REPORT OF THE FLY CONTROL CAMPAIGN IN MANHATTAN, KANSAS, 1950

by

CHRISTIAN CARL BURKHARDT

B.S., Kansas State College
of Agriculture and Applied Science, 1950

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Entomology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1951

TABLE OF CONTENTS

INTRODUCTION

The community fly control problem is not one of recent origin, however, during recent years, the public has become increasingly aware of flies as possible vectors of human diseases. The problem is basically one of sanitation and therefore the elimination of or at least the reduction of fly breeding reservoirs is of major importance. Such a program entails provisions for proper disposal of garbage and trash in a community, as well as a sanitary method of disposal of human and animal wastes. Another phase of the community fly control problem is that of controlling those flies, by chemical means or otherwise, which exist in spite of sanitary measures having been carried out.

It is quite evident why a community is interested in and concerned with fly control. Fly control is a vital factor in maintaining health in a community. Watt and Lindsay (1948) showed clearly that, in Hidalgo County, Texas, the extent of infection, disease, and death caused by the organisms of bacillary dysentery was materially reduced by fly control. Pathogenic organisms have been recovered from naturally infested flies of various species by Francis et al. (1948), Herms (1939), Melnick et al. (1947) and Melnick (1949). Extensive work by Bishopp (1915) and James (1947) indicates there are several species of flies causing myiasis in man and animals. Paul et al. (1941), Sabin and Ward (1941), Ward et al. (1945) and Melnick et al. (1947) found the virus causing poliomyelitis present in flies.

In addition to being hazardous to health, flies are an annoyance.

The problem of controlling flies has probably existed as long as man himself and has increased in complexity with man's social development. Such primitive methods as swishing away the flies which have alighted in undesirable places and swatting those which are persistently annoying, are still with us; however, as man learned more about the habits of flies he devised more resourceful methods for obtaining partial control or abatement. Through study, man found that sanitation was the principal weapon in controlling flies and since that time many other methods of control have fallen by the wayside or have been relegated to roles of minor importance. Among these are such methods as baited traps, poisons for ingestion and sticky fly papers. The use of wire or cloth screening to introduce a mechanical barrier was found quite effective. The most recent method used was chemical control or a combination of sanitation and chemical applications.

Nearly a half century ago a Kansas health officer, Dr. Samuel J. Crumbine, conducted one of the first community fly control programs in the nation (Hodgden, 1950). Dr. Crumbine urged the cleaning up of insanitary conditions and the use of a new invention, the fly swatter. His slogan, "Swat the fly" became nationally famous.

In 1909-1910, W.B. Herms conducted a successful community-wide fly-control campaign in Berkeley, California. Then for quite some time there was a lull in campaigns of this type (Herms, 1911).

Recently, since the advent of DDT, community fly control programs have again been stimulated.

A successful community fly control program consists of three essential phases of a balanced program: education, sanitation, and spraying.

AIM OR PURPOSE

The purpose of this study was basically three fold:

1. To execute methods and procedures involved in making sanitary surveys, including pretreatment and posttreatment surveys.

2. To establish the importance of sanitary surveys. For example, these surveys were necessary to spot potential fly breeding areas; to locate areas where sanitary measures must be taken; and to obtain an estimate of costs and materials needed. Without pretreatment surveys, areas of high fly population could not have been readily located. By locating these areas, it was then possible to reduce many of the fly breeding reservoirs or apply chemical treatment or do both. Pretreatment fly counts had to be obtained in order to have data to compare with posttreatment data in establishing the degree of fly control obtained or to provide criteria for evaluation of control. In addition, a species breakdown of the fly population was obtained, to provide data for showing the prevalent species of flies in this locality.

3. To obtain fly control in the community of Manhattan, Kansas, by a program combining sanitation and application of chemicals.

This is a report on a municipal fly control program co-ordinated with the Riley County Board of Health and the Kansas State Board of Health.

EQUIPMENT AND MATERIALS

A 36 inch square fly grill was constructed as described by Scudder (1947). All counts made with the Scudder fly grill were recorded on fly grill cards prepared by the United States Public Health Service (Coffey and Schoof, 1949). Large 24 x 28 inch charts entitled "Daily Master Chart of Grill Counts and Spraying Operations" also prepared by the United States Public Health Services, were used to record daily data.

Both large and small maps of the city of Manhattan, Kansas, were obtained for use through the courtesy of the city engineers and the chamber of commerce.

A Hardie spray rig, owned by the city of Manhattan and operated by a crew from the city tree department, was employed to carry out the necessary spraying operations.

The insecticide used was a 2.6 per cent water emulsion of DDT prepared from a 25 per cent emulsifiable concentrate.

PROCEDURE AND RESULTS

A sanitation and fly control program, was set up for the city of Manhattan, Kansas. The participating personnel consisted of a fly-control committee, a supervisor in charge of the program, and a spraying crew from the city tree department. The program was operated in close conjunction with the Riley County Health Officer and the city sanitarian.

Preliminary Survey

During the latter part of May 1950, a preliminary survey was made to determine sanitary conditions and locations of potential fly breeding areas in Manhattan, Kansas, a city of approximately 14,000 population.

This preliminary survey disclosed approximately 344 blocks within the city limits of Manhattan; 67 blocks contained a total of 86 chicken pens, 18 blocks contained a total of 49 privies (an average of 2.7 privies per block in each of 18 blocks); and 13 cases of horse manure attractant within the city limits.

On the basis of the preliminary sanitation survey, the city was divided into three sections; Section I or business district, Section II or lower class residential district and Section III consisting of the major residential area (See Fig. 1). Each section was in turn broken down into small unite as described in the Communicable Disease Center Manual of Operations (1950). All sections of the city, with the exception of the better class residential areas, were divided into evaluative units of approximately 10 contiguous blocks (ranging from 8-12). In selecting the limits of each unit, the basic criterion was the homogeneity of the inclusive blocks (e.g., in a residential area which includes a small business center of 10 contiguous blocks, all these blocks

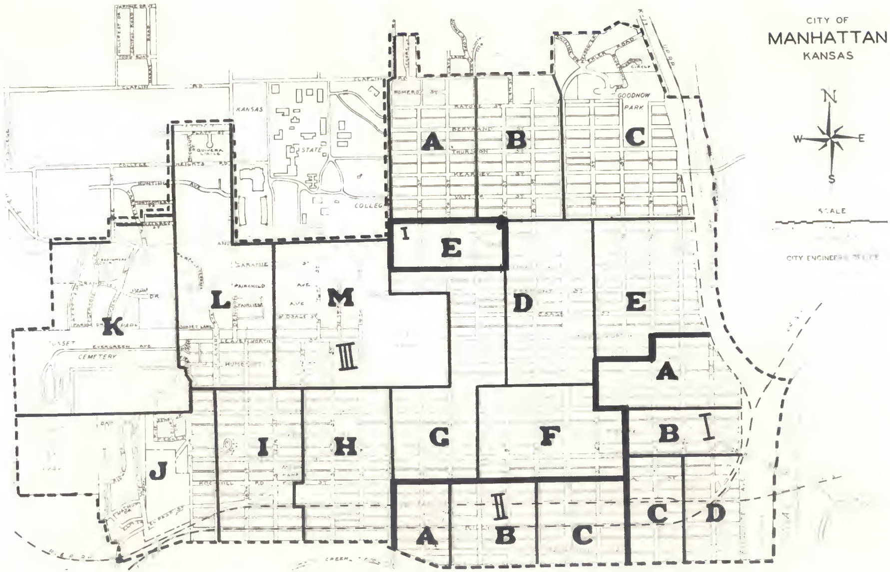

Fig. 1. May of Manhattan, Kansas showing the division of the city into Sections I, II and III and the units within each section.

should be confined within a single unit instead of distributing such blocks among 2 or more units). For high class residential sections where fly densities were normally low the size of the evaluative unit was extended to include approximately 20 homogeneous blocks.

Section I consisted of units A, B, C, D, and E, and covered a total of 49 blocks. Section II was composed of units A, B, and C, and covered a total of 31 blocks. Section III contained units A through M, and took in an area of 264 blocks. All blocks within the city were given a number (Communicable Disease Center Manual of Operations, p. 2, 1950).

This preliminary survey was necessary in that it not only familiarized the supervisor with the general lay-out of the city, the existing state of sanitation and the potential fly breeding areas, but also was important in providing information which lead to early sanitation measures, thereby helping to alleviate the fly problem. In addition, this survey provided a basis for estimating the cost of control materials.

