

LIGHT-TRAP STUDIES OF SEASONAL AND GEOGRAPHICAL OCCURRENCE
OF CERTAIN SPECIES OF LEPIDOPTERA IN KANSAS

by

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B. S., Xavier University of Louisiana, 1957

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Entomology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1961

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INTRODUCTION

The literature concerned with the study of insect activity by use of light-traps is very vast. However, that which deals with the study of insects in Kansas is limited. The moths considered in this study are of general economic importance.

The purpose of this study was to analyze trap collections with respect to population distribution and seasonal and geographical variations, of selected species of moths (Lepidoptera) caught in light-traps during certain seasons at five different locations in Kansas.

GEOGRAPHICAL AND CLIMATIC REGIONS

Kansas is the geographical center of the continental 48 United States. It is bound north and south between 37 and 40 degrees latitude, and it extends east to west from 90°50' to 102° longitude. Kansas has a climate typical of the American Great Plains. There are no extensive water areas, the air is generally dry, and the temperature range is considerably variable.

The state's average annual precipitation varies from 18 inches in the Northwest Region to 42 inches in the Southeast. A two-years' average annual precipitation of 17.5 inches was reported for Garden City. It was 22.5 inches at Hays in the Central Region. The average annual was 32.5 inches at Manhattan, and Wathena's was 38.7 inches. Mound Valley in the Southeast Region had an average annual precipitation of 44.7 inches.

Elevation in Kansas varies from below 1,000 feet in the Southeast to more than 4,000 feet in the extreme Western part. At Mound Valley the elevation is 800 feet. Further north at Wathena it is 1,088 feet. Manhattan has an

elevation of 1,040 feet. In the Central Region at Hays the elevation is 2,000 feet, and it is 2,840 feet at Garden City.

REVIEW OF LITERATURE

A survey of the literature on light-traps as a means of collecting insects revealed that many types, varieties, and modifications of traps have been used. One of the earliest and probably the most basic was that used by Slingerland (1902). His trap consisted of a kerosene lantern on a brick in a pan containing water, placed on a post. He mentioned some of the earlier "trap-lanterns" used in an effort to control insects.

As time passed, individuals interested in the study of nocturnal insects sought new and better means of trapping. This resulted in volumes of articles on many insects. A more recent type was reported by Common (1960). This is a transparent trap designed to exclude Scarabaeidae, and automatically segregates from the remainder of the catch most of those which enter the trap. It is operated on the ground with the light source completely visible from above. Sloping transparent perspex sides and funnel enable the light to be seen from all sides as well. A transparent hood can be fitted above the trap during rain. The trap is divided into an upper and a lower chamber by shallow trays, which aid in segregating the beetles from the moths. All insects drop into the inner tray upon entering, but he noted that most beetles tend to crawl rather than fly. Thus they would drop into the lower tray through provided openings. Most of the other insects remain in the upper section of the trap. It was reported to be most efficient for collection of most insect orders, except Coleoptera, and the quality of the specimens was always high.

The types of lights used, the size and locations of the traps, and variable factors such as climate and weather have been studied by some workers. Cook (1923) studied the physical ecology of the Noctuidae at Minnesota. This involved determining the effects of various meteorological factors on the distribution, seasonal abundance, and activity of certain species of this family.

Stirrett (1938) did extensive work on the European corn borer, (Pyrausta) Ostrinia nubilalis Hubner, at Minnesota. The effects of certain physical factors on flight and the general life cycle were considered.

Knutson (1944) used a battery of two sets of light-traps at different locations during his work at Minnesota. One battery was equipped with different colors of incandescent and gas-tube lights. He surmised that the use of multi-light-traps each night during the season in one locality showed an increase in the number of specimens of certain species during one to three periods. These increased catches usually indicated the number of generations. He also considered the effects of meteorological factors, and found that certain species were more influenced by weather conditions than others. Hand collections and rearings were made. This work consisted of 395 species, and additional forms, which occurred in Minnesota. The light-trap collections made by Dr. C. T. Schmidt in 1927, 1928, and 1929 were studied and included. He stated that the light-traps operate over a long period of time, and are much more reliable than if done by hand collections or other methods. This was corroborated by most of the workers who used a light-trap. They agreed that it was a very effective means of obtaining information about insects.

A comparative study was made by Johnson (1954) in Northeast Derbyshire using two box type light-traps. He employed a 100-watt, gas-filled electric

lamp in a trap elevated 9 feet, and an 80-watt (mercury vapor) m. v. lamp in another on a wall facing south. Results showed that a trap facing the wind takes fewer insects than one faced away from the wind. The number of moths caught varied with the direction of the wind. The position of the trap was found to be more important than the type of illumination, and though the m. v. lamp was a better attractant to insects, the ordinary gas-filled electric lamps were a satisfactory substitute.

Williams et al. (1955) made similar studies at Rothamsted using four of two different designed traps. These were the Rothamsted trap, with its light source from within, and the Robinson trap with the source of light above the trap. Each had a different type of light and was rotated at four collecting sites. They concluded that for a trap-type and illumination comparison, a 125-watt m. v. lamp gave catches that were from one to three times larger than those obtained with a 200-watt ordinary bulb. They further found that the Robinson type trap was better for catching the heavier insects while the Rothamsted trap proved superior in catching the smallest insects.

Craufurd (1957) used the mercury vapor type lamp in a comparative study of entrapments made in 1957 with that of 1956. He found it to be very efficient in this work.

Comparative studies of two ultra violet light-traps were made at Rothamsted by Hosney (1959). Trapping occurred over a period of two years in which one trap was placed in a wooded area and the other was exposed. He considered the effects of temperature, winds, and humidity as well as certain secondary environmental conditions. These were moonlight, fog, night duration, and thundery weather. He observed that the trap in the wooded area showed much more stability in catches than the one which was in the open.

The literature concerned with light-traps as a means of determining insect population, abundance, and variation in Kansas is limited. Nonemaker (1933) made observations and studies on certain species of moths, and used two distinct types of light-traps at Manhattan, during the summers of 1932 and 1933. A funnel-type trap, designed by Roger C. Smith in 1910, with a 500-watt electric bulb, was used. It had three jars attached to the main spout. The second trap used was a box type designed by Doctor Smith in 1932. It used a gas lantern or an electric bulb. These traps were operated at different locations and different heights from the ground. Twenty-five common species of moths were observed and their flight patterns noted. A comparative study of weather conditions was made at the time of the large and small catches. He concluded that few moths were caught when the temperature was 60° F. or lower and the relative humidity was 59 percent or lower. At temperatures above 90° F. the catches were reduced. The largest catch was made when the humidity was 90 to 100 percent. Wind was the most important climatic factor. The catches were smaller on a bright moonlight night. The light-traps provided a good method of catching the first and the last emerging moths during a season and of determining the number of broods of the species.

Walkden and Whelan (1942) used several of two types of light-traps in their work on Owllet moths in Kansas and Nebraska. The first type used was the same trap described by Nonemaker (1933). The second type was similar and designed by Walkden. These traps were placed at six locations across the states and operated for various seasons during four years. They included 305 species of Phalaenidae. Tables and graphs on species of economic importance were made. These gave flight periods of the species, numbers and total

taken at each station, and a proportion of the sexes. They found that those species with a single generation annually had a short flight period, and overlapping of the broods was common in those multiple-generation species.

Further work on moths was done by Walkden (1950). This was an investigation of the bionomics of the cutworms, armyworms, and related species attacking cereal and forage crops in the central Great Plains. Keys to the larvae of some species of Phalaenidae were given. The distribution, economic status, crops attacked, types of injury, seasonal histories, and natural enemies for 27 species also were given.

MATERIALS AND METHODS

Five light-traps were used to collect the moths. These traps (Plate I) were identical, except the trap at Manhattan did not have the baffles while operating. This type of trap was designed by the USDA and is reported to have first been used in Indiana in 1949. It is presently being used in 26 states in the United States.

The light-traps operate on 120 AC volts, using one 15-watt black light fluorescent tube type light with 3957 angstroms wave length. They have a receptacle measuring approximately one and one-half gallons. In the container approximately 5 ounces of Cyanogas, A-dust (42 percent Calcium Cyanide), were placed in a small paper bag to kill the insects. This chemical was renewed approximately every ten days.

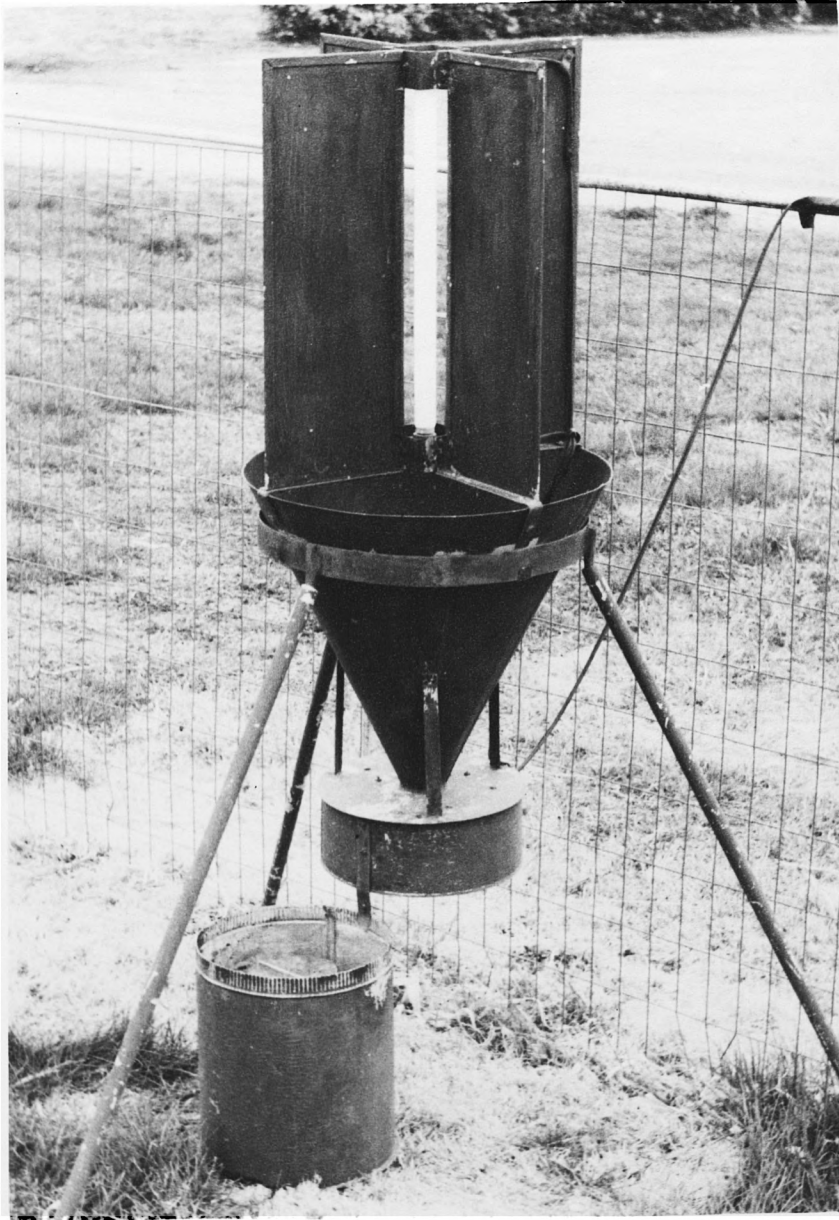
The locations of the traps (Fig. 1) during the collecting periods of 1959 and 1960 were Manhattan, Hays, Wathena, and Garden City. The trap at Mound Valley was not in operation during 1959. It was started in 1960.

EXPLANATION OF PLATE I

This type of light-trap¹ was used at all stations to collect the moths for this study.

¹Photograph by Leroy L. Peters.

PLATE I



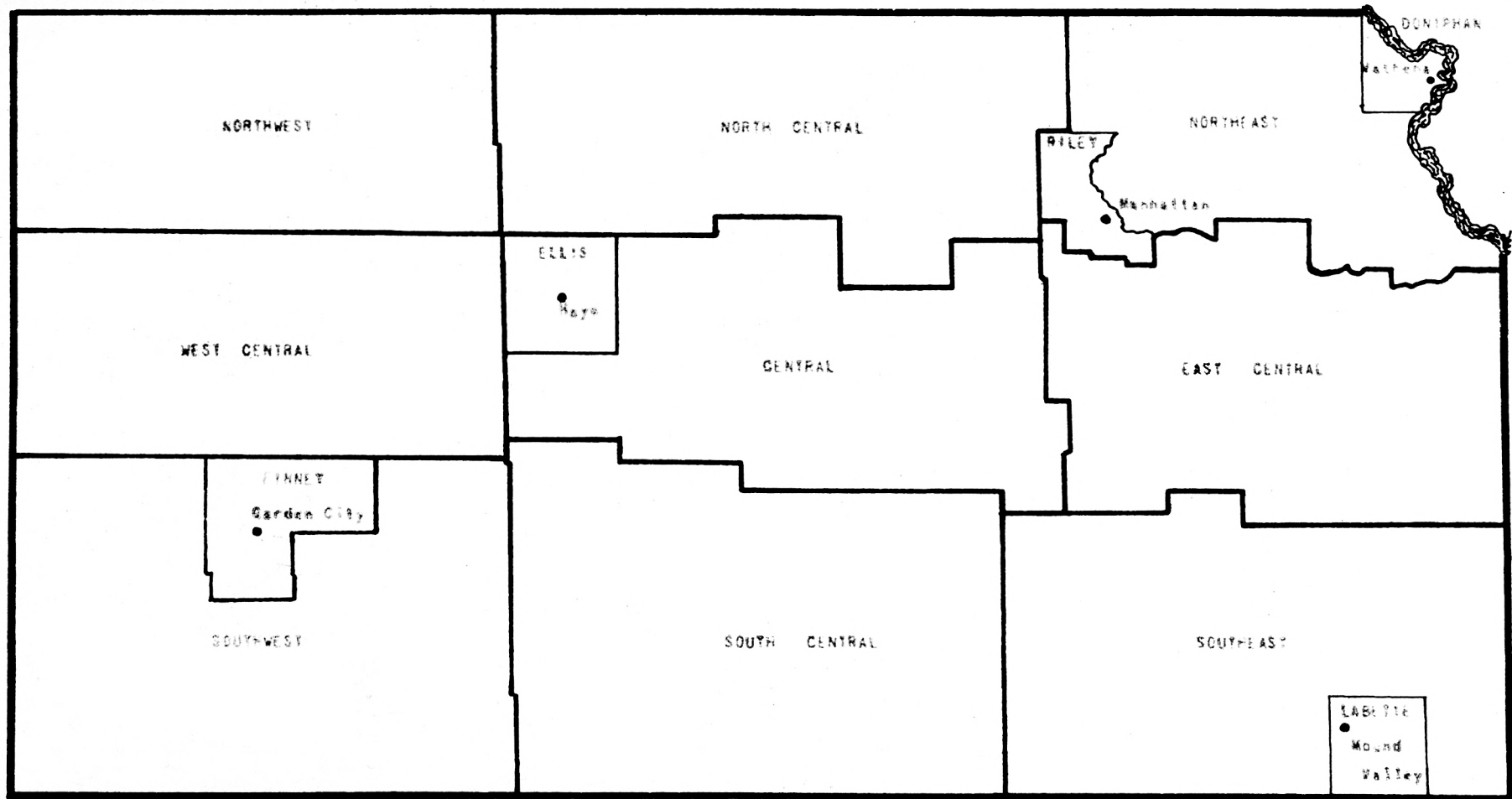


Figure 1. Location of the light traps by geographical regions, counties, and towns.

The trap at Manhattan in Riley County was situated 35 to 40 feet high on the south side of Fairchild Hall, located on the campus of Kansas State University. Its light was visible for several miles, depending upon obstructions.

The trap at Hays in Ellis County was located at the Fort Hays Experiment Station. It was mounted on a tripod-type stand 3 to 4 feet above ground level. This trap was about 300 yards from homes and other lights operated at night. A $\frac{1}{2}$ -inch hail screen mesh was used, in 1959 only, to filter the large insects, and it was equipped with four baffles.

The trap at the Garden City Experiment Station in Finney County was also located on a tripod stand of similar height as the one used at Hays. No lights were operating within a quarter of a mile of the trap. The nearest light was a 230-watt, 110-volt bulb in a red warning light at the top of a water tower. No screening was used during the entire operating periods, and the trap was equipped with four baffles.

The trap at Mound Valley in Labette County was located 200 feet from the nearest occupied house. It was mounted 3 to 4 feet above the ground on a tripod. Four baffles were present but no filter screening was employed.

The trap at Wathena in Doniphan County, in the extreme Northeast corner of Kansas, was approximately three-fourths of a mile to the nearest light. A $\frac{1}{2}$ -inch hail type screen was used to filter insects into the receiving container. Four baffles were also employed on this trap.

All traps except the one at Mound Valley went into operation on 15 March 1959 to 15 November 1959. They were again turned on and off at these dates during 1960. The light-trap at Manhattan was turned on and operated continuously throughout the seasons. However, the ones at Hays, Garden City, Mound Valley, and Wathena operated intermittently three to four days per week. This

was considered in the general discussion of relative abundance of these traps. The light-trap at Mound Valley operated only during the collecting season of 1960.

The entrapments were collected by the personnel of the stations at Hays, Garden City, Mound Valley, and Wathena and mailed to the Department of Entomology at Kansas State University. For this purpose, mailing tubes one pint and one quart in size were used. Identifications and data recordings were made by graduate assistants of entomology, under the supervision of the Survey Entomologist at the University.

A standard mimeographed form (Fig. 2) for recording each station's light-trap count was used. The data sheets for the years 1959 and 1960 were compiled by weeks as listed in Tables 1 and 2.* All findings and discussions were based upon these data. A comparison of the occurrence at the five collecting stations was done to determine the prevalence of certain species over the state. Flight periods have been illustrated by the use of graphs.

RESULTS AND DISCUSSION

European Corn Borer

Ostrinia nubilalis (Hübner) (European corn borer) has presented a problem to Kansas as one of its most destructive economic pests. However, it was reported by Peters (1960) that this insect was of no great economic importance during the years 1959 and 1960. He stated further that only 0.8 percent of the total corn losses were due to the European corn borer.

The flight periods ranged from the third week of May to the first week of October. During 1959 and 1960, there were intervals of no catch in light-traps. In 1959 the first moths were caught at Manhattan in the last week of May. In

* Tables are on p. 80-84.

INSECT LIGHT-TRAP REPORT

STATE: KANSAS

TRAP NO. _____ LOCATION _____ COUNTY _____

MONTH _____ YEAR _____

INSECT	DAY OF MONTH COLLECTED										TOTALS
TOMATO HORNWORM											
TOBACCO HORNWORM											
CORN EARWORM											
ARMYWORM											
ARMY CUTWORM											
BLACK CUTWORM											
FALL ARMYWORM											
WHEAT HEAD ARMYWORM											
EUROPEAN CORN BORER											
VARIEGATED CUTWORM											
YELLOW-STRIPED ARMYWORM											
PALE WESTERN CUTWORM											
SOUTHWESTERN CORN BORER											
DINGY CUTWORM											
FORAGE LOOPER											
WEBWORMS, ALFALFA											
" , BEET											
LINED SPHINX											

Fig. 2. Example of the standard mimeographed form used to record light-trap catches during 1959 and 1960.

1960 the moths did not appear until mid-July.

It was noted that the European corn borer is greatly influenced by climatic factors. Metcalf et al. (1951), p. 420, stated that "dry summers, extremely cold winters, and heavy rains at the time of hatching are very unfavorable to this insect." This was further demonstrated by Burkhardt (1961) who made surveys to determine the overwintering mortality percentage of O. nubilalis larvae. The survey was made in the Northeast Region and he found that the mortality percent for winters of 1958-59 and 1959-60 to be 85 and 48 percent, respectively.

Arbuthnot (1949) indicated that the number of generations could be predicted for a particular climatic region. This is based on the mean annual temperature and precipitation.

The light-trap counts for both years indicated the greatest peak (Figs. 3 and 4) in the last week of May and the first of June. The highest peak for 1959 occurred at Hays. There was only one flight period at Hays. A flight took place between 1-7 June in 1959 when a large number of the moths were taken. The flight of 1960 was exactly at the same time as 1959; however, the numbers caught were greatly reduced.

Wathens's trap counts showed a flight period from May 30 to June 30 in 1959. The flight patterns were a week earlier in 1960. A few moths were caught on the last of July in 1959.

Flights at Garden City occurred between 15-21 July in 1960, and again a few moths were caught in the first week of October. Only one moth was taken in 1959.

Moths were caught at Manhattan up to 22 September in 1959. Flight peaks appeared at three points in this year; June 15th, July 31st, and September 7th.

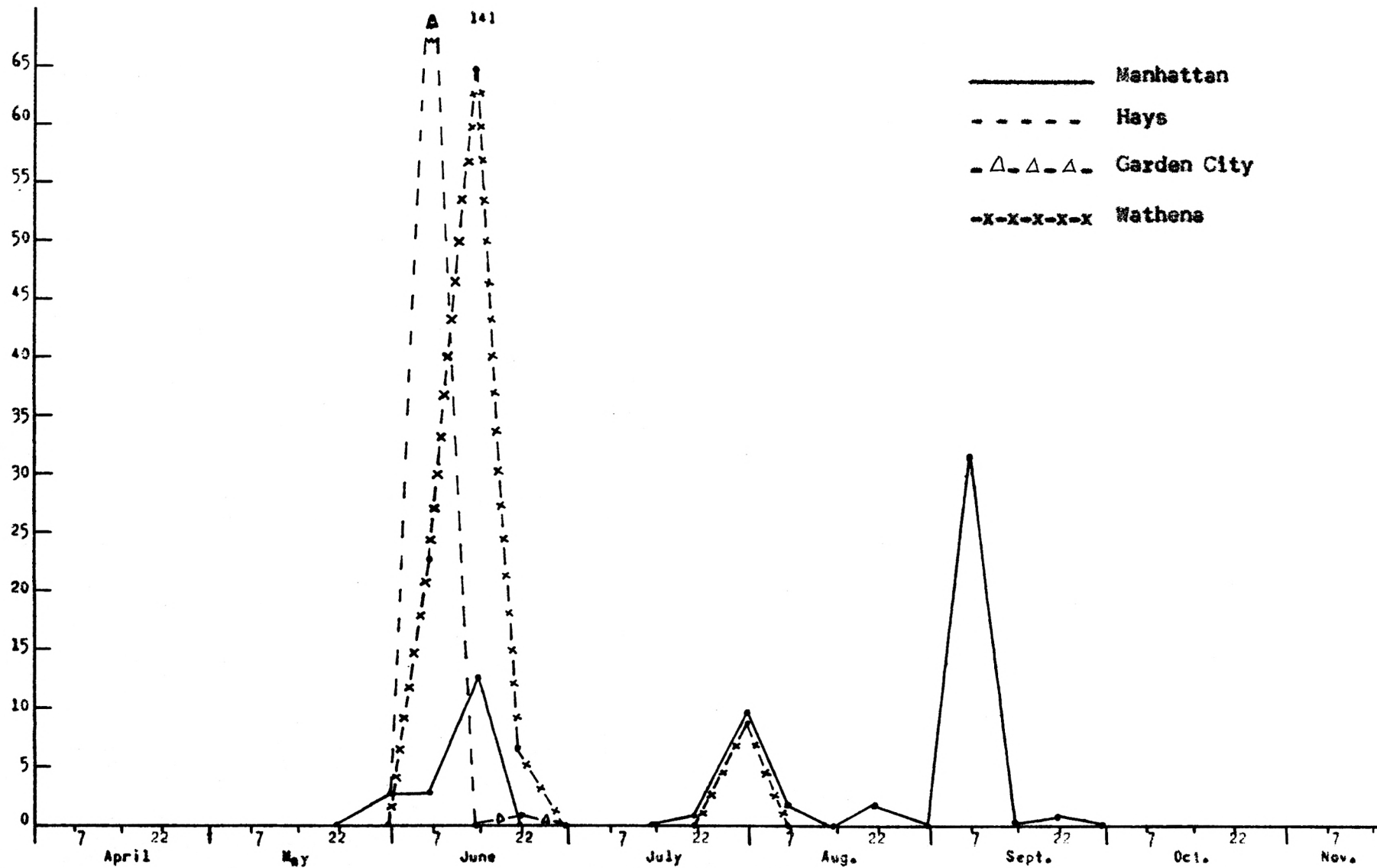


Fig. 3. EUROPEAN CORNBORER Flights during 1959.

