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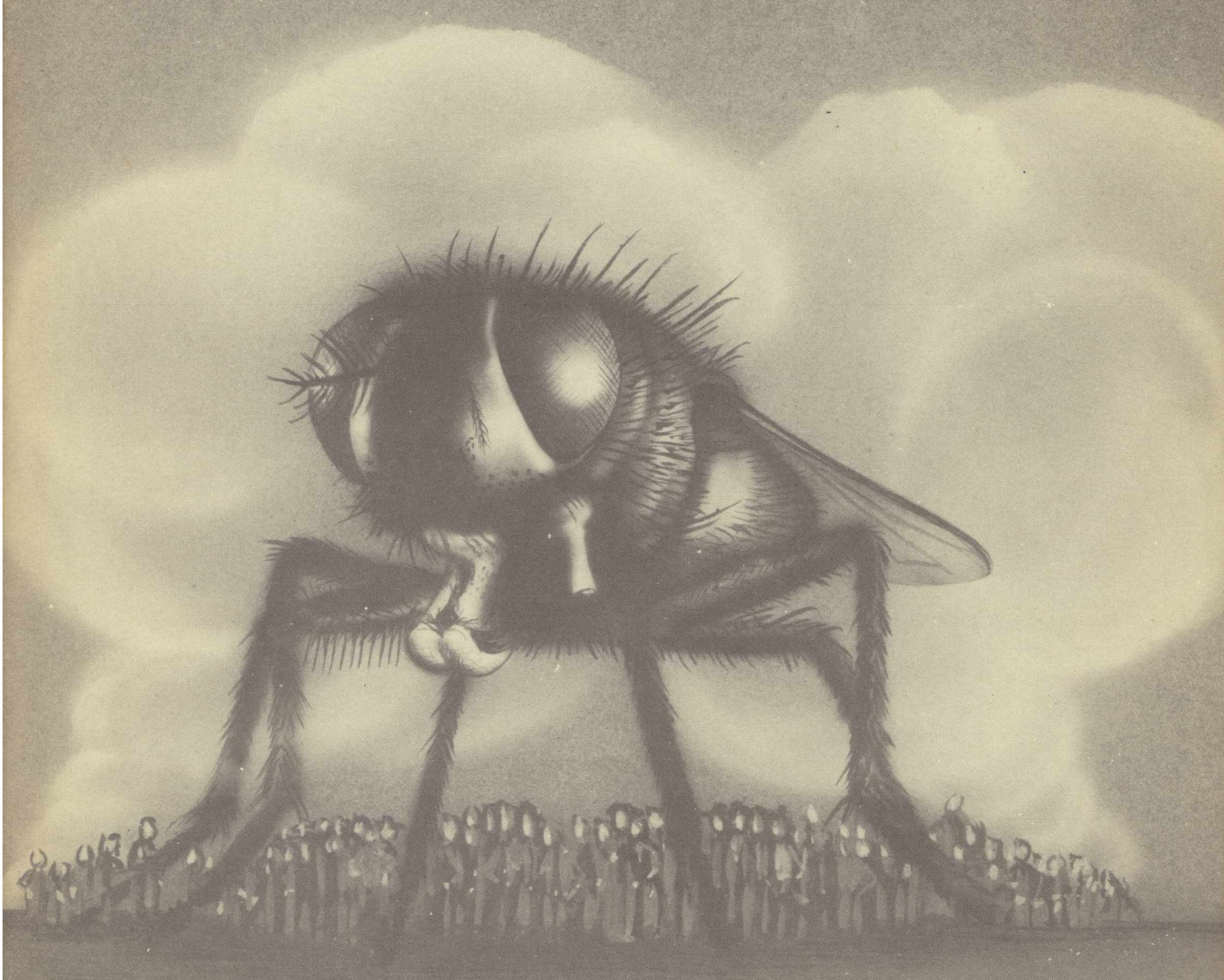

FEDERAL SECURITY AGENCY
Public Health Service
Communicable Disease Center
Atlanta, Ga.

. . . FROM OUR "SUPERINSECTICIDES," A "SUPERFLY". . . ?

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Contents

THE SIGNIFICANCE OF HOUSE FLY RESISTANCE TO INSECTICIDES IN FLY CONTROL OPERATIONS 1

THE ARKANSAS-WHITE-RED BASINS INTER-AGENCY COMMITTEE 6

FOREIGN VISITORS TO CDC 7

PLAGUE SURVEYS BY STATE HEALTH DEPARTMENTS 8

SEROLOGIC TITERS IN RICKETTSIAL INFECTION AS AFFECTED BY A COURSE OF ANTIBIOTICS 9

EVALUATION OF PUBLIC HEALTH FIELD TRAINING 11

THE IMPORTANCE OF RESPIRATORY DISEASES 13

IRRIGATION CYCLES, MOSQUITO CYCLES, AND GENERATIONS OF *AEDES* MOSQUITOES IN IRRIGATED PASTURES IN CALIFORNIA 18

ECTOPARASITE COLLECTING DEVICE 24

KENTUCKY DYSENTERY AND DIARRHEA FLY CONTROL PROGRAM (F. Y. 1951) 25

INTERDEPARTMENTAL COMMITTEE ON PEST CONTROL 29

BOOK REVIEW: Communicable Diseases 30

PICTORIAL REVIEW: Chick Embryo Techniques 31

FALL 1951 COMMUNICABLE DISEASE CENTER ANNUAL MEETING 32

HAVE YOU READ? 32

REPORTED CASES OF RABIES IN ANIMALS . . . . Inside back cover

RECENT PUBLICATIONS BY CDC PERSONNEL . . . . Inside back cover

MORBIDITY DATA . . . . Outside back cover

FEDERAL SECURITY AGENCY
Public Health Service
Communicable Disease Center
Atlanta, Georgia

The printing of this publication has been approved by the Director of the Bureau of the Budget, January 19, 1950.

The Significance of House Fly Resistance to Insecticides in Fly Control Operations

Dale R. Lindsay, Scientist*

The chronicle of house fly (*Musca domestica* Linn.) resistance to or tolerance for insecticides has passed the point of recounting as an interesting phenomenon and now is depressing to read. Since first documented by Wiesmann (1) and Sacca (2) in 1947, reports of this resistance have increased alarmingly. Many of these reports serve both as obituaries for one insecticide and as birth announcements for another. The reader's depression is increased by sequent publications, sometimes after an incredibly short interval, that the recently announced youngster had enjoyed excellent health for a time but had suddenly passed into limbo with doubtful expectancy of resurrection. DDT was the first of the miracle insecticides and enjoyed the longest useful life. A wishful hope may lie in the fact that although DDT was losing ground rapidly from 1947 to 1950, it again holds some promise when coupled with other compounds (3) to prevent detoxification of the DDT within the house fly. Thus far, under field conditions, no other species of non-biting muscoid fly has presented a problem of resistance to insecticides comparable to that of the house fly.

DISTRIBUTION OF RESISTANT HOUSE FLIES

Unfortunately, resistance in house flies has occurred where the benefits of DDT are most needed. This is hardly surprising, however, because in general the need for fly control reflects both a large volume of house fly breeding and proportionate usage of DDT. Furthermore, such problem areas generally develop coincident with agricultural crops requiring extensive usage of insecticides, as pointed out by Quarterman (4). Therefore, these same areas are sites of extensive trials of new insecticides and, at least thus far, of further failure to achieve lasting effectiveness. In brief, the geographical distribution of insecticide resistance in house flies is dependent upon only two factors, good breeding potentials for the flies and intensive usage of the insecticide. DDT probably has been more widely and intensively used in the United States than any other insecticide. As a result, wherever house flies are a problem in this country, their naturally occurring populations are resistant in some degree to DDT. The only house fly populations that remain as susceptible as they were prior to the general use of DDT are those maintained in laboratory colonies out of contact with all insecticides. Most of these colonies have been maintained free of insecticides since before resistance became widespread. A few laboratories, however, have succeeded in selecting for susceptibility by applying the tedious selection procedure of collecting eggs from individual female house flies, subsequently subjecting these females to minimal doses of insecticide, and saving only the progeny of those easily killed. Even with this technique, difficulty has been encountered in attaining the degree of susceptibility originally present.

THE NATURE OF INSECTICIDE RESISTANCE

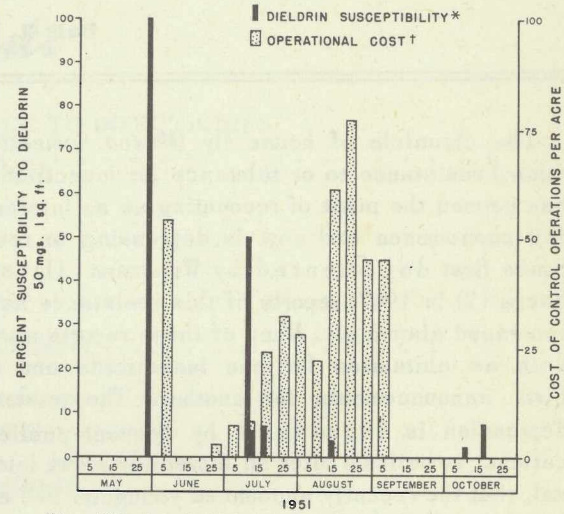
In 1947, the resistant house fly populations encountered were recognized as being a result of the selective action of DDT but the method of selection was not obvious. It was first attributed to race or species selection, assuming either that the original species had been composed of two or more hitherto unrecognized forms or that resistant mutations occurred frequently and were isolated by the killing of the normal susceptible strain. Careful comparisons were made of morphological differences between resistant and susceptible strains, particularly with regard to the pulvilli and tarsal structures where primary contact with residual surfaces took place. Thickness of cuticle, pigmentation, size, and vigor also were compared. No consistent or significant differences of any kind were found until the work of Sternburg, Kearns, and Bruce (5), and Perry

*Thomasville, Ga., Field Station, CDC.

FIGURE 1

DECREASED INSECTICIDE SUSCEPTIBILITY MEANS INCREASED OPERATIONAL COST

WHIGHAM, GA.



*Susceptibility Tests Consisted of Standard 15-Minute Exposures of Field—Collected House Flies to Treated Glass Surfaces.

†Control Operations Involved the use of Dieldrin, DDT, and DDT—DMC Sprays as Needed for Fly Control.

FSA-PHS-CDC ATLANTA, GA. OCT. 1951

and Hoskins (6) showed that the resistant flies possessed the ability to detoxify DDT to relatively nontoxic metabolites. Further work of Babers and Pratt (7), Sacktor (8), and others showed that resistant flies were characterized by higher cholinesterase and cytochrome oxidase activity than were susceptible flies. However, flies resistant to DDT are not necessarily resistant to other groups of insecticides, suggesting that differences in enzymatic systems are involved in imparting the ability to detoxify the various groups of insecticides. It is possible, even probable, that the nature of resistance to any given insecticide in one area may not be exactly comparable to that causing resistance in another area. Moreover, house fly colonies developed for resistance to dieldrin and chlordan only are nearly as susceptible to DDT as are the nonresistant flies, further emphasizing the fact that simultaneous resistance to several insecticides found at any one time is due to combinations of systems existing in these flies through previous selections.

Both field and laboratory tests have demonstrated that populations of house flies resistant to one insecticide may quickly become resistant to other insecticides applied. Under field conditions where breeding potentials are high, appreciable numbers of house flies resistant to a previously unused insecticide may be found after only two or three generations (3 to 4 weeks) of selection by the new insecticide. This has occurred even without the use of the same insecticide for larvicidal purposes, a practice which has been demonstrated to intensify selection for highly resistant house flies (9, 10). Under such conditions, satisfactory control can scarcely be maintained with insecticides previously used. Thus, resistance developed to one insecticide is also found to operate against chemically related insecticides in varying degrees; and genetic selection for resistance to one type apparently predisposes a house fly population to rapid selection for resistance to other nonrelated chemicals. Even the nonresidual insecticides, such as mixtures of pyrethrins and piperonyl butoxide, are not exempt from this accelerated selective action. Probably the high cost of the nonresidual types has limited their use to the extent that fewer failures due to resistance have been reported. Another factor of importance in limiting development of resistance in the field has been the fact that the nonresidual space sprays manifest a discontinuous selective action as compared to the continuous selection exercised by the residual types.