Pretreatment Surveys and Grill Counts

Following the initial survey during the latter part of May 1950, additional surveys and inspections were made. Precontrol surveys and grill readings with the Scudder fly grill were carried out and the data recorded on fly grill cards (Fig. 2) printed for IBM tabulation.

In estimating the pretreatment and posttreatment fly-population indices, the grill-device method of sampling was used. This method

FLY GRILL CARD

2 TOWN Manhattan, Kansas	3 BLOCK NO. 0409	7 TEMP 63°	9 SKY 2	10 WIND 1
11 DATE MO. 07 DAY 13 YR. 50	16 SECT. III-H	17 (TO NEAREST HR.) TIME 04	19 MOISTURE 1	INSPECTOR ccf

GRILL READING	1	2	3	4	5	
20 ATTRACTANT	12	42	14	55	42	
22 SHADE	2	1	1	1	2	TOTAL
23 M DOMESTICA	003	007	004	007	002	023
26 PHAENICIA			002	007		009
29 SARCOPHAGA				002		002
32 PHORMIA						
35 MUSCINA						
38 OPHYRA						
41 CALLIPHORA						
44 STOMOXYS						
47 CALLITROGA						
50 OTHER	002		005			007
53 TOTAL	005	007	011	016	002	041
56 BLOCK AVERAGE	008	59 BLOCK MEDIAN	007	62 HIGH COUNT	016	

2. TOWN	3. BLOCK NO.	7. TEMP.	9. SKY	10 WIND
1 = MUSK. 2 = CHAR. 3 = TROY 4 = TOPEKA 5 = PHOEN	0001 TO 9999	32 – 99 = AS IS 100 = 00 101 = 01, etc.	1 = ○ 2 = ⦶ 3 = ⦷ 4 = ⊕	1 = CALM 2 = LIGHT 3 = GENTLE 4 = MODERATE 5 = FRESH 6 = STRONG

11. DATE:	16. SECT	17. TIME TO NEAREST HOUR	19. MOISTURE
MO. 01-09 = JAN-SEPT., 10 OCT, 11 NOV, 12 DEC DAY 01 TO 31 YR. 48 = 8, 50 = 0 etc.	1 = A 2 = B etc.	10 = 9:31 TO 10:30 02 = 1:31 TO 2:30 03 = 2:31 TO 3:30, etc.	1 = DRY 2 = VEG. WET WITH DEW 3 = GROUND WET 4 = GROUND & VEG. WET

20. ATTRACTANT:

1. EXCREMENT
   - 11 = COW
   - 12 = HORSE-MULE
   - 13 = HUMAN
   - 14 = FOWL
   - 15 = DOG-CAT
   - 16 = GOAT-SHEEP
   - 17 = OTHER
   - 18 = PIG
2. RUBBISH
   - 21 = BRUSH, GRASS, LEAVES, WEEDS.
   - 22 = BOTTLES, BOXES, CANS.
3. COMMERCIAL WASTES
   - 31 = CANNERY
   - 32 = SLAUGHTERHOUSE
   - 33 = TANNERY
   - 34 = WINERY, BREWERY etc.
   - 35 = OTHER
4. MIXED GARBAGE
   - 41 = SCATTERED
   - 42 = IN CONTAINER
5. MISCELLANEOUS
   - 51 = DISH WATER
   - 52 = COFFEE GROUNDS
   - 53 = MELONS
   - 54 = OTHER FRUIT
   - 55 = DEAD ANIMAL
   - 56 = ANIMAL PEN OR YD.
   - 57 = VEGETABLES
   - 58 = BONES
   - 59 = MEAT
6. MISCELLANEOUS
   - 61 = OTHER
   - 62 = SEAFOOD WASTES
   - 63 = STOCK FEEDS

22. SHADE
   - 1 = DIRECT SUNLIGHT
   - 2 = PARTIALLY SHADED
   - 3 = COMPLETELY SHADED

23 TO 53. SELF EXPLANATORY

56 BLOCK AVERAGE: TOTAL OF 5 GRILL READINGS ÷ 5 = AVERAGE. USE NEAREST WHOLE NUMBER.

59 BLOCK MEDIAN: EQUALS "MIDDLE" NUMBER OF 5 GRILL READINGS. e.g. READINGS

1	2	3	4	5
009	012	017	016	(014)

62. HIGH COUNT: HIGHEST COUNT OF 5 GRILL READINGS.

PHS 200.17 (CDC) GA. 8-48

Fig. 2. The front and reverse side of the fly grill card used to record data from Manhattan and Lawrence, Kansas. This card was the type used by the Communicable Disease Center on experimental community fly control programs. Coding is for IBM tabulation.

consisted of placing a three-foot-square grill, made up of alternate three-quarter inch slats and open spaces, on any surface attracting a concentration of flies, as described by Smith (1949), Baker and Schwartz (1947) and others.

A grill count was defined as the number of flies which settled back upon the grill after they had been momentarily disturbed by the placement of the grill. A short interval of time (15 to 20 seconds) was allowed between the placement of the grill and the time of counting.

Usually fly counts were made at ten to twelve different placements in each block, no two placements being less than ten feet apart, but only the grill readings consisting of the five highest counts in each block were recorded (Coffey and Schoof, 1949, p. 22). In making these grill counts, flies were not counted on a purely quantitative basis, but for the determination of the various genera and species (where possible) of flies as well.

The grill coverage in this program was made on the basis of the station method as described in the USPHS Communicable Disease Center Manual of Operations (p. 1-12, May 1950). This method consisted of the dump block station, the fixed block station and the random block station. The above types of survey stations are defined in the Communicable Disease Center Manual of Operations as follows:

1. Fixed block station is that block within each evaluative unit, which exhibits the greatest fly breeding potential by observed fly densities and/or fly breeding conditions. This block is

to be inspected weekly.

2. Random block station is a second block within each unit to be surveyed on a weekly basis. Selection of this block is to be made on a randomized basis with a different block being covered each successive week until all the blocks in a unit have been inspected.

3. Dump block station is that block which exhibits an extremely high fly breeding potential and it is typical in make-up and fly density level as compared to the remaining blocks in the section.

Keeping the above definitions in mind, fixed block stations were spotted and labeled on maps for each evaluative unit.

The schedule of inspection was followed as outlined in the Communicable Disease Center Manual of Operations. Any insanitary conditions which provided fly breeding media were reported to the city sanitarian.

It is obvious that a precontrol fly survey of the community was important to determine the cause and extent of the problem and to serve as a guide in recommending control measures.

Having recorded the conditions and fly counts in each block, a spot map was prepared to show where, in the city, the fly population was the highest. From this pattern a spray schedule was prepared and the spraying operations were so directed to spray the highest count blocks first. The Master Chart of Daily Grill Fly Counts and Spraying Operations, prepared by the Federal Security Agency, Communicable Disease Center, at Atlanta, Georgia, was used to record both inspection and spraying data (Coffey and Schoof, 1949, p. 25).

Spraying Operations

The spraying operations were carried out by the city-park spraying crew under the direction of the supervisor in charge of the program. A 2.6 per cent water emulsion of DDT prepared from 25 per cent emulsifiable concentrate of DDT was used. This solution was applied at the rate of approximately 100 milligrams of DDT per square foot. Application was made by means of ground equipment drawn behind a truck. The spray rig used was a "Hardie", high pressure, 300 gallon capacity machine, operating at a pressure of approximately 100 pounds per square inch.

Two spray guns were used. Each spray gun consisted of an 18 inch hand operated wand with a trigger type, cut-off valve in the base of the gun. T-jet nozzles dispersing 0.4 gallon per minute in a flat-fan-shaped pattern, were used. This assembly followed the recommendations of the Communicable Disease Center at Atlanta, Georgia.

The DDT water emulsion was applied to the garbage, garbage cans and racks, back doors, and back walls of buildings along the alley ways. The intervals between treatments were determined by the entomological inspections in which the Scudder grill was used to determine the fly index.

The treatment was concentrated on those blocks having a higher average number of flies per grill count than 3, which was the standard set in the early part of the program and later had to be changed to 5 flies per grill count.

Posttreatment Grill Counts

Methods used in measuring fly densities on the precontrol survey were the same as those utilized on postcontrol surveys so that comparisons of the respective data were made possible.

The posttreatment surveys served primarily as periodic "checks" upon the effectiveness of the control measures used.

