The new program is small in comparison with other operation programs of CDC; probably no more than a dozen projects can be activated this year with the limited funds available. In contrast to its size, the following results expected from the program appear prodigious:

(a) The focusing of attention on the areas of exceptionally high mortality rates of dysentery and diarrheal diseases.
(b) The acceleration of "general" sanitation programs by introduction of an additional motive, namely, fly control.
(c) The more rapid spread of technical information concerning fly control as a health measure, thus bringing relief to certain areas of high morbidity years in advance of the normal turn of events.
(d) The increase of fly control programs in areas of high dysentery-diarrhea morbidity and high fly density is expected to broaden the base of the findings of the work of Watt and Lindsay in Hidalgo County, Tex.
(e) The pilot projects introduced with Federal assistance and guidance are expected to induce similar practices in nearby communities having similar problems.
(f) The operation of fly control projects in numerous States under a variety of conditions should produce new techniques and advances in present fly control procedures.

Taken as a whole, the new dysentery-diarrhea fly control program may be regarded as another undertaking for CDC in the fields of epidemiology, entomology, and engineering.

Whereas the new program is starting out in a very small way, its implications for the future are very broad. The possible expansion in this field of endeavor will depend largely on the success attained during this coming season.

# A Preliminary Report of Studies on the EFFECTS on FLY ABUNDANCE of IMPROVED MUNICIPAL GARBAGE COLLECTION and DISPOSAL

DALE R. LINDSAY, Scientist
and
DUFFY E. McBRAYER, Sanitary Engineer

During the summer of 1948 considerable attention was given by the authors to an investigation of the sources of fly production in municipalities. This investigation was prompted originally by the overemphasis then placed upon the chemical control of flies. Failures of the most widely used of the chemical insecticides, DDT, in maintaining satisfactory fly control provided an added incentive to the study. Fly breeding sources in municipalities in New Mexico, Texas, and Georgia were investigated.

## CONDITIONS PROMOTING FLY BREEDING IN MUNICIPALITIES

Although no startling or unsuspected discoveries were made, it was determined that in most of the small cities the production of flies was due in large part to the improper handling of household garbage, both by individuals and by the municipalities, and of animal refuse by individuals. In the larger cities an additional fly production source was found in various organic wastes from such industries as canneries and other fruit and vegetable processing plants, and from meat packing plants. In the Southeastern States fly breeding conditions are enhanced by normal climatic conditions which provide moisture as well as a relatively

prolonged breeding season.

A condition common to all the areas investigated was the failure to enact or enforce ordinances to regulate or exclude livestock from municipalities. While fly breeding nuisances were thus maintained on much of the residential property, the systems of garbage collection and disposal were usually so deficient as to provide little incentive to the average citizen to clean up his premises. In the Southeastern States poor garbage collections were not improved by the prevalence of very large blocks with deep residential lots and without service alleys – a condition that required either increased operational man-hours of city garbage crews or individual cooperation in placing garbage cans along the street curb on collection days.

In spite of rapidly expanding sewerage systems in nearly all of the areas investigated, many small cities, and the peripheral residential areas of larger cities, had numerous pit and surface privies. Since these are frequently both producers of flies and potential reservoirs of human enteric diseases, they operate with other and more important fly production sources to create a distinct hazard to human health. This factor alone is sufficient justification for increased expenditures by municipalities in improving both garbage and sewerage facilities. Whereas the extension of sanitary sewerage involves a significant expense, both to the municipal government and to the property owner it serves, the improvement of a garbage collection and disposal system was believed possible in many instances without substantially increasing city costs. For this reason the study described below was undertaken. Although the study is still in progress certain preliminary results are noteworthy, and together with the above presentation of the conditions normally existing, should be of value in planning improvements in municipal and environmental sanitation.

## OBJECTIVES OF THE STUDY

1. To determine the degree of fly control that could be attained through improved garbage collection and disposal in a municipality.
2. To determine by epidemiological methods the effects, if any, of such control upon human enteric diseases.
3. To determine some of the important cost-amortizing possibilities of improved sanitation so that monetary as well as welfare gains over a period of time may be pointed out to financially handicapped cities.