Much study in many laboratories has been devoted to the length of time, or number of generations, that insecticide resistance will remain in house fly populations in the absence of the insecticide. The results of these studies have varied, but in most instances the resistance has remained at a high level for laboratory periods equivalent to 2 or more years in the field. Such tests are, of course, not representative of field conditions where we cannot immediately and completely remove the residual insecticides that have been applied and which continue to exercise selective activity. Under field conditions we once assumed that the gradual decrease in residual effectiveness of the insecticide would be augmented, in returning the house fly populations to their susceptible normalcy, with the invasion of the sprayed area by normal flies from nonsprayed areas. It currently appears either that these normal susceptible flies succumb to the insecticide before they can interbreed with resistant flies or that no such normal flies now exist. In any event, experiments designed on this premise have been fruitless.

Work is in progress in several laboratories to determine the enzymatic systems or other physiological functions which, when present in the resistant house fly, can detoxify the chemical used and render it relatively harmless. When these systems are determined it will increase the possibility for finding and using supplemental compounds to inhibit this detoxification process. Some success has been shown against DDT-resistant flies by adding to regular dosage rates of DDT an appreciable amount of the compound 1, 1-bis-(*p*-chlorophenyl)-ethanol (3). This compound, known more widely as p, p'-dichorodiphenyl methyl carbinol or DMC, caused remarkable increases in resistant fly mortality when added to DDT in quantities of 10 to 100 percent of the DDT. Preliminary reports of similar synergistic compounds are appearing but in field trials the synergized DDT, particularly in residual form, is rarely as effective against resistant flies as DDT alone is against susceptible flies. Part of this failure appears to lie in the shorter residual life of the DMC. Laboratory tests show relatively low mortalities among DDT-resistant flies at substandard dosages of the DDT-DMC mixture.

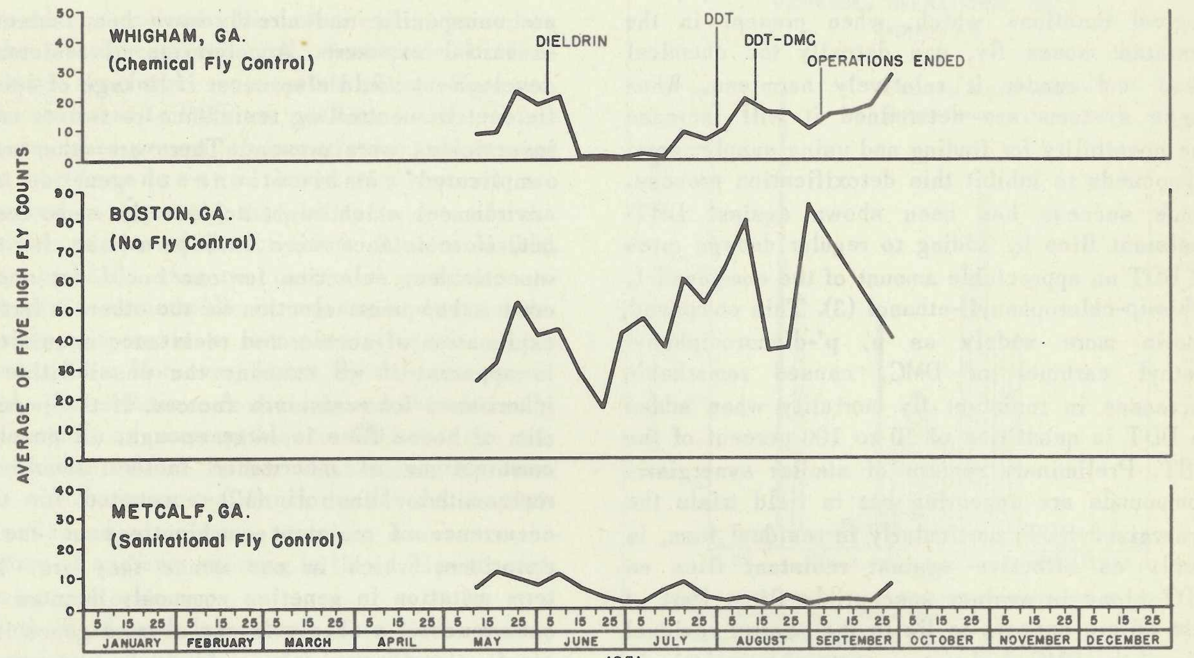
A second basic investigation of considerable importance is determination of the inheritance patterns of these physiological systems. In spite of an article by a British worker (11) declaring that the DDT-resistance in the experimental flies used (of Italian origin) was controlled by a single pair of allelomorphs, workers in this country are generally agreed that DDT-resistance is due to complex multiple factors. There is little reason to believe that house fly resistance to other insecticides is less complex. If it is possible to find both the physiological function and the pattern or patterns of inheritance for the resistance of the house fly to each insecticide, then there is hope that insecticides may be used in planned alternation to minimize interaction of specific selection methods. It is at least of equal likelihood that even the knowledge sought for will be of little practical use when discovered.

Recent work in many areas has demonstrated that house fly populations may attain a high degree of resistance at greatly accelerated rates as compared to rates observed in the early years of the residual insecticides. This accelerated acquisition is associated invariably with the prior existence of resistance in some degree to a previously used insecticide, usually DDT or chlordan. Resistant populations may develop more rapidly if some of the factors for resistance are nonspecific and already have been selected in initial exposure. Acceleration of resistance development could also occur if linkage of specific factors controlling resistance to two or more insecticides were present. There are other more complicated combinations of genetics and environment which might achieve the same result but, if resistance were independent for two insecticides, selection for one could not accelerate subsequent selection for the other. A further explanation of accelerated resistance acquisition is apparent if we examine the possibilities of inheritance for resistance factors. If the population of house flies is large enough, all possible combinations of inheritance factors should be represented. Missiroli (12) accounted for this occurrence of resistant combinations as due to mutations, which in one sense they are. The term mutation in genetics commonly denotes the occurrence of a change in one or more genes in a single chromosome from a kind already present to a new kind. It is the penchant of some people to attribute any unexplained evidence of a new kind of gene to mutation rather than to an ignorance of what has really occurred. A simple recessive gene present in a large and freely interbreeding population in a frequency of 1:1000 will produce only one offspring per million exhibiting the phenotypic expression of this gene. Actual conditions are but rarely this simple, and the presence of a gene in a population may be very difficult to detect in the absence of any selective agent that operates against the more frequently occurring, normal, and often dominant factors. The efficient residual insecticides serve as that selecting agent and, by the simple expedient of killing most of the susceptible flies, very rapidly increase the frequency of genes for resistance. The selection pressure of the insecticides may thus allow the phenotypic expression of existence of a gene or set of genes possibly present for countless preceding generations.

It is only reasonable to assume that progressive selection occasioned by a succession of different insecticides will continue to eliminate the physiological systems that function only in the absence of these insecticides. As implied above, such theoretical selection is feasible only in populations of great size and in which

FIGURE 2

COMPARATIVE RESULTS OF CHEMICAL AND SANITATIONAL FLY CONTROL *



* Note Temporary Period of Dieldrin Effectiveness in Whigham, Ga.

FSA-PHS-CDC

ATLANTA, GA. OCT. 1951

all, or nearly all, of the possible genetic combinations are represented. If such occurs, there is scarcely a more likely organism than the house fly in which it might be demonstrated. The house fly not only possesses a tremendous biotic potential, but coupled with its reproductive ability it has an unsurpassed adaptability to a wide variety of breeding media and environmental conditions. The fact that it far exceeds other species of flies in this latter respect probably accounts for its currently unique position with regard to the failure of chemical insecticides in fly control. Less versatile species will be slower in selecting for insecticide resistance. Furthermore, lest initial successes create undue optimism, we must consider that similar selections will probably occur to eventually overcome any advantage we may temporarily gain through the use of synergists which block the detoxification processes. We have through our "superinsecticides," selected a "superfly" which will remain with us indefinitely.

THE FUTURE OF FLY CONTROL PROGRAMS

In spite of the fact that we can expect no single chemical insecticide to long remain effective against such an adaptable organism as the house fly, and that rotations, combinations, and synergists may well share the same fate, we still have the same opportunity for fly control that we had before DDT. We weren't so discouraged then and we should not be now. Then as now we had a means of fly control that worked, the application of prophylactic sanitation. The promise of immediate and sometimes undeserved insect control by means of DDT and more recently developed insecticides, was more attractive. In one respect, the great strides of the past 30 years in developing insecticides may have delayed the general application of prophylactic sanitation to prevent fly breeding. Insecticides promised easier fly control than did cleaning up. Our experience in this country since 1945, and particularly since 1948, has probed both extremes in fly annoyance. We have enjoyed almost complete freedom from flies and we have endured the frustration and indignation that has accompanied the failures with chemical control. Although large sums of money have been expended without lasting effect, we have profited immeasurably. The house fly stands indicted, and under centain conditions has been convicted, as a disease vector of shigellosis and possibly of other enteric infections (13, 14), as long has been suspected from laboratory studies. In addition, we have had the opportunity to evaluate the other benefits of fly control.

During this same period of time in which we have suffered disillusionment by chemical control of flies we have continued studies in improving sanitation on many fronts. These studies must be intensified. The concomitant benefits of improved sanitation are sure to be reflected in the reduction of certain other infections as well, regardless of their mode of spread. In every study of the methods and effects of improved sanitation, it has been found that results are measurable even from small efforts. Virtual freedom from fly annoyance and vector-borne disease is a real possibility within our reach. Municipal problems are nearer solution than are the rural and agricultural problems, but both types are regulated by the principle of eliminating fly breeding. An effort equal to that expended during the past 6 years can demonstrate the effectiveness as well as the economic feasibility of fly control by sanitation.

Meanwhile we should recognize the chemical control of house flies in its true perspective as an adjunct and not a substitute for sanitation (13). The insecticides which we have, as well as the new ones being developed, are valuable tools as stopgaps and emergency measures and should be used as such. Decker and Bruce (15), in a recently published article pointedly entitled, "Where Are We Going With Fly Resistance?", have set forth three good basic rules for the use of insecticides. They recommend firstly, that mixtures of adulticides be avoided in order to prolong the value of each type; secondly, that if larvicides are used they should not be closely related chemically to the adulticide in order to prevent unnecessary acceleration of resistance to the adulticide; and lastly, that the larvicidal effect of adulticides contaminating breeding material should be avoided for the same reason. To these we should add a fourth borrowed from the doctor's prescription: Use only as needed.

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The Arkansas-White-Red Basins Inter-Agency Committee

JOHN H. BRIGHT, Sr. Sanitary Engineer*

During the last century many Federal and State executive departments and agencies have successively been charged with responsibilities relating to the development, utilization, and conservation of the Nation's water resources. Progress in coordinating and integrating the activities of these agencies has been achieved both through statutory provisions and administrative actions. Federal inter-agency cooperation on matters concerning public health has been accomplished largely through administrative procedures.

For a number of years, inter-agency agreements have formed the basis for Public Health Service undertakings related to Federal development of water and land resources. The malaria surveys, reports on impounded water activities, and mosquito investigations in irrigated areas, exemplify Communicable Disease Center activities undertaken in accordance with such agreements reached with the Corps of Engineers and Bureau of Reclamation. Although much benefit has accrued as a result of efforts to incorporate public health considerations into planning for major water resources programs, many weaknesses have been evident in this agreement procedure for voluntary cooperation. While consultant services by CDC have been rendered to constructing agencies under various agreements, heretofore there has been a noticeable lack of provisions for integrated planning with interests such as Fish and Wildlife Service, Soil Conservation Service, National Park Service, Forest Service, and others. The establishment of the Arkansas-White-Red Basins Inter-Agency Committee (AWRBIAC) and participation by CDC in the work of that Committee, now make close coordination within these constituent agencies a reality. The potentialities of the AWRBIAC are great. A review of the steps leading to its formation may add to a better understanding of its importance.

The need for comprehensive planning and development to meet national objectives and derive maximum benefits from our river systems and their watersheds long has been recognized. A forward step was taken on December 29, 1943, when an inter-agency agreement established the Federal Inter-Agency River Basin Committee (FIARBC). (Original members included the Departments of Agriculture, the Army, the Interior, and the Federal Power Commission. The Department of Commerce became a party to the agreement in 1946 and the Federal Security Agency in 1950).