Table 1 shows the number of blocks inspected during the month of June, 1950, the grill averages of the number of flies per block before treatment, the number of blocks sprayed and the grill averages of the number of flies per block after treatment. The reduction of the fly population as shown in Table 1, was credited to the residual effects of the DDT. The prespray inspection of 272 blocks resulted in an over-all city grill average of 3.6 flies per block. Of the 272 blocks inspected 201 blocks were sprayed and postspray inspections were made. The postspray over-all city grill average was 0.9 flies per block. Postspray grill counts were made within 48 hours after treatment.

The data in Table 1 indicate approximately 75 per cent control. However, factors other than residual toxicity may have slight bearing on the results. Climatic factors as temperature and precipitation undoubtedly had some bearing on the per cent of control obtained. Heavy precipitation within 24 hours after spray applications in Section I, tended to reduce residual toxicity considerably. Consideration of this fact could make it appear that approximately 75 per cent control was enough.

Table 1. The number of blocks inspected, block averages, and number of blocks sprayed during June, 1950, of the city of Manhattan, Kansas, fly control program.

Sec. & unit	No. of blocks	No. blocks inspected	Prespray grill av.	No. blocks sprayed	Postspray grill av.
I-A	13	13	6	14	1
I-B	8	8	7	8	1
I-C	10	10	5	10	2
I-D	10	10	5	10	1
I-E	8	8	7	8	1
II-A	7	7	6	5	1
II-B	12	12	5	10	1
II-C	12	12	5	12	2
III-A	21	21	1	0	
III-B	18	18	1	11	0
III-C	26	26	1	5	0
III-D	21	21	1	20	0
III-E	22	22	2	22	1
III-F	19	19	1	18	0
III-G	24	24	2	22	1
III-H	20	20	3	19	1
III-I	21	21	0	0	
III-J	14	0		1	
III-K	18	0		0	
III-L	22	0		0	
III-M	18	0		0	
Totals	344	272	3.6	195	0.9

On the other hand, considerable cool weather with mean temperatures ranging between 68° and 86° Fahrenheit (during the latter part of June) with a tendency toward the lower mean, may have decreased the average grill counts to some extent. This being the case the actual per cent of control would have been less than the 75 per cent figure.

The figures in Table 1 also show the tendency towards higher grill averages in Section I (business district) and Section II (low-class residential district) compared with those of Section III (medium to high class residential district). This was an indication that attractants were more abundant in the business and low-class residential district than in the remaining residential district.

Weekly Sanitary and Entomological Inspections

Weekly sanitary and entomological inspections were made in each evaluative unit of Sections I, II and III, with the exception of Units J and K in Section III due to lack of a fly problem in those units; also units L and M in Section III were not inspected during the month of June, but were inspected thereafter.

Each week, beginning with week number 24 and continuing through week number 33 (June 26, 1950 to August 26, 1950 respectively), the fixed block in every unit and one or more random blocks in every unit, were grilled. The five highest grill counts for each block were recorded on the IBM fly grill cards

(Fig. 2) and the block averages were calculated. By this method, Sections I, II and III were covered each week.

Having obtained and recorded the average number of flies per block, this average was compared to a standard number (an average grill count of three (3) flies per block) previously selected on an arbitrary basis. When a block average was in excess of this standard, control measures were applied. During the early part of the spraying program, an average grill count of three (3) flies per block was considered the standard, but later in the program, due to insufficient funds the standard was increased to five (5).

Dump blocks also were inspected and grilled weekly.

Table 2 shows summaries of grill survey data for Sections I, II and III, of Manhattan, Kansas.

The fixed block survey of Section I (business district) indicates that this evaluative unit consistently had a higher average number of flies per grill count than did the random blocks (Table 2). The same consistent results are shown of Sections II and III of Manhattan, Kansas. This is an indication that within a certain area, whether it be blocks or units, there are those blocks which are the potential or actual fly breeding reservoirs (as shown here by fixed block stations) which become the principle source of fly population for the surrounding area.

The following additional information is shown for both fixed and random blocks for Sections I, II and III of Manhattan, Kansas, during the period, week 25 through 33 (June through August) in Table 2:

1. The number of fixed and random blocks grilled.

2. The highest grill count obtained.

3. The average number of flies per grill count.

The figures in this table show also that as one goes from Section I through II and III, the average grill count decreases.

Through the courtesy of the USPHS Communicable Disease Center at Atlanta, Georgia, the same type data as were taken at Manhattan, Kansas, were made available from Lawrence, Kansas, for comparative purposes. Table 3 gives summaries of the grill data of Sections VI, VII and VIII of Lawrence, Kansas, In Lawrence, Kansas, Section VI is the business section, Section VII is the low class residential district and Section VIII the remainder of the residential district; hence Sections VI, VII and VIII in Lawrence correspond to Sections I, II and III respectively of Manhattan.

Upon further examination of the Lawrence, Kansas data, it can be seen that the general trend there correlates quite closely with the trend in Manhattan, with the exception that in Lawrence, the average fly counts (grill averages) are appreciably higher and consistently so. There was no spraying program carried on at Lawrence because this city was serving as an untreated area for comparison with a control program in nearby Topeka, Kansas.

A better perspective regarding fly densities in Manhattan and Lawrence can be obtained from close examination and comparison of Figs. 3 and 4. Figure 3 shows the weekly grill averages of fixed and random stations for weeks 25 through 33, of Sections

Table 2. Summary of fly grill survey data of Manhattan, Kansas, June through August 1950.

Week	Fixed block survey			Random block survey		
	No. blocks	Highest grill count	Av. flies per grill count	No. blocks	Highest grill count	Av. flies per grill count
			Section I			
25	5	12	3.0	5	15	1.0
26	5	21	3.0	5	3	0.0
27	5	27	5.0	5	13	2.0
28	5	15	4.0	10	41	3.5
29	5	33	5.0	10	31	3.9
30	4	37	10.0	8	21	2.7
31	5	13	4.2	10	38	2.9
32	5	37	5.8	10	35	1.4
33	5	54	3.8	15	31	2.4

Table 2. (Cont.)

Week	Fixed block survey			Random block survey		
	No. blocks	Highest grill count	Av. flies per grill count	No. blocks	Highest grill count	Av. flies per grill count
			Section II			
25	3	13	3.0	3	7	1.0
26	3	11	3.0	3	1	0.0
27	3	119	10.0	3	6	1.0
28	3	27	5.3	6	4	0.2
29	3	31	4.6	6	28	2.5
30	3	11	2.3	6	4	0.9
31	3	4	1.3	6	27	1.8
32	3	9	1.0	6	3	0.3
33	3	3	1.6	9	11	1.0

Table 2. (Concl.)

Week	Fixed block survey			Random block survey		
	No. blocks	Highest grill count	Av. flies per grill count	No. blocks	Highest grill count	Av. flies per grill count
			Section III			
25	3	3	1.0	3	1	0.0
26	11	13	3.0	11	11	1.0
27	11	19	4.3	11	30	2.5
28	11	37	4.3	22	33	2.9
29	11	27	3.2	22	29	2.5
30	Not Inspected		-	-	-	-
31	11	9	1.9	22	13	1.7
32	11	9	2.3	22	9	1.1
33	11	13	1.9	33	10	0.5

Table 3. Summary of fly grill survey data of Lawrence, Kansas, June through August, 1950.

Week	Fixed block survey			Random block survey		
	No. blocks	Highest grill count	Av. flies per grill count	No. blocks	Highest grill count	Av. flies per grill count
			Section VI			
25	3	13	4.3	3	9	2.5
26	3	7	1.3	3	2	0.3
27	3	27	10.3	3	6	3.3
28	3	156	31.3	3	17	5.3
29	3	38	10.3	3	9	3.0
30	3	100	15.7	3	100	17.3
31	3	1020	181.3	3	6	3.0
32	3	73	23.7	3	41	6.7
33	3	95	18.0	3	17	3.7

Table 3. (Cont.)

Week	Fixed block survey			Random block survey		
	No. blocks	Highest grill count	Av. flies per grill count	No. blocks	Highest grill count	Av. flies per grill count
			Section VII			
25	6	24	5.7	6	49	4.5
26	6	12	5.0	6	6	1.8
27	6	39	12.0	6	40	8.3
28	6	23	6.8	6	8	3.2
29	6	27	10.5	6	27	5.3
30	6	53	10.0	6	16	4.2
31	6	31	10.3	6	18	6.3
32	6	37	10.5	6	108	11.5
33	6	21	6.7	6	12	5.2

Table 3. (Concl.)