## SELECTION OF STUDY AREAS

In order to attain the above objectives it was essential that this study be conducted in the general area in southern Georgia where a study of the effects of fly control measures upon the morbidity rates of human diarrheal diseases was already under way. Two comparable municipalities, each with populations of 15,000 to 18,000, were selected. At the time the studies were being planned, both cities had deficient garbage-collection schedules averaging one collection weekly in residential areas; both cities had numerous livestock enclosures and pit or surface privies. The only difference in city sanitation was in the method of garbage and refuse disposal. In City I an area fill, located about 1½ miles north of the main residential area, was used. The garbage placed in the fill was poorly compacted and covered once or twice a week with a layer of dirt of highly variable thickness. Although this method served to bury the refuse, it imposed very little restriction upon fly emergence from the already heavily maggot-infested garbage. In City II garbage and other refuse were piled on an open dump, located at the northwest corner of the city. Some control of fly breeding was attempted at this dump through burning of combustible refuse. Approximately 150 city-owned hogs were penned on the dump and served to increase the surface area of fly breeding material through their foraging activities. In both cities the weekly collection schedules, frequently interrupted by weather or by equipment breakdown,


In a sanitary land fill, each day's collection of garbage should be compacted in a cell with a 2 foot cover of dirt.

favored excessive amounts of fly breeding in the garbage. Emergence rates of flies from such garbage, collected from both fixed and random sites, reached a figure of 1,500 flies per day per garbage can and consisted of many species with *Phaenicia pallescens* (Shannon) predominating at 95.0 percent and *Musca domestica* Linn. included at 1.5 percent.

The county in which City II was situated had participated during 1948 in the Malaria Control Program, and thus the residents of City II could request a free residual application of DDT in their homes. Records for the 1948 season revealed that not more than 15 percent of the homes in this city were thus sprayed and the authors felt that the over-all effects of this spraying upon the city's fly population would be negligible. This feeling was supported by high fly indices found in the city during 1948 and was further substantiated by records during the 1949 season when little, if any, effect upon house flies out-of-doors was noted. City I had enjoyed no such services, and only DDT applications by individual householders were expected.

On the dual basis of the willingness of city officials to cooperate and the fact that results would not be obscured by the effects of widely used chemical insecticides, City I was selected as the site of intensified sanitational measures during fiscal year 1950, for comparison with normal procedures in City II.

## METHODS USED

The following arrangements for increased sanitational services were made with the officials of City I in order to provide suitable conditions for the study.

1. Garbage collections were increased from one per week to three per week. Three-times-per-week garbage collection effectively curtails fly breeding in garbage. In twice-weekly collection schedules, maggots of the genus *Phaenicia* can reach maturity during the intervals between collections and enter the adjacent soil to form puparia prior to emergence as adult flies.
2. The area fill method was discontinued and a daily-operated sanitary land fill was started on the same site. In order to shrink the operational costs of hauling garbage the authors recommended that this operation be moved into or nearer the city, but city officials demurred on the basis of nonavailability of suitable city-owned land. In addition a smaller machine (1 cubic yard capacity) than previously used (2 cubic yard capacity) was put into service on the sanitary land fill to further reduce maintenance costs. In addition to reduced operational cost the initial cost of this machine was approximately one-half that of its predecessor.
3. In order to obtain suitable cost figures on the comparative costs of back-yard versus street-curb collection of garbage, the cooperation of the householder in the latter was simulated by city crews who placed the cans along the street-curb in advance of the truck.
4. Enforcement of city ordinances regulating the holding of garbage, industrial refuse, domestic livestock, and the like was promised by city officials.