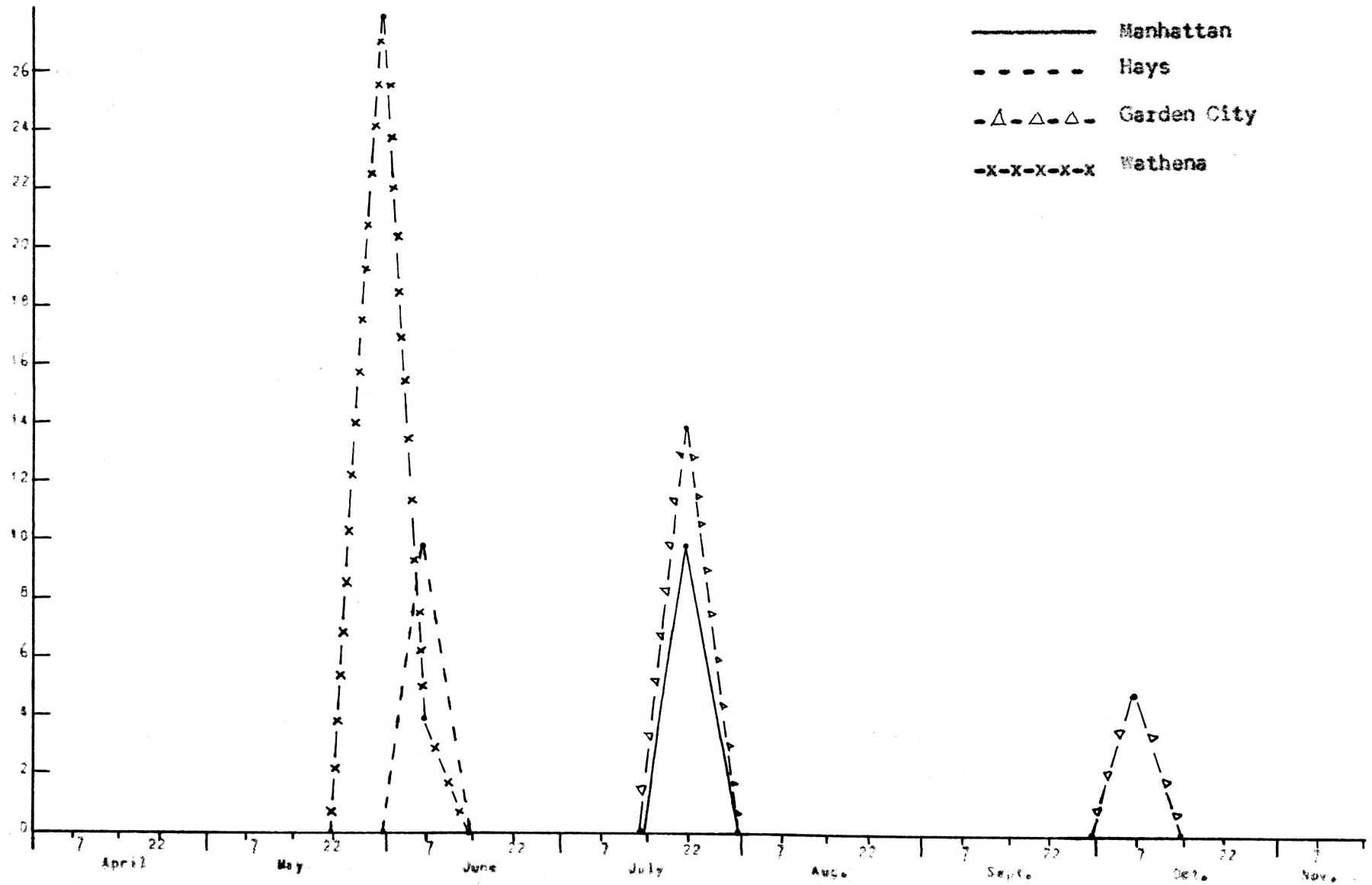


Fig. 4. EUROPEAN CORNBORER Flights during 1960.

It is possible that the climatic factors were favorable for the borers and two generations were produced. According to Arbuthnot (1949), Manhattan should have two generations of the European corn borer per year.

No specimens were trapped at Mound Valley during the 1960 periods of flight.

Alfalfa Webworm

Loxostege commixtalis (Walker), the alfalfa webworm, is of some economic importance because of its habits of destroying alfalfa and some other crops. It is known to feed on most plants except grasses and has been implicated as a serious pest of sugar beets. Metcalf et al. (1951) stated that there were three partial generations over much of its range. He further indicated that the time required for development from eggs to the adult stage was approximately 5-7 weeks. Nonemaker (1933) observed three brood flights at Manhattan.

The flight period was noted to be from about mid-April to late October. The first moths were caught in the last week of April in 1959. These appeared one week earlier in 1960 (Figs. 5 and 6).

Only a few moths were taken at Manhattan. The first were caught between 1-7 May in 1959. Only three small catches were made by this trap in June of the same year. The first flight at Manhattan occurred in the last week of July in 1960. This was the greatest peak for this species. A few moths were noticed as late as 31 October in 1960. According to the light-trap data, the first brood appeared at Manhattan between 1-7 July. These were probably moths developed from the overwintering larvae. Metcalf et al. (1951) stated that the adults from overwintering larvae are present in the fields from late March to late June. The second brood appeared between 1-7 September, and a third

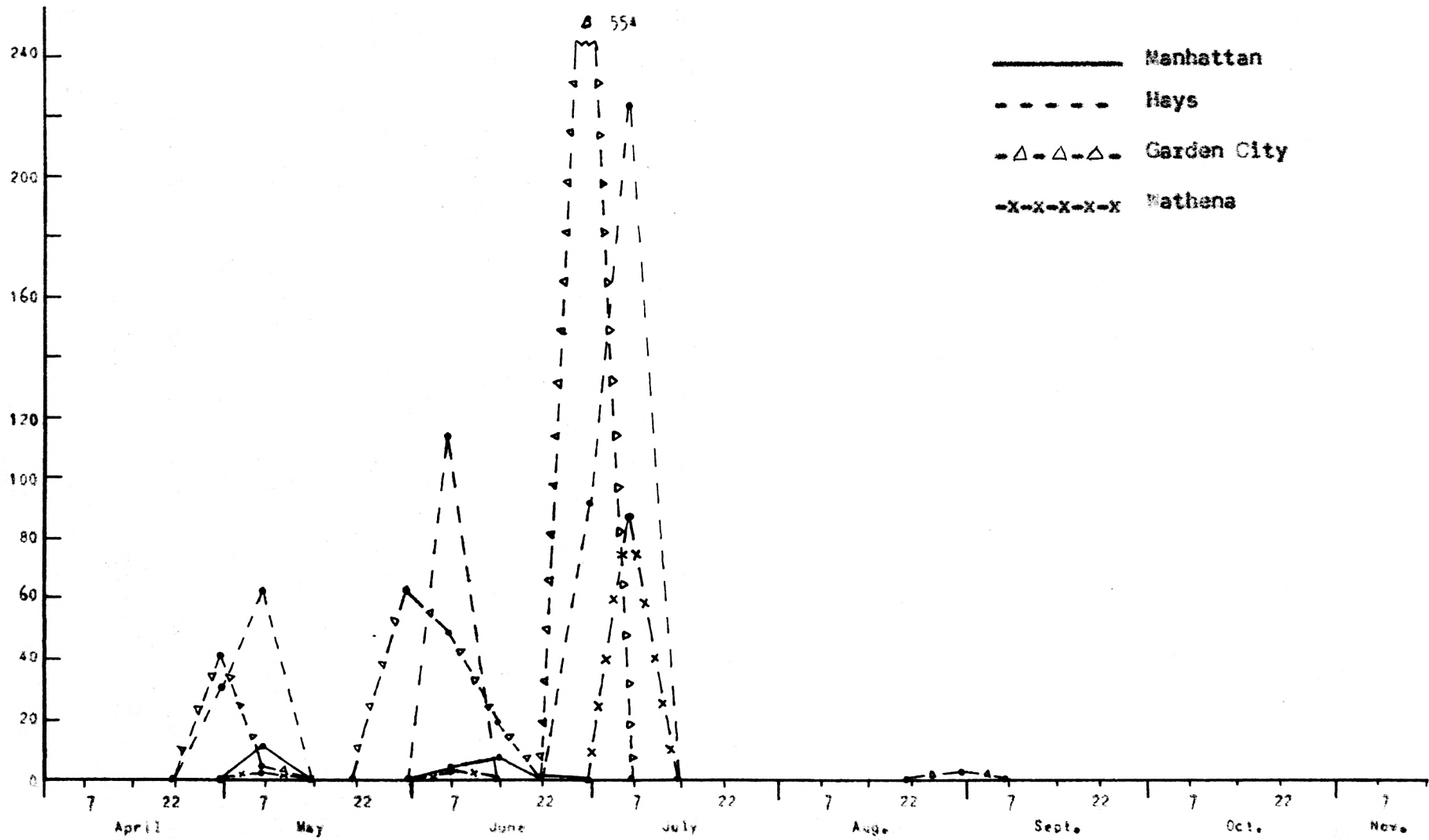


Fig. 5. ALFALFA WEBWORM
Flights during 1959.

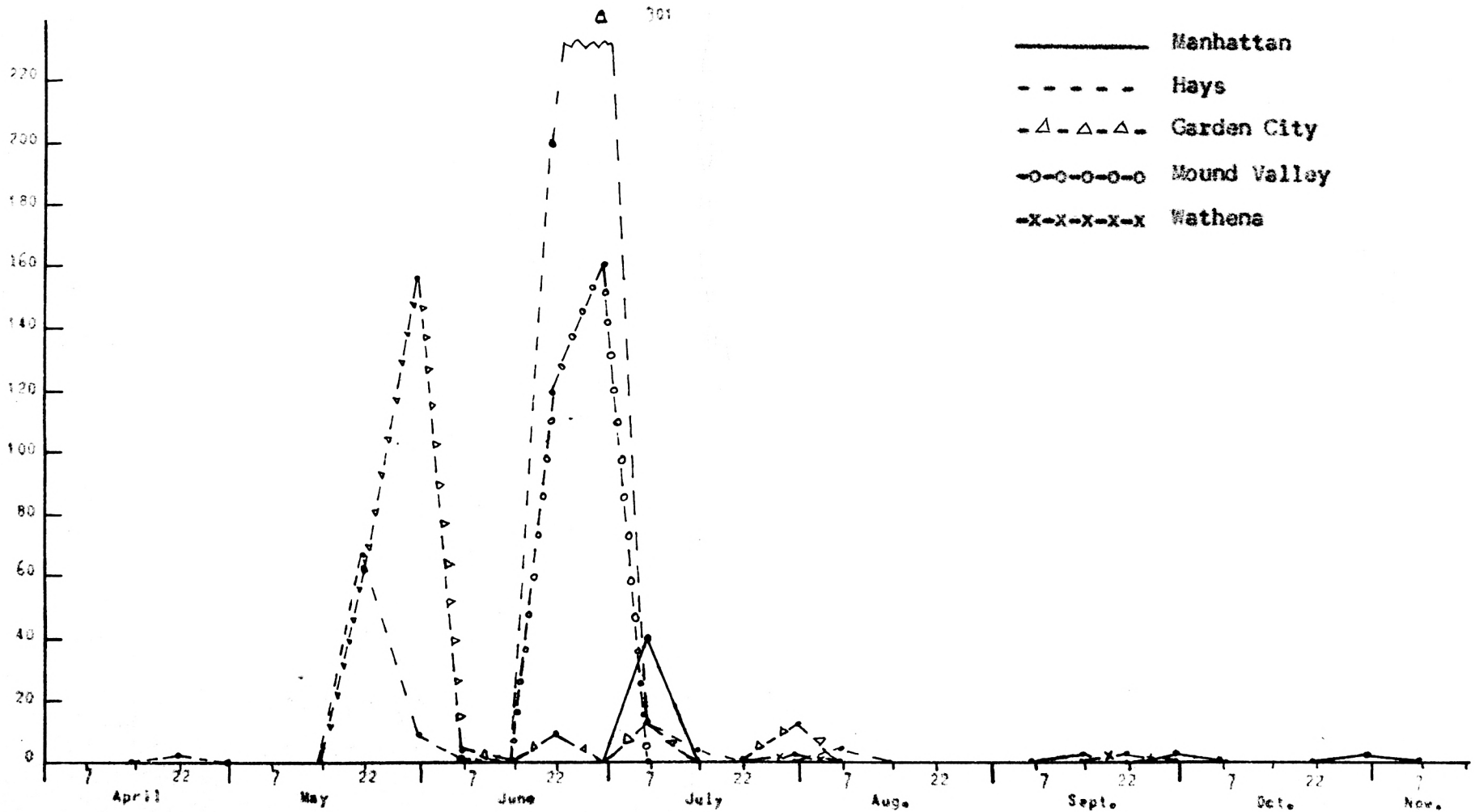


Fig. 6. ALFALFA WEBWORM
Flights during 1960.

was observed about 31 October. The data indicated some inconsistency in their time of appearance for the two years, 1959 and 1960.

There were three flight intervals at Hays in 1959. These were approximately one month apart, starting on 31 April to 7 June. The number of moths increased at each flight.

Three flights were observed at Hays in 1960. The number of moths taken was considerably greater than in 1959. Time of flights for 1960 was approximately a week earlier. The maximum peak, 301 specimens (Fig. 6), occurred between 22-30 June.

At Garden City it was noted that in 1959 the flight periods occurred between 22 April and 30 June. In 1960 the flights occurred between 15 May and 31 July. The light-trap counts showed peaks (Fig. 5) on 30 April, 31 May, and 30 June. These peaks were more clearly defined than those which occurred in 1960. Also, the number of moths taken was greater in 1959 than that of 1960. The maximum count was approximately 554 moths taken between 22-30 June. The total number of moths caught was 736 in 1959 and 262 in 1960.

The alfalfa webworm's flights at Mound Valley were observed to be from 15 June to 7 July, with only two peaks (1960 only).

At Wathena 97 moths were taken between 30 April and 15 July; 86, the maximum peak, were caught between 1-7 July. In 1960, four moths were taken from the last week in July to 22 September.

In summary, the alfalfa webworm's population varied from one season to the next. Where it was noticed in great abundance at a particular time and place one season, it was seen in much less numbers at that same place and time during another season. The collections were greater in the Central and

Southwest Regions than in the Northeast and Southeast Regions. A total of 1,385 moths was taken from the four traps in 1959. Approximately 93 percent were taken in the Central and Southwest Regions. In 1960 a total of 1,198 moths was caught in the five light-traps; about 25 percent were caught at the light-traps in the Northeast and Southeast Regions.

Beet Webworm

Loxostege sticticalis Linn., the beet webworm, is one of the most destructive insects attacking sugar beets. It is very similar to the alfalfa webworm in habits and life history. It was observed by Dean and Smith (1935) that there were three generations a year in Kansas, and that it overwinters in the larval stage. Wilbur (1935) indicated the same number, and stated that it was the members of the third generation which caused the most destruction because of their great numbers.

Collections were from the first week of April to about the last of October. The greatest flight peaks were observed (Figs. 7 and 8) to have occurred in the Central and Southwest Regions. A very few were caught in the Eastern part of the state.

In 1959 the first moth was taken at Manhattan between 1-7 April. Three weeks later six were taken. Another catch was made between 16-22 May, and was the last until the last of July when one moth was taken.

It was not taken at Manhattan until the first of July in 1960. Five weeks later another catch was made, and on the last of September the last moths were caught. Twenty-one moths were taken in 1959 and 35 in 1960.

Flights occurred at Hays from 22 April to about 15 October. Three distinct peaks are seen in Fig. 7. The first occurred between 1-31 May;

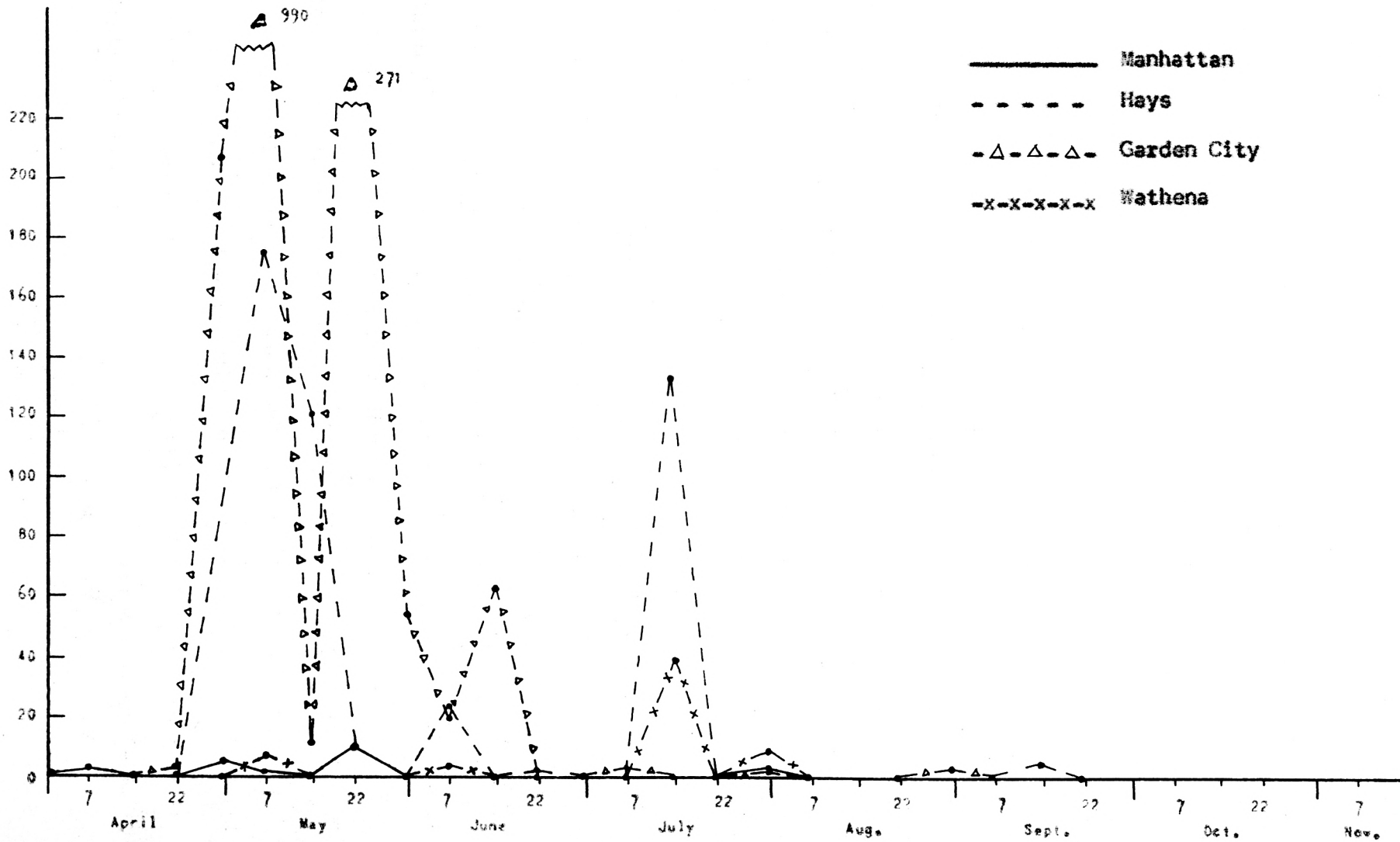


Fig. 7. BEET WEBWORM
Flights during 1959.

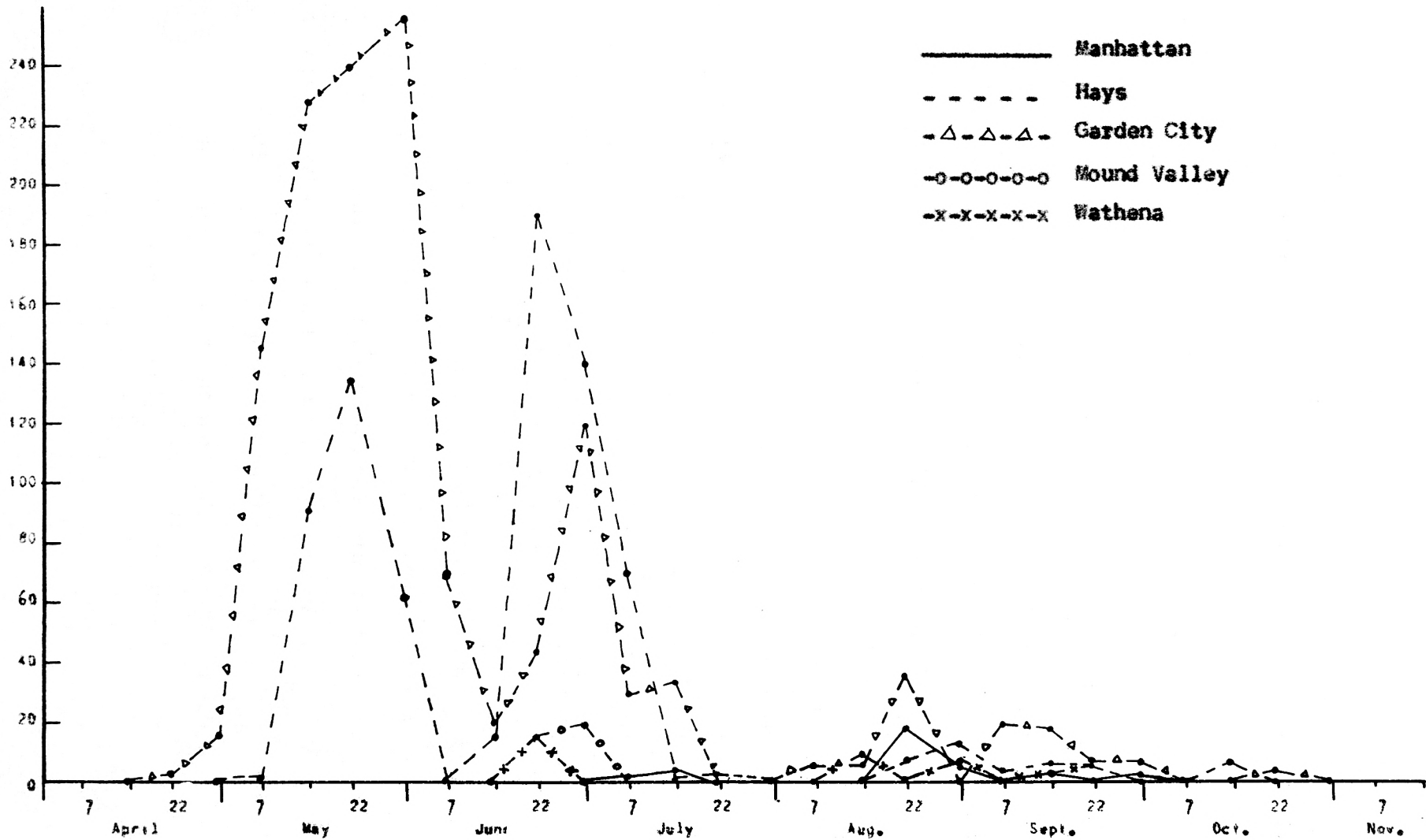


Fig. 8. BEE FLYWORM
Flights during 1960.

the second from 8 June to 22 July; and the third from 16 August to 22 September. These dates agree with Wilbur (1935), p. 144, who reported that

The moths appear in late April or May. The first generation of worms occur in June and in early July and develop into moths throughout late July. The second generation of worms are present throughout late July and much of August. They emerge as moths in late August and early September.

The second flight in 1960 was much greater than the first flight in 1959, when 159 moths were caught compared to 420. The weekly average temperature during both years differed only by about two degrees. The precipitation at Hays in 1959 was 3.20 inches and in 1960, 1.55 inches.

The third flight of 1959 and 1960 was about the same. However, the number of moths taken was greatly reduced. Moths were observed as late as 15 September in 1959 and up to about 15 October in 1960.