Week	Fixed block survey			Random block survey		
	No. blocks	Highest grill count	Av. flies per grill count	No. blocks	Highest grill count	Av. flies per grill count
			Section VIII			
25	9	73	4.8	9	18	0.7
26	9	33	4.6	9	7	1.7
27	9	13	3.4	9	7	1.1
28	9	24	4.6	9	5	1.2
29	9	41	4.6	9	5	1.1
30	9	31	5.9	9	7	1.3
31	9	12	3.8	9	7	1.8
32	9	11	3.8	9	9	3.4
33	Not Inspected		-	-	-	-

I, II and III of Manhattan, Kansas. Figure 4 shows the same information for Sections VI, VII and VIII of Lawrence, Kansas.

A general statement can be made regarding the curves on the graphs of both Manhattan and Lawrence (Figs. 3 and 4), namely that the curves plotting the weekly grill averages follow the same general trend in both cities.

In the business section of Manhattan, the highest peak of fly population (Fig. 3, Section I) was obtained during the 30th week which was the first week in August. For Lawrence, the highest peak of population for the corresponding area was during the 31st week.

Sections II and VII of Manhattan and Lawrence respectively, obtained the peak of population on the 27th week. The remaining Sections III and VIII of the two towns show no appreciable peak in fly population.

Weighted Over-all City Grill Averages

In addition to the weekly breakdown of species population, and the comparative grill averages for both fixed and random block stations, a weekly weighted over-all city grill average was maintained for both Manhattan and Lawrence, Kansas.

The over-all city grill average is a weighted average and is computed as described on page 9 of the USPHS Communicable Disease Center Manual of Operations, May 1950. The computation of the city-wide average is made on the basis of combined sectional grill averages weighted in accordance with the percent-

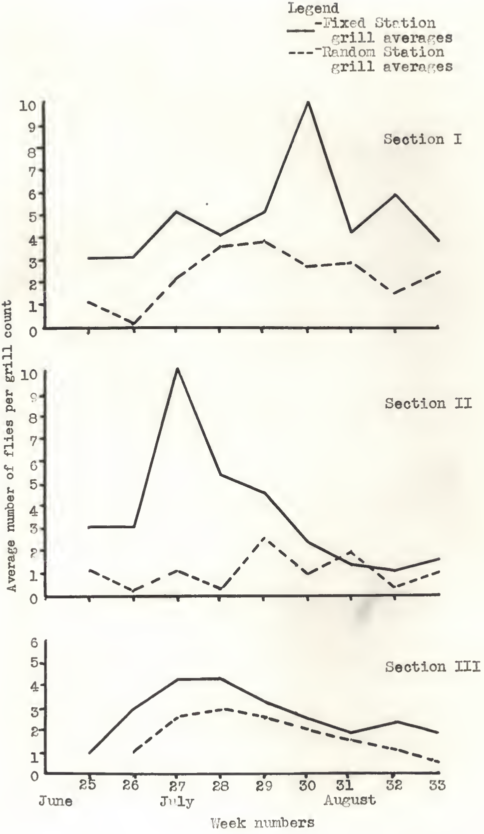

Fig. 3. Summary of weekly grill averages of fixed and random stations from June 26, 1950 (25th week) to August 26, 1950 (33rd week) at Manhattan, Kansas.

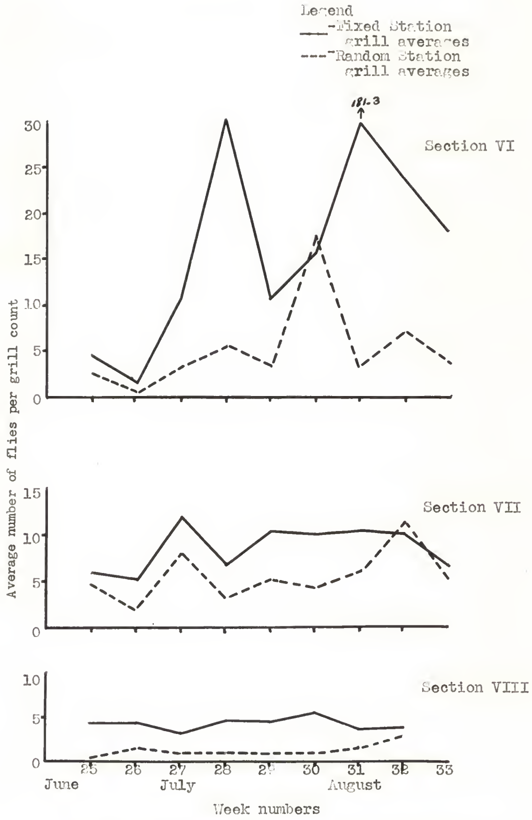

Fig. 4. Summary of weekly grill averages of fixed and random stations from June 26, 1950 (25th week) to August 26, 1950 (33rd week) at Lawrence, Kansas.

age of blocks in each section as related to the total number of blocks in the city. For example if Sections I and II each represented 25 per cent of the total number of blocks in the city with weekly grill averages of 6.0 and 3.0, respectively, and Section III represented 50 per cent with an average of 1.0, then computation of the weekly city-wide averages is made as follows:

Section I - 6.0 times 25% - 150
Section II - 3.0 times 25% - 75
Section III - 1.0 times 50% - 50

100)275

2.75

Hence 2.75 was the weighted, weekly over-all city grill average in the example given above. The sectional grill averages were obtained by combining the fixed and random block grill averages in each section. By this method the weekly over-all city grill averages for Manhattan were computed for the weeks 23 through 33 (June through August). Sections I, II and III, in Manhattan, composed 15 per cent, 10 per cent, and 75 per cent, respectively, of the total city area.

Through the courtesy of the USPHS Communicable Disease Center the same type of information, obtained in exactly the same manner, was made available for Lawrence, Kansas, in which no control measures were carried out. The weighted weekly over-all city grill averages for both cities are tabulated in Table 4.

A better perspective of the fly population in the two cities involved, can be obtained by comparing the curves (Fig. 5)

Table 4. The weighted weekly over-all city grill averages for Manhattan and Lawrence, Kansas, for weeks 23 through 33 (June through August 1950).

Town	Weighted weekly over-all city grill averages										
	Weeks										
	23	24	25	26	27	28	29	30	31	32	33
Manhattan, Kansas	2.1	0.6	0.9	1.9	3.6	3.5	3.1	2.5	2.0	1.9	1.5
Lawrence, Kansas	3.3	3.6	3.6	2.8	5.5	6.6	5.1	7.2	22.3	8.1	5.0

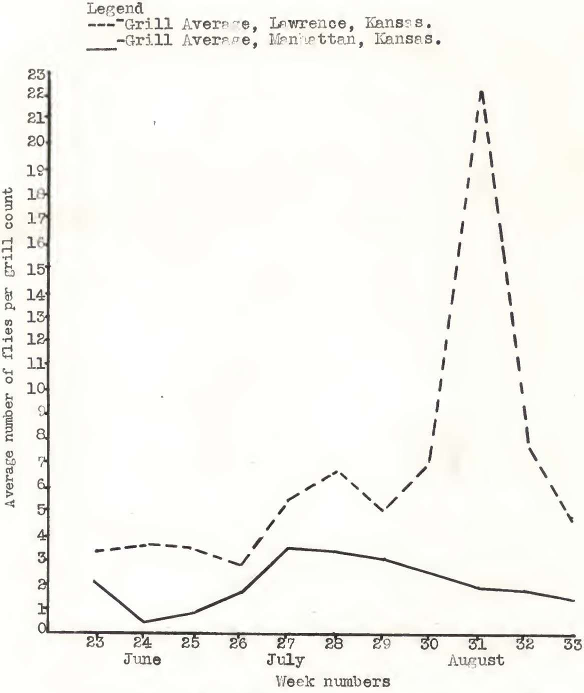

Fig. 5. The above graph shows the weighted over-all city grill averages from week 23 through week 33 for months June, July and August, 1950, for Lawrence and Manhattan, Kansas.

which resulted by plotting the grill averages. It is obvious that Lawrence (which served as a "check" or control) had higher fly indices than did Manhattan. The lowest over-all city grill average of Lawrence was 2.76 which was not far from the highest grill average of Manhattan (3.6) for the whole season's data.

The general trends of population were comparable from week 25 through 29 with the exception of a marked decline in fly densities at Manhattan at the end of week 24, following a rather thorough spraying operation in Section I and parts of Section II during that week. Although there was a steady decline in fly densities in Manhattan from week 29 through 33, the reverse was exhibited in Lawrence with a slight increase during the 30th week and continuing with an all season high grill average of 22.31 at the end of the 31st week. This population however, decreased as rapidly in the following two weeks as it had increased in the previous two weeks. No explanation can be offered for such a reaction other than the influence of climatic factors. Figures 6 and 7 show that M. domestica and Phaenicia spp. reached the same high peak at Lawrence during the 31st week, particularly in the business district and naturally would tend to increase the over-all city grill average.

