FLY CONTROL AND THE ACUTE DIARRHEAL DISEASES

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In the majority of diseases with known arthropod vectors, the vector plays an integral part in the life cycle of the parasite. Therefore, control measures designed to eliminate the vector can be expected at the same time to eliminate the disease. The diseases, however, in which flies are believed to play an important role, in general do not fall into this particular classification and those which do will not be considered in this discussion. We are concerned chiefly with those infections in which flies may play an accessory role, more specifically the enteric infections, which still are a major cause of illness in a large part of the world.

Almost since the beginning of the science of bacteriology, the spread of enteric infections has been credited in part to flies. For typhoid fever we had the old alliteration of "food, fingers, and flies" as a description of the transmitting agents. Yet control measures designed to prevent mass spread of this disease by improvement of water, milk and shell-fish supplies, and the control of chronic carriers, have brought this disease to the point of practical elimination in many areas without any specific fly control programs. These measures have not been as effective in the reduction of infections with the Salmonella and Shigella groups of organisms, and while the fly has been suspected in the spread of these bacteria, until recently we have never known just how important they were in the dissemination of these micro-organisms.

With the advent of new potent insecticides, we have been able to evaluate the effect of fly control in at least one area. I should like to show briefly the results obtained in an area where flies are abundant and diarrheal disease is a major cause of illness and death[1]. The first chart shows curves of fly counts made in two groups of towns in the same county in Texas. Fly control activities were carried out in five towns (Group A) and in four other towns (Group B) there were no control activities during 18 months. The method used to determine these two levels of fly abundance has been described elsewhere. In brief, it consists of employing a uniform surface on which flies can be readily counted. This surface, composed of a series of slats fastened to a frame, is called a grill. In use it is placed over an area where flies have congregated so that the disturbed insects can and do come to rest on the slats and are counted. Averages of such counts are shown in the chart.

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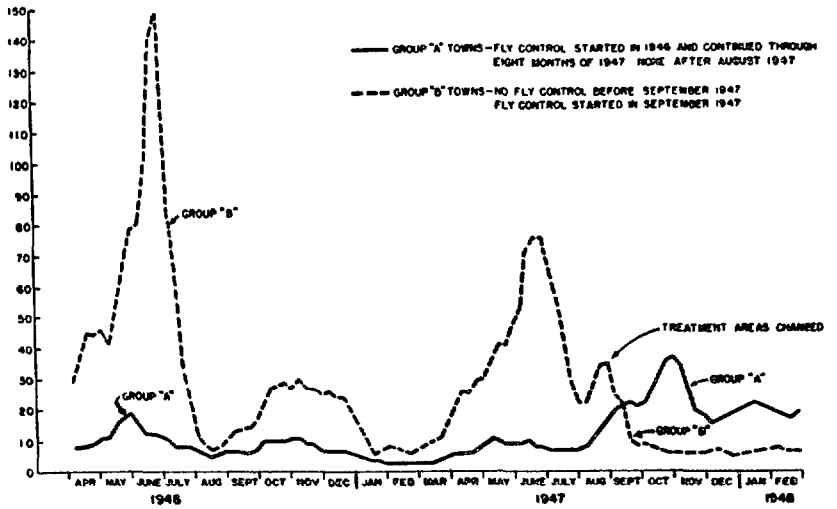
[1] Watt, James and Lindsay, Dale R.: Diarrheal Disease Control Studies. I. Effect of fly control in an area of high morbidity. Pub. Health Rep., Vol. 63: No. 41, pp. 1319–1334.

A definite differential in fly level was maintained throughout the study. During the first 18 months, control activities were carried out in the Group A towns. At the end of that period, control operations were stopped in the original towns and transferred to those which had served as a comparison area. As you will notice, within a matter of two weeks, the fly levels had been reversed and for the first time since the beginning of the study, a higher count was found in the Group A towns.

