low density of tobacco budworms on these plants, all except buffalo bur are very common in this area and in an overall view probably supported large populations. Tobacco was severely attacked by this generation and remained the preferred host until its destruction in late August. No conclusions can be made regarding this host, however, since it is not native and only a small number of plants were available for oviposition.

The third generation in July was primarily on tobacco, black medic, spider flower, cotton and okra. This generation was responsible for damage to cotton in many fields where automatic insecticide treatment was employed. Deergrass, an important wild host in other areas was only occasionally infested.

The fourth generation occurred in

August and early September on spider flower, tobacco, okra and cotton. Occurrence on cotton for this generation was almost non-existent, averaging less than 1 larva per 100 whole plants. *Desmodium rigidum* was first found infested by this generation and apparently is the preferred host during this period. Additional small populations were recorded on lespedeza and alfalfa.

The fifth and last generation from mid-September thru October again infested *Desmodium rigidum* and another wild host, *Haplopappus divaricatus*. This species reported by Barber (1935) as not supporting particularly large numbers of larvae in Georgia, was found with high populations, comparing with those on *Desmodium rigidum*. No larvae was collected from cotton during this period but they were still abundant on spider-flower and okra. The utilization of these two wild hosts during late season probably accounts for the variation in reports of budworm activity on cotton from areas of Texas (Brazzel and Newton, 1963) as compared with other states (Snow 1963, Young an Brazzel 1963). In the area of Texas under discussion these two wild plant species are absent thus forcing populations to utilize cotton in late season. In the Mississippi situation budworm activity during this period is concentrated on the two wild plant species.

SUMMARY

The bollworm was recorded as attacking a total of 17 species of cultivated plants. Of these, alfalfa, corn, cotton, crimson clover, lespedeza, okra, peanuts, soybeans, spider-flower, tobacco and tomato were found to be of primary importance. Cultivated plants of lesser significance were crotalaria, egg plant, sesame, string beans, sorghum and white clover. This species was recorded feeding on 11 wild species of plants which, in an overall view, played a small role in the seasonal biology. Included species were Desmodium rigidum, black medic, buffalo bur, bur clover, cockle bur, hop clover, horse nettle, Johnson grass, perennial pea, Persian clover, and toadflax.

Tobacco budworms were found on a total of 8 cultivated plant species of which cotton, crimson clover, lespedeza, okra, spider-flower and tobacco were of primary importance. Of lesser importance was alfalfa and sesame. A total of 11 species of wild plants was attacked and apparently these played a much greater role than in the case of bollworms. *Haplopappus divaricatus* and *Desmodium rigidum* were of particular importance in late season. Other infested species were black medic, buffalo bur, cockle bur, deergrass, swamp rose, horse nettle, Persian clover, sweet clover and toadflax.

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