The fly indices of Lawrence, which were used as a control or check, were assumed to be reasonably accurate and were compared with the fly indices of Manhattan since climatic and environmental conditions were approximately equal. The comparison indicated that approximately 70 per cent control of flies was obtained in Manhattan during the 1950 season. The per cent control was computed from the weekly weighted over-all city grill averages of both towns.

This can be compared with the results of an initial spray application in Hattiesburg, Mississippi in 1947 (Smith, 1948), where a reduction of 94.8 per cent in the fly index was obtained.

Climatic Factors Involved

Temperature, precipitation and presence or lack of sunshine undoubtedly had some effect on the fly population of Manhattan during the 1950 season.

The temperature (Table 5) at Manhattan during the month of June, 1950 ranged from a high of 100°F. to a low of 41°F., with an average of 74°F. This was only a -0.7°F. departure from the normal June temperature. However, during the month of July, a much cooler than normal temperature prevailed. The highest and lowest temperatures during July were 91°F. and 50° F., respectively, with an average of 70.9° F. The normal average July temperature is 80.2° F. Furthermore, only 2 days of that month reached a maximum temperature of 90° F. or above. A similar situation resulted regarding the August temperatures. The average maximum and minimum temperatures of Manhattan, are shown in the following data:

Temperatures, °F.	June	July	August
Average maximum	86.2	81.1	82.7
Average minimum	61.8	60.7	61.0

Table 5. A summary of temperature[1] conditions during the months June, July and August, 1950, at Manhattan, Kansas.

Month	Temperature							
	Av.	Depart. from normal	High-est	Date	Low-est	Date	Number of days: Max. of 90°F.	Number of days: Min. of 32°F.
June	74.0	-0.7	100	25	41	4	10	0
July	70.9	-9.3	91	1	50	14	2	0
Aug.	71.0	-6.6	91	16	45	11	2	0

Table 6. A summary of precipitation[1] during the months June, July and August, 1950, at Manhattan, Kansas.

Month	Precipitation									
					Snow, sleet, hail			No. of days		
	Total	Depart. from normal	Grea-test day	Date	Total	Max. depth on ground	Date	.01 or more	.25 or more	1.00 or more
June	3.61	-1.00	1.81	24	.0	.0		6	4	1
July	13.68	9.95	4.00	2	T	0		13	8	6
Aug.	3.98	-0.26	1.79	12	0	0		13	3	1

[1]Source: Garrett, Richard A., Climatological Data-Kansas, U.S. Department of Commerce Weather Bureau 64 (6.7,8) 1950.

The cooler temperatures experienced during the 1950 season tended to affect the fly density in three ways:

1. The flies did not multiply as rapidly, particularly during the cooler periods of July and August, as they normally would have done. However, to help offset the unfavorable temperatures for propagation, higher than normal amounts of precipitation made conditions favorable for fly breeding.

2. The effects of a toxic insecticidal residue are normally more lasting in cool temperatures but here again it was not possible to take advantage of such a normally favorable circumstance because it was accompanied by heavy precipitation particularly during the month of July (Table 6). Toxic effects of residues were decreased as the precipitation increased.

3. Cooler temperatures tended to decrease the number of flies per grill count.

In summarizing the effects of climatic factors on fly population, it was observed that while precipitation made situations favorable for breeding, it also made conditions unfavorable for spraying. The cool temperature, though it did not inhibit the production of flies, did on the other hand in some instances decrease the number of flies appearing on the fly grill while obtaining fly counts. All these factors must be taken into consideration in determining whether or not 70 per cent control is sufficient.

Breakdown of Fly Species

Some of the more important as well as interesting data obtained through these surveys were those of species breakdown. Accompanying each grill count, a species breakdown of the more prevalent and those of economic importance was procured, as shown in Fig. 2. For example a grill reading may have consisted of 29 flies; 17 of these may have been _Musca domestica_, 8 may have been _Phaenicia_ spp., 1 _Sarcophaga_ sp., 2 _Phormia_ spp. and 1 other species listed under "others" on the fly grill cards.

These species mentioned above, were identified macroscopically as they appeared on the fly grill; but determinations made were as accurate as possible.

These observations were made to provide data for showing the prevalent species at weekly intervals through the season as well as the species relationship to different attractants. It was further found that the fly control was to some degree affected by the type of species present.

Table 7 shows the species breakdown by giving the weekly grill averages for _M. domestica_, _Phaenicia_ spp., _Sarcophaga_ spp., and _Phormia_ spp. from week 21 through 33 (June, July and August) 1950 at Manhattan, Kansas. The breakdown is given separately for Sections I, II and III.

The species breakdown data for Lawrence, Kansas, which were used as a comparison with the data for Manhattan, were obtained in the same manner and were secured through the courtesy of the USPHS Communicable Disease Center at Atlanta, Georgia.

Table 7. Species breakdown showing the weekly grill averages for *M. domestica*, *Phaenicia*, *Sarcophaga* and *Phormia* species from week 21-33 (June through August) 1950 at Manhattan, Kansas.

Week	M. domestica	Phaenicia spp.	Sarcophaga spp.	Phormia spp.
		Section I		
21	1.09	3.11	0.26	1.69
22	1.29	3.82	0.32	1.40
23	0.24	0.64	0.14	0.25
24	0.84	0.92	0.19	0.07
25	1.08	0.89	0.11	0.08
26	1.60	0.27	0.09	0.00
27	4.29	0.94	0.07	0.00
28	3.82	1.22	0.02	0.01
29	4.61	0.93	0.02	0.00
30	5.47	0.38	0.01	0.00
31	3.41	0.94	0.01	0.00
32	2.95	0.42	0.00	0.00
33	2.74	1.07	0.02	0.00
		Section II		
21	-	-	-	-
22	1.17	2.81	0.30	1.55
23	-	-	-	-
24	0.50	0.64	0.21	0.04
25	1.20	0.83	0.10	0.00
26	1.20	0.17	0.03	0.00
27	3.73	1.57	0.03	0.00
28	1.69	0.20	0.02	0.00
29	2.24	0.67	0.00	0.00
30	1.13	0.02	0.00	0.00
31	1.35	0.42	0.00	0.00
32	0.53	0.27	0.04	0.00
33	0.86	0.23	0.00	0.00
		Section III		
21	-	-	-	-
22	0.43	0.56	0.40	0.80
23	0.24	0.75	0.25	0.41
24	0.21	0.52	0.30	0.08
25	0.19	0.29	0.16	0.04
26	0.39	0.58	0.14	0.02
27	2.00	0.76	0.07	0.02
28	2.68	0.73	0.07	0.00
29	2.18	0.60	0.03	0.00
30	-	-	-	-
31	1.24	0.57	0.00	0.02
32	1.01	0.57	0.04	0.00
33	0.56	0.42	0.03	0.00

Geographical and climatic conditions of Manhattan and Lawrence were similar enough, that some conclusive evidence might be obtained by a comparison of the species data.

In the species breakdown at Lawrence (Table 8) it should be remembered that the Sections VI, VII and VIII correspond to Sections I, II and III of Manhattan.

To obtain a better view of the species population and how they compare, the weekly grill averages for M. domestica, Phaenicia spp., Sarcophaga spp. and Phormia spp. were plotted on graphs.

Since Musca domestica Linn. (the common housefly) was the predominant species in both localities (Fig. 6), it was the logical species to consider first. M. domestica reached two major peaks in population in Section I (business district) of Manhattan, during the June through August season of 1950. The first peak was attaned during the 27th week (second week in July) with a grill average of 4.29 M. domestica per grill count. The second peak consisting of a grill average of 5.47 was reached during the 30th week (first week in August).

In Section VI of Lawrence (Fig. 6), M. domestica also reached two peaks of population; a grill average of 8.83 on the 28th week and 39.27 on the 31st week.

By examining Sections II and VII (Fig. 6), it is seen that M. domestica reached its major peak (grill average of 3.73) in the lower class residential district of Manhattan on the 27th week (second week in July). The lower class residential district

Table 8. Species breakdown showing the weekly grill averages for M. domestica, Phaenicia, Sarcophaga and Phormia species from week 21-33 (June through August) 1950 at Lawrence,[1] Kansas.