The purpose of the agreement was to provide a means for constituent agencies "to cooperate more completely in the preparation of reports on multiple-purpose projects and to correlate the results to the greatest practicable extent." Of special interest to this group was the River and Harbor and Flood Control Acts of 1950, which, among other things, contained a special provision for a comprehensive survey of the Arkansas, White, and Red River Basins. (The Arkansas, White, and Red River Basins contain about 180,000,000 acres of land located in 8 States, namely: Louisiana, Arkansas, Missouri, Texas, Kansas, Colorado, Oklahoma, and New Mexico.)

Upon passage of this bill the President of the United States pointed out in separate letters to member agencies of the FIARBC that "It is essential that the Executive agencies organize their efforts to realize as far as possible under existing law, the potentialities of the broad-scale, integrated national resources study for the Arkansas, White, and Red River Basins authorized in H. R. 5472." For the purpose of conducting this survey, the President requested as a first step that the various agencies concerned "organize an inter-agency committee, formulate procedure, and map out a joint plan of investigation, indicating specifically the precise responsibilities of each and the

*Engineering Services, CDC. Currently attending Columbia University.

prospective allocation of agency resources to the joint effort." The establishment of the field interagency committee requested by the President was directed by resolution of the FIARBC on June 12, 1950.

Representatives of the Communicable Disease Center attended the first meeting of the AWRBIAC* on July 28, 1950. There plans were laid with the FSA representative for CDC participation in Public Health Service phases of the comprehensive study. An agreement between Public Health Service Divisions provides that "The FSA representative on the field committee shall have responsibility for all PHS matters contained in the report of the AWRBIAC and shall have full responsibility for PHS work with the Committee," and "Liaison men will be designated by CDC, EHC, and the Sanitation Division to cooperate with the FSA representative."

Public Health Service interests as stated to the Committee by the FSA representative are: "(1) The prevention or reduction of pollution of inter-State waters and their tributaries and the improvement of surface and underground water, (2) the safeguarding of public and domestic water supplies, (3) the protection and proper management of water recreational facilities for the benefit of health and welfare, (4) safeguarding against property damage resulting from pollution and from the harmful effect of mosquitoes, and (5) public health aspects of flood control, drainage, and irrigation." It was further stated that "It is an objective of the Public Health Service to determine that no serious public health hazards be incorporated into water resources development projects."

In preparation for a comprehensive report, the Committee has designated the Public Health Service as the Chairman Agency for work groups to study and report on Pollution Abatement and Mosquito Control. The subjects for which work groups have been established are: (1) Navigation; (2) Flood Control, Water Flow Retardation, and Flood Forecasting; (3) Drainage; (4) Domestic and Industrial Water Supply; (5) Irrigation and Reclamation; (6) Hydroelectric Power Development and Utilization; (7) Agriculture, Soil Conservation, Forestry and Sediment Control; (8) Fish and Wildlife; (9) Recreation; (10) Pollution Abatement; (11) Land Resources Data; (12) Economic Base Survey; (13) Water Resources Data; (14) Mapping; (15) Mineral and Geology; (16) Mosquito Control and Allied Problems; (17) Description of Basin and Statistical Information; and (18) Benefits and Costs. The Communicable Disease Center, having primary interest in item 16 above, assigned a representative to the office of the FSA member on October 1, 1950 to carry out the study and prepare the Mosquito Control Report. In performing this function, this representative is assisted by other members of the work group, including interested Federal agencies and representatives of the eight States. Thus, coordination is achieved during the planning stages.

*Composed of same agencies as FIARBC.

Foreign Visitors to CDC

During the month of September the following public health officers and trainees were visitors to CDC:

Miss Edith M. Radley, Missionary Nurse, United Church of Canada, Angola, Portuguese West Africa.

Kenneth H. Ave, District Sanitary Inspector, Department of Health, Hilo, Hawaii.

Robert Y. W. Lee, Supervisor, Rodent Control, Department of Health, Hilo, Hawaii.

Allan McDermott, Superintendent of Roads and Works, Jamaica Government, Montego Bay, Jamaica, B.W.I.

Walter J. Sczawinski, Sanitarian, Alaska Department of Health, Anchorage, Alaska.

Plague Surveys by State Health Departments

Vernon B. Link, Sr. Surgeon*

Although the U. S. Public Health Service deserves a large share of the credit for initiating and maintaining surveys in the search for wild rodent plague foci, it has not been responsible for all of the field or laboratory accomplishments in this country. Of the 15 known-infected Western States, 9 have conducted their own surveys at one time or another, and 2 have carried out their own laboratory procedures. The Public Health Service has done the laboratory work for the other seven. The known infected States are Arizona, California,** Colorado,*** Idaho,*** Kansas, Montana,*** Nevada, New Mexico,*** North Dakota, Oklahoma, Oregon,*** Texas,** Utah,*** Washington,*** and Wyoming. Without the able assistance provided by the nine States which conducted surveys, the present knowledge about plague foci in wild rodents would be far less complete than it is.

The California Department of Public Health has maintained an active interest in wild rodent plague since 1910, shortly after the discovery of the first wild rodent plague focus in Contra Costa County in the summer of 1908. At first, California was concerned primarily in assisting with squirrel destruction. In 1914, the State legislature appropriated $100,000.00 to aid in the control of plague in squirrels. On February 1, 1936, the Public Health Service transferred all its plague control activities in California to the California Department of Public Health and proceeded to concentrate its own efforts on the search for wild rodent plague foci in other Western States. Since 1936, California has maintained its own survey units and has performed all of the laboratory procedures necessary to carry out the diagnosis of plague on the suspected specimens obtained. It is appropriate that California, with the greatest number of human and rodent infections, should have undertaken and continued this interest in plague.

Until 1934, plague apparently was limited to the wild rodents of the State of California only. In that year, the death of a sheepherder in Lake County, Oreg., served notice that California was not the only State involved. In fairly rapid succession, plague foci were demonstrated in 14 other Western States. During the period between 1935 and 1951 inclusive, the Public Health Service, with the assistance of the 9 State health departments, has demonstrated that plague did exist in these 15 States (table 1).

Table 1
PLAGUE FINDINGS IN 15 STATES

State	Year first found	Number of counties
Arizona	1938	3
California	1908	35
Colorado	1941	8
Idaho	1936	7
Kansas	1945	6
Montana	1935	7
Nevada	1936	6
New Mexico	1938	20
North Dakota	1941	1
Oklahoma	1944	2
Oregon	1935	10
Texas	1946	6
Utah	1936	8
Washington	1937	10
Wyoming	1936	10
	Total	139

Following the realization in 1934 that plague-infected wild rodents no longer were confined to California, the Public Health Service shifted its attention from that State to others. In 1935, plague foci were demonstrated in Oregon and Montana, and in 1936, in Idaho, Nevada, Utah, and Wyoming. The interest of certain State health departments was aroused and as a result they undertook to conduct surveys of their own territories.

In April 1936, the Washington State Department of Health began its own survey work, even before it was known that wild rodent plague existed in the State. It has maintained these surveys continuously since that time, and has made important contri-

*Western CDC Laboratory, San Francisco, Calif.
**Surveys and laboratory.
***Surveys.

butions to the knowledge of plague, particularly in the matter of the importance of the pigmy vole (*Lagurus curtatus*) as a reservoir host.

In June 1936, the Idaho Department of Public Health initiated its own survey unit which operated until July 1938. It was reactivated during 1941 and 1942.

The Oregon State Board of Health began its plague surveys in August 1936. These have continued to the present time.

In April 1937, the Utah State Department of Health organized a survey unit which continued working until July 1938.

The Montana State Board of Health initiated plague surveys in May 1937. These were continued until 1946.

Three States have carried on plague surveys with financial assistance from the Communicable Disease Center. In 1946, following the first demonstration of wild rodent plague in Texas, the Texas State Department of Health and the Communicable Disease Center set up a plague study headquartered at Brownsfield. This study continued until July 1, 1949. During 1948 and 1949, plague surveys were conducted in Colorado and Utah as a joint effort of the Communicable Disease Center and the health departments of those States.

In 1949, New Mexico experienced the first of six human cases of plague. To date, plague has been found in 20 of the 31 counties. Except for California, New Mexico has reported the largest number of human cases of plague, the largest number of wild rodent plague foci, and the largest number of counties involved. For these reasons, the New Mexico Department of Public Health, in cooperation with the Western Communicable Disease Center Laboratory, has been operating its own survey unit since 1950.

It is somewhat surprising, at first glance, to note that so many of the western State health departments have actively participated in these plague surveys for such a long time. The actual number of human infections from wild rodent sources has been small in relation to other more important causes of human diseases. Yet plague still remains a potential threat of unknown proportions. There are indications that it can still cause deaths in spite of the remarkable efficacy of antibiotics in its treatment, and no one knows when another epidemic may start. For these reasons, it is hoped that Western States will continue their support of plague surveys within their boundaries.

Serologic Titers in Rickettsial Infection as Affected by a Course of Antibiotics

JOSEPH H. SCHUBERT, Scientist (R)*

The question of what effect antibiotics have upon the Weil-Felix and complement fixation titers in rickettsial infections has concerned laboratory workers for some time. Although numerous studies have been made on the subject, the data as a rule have been reported as parts of other studies. Such information was compiled and is presented here.

In 1945 Rose, Duane, and Fischel (1) studied the treatment of Rocky Mountain spotted fever with para-aminobenzoic acid. Although treatment was started early in the disease (third day of onset), serologic specimens taken at regular intervals showed a rise in titer which reached 1:1280. Sadusk, Hjerpe, and Freedman (2) studied the effect of para-aminobenzoic acid upon the clinical course of typhus in the guinea pig. Administration of para-aminobenzoic acid to guinea pigs infected with murine typhus generally prevents the appearance of clinical signs of this infection but permits appearance of rickettsia in the circulating blood and the formation of complement-fixing antibodies. Complement-fixing antibodies and rickettsemia develop in a comparable degree in both treated and untreated control animals at about the same time. The rise in titer during the period of convalescence is also similar in both groups of animals.

When antibiotics replaced para-aminobenzoic acid as the drug of choice, a somewhat different picture was obtained. Cox (3) states that in mild rickettsial infections or in those cases where the disease was diagnosed quite early, aureomycin modified the course of infection, rendering it exceedingly mild, or even aborted the infection. Under these conditions, experimental animals as well as man may show no demonstrable complement fixation antibodies. If guinea pigs are infected with massive doses of rickettsia and then treated early with aureomycin, clinical signs of the disease may be prevented although complement fixation antibodies may appear in the blood.

Angstein, Whitney, and Beninson (4) studied the protective effect of aureomycin in experimental Rocky Mountain spotted fever and typhus. Complement fixation tests were made on guinea pigs infected with spotted fever. Guinea pigs were given aureomycin 2 hours after intraperitoneal infection and were bled on the fourteenth day. A low complement fixation titer of 1:16 and 1:32 was found in guinea pigs treated with 2.0 mg./dose, as compared to higher titers (1:128 - 1:256) of the group treated with 1.0 mg.

Schoenbach, Bryer, and Long (5) treated a number of patients ill with Rocky Mountain spotted fever (eastern type) with aureomycin. The treatment was started after hospital admission at about the third day of the disease. Weil-Felix tests on one patient at about the fifth day were positive at 1:80 dilution and 1:1280 on the thirteenth day. Similarly, another patient with a Weil-Felix titer of 1:20 on the day of admission was 1:160 on the seventh day after.

Smadel (6) studied the effect of chloromycetin on scrub typhus. Results with the Weil-Felix test indicated that the average titer was one dilution lower with treated patients as compared to untreated patients. There was no significant difference in the time of appearance of Weil-Felix antibodies in treated and untreated patients. However, a group of volunteers whose disease was terminated within less than 3 days after onset had a delay in the appearance of Weil-Felix antibodies but had an average titer of 1:640. Complement fixation tests with scrub typhus could not be compared since the incidence of positive reactions were approximately 50 percent in treated and untreated cases.

In conclusion, it is evident that the introduction of chloromycetin, aureomycin, and other antibiotics for the treatment of rickettsial infection has greatly changed the course of the disease in humans and animals. The serologic picture has also changed but to a lesser degree. Experiments have shown that the Weil-Felix test will detect antibodies in rickettsial infections in untreated as well as treated patients. Treated patients, however, will show a somewhat lower titer. Results with the complement fixation test give a more variable picture and are less predictable. It is seen that a patient must be severely infected in order to show complement fixation antibodies. Complement fixation antibodies usually develop on the fourteenth day after the infection, accompanied by a corresponding rise in titer with time. The Weil-Felix antibodies, however, will develop on the fifth day, accompanied by smaller rise in titer. Weil-Felix antibodies can be detected when the infection is of a lighter nature such as that modified by antibiotics, whereas the complement fixation antibodies may not be demonstrable. From this, it would appear that the importance of the Weil-Felix test in the serologic analysis of the rickettsial infections has by no means decreased.