CHART I.—*Three week moving average of high grill index of total flies.*



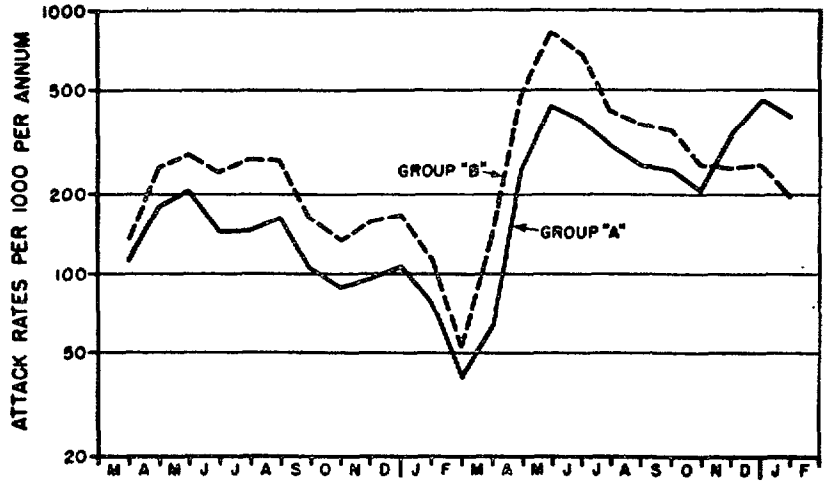
The effect of this fly control on the human population was measured in three ways: first, its effect on infection as found by cultures of normal population groups; second, its effect on disease as determined by histories taken each month in the same population groups as were cultured; and third, the effect on reported mortality from diarrheal disease in the two areas. The second chart shows a comparison of the results in the two areas using two of these measures.

Graph 1 at the top plots the attack rate per thousand per annum of reported diarrheal disease in children under 10 years of age. As was true with the fly counts, the attack rate was highest in the Group B towns throughout the first 18 months. After fly control measures were shifted from Group A to Group B in September, the lines began to converge, and by the end of November had crossed, with the Group A towns reporting a higher attack rate from then on.

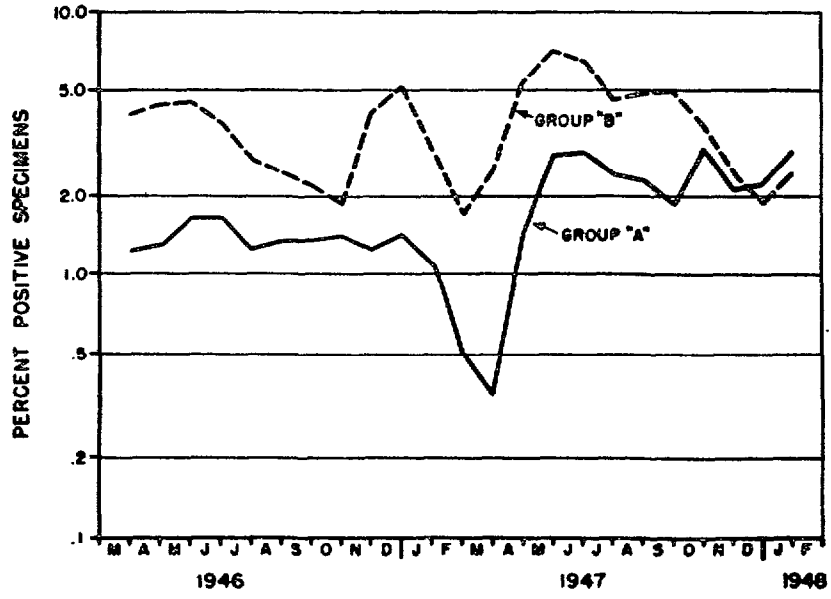
Graph 2 shows the percentage of children under 10 years of age with new Shigella infections, without regard to whether or not diarrhea was present. This is a two months moving average of the percentage of

positive cultures among all the cultures taken. The cultures were made on individuals without reference to previous or present history of diarrheal disease.