Week	M. domestica	Phaenicia spp.	Sarcophaga spp.	Phormia spp.
		Section VI		
21	0.17	0.47	0.03	0.40
22	0.40	1.43	0.10	1.80
23	0.53	1.33	0.20	0.70
24	0.77	3.53	0.03	1.23
25	0.83	2.33	0.07	0.30
26	0.07	0.67	0.00	0.00
27	1.57	4.43	0.07	0.30
28	8.83	6.67	0.23	1.07
29	3.63	2.23	0.07	0.40
30	11.40	3.20	0.00	0.83
31	39.27	19.00	0.07	0.67
32	10.97	2.20	0.10	0.33
33	6.93	1.80	0.13	1.03
		Section VII		
21	0.02	0.08	0.00	0.08
22	1.08	3.70	0.12	1.25
23	0.52	1.76	0.03	0.58
24	1.62	1.65	0.02	0.48
25	2.08	2.08	0.20	0.46
26	2.48	0.75	0.10	0.02
27	6.38	2.78	0.20	0.36
28	2.85	1.75	0.05	0.03
29	5.33	1.80	0.08	0.10
30	3.52	2.62	0.03	0.55
31	5.40	2.18	0.12	0.10
32	8.02	2.08	0.05	0.43
33	4.42	1.05	0.25	0.08
		Section VIII		
21	0.09	0.36	0.04	0.13
22	0.52	1.11	0.16	1.49
23	0.19	1.49	0.02	0.88
24	0.67	0.89	0.11	0.23
25	1.13	1.17	0.02	0.23
26	1.52	1.36	0.07	0.12
27	0.92	0.92	0.07	0.07
28	1.46	1.07	0.03	0.08
29	2.39	0.23	0.06	0.03
30	2.84	0.54	0.09	0.03
31	1.66	0.80	0.09	0.12
32	2.71	0.64	0.06	0.04
33	No inspections in this section this week			

[1]Sections VI, VII, and VIII of Lawrence, Kansas, correspond to Sections I, II, and III of Manhattan, Kansas, respectively.
Source: Communicable Disease Center, U.S. Public Health Service, Atlanta, Georgia.

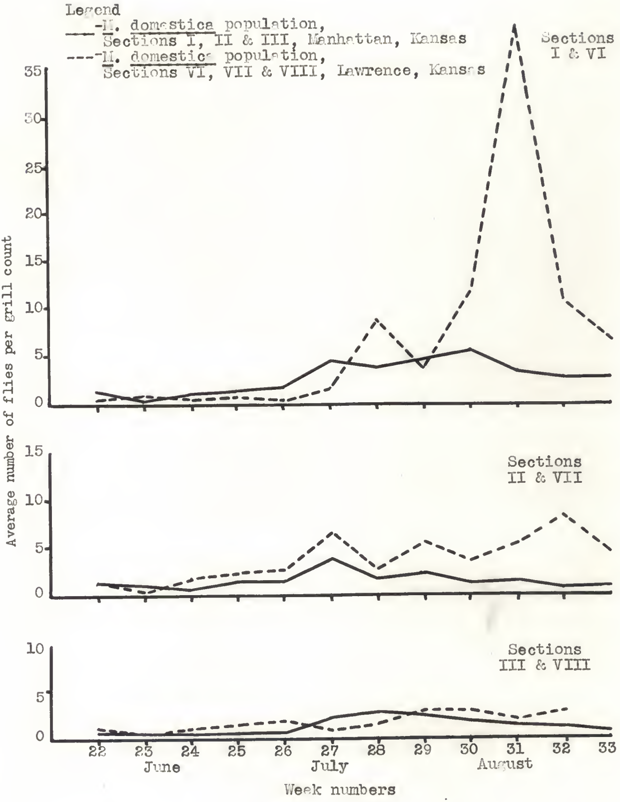

Fig. 6. A comparison of the *Musca domestica* L. densities during the weeks 22 through 33 (June, July and August) 1950, for Sections I, II and III of Manhattan, Kansas and for corresponding Sections VI, VII and VII of Lawrence, Kansas.

of Lawrence had a higher season average of M. domestica than Manhattan, with three peaks during weeks 27, 29 and 32, respectively.

According to the grill count averages in the higher class residential districts of both towns (Fig. 6, Sections III and VIII) there was no appreciable differential in M. domestica density in these areas, the highest grill count in either area was 2.84.

One factor responsible for the small variation in housefly population in the higher class residential districts of both towns is that spraying operations in that section in Manhattan were kept at a minimum due to existing low grill averages. In the case of Sections I and II (Manhattan) versus Sections VI and VII (Lawrence) the same general trends in M. domestica population, with slight variations, were followed. However, the density at Manhattan was kept at a lower level than at Lawrence, due to control operations (spraying) being carried out in the former town.

The second most commonly encountered species were those of the genus Phaenicia. This genus includes a group of blowflies, which are typically scavengers and are more commonly known as the greenbottle flies. The majority of the species present in this locality consisted of Phaenicia (= Lucilia) sericata (Meig.). These species were found most abundantly around dead animals, garbage and/or excrement.

The Phaenicia spp. population reached its highest point in Manhattan on the 22nd week or the first week in June.

During this week the grill count average was 3.82 Phaenicia spp. per block, which incidentally occurred in Section I or the business district. Considerable spraying was done during the 24th week in Section I and parts of Section II. For the remainder of the season the average was kept below 3.82 (Fig. 7).

In comparing the Phaenicia spp. population of Section I (Manhattan) with that of Section VI (Lawrence), both business districts (Fig. 7), it can be seen that the population at Lawrence reached high levels on the 24th, 28th and 31st week. The data regarding Manhattan, show that the Phaenicia spp. population was high during the same three weeks. However, the fly density of Manhattan was approximately only one-third that of Lawrence.

By further examination of Fig. 7, it can readily be seen that the trend of Phaenicia spp. densities with its fluctuations are very similar in the lower class residential districts of both towns (Section II and VII). Here again the population was consistently higher throughout the season in Lawrence, Sections III and VIII show almost an identical population pattern (with the exception of a slightly higher count in Lawrence) which could be expected since the spraying done in Section III of Manhattan was not very extensive.

Figure 7 indicates that the Phaenicia species presented more of a problem in the business district than elsewhere. Secondly it indicates that every three to four weeks there was a definite increase in the fly indices with a proportionately

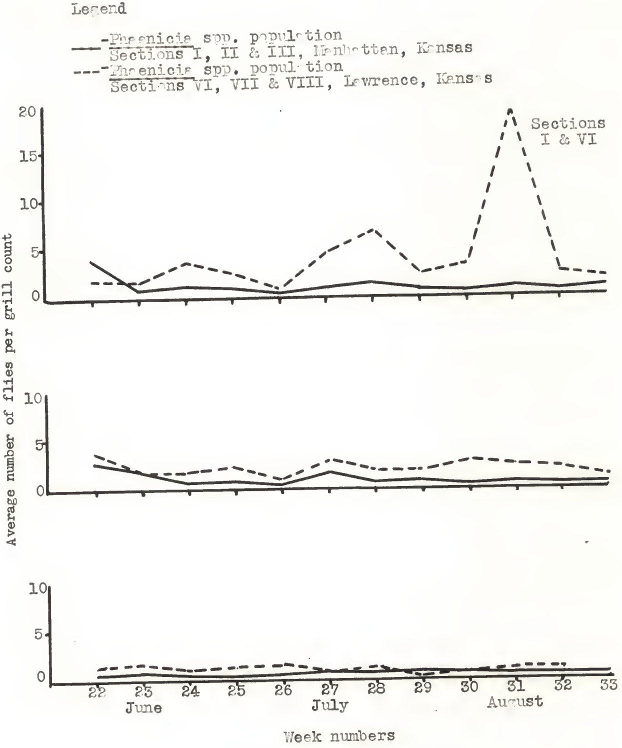

Fig. 7. A comparison of the *Phaenicia* spp. densities during the week 22 through 33 (June, July and August) 1950, for Sections I, II and III of Manhattan, Kansas and corresponding Sections VI, VII and VIII of Lawrence, Kansas.

higher peak at each interval as shown by the "check" at Lawrence but which was not the case at Manhattan since control measures were taken there.

A summarizing statement regarding *Phaenicia* spp. in these two towns can be made, namely that general population trends were very similar, with the counts at Lawrence being higher than those at Manhattan.

Flies of two other genera, *Sarcophaga* and *Phormia*, were encountered in sufficient number to be considered also.