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Evaluation of Public Health Field Training

MARY L. GARRETSON*

Prior to January 1948, evaluation of field training of public health workers consisted principally of observation by staff personnel of Training Services, CDC, and suggestions of trainees and health officials. At that time the need for a more objective approach to supplement these judgments was felt and a program was inaugurated to develop and coordinate the evaluation of field training activities.

It was evident that the evaluation program should be developed in terms of the training program's chief objectives and that practical means and methods for carrying out a program of evaluation should be found and employed. As a statement of these objectives, the following questions were formulated:

1. Are we meeting the needs for practical field training of those persons who are attending our field training programs?

2. In what way can we improve the value of this training for public health workers?

Certain basic principles to be followed in the development and use of measures for the evaluation studies were adopted early in the program. Some of these principles are as follows:

1. The types of field training courses, as much as they differ in detail and subject matter, are essentially alike in their underlying purpose and organization.

2. Methods of evaluation should recognize differences in the trainees' experience, education, and working conditions.

3. The bases and methods of evaluation should be such as to require interest and participation in the process on the part of the trainees and their supervisors, the training staff, and members of participating agencies.

4. Methods of evaluation should be based on two factors: (a) objective evidence such as questionnaires, standardized tests, and similar devices; and (b) considered judgment of competent health officials and others concerned.

As the attention of the training staff was focused on their training problems and as these problems became more clearly defined, the end results toward which the evaluation program should be directed were discerned. Goals were stated and adopted. They have been modified somewhat as policies and procedures are determined, but fundamentally they remain the same.

At the 1950 conference of training officers these goals were restated by the committee on evaluation and the needs for a program of evaluation were defined. The work done by this committee was a definite step forward in the understanding and acceptance of the role that evaluation can play in a field training program. The needs as defined are:

1. To establish bases for assisting the training officer in program planning so that he may present the best possible training for the trainee and employer.

2. To establish bases for the Training Services Headquarters to assist training centers in their training problems.

Some of the end results which the committee felt should be provided by the program insofar as possible are:

1. Improvement of training methods and techniques.

2. Improvement of curriculum as to subject matter and allocation of time.

3. Determination of the extent to which we are meeting the desires and needs of trainees and employers.

4. Reasonably objective evidence of the effectiveness of field training as a justification of expense involved.

5. Determination of the extent to which the attitudes and philosophy of the trainee toward his work have been changed.

6. Appraisal of the training center as to physical plant, staff, organization, and administration.

MEASURES AND TECHNIQUES

In determining the methods and measuring devices to be used, several approaches and techniques have been considered. Use of some

*Training Services, CDC.

of these evaluation techniques has been postponed until standards can be established; others have proved impractical because of the expense involved or time necessary for study and research. Those which have been used or are being developed are: (1) judgments of trainees and supervisors through the medium of a questionnaire study, (2) a standardized test for the environmental sanitation field training courses, and (3) standards for training literature insofar as readability and comprehensibility are concerned.

SURVEY OF TRAINEES AND SUPERVISORS

This survey was made through the medium of questionnaires to trainees and their supervisors 6 months or more after completion of the 3-month field training course in environmental sanitation. In spite of the limitations inherent in such an evaluation, it was hoped that some information could be obtained concerning the extent to which knowledge, skills, and attitudes had been acquired and were being utilized. Comments and criticisms which would improve the value of this training also were desired.

Questionnaires were distributed during the period June 1948 to July 1949. On the whole the response was satisfactory. Of the 318 questionnaires distributed, 83 percent were completed and returned. The report was completed in January 1950.

In general, the replies of trainees and supervisors were in agreement and were strongly favorable concerning the extent to which improvement in the work of the trainee should be credited to the impetus given by the training. The degree of credit varied according to the trainee's education and experience level, with the poorer qualified trainee giving comparatively more credit to the training than did the better qualified trainee. Based on their replies, the following statements appear justified:

1. There is a better understanding by trainees of the work involved in their present duties.

2. The training has made it possible for the trainees to assume increased responsibilities and broaden the scope of their work.

3. Trainees generally are carrying on more comprehensive programs.

4. Trainees have developed increased assurance and ability to meet people and to promote public health activities.

A number of interesting points were brought out in the survey. Of considerable interest were the phases of the 3-month environmental sanitation course found most helpful by trainees. The six most valuable subjects were, in descending order: milk sanitation, food sanitation, sewage disposal, water supplies, bacteriology, and insect and rodent control.

Other points of interest were that 98 percent of the trainees who participated in the survey were engaged in environmental sanitation duties, and that 65 percent of the trainees had received an advancement in position.

Based on the findings of the survey, it was concluded that:

1. There is definite improvement noted in the sanitarians' work after the training experience. Although there were undoubtedly other contributing factors, this improvement is credited by the trainees and supervisors to the training program.

2. Training time in the various subject matter areas apparently is apportioned according to the trainees' needs.

It was recommended that further consideration be given to: (1) special topical courses for trainees who have taken the 3-month environmental sanitation course, (2) additional training in public speaking and public relations, (3) development of a manual for the environmental sanitation trainee, and (4) continued improvement in field training practices.

ENVIRONMENTAL SANITATION ACHIEVEMENT TEST

An achievement test for the environmental sanitation field training program is being developed to measure the growth of the trainee's factual knowledge during the training period and to determine the trainee's strength and weaknesses in the major areas of knowledge. The test is being developed in cooperation with the State Merit System Service, American Public Health Association. When completed, it will consist of two tests, of approximately 125 items each, for use as pretests and post tests.

Administration of the preliminary form of this achievement test to 200 trainees as a pretest and as a post test has been completed. Five regional field training centers and three State field training centers participated in the testing program. In selecting the 480 test items included in the preliminary test, an outline was used which reflected the emphasis to be placed on the subject matter areas covered by the course. The outline was based on an analysis of course breakdowns submitted by the field training centers and the philosophy and objectives of these courses. The items were selected by the American Public Health Association and were reviewed by a committee of representative training officers. Items not considered applicable were discarded and additional items selected to conform to the emphasis of the course. Upon completion of the item analysis by APHA, the committee of training officers will meet again to set up the two comparable forms of the test.

To determine the validity of the test, one criterion to be used is the rating by training officers of trainees' knowledge in the various subject matter areas covered by the training experience. Use of other criteria such as trainees' education and experience is planned.

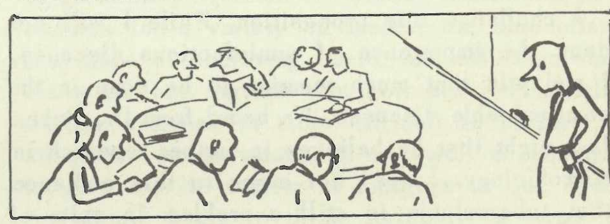
The test should be ready to accompany courses beginning in January 1952. It is hoped that the test can be used to determine the most effective training methods employed in regional and State field training centers and to assist the States in maintaining the level of instruction at established field training centers.

READABILITY OF TRAINING MATERIALS

A program to determine the readability of various training materials was initiated in July 1950 with the assistance of the Experimental and Evaluation Branch, Division of Health Education, U. S. Public Health Service. Although some of the methods used were fairly crude and frankly experimental, the results point up certain factors which indicate the value of pretesting training materials before they are published. Further study and experiments in cooperation with the Experimental and Evaluation Branch are planned.

SUMMARY

The evaluation program has been mainly experimental. As objectives become more clearly defined, evaluation methods and devices are determined and specialists called upon for assistance in their development. Some measuring devices have proved effective; others are still in the preliminary stage. It has been a slow process as there has been little precedent to follow so far as the evaluation of field training is concerned. However, the bases on which the program is being built appear to be sound, and it is believed that a useful program of evaluation will result.



*The Importance of Respiratory Diseases**

ALEXANDER D. LANGMUIR**

In speaking to you, I propose to examine some of the general epidemiological principles that have led to our successful control of many communicable diseases. I shall attempt to analyze the prospects of substantial improvement in the control of the respiratory diseases that still plague us. May I quote from the book, *Plague on Us*, by Mr. Geddes Smith:

"Great and small, the respiratory infections are indubitably unfinished business. These common ailments form a nosological jungle in which bacteria and viruses roam at will, despoiling the human race and defying both classification and control. Symptoms overlap and no one knows how many different diseases lurk behind them. For some of them the doctor can do little. The epidemiologist who hacks his way into this mess

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**Epidemiologic Services, CDC.

courts frustration. The statistician has to content himself with omnibus calculations. The plain citizen talks glibly of grippe or flu, gulps or sniffs his favorite panacea, and, without any clear notion of what is happening to him, hopes for the best."

Perhaps the title of this paper should have been "Courting Frustration in a Nosological Jungle," or as you will hear, a more appropriate title would be, "The Possibilities of Eradicating Respiratory Diseases."

In considering my broad subject, I would like to start by challenging a widely held belief that has inhibited, and even frustrated, those of us who have chosen the public health profession. I refer to the proposition that the communicable diseases are now conquered and, therefore, need little further concerted effort.

Many of my good friends tell me I am wasting my efforts by working in a dying field. They say that the future lies in the noninfectious, the metabolic, and the chronic debilitating diseases of older ages.

I challenge this proposition. While I will not deny the importance of noninfectious diseases, I maintain that much remains to be done in the communicable diseases. We heard from Dr. Dubes last night that he believes in further research in microbiology. I need not argue to this audience that tuberculosis is still a problem in spite of the present steep downward curves of tuberculosis mortality. I firmly believe that in the field of the infectious diseases there is a happy hunting ground for major discoveries and contributions to the welfare of mankind that for some time to come will equal, if not surpass, those to be made in the field of the degenerative diseases.

Most of the infectious diseases may be classified into three broad groups as follows: (1) the enteric infections, (2) the arthropod-borne infections, and (3) the respiratory infections.

In Western civilization, progress in the control of the first two of these three groups of diseases has been impressive. We have practically eliminated typhoid fever and the dysenteries. Yellow fever and dengue are gone from this country and Northern Europe. Typhus and plague are now trivial problems. Perhaps the most impressive of all is the story of malaria. This disease was heavily endemic and seemingly permanent in large areas of the South in the mid 1930's, but now has disappeared as a naturally spread disease.

In contrast, our control of the respiratory group is unimpressive. Smallpox is our only total success. We can take considerable pride in the record of diphtheria. We have only begun to apply our knowledge effectively against whooping cough. The seriousness of the streptococcal infections, bacterial pneumonia, meningitis, and the bacterial complications of measles and influenza has been materially reduced by the specific antimicrobial therapies; but the beginning is yet to be made in their effective control or elimination. Poliomyelitis, infectious hepatitis, mumps, chickenpox, the common cold, and that group often termed the "undifferentiated respiratory diseases" continue amongst us unabated. "Indubitably," to quote Mr. Smith again, "the respiratory diseases are unfinished business."

Why have we been so successful with the enteric and arthropod-borne diseases and yet have so largely failed with the respiratory infections? The answer is clear. The former two groups of infections depend for their survival either on gross fecal contamination of the environment, or on the close association of insects or rats with the human population. These basic conditions for survival have been eliminated both by conscious public health effort and as a beneficient concomitant of an advancing standard of living.

The reasons for our failure with the respiratory diseases are equally understandable. These infections depend for their survival on direct person-to-person transmission which cannot readily be attacked by the broad community approach of environmental sanitation. In the few respiratory diseases which we have successfully controlled, we have depended on immunization. While all of us, even health officers, have a personal aversion to needles, I believe that the principle of immunization provides the most promising basis for future advance.

What are the prospects? I believe they are very real. Let us first apply what we now know. There is little excuse for most of the 9,600 reported cases and 634 deaths from diphtheria in 1948, (the last year for which national mortality figures are available), nor for the 74,000 reported cases and 1,100 deaths from whooping cough. These could be materially reduced and possibly eliminated by the effective application of existing knowledge. This problem is essentially one of health education of the medical and public health profession and of the general public. The National Tuberculosis Association has a long and brilliant record in these techniques.