At Garden City, flights ranged from 15 April to about 22 October. Three major flight peaks were observed; the first was caught between 16-22 April during both years. In 1959 the maximum peak occurred between 1-7 May when 990 specimens were taken. In 1960 the greatest peak occurred about the end of May, although fewer were caught. The next moths appeared about 15 May to 22 June in 1959, and between 15 June and 22 July in 1960. Small catches were made from the last of July to 22 October in 1960. The last moths were caught by the end of August in 1959.

At Mound Valley only 36 moths were caught between 16-30 June in 1960.

L. sticticalis appeared at Wathena from the end of April to about the last of August in 1959. Flights were from 15 June to 7 October in 1960. The number taken was very low; the highest peak was approximately 39. Three small flight peaks were observed. The first occurred between 1-7 May; the second between 1-7 June; and a third from 7-31 July in 1959. In 1960, the first

flight occurred between 16-22 June, another 8-31 August, and the last 8-22 September.

The beet webworm was observed to be in greater abundance in the central and western parts of the state. The light-trap counts for the four traps operated in 1959 netted a total of 2,185 moths (Table 1), of which 1,629 were taken at Garden City and 474 at Hays. The remaining 82 were taken at Manhattan and Wathena, combined. In 1960 a total of 2,189 moths was taken (Table 2). There were 1,314 at Garden City and 757 at Hays. The traps at Manhattan, Wathena, and Mound Valley had a combined total of 118.

Army Cutworm

Chorizagrotis auxiliaris (Grote), the army cutworm, was reported by Burkhardt (1954) to be of major economic importance in Kansas each year, and Metcalf et al. (1951) stated that it was known to have destroyed 100,000 acres of winter wheat in one year in Montana. Nonamaker (1933) reported that during 1933, outbreaks occurred in eastern and southern Kansas. He further stated that there is only one generation per year and that it overwinters as a half-grown larva. Walkden (1950) and Metcalf et al. (1951) reported only one generation a year. The moth is said to be distributed throughout the semi-arid region of the Great Plains.

The flight patterns, illustrated graphically in Figs. 9 and 10, indicate flights from the first week in April to about the first week in November. In 1959, at Manhattan, the first moths were caught during the middle of April. For a three-week period only a few moths were trapped. This pattern of very low counts was constant throughout the season. There was an interval from 16 June to about the last of August in 1959 when no moths were taken. This

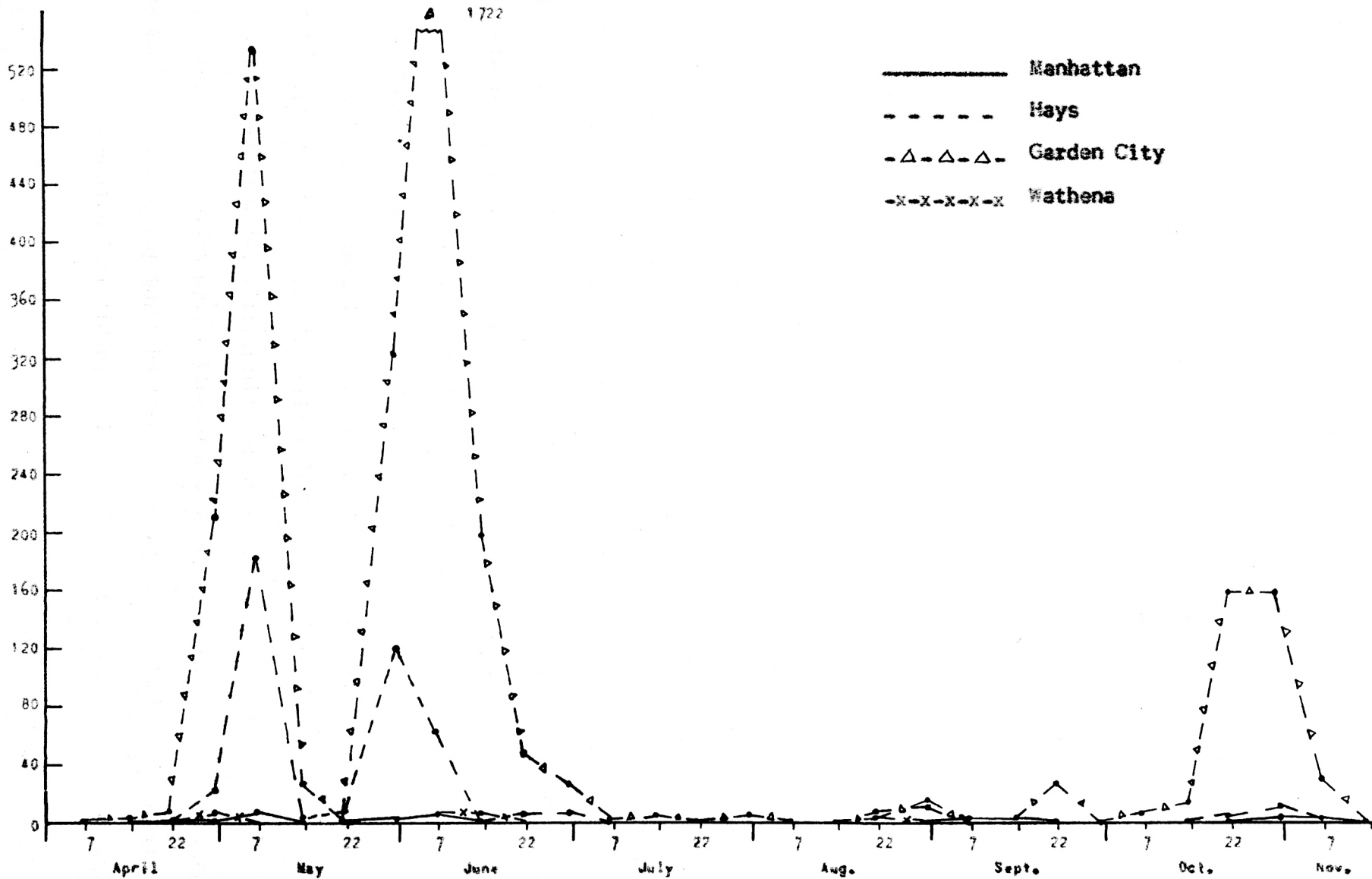


Fig. 9. ARMY CUTWORM
Flights during 1959.

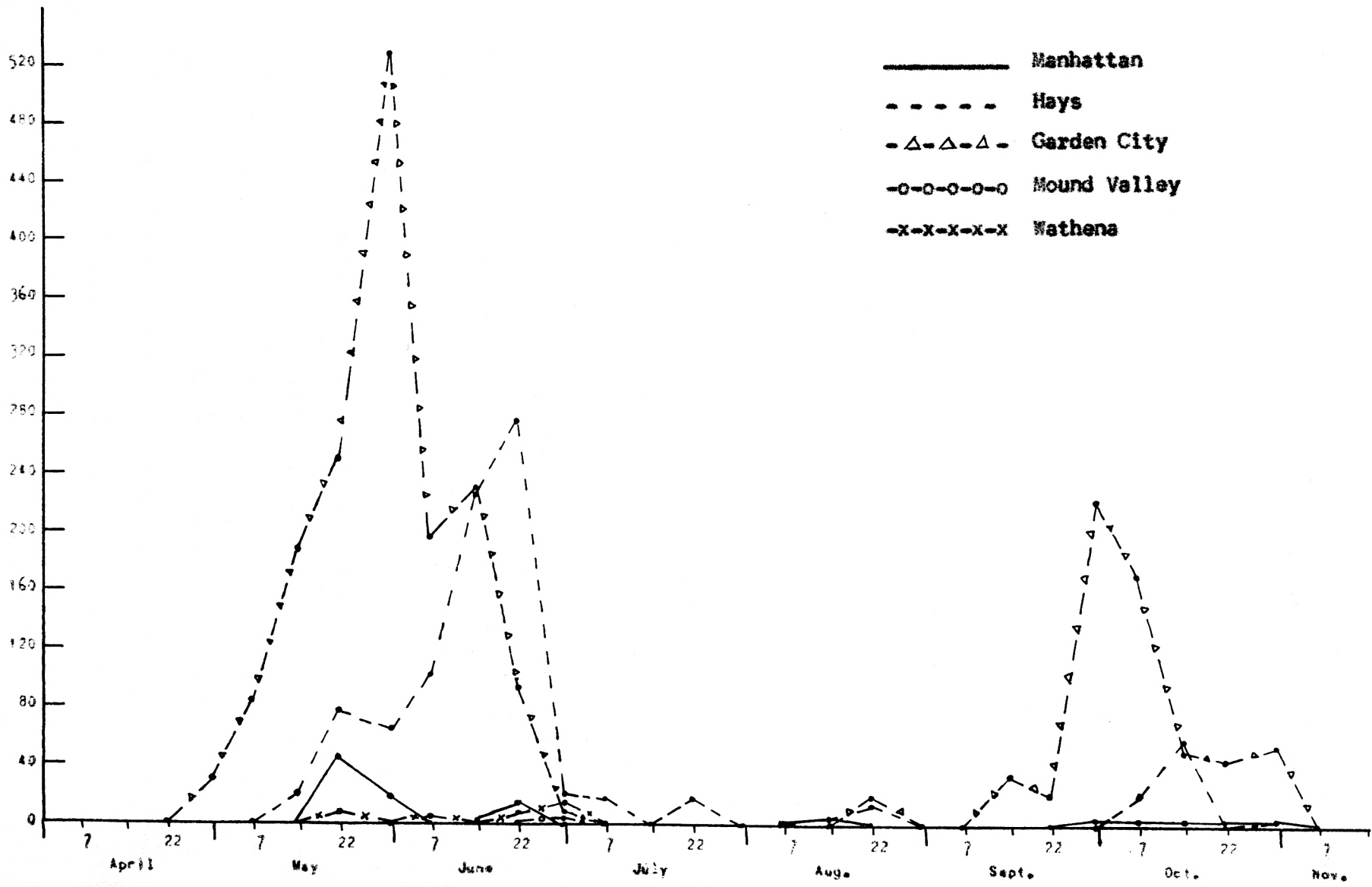


Fig.10. ARMY CUTWORM
Flights during 1960.

flight void occurred again in 1960 from 23 June to 15 August. One moth was recorded on the latter date and for five weeks no catches were made. Cook (1923) reported that the moths emerge in June and aestivate for a period of at least three months before maturation. This practice was thought to result in escape from heat and drought during the summer.

Walkden (1950), who made studies of both larvae and adults, indicated that the flights immediately after the June emergence subsides suddenly, and that in the central Great Plains the army cutworms aestivate as adults.

During 1959 the moths were active for a four-week period, over which time ten were taken in the trap at Manhattan. There were no catches from the last week of September until the last week in October when four moths were caught. The late flight activities at Manhattan occurred from about the last of September to the end of October during 1960 when ten moths were trapped. It did not appear to be abundant at this location during both years. Thirty-eight were caught in 1959, and 97 in 1960.

Flights at Hays were from the last week in April to the first week in November during 1959. In 1960, flights were delayed until the middle of May and ended about the last of October. Intervals of no flight activity were observed during both years. Each interval was interrupted by the appearance of a few moths at the light-trap, after which their absence was again noticed. The flights after aestivation commenced during the middle of October in 1959, and during the first week of this month in 1960. These flights were generally considerably reduced, compared to early flights. Over 90 percent of the total entrapment was taken during the first few weeks of flight. The greatest peak occurred between 16-22 June in 1960 when 279 moths were taken, and the greatest peak during the first week in April in 1959, at which time 183 specimens were

caught. A total of 451 moths was trapped in 1959, and 951 during 1960.

Flights at Garden City were from 1 April to about the first week in November during 1959. In 1960, flights occurred from the last week in April to the last week in October. Aestivation probably happened between the middle of July and the end of September in 1959, although catches were recorded intermittently throughout this period. The aestivation period for 1960 was more clearly defined, apparently from the first of July to about 8 September. Flight peaks were observed (Fig. 9) on 7 May and 7 June in 1959. This same peak pattern was observed at Hays. Perhaps some outside factors affected the flight of this insect during the last two weeks in May, and caused it to suddenly drop. Between 7-22 May, several days had a maximum temperature well below 70° F. at Garden City, and two days were 53° F. Also, the minimum temperature fell well into the lower 40's. Hays' daily maximum and minimum temperatures were about the same as those at Garden City although a greater number of days with lower temperatures occurred at Garden City.

Precipitation during 7-22 May was 2.66 inches at Hays and 2.02 inches at Garden City. Over 50 percent fell during the first few days of this period at both Hays and Garden City. Perhaps these climatic factors caused the fluctuations in flights. These were not observed during the 1960 flight on these dates. A study of the climatological data for that time revealed the temperatures to be very much the same, but the amount of precipitation was far less than in 1959.

The maximum peak for Garden City occurred on the first week of June of 1959 when 1,722 moths were recorded. In 1960 the greatest peak was observed on the last of May when 528 were caught. The peaks at the end of the seasons contained less than the numbers reported for the earlier flights. It appeared

in more abundance during 1959 than in 1960.

The army cutworm was not taken in great abundance at Wathena. It was taken from the last of April to the middle of August in 1959. It occurred from mid-May to the end of June during the 1960 season. Six moths were caught during the last week of April in 1959. Between the 1-7 June, six more were recorded, and immediately another catch of seven followed. Four moths were taken about the middle of August. These totaled 23 for 1959.

The flight during 1960 occurred within a span of about five weeks and totaled 38 moths. The scarcity at Wathena is not believed to have been caused by climatic factors such as temperature fluctuations or precipitation. Other species of Phalaenidae were recorded in abundance during the same period. This is primarily a Great Plains species and hence, Wathena, located in extreme northeast Kansas, is in the fringe of its distribution.

Eight moths were taken at Mound Valley during the 1960 season. Four of these occurred on the last of June and four more were observed on 31 October.

In summary, 4,053 moths were caught in 1959. Over 75 percent were caught at Garden City, and approximately 24 percent at Hays. Less than one percent came from the light-traps at Manhattan and Wathena. During 1960, 3,356 moths were trapped, of which 2,262 appeared at Garden City and 951 at Hays. This species occurred in greater abundance in the Central and Southwest Regions than it did in the eastern parts of Kansas. A trend of alternate years of abundant occurrences was reported by Walkden and Whelan (1942). At Garden City, both in 1959 and 1960, large light-trap collections were made.

Pale Western Cutworm

Agrotis orthogonia Morrison, the pale western cutworm, according to Metcalf et al. (1951), has destroyed millions of dollars worth of grains, alfalfa, and other crops in western United States and parts of Canada. Walkden (1950) stated that it is a dry-land species and is confined to the semi-arid region of the United States. It was observed by DePew and Harvey (1957) to have caused damage to dry-land winter wheat in northwestern Kansas during the spring of 1956.

No moths were caught during 1959 and 1960. Perhaps this was due to the amount of moisture obtained during these years. It is likely that moths would have been taken if a light-trap had been operated in northwestern Kansas. Walkden (1950) indicated that this insect was of importance after a series of dry years. He further stated that the most easterly point of occurrence in the central Great Plains is about 12 miles east of LaCrosse, Kansas. Walkden and Whelan (1942) reported that the flight period of A. orthogonia was from about August to October, and indicated that only one generation per year occurred. Their data showed that moths were in flight at Hays and Garden City during seasons of 1934 and 1935. It was also reported at Garden City during 1936 and 1937.

Black Cutworm

Agrotis ipsilon (Hufnagel), the black cutworm, is of minor importance and is primarily a pest of young corn. The exact number of generations that occur in Kansas is not known. Walkden (1950) suggested that probably there were four complete generations and sometimes a partial fifth in the central Great Plains. According to Metcalf et al. (1951), this species has four generations in

Tennessee and overwinters as a larva or pupa. Walkden (1950) stated that in Kansas it probably overwinters in the pupal stage although attempts to grow it under controlled conditions failed. Knutson (1944), p. 23, suggested that apparently there was a wide deviation from any "seasonal history rhythm" by this moth.

This insect was in flight from the first week in April to about the first week in November. The major peaks appeared between 22 June and 7 July during both 1959 and 1960.

Flights at Manhattan occurred from 22 April to 7 November in 1959, and from 7 April to about 22 October in 1960. The flight peaks, totaling four, were more constant for 1959 (Fig. 11). The first was minor and appeared between 30 April and 15 June. The second was the greatest and came between 22 June and 15 July. The third was observed from 22 July to about 31 August, and the fourth peak from 1 September to about 15 October. Two moths appeared during the first week in November. These could have been late arrivals of the fourth group. Walkden (1950) noted that between 46 and 52 days were required for completion of the summer generations from egg to adult. The time of the third and fourth peaks is supported by his findings.

Early flights at Manhattan during 1960 were clearly defined (Fig. 12). From 15 May to about 7 September, the maximum flight occurred when over 80 percent were taken. The greatest peak came between 1-7 July. This insect appeared in greater numbers during 1960 than it did in 1959. However, the flight peaks were clearer during the latter year. A tremendous overlapping of broods might have caused some of this difficulty in 1960. A total of 294 black cutworms was caught in 1959, and 1,338 in 1960 at Manhattan.

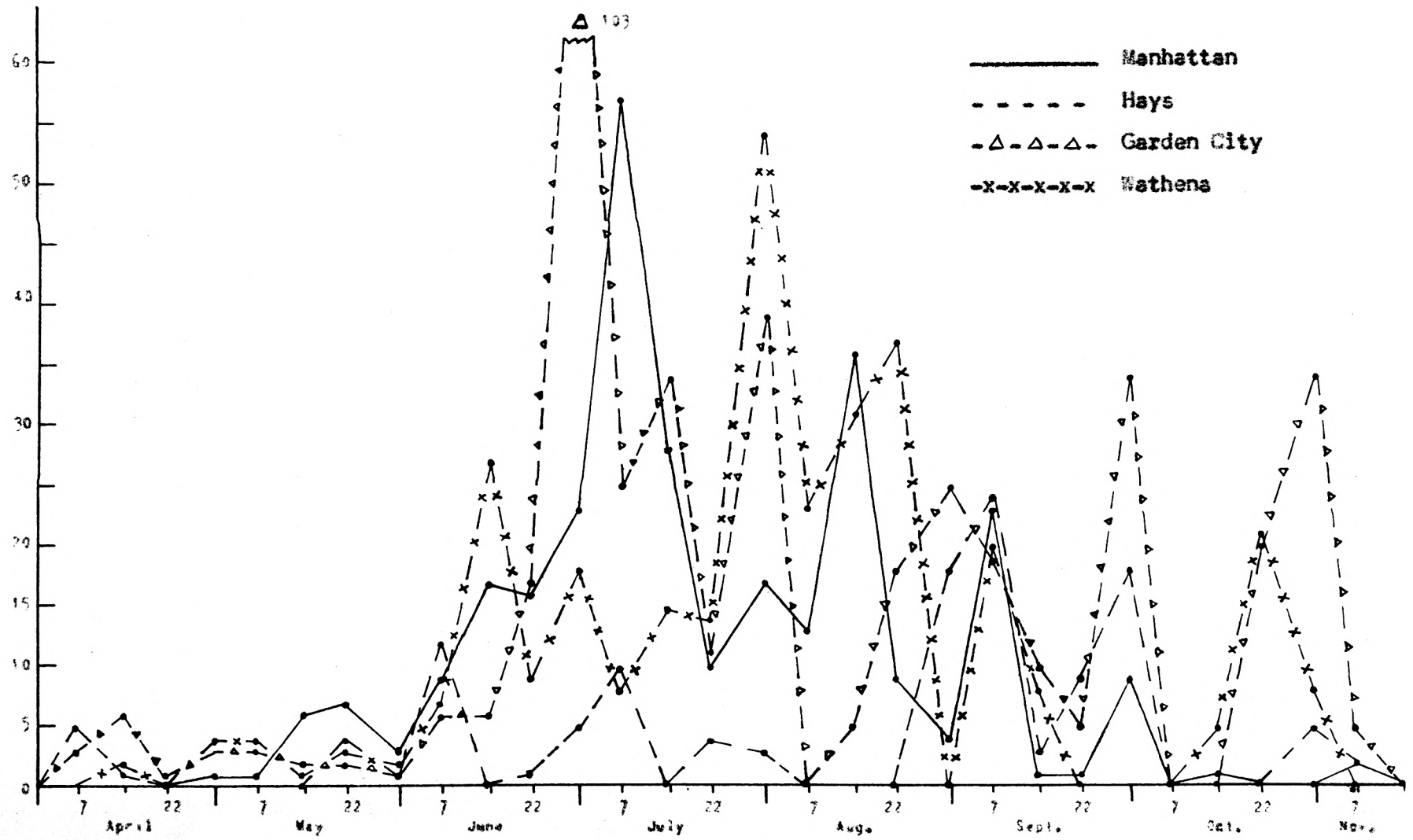


Fig. 11. BLACK CUTWORM
Flights during 1959.

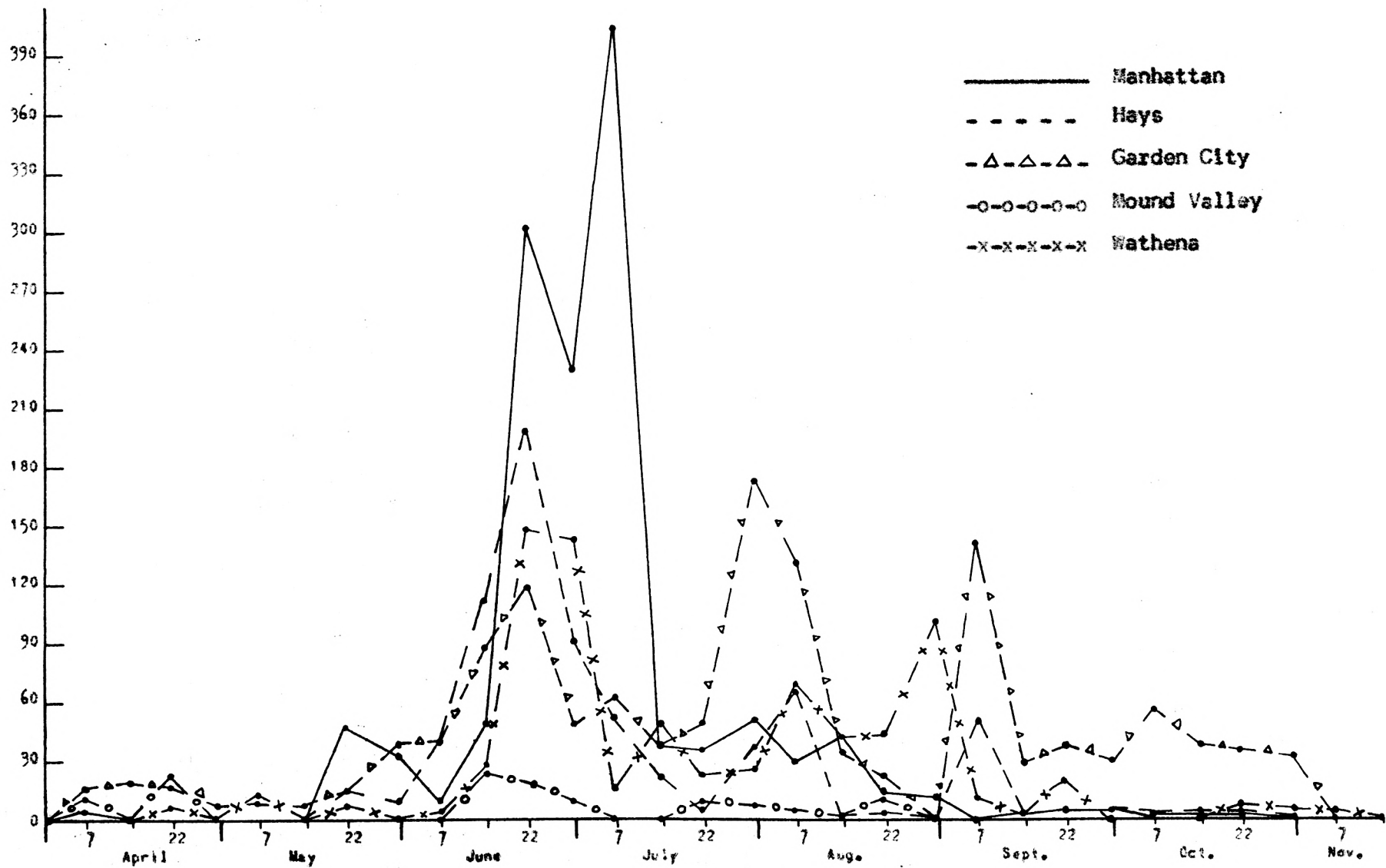


Fig. 12. BLACK CUTWORM
Flights during 1960.