The *Sarcophaga* spp., more commonly known as flesh flies, have a wide range of feeding habits but are primarily scavengers. They are usually found around carrion and mammalian excrements. They also are often observed on weeds and piles of grass clippings.

Phormia regina (Meig.), known as the black blowfly was the predominant species of the genus *Phormia*, but all species were recorded as *Phormia* spp.

At Manhattan, Kansas, both *Sarcophaga* and *Phormia* spp. (Fig. 8) exhibited the highest mark in population early in the season, during the 22nd week (early part of June). The highest average number of flies per grill for *Phormia* spp. at that time was 1.55 which existed in the lower class residential district (Section II). The density of *Sarcophaga* spp. was considerably lower and at no time during the season averaged higher than 0.4 fly per grill count. There was a close correlation in population trends in all three sections of Manhattan regarding the above two species.

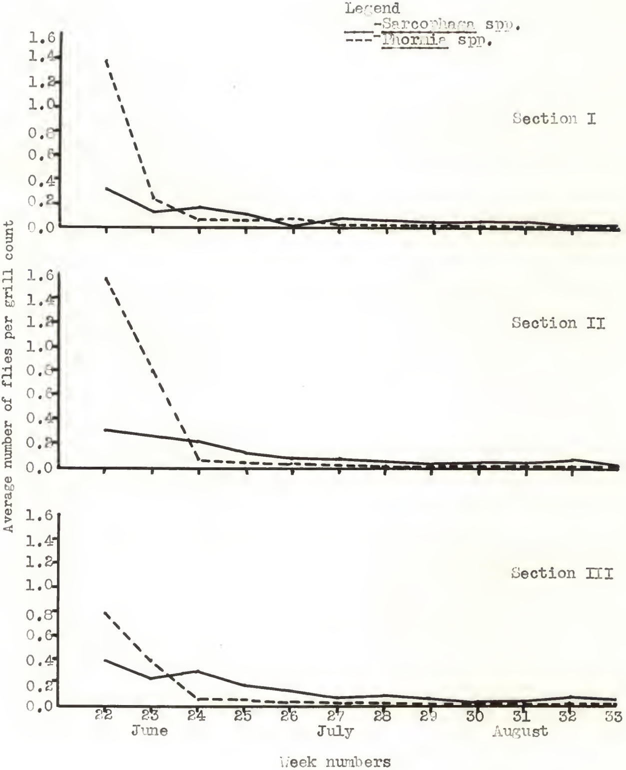

Fig. 8. Summary of grill averages of *Sarcophaga* spp. and *Phormia* spp. during the weeks 22 through 33 (June, July and August) at Manhattan, Kansas. 1950.

By examining Fig. 9, it can be seen that the *Phormia* spp. at Lawrence, Kansas, also reached its highest peak in all sections of the city during the 22nd week. This species appears to prefer the cooler temperature and has been referred to as a "cold weather" fly by Herms (1950). There is some inconsistency in the *Phormia* population of the business districts of both towns, since in the business district of Lawrence, three peaks of lower levels followed the highest peak of the 22nd week, whereas in Manhattan, the species practically disappeared. The only explanation to be offered is that of the effect of the control measures in Section I of Manhattan. The general population trend in Sections II and III (Manhattan) and corresponding Sections VII and VIII (Lawrence) is similar with no appreciable difference in number of flies per grill count (grill averages).

Other flies occasionally encountered were species of *Callitroga* (screw-worm) and the *Muscini* and were recorded as "others". This group actually made up a very small percentage of the city fly population.

Table 9 shows the percentage of various species for both Manhattan and Lawrence, Kansas during the months of June, July, and August, 1950.

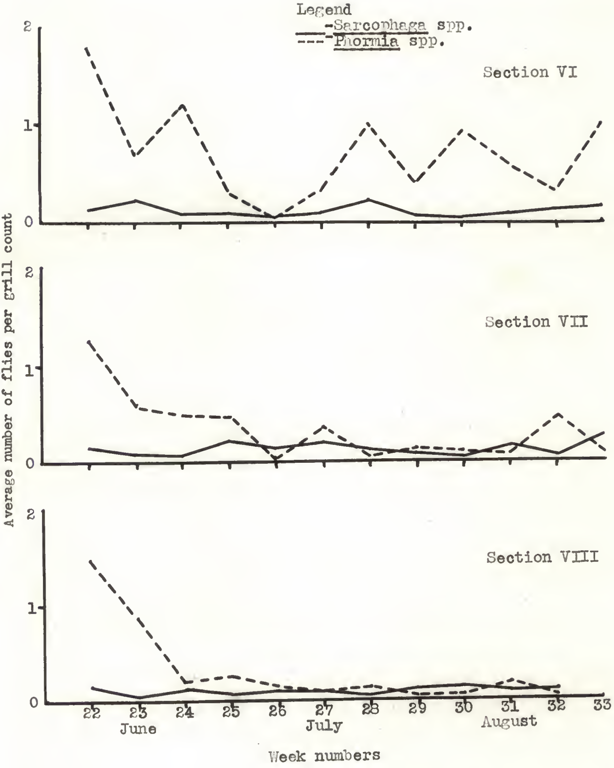

Fig. 9. Summary of weekly grill averages of *Sarcophaga* spp. and *Phormia* spp. during the weeks 22 through 33 (June, July and August) at Lawrence, Kansas, 1950. Sections VI, VII and VIII of Lawrence correspond to Sections I, II and III of Manhattan, Kansas.

Table 9. The relationship in per cent, of each species to the total fly population of Manhattan and Lawrence, Kansas for the months June, July and August, 1950.

Town	M.domestica	Phaenicia spp.	Sarcophaga spp.	Phormia spp.	Other
	Per cent				
Manhattan, Kansas	58.2	28.0	3.4	6.3	4.3
Lawrence, Kansas	54.4	31.5	1.2	6.4	6.4

The percentages of the more prevalent species correspond closely in both towns. From Table 9 it is evident that the majority of the fly population consisted of Musca domestica and Phaenicia spp.

DISCUSSION

In community fly control programs, the evaluation of the effectiveness of control measures is largely confined to measuring the fluctuations of adult fly densities. The program carried out at Manhattan, Kansas, followed the methds and principles set up and recommended by the Communicable Disease Center of the United States Public Health Service at Atlanta, Georgia.

The Scudder grill technique of measuring fly densities, which has been the recommended and most widely used procedure was also used in Manhattan. Recently (Schoof, 1951), reconnaissance surveys have received increased attention because of the rapidity with which they can be conducted, together with the realization that visual estimates of fly densities are not as grossly inaccurate as originally believed. Since community fly control programs vary in scope from those of a purely operational nature to those established for research purposes, the reconnaissance survey though adequate for a small operational program, may lack the degree of accuracy required on a research endeavor.

Reliance on the reconnaissance method further places greater dependence upon the inspector's skill and experience and removes the advantage of counting and identifying the flies at a single place of observation such as occurs with the grill. However, from a practical standpoint, the rapidity with which the reconnaissance method can be conducted enables a reduction in manpower requirements or with the same inspection force, permits an increase in the sample size.

At Manhattan, Kansas, the data were obtained from an approximate 16 per cent sampling of the total blocks in the city.

Although limited time for an increased entomological surveillance was a factor involved, a 16 per cent sampling, considering the manner in which it was conducted, was considered sufficient to give a rather accurate picture of the fly densities. Schoof (1951) referred to experiments where the relative fluctuations of fly densities derived from 100 per cent and 20 per cent samples in the same area approached similarity in reflecting trends in treated and untreated towns.

Regarding the feasibility of the program at Manhattan, approximately 70 per cent control was obtained at a cost of 9.6 cents per capita, exclusive of the cost of supervision. A similar program at Hattiesburg, Mississippi, and one at Columbus, Mississippi (Smith, 1948) cost 12 cents and 2.1 cents per capita, respectively, exclusive of supervision.

Since this program was operated on an experimental basis, additional funds were made available which otherwise probably would not have been attainable.

This type of program, including the grill technique and other features of the entomological surveillance, would not appear practical for operation in the average community, particularly from the standpoint of finances.

SUMMARY AND CONCLUSIONS

A community fly control program was carried out at Manhattan, Kansas, during the summer of 1950. This municipal campaign was co-ordinated with the Riley County Board of Health and the Kansas State Board of Health. The program was carefully planned and carried out, for the most part, according to procedures recommended by the Communicable Disease Center of the U.S. Public Health Service at Atlanta, Georgia. All data concerning fly densities were obtained by the use of the Scudder fly grill. These data were used to evalute the per cent of fly control and to supply information pertaining to the species encountered. Furthermore, the data concerhing Manhattan were compiled from approximately 16 per cent sampling of the total number of city blocks each week. Similar data from Lawrence, Kansas, served as a check or control and were made available through the USPHS, Communicable Disease Center at Atlanta, Georgia.