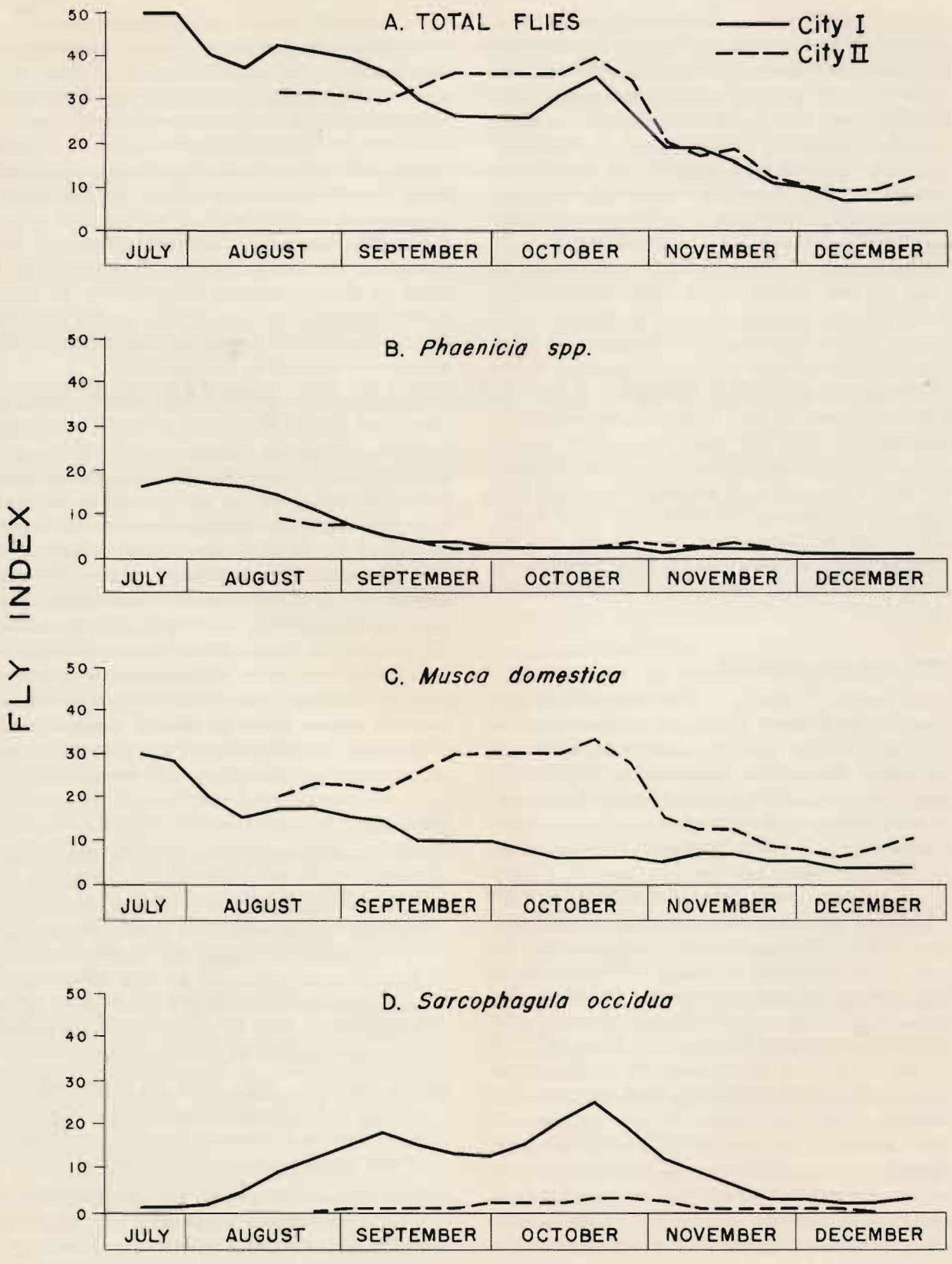
## PROGRESS TOWARD OBJECTIVES

The intensified sanitational program was begun in City I early in August 1949. By mid-August the accelerated garbage collection schedule was operating fully, and after one week of operation the fly maggots had almost completely disappeared in garbage containers and in garbage brought to the sanitary land fill. Since the pupation period of *Phaenicia* spp. may last as long as 2 weeks under field conditions the curtailment of adult fly populations of this genus was not great until late in August.

During this same period breeding conditions became favorable at a peanut processing plant centrally located in City I and the resultant emergence of adult house flies, *M. domestica*, caused a temporary rise in the index of this species. In view of the other studies in progress it was decided to use a mist sprayer in applying DDT in the immediate three-block vicinity of the peanut mill in order to be able to observe results of the intensified garbage program. This was done on a weekly basis for 5 weeks and constituted the only use of a chemical insecticide in the study of City I.

Although operation of a sanitary land fill was begun on schedule, and immediately accomplished the desired prevention of fly breeding with relative ease, the most efficient operation of the equipment was not attained until January 1950. Cost records during the remainder of the study should be sufficient for purposes of determining operational costs.

Meanwhile officials of City II, the comparison




FSA-PHS CDC-ATLANTA, GA. APRIL 1950

city, had decided to undertake a fly control program of their own design. Between the dates of July 15 and September 1, 1949, they effected a 3-times-per-week garbage collection schedule, but did not change their method of disposal. In addition they purchased and dispersed, partially by knapsack sprayers and partially by mist-blower machine, 5,000 gallons of a commercially prepared 5 percent DDT solution in oil. Garbage can spraying with this material took place in City II throughout the summer of 1949; city-wide applications by a mist-blower machine were made twice weekly during the two periods of July 8 to August 1 and August 20 to September 11. Because of these changes, which do not permit a comparison of the 3-times-per-week garbage collection system of City I with one of less frequency, an additional municipality, City III, has been added to the study. City III, situated in the same general area and with a population of approximately 6,000, has twice-weekly garbage collection, an open dump, and animal enclosures and privies proportionate to those found in Cities I and II. City III has been under entomological surveillance since February 1950.