At Hays, flights were observed from the first of April to about the first of November during 1959, and in 1960 from 8 April to about the end of October. The flight patterns were almost similar for the two years except the numbers were much greater in 1960. Four peaks were observed during 1959 and three in 1960. Probably four broods were produced at Hays, but because of overlapping, they were not clearly defined during both years. The first peak came between 7 April and 7 June; the second between 15 June and 7 August; the third from 22 August to 15 September; and the fourth from 16 September to about 7 October. A few stragglers were observed from the end of October to about 7 November.

The greatest peak at Hays occurred about 7 September in 1959, and in 1960 about 22 June when 200 moths were recorded. A total of 125 moths was trapped in 1959; and in 1960, 762 appeared at Hays.

At Garden City this species was in flight from the first week in April until the first week in November during both years. The number of peaks observed during 1959 and 1960 showed that probably four broods were present. The first appeared between 7 April and 31 May; the second between 7 June and 22 July; the third between 23 July and 7 September; and the fourth between 15 September and 7 November.

In 1959 the greatest peak occurred about 30 June when 103 moths were caught. During 1960 the greatest peak came on July 31, when 173 were taken. A total of 437 was trapped in 1959, and 1,366 during 1960. Based on the greatest flight peak and the total number of moths taken, the population was in greater abundance during 1960 at Garden City.

At Mound Valley, A. *ippsilon* was active from 1 April until the end of October with three peaks. The first flight occurred between 1-22 April. The

second did not appear until about 8 June and ended about 30 June. The third flight came between 16 July and 22 August. Though represented by only one moth, the fourth flight probably appeared during the last two weeks in October. The greatest peak occurred during mid-June when 28 specimens were recorded. All flights were consistently low in numbers during the season. The total was 142.

The black cutworm's flight periods at Wathena were from 8 April to about 7 November. Four flight peaks were observed during 1959. The first appeared between 8 April and 31 May; the second between 7 June and 15 July; the third from 22 July to about 31 August; and the fourth from 22 September to about 7 November. The patterns were very much the same for both 1959 and 1960 except the number at each flight was considerably greater during 1960. The maximum peak occurred about 31 July in 1959 when 54 moths were trapped. The greatest peak was between 16-22 June in 1960 when 150 moths were trapped. The total during 1959 was 321; and in 1960, 811.

It occurred in great abundance in 1960 at Manhattan, Hays, and Garden City, and in light numbers at Wathena and Mound Valley.

In 1959 it was not common. The total number caught in the four light-traps operated was 1,177. During 1960 the five traps netted 4,419. Approximately one fourth of these came from Manhattan and about a quarter at Garden City. The light-trap at Wathena caught more moths during both seasons than did the one at Hays. This insect was found to be well distributed across the state, and except for its scarcity at Mound Valley it was found to be firmly established in the other geographical regions of the state.

Dingy Cutworm

Feltia subgothica (Haworth), the dingy cutworm, is of minor economic importance in Kansas. Walkden (1950) stated that it damaged alfalfa in eastern Kansas on one occasion but the larva generally fed on plants found in pastures and roadsides. Knutson (1944), quoting Webster (1890), reported subgothica to have been destructive and common in Indiana cornfields in 1889, and Illinois in 1887.

One generation per year is indicated in Kansas. Its flight activity usually occurred late in the year. During 1959 the flight period was from about 22 July to about 7 November. Flights started as early as 15 June, and ended on 7 November during 1960.

The flight at Manhattan in 1959 was from 22 August to 15 October. It occurred from 15 August to 15 October during 1960. The maximum peak came on 30 September in 1959, and two weeks earlier in 1960. A total of 323 were taken during the 1959 season, and 1,137 in 1960.

Nonemaker (1933) also reported one flight and one generation at Manhattan. Walkden (1950) stated that this insect overwintered as a partly grown larva, and did not begin to emerge as a moth until late in August.

The flight period at Hays occurred between 23 August and 7 November in 1959, and from 16 June to 31 October in 1960. During the last two weeks of June, 16 appeared. Three weeks later the flight was resumed and was continuous from 23 July to the end of the season. The greatest peak was on 22 September in 1959, and in 1960. During 1959 the flight pattern was observed (Fig. 13) to have taken a sudden drop between 1-15 October. It then immediately went almost up to the maximum peak before it tapered off at the end of the season. This did not occur in 1960.

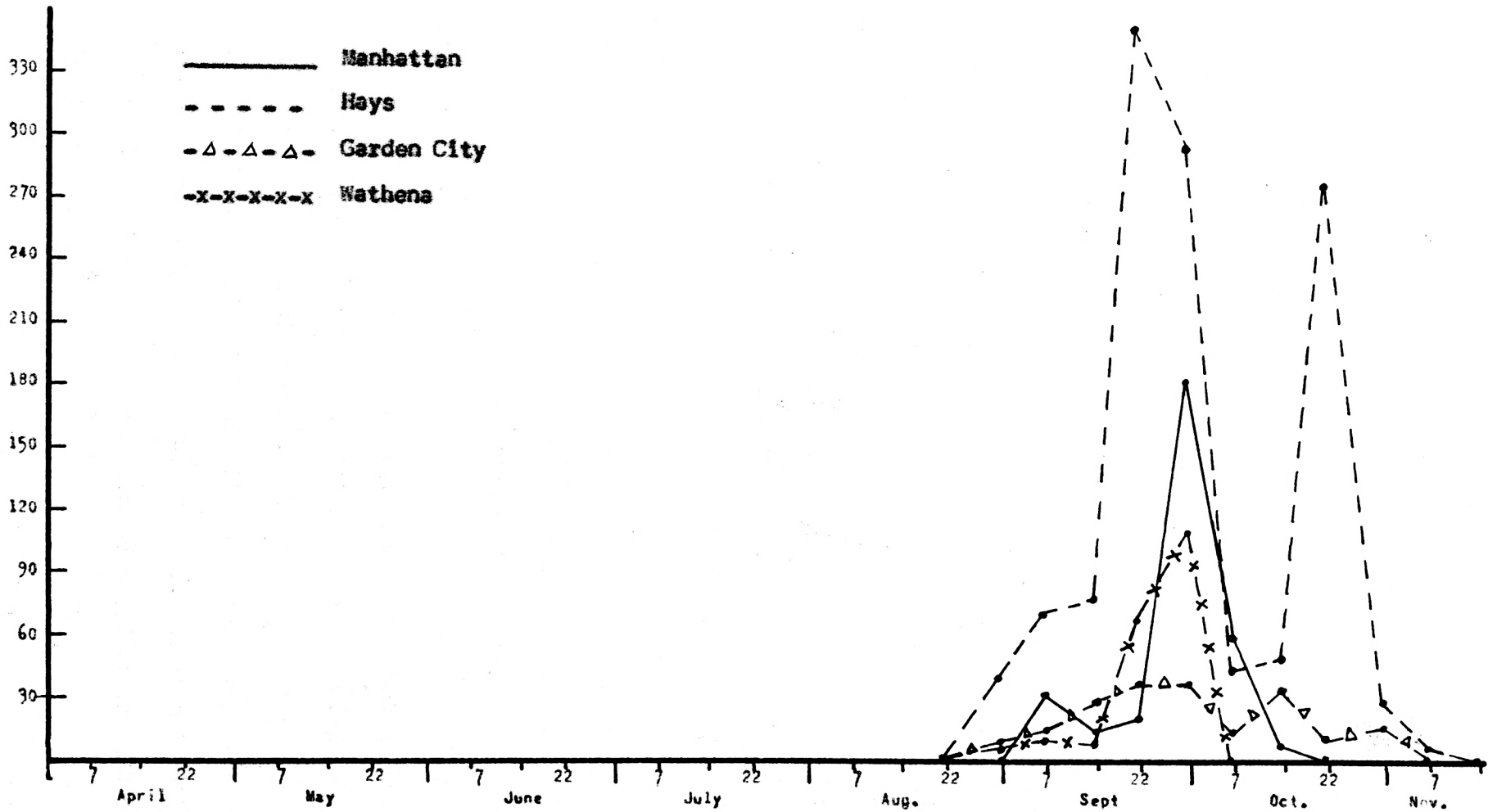


Fig. 13. DINGY CUTWORM
Flights during 1959.

The numbers taken at Hays in 1960 were considerably greater than that of the previous year. A total of 1,244 moths was caught in 1959. This was over 65 percent of the total taken by all light-traps during that season. In 1960, 2,542 were trapped.

At Garden City, in 1959, two moths were caught in the last week of July. No others appeared in the trap until 23 August. The flight continued until 7 November with its greatest peak between 16-30 September. The flight started from 23 July and ended about 31 October in 1960. The maximum peak was on 15 September when 1,170 (Fig. 14) were recorded, the greatest peak for any light-traps. A total of 213 was taken in 1959, and 2,297 appeared during 1960. This was an increase of over 2,000 moths for this season, and was almost 25 percent of the total collection at all of the stations.

Six moths were trapped at Mound Valley between 23-30 June but there were no further catches.

The flight at Wathena occurred from 23 August to about 31 October in 1959. The maximum peak was on the last of September when 112 were trapped. Two weeks expired before another appeared. During 1960 the flight was between 31 July and 7 November. After the initial catch of two moths there was an interval of three weeks. These short intervals occurred throughout the season. The greatest peak was on 15 September when 856 moths were taken. During the 1959 season 214 were trapped, and in 1960, 2,451.

To summarize, during 1959, 1,994 were trapped, of which more than two thirds were taken in the light-trap at Hays. In 1960, 8,433 moths were caught. Though only four light-traps were used during 1959, the extra trap used in 1960 netted only six of the grand total taken. The dingy cutworm appeared in abundance at Manhattan, Hays, Garden City, and Wathena during

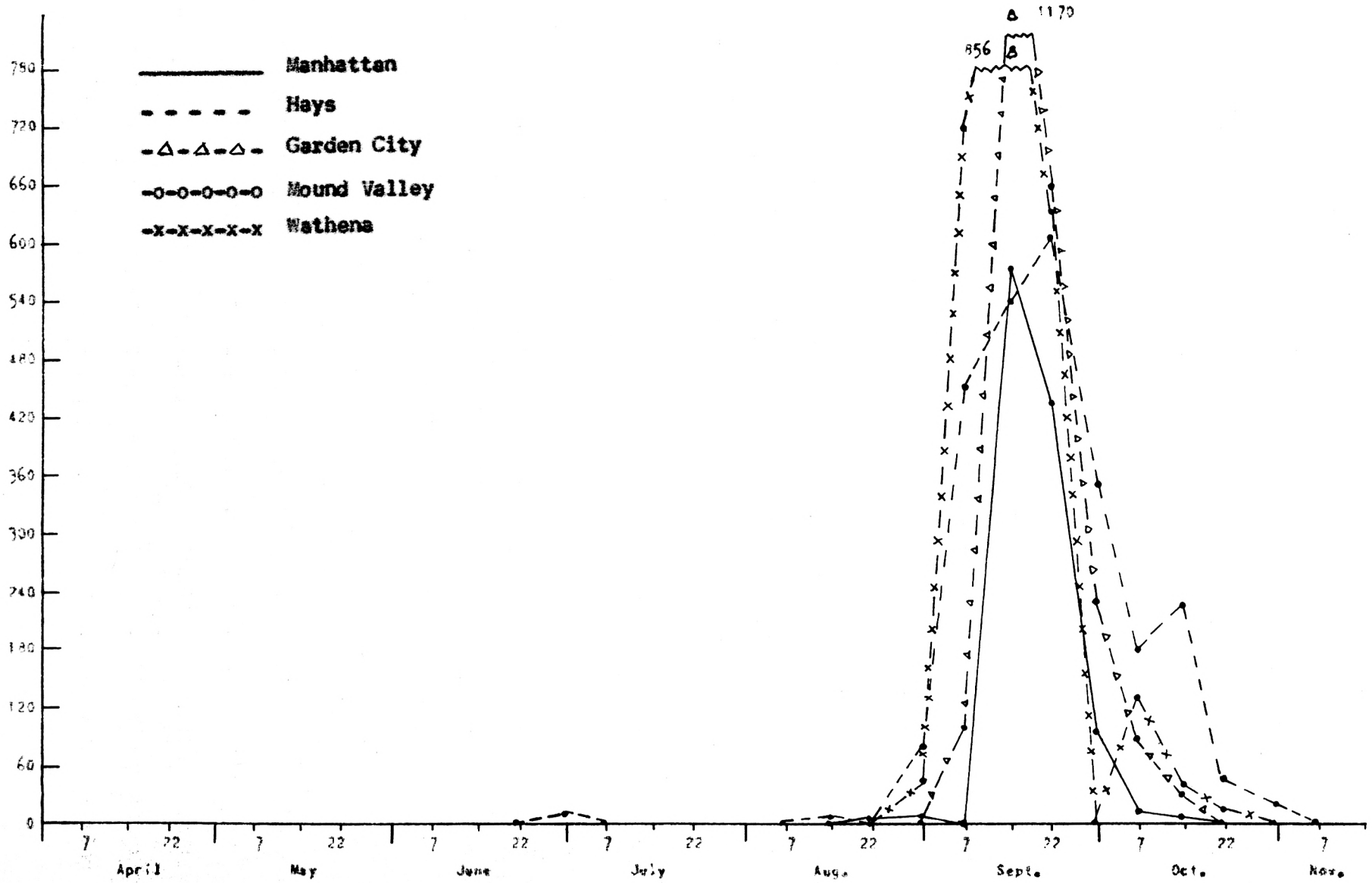


Fig. 14. DIACY CUTWORM
Flights during 1960.

the 1960 season. One flight appeared at each station during the two years, 1959 and 1960.

The maximum peaks at Wathena and Garden City occurred at the same time. Both had a very large increase in population from 1959 to 1960, and the two had short intervals of no activity at the light-trap.

Variegated Cutworm

Peridroma saucia (Hübner), the variegated cutworm, is considered one of the most destructive pests in the United States. At Minnesota, Knutson (1944) reported it the second most destructive Phalarid in that state. It is of major economic importance in Kansas. Alfalfa, clover, and many vegetable plants are reported to be attacked. According to Peters (1960), it caused damage to alfalfa in the south central and east central areas of Kansas during June of 1960.

This species was in flight from the first week in April to about the first week in November. In 1959, these occurred from the first week in April to the end of September, and in 1960 they were between the second week in April and the first of November. Walkden (1950) reported that it had been taken during every month except December, January, and February. There were probably three flights a year. Knutson (1944) indicated two or more generations a year in Minnesota. Walkden (1950) stated that he reared three and a partial fourth generations in one year at Manhattan.

Flights at Manhattan occurred from about 1 April to 15 September in 1959. There probably were three flights during this season. The first occurred from the first week in April to about the end of May. Its peak came during the last week in April. The second flight took place between 1 June and mid-July with

its greatest peak on 7 July. The second flight was the greatest in abundance. The third flight probably occurred from the third week in July to the second week in September. Overlapping of the broods was observed, thus the beginning of the third flight was not clearly defined. The number taken during this flight was much smaller than the earlier flights.

Three flights occurred at Manhattan during 1960. The first flight arrived in the second week of April. A lapse of four weeks was observed before the flight continued. Its peak came during the last week in May, and the first flight was completed by 7 June. The second flight started about 8 June and within two weeks had reached its maximum; it ended about 31 August. The third probably came between the first week in September and the last week in October. The peak occurred during the last week in September. Overlapping of the broods was observed. A total of 231 moths was trapped in 1959, and 523 were recorded at Manhattan during 1960.

Three flights were observed at Hays from 23 April to about 30 September during 1959. The first appeared between the last week in April and the end of May. The second flight did not appear until the last week in June. It was the flight of greatest abundance, and probably ended about 31 July. The third flight came from 23 August to the end of September. Catches were separated by intervals of three weeks in which no moths were trapped. This occurred during the earlier flights also.

During 1960 three flights occurred at Hays. These were more clearly defined than in 1959 (Figs. 15 and 16). The first flight started about the first week in May and ended by mid-June with the peak on 15 June. The second flight came from 23 June to about 31 July. It was the maximum flight and its peak was during the second week in July when 103 moths were trapped. The

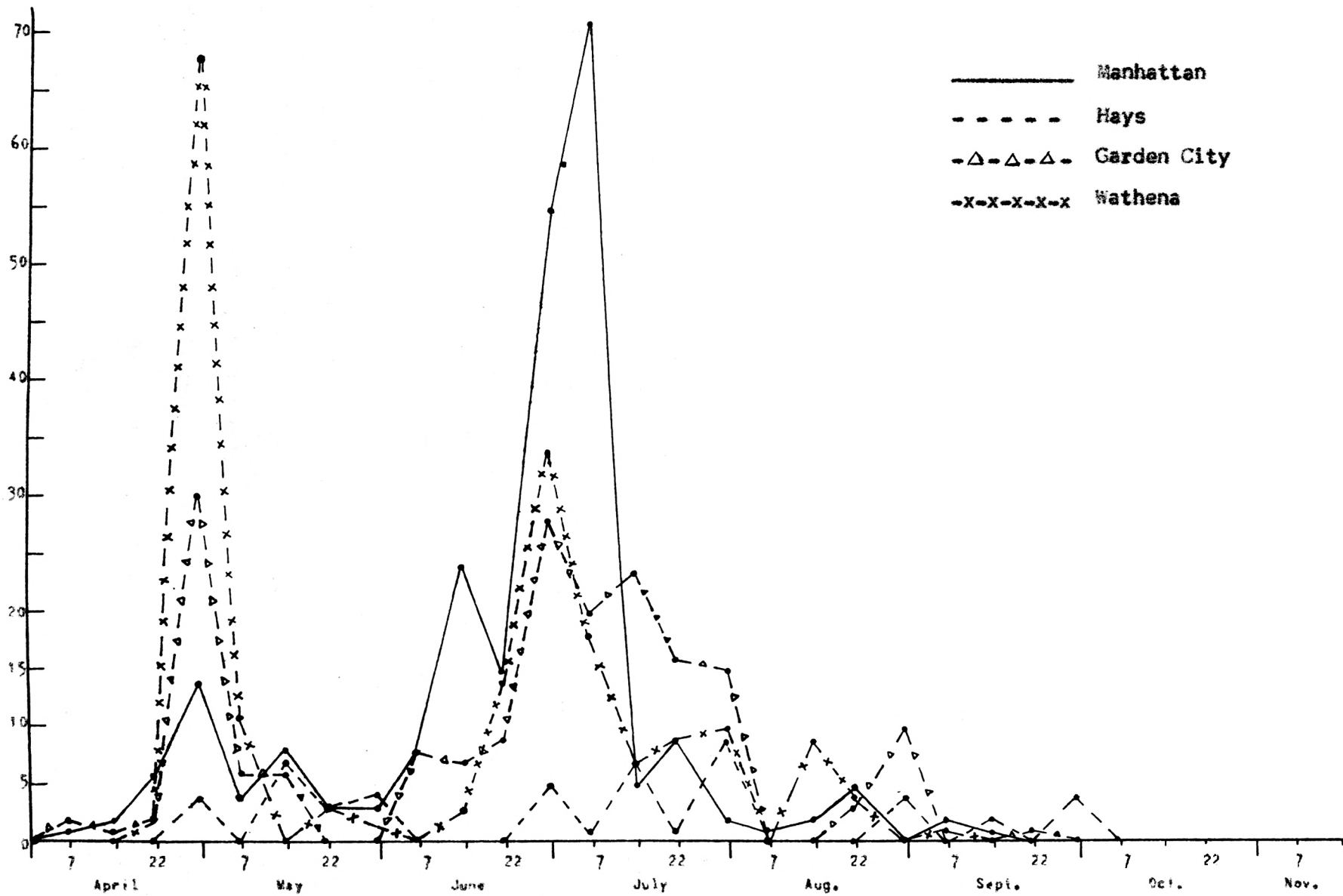


Fig. 15. VARIEGATED CUTWORM
Flights during 1959.

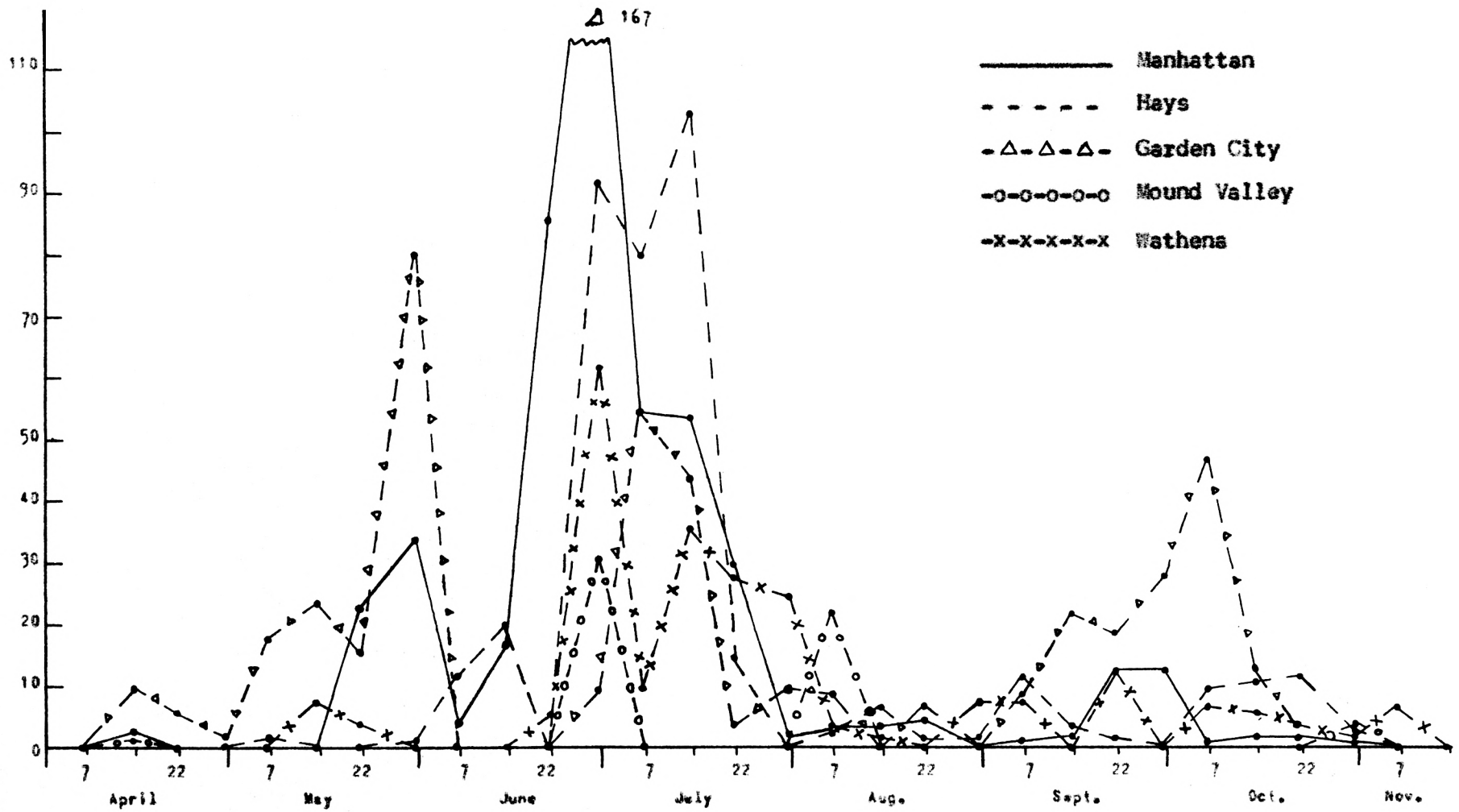


Fig. 16. VARIEGATED CUTWORM
Flights during 1960.

third flight was from the first of August to about the end of October. This was the longest flight during 1960. A total of 394 was taken at Hays and 51 during 1959.