CHART II.—GRAPH I.—*Attack rate per 1000 per annum of reported diarrheal disease in children under 10 years of age—2 months moving average.*

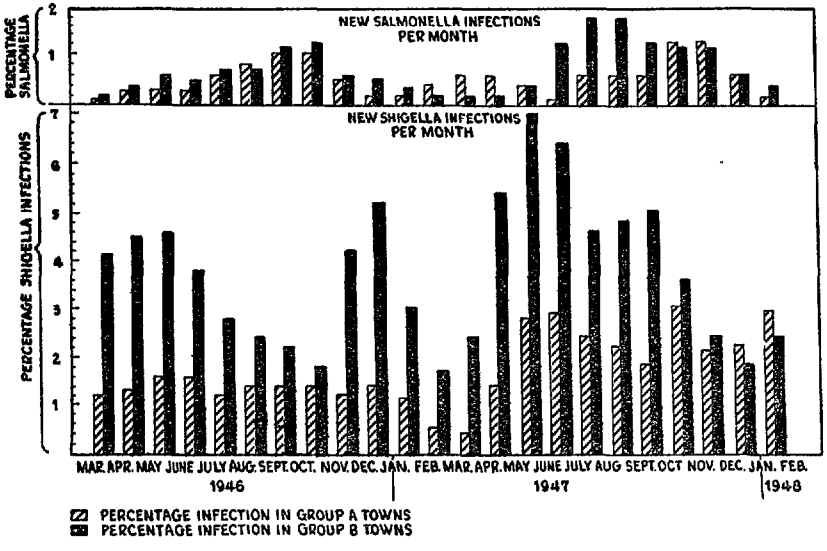


GRAPH II.—*Percentage of children under 10 years of age with new shigella infections—2 months moving average.*



The similarity of these two graphs is striking. Again the rate is consistently higher in the Group B towns throughout the study period until the change in treatment areas. The lines then converge and cross, again towards the end of November. Not shown on the graph are the results of cultures taken in April and May, 1948. These showed that the differential established in December had continued and had increased, in that we found slightly over 10 per cent positive in the Group A towns as contrasted with 4 per cent positive in the Group B towns. Mortality rates showed the same pattern as the other comparison measures.

CHART III.—*Percentage of stool cultures positive by treated and untreated towns two months moving average.*



Thus it is evident that in an area where diarrheal diseases are prevalent and flies common, we can expect very real benefits from control of these arthropods. At the same time, I think we must concede that other measures are needed if we are really to control the diseases under discussion, since we still find, in spite of our best control activities, that a significantly high attack rate is recorded in those areas where treatment measures were being carried out. A part of this may be due to incomplete control of these insects. On the other hand, we know that Shigella infections can and do spread widely in many population groups in the complete absence of any flies. It therefore is essential in considering inauguration and extent of control activities that we first evaluate, for the specific locality concerned, the extent of the problem both as regards the disease and the vector. This is emphasized in Chart III, in which the curve of prevalence for Salmonella infection is shown with the curve of prevalence of Shigella infection. As you saw in the preceding chart,

fly control definitely modified the shape and form of the curve which represents infections with the Shigella group, but this is not the case with the Salmonellas. An age specific analysis (not in the chart) of the Salmonella infections did show that in each age group fewer infections occurred in the treated area than in the untreated area. In spite of the uniform reduction in infection when fly control was carried out, it is apparent that treated and untreated areas showed a similar variation in prevalence. Furthermore, this general trend did not conform with that of the fly curve. Consequently, we cannot expect fly control activities to be as beneficial in areas with high infection rates due to Salmonella as we can in areas where the Shigellae are relatively more common. A similar lack of benefit may be found in areas where infection rates for Shigella are low compared with the area in which our observations were made. Where rates are relatively low, it is probable that a higher proportion of the infections are spread by person to person contact.

I believe that we may conclude from these studies that flies do play an important role in the spread of enteric infection under conditions similar to those in our study area. As a corollary to such a conclusion, we may state that fly control on a large scale is a proper field of health department activity.

CONTROL METHODS

Having decided that fly control methods should form an integral part of health department activities, what do we know about fly control methods? All of us have seen the reports of spectacular successes achieved in the control of these insects with some of the new insecticides. I wish it were as simple as many of the feature writers would have us believe. We have been studying fly control methods now for almost three years, and the clearest conclusion that can be reached from all of our work is that insecticidal methods alone were not the answer to this problem.