This study deals with data taken at both Manhattan and Lawrence, Kansas during the months June, July and August, 1950.

The following conclusions can be drawn from this study:

1. The most abundant species of flies in both cities consisted of *Musca domestica*, making up 58.2 per cent and 54.4 per cent of total fly population in Manhattan and Lawrence, respectively.

2. The *Musca domestica* population followed the same general trend in both cities, with an average of 1.8 and 3.8 *M.*

domestica per grill count at Manhattan and Lawrence, respectively. In the business district of Manhattan (which proved to be the outstanding fly problem of that city) two major peaks of M. domestica were observed during the 27th and 30th week, whereas in the Lawrence business district the two major peaks were reached during the 28th and 31st week.

3. The Phaenicia (blowfly) species were the second most abundantly encountered species in both cities. The Manhattan fly population consisted of 28 per cent Phaenicia species, while at Lawrence they made up 31.5 per cent of the total number of flies. The average number of Phaenicia per grill count were 0.8 and 2.2 at Manhattan and Lawrence, respectively. The density of Phaenicia in Lawrence, Kansas reached high levels on the 24th, 28th and 31st week. Phaenicia population at Manhattan was high during the same three weeks.

4. The population trends of Sarcophaga (flesh flies) and Phormia (black blowflies) species in both Manhattan and Lawrence followed the same general pattern. In both cases the trends indicate high population early in the season (June).

5. The major fly problem as indicated by consistently high counts, appeared in the business districts of both towns.

6. The weighted over-all city grill averages of Lawrence were consistently higher than those at Manhattan. In Lawrence the seasonal over-all city grill average was 6.6 flies per grill count compared with 2.1 for Manhattan.

7. Using the Lawrence observations as a control for the

Manhattan project, it was found that approximately 70 per cent control was obtained in Manhattan at the cost of 9.6 cents per capita, exclusive of cost of supervision or 13.9 cents per capita including supervision. The total cost of the Manhattan program was approximately $1,946.91.

8. The grill technique method of surveillance, though of considerable value in research endeavors, is too time-consuming and hence too costly to be practiced in practical community fly control campaigns. A method of reconnaissance survey would seem better suited for this type of problem.

ACKNOWLEDGMENTS

Grateful acknowledgment is extended to Dr. Paul A. Dahm of the Department of Entomology, under whose guidance and advice this work was undertaken. Acknowledgment is also gratefully extended to Dr. Roger C. Smith, Head of the Department of Entomology at Kansas State College, for his timely suggestions and criticisms.

Thanks are due to Dr. H.F. Schoof of the Communicable Disease Center at Atlanta, Georgia, through whose efforts and cooperation the data from Lawrence, Kansas were made available. Also to Mr. Pascal A. Roniger, Manhattan's city sanitarian, for his advise and supervision, as well as to Dr. F.P. Bestgen, the Riley County Health Officer. Acknowledgment is extended to Dr. Burton B. Hodgden, Public Health Entomologist with the Kansas State Board of Health, for his aid.

Appreciation is expressed to the city of Manhattan, Kansas, the Kansas State Board of Health and the Riley County Board of Health for financial assistance in making the project possible.

LITERATURE CITED

Baker, W.C. and L.G. Schwartz.
Preliminary studies on the control of blowflies with DDT. Public Health Report. 62:800-807. 1947.

Bishopp, F.C.
Flies which cause myiasis in man and animals - some aspects of the problem. Jour. Econ. Ent. 8:317-327. 1915.

Coffey, J.H., and H.F. Schoof.
The control of domestic flies. Communicable Disease Center, U.S. Public Health Service. 72 p. 1949.

Francis, J., G.C. Brown and L.R. Penner.
Search for extrahuman sources of poliomyelitis virus. Amer. Med. Assoc. Jour. 136:1088-1093. 1948.

Herms, W.B.
Medical entomology with special reference to the health and well-being of man and animals. 3rd ed. New York:McMillan. 582 p. 1939.

Herms. W.B.
The housefly in its relation to the public health. Berkeley: Univ. Calif. Agr. Expt. Sta. Bul 215:513-548. 1911.

Herms, W.B.
Medical entomology with special reference to the health and well-being of man and animals. 4th ed. New York:McMillan. 643 p. 1950.

Hodgden, B.B.
Community fly control manual. Kans. State Board of Health. 55 p. 1950.

James, M.T.
The flies that cause myiasis in man. U.S. Dept. Agr. Misc. Pub. 631:175 p. 1947.

Melnick, J.L., R. Ward, D.R. Lindsay and F.E. Lyman.
Fly abatement studies in urban poliomyelitis epidemics during 1945. Public Health Reports. 62:910-921. 1947.

Melnick, J.L.
Isolation of Poliomyelitis virus from single species of flies collected during an urban epidemic. Amer. Jour. Hygiene. 49:8-16. 1949.

Paul, J.R., J.D. Trask, M.B. Bishop, J.L. Melnick and A.E. Casey. The detection of poliomyelitis virus in flies. Science. 94:395-396. 1941

Sabin, A.B., and R. Ward. Flies as carriers of poliomyelitis virus in urban epidemics. Science. 94:590-591. 1941.

Schoof, H.F. Entomologic appraisal of fly control programs. Communicable Disease Center Bul. 10(2):25-28. February, 1951.

Scudder, H.I. A new technique for sampling the density of housefly populations. Public Health Report. 62:681-686. 1947.

Smith, W.W. Fly control in a small city by use of DDT-oil mist. Jour. Econ. Ent. 41:828-829. 1948.

Smith, W.W. Reduction of fly indices in the business section of a small city by the use of DDT residual sprays. Jour. Econ. Ent. 41:829-830. 1948.

Ward, R., J.L. Melnick, and D.M. Horstmann. Poliomyelitis virus in fly-contaminated food collected at an epidemic. Science. 101:490-491. 1945

Watt, James, and D.R. Lindsay. Diarrheal disease control. Public Health Report. 63:1319-1334. 1948.

U.S. Public Health Service. Communicable disease center manual of operations. May, 1950.

REPORT OF THE FLY CONTROL CAMPAIGN
IN MANHATTAN, KANSAS, 1950

by

CHRISTIAN CARL BURKHARDT

B. S., Kansas State College
of Agriculture and Applied Science, 1950

ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Entomology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1951

A community fly control program was carried out at Manhattan, Kansas, during the summer of 1950. This municipal campaign was co-ordinated with the Riley County Board of Health and the Kansas State Board of Health. The program was planned and carried out according to the procedures recommended by the Communicable Disease Center of the U.S. Public Health Service at Atlanta, Georgia. Fly densities and species data were obtained by the Scudder fly grill technique. These data were used to determine per cent of fly control at Manhattan; to evaluate the procedures used; and to provide data pertaining to the species encountered.

Control measures consisted of sanitation and application of 2.6 per cent water emulsion of DDT prepared from a 25 per cent emulsifiable concentrate. Weekly entomological inspections were made throughout the city, thereby sampling approximately 16 per cent of the total number of city blocks each week.

The data from Manhattan were compared with the data from Lawrence, Kansas, which served as a check or control.

The following conclusions were drawn from this study:

1. The houseflies, Musca domestica, composed 58.2 per cent of the total fly population in Manhattan. In Lawrence, Kansas, the total population consisted of 54.4 per cent M. domestica. The same general M. domestica population trends existed in both cities with an average of 1.8 and 3.8 M. domestica per grill count at Manhattan and Lawrence, respectively.

2. The *Phaenicia* (blowfly) species were the second most encountered species in both cities. The Manhattan fly population consisted of 28 per cent *Phaenicia* while at Lawrence, the *Phaenicia* made up 31.5 per cent of the total fly population. The average number of *Phaenicia* per grill count were 0.8 and 2.2 at Manhattan and Lawrence, respectively.

3. The population trends of *Sarcophaga* (flesh flies) and *Phormia* (black blowflies) species correlated rather closely in both cities with an indication of higher population early in the season.

4. The major fly problem appeared in the business district of both towns.

5. At Manhattan, a 70 per cent control of flies was obtained at a cost of 13.9 cents per capita, including supervision.

6. Climatic factors, particularly temperature and precipitation effected the per cent of control.

7. The grill technique method of surveillance is not practical from the economic standpoint, to be used in community fly control campaigns.