Next, let us look at other respiratory diseases for which a generally accepted immunizing agent is not now available. The viruses of influenza and mumps can be grown in the embryonated hen egg. This means that antigen can be made available in almost limitless quantities. Thus, the major stumbling block to the preparation of a vaccine has been removed. While I do not wish to minimize the still substantial developmental problems remaining to be solved before a practicable, safe, and effective immunizing agent for generalized use among the population can be available for these two diseases, it seems wholly reasonable that this objective can be achieved for both in the near future. The isolations of the viruses of measles, infectious hepatitis, and the common cold have been reported. This means the first step toward development of vaccines has been taken, but whether adequate amounts of antigen can be produced still is problematic.

A recent development announced by Dr. Jonas Salk in Atlantic City just 2 weeks ago has direct bearing on our problem of immunization. In my judgment it constitutes a very major advance in this field. By starting with the pioneer work of Dr. Jules Freund, who opened up the field of the use of adjuvants to enhance antibody response, Dr. Salk has found that by selecting a simple mineral oil of low viscosity, and the right detergent or emulsifying agent, he can obtain, in both monkeys and man, high and sustained influenza antibody titers with but a single injection. Furthermore, the material is essentially reaction free and the total antigen required is fractional compared with the amount formerly used in influenza vaccines.

This discovery means that many other stumbling blocks to the control of respiratory diseases have been removed. One of these is that the small amount of antigen required indicates that multiple types and substrains of influenza viruses may be included in one inoculation, thereby giving a much broader antibody response than has been attainable heretofore. While still new and different antigenic strains of influenza virus may appear in the population, it would seem that we are much nearer to the development of a practical influenza vaccine than we were prior to Dr. Salk's development.

Also, this work quite adequately disposes of two commonly accepted fallacies.

The first fallacy is: that we cannot expect to achieve by artificial means a greater immunity than is created by naturally acquired infection.

He has clearly produced antibody responses that regularly exceed the natural response in influenza. While I freely admit that the titer of antibody in the circulating blood may not be a direct measure of immunity, there is certainly an established relation in influenza and in a number of other infectious diseases. I believe that we can look to the future field trials with the new influenza vaccines with considerable enthusiasm.

The second fallacy is: that to achieve substantial immunity, two or more properly spaced doses of immunizing agent are necessary, the first, to condition the virgin susceptible to an initial response, and the second, to act as a booster dose to bring out the recall phenomenon and lead to higher and more sustained titers.

With Dr. Salk's preparation, antibody responses to a single dose regularly exceed the titers achieved after multiple doses of saline prepared vaccine.

Not only does this discovery lend solid prospect to great simplification of existing immunizing procedures for a variety of agents, but also offers real hope of achieving useful and effective vaccines for new agents that now are intrinsically weaker antigens or more difficult to prepare in adequate concentrations. It may well be possible to give a wide variety of antigens in one dose. We should begin to think seriously in terms of a dozen or more antigens in one reaction-free dose. This, veritably, would be a magic bullet.

May I draw the conclusion that the prospects for major advances in the future control of respiratory diseases are bright; but we still have a long way to go, both in applying what we now know and in making new discoveries.

What is the theoretical limit we can shoot for? I think this limit is clear but to discuss this I must challenge another commonly held belief, even a fetish in many circles. It is the proposition that eradication of an infectious disease is not an attainable or practical goal. If one will accept Dr. Justin M. Andrews' definition of the concept, namely area-eradication or the elimination of the natural spread of the disease in a large contiguous area, such as the United States, I maintain that eradication is a reasonable and attainable objective for a number of diseases. It was achieved for yellow fever and dengue decades ago, and within the past decade even for malaria.

In the past 5 years the Communicable Disease Center has made an intensive search for evidence of the occurrence of mosquito-transmitted malaria in this country. While a small number of single verified cases has been uncovered, they have almost all been evident relapses, introduced cases, or transfusion malarias. A very few are unexplained but not a single instance of two or more cases occurring in epidemiological relationship has been discovered. This constitutes area-eradication as Dr. Andrews defines it.

These achievements are not limited to the arthropod-borne infections. Since 1948, less than 100 cases of smallpox have been reported each year from the entire Nation. These few cases are not concentrated along the Mexican border or in the port cities where occasional introductions may well occur; and, therefore, it is a reasonable epidemiological conclusion that they are erroneous diagnoses. The last outbreak of smallpox in this country, that I have been able to find, occurred along the Mexican border in 1949. While to the purists we cannot claim eradication, we all know that for all practical purposes this has been achieved.

I maintain that to argue, as some do, that no infection can be considered as eradicated from an area because it may be accidentally introduced from outside, shrouds the significant fact that the disease has been successfully eliminated. This rigid semantic position inhibits us from declaring our logical objectives and makes us complaisant with partial success.

Let us examine the epidemiological basis for the disappearance of smallpox. This leads to the subject of Epidemic Theory developed first by Farr, Hamer, Brownlee, and Soper in England and extended in this country, by Frost, Reed, and Wilson. It is axiomatic that, for the survival of any disease which is caused by an obligate parasite of man, one infected individual must give rise on the average to one new infected individual. This ratio, of course, may vary. If at one particular time the circumstances are such that one case gives rise to more than one case in the next generation, the incidence rises. As the epidemic progresses, however, recovered cases become immune and the susceptibles become depleted to the point where new cases no longer give rise to an equal number of subsequent cases. Then, the incidence falls and the epidemic subsides. For respiratory diseases such as measles, influenza, and many others, the epidemic terminates long before the susceptibles are exhausted. Another epidemic does not recur until the susceptibles are replenished by the addition of newborn individuals as in measles, or by waning immunity as in influenza.

The agents of this group of diseases may be said to have achieved a successful biological balance with the human race. Their incidence fluctuates over short-time intervals; but, averaged over longer time spans, it has been remarkably stable.

The epidemic theorists have written a simple equation that accounts for this waxing and waning of incidence of such diseases as measles. The incidence rate may be expressed as a function of only two factors: (1) the proportion of susceptibles in the population, (2) the contact rate.

The former is a simple concept that can be measured in at least approximate terms for several diseases. The latter is a composite of many variables including the ease of transmission of the particular infection from person to person and the frequency with which people come in contact with each other in a given time period. Thus, the contact rate is a statistical parameter determined by the biological characteristics of the host parasite relationship and the standard of living. For diseases such as measles and mumps, in which the host–parasite relationship has been stable for centuries, the important factor determining the incidence rate is the proportion of susceptibles in the population.

For each contagious disease there is a certain threshold of susceptibles which, if it is exceeded, leads to the occurrence of a rising incidence, or an epidemic; and in converse, if the proportion of susceptibles is less than the threshold, no epidemics can occur. The characteristic 2- to 3-year periodicity of measles, which occurs so regularly in many of our cities, can be adequately accounted for essentially in these simple terms.

On the basis of this theory, the eradication of respiratory disease follows logically. All that is necessary is to maintain the threshold by artificial means, such as immunization, well below that which is necessary for one case to give rise to one subsequent case. If this reduction in susceptibles is maintained effectively and generally over a large area, such as a whole Nation, and particularly in pockets of the population where the contact rate is especially high, the disease must steadily and progressively disappear. With a truly effective program of immunization, this disappearance should be rapid, a matter of only a few years.

It should be emphasized that the conditions necessary for the disappearance of such an infection do not, by any means, require that the total population be immunized. Probably a 50 percent reduction in the proportion of susceptibles, if well distributed, would be sufficient.

This is exactly what has happened with smallpox. Although 150 years have now passed since Jenner's discovery, we substantially achieved this goal many years ago. We have reached the goal in spite of the fact that vaccination is by no means universal and the immunity conferred by vaccination is neither absolute nor permanent. Vaccination is a sufficiently widespread practice, particularly as a requirement for admission to schools, to maintain the threshold of susceptibility to the disease at the level where the disease was forced to disappear as an endemic infection.

Two additional factors are important in this achievement. The first is the rigidly enforced requirement that all travelers, both immigrants and tourists, must have a recent successful vaccination before entering the country. This materially reduces the chance of introduction of the disease. The second factor is the popular clamor and demand for vaccination whenever a case of smallpox is reported. The primary factor, however, is the routine vaccination of our school children which keeps the threshold at a safe, low level. If we fail to maintain this practice, we expose ourselves to danger.

I believe these principles are epidemiologically sound and generally applicable to any acute infectious disease caused by an obligate parasite of the human race, and for which acquired immunity is the factor controlling incidence. They certainly apply to measles, mumps, and chickenpox, where a high proportion of the total infections are clinical cases and immunity is long lasting. I can see no theoretical reason why they should not apply to diseases such as diphtheria, whooping cough, and poliomyelitis where a higher proportion of infections are inapparent. The streptococcal, pneumonococcal, and meningococcal infections, and influenza, present special problems because of the multiplicity of immunologically distinct types. These may raise practical problems in the development of specific vaccines but not basic theoretical objections of an epidemiological nature. The basic requirement is an effective immunizing agent.

In summary, then, the necessary conditions for the area-eradication of the common respiratory contagious diseases are:

(1) The reduction of the threshold of susceptibles to a level where one case gives rise, on the average, to less than one case in the next generation. This implies rather widespread and continuing practice of immunization and the availability of a safe, effective, and practical immunizing agent. It does not imply universal immunity.

(2) The maintenance of effective requirements of immunization of immigrants and tourists entering the country to prevent introduction of the disease.

(3) A constant and vigilant epidemiological surveillance, supported by an informed and cooperative public to stamp out by intensified immunization any accidental introduction that may occur.

The respiratory diseases are unfinished business. Etiological discoveries, particularly the cultivation of specific agents in the chick embryo, and the simplification and enhancement of immunizing procedures, give promise of new achievements in the near future. The area-eradication of respiratory diseases is the ultimate goal which should be theoretically attainable for a number of respiratory infections. When this is achieved the noninfectious, chronic, debilitating diseases will justly command the primary attention of the epidemiologists.

Irrigation Cycles, Mosquito Cycles, and Generations of Aedes Mosquitoes in Irrigated Pastures in California*

DEED C. THURMAN, JR., S. A. Sanitarian,** R. C. HUSBANDS,***
E. W. MORTENSON, † and BETTINA ROSAY,***

INTRODUCTION

Mosquitoes in irrigated pastures in California have been a major reason for one of the most intensive large-scale insect abatement programs ever organized in the interest of public health and community welfare. The program has expended millions of dollars and has received such public commendation that the future will bring an extension of mosquito control to additional areas of California and neighboring States.

The advance of technical and scientific knowledge is falling behind the advancing desire on the part of the public for expanded and intensified mosquito control. In this field, the science of mosquito ecology has probably lagged farthest behind. Several reasons for this condition exist. Firstly, the need for operational investigations on the ecology of irrigated pasture mosquitoes could not be recognized until after the need for mosquito abatement over large areas became recognized as important to the welfare of the people in California. Secondly, the control program had to establish itself in the financial systems of State and local governments as a continuing program before efforts could be turned to less well understood aspects of the science of mosquito ecology.

There are several factors contributing to the present existence of a State investigation on the ecology of irrigated pasture mosquitoes: firstly, the almost complete lack of knowledge of many of the most fundamental aspects of the natural history of irrigated pasture mosquitoes; secondly, the ever-increasing demand for even greater efficiency in the control program; thirdly, the pending increase in irrigated acreage brought about by the Central Valley Project (1) which will subject the Great Central Valley to a predicted increase of one-third in total mosquito control problem area; and lastly, increased difficulties in maintaining the standard of control established for the California program.

The purposes of the present investigations, which began in July 1949, were to establish fundamental facts with regard to the natural history of irrigated pasture mosquitoes. The essential problems were to determine the mosquito species existing in a typical habitat, the relative species abundance, the number of irrigation cycles each year, the mosquito growth cycles, and the effect of temperature on the growth and activities of the irrigated pasture mosquitoes. Much of this basic information was obtained.

MATERIALS AND METHODS

For special study during the 1950 season an irrigated pasture of approximately 90 acres, located in Stanislaus County in T55, R9E, S9,†† was chosen. At one time this pasture, referred to herein as the Schaub Study Pasture, had been planted to Ladino clover and pasture grasses, but a large portion of the pasture was in poor condition at the beginning of observations in March 1950. The soil is Fresno series dry sandy loam underlaid

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**Formerly CDC, assigned to Bureau of Vector Control, Berkeley, Calif. Now with Division of International Health.