In 1959, three flights occurred at Garden City, from 1 April to 22 September. The first was between 1 April and 15 May. Its peak came during the last week in April. The second flight occurred from 1 June to the end of July with its peak in the last week of June. This was the maximum flight. Though represented by a very few moths, the third flight occurred from about 16 August to 22 September.

During 1960 three flights occurred at Garden City. Flight periods ranged from the second week in April to the end of October. The first flight came between 8 April and 31 May and its peak was during the last week in May. This was also the flight of greatest abundance. The second flight started during the last week in June and was completed by 22 August. Its peak occurred during the first week in July. The moths of the third flight appeared on 1 September, the peak arrived by 7 October, and the end came about 31 October. A total of 440 moths was taken in 1960, and 190 were trapped during 1959.

The entrapments taken at Mound Valley showed the flights were not clearly defined, due to the infrequent moths at the light-trap. During the second week in April one moth was trapped and four weeks later another was taken. During the last week in June 31 moths appeared and for four weeks no catches were made. Twenty-two were trapped during the first week in August. No more arrived until the final catch of four moths at the end of October. In all, 59 were trapped.

This insect was in flight at Wathena from 16 April to about 7 September in 1959. Three flights probably occurred. The first flight was the greatest

in abundance (Fig. 15) and came during the third week in April; it was completed about the end of May. The maximum peak was during the last week in April. The second flight happened from 8 June to about 31 July. Its peak occurred in the last week of June. The third flight appeared from the second week in August to about the first week in September. It was poorly represented in numbers.

During 1960 this species appeared in the light-trap at Wathena from the second week in May to 7 November. Three flights probably occurred but were not clearly defined. The first flight came during the second and third weeks in May. Three weeks passed before another catch was made. The peak of the second flight came during the last week in June, and was probably completed in the second week of August. It was the flight of maximum abundance. The moths of the third flight appeared between 23 August and 7 November. No catches were made during the second and last weeks in September. A total of 240 moths appeared during 1960 and 194 were recorded for the 1959 season.

In summary, the variegated cutworm was in greater abundance in 1960 than during 1959. A combined total for all light-traps was 676 moths for 1959, and 1,656 during 1960. All light-traps showed an increase in the number of moths trapped during 1960. Hays showed the largest increase in abundance. Generally, three flights occurred during both seasons; however, a certain amount of brood overlapping was observed. During the 1959 season the peak occurrence of the first flight appeared on the same date for the four light-traps used. Shifting of flight abundance was detected, and was probably due to the time flights were started in the season or some outside variables. This insect was trapped at Mound Valley in very low numbers.

Wheat Head Armyworm

Faronta diffusa (Walker), the wheat head armyworm, is reported to generally be of minor economic importance. Some small damage is done to wheat, oats, and rye. According to Knutson (1944) outbreaks occurred in Minnesota where destruction to timothy seed and hay was caused by this species. He stated that though it was a common insect in that state, it fed primarily on grasses.

Nonamaker (1933) reported two broods at Manhattan. This was also observed by Walkden and Whelan (1942). They reported that two distinct flights occurred at Manhattan, one early in May and the other late in August or the first of September. The light-trap data illustrated in Figs. 17 and 18 show that it was in flight from the last week in April to the end of September in 1959. Flights occurred from mid-April to mid-October during 1960.

At Manhattan it was in flight from the last week in April until the third week in September during 1959. There seem to have been two flights, but due to the possible late emergence of some moths in the first brood, overlapping occurred and these flights were not clearly defined. The first moths arrived by the end of April and were followed by another catch which was the peak. The flight gradually declined until mid-June when no moths were trapped. After a void week the moths appeared until mid-July. Another peak was reached during the first week in July. From 16 July to 7 August no wheat head armyworms were caught. Between 8 August and 7 September a few were taken. No catches were made during the second week in September but one specimen appeared in the third week. The flight season at Manhattan totaled 42 moths.

Faronta diffusa was in flight at Manhattan from the third week in May to the last week in September in 1960. The first of the two flights observed came

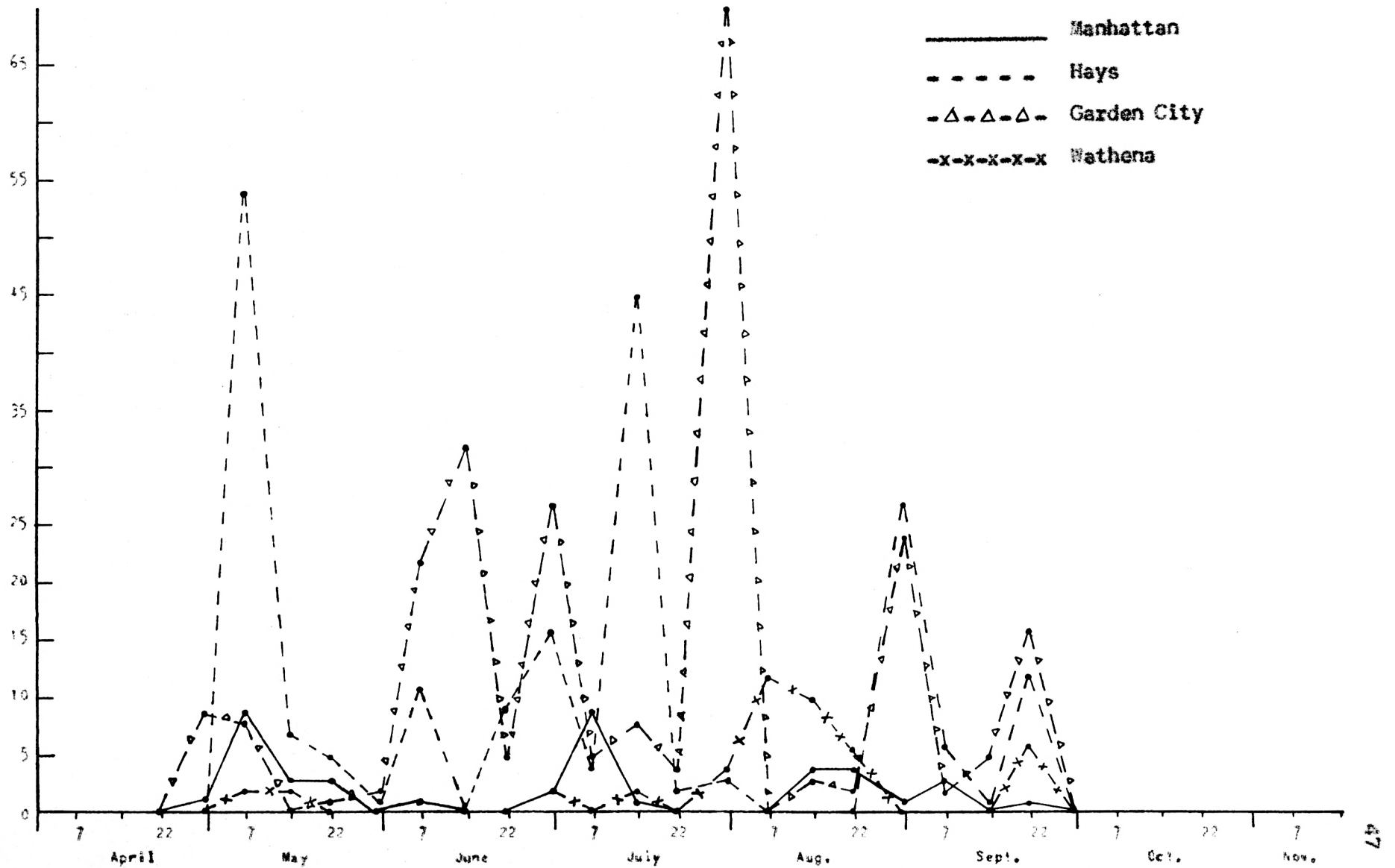


Fig. 17. WHEAT HEAD ARMYWORM
Flights during 1959.

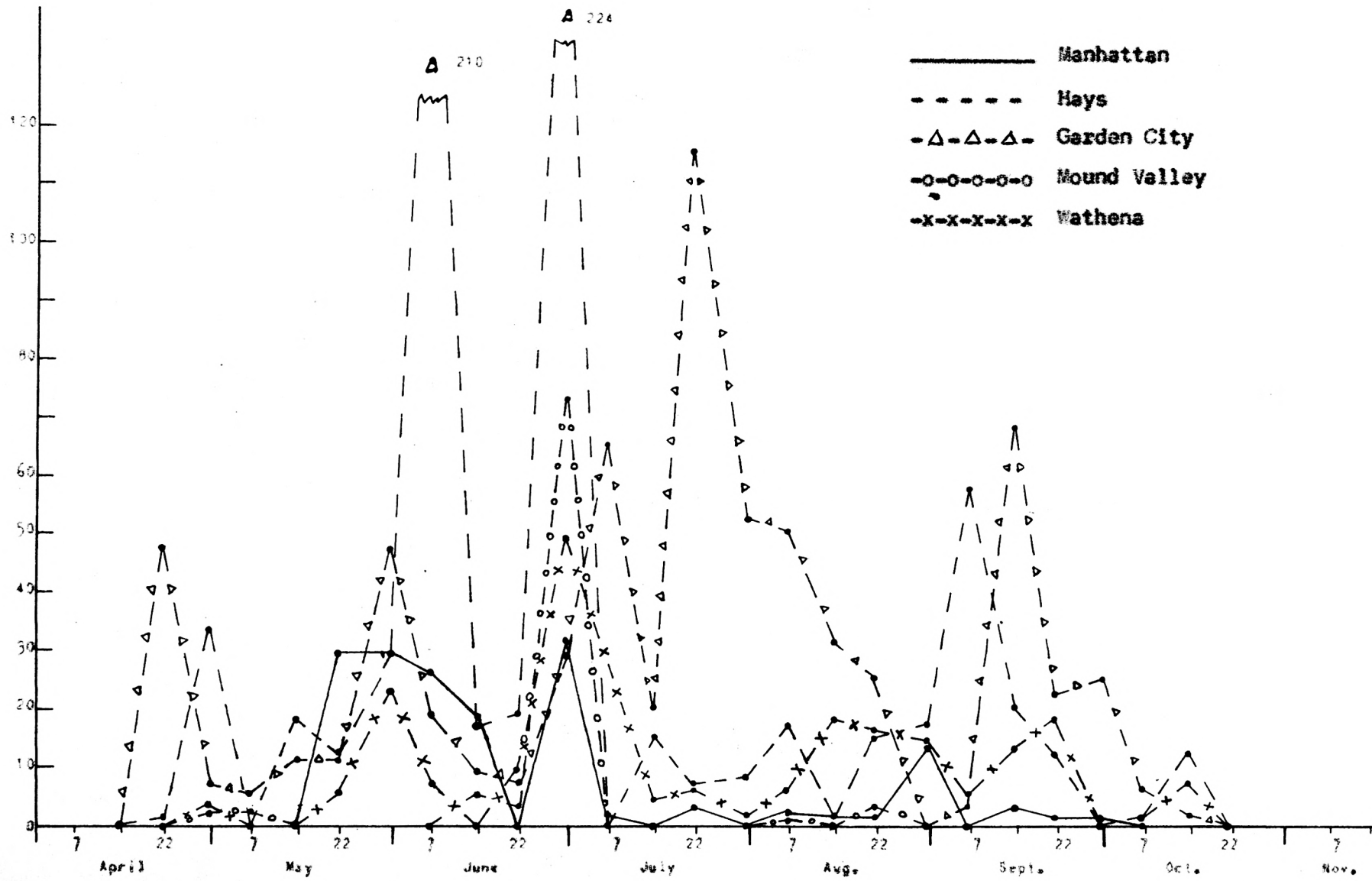


Fig. 18. WHEAT HEAD ARMYWORM
Flights during 1960.

during the third week in May and was completed by 7 July. Its peak appeared on 30 June. The second occurred from mid-July to the last week in September, the peak occurring during the last week in August. A total of 171 moths, the majority of which came during the first flight, was trapped at Manhattan during the 1960 season.

Flight periods at Hays started 1 May and ended about 22 September in 1959. Figure 17 shows a very erratic flight. There were probably two flights, the first being the greater. The maximum peak occurred during the first week in May. A sudden drop continued during the next three weeks. In the first week in June another rise was observed, followed by a dip to zero. This rise-and-fall pattern was seen until 7 July. Though not clearly defined, this probably marked the beginning of the second flight. A peak was reached on 15 July, after which the previous pattern of ups-and-downs was seen until the arrival of the last moths. These came during the third week in September and by then, 203 had been trapped.

This insect was e-wing at Hays from 16 April to 15 October during 1960. Similar flight patterns of the 1959 season were observed (Fig. 18) during this season. However, the flights started two weeks earlier and extended two weeks into October. There were probably two flights, and the first lasted from 16 April to 7 July. Maximum numbers occurred during 1-30 June. Within the first flight, three peaks were observed. These were on 30 April, 7 June, and 30 June. The second flight started during the second week in July and ended by mid-October. The peak was seen on 7 September. A total of 962 moths was collected at Hays in 1960.

Flights at Garden City during 1959 were somewhat like those at Hays. They started at Garden City a week earlier which was during the last week in

April. They were completed by 22 September. The first flight occurred from 23 April to about the first or second week in July. The maximum peak came during the first two weeks in June and overlapping of broods was observed. Moths of the second flight probably arrived from 23 July to 22 September. Its greatest peak occurred during the last week in July, and it was also the larger flight. A total of 245 was trapped in 1959.

During 1960 this insect was in flight at Garden City from the third week in April to the second week in October. Two flights probably occurred. The first was from 16 April to about 22 June. Two peaks of the same magnitude occurred during this flight. The second flight probably began during the last week in June or the first week in July. It was not clear because of some stragglers of the previous flight. The second flight ended by 15 October. It was the flight of greatest abundance, and its maximum peak occurred during the last two weeks of July. A total of 698 moths was trapped at Garden City during 1960.

F. diffusa in 1960 indicated some similarities in the flights at Garden City and Hays. These were observed to have started during the third week in April and ended by mid-October at both stations. However, the first flight was greater at Hays, while the second flight was greater at Garden City, and two equal peaks were observed during the first flight at Garden City. Both stations showed intervals of sudden rises and falls in the flight curve throughout the season. Overlapping of the broods was common for both.

This species occurred at Mound Valley from the last week in April to about 22 August. The number of flights was not well defined. However, during the last week in April and the first week of July six moths were taken. Four weeks expired before the next moths were caught. This was in the second

week of June. For two more weeks this insect continued its flight to the light-trap. During the last week in June 74 appeared; this was followed by an interval of four void weeks. A small catch was made about 7 August and the final one between 16-22 August. A total of 95 moths was trapped during 1960.

Flights occurred at Wathena between 1 May and 22 September in 1959. During the first two weeks in May four moths were trapped, and no more came during the next five weeks. Two moths were caught on 30 June, and these were followed by a week of no activity or small catches for the rest of the season. The peak came during August. Forty-three moths were taken during 1959.

This species was in flight at Wathena from 23 April to about 15 October in 1960. There were probably two flights. The first appeared from the last week in April to about mid-July. Its peak was during the last week in June, and it was the larger flight. The second occurred between 16 July and 15 October. Overlapping was observed. A total of 225 moths was trapped at Wathena during 1960. This was an increase over that taken in 1959.

The wheat head armyworm occurred in abundance during 1960. A sum of 2,151 was trapped by the five light-traps used. Over 75 percent were taken at Hays and Garden City.

Armyworm

Pseudaletia unipuncta (Haworth), the armyworm, often in the literature as Cirphis, and one of the most destructive species of the phalaenidae (Noctuidae), attacks grasses, small grains, corn, some bean crops, and many other plants. Walkden (1950) reported that larvae frequently feed on the heads of ripening wheat and often cut off the head at its connection with the

stem. According to Peters (1960) the armyworm caused an estimated \$930,000 loss to Kansas wheat in 1960.

Knutson (1944) observed at Minnesota that this insect had a normal two generations with the probability of three during a long growing season.

There were three flights at Manhattan. This was substantiated by Nonemaker (1933) who reported three generations at Manhattan. Walkden (1950) also stated that there are normally three generations annually in the central Great Plains.

The light-trap counts (Figs. 19 and 20) show that this species was a-wing from the first week in April to the first week in November. In 1959 one moth was caught at Manhattan between 1-7 April. The next moth did not appear until the last week in April when two moths were trapped.

The major flight peaks occurred between 7 June and 15 July in 1959, as did the peaks in 1960, but the numbers were much greater. There were 828 between 16-22 June, 2,201 during 23-30 June, and 666 moths from 1-7 July. Nonemaker (1933) recorded 68 moths at Manhattan in light-traps over two seasons. He concluded that this insect was not very common at Manhattan at that time. A total of 710 moths was trapped at Manhattan during 1959, and 4,880 during 1960.

The flight periods at Hays ranged from 16 April to about the last week in October. Three peaks were observed (Figs. 19 and 20) during both 1959 and 1960. The first occurred in the third week of May, the second about the last of June, and the third during the first week of September during 1960. These peaks also were observed during 1959, but the first flight occurred one month later and the second flight shifted two weeks into July. The numbers caught during 1959 were considerably less.

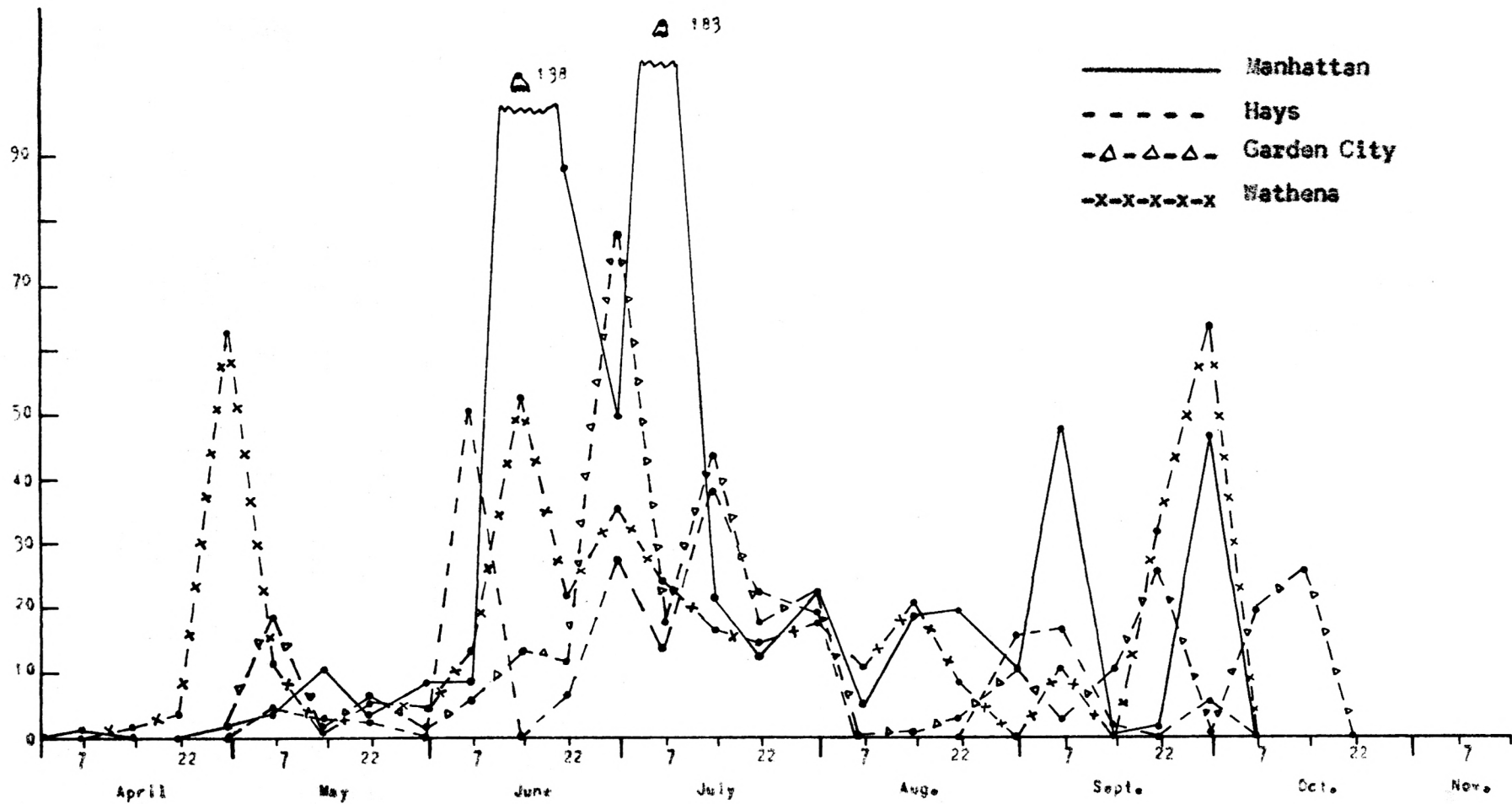


Fig. 19. ARMYWORM
Flights during 1959.

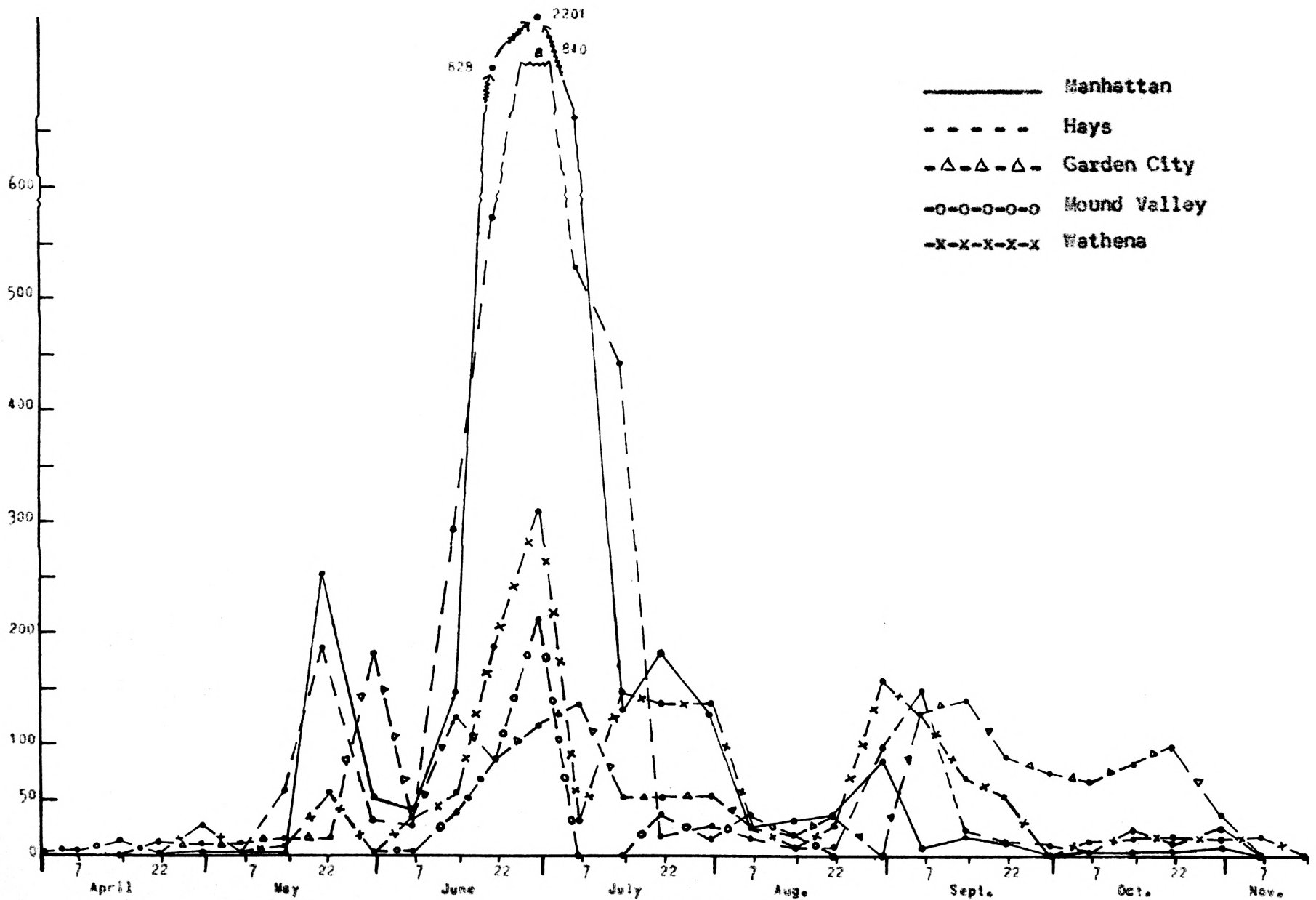


Fig. 20. ARMYWORM
Flights during 1960.