Reference again to Chart I, I believe, will clearly demonstrate this point. We did not eliminate the flies from the treated area at any time, and there was some seasonal change in spite of our best efforts. The smoothing effect of an average also conceals the fact that at times we did have localized high fly levels even with the best insecticidal methods known to us. Nature demonstrates another important consideration. The drop in counts occurring after the first of July 1946 is as spectacular as could possibly be achieved by any man-made control method. The flies in the uncontrolled area reached a level almost as low as that found in the treated towns. This drop was due to seasonal conditions, for in June the weather becomes hot and dry, and the end of the harvest of the field vegetable crops brings also the end of the canning season. When the canning wastes cease to accumulate, these major breeding areas and many others are eliminated by the dryness. A third and more obvious

consideration is the rapidity with which the fly levels were reversed in the two areas after treatment was changed. We brought about a prompt fall in fly levels in the Group B towns and the effect of our control activities in Group A disappeared almost as soon as we stopped spraying. However, the drop due to treatment was no sharper than the one in the preceding year, or for that matter in July of the same year when nature wiped out the breeding places.

In other words, the control activities based on insecticidal means alone, at best, held fly populations in check only as long as operations were continued. When the spraying stopped, so did control. It seems almost like stating the obvious to say this, and yet it must be emphasized. One has only to read the many popular articles on the "miracle insecticides" to realize how completely the use of these products has seized the popular fancy, and many officials, through lack of experience, have invested in machines whose work at best is inefficient and frequently results in a complete waste of money. The same basic objections are applicable to any program which is based on larviciding by chemical means. Here, too, we are in effect attempting to use curative medicine rather than stick to our own particular profession of preventive medicine.

As stated in the beginning, we are concerned with a group of insects, principally the non-biting muscoid flies, which serve as incidental or accidental vectors of disease. These flies are not definite hosts of Shigella organisms or of many other disease agents for whose spread the fly has been blamed, but for which no actual proof of his role is available. There are literally thousands of species of flies, but fortunately we need to consider only a limited number. The characteristic which is important to us is that they live in close proximity to man and depend upon organic material associated with man for both larval and adult food. Recognizing this, we may plan fly control on the basis that only flies associated with man are potentially dangerous and that these are to be controlled regardless of some of the specific details of their ecology. Surveys made in a number of areas indicate that these flies are bred and fed by man, not intentionally, of course, but none the less effectively. In our major cities garbage usually accounts for the greater portion of the fly breeding. In smaller towns and rural areas, in addition to household wastes, refuse from various canning and food processing industries becomes a major factor. In the South of Mexico, I am told, one of the worst fly breeding materials is the refuse from processing henequen, the pulp of which is discarded after the fibre has been extracted.

If these by-products of man's life and work were properly disposed of, the major part of our fly problem would be solved. Industries which create these hazards can be regulated and as a general rule are glad to cooperate in any program designed to care for their wastes effectively. Individual householders can and should be made to cooperate with the municipal housekeeping program to the extent of preventing breeding

on their own premises. This pre-supposes that the towns themselves will undertake and carry out routine garbage collection, which shall be uninterrupted during the fly breeding season. Such a program, of course, is not only a part of fly control, but provides an extra dividend in that it is also an essential part of rat control, another important activity of any health department.

In the smaller towns, in addition to the refuse from man's kitchen and his factories, we have other major sources of fly breeding. Their importance will vary tremendously according to the character of the country. Domestic animals, when improperly cared for, easily create fly breeding conditions. Most foodstuffs satisfactory for cattle and horses can serve as excellent fly breeding media and when spilled in a moist area, will quickly create a major fly breeding site. Improper disposal of manure will also contribute to the problem.

Another important possibility is human excrement. When improperly disposed of in poorly constructed privies, or in the open where shade and moisture are present, it becomes a fly attracting and breeding medium. Since human excrement is probably the only source from which flies can become infected with members of the Shigella group, this may be the really crucial factor in control of these infections as far as flies are concerned.

What, then, should be our approach in planning a health program to control those diseases in which the fly does or may play an important role? First, we should evaluate each particular locality to determine, insofar as possible, whether or not the flies present in that area are actually playing any part in the transmission of those diseases. In doing this, we can also determine predominating fly species. This latter point is important. There will be major variations from place to place and from season to season, and, while there is considerable overlapping, certain characteristics in the ecology of each species will let us institute more effective control measures when these features are known.

Second, having determined that fly control is desirable, we should set up a program designed to eliminate breeding areas. This includes first the adequate disposal of garbage; second, the adequate disposal of human excreta; third, proper care and feeding of domestic animals so that a fly breeding potential is not created; and finally, careful supervision of all industries with a waste disposal problem which can constitute a fly breeding menace.