***Resident Entomologist, and Assistant Entomologist, respectively, Central Valley Mosquito Ecology Studies, California Mosquito Control Association.

†Parasitologist, Bureau of Vector Control, Fresno, Calif.

†† Through courtesy of the owner and of the Turlock Mosquito Abatement District, no control was done in this pasture during most of the study (the first 13 irrigations).

with an almost impermeable hardpan at depths of from 12 to 30 inches.

The pasture is an inverted L-shaped block of land located about 8 miles west of Turlock in the midst of an intensively-farmed area. At the time of the study it was surrounded by several different types of crops. It was bordered on the north by a watermelon patch and a corn field, and on the east by a settlement of about 20 inhabited farm houses and groves of eucalyptus trees. To the south, a small pump-irrigated rice field stood adjacent, fitting into the angle of the L and lying just to the east of another irrigated pasture. On the west, it was bordered by a State highway beyond which were a corn field and additional pasture land. The owner's house and barns were located in approximately the northwest corner of the pasture.

Most of the studies were conducted in a 50-acre section of the pasture which in turn could be divided into three areas. These were: (1) an 18-acre section just south of the farm buildings; (2) a 20-acre section centrally located; and (3) an area of approximately 10 acres located east of the 20-acre section and adjacent to the rice field. These sections were separated by irrigation ditches and were bordered by fences or fence posts.

Strip checks, which are level strips of land about 50 ft. wide bordered by foot-high earthen ridges, extended from east to west. Irrigation was started in the higher eastern end of the checks and was completed in sequence beginning with the most easterly sections of the pasture and progressing to the west as needed.

The pasture was kept under continuous observation from the beginning of irrigation in the spring to early September. Special attention was given to the central sections of the pasture where observation stations were established for regular daily visits.

A standard weather station type of structure was located in the central portion of the field and contained a hygrothermograph set for weekly records of temperature and humidity.

Irrigation as practiced by the farmer was dependent upon the schedule of delivery through the canal supply system of the local irrigation district. The farmer's field practices for handling this water were different for each irrigation but generally resulted in the flooding of certain low areas during each cycle. Usually about 12 to 18 hours was required for a complete irrigation of the pasture although the central 20 acres generally was flooded in about 6 hours.

Water maps were prepared to delineate the area covered after each irrigation. These maps were made about 24 to 36 hours after the irrigation had ceased so that preliminary drainage could occur and so that the fixed point after which the receding water must leave the checks by either percolation, absorption, transpiration, or evaporation could be ascertained. These maps coincided with the development of second stage larvae of *Aedes nigromaculis* (Ludlow) and with the beginning of control operations under certain circumstances.

Observation stations were set up in selected checks and daily records were made of the water depth, the temperature of the water and air, and the larval density in terms of the number of larvae taken per dip. Aquatic stages were collected from each station during each visit and were preserved for future identification of stage and species of the larvae and the genus and sex of the pupae.

A. nigromaculis, the most abundant species under observation, received a major portion of the attention during the study. For purposes of the study, cycles of growth for this species were arbitrarily determined to begin with the flooding of the field and to end with the emergence of adults. These two points in the life cycle of the species population were believed to be those which could be accurately determined and therefore would result in comparable data.

Records of adult mosquitoes were made by the use of the cloth flag counting method (2) during the day and of a light trap located near the pasture at night. These indexes to adult density and activity provide information for a better understanding of the natural history of *A. nigromaculis*.

RESULTS

Eighteen cycles of irrigation were conducted in the Schaub Study Pasture. A growth cycle of *Aedes* mosquitoes occurred at each irrigation. The length of the growth period shows close correlation with the temperature. At temperatures averaging above 85° F., a growth cycle of less than 5 days occurred. At temperatures between 75° F. and 80° F., three cycles were recorded requiring from 5.75 to 6.5 days. At 70° F. to 74° F., three cycles were recorded requiring 6.5 to 6.75 days. When the mean temperature was from 65° F. to 70° F., two cycles of 7 and 8.5 days were recorded. Two cycles of 9 and 10 days were recorded for temperatures averaging 60° F. to 65° F., and two cycles of 14 and 16 days were recorded for mean temperatures 57° F. and 54° F., respectively, (table 1).

Samples of larvae identified showed that *A. nigromaculis* amounted to 98.3 percent of the *Aedes* larvae collected and 86.9 percent of the total mosquitoes collected. *Culex tarsalis* Coquillett was the most common *Culex* and amounted to 90.5 percent of the specimens of that genus collected. This species accounted for 10.2 percent of the total types of mosquito larvae taken. *Culiseta inornata* (Williston), the only *Culiseta* collected in the larval stage, amounted to 0.3 percent of the total. The genus *Culiseta* occurred in only the first six cycles.

It was noted that for 676 *Culex* pupae collected there was an almost 50-50 ratio of males to females, while for 6,077 *Aedes* pupae collected there was a ratio of 46.6 males to 53.4 females. Examination of the data also indicated that the number of female *Aedes* pupae exceeded the number of male *Aedes* pupae collected in every case in which more than 200 *Aedes* pupae were collected; whereas the male pupae exceeded the females when fewer than 200 pupae were collected.

During the longest growth cycle (flooding of pasture to adult emergence) which consisted of 16 days from March 16 to March 31 inclusive, the following periods of time were required for each larval stadium: first, 3 days; second, 2 days; third, 2 days; fourth, more than 6 days. The pupal stage required 3 days. The shortest growth cycle studies occurred from June 29 to July 4, a total of 4.75 days. During this short cycle the following periods of time were required for each larval stadium: first, 24 hours; second, 12 hours; third, 24 hours; fourth, 36 hours. The pupal stage required about 24 to 36 hours.

In making these observations it must be noted that there was some overlap of stadia—some specimens reached the fourth instar while others were moulting from second to third. The major portion of each brood of *A. nigromaculis* larvae changed en masse from one instar to the next.

The relationship of two indexes to adult *Aedes* density is shown in table 2 in which flag counts and light trap counts are compared for 13 cycles of irrigation in the study pasture.

Table 1

Irrigation Dates (Hatching Date for "Aedes" eggs), Dates Adults First Emerged, Length of Growth Cycle in Days and the Mean of the Maximum, Minimum, and Mean Air Temperatures for the Period.

Cycle	Date Irrigated	Date Adults Emerged	No. days for Energence	Mean of temperatures in $^{\circ}$F. Max.	Min.	Mean
1	March 16 (6 a.m.)	April 1 (a.m.)	16.0	67	41	54
2	April 6	April 20	14.0	70	44	57
3	April 20	April 29	9.0	78	43	61
4	May 3 (2 a.m.)	May 13 (a.m.)	10.0	76	44	61
5	May 13 (8 p.m.)	May 22 (a.m.)	8.5	84	48	66
6	May 25 (4 p.m.)	June 1 (a.m.)	6.5	93	56	75
7	June 5 (10 p.m.)	June 14 (8 a.m.)	8.5	78	49	64
8	June 17 (6 p.m.)	June 24 (a.m.)	6.5	87	53	70
9	June 29 (6-12 a.m.)	July 4 (a.m.)	4.75	107	64	86
10	July 11 (5-12 a.m.)	July 17 (a.m.)	6.0	96	60	78
11	July 23 (a.m.)	July 29 (p.m.)	6.5	91	55	73
12	August 3 (a.m.)	August 10 (noon)	6.75	87	53	70
13	August 15 (noon)	August 21 (a.m.)	5.75	100	58	79
14	August 26 (a.m.)	Sept. 1 (a.m.)	6.0	97	60	79
15	September 6	September 13	7.5	82	53	67
16	September 18	September 24	6.5	87	53	70
17	September 29	October 6	8.0	81	47	64
18	October 9	October 20	11.0	84	50	66

Table 2

PEAK ADULT INDEX OF FEMALE "AEDES NIGROMACULIS" (LUDLOW) FROM CLOTH FLAGS AND LIGHT TRAPS, SCHAUB STUDY PASTURE, TURLOCK, 1950.

Cycle No.	Date Adults Emerged	Peak Index			
		Flag Count		Light Trap 11	
		Date	Index	Date	Count
1	April 1	April 4	4.8	April 6	30*
2	April 20	April 25	0.7	April 24	32*
3	April 29	May 9	0.6	May 13	4*
4	May 13	May 20	0.4	May 13	4*
5	May 22	May 25	5.9	**	**
6	June 1	June 3	1.3		
7	June 14	June 17	14.7		
8	June 24	June 26	9.6	June 26	216
9	July 4	July 6	23.3	July 7	1,519
10	July 17	July 18	7.1	July 22	976
11	July 29	August 1	56.8	July 31	1,274
12	August 10	August 12	14.4	August 13	236
13	August 21	August 24	21.9	August 24	1,181

*Collections for 3-day periods.
**Collections destroyed by museum pests before identification.

Records of temperatures, shown in table 3 and table 4, indicate there is a difference between the water and air temperatures and that the surface and bottom temperatures vary with the depth of the water and the amount and type of vegetation present. For seven stations, varying from 4.5 to 9.5 in. in depth and showing a change in type and amount of vegetation, there was a difference of from 1^{o} to 17^{o} between the bottom temperatures and the surface temperatures of the water.

Daily fluctuation of air temperatures during the early part of July was found to be more than 40^{o} F. From a low of about 64^{o} F. which occurred about 5 a.m. each morning, the air temperature rose rapidly reaching more than 106^{o} F. by 4 p.m. Water temperatures during the same period ranged from 77^{o} F. to 108^{o} F.

The need to have measurements of the volume and extent of water producing a brood of *A. nigromaculis* within the Study Pasture was met by carefully mapping a single check each morning during the tenth irrigation cycle. This check (Number 9) was mapped for 630 ft. of its length and for 57.5 ft. in width. This area was computed to be 36,225 sq. ft. (0.83 acres) of which 96.9 percent was flooded (table 5). Based on an estimated average depth, the volume of water amounted to 53,325 gal. This cycle required 6.0 days from flooding of the field to the first observed emergence of adults. On the morning of the sixth day only 10,368 sq. ft. of the original flooded area was still covered with water and that amounted to 9,720 gal. By the time the adult *Aedes* had all emerged, only about 10 percent of the check under observation was still flooded. Ten days after the irrigation of July 11 and two days before the field was reirrigated, only an estimated 397 gal. of water covered less than 3 percent of the ground area. This is further complicated by the fact that survival of the species is not indicated by remaining water. *Aedes* that are able to reach late fourth stage or pupae can sometimes survive on moist soil to finally emerge as adults after a short period of development.