The maximum flight occurred during the last week in June of 1960 when 344 specimens were trapped. The greatest flight peak during 1959 was between 1-7 June when 51 moths were recorded.

At Garden City the flight periods ranged from 16 April to about 31 October. In 1959 the first moths were trapped during the last week in April, and in 1960 these occurred during the third week in April. Flight appearances were continuous except from 1-7 August of 1959. This interval of no apparent flight occurred in the last week of August during 1960. The second peak occurred between 22 June and 7 July in 1959. While this was the greatest peak at Garden City, during this same time the moths' flight at Manhattan dropped. Climatological data showed that the weekly average temperature for the two stations differed only by 0.2 degree and Garden City had 0.29 inch of precipitation and Manhattan 0.23 inch during this interval.

In 1960 the second flight appears to have occurred between 7 June and 7 August. The third flight occurred from 1 September to about the first week in November. The total number caught in 1959 was 347 moths, and 1,759 were trapped at Garden City during 1960.

Mound Valley's collections extended from 1 April to 31 October, representing three flights. The first peak was from 1 April to about 1 May; the second, which was the maximum peak, was from 1-30 June; and the third from mid-July to mid-August. A last catch of four moths was made during the last week in October. A total of 509 specimens was trapped during the 1960 season.

Flights occurred at Wathena from 23 April to about 7 November in 1960, and from 8 April to about 30 September during 1959. Three major peaks were observed during both seasons. The first was seen during the last week in

April. However, it was not as clearly defined in 1960 as it was in 1959. The second occurred about the middle of June in 1959, and two weeks later in 1960. This was the maximum peak during 1960. The third flight peak was seen during the last week in September of 1959. It appeared about the last of August during 1960. Figures 19 and 20 show that the first and third peaks during 1959 were very similar, 63 and 64 moths, respectively. A total of 441 was trapped at Wathena in 1959, and 1,762 during 1960.

During 1960, the greatest peak occurred at the same time at Manhattan, Hays, Wathena and Mound Valley. The peaks occurred between 23-30 June. Weather conditions at the four stations were not similar; however, the amounts of precipitation ranged from traces at Mound Valley to 2.17 inches at Wathena, and the weekly average temperatures ranged from 73.4° F. at Wathena to 79.3° F. at Mound Valley. Howe (1959) reported that in southeastern Kansas "a swarm" that consisted of thousands of moths appeared on a warm and humid evening. Over half were P. unipuncta. He further added that it had rained earlier a few miles away on this date, 9 May. However, Nonemaker (1933), p. 17, stated that "the fluctuation in the size of the catches can not be closely correlated with either the temperature or the humidity, but the catches apparently tend to increase with rise in temperature until the optimum is reached, after which the catches tend to decrease."

During 1959, 1,732 moths were taken by the four traps and 12,372 were trapped during 1960 by the five traps. This was by far the largest collection of any species studied, representing about 25 percent.

Yellow-striped Armyworm

Prodenia ornithogalli Guenee, the yellow-striped armyworm, is of minor economic importance in Kansas. It is reported to be of major importance in the

South where cotton and vegetables are damaged. Metcalf et al. (1951), p. 406, indicated that it was also known by the common name "cotton cutworm." Walkden (1950) stated that there were three to four generations a year and it overwinters in the pupal stage.

Flights occurred from the second week in May to 15 October in 1959. They were between the second week in April and the last week of October during 1960. At Manhattan the flights were from 8 May to 15 October in 1959. Figure 21 shows three flights during this season. The first started about the second week in May and gradually increased until its peak was reached during the last week in July, and was the end of the flight. This was the flight of greatest abundance, as well as the longest. Overlapping of the first and second broods occurred but moths of the second flight probably arrived during 1 August and 7 September. The maximum peak was reached during the second week in August. The third flight started about 16 September and was completed by the second week in October. Its peak came in the last week of September.

This species was in flight at Manhattan in 1960 from the second week in April to the third week in October. Three flights probably occurred. A pattern occurred (Fig. 22) which was not previously present. This was an interval between 8 July and 8 August in which no moths were trapped. This was observed at the other light-trap stations also. After the initial catch during the second week in April no moths appeared for about four weeks. From 16 May the flight curve gradually climbed until the maximum peak was reached, during the third week in June. The flight was completed by 7 July. What appeared to have been the moths of the second flight started arriving during the second week in August. They continued until the peak had arrived. It was the flight of maximum abundance. From 1-7 September a sudden drop occurred, and the flight was ended during the second or third week in September. The third flight probably

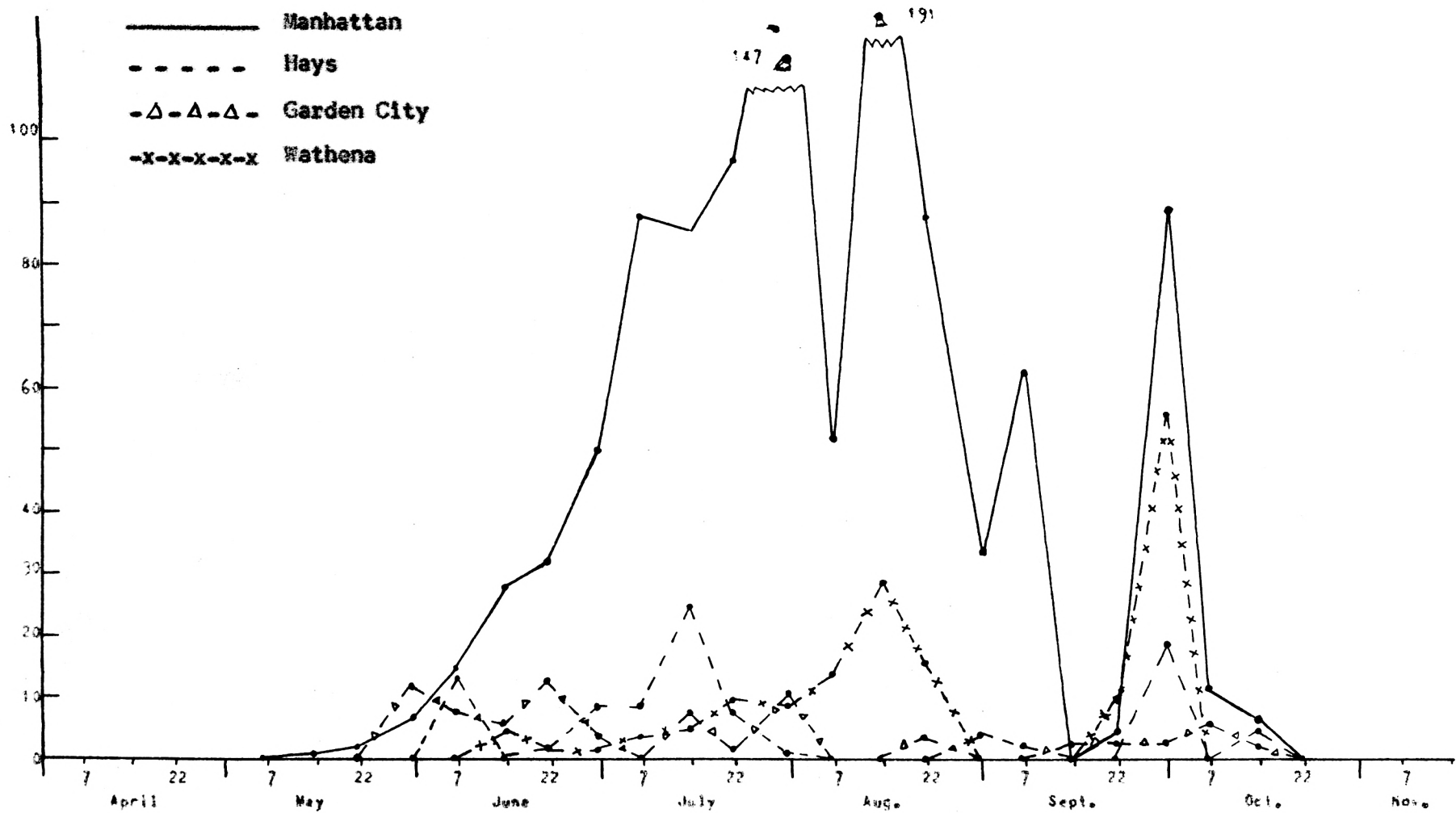


FIG. 21. YELLOW-STRIPED ARMYWORM
Flights during 1959.

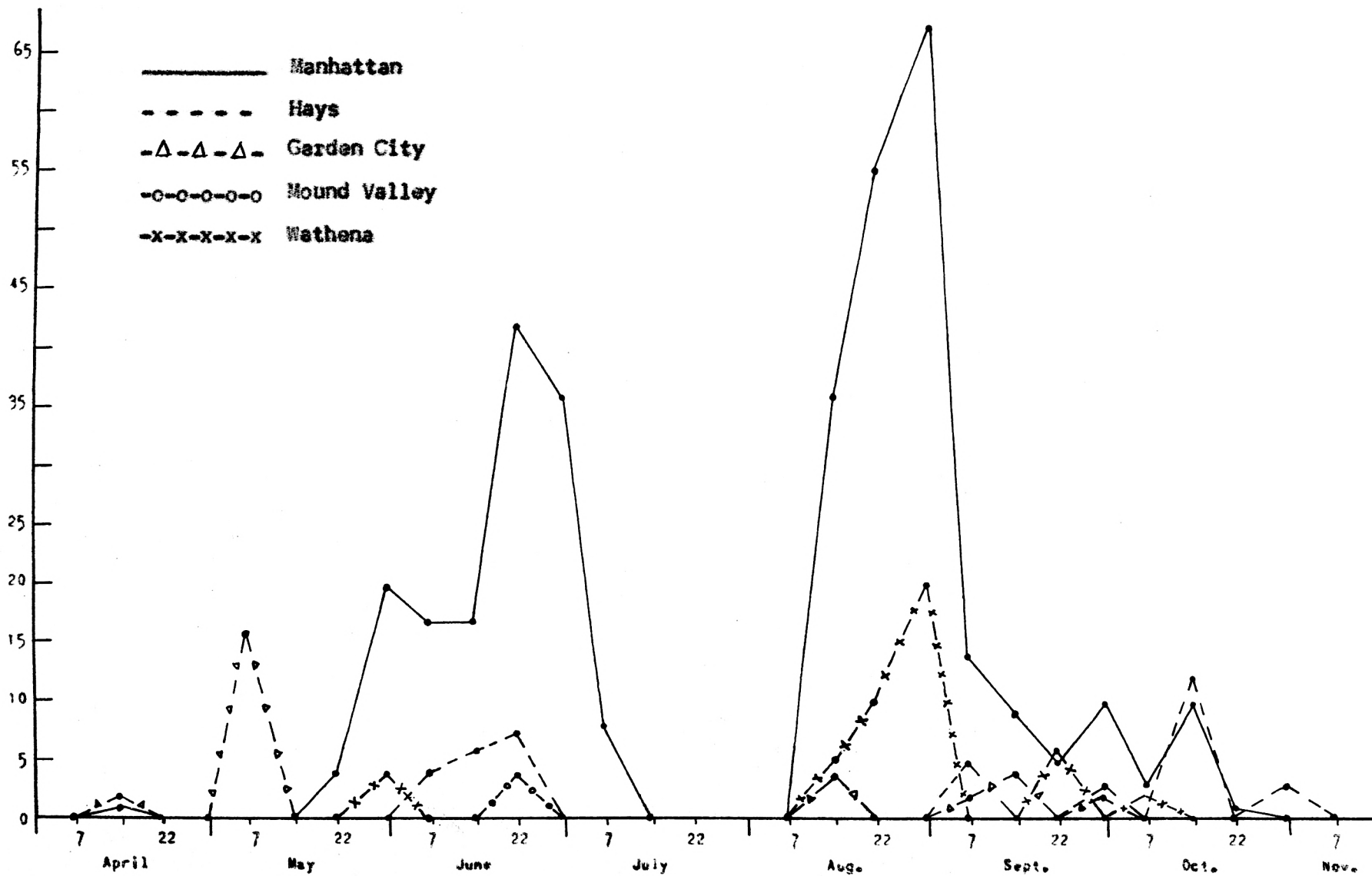


Fig. 22. YELLOW-STRIPED ARMYWORM
Flights during 1960.

started at this time and continued through the third week of October. A total of 355 moths was trapped during 1960 compared to 1,094 during the 1959 season.

The yellow-striped armyworm appeared at Hays during 1959 from the first week in June to about mid-October. Three flights probably came during this season but were not clearly revealed in Fig. 21. The first was the largest; it occurred from 1 June to 31 July. Its peak came during the second week in July. The second flight probably occurred between mid-August and mid-September, representing six moths caught from 23 August to 7 September. Nineteen were taken during the last week in September, probably the first arrivals of the third flight. The last moths were trapped on 15 October.

During 1960, the flight periods at Hays were from 1 June to about 31 October. The first moths arrived during the first week of June. They continued through the third week during which the peak occurred. For nine weeks no moths were trapped. It is possible that moths of the second flight were not trapped. However, during the first week in September five were taken, and three weeks later three more appeared. During the second and last weeks in October a few moths were trapped. The total for 1960 was 43 moths. Ninety-eight were trapped during 1959. Only two flights occurred at Hays, and it was not common during either season.

P. ornithogalli was a-wing at Garden City from the last week in May to about 15 October in 1959. Members of the first flight came during the last week in May, and the period was probably completed by 15 July. Its peak arrived between 16-22 June, and it was also the flight of maximum abundance. The second flight was from 16 July to about the last week in August. It was the smallest. Moths of the third flight came from 8 September to 15 October.

The number taken was low but the moths appeared constantly throughout the flight.

Flight periods at Garden City in 1960 were from 8 April to about 30 September. The first catch occurred during the second week in April. After two weeks another occurred. Three weeks elapsed before the arrival of the next moths, which came between 1-7 June, and was probably the end of the first flight. After eight weeks a small catch was made, followed by a two weeks void period. During the first two weeks in September six moths were taken. The final catch was made during the last week of the same month. A total of 36 moths had been trapped. Eighty-five were caught at Garden City during the 1959 season.

Five moths appeared at Mound Valley in 1960, the first between 8-15 April and the final four during the third week in June.

At Wathena this insect was taken from the second week in June to about 30 September in 1959. Three flights probably occurred but no definite point of separation could be detected. The first moths came about 8 June and their presence continued to 22 August. The peak was reached one week earlier. The final moths were caught during the last two weeks in September. The greatest peak appeared between 23-30 September when 56 moths were trapped.

The flights during 1960 occurred from 23 May to about 7 October at Wathena. Four moths were taken during the last week in May. This species was not trapped for the next nine weeks. The peak occurred between 8-31 August. These were probably moths of the second flight. A catch was made from 16-22 September, and the final during the first week in October. Forty-seven specimens were trapped during 1960 and 162 during 1959.

It was not abundant during either season. A total of 1,439 appeared in 1959, and 486 were trapped during 1960. Excluding Mound Valley, it appeared least abundantly at Hays and Garden City. All light-traps showed a decrease in abundance from 1959 over 1960, and during 1960 each showed intervals of from four to nine weeks without catches. These occurred between June and September, shifting one or two weeks in either direction. This indicated that the second flight appeared later than usual, or there were only two flights during the season. Walkden (1950) reported that the summer generation developed rapidly and the adults were out by September. Figure 22 shows that the time in which the third brood was ordinarily in flight was generally moved to the last few weeks of the season.

Fall Armyworm

Laphygma frugiperda (Smith), the fall armyworm, was reported to be of economic importance. Young winter wheat, late corn, and grasses are damaged by it. Peters (1960) reported complete destruction of stands of fall seeded alfalfa, wheat, rye, and oats in fields in eastern Kansas, and slight damage to corn and grain sorghum. The flight generally occurred from early August to about 7 November according to Walkden (1950), and one generation generally occurs in Kansas. According to Burkhardt (1952) it overwinters in the pupal stage in the South and migrates northward in the spring.

During early 1959 ten were taken at Manhattan, from 1 April to 22 May. The regular flight started about 8 August when one moth was trapped. The next appeared between 1-7 September and eight were recorded.

The flight at Manhattan in 1960 appeared from 7 September to 22 October. The maximum peak (Fig. 23) occurred at the end of the flight period when 86

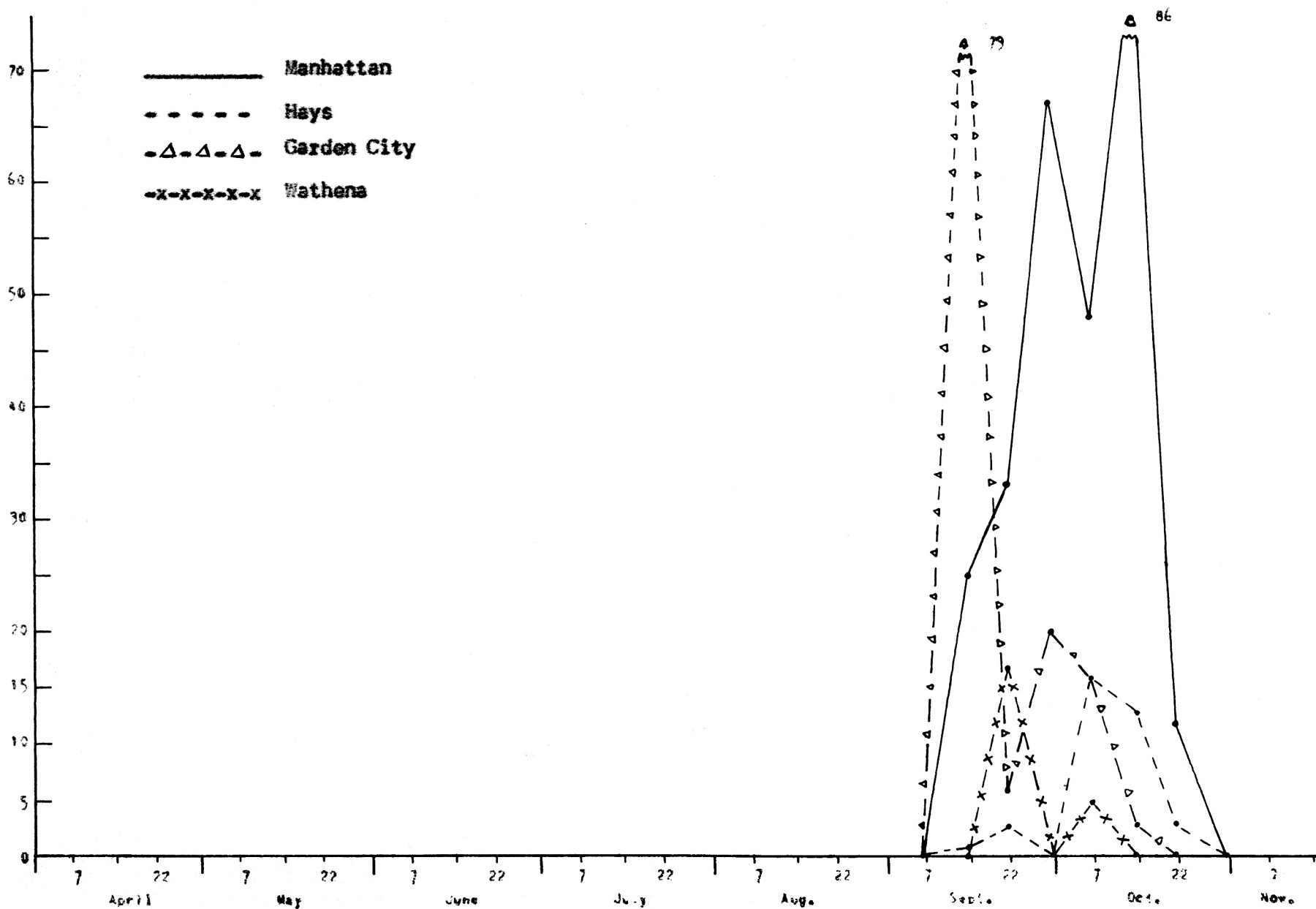


Fig. 23. ALL ARMYFORM Flights during 1960.

were taken. A total of 271 was trapped in 1960. One brood flight was seen at Manhattan during 1960.

No specimens were taken at Hays during 1959. In 1960 flights occurred from 8 September to 22 October, when 16 moths were caught. A total of 36 was trapped during the season.

Two moths were taken in the light-trap at Garden City in 1959, between 1-7 September. In 1960 its flight was observed from 8 September to 15 October, with the maximum peak the initial catch of 79 moths. A total of 124 was trapped during the season.

This species did not appear in the light-trap at Mound Valley during 1960.

At Wathena 18 moths appeared between 16-30 September in 1959, and 22 between 16 September and 7 October during 1960.

A total of 39 was taken in 1959, and 453 during 1960.

Corn Earworm

Heliothis zea (Boddie), the corn earworm, is one of Kansas' most destructive pests of corn and grain sorghum, and may cause damage to alfalfa. Walkden (1950) stated that because of a lack of more favored foods its feeding habits were extended, and in one case in the central region of the state over 2,000 acres of wheat were destroyed. During 1960 this insect was listed by Peters (1960) as one of the ten most important crop pests in Kansas. He further reported that an estimated 3 million dollars loss to field corn was caused by it.

Nonemaker (1933) in studies at Manhattan reported three broods. It was said to spend the winter in the pupal stage. However, Metcalf et al. (1951)

indicated that there were some doubts if the pupa could survive the winter north of the 40 degrees North latitude. This point was mentioned by Walkden (1950), too. He stated that in severe winters this species was probably almost eradicated from the region and reinfestations were due to migration by adults from further south. Knutson (1944) made this observation at Minnesota also.

It was trapped from 1 May to about 7 November in 1959. During 1960, it was a-wing from about mid-April to about the first week in November. The greatest flight peaks occurred from the last week of August to the end of October. The numbers taken increased as the season of flight progressed. This was noticed by Nonemaker (1933), p. 34, who stated that "the number of moths caught increased as the number of generations increased".

Flights at Manhattan were from 8 May to about 7 November in 1959. These occurred from 1 June to about 31 October during 1960. The first occurred from 7 May to about 22 July (Fig. 24); the second from 23 July to about 22 September; and the third from 23 September to about 7 November. In 1960 these flights were observed (Fig. 25) from the first week in June to about 7 November. The first occurred between 1 June and 22 July, with its maximum on 22 June. The second flight came from 7 August to about 30 September. Its peak was on 22 September. The third flight occurred from 7 October to about 7 November, and its peak was on 15 October. It was the flight of greatest abundance for 1960, when 469 moths were taken. The maximum peak in 1959 occurred on 30 September when 1,994 were trapped. A total of 4,423 was caught during 1959, and 1,916 appeared in 1960 at Manhattan. Almost 75 percent less appeared during 1960 than in 1959.