Finally, we come to the role which can be effectively played by insecticides and larvicides in fly control. Basic sanitation procedures cannot be accomplished overnight, and while such a program is getting under way, insecticidal activities can bring about a marked reduction in the fly population. There are a number of methods used in applying insecticides. In essence they are either space spray techniques or

residual spray techniques. A great deal of publicity has been attached to some of the more spectacular space spray methods, particularly the use of the airplane. This method is of proven value in malaria control, but it is doubtful if airplane techniques have any place in civilian fly control procedure. Effective fly control demands a much heavier dosage than is necessary for mosquito control, and DDT is not effective as a fly larvicide. Space sprays, therefore, must contact the adult insects if they are to be effective. It should be obvious therefore that an airplane will not do as efficient a job of fly control as will methods which can be more effectively regulated. A number of ground spray machines are available and they all have one or another special feature. Ideally, such a machine should be adaptable to all of the varying conditions of urban life, and its use should not be limited completely by weather, convection currents and other factors of this sort. The guiding principles of the evaluation of any space spray technique should be (a) mobility; (b) ease of control both in direction of spray and quantity of material applied; (c) usefulness under varying weather conditions; and (d) ease of maintenance and repair.

Residual sprays which kill by contact are relative newcomers to insecticidal fields. They have earned their place in malaria control. In fly control we know that they are very helpful in maintaining low fly populations in unscreened dwellings, dairies, barns, and other types of farm buildings. The choice between methods is dependent upon local conditions, and at present our knowledge is not sufficient to permit rule of thumb directions. In general where fly control is being instituted simply as an abatement procedure while basic sanitary clean up is being carried out, a space spray method will have the widest application. During this same period, adequate inspection service will show many new and unsuspected fly breeding areas. Larvicides such as orthodichlorobenzene, applied to these areas will have a dramatic effect on the fly population in the immediate future, and their use is justified if prompt and effective action is taken to prevent a continuation of the practice, whatever it may be, which brought about the creation of this particular problem.

Even after an improved municipal housekeeping program has reached its maximum effect, new conditions may arise which will create a fly hazard. Whenever this occurs, insecticides and larvicides should be used to reduce quickly the local populations which have built up. Employed in conjunction with elimination of breeding areas these chemical control measures will have their maximum value, and their cost will be within the means of any normal municipality. The major emphasis though will be, as it should, on an enduring preventive program rather than a temporary palliative measure.

CONTROL DE MOSCAS Y LAS ENFERMEDADES ENTÉRICAS AGUDAS

(*Sumario*)

En la mayoría de las enfermedades con artrópodos vectores conocidos, éstos desempeñan papel integral en el ciclo evolutivo del parásito, por lo cual es de esperar que las medidas de lucha destinadas a la eliminación del vector, eliminen a la vez la enfermedad. Sin embargo, como las enfermedades en que se supone juegan papel importante las moscas no caen usualmente dentro de esta clasificación particular, este trabajo se ocupa especialmente de aquellas infecciones en que las moscas pueden desempeñar un papel accesorio, es decir, específicamente, las infecciones entéricas, que aun juegan un papel importante como enfermedades en gran parte del mundo.

Casi desde el comienzo de la bacteriología como ciencia, la propagación de las infecciones entéricas ha sido atribuída en parte a las moscas, y en relación con la tifoidea existe una vieja expresión en inglés: "Food, fingers and flies" (alimentos, dedos y moscas) como descripción de los agentes transmisores. Sin embargo, la enfermedad ha sido prácticamente eliminada de muchas zonas mediante el mejoramiento de los abastos de agua, leche y mariscos, medidas que no han resultado igualmente eficaces en la disminución de las infecciones producidas por salmonelas y shigelas.

Los efectos del control de moscas sobre la población humana fueron medidos de tres maneras: (1) Su efecto sobre infecciones, constatado en grupos de población normal por medio de cultivos; (2) Su efecto sobre la enfermedad, determinado por historias clínicas tomadas cada mes en los mismos grupos de población donde se hicieron los cultivos; (3) El efecto sobre los informes de mortalidad por enfermedades diarreicas en dos zonas.