DISCUSSION OF RESULTS

Results of these measurements indicate the complexity of the ecological problems involved. Each irrigation cycle is a potential source of increasing numbers of mosquitoes. A succession of species occurs with each irrigation, beginning with the *Aedes* and ending with the *Culex*. Although the dominant species is *A. nigromaculis*, *Aedes dorsalis* completes for that dominance during the cooler spring and summer months. In the Stanislaus County area where the studies were conducted, the production of 18 irrigation cycles does not necessarily indicate the produc-

Table 3

RECORDS OF WATER TEMPERATURES, AIR TEMPERATURES, AND DEPTHS AT SELECTED STATIONS IN THE SCHAUB STUDY PASTURE, JULY 1, 1950

Station Number	Temperatures Air	Water Surface	Water Bottom	Hour of Day (PM)	Depth of Water (Inches)
6A	101	104		1:45	3.50
17A	96	105		1:00	2.50
19A	96	92		12:50	7.25
E23A	100	94		2:10	2.75
13A	97	95	89	1:10	5.25
W. Ditch at 12A	98	94	85	1:15	9.50
9A	98	96	79	1:20	6.75
10A	98	102	100	1:30	4.50
7A	98	101	100	1:35	4.50
W. Ditch at 6A	101	97	89	1:50	5.00
E12C	100	100	89	2:00	4.75
Mean (Last 7)	98.5	97.8	88.7		5.73

Table 4

RECORDS FOR THE POOL OF STANDING WATER IN THE WEST END OF TWO CHECKS IN THE SCHAUB STUDY PASTURE, JULY 1

Station Number	Water Depth (Inches)	Temperatures Air	Water Surface	Water Bottom
Check 7 - Open Water, No Vegetation, Alkali Bottom, 1:35 p.m.				
1	1.00	98	103	103
2	5.00	98	102	100
3	0.50	98	103	103
A	4.50	98	101	100
Check 13 - Short Ladino Clover Covering Bottom Emergent When Water is 1 to 2 in. Deep				
1	1.75	97	103	100
2	3.50	97	101	98
3	5.00	97	101	96
4	1.00	97	104	104
A	5.25	97	95	89

tion of the same number of generations of *A. nigromaculis*. Other factors complicate this problem. The unknown factors involved in the production, conditioning, and maturation of *Aedes* eggs must be considered. The egg-to-egg generation is the most difficult to measure since dormancy may affect the number of eggs that will hatch. This dormancy results in the partial overlapping of hatches of eggs deposited by several preceeding generations with each flooding of the pasture, and causes explosive increases in the adult mosquito population. This is further complicated by the fact that as the temperature increases, the rate of growth in the aquatic stages is speeded up which results in a shorter egg-to-egg cycle. The shortening of this cycle increases the

Table 5

Measurements of Amount of Water Covering a Single Check (Number 9) Schaub Study Pasture, Stanislaus County, Calif., 1950. (Total Area of Check Estimated at 36,225 Sq. Ft.)*

Date	Days After Irrigation	Area Covered By Water (Sq. Ft.)	Percent of Area Covered By Water	Volume of Water (In gallons)	"Aedes" Emergence
July 11	0	35,110	96.9	53,325	Hatched
12	1	26,505	73.2	43,897	
13	2	25,209	69.6	33,870	
14	3	21,645	59.8	28,410	
15	4	18,101	50.0	21,502	
16	5	**	**	**	
17	6	10,368	28.6	9,720	Emergence Began
18	7	5,184	14.3	4,665	
19	8	3,564	9.8	2,452	Completed
20	9	1,782	4.9	1,110	
21	10	972	2.7	397	

*Table prepared from data collected by William E. Trimmingham, Entomological Assistant.
**No record made on this day.

number of mature eggs available for hatching with each irrigation. The synchronization of the egg-to-egg cycle and of the irrigation cycle may occur in midsummer. Large increases in the adult populations of *A. nigromaculis* occurred in July, August, and September during the 1950 season.

Control measures differ in various parts of the Central Valley of California where irrigated pastures are found. In general, larval control is directed at the second to fourth stage larvae of *A. nigromaculis*. As the summer temperatures rise, the growth rate of these stages is speeded up until the time available for larviciding may be cut in half. In some cases the timing becomes so critical that the operator may have only a single day to reach flooded areas where the water area is small enough that it can be treated economically and still control the larvae before pupation occurs.

SUMMARY

1. Each of eighteen irrigation cycles produced a corresponding growth cycle of *Aedes* mosquitoes in a selected study pasture.

2. The dominant species in irrigated pastures is *Aedes nigromaculis* (Ludlow). *Cultex tarsalis* Coquillett is the dominant *Culex* and occurs in areas of poor drainage and standing water.

3. The growth rate of aquatic stages of *A. nigromaculis* varied with the temperature. As the mean temperature increased, the rate of growth increased and the time spent in various instars decreased.

4. In the pastures studied, peaks of *A. nigromaculis* production occurred during the months of July, August, and September.

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Ectoparasite Collecting Device

MILTON H. BUEHLER, JR., S. A. Sanitarian (R)*

To facilitate the collection of ectoparasites from trapped rats, an ectoparasite collecting device has been made, utilizing the suction provided by the windshield wiping mechanism of an automobile (figure 1).

Figure 1

This apparatus makes it possible to collect ectoparasites in the field immediately after killing of the rodents in a cyanide jar. Ectoparasites collected can be segregated by individual rodent from which taken, or by location pools, merely by changing the collection bottle and labeling it. Separation and identification can then be accomplished in the laboratory in the usual manner. The collector enables personnel making rat surveys or conducting rat eradication to dispense with the pans, trays, combs, and files usually employed in the ectoparasite phase of their work. It also eliminates the necessity of bringing rats to the laboratory for combing at the end of the day, at which time the hair on many rodents has begun to slip as a result of decomposition.

In operation, the rat is held in the hand and gently combed by raking the comb back and forth over the rodent. The dislodged ectoparasites are sucked into the device.

The collecting device has been used on several rats which later were combed in the conventional manner without recovering additional ectoparasites. It has collected the following species: fleas — *Nosopsyllus fasciatus* and *Ctenocephalides felis;* mites — *Macrocheles* spp.; and lice — *Polyplax spinulosa.*

Materials used in the construction of this vacuum device consisted of copper tubing, brass oil line fittings, a small valve, 150-mesh screen, rubber tubing, and a standard sputum bottle.** The mechanism was mounted on an aluminum disk which was attached to the dashboard of the automobile in the opening originally designed for a radio loudspeaker.

The new device should save much time and effort for personnel engaged in ectoparasite collection.

*Oregon State Board of Health, CDC Activities, Portland, Oreg.

**Details on this device are available from the author upon request.

Kentucky Dysentery and Diarrhea Fly Control Program (F.Y. 1951)

E. V. WELCH* and S. A. LACY**

In May 1950, aid for a cooperative program to control dysentery and diarrhea, through fly control measures, was made available to Kentucky by the Communicable Disease Center.

In setting up the program the Communicable Disease Center recommended that an area of high endemicity be selected. In view of the relatively high incidence of these diseases in eastern Kentucky, it was proposed that the project be set up in a city in that part of the State. To participate in the program, the city was expected to provide for sanitation activities, labor for spraying, maintenance and storage of equipment, and insecticides. Federal funds were to be utilized to provide for vehicular equipment, spray machines, and technical and supervisory personnel as required. CDC participation in the program was contingent upon continued Federal appropriations.

During the latter part of May and in June 1950, health departments in eastern Kentucky were contacted and the program was outlined to them. These contacts were made to select a city that could meet the above requirements and that would be interested in the program. The city of Harlan was finally selected since it was the only city in a position to provide the necessary cooperation, and since it had a sufficiently high incidence of dysentery and diarrhea to qualify.

On June 28, 1950, representatives of CDC and of the State Department of Health were invited to meet with the Harlan City Council to explain the program. The council accepted the program and on that date voted an appropriation for fly control for the remainder of calendar year 1950. At that meeting, the council agreed to furnish two laborers for spraying; storage facilities for trucks, equipment, chemicals, and supplies; and maintenance of trucks in lieu of the purchase of chemicals. The Harlan County Health Department agreed to furnish office space and clerical assistance. CDC agreed to furnish trucks, spray machines and equipment, and an area supervisor and other technical assistance.

During the council meeting it was emphasized that to obtain fly control, principal emphasis should be placed upon the elimination of fly breeding foci through the improvement of municipal practices presently employed in the collection, storage, and disposal of refuse. Chemical treatment should be employed only as a supplement to improved sanitation.

In a special meeting in March 1951, the Harlan City Council accepted a program for calendar year 1951, essentially the same as that for calendar year 1950.

Harlan lies at the junction of Martins Fork and Clover Fork Creeks, headwaters of the Cumberland River. The business district and much of the residential districts are in a valley almost entirely surrounded by mountains. The city is located on U. S. Highway 119 and State Highways 66 and 257. It is served by a branch of the Louisville and Nashville Railroad.

Harlan has a population of 4,779 inhabitants (1950 preliminary census). In the outlying areas adjacent to the city there are approximately 2,000 people, making an over-all population of approximately 6,779 in the area. The chief industry in the area is coal mining. Although some farming is practiced, it is of little consequence.

The city is served by the Harlan County Health Department with both office and clinic located in the city. The County Health Department was organized in August 1920. Prior to that date there had never been an organized city- or county-wide health or sanitation program. At present the County Health Department is staffed by a part-time health officer, one full-time sanitarian, one field nurse, and two clerks.

In July the Communicable Disease Center assigned Mr. Henry B. White, Jr. to the Kentucky

*State CDC Entomologist, Kentucky.
**Assistant State Director, CDC Activities, Kentucky.

State Department of Health to serve as an area supervisor in fly control activities in the State. Since Mr. White had a background of 8 years experience in vector control operations, he received only a brief orientation in Louisville and proceeded to Harlan on July 17 to supervise the progress in that city. With assistance from CDC headquarters, he spent the remainder of July in setting up office space, holding conferences with health and city officials, arranging for storage of equipment and supplies, and selecting and mapping a check city.

For inspectional and operational purposes Harlan was divided into sections based upon fly densities, sanitation levels, and socioeconomic conditions. The city has a compact, well-defined business district, two widely separated low-class residential areas, and single middle- and high-class residential districts. Boundary lines were established for these five sections and each block was assigned a number. Each section was then divided into evaluative units consisting of approximately 10 contiguous blocks in the business districts and the low- and middle-class residential districts, and approximately 20 homogeneous blocks in the high class residential district. Within each evaluative unit, the block that had the greatest density of flies or fly breeding conditions was designated as a fixed block station. In addition to the fixed block a second block was selected at random in the evaluative units and inspected weekly.

To provide information on the normal trends of fly prevalence in a city in the area in which fly control practices are not employed, the city of Cumberland, situated 22 miles northeast of Harlan, was selected as a check city. Selection of Cumberland over other cities in the area was based on its similarity to Harlan in socioeconomic, industrial, and sanitation levels; fly prevalence; and its proximity to Harlan. The city was divided into sections and evaluative units the same as was done for Harlan.

Grill surveys were made at weekly intervals in all fixed and random blocks. Inspection of comparable sections in both cities was scheduled insofar as possible on the same day to minimize the effect of daily variations in weather conditions. Under normal conditions, less than 2 days was required for the inspection work and adjustment of the schedule was made whenever disrupted by weather. For all regular surveys the Scudder grill* was used.

Unfortunately, due to delays in the arrival of equipment, chemicals, and other supplies, the control and inspection activities did not get under way until the first week in August 1950. A pretreatment grill survey was made in Harlan the week of August 6. Chemical treatment was begun in the business section of the city during the same week. The chemical treatment was extended to all sections of the city and treatment was continued until the middle of October. During this 2½-month period some of the sections were treated at least three times based on the fly prevalence as determined by the posttreatment grill surveys. Cold weather curtailed fly activity and weekly grill surveys were discontinued in both the treated and untreated city at the end of October 1950.

The weekly grill surveys were resumed in Harlan and Cumberland during the week of May 14, 1951, and chemical treatment was begun in Harlan during the week of June 4 (see table 1). Treatment was extended to all sections of the city by the end of the month. The grill surveys and chemical treatment were performed in the same manner as during the previous season.

A 2½-percent oil emulsion solution of chlordan was used in the chemical treatment. This chemical was selected since it was desirable to conduct control from a residual spray standpoint and also to use the chemical as a larvicide. The chemical treatment was applied to garbage stations, garbage cans, and areas adjacent to garbage cans where flies were likely to congregate. Animal shelters also were treated. In the lower economic housing areas, back porches were sprayed along with garbage stations. Outside and underneath insanitary privies were also sprayed. Due to the insanitary conditions existing in some areas, it was necessary to spray both scattered garbage and human feces. This was especially true along the river banks where the houses were elevated. A summary of residual spray operations is given in table 2.

In November 1950, activities of the area supervisor were concentrated on making environmental sanitary surveys in Harlan. These surveys were completed in March of 1951. As a result of the surveys, a much clearer picture of sanitation conditions in Harlan was obtained. Many insanitary conditions were uncovered that the health department or the city council had not known were exist-

*Pub. Health Rep. 62: 681-686 (1947).

Table 1

GRILL AVERAGES BY WEEKS

Date 1950	Week No.	Harlan (Treated City) Grill Average	Cumberland (Untreated City) Grill Average
August 6-12	32	6.9 (Pre-spray	7.7
August 13-19	33	4.2 inspection)	8.7
August 21-25	34	4.1	7.9
August 28 to Sept 1	35	1.5	6.1
September 4-9	36	2.2	No inspection
September 11-16	37	No inspection	No inspection
September 18-22	38	1.9	7.0
September 25-30	39	1.1	4.4
October 2-6	40	1.4	7.2
October 9-13	41	1.0	4.6
October 16-20	42	1.5	5.9
October 23-27	43	1.0	5.4
1951			
May 14-19	20	0.6	0.9
May 21-26	21	2.0	1.5
May 28 to June 2	22	1.4	2.0
June 4-9	23	2.1	3.2
June 11-15	24	2.0	3.3
June 18-22	25	1.6	2.0
June 25-30	26	1.2	5.3

ent. A report of the findings was presented to the mayor of Harlan and to the Harlan County Health Officer. Table 3 gives a summary of the sanitary survey in the Harlan area.