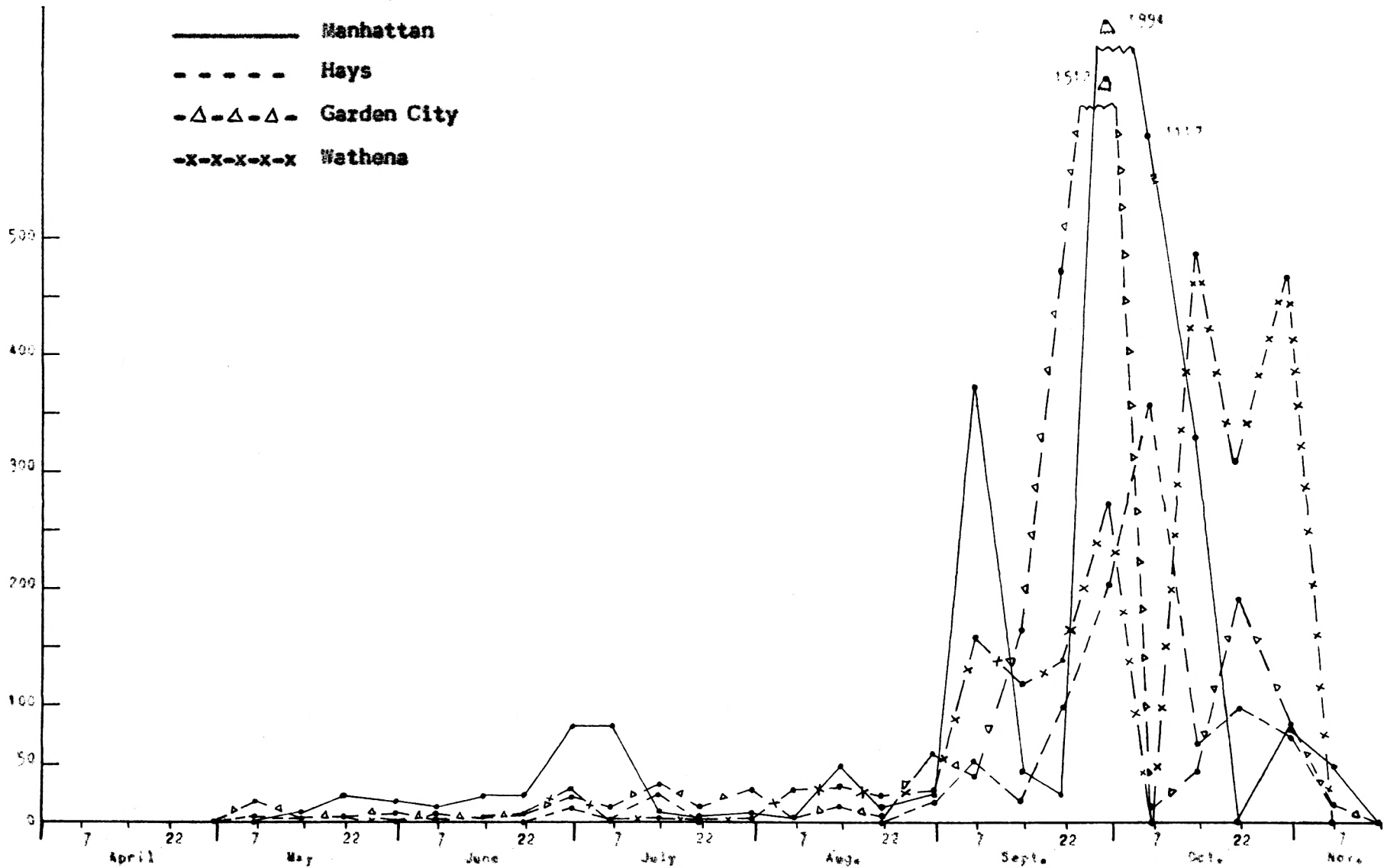


Fig. 24. CORN LARWORM
Flights during 1959.

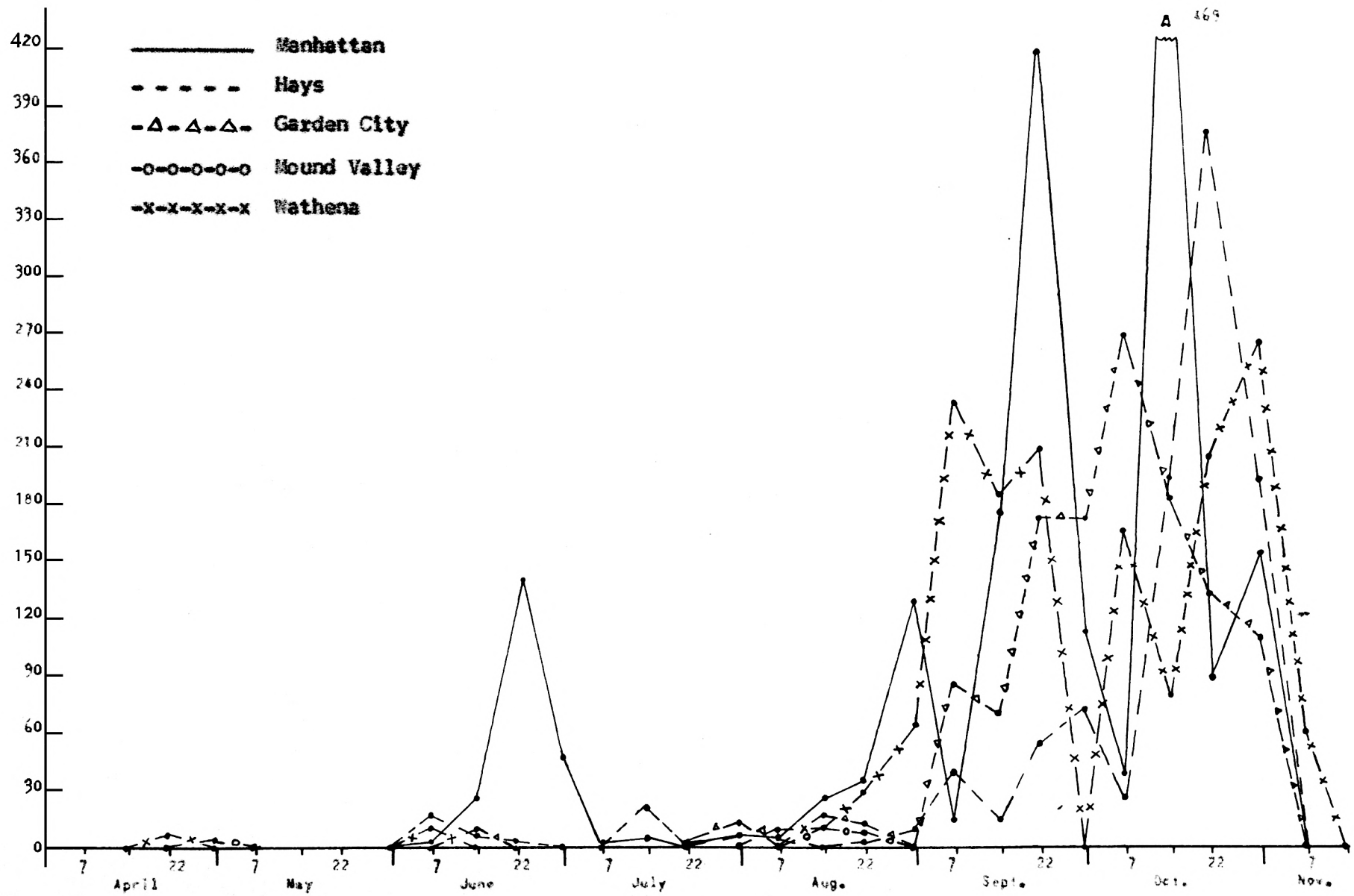


Fig. 25. CORN EARWORM
Flights during 1960.

Heliothis zea was in flight at Hays in 1959 from 1 May to about 7 November. Three flights probably occurred. The early flights were not clearly defined. The last flight, which was the largest, occurred about mid-September to 7 November. The greatest peak was seen on 7 October when 362 specimens were trapped.

In 1960 flights occurred from 1 June to about 31 October at Hays. Again, it was observed that the initial flight peaks were obscured; however, the final flight was well defined. It started about 15 September and ended on 7 November. Greatest peak occurred on 22 October when 378 moths were trapped.

Tables 1 and 2 indicate that the first flight at Hays during 1959 probably came between 1 May and 7 July and the second probably from 8 July to about 7 September. In 1960 the first probably happened from 1 June to about 15 July, and the second could have appeared from 22 July to about 15 September.

During 1959 a total of 1,092 was recorded at Hays, and in 1960, 1,044. Not much difference was exhibited in the abundance during the two seasons. Population fluctuations occurred in the time of the flights and in flight consistence. Five weekly intervals occurred in which no catches were made during 1959. In 1960, three of these void intervals occurred. The largest percent was trapped at Hays from mid-September to mid-October in 1959. The maximum appeared during October in 1960.

The flights at Garden City were from 1 May to 7 November during 1959. The first flight lasted about 7-9 weeks, from 1 May to about 30 June. The second transpired between 7 July and about 7 September. The third flight came from 8 September to about 7 November; it was the largest. Its peak was

recorded on 30 September, at which time 1,512 were trapped.

During 1960 the flights occurred at Garden City from mid-April to 31 October. The first moths appeared between 16-22 April when two were taken. An interval of six weeks lapsed before another catch was made. This happened between 8-15 June when 10 moths appeared. From the first week in July to the end of the flight season, collections were more constant and the numbers increased considerably. The greatest peak was seen on 7 October when 270 were recorded. This peak was one week earlier than the maximum peak during 1959.

At Garden City 2,786 moths were caught during 1959; and 1,273 in 1960, indicating a decrease by more than half during 1960. The majority occurred during the last flight period.

A few moths were taken at Mound Valley in 1960. Three flights were observed. The first appeared during the last week in April (two moths), the second 8-15 June, and the third probably between 16 July and about 22 August (32 specimens).

Flights at Wathena during 1959 were from 8 May to about 31 October. The first flight occurred between 8 May and 15 July with its peak about 30 June. The second appeared between 16 July and about 31 August. The third was from 1 September to 31 October; it was the largest.

The flights did not deviate greatly from the established pattern for 1959. Moths were trapped as early as 16 April and as late as 7 November. Four moths represented the first flight, and it was followed by five weeks of no catches. Between 1-7 June, 12 moths appeared and about three weeks passed before another was caught. From about 1 August to 7 November there were more constant entrapments. The greatest peak was on 31 October when

267 moths were taken. The last members appeared at Wathena during the first week in November of 1960. The other catch was completed by 31 October. In 1959 a total of 2,145 moths was trapped, and 1,543 were taken during 1960 at Wathena.

To summarize, during 1959 the total trapped at all stations was 10,451. In 1960 the total was 5,820, mainly from Manhattan, Hays, Garden City, and Wathena. Abundance did not change greatly at Hays during the two years. However, populations at Garden City and Wathena exchanged positions from 1959 to 1960 (Tables 1 and 2). At Garden City over 500 more were taken in 1959 than at Wathena. During 1960 almost 300 more were trapped at Wathena than at Garden City. The two stations' data indicated almost similar flight patterns. The greatest peak occurred on the same date at Garden City and Manhattan during the 1959 flight season.

Heliothis zea was second in abundance to the common armyworm, Pseudaleta unipuncta (Tables 1 and 2).

Forage Looper

Caenurgina erecta (Cramer), the forage looper, was reported by Smith (1924) to be of minor economic importance. It is often found on alfalfa, sweet clover and other plants. According to Nonemaker (1933), there are three generations per year at Manhattan. Walkden (1950) reported that probably there are three generations in Kansas. Overlapping was observed, and the insect overwinters in the pupal stage. Adult moths were seen early in the spring. Knutson (1944) observed two generations at Minnesota and that in some years the flights are not well defined.

Three flights occurred at Manhattan from 1 April to 7 September in 1959 (Fig. 26). The first flight (two moths) probably occurred from 1 April

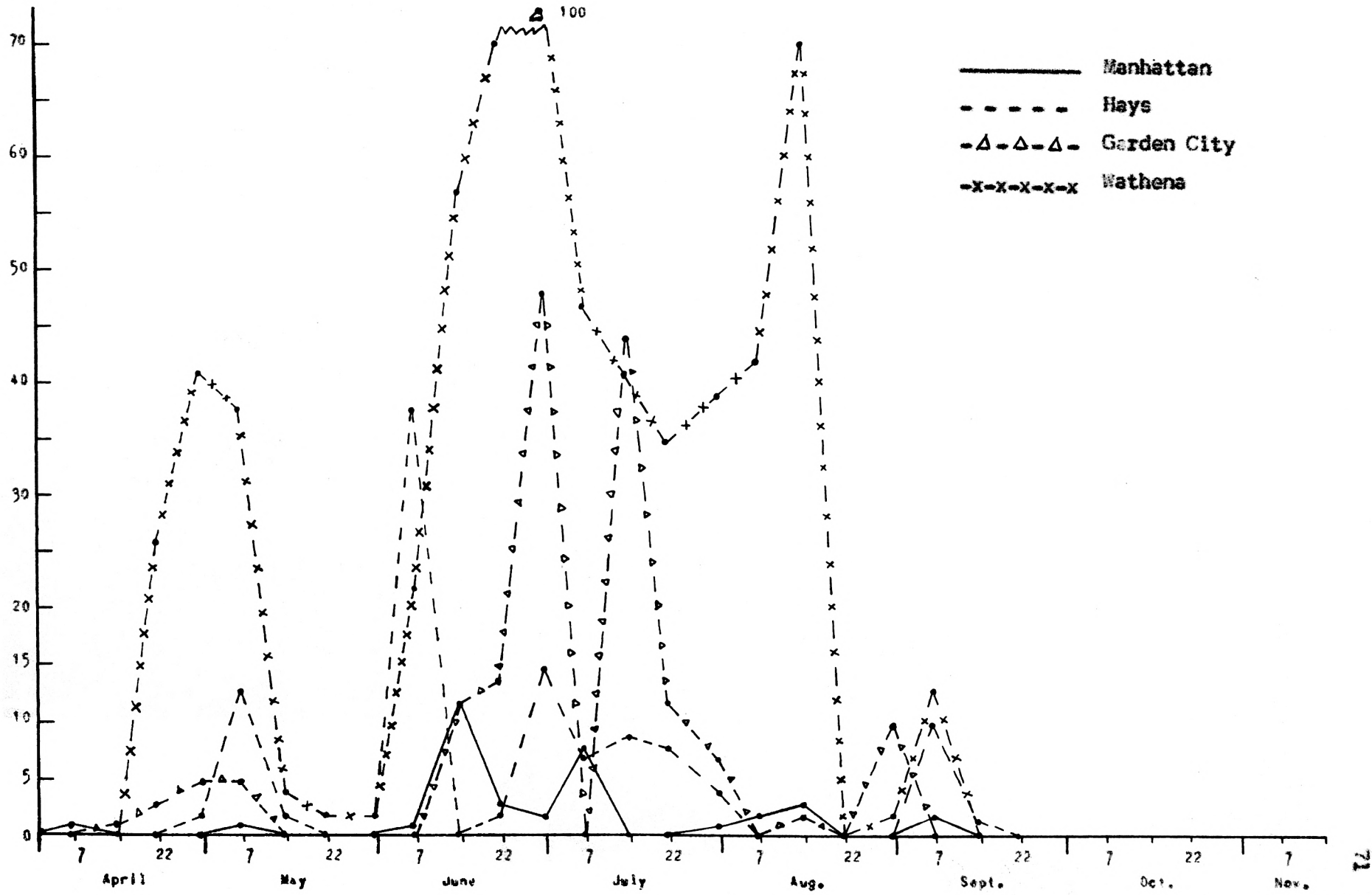


Fig. 26. FORAGE LOOPER
Flights during 1959.

to 7 May. The second flight was observed between 1 June and 15 July with its peak on 15 June when 12 were caught. The third flight was observed between 1 June and 15 July with its peak on 15 June when 12 were caught. The third flight probably occurred from 23 July to 7 September. Its peak occurred on 15 August.

During 1960 (Fig. 27) flights were observed at Manhattan from 16 May to 31 October. The first probably came between 16 May to 7 July, its peak occurring on 22 June. The second occurred from 8 July to about 31 August, and the third between 8 September and 31 October. Most moths came during the first flight period. A total of 163 moths was caught during 1960, and 36 in 1959.

The forage looper was in flight at Hays from 23 April to about 15 September in 1959. Three flights were observed. The first occurred between 23 April and 7 June with its peak during the first week in June. The second flight occurred from 15 June to about 31 July. The third was not clearly defined in that no catch was made until the first week in September. At this time 10 moths were trapped, and the final one was taken the following week.

During 1960 three flights occurred at Hays from the second week in April to the last of October. The first came 8 April and 31 May. After an initial catch of two moths, three weeks expired in which no moths appeared. The peak was seen about the last of May when 88 were trapped. The second flight started about 8 June and continued to about 22 July. It was the heaviest flight with its peak on 30 June. The third flight occurred from about 8 August to about 31 October. It lacked definition which was probably due to the pattern of broods overlapping. It gradually decreased in numbers for two weeks, and during the last week in September no moths appeared. An increase in catches was observed for two weeks, and then a gradual decline brought the

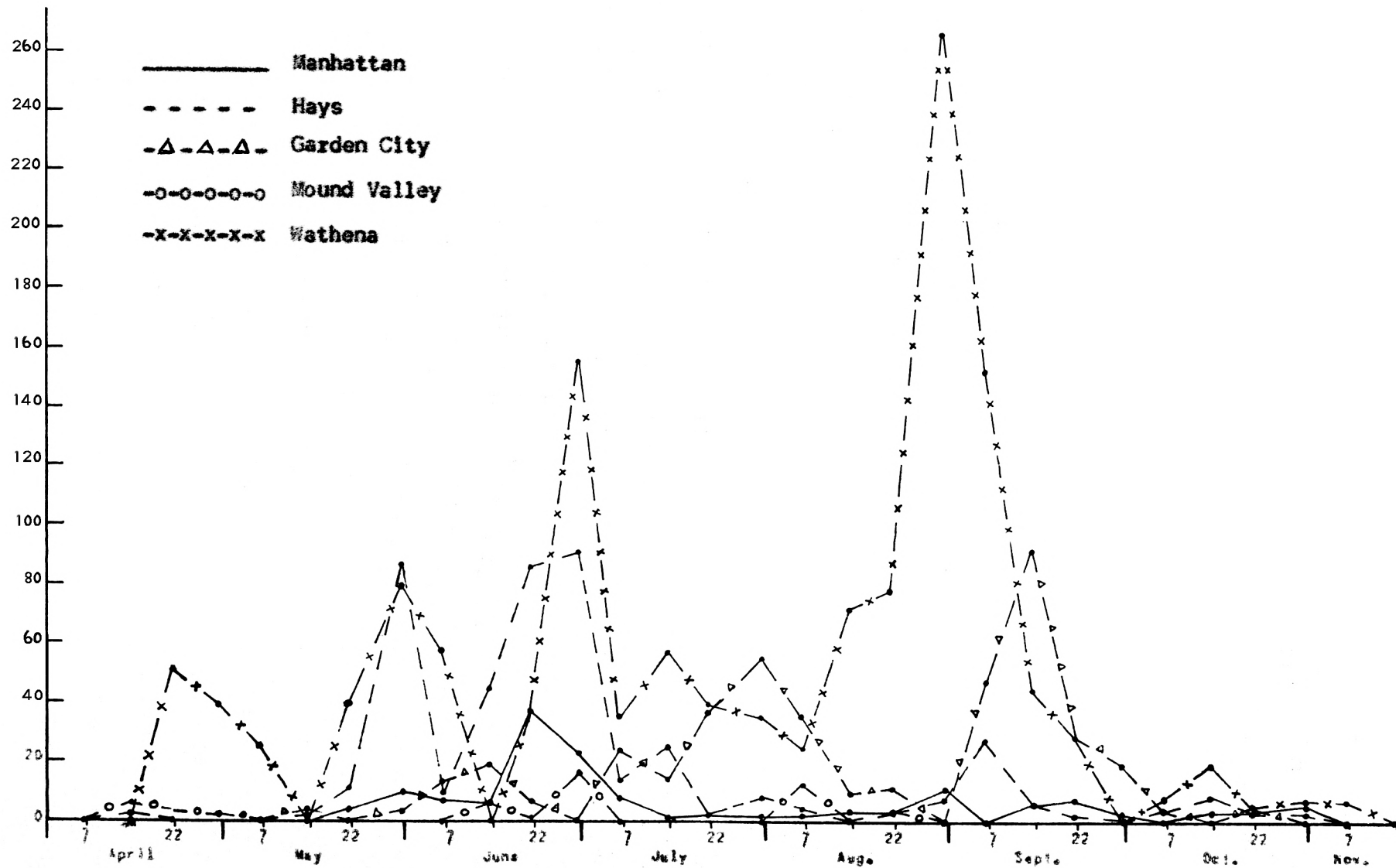


Fig. 27. FORAGE LOOPER
Flights during 1960.

flight to its end on 31 October. A total of 465 was taken during 1960 compared to 111 in 1959.

At Garden City during 1959, flights occurred between 8 April and 31 August. Three probably transpired during this season. The first appeared from 8 April to about 22 May. However, Fig. 26 indicates that no moths were caught between 8-22 May. The peak arrived about 7 May. The second flight came during the second week in June and 31 July. Its peak came during the last week in June after which there was a sudden drop. The second was the largest. The third flight, like the first, was not clearly defined but probably occurred between 7 August and 7 September. Only two catches were made during these dates. Each was separated by a week.

Three flights occurred at Garden City during 1960, from 8 May to about 31 October. The first appeared between 8 May and 22 June. No moths appeared during the last week of June. The second flight appeared to have been from the first week in July to 22 August. No moths appeared during the last week in August. The peak of the second flight came on 31 July when 56 specimens were recorded. The third flight came during the first week in September and the last of October. Its maximum peak arrived during the second week when 92 were trapped. A gradual decrease in numbers was observed throughout the remainder of the period. Greatest abundance occurred during the third flight. A total of 444 was trapped during the three flights of 1960, and 163 during 1959, at Garden City.

The flight periods at Mound Valley in 1960 were from the second week in April to about the third week in August. The first flight came between 8 April and 15 May. Its peak appeared about 15 April. The second flight came about 8 June, and the last moths were trapped about 30 June. No moths were recorded during the first two weeks in July. The third flight probably

started during the third week of July when one moth was taken. A week expired before another catch was made. This was the peak for this period, and the last moths appeared about 22 August. Sixty-one moths were trapped during the entire season of 1960 at Mound Valley.

At Wathena three flights occurred during 1959. The first moths appeared during the third week of April, and the last during the first week of September. The first flight was from 16 April to about 30 May. Its peak came during the last week in April. The second flight probably occurred between 1 June and 22 July. Its peak was during the last week of June when 100 moths were trapped. This was the largest flight. There was great overlapping by the second and third flights, but it probably started in the last week of July and ended about 7 September. Its peak occurred from 8-15 August when 70 were taken.

Three flights occurred at Wathena during 1960. Figure 26 shows that they started on the same dates as in 1959. However, they extended much farther into the fall and ended about the first week in November during 1960. The first flight began about 16 April when 52 moths were taken. A gradual decrease in numbers was seen until mid-May. It then picked up, and during the last week in May the maximum peak was reached. The first flight was completed by 7 June. The second was from about 15 June to about the first week in August. Its peak occurred during the last week in June, and the end, though not clearly defined, probably came during the first week in August. Overlapping of broods between the second and third flights probably caused this, but the third flight could have started on 8 August. During the last two weeks in July and the first week in August, there was a constant decrease in the moths trapped. This decrease continued until about

8 August when a sudden rise was noticed. The number of specimens continued to increase until a maximum was reached. This came during the last week in August, at which time 266 moths were trapped. A rapid decrease in numbers prevailed until the end of the third flight. The greatest numbers occurred during this last flight, and a total of 659 were taken at Wathena in 1959. During 1960, 1,377 were recorded.

In summary, the forage looper appeared abundantly during 1960 when a total of 2,510 was trapped by the five light-traps. Over 50 percent occurred at Wathena where well over two thirds of the total trapped in 1959 were taken. This insect was abundant at Hays and Garden City. It was not abundant at Manhattan and it was not prevalent at Mound Valley. Generally, three flights occurred at all stations. Overlapping was observed, and a pattern of shift in flight abundance was noted.

Southwestern Corn Borer

Zeadiatraea grandiosella (Dyar), the southwestern corn borer, is a major pest of corn in all but northeast Kansas. Wilbur et al. (1950) described in detail earlier outbreaks in which accounts of damage and spread across the state were made. Lesser damage to forage and grain types of sorghums occurred. Metcalf et al. (1951) reported that one to three generations developed annually, and it overwinters as a larva. This was substantiated by Wilbur et al. (1950) who indicated that possibly three generations occur in Kansas.

Table 1 shows that the only moths were caught during the second week in June of 1959, when 32 were trapped at Garden City.

SUMMARY AND CONCLUSIONS

A study of the entrapment of 15 species of moths (Lepidoptera) was made. This involved the use of five light-traps at various locations in the state. Catches of these light-traps were evaluated for 1959 and 1960. Flight occurrence, seasonal distribution, and abundance were recorded. Climatic factors such as temperature and precipitation were studied as possible influences on these species. Graphic illustrations are presented to show flight curve and seasonal record at each location.