Es evidente que en una zona donde las enfermedades diarreicas son prevalecientes y las moscas abundantes pueden esperarse beneficios reales mediante el control de estos artrópodos, reconociendo, sin embargo, la necesidad de otras medidas. Por otra parte, se sabe que las infecciones de shigelas pueden y se propagan ampliamente en muchos grupos de población, con completa ausencia de moscas. A pesar de la reducción uniforme de las infecciones cuando se lleva a cabo el control de las moscas, es aparente que tanto las zonas tratadas como las no tratadas muestran una variación similar en prevalecencia, por lo que no es de esperar que las actividades de control de moscas resulten tan beneficiosas en las zonas de índice elevado de infección por salmonelas, como en aquellas donde las shigelas son relativamente más comunes.

Se han estudiado métodos de control durante casi tres años y se ha llegado a la conclusión de que los métodos que emplean sólo insecticidas no son la solución del problema.

Cuando más, las actividades de control basadas exclusivamente en insecticidas mantuvieron las poblaciones de moscas controladas solamente mientras las operaciones fueron continuadas, terminándose el efecto al suspender la pulverización.

Muéstrase interés en un grupo de insectos, principalmente moscas que no pican que sirven como vectores incidentales o accidentales de enfermedades. Esas moscas no son huéspedes definitivos de las shigelas o de otros agentes de enfermedades, de cuya propagación han sido inculpadas sin que se tengan pruebas exactas.

El punto de vista recomendado al planear un programa de salubridad para el control de aquellas enfermedades en las cuales la mosca tiene o puede tener un papel de importancia deberá ser: (1) Avaluar cada localidad particular para determinar hasta donde sea posible si las moscas presentes en esa zona juegan o no papel importante en la transmisión de esas enfermedades, determinando al mismo tiempo las especies de moscas predominantes, punto éste muy importante; (2)

Una vez determinado que el control de moscas es deseable, organizar un programa destinado a eliminar los criaderos, lo que incluye, primero, la disposición adecuada de basuras, y, después, la de materias fecales humanas. (3) Atención y alimentación apropiada de los animales domésticos, de modo que no se conviertan en un peligro potencial de criaderos, y finalmente, la cuidadosa vigilancia de todas las industrias cuyos desechos puedan constituir una amenaza de criaderos.

En cuanto al papel que puedan jugar eficazmente los insecticidas y los larvicidas en el control de moscas, se ha dado gran publicidad a algunos de los métodos de pulverización espaciada, particularmente el uso de aeroplanos. Este método es de valor comprobado en el control del paludismo, pero es dudoso en el control de moscas en las ciudades, ya que esto requiere una dosis mucho mayor que el control de mosquitos. Existe un número de maquinarias pulverizadoras cuya evaluación puede basarse en: (a) movilidad; (b) facilidad de control, tanto en la dirección de la pulverización como en la cantidad de material aplicado; (c) utilidad bajo condiciones variables del tiempo y facilidad para su mantenimiento y reparación. Las pulverizaciones residuales que matan por contacto son relativamente nuevas en el campo de los insecticidas y han ganado su sitio en el control del paludismo; en el de moscas son de gran ayuda en el mantenimiento de una población baja de moscas en habitaciones sin mallas protectoras, lecherías, establos y otros tipos de edificios rurales. En general, en el control de moscas simplemente como procedimiento paliativo, la pulverización espaciada tendrá la más amplia aplicación. La inspección durante ese período descubrirá muchos criaderos de moscas nuevos e insospechados. Los larvicidas tales como el ortodiclorobenceno aplicado a esas zonas ejercerá un efecto dramático en la población de moscas en el futuro inmediato.

Aun después que un programa municipal mejorado de limpieza ha logrado su efecto máximo, pueden presentarse nuevas condiciones, las cuales crearán peligro de moscas. Donde esto no ocurra deben emplearse insecticidas y larvicidas para disminuir rápidamente las poblaciones locales de moscas; empleadas conjuntamente con la eliminación de criaderos estas medidas químicas de control tendrán su valor máximo y su costo estará dentro de las posibilidades de toda municipalidad normal. Sin embargo, siempre debe hacerse hincapié en un programa de medidas preventivas duraderas, más bien que en medidas temporales paliativas.