## PRELIMINARY RESULTS

The results of the intensified sanitational program in City I during the first 5 months of operation, as compared with the intensified sanitational and added insecticidal operations in City II, are shown in the chart. While consideration of the total species index, part A, appears to show equal results from both of the programs, a breakdown of the total fly counts into species, parts B, C, and D, reveal interesting features. In part B the *Phaenicia* spp., breeding primarily in garbage, have indices of approximately equal magnitude in both cities indicating a similar effectiveness in both garbage collection programs. In part C the index of the common house fly, *M. domestica*, is about three times as high in City II as in City I during the months of maximum effect (September and October) until curtailed in both cities by cool weather. The significance of this is apparent from inspection records which reveal that high fly indices were obtained in the northwest section of City II nearest the dump and are undoubtedly a reflection of migration from the open dump into the city. Such house fly breeding as reflected in the index for City I was determined by surveys to be occurring in improperly maintained animal enclosures, primarily where cows, horses, and mules were stabled. In part D, the index of *Sarcophagula occidua* Fabr. began rising in City I about the time that the garbage collection was intensified and remained high until curtailed by cool weather. Since the breeding of this species is most often encountered in the excrement of carnivorous animals, including man, the garbage program would be expected to have little effect upon its abundance. The index for this species remained low throughout the season in City II, probably as a result of the insecticides dispersed by the mist-blower machine. In other towns in the area the authors have found space-spraying methods very effective in controlling this species.

It appears, therefore, that the difference between City I and City II which may be ascribed to sanitational methods is limited to the effects of a sanitary land fill, even though improperly operated during the period shown, as compared to an open dump where sporadic efforts were made by City II to control the flies by insecticidal means. This does not mean, however, that there were no measurable effects of the intensified sanitational program. On the contrary, as concerned with garbage collection alone, these effects were spectacular in both areas. Both cities still have much to accomplish in obtaining the maximum sanitational effect upon fly control primarily through enactment and enforcement of ordinances to prevent sanitational malpractices in the keeping of livestock.

## SUMMARY


1. The general results of an investigation into the primary sources of fly production in municipalities located in New Mexico, Texas, and Georgia are presented. A preliminary account of the effort to apply the garbage handling improvements indicated by this investigation as fly control measures in a municipality in the Southeast, is given in order to point out some of the basic features of such measures.
2. The objectives of the study are to determine the effects of the possible improvements in garbage collection and disposal upon fly abundance, human disease, and operational costs.
3. The methods employed and the progress in effecting the improvements are given, as are the preliminary results obtained. Fly breeding in garbage, both in cans and at the sanitary land fill, virtually was eliminated by the accelerated

collection and disposal system. House fly breeding remained a problem but originated primarily from animal enclosures, pointing out the need for enforced ordinances to regulate livestock within the city. The difference in house fly indices between Cities I and II is due primarily to the house fly breeding in the open dump at City II. The spraying program in City II is believed to have been primarily effective in the control of the excrement-breeding fly, *Sarcophagula occidua.*

4. In addition to cost data the results of the study will yield data on the effects upon fly densities and human disease in: (a) City I with 3 garbage collections per week and an efficient sanitary land fill; (b) City II with 3 garbage collections per week but with inadequate disposal; and (c) City III with twice-weekly garbage collection subject to some variation and inadequate garbage disposal.

# CONSIDERATIONS IN SAMPLING FLY POPULATIONS

**JUDSON U. McGUIRE, JR., Assistant Sanitarian (R)**
**and**
**DALE R. LINDSAY, Scientist**

In recent years many programs for the control of house-frequenting flies have been undertaken. As might be expected in such developmental programs, greater emphasis has been placed upon the methodology of control operations than upon the measurement of the fly populations. Various devices have been used in evaluating the effectiveness of the fly control measures, such as baited fly traps, tanglefoot tapes and sheets, and time counts over uniform attractants. The fly grill developed by Scudder* has been perhaps the most widely used of these devices in programs sponsored by the Communicable Disease Center. However, the application of the grill has varied between programs, and this lack of uniformity in the methods of taking and interpreting fly population samples has prevented really accurate direct comparison among programs.

The need for a standard method of sampling fly populations is indicated, not only to facilitate the evaluation of fly control operations but to make possible the correlation of the results with standard epidemiological measurements. A reliable sampling method should have the following characteristics:

1. It should be repeatable, and objective.
2. It should be useful in guiding control operations.
3. It should be economical to apply.
4. It should supply data which are suitable for statistical analyses.
5. It should be applicable over wide geographic areas.
6. It should be adaptable to a wide range of conditions.

The following discussion of the methods established and in use by the authors and their coworkers on an experimental study in south Georgia is presented for consideration by other programs.

## PREREQUISITES TO SAMPLING

The following steps were followed in establishing the sampling program on the experimental project under discussion.

1. Maps of the cities were obtained and brought up to date. Besides large office maps, small notebook-size reductions were made for field use.
2. All blocks in the cities were numbered for easy reference.
3. The cities were divided into sub-areas of about 10 blocks, or a 10 percent sample, except that in the high-income residential districts, sub-areas of 20 blocks, or a 5 percent sample, were used. Sub-areas which included industries with

*Scudder, H. I.: A New Technique for sampling the density of housefly populations. Pub. Health Rep. 62:681-686 (1947).