A survey of the literature revealed that light-traps of all designs have been employed. Most workers agree that traps are very potential aids.

During 1959, 26,978 specimens of the 15 species were trapped. In 1960 these amounted to 45,114. They were fairly well distributed throughout the five locations. However, the entrapments at Mound Valley ran consistently lower.

The European corn borer, Ostrinia nubilalis, fell in numbers considerably at all stations from 1959 to 1960.

The alfalfa webworm, Loxostege commixtalis, population was found to have varied considerably between 1959 and 1960. The same was observed for the beet webworm, Loxostege sticticalis; however, this species was found to be more prevalent in the central and western parts of the state.

Chorizogrotis auxiliaris was common during both seasons, but a decrease was observed in 1960. Garden City recorded a continuously high count; over three fourths of the total occurred there.

The black cutworm, Agrotis ipsilon, increased almost 75 percent in abundance from 1959 to 1960. An increase was observed at all stations.

One flight was observed during both seasons for Feltia subgothica, the dingy cutworm. It occurred from August to about the end of October. It was in greater abundance during 1960.

Peridroma saucia, the variegated cutworm, had three flights during both years at all stations. Tremendous overlapping of the broods was seen, and the seasonal occurrence varied. Very few appeared at Mound Valley.

The wheat head armyworm, Faronta diffusa, was abundant in the central and western sections of the state.

Pseudaletia unipuncta, the armyworm, flights ranged from April to November, during which time flights of three broods probably occurred. This species was the most abundant of all those considered. It represented approximately one fourth of the grand total catch.

The yellow-striped armyworm, Prodenia ornithogalli, occurred in flights from April to October. It was not abundant during either season. It appeared least in the central and western sections of the state.

The fall armyworm, Laphygma frugiperda, occurred in very low numbers during both seasons. It did not appear at Hays during 1959, and only a very few came in 1960. Generally one flight occurred from September to mid-October.

Heliothis zea, the corn earworm, was a-wing from mid-April to November with its maximum appearing during the last few weeks of the season. This insect was trapped in much greater numbers during 1959 than in 1960. It occurred second in abundance to the armyworm.

The forage looper, Caenurgina arechtes, appeared from April to September in 1959. Its flights started later and ended in October in 1960. Three flights were observed and overlapping of the broods occurred. Over 50 percent

of the total entrapment came in the light-trap at Wathena in northeast Kansas. A greater abundance occurred in 1960 than in 1959.

The Southwestern corn borer, Zea diatraea grandiosella, appeared only at Garden City in 1959, and it was not trapped at any of the light-traps during 1960.

Though trapping started on 15 March, no catches were made until the first week in April. All of the light-traps had recorded its final catch by 31 October in 1960 except at Wathena; moths of six species were trapped there during the first week in November. In 1959 catches were made of four species from 1-7 November at Manhattan, Hays, and Garden City. Neither light-trap recorded a catch during the second week in November of both years.

Table 1. Total entrapment of fourteen species of moths taken at four light-traps, April to November, 1959.

Insects	Sections	March			April			May			June			July			Aug.			Sept.			Oct.			Nov.		Totals			
		15-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7		8-15		
<u>Ostrinia</u> <u>nubilalis</u>	Manhattan	-	-	-	-	-	-	-	3	3	13	-	-	-	-	1	10	2	-	2	-	32	-	1	-	-	-	-	-	67	
	Hays	-	-	-	-	-	-	-	-	141	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	141	
	Wathena	-	-	-	-	-	-	-	-	23	65	7	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	104	
	Garden City	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
<u>Loxostege</u> <u>commixtalis</u>	Manhattan	-	-	-	-	-	12	-	-	-	5	8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	313	
	Hays	-	-	-	-	32	63	-	-	-	114	-	1	92	224	-	-	-	-	-	-	-	-	-	-	-	-	-	-	526	
	Wathena	-	-	-	-	-	3	-	-	-	6	-	-	-	88	-	-	-	-	-	-	-	-	-	-	-	-	-	-	97	
	Garden City	-	-	-	-	42	4	-	-	64	50	20	-	554	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	736	
<u>Loxostege</u> <u>sticticalis</u>	Manhattan	-	1	-	-	6	3	-	11	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	22	
	Hays	-	-	-	-	2	176	122	12	-	24	-	2	-	133	-	-	-	-	-	-	-	-	3	-	-	-	-	-	474	
	Wathena	-	-	-	-	-	7	-	-	-	3	-	-	-	39	-	11	-	-	-	-	-	-	-	-	-	-	-	-	60	
	Garden City	-	-	-	1	209	990	13	271	56	21	64	-	-	1	-	2	-	-	-	1	-	-	-	-	-	-	-	-	1629	
<u>Chorizagrotis</u> <u>auxiliaris</u>	Manhattan	-	-	-	1	4	8	-	-	2	6	3	-	-	-	-	-	-	-	-	1	4	3	2	-	-	-	3	1	38	
	Hays	-	-	-	-	22	183	6	7	121	62	-	5	6	-	-	-	-	-	-	18	-	1	-	-	-	4	12	4	451	
	Wathena	-	-	-	-	6	-	-	-	-	6	7	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	23	
	Garden City	-	2	3	9	215	531	27	6	322	1722	200	48	24	4	4	-	2	-	-	6	10	-	2	28	-	6	16	161	160	33
<u>Agrotis</u> <u>ippsilon</u>	Manhattan	-	-	-	-	1	1	6	7	3	9	17	16	23	57	28	10	17	13	36	9	4	23	1	1	9	-	1	-	2	294
	Hays	-	5	1	-	-	-	-	4	1	12	-	1	5	10	-	4	3	-	-	18	24	3	9	18	-	-	5	2	125	
	Wathena	-	-	2	-	4	4	1	3	2	7	27	9	18	8	15	14	54	23	31	37	-	20	8	-	-	5	21	8	321	
	Garden City	-	3	6	1	3	3	2	2	1	6	6	17	103	25	34	11	39	-	5	18	25	19	10	5	34	-	20	34	5	437
<u>Feltia</u> <u>subgothica</u>	Manhattan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	34	16	22	182	59	9	-	-	323	
	Hays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	42	71	78	351	294	46	52	275	28	7	1244
	Wathena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	12	10	68	112	-	-	3	1	214	
	Garden City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	11	16	31	38	38	13	35	11	17	1	213
<u>Peridroma</u> <u>saucia</u>	Manhattan	-	1	2	6	14	4	8	3	3	8	24	15	55	71	5	9	2	1	2	5	-	2	1	-	-	-	-	-	1994	
	Hays	-	-	-	-	4	-	7	3	4	-	-	-	5	1	7	1	9	-	-	4	-	2	-	4	-	-	-	-	51	
	Wathena	-	-	-	2	68	11	-	3	1	-	3	14	34	18	7	9	10	-	9	4	-	1	-	-	-	-	-	-	194	
	Garden City	-	2	1	2	30	6	6	-	-	8	7	9	28	20	26	16	15	-	-	3	10	-	1	-	-	-	-	-	190	
																														676	

Table 1. (concl.)

Insects	Sections	March	April			May			June			July			Aug.			Sept.			Oct.			Nov.		Totals							
		15-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22		23-31	1-7	8-15				
<u>Faronta</u> <u>diffusa</u>	Manhattan	-	-	-	-	1	9	3	3	-	1	-	-	2	9	1	-	-	4	4	1	3	-	1	-	-	-	-	-	42			
	Hays	-	-	-	-	-	54	7	5	1	11	-	9	16	4	45	2	3	1	-	27	6	1	12	-	-	-	-	203				
	Wathena	-	-	-	-	-	2	2	-	-	-	-	2	-	2	-	4	12	10	3	-	-	6	-	-	-	-	43					
	Garden City	-	-	-	-	9	8	-	1	2	22	32	5	27	5	8	4	70	-	3	2	24	2	5	16	-	-	-	245				
<u>Pseudaleta</u> <u>unipuncta</u>	Manhattan	-	1	-	-	2	4	11	4	9	9	138	88	50	183	22	13	23	5	19	20	11	48	1	2	47	-	-	710				
	Hays	-	-	-	-	-	5	3	3	-	51	-	7	28	14	39	23	20	-	-	16	17	2	-	6	-	-	234					
	Wathena	-	-	2	4	63	12	1	6	5	14	53	22	36	25	17	15	18	11	21	-	11	-	32	64	-	-	441					
	Garden City	-	-	-	-	2	19	2	7	2	6	14	12	78	18	44	18	23	-	1	3	11	3	11	26	1	20	26	347				
<u>Prodenia</u> <u>ornithogalli</u>	Manhattan	-	-	-	-	-	-	1	2	7	15	28	32	50	88	86	97	147	52	191	88	34	63	-	5	39	12	7	-	1094			
	Hays	-	-	-	-	-	-	-	-	-	14	-	2	9	9	25	8	1	-	-	-	4	2	-	-	19	-	5	-	98			
	Wathena	-	-	-	-	-	-	-	-	-	-	5	2	2	4	5	10	9	14	29	16	-	-	10	56	-	-	-	162				
	Garden City	-	-	-	-	-	-	-	-	12	8	6	13	4	-	8	2	11	-	-	4	-	-	3	3	3	6	2	-	85			
<u>Laphygma</u> <u>frugiperda</u>	Manhattan	-	4	-	-	2	1	1	2	-	-	-	-	-	-	-	-	-	1	-	-	-	8	-	-	-	-	-	1439				
	Hays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19				
	Wathena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	10	-	-	-	0				
	Garden City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	18				
<u>Heliothis</u> <u>zea</u>	Manhattan	-	-	-	-	-	-	12	24	20	16	27	23	87	85	9	4	7	5	52	14	25	375	48	27	1994	1117	330	-	79	48	-	4428
	Hays	-	-	-	-	-	2	4	5	1	12	-	-	17	1	26	3	4	-	-	-	20	53	20	99	206	362	68	100	73	16	-	1092
	Wathena	-	-	-	-	-	-	1	5	-	-	1	8	30	2	3	2	5	32	39	23	28	165	120	140	272	-	490	309	470	-	-	2145
	Garden City	-	-	-	-	-	18	2	5	9	2	2	11	24	13	36	13	32	-	14	2	62	41	164	474	1512	12	44	193	85	16	-	2786
<u>Caenurgina</u> <u>erechtea</u>	Manhattan	-	1	-	-	-	1	-	-	-	1	12	3	2	8	-	-	1	2	3	-	-	2	-	-	-	-	-	-	-	-	36	
	Hays	-	-	-	-	2	13	2	-	-	38	-	2	15	7	9	8	4	-	-	-	-	10	1	-	-	-	-	-	-	-	163	
	Wathena	-	-	-	26	41	38	4	2	2	22	57	70	100	47	41	35	39	42	78	-	2	13	-	-	-	-	-	-	-	-	659	
	Garden City	-	-	1	3	5	5	-	-	-	-	12	14	48	-	44	12	7	-	2	-	10	-	-	-	-	-	-	-	-	-	111	
<u>Zeodietraea</u> <u>grandiosella</u>	Garden City	-	-	-	-	-	-	-	-	-	-	32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	969	
	Grand Total	-	20	18	55	789	2200	254	406	653	2478	883	469	1574	1049	768	346	612	215	549	276	430	1082	545	1387	4970	1653	1090	1097	975	135	-	26978

Table 2. Total entrapment of thirteen species of moths taken at five light-traps, April to November, 1960.

Insects	Sections	March					April					May					June					July					August					September					October					November		Totals
		15-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15												
<i>Ostrinia nubilalis</i>	Manhattan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10								
	Hays	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10									
	Wathena	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4									
	Garden City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	19									
<i>Loxostege commixtalis</i>	Manhattan	-	-	-	-	-	-	-	-	-	-	-	-	-	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	41										
	Hays	-	-	-	-	-	-	-	-	67	10	2	-	200	301	14	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	606									
	Wathena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	4									
	Garden City	-	-	-	-	-	-	-	-	64	156	4	-	10	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	262									
<i>Loxostege sticticalis</i>	Manhattan	-	-	-	-	-	-	-	-	-	-	-	-	-	1	5	-	-	-	19	6	-	3	-	1	-	-	-	-	-	-	-	-	1198										
	Hays	-	-	-	-	-	1	92	135	63	-	16	190	140	70	2	2	-	-	8	14	4	7	6	-	-	7	-	-	-	-	-	757											
	Wathena	-	-	-	-	-	-	-	-	-	-	-	16	-	-	-	-	-	10	2	8	4	6	-	1	-	-	-	-	-	-	-	-	47										
	Garden City	-	-	-	2	16	146	228	240	256	70	20	44	120	30	34	-	-	6	7	36	-	20	19	8	8	1	-	3	-	-	-	-	1314										
<i>Chorizagrotis auxiliaris</i>	Manhattan	-	-	-	-	-	-	48	20	-	2	16	-	-	-	-	-	-	1	-	-	-	-	1	-	-	-	1	1	3	1	4	-	97										
	Hays	-	-	-	-	-	20	81	67	104	230	279	22	20	-	20	-	-	4	14	-	-	-	-	-	-	22	59	4	5	-	-	-	951										
	Wathena	-	-	-	-	-	-	8	-	4	-	10	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	38										
	Garden City	-	-	-	-	32	86	194	254	528	198	230	97	10	-	-	-	-	-	-	-	-	20	-	36	22	224	174	54	46	57	-	-	2262										
<i>Agrotis ipsilon</i>	Manhattan	-	2	-	-	-	-	50	34	13	51	302	231	404	39	38	53	30	44	15	14	-	2	6	6	1	2	1	-	-	-	-	4419											
	Hays	-	-	6	-	3	-	4	17	11	42	114	200	94	54	25	6	38	66	4	1	2	52	3	6	5	2	4	2	1	-	-	762											
	Wathena	-	-	-	8	4	14	-	10	-	4	30	150	146	18	50	24	28	69	44	46	102	12	4	21	-	3	4	9	6	5	-	811											
	Garden City	-	18	22	20	8	12	8	8	40	42	90	120	50	65	40	50	173	133	37	25	-	143	29	38	31	58	39	35	32	-	-	1366											
<i>Feltia subgothica</i>	Manhattan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	7	1	573	436	100	9	6	-	-	-	-	-	4419											
	Hays	-	-	-	-	-	-	-	-	-	-	-	4	12	-	-	-	1	4	8	1	80	454	540	608	352	180	229	48	21	-	-	1137											
	Wathena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	49	720	856	632	-	133	40	15	-	4	-	2542											
	Garden City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	5	2	-	-	102	1170	660	230	90	33	-	3	-	-	2297											
Mound Valley	-	14	3	25	-	-	-	-	-	-	28	20	11	-	-	11	10	6	3	10	-	-	-	-	-	-	-	-	-	-	-	-	6											

Table 2. (contd.)

Insects	Sections	March			April			May			June			July			Aug.			Sept.			Oct.			Nov.		Totals						
		15-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7		8-15					
<u>Peridroma</u> <u>saucia</u>	Manhattan	-	-	3	-	-	-	-	23	34	4	17	86	167	55	54	30	2	4	4	5	-	1	2	13	13	1	2	2	1	-	-	523	
	Hays	-	-	-	-	-	2	-	-	-	12	20	-	92	80	103	15	-	3	7	2	2	12	4	2	1	10	11	12	3	-	-	394	
	Wathena	-	-	-	-	-	-	8	4	-	-	6	62	10	36	28	25	4	2	-	8	8	-	13	-	7	6	4	2	7	-	-	240	
	Garden City	-	-	10	6	2	18	24	16	80	-	-	-	10	55	44	4	10	9	-	7	-	9	22	19	28	47	13	4	3	-	-	440	
	Mound Valley	-	-	1	-	-	-	1	-	-	-	-	-	31	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-	4	-	-	59	
																																		1656
<u>Feronta</u> <u>diffusa</u>	Manhattan	-	-	-	-	-	-	-	30	30	27	19	-	32	1	-	4	-	3	2	2	14	-	4	2	1	-	-	-	-	-	-	171	
	Hays	-	-	-	1	34	-	19	13	30	210	18	20	424	-	16	8	9	18	2	16	18	58	21	13	-	1	13	-	-	-	-	962	
	Wathena	-	-	-	-	4	-	-	6	24	8	-	10	50	2	5	7	2	7	19	17	15	6	14	19	-	2	8	-	-	-	-	225	
	Garden City	-	-	-	-	48	8	6	12	12	48	20	10	8	30	66	21	116	53	51	32	26	-	4	69	23	26	7	2	-	-	-	-	698
	Mound Valley	-	-	-	-	-	3	3	-	-	-	-	6	4	74	-	-	-	-	1	-	4	-	-	-	-	-	-	-	-	-	-	-	95
																																		2151
<u>Pseudaleta</u> <u>unipuncta</u>	Manhattan	-	-	-	-	-	1	2	253	53	23	148	828	2201	666	136	183	129	26	35	39	89	8	19	16	6	3	5	3	8	-	-	4880	
	Hays	-	-	-	2	3	-	58	191	35	30	290	574	844	530	446	20	28	21	12	9	98	151	26	16	10	3	25	14	26	-	-	3462	
	Wathena	-	-	-	-	32	2	12	64	4	36	60	190	310	36	152	140	140	30	10	30	160	132	74	57	-	15	20	19	18	19	-	-	1762
	Garden City	-	-	-	16	12	14	16	20	188	36	125	90	120	140	54	56	58	26	16	30	-	131	143	93	76	71	84	100	44	-	-	509	
	Mound Valley	-	1	6	15	2	1	-	-	-	2	40	90	215	-	-	40	22	40	24	7	-	-	-	-	-	-	-	-	4	-	-	-	1759
																																		12372
<u>Prodenia</u> <u>ornithogalli</u>	Manhattan	-	-	1	-	-	-	-	4	20	17	17	42	36	8	-	-	-	-	36	55	67	14	9	5	10	3	10	1	-	-	-	355	
	Hays	-	-	-	-	-	-	-	-	-	4	6	10	-	-	-	-	-	-	-	-	-	5	-	-	3	-	12	-	3	-	-	43	
	Wathena	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	5	10	-	20	-	6	-	2	-	-	-	-	-	-	47
	Garden City	-	-	2	-	-	16	-	-	-	6	-	-	-	-	-	-	-	-	4	-	-	2	4	-	2	-	-	-	-	-	-	-	36
	Mound Valley	-	-	1	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
																																		486
<u>Laphygma</u> <u>frugiperda</u>	Manhattan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	33	67	48	86	12	-	-	-	-	271	
	Hays	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	-	16	13	3	-	-	-	-	36	
	Wathena	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	5	-	-	-	-	-	22	
	Garden City	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	79	6	20	16	3	-	-	-	-	-	124	
	Mound Valley	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
																																		453
<u>Heliothis</u> <u>zea</u>	Manhattan	-	-	-	-	-	-	-	-	-	1	27	142	48	3	6	2	7	5	27	37	131	15	178	420	114	39	469	90	155	-	-	1916	
	Hays	-	-	-	-	-	-	-	-	-	18	7	4	-	-	21	-	2	4	-	1	10	40	14	56	74	26	195	378	194	-	-	1044	
	Wathena	-	-	-	4	-	-	-	-	-	12	-	-	-	1	-	-	-	8	12	30	65	234	186	211	-	167	80	207	267	59	-	-	1543
	Garden City	-	-	-	2	-	-	-	-	-	-	10	-	-	2	5	-	14	4	18	14	-	87	71	174	174	270	184	207	110	-	-	1273	
	Mound Valley	-	-	-	-	2	-	-	-	-	-	10	-	-	-	-	1	5	4	12	10	-	-	-	-	-	-	-	-	-	-	-	-	44
																																		5820

Table 2. (conc.)

Insects	Sections	March			April			May			June			July			Aug.			Sept.			Oct.			Nov.		Totals						
		15-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7	8-15	16-22	23-30	1-7	8-15	16-22	23-31	1-7		8-15					
<u>Caenurgina</u> <u>erechtea</u>	Manhattan	-	-	-	-	-	-	4	11	8	7	38	24	9	2	3	2	3	4	4	12	-	7	8	3	-	4	4	6	-	-	163		
	Hays	-	-	2	-	-	-	1	12	88	10	46	87	92	15	26	2	9	5	1	3	9	28	7	2	-	4	9	4	3	-	-	465	
	Wathena	-	-	-	52	40	26	-	40	80	58	2	38	156	36	58	40	36	25	72	78	266	152	45	30	-	8	20	5	7	7	-	-	1377
	Garden City	-	-	-	-	-	-	4	-	4	14	20	8	-	25	15	38	56	36	10	12	-	48	92	29	19	5	2	6	1	-	-	444	
	Mound Valley	-	-	7	4	1	-	2	-	-	-	8	1	18	-	-	1	-	13	1	5	-	-	-	-	-	-	-	-	-	-	-	61	
	Grand Total	-	35	64	206	206	348	705	1674	1947	1053	1724	4074	6379	2472	1399	913	930	691	536	655	1266	2653	4363	3740	1607	1456	1756	1166	995	101	-	2510	45114

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation and gratitude to Mr. Leroy L. Peters, Survey Entomologist, Kansas Entomological Commission, stationed at Kansas State University, for his assistance in selecting this study, his guidance and reading the manuscript.

Appreciation is extended to Dr. Herbert Knutson, Head of the Department of Entomology and major professor, Kansas State University, for his ever available guidance and advice, and for reading the manuscript.

Thanks are due Messrs. Lester J. DePew, E. L. Eshbaugh, Tom L. Harvey, and Norton Ford at the four Experiment Stations for their cooperation by supplying the specimens; and to the Department of Entomology for supplying the determinations of the specimens.

My gratitude is extended to Dr. Dean L. Bark, Department of Physics, Kansas State University, for his assistance and use of climatological records; and to Mr. Chester P. Davis, Agricultural Engineering, USDA, for information concerning the light-traps used.

Appreciation is extended to Dr. Reginald H. Painter, Department of Entomology, Kansas State University, for aid in finding certain literature and on the proper methods of citing the same.

Thanks are also conveyed to many fellow students for their help and suggestions.

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LIGHT-TRAP STUDIES OF SEASONAL AND GEOGRAPHICAL OCCURRENCE
OF CERTAIN SPECIES OF LEPIDOPTERA IN KANSAS

by

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B. S., Xavier University of Louisiana, 1957

AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Entomology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1961

Light-traps of many types have been used to study insect activities. However, that which deals with the study of insects in Kansas is limited. The purpose of this study was to make an analysis of the entrapments with respect to seasonal and geographical variations of fifteen species of moths (Lepidoptera), which are of economic importance.

Five similar light-traps, that operate on 120 AC volts using one 15-watt black light, fluorescent tube type with 3957 angstroms wave length, were used to collect the moths. Trapping occurred between March and November in 1959 and from March to November during 1960. The traps were located at Hays, Garden City, Mound Valley, Manhattan, and Wathena.

Graphic illustrations of each species were made to show seasonal flight history. Weather conditions were considered in certain instances to determine possible influence.

A total of 26,978 specimens was collected during 1959, and 45,114 in 1960. These were well distributed among the traps except Mound Valley where collections were low. The armyworm, Pseudaletia unipuncta, comprised about 25 percent of all catches and showed three flights; Heliothis zea, the corn earworm, occurred second in great abundance, had three flights, the last largest and well defined. Other species studied were Feltia subgothica (one late flight), Agrotis ipsilon, generally four flights, and Chorizagrotis auxiliaris with one flight separated by a period of aestivation; those less abundant were Faronta diffusa (two flights), Loxostege sticticalis (three flights), and Caenurgina erechtea with three flights. Loxostege commixtalis, with three flights, was more prevalent in the central and southwestern parts of the state than in the eastern. Peridroma saucia and Prodenia ornithogalli, though not clearly defined, had three flights. Intervals, from four to nine

weeks when no apparent flight occurred, were seen during the latter's flight period. (Pyrausta) Ostrinia nubilalis and Laphygma frugiperda did not appear in large numbers, and only one catch of Zeadiatraea grandiosella was made. Agrotis orthogonia was not trapped during both 1959 and 1960. Generally each species occurred in greater numbers during one season than during the other. Overlapping of the broods was common for those having multiple flights.