Following the environmental sanitation survey, a survey of garbage and refuse storage, collection, and disposal was made. The city maintains a regular system of garbage and refuse collections, collection being made on the fee system. The fee for residences was increased from $1.50 to $2.00 per month in the early part of 1951, about 60 percent of the residents subscribing for this service.

Table 2

SUMMARY OF RESIDUAL SPRAY OPERATIONS

Number of Premises Treatments	4,258
Number of Gallons 2½ percent Chlordan used	2,282
Man-hours: CDC (Supervision and Inspection)	554*
Local	875
Total Man-hours Expended	**1,429**
Cost of Chlordan (2½ percent solution)	$411.83
Maintenance of Vehicles, Gas, Oil, and Miscellaneous Expenses (local)	51.80
Man-hours, Local, per Premises Treatment	0.21
Man-hours, Local, per Gallon - 2½ percent Chlordan	0.38
Gallons of 2½ percent Chlordan per Premises Treatment	0.54

*One CDC Fly Control Aid was employed in May 1951 to assist with grill inspections and other activities.

Table 3

SUMMARY OF SANITARY SURVEY HARLAN AREA

Type of Facilities	In City	Outside City	Total
Number of Dwellings	1,109	471	1,580
Number of Restaurants	29	3	32
Number of Grocery Stores	33	16	49
Number of Dwellings with no Toilet Facilities	15	?	?
Number of Dwellings with Private Sewers	19	?	?
Number of Dwellings with Privies	80	365	445
Number of Homes with no Garbage Container	446	305	751
Number of Hog Pens	9	47	56
Number of Other Animal Pens	82	116	198

Garbage and refuse collected from the city is disposed of at the municipally owned and operated incinerator, and at an open dump within the city limits. The dump is used mostly by people who do not subscribe to the municipal collection system. The dumping area supposedly is the landfill operated in connection with the incinerator. Promiscuous dumping is practiced by some of the inhabitants throughout the city. The city operates two trucks in the city collections; one is a 2-ton truck equipped with a K-9-X Dempster-Dumpster* unit, and one is a 1½-ton open dump truck. Collections are made daily in the commercial district, and twice weekly in the residential area. A report of the garbage and refuse survey was presented to the health department and the city council.

Since the reports of the environmental sanitary survey and the garbage and refuse survey were presented, some slight progress has been made in sanitation activities in the city, such as improved garbage and refuse storage, collection and disposal, and elimination of a few animal pens and insanitary privies. However, much work is needed to effect environmental sanitation in the city. It was estimated that over 300 garbage cans were sold by local hardware stores during the sanitary

*The trade name is carried as a means of identifying the product under discussion, and does not represent endorsement of the product by the Public Health Service.

Table 4

SPECIES OF FLIES TRAPPED IN BUSINESS AND RESIDENTIAL SECTIONS OF HARLAN, KY., FROM AUGUST 14 TO OCTOBER 24, 1950

Species	Number of Specimens*	Percent
Calliphoridae		
Calliphora vicina	48	2.3
Callitroga macellaria	44	2.1
Lucilia illustris	12	0.6
Phaenicia caeruleiviridis	92	4.4
Phaenicia pallescens	132	6.3
Phaenicia sericata	203	9.7
Phormia regina	422	20.2
Minor species (1)	1	
Total	**954**	**45.6**
Muscidae		
Musca domestica	175	8.4
Muscina stabulans	102	4.9
Ophyra leucostoma	219	10.5
Fannia canicularis	88	4.2
Minor species (13)	145	6.9
Total	**729**	**34.9**
Sarcophagidae		
Sarcophaga haemorrhoidalis	158	7.6
Sarcophaga pusiola	63	3.0
Sarcophaga rapax	25	1.2
Sarcophaga ventricosa	49	2.3
Minor species (16)	64	3.1
Total	**359**	**17.2**
Minor families (10)	68	2.3
Grand Total	**2,090**	**100.0**

*Total number of collections - 32

survey. During the month of April a spring clean-up campaign, sponsored by a civic group, was conducted in Harlan. Approximately 200 truck loads of refuse were removed from the city during the campaign.

In addition to the personal contacts, radio and newspaper publicity was employed to keep the public informed concerning the program and the necessity of practicing general sanitation as a means of fly control. Twenty-six newspaper articles appeared in the local paper, 90 radio talks and spot announcements were made, and 16 talks were given to schools and civic groups. Two films were used, "Fly Control Through Basic Sanitation" and "Insects as Carriers of Disease."

In connection with the entomological activities, fly-trap collections were made in Harlan and Cumberland. The traps were operated for periods of 24 hours, using a bait composed of meat or fish, and decaying vegetables and fruit. The flies collected in the traps were killed, stored in containers, and identified during the winter months. Table 4 lists the species of flies recovered from fly traps operated from August 14 to October 24, 1950, in Harlan. The bait-pan type trap was used for trapping.

Interdepartmental Committee on Pest Control

A STATEMENT ON THE HEALTH HAZARDS OF THERMAL GENERATORS AS USED FOR THE CONTROL OF FLYING INSECTS

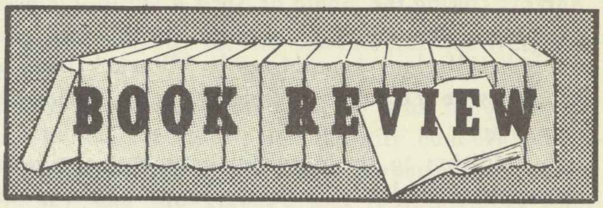
The Interdepartmental Committee on Pest Control composed of representatives of the Departments of Agriculture, Interior, and Defense, and the Federal Security Agency held its regular third quarterly meeting on September 21, 1951 at Washington, D. C. This Committee agreed upon the following release relative to the use of insecticidal vaporizing devices:

"It is the considered opinion of the Interdepartmental Committee on Pest Control that there are at present no data to indicate that the use of thermal generators dispensing only lindane, DDT, or mixtures of the two, for the control of flying insects is unsafe when the following restrictions are enforced:

1. The insecticide shall be released at the rate not to exceed 1 gram per 15,000 cubic feet per 24 hours.
2. Installation shall be made only in commercial or industrial premises, mess halls, and similar locations where human exposure will be on a working day basis – not continuous.
3. The devices should not be used in homes or sleeping quarters.
4. Devices shall be so constructed that output in excess of that recommended is impossible. Fuses to protect against overloading and high temperatures, and a pilot light to indicate whether or not the unit is operating should be 'built-in' features.
5. Units should be mounted above head height and 3 feet or more from the ceiling.
6. Installation shall be such that any material which might condense on nearby equipment, walls, or ceiling cannot be dislodged and fall into or otherwise contaminate food.

Since DDT and lindane are poisons, it is the opinion of the Committee that danger will arise from deliberate or unintentional violation of these basic principles."

Communicable Diseases



Edited by ROSCOE L. PULLEN
Lea & Febiger, Philadelphia, Pa., 1950*

This textbook on communicable diseases was written by 53 authors and edited by Dr. Roscoe L. Pullen, Vice-Dean of the School of Medicine of Tulane University of Louisiana. Eight of the authors were Public Health Service officers.

The communicable diseases included in the book were selected from the 1945 Report of the American Public Health Association.

The arrangement of the 1,006 pages follows the regions and systems of the human body, except for the diseases caused by macroscopic and "higher" parasites. Its last section deals with diseases of only potential menace to the United States. Several communicable diseases not introduced into this country in several decades are included, possibly because they were in the 1945 Committee Report of the APHA.

This text has a unique approach to the subject matter. The reader is assumed to be faced with a patient at the bedside in the home, ward, or admission room. The text takes the reader through the mental processes required to rule out or identify any communicable disease and to determine the treatment of the patient, both as an individual and in relation to society. Related problems of allergy, immunity, virulence, and more or less theoretical considerations are subjected to the practical ward and admitting room deliberations. Consequently, the material is treated in more chapters from a predominantly clinical viewpoint than from a public health viewpoint.

Epidemiology enters the picture from the very first, when the patient's history is taken. The editor and some of the authors demonstrate the very healthy intellectual attitude that many illnesses may never be diagnosed with certainty, and that no diagnosis is better than a fallacious one. Nevertheless, one author supports the diagnosis of poliomyelitis without paralysis or virus isolation.

In spite of the criticisms that this text is sure to invite, much more can be said in its favor than against it, for it is at least a beginning toward filling the glaring need of a general textbook on communicable diseases suitable for polyprofessional reference use. In subsequent editions, the editor will surely have more time and inclination to critically review the text, with a view to decreasing duplicity of content and yet assuring the inclusion of as late content material as possible.

Because many authors composed the chapters of this textbook, the quality of each chapter varies with the capability and experience of the author. For that reason, although many of the chapters are excellently prepared and reasonably up to date, an equal or greater number were poorly prepared or woefully behind time. For example, the latest reference for the encephalitides was an article published in 1948 in the New England Journal of Medicine, with little public health content. The next latest reference for this chapter was 1944. The epidemiology of St. Louis encephalitis was apparently based on the conclusion of Leake *et al.*, in 1934, on the basis of their experience with the original recognition of the first recognized major outbreak of this disease. In contrast, some of the chapters err on the side of overinclusiveness, and contain far more complete detail than a practitioner, medical student, nurse, or other health worker would be expected to assimilate. For example, the chapter on Rocky Mountain spotted fever is 30 pages long and reflects the extensive medical entomological experience of the Public Health Service research group at the Hamilton, Mont., Rocky Mountain Laboratory. More critical editing would have shortened the text without sacrificing the important content and intent of some of the overly long chapters.

It is regrettable that the etiological agents named in the text could not have been designated according to recent taxonomic laws and customs.

Some of the single chapters are concerned with several closely related but etiologically and clin-

*For another review of this text by an anonymous reviewer, the reader is referred to the Journal of the American Medical Association, 144(14): 1217 (1950).

ically separate diseases, such as the typhus fevers and the malarias. Consequently, the student, particularly, will frequently be lost in the cross-references and comparisons of the diseases, one with the other. To benefit from reading these multidisease chapters, the student should have reviewed rather extensively other text materials on the diseases separately.

Griffith E. Quinby, M. D.

PICTORIAL REVIEW

Chick Embryo Techniques

PRODUCTION NO: CDC M42, released 1951

DATA: Motion picture, 16 mm., sound, black and white, 15 minutes, 557 ft.

PURPOSE

To demonstrate the most practical methods of effective use of chick embryos in virus and rickettsial laboratory procedures.

AUDIENCE

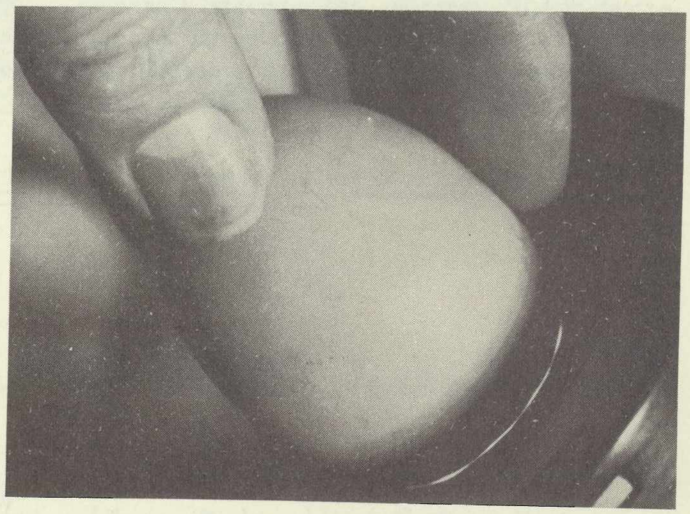
Laboratory technicians and instructors in laboratory techniques.

CONTENT

The developing chick embryo serves as an excellent and practical culture medium for many of the viruses, rickettsiae, and pathogenic bacteria which require living cells for their propagation. Direct isolation of the infectious agent by inoculation of embryos with properly collected and treated materials from patients, is fast becoming standard procedure for the etiologic diagnosis of several viral, rickettsial, bacterial, and mycotic diseases. Also, the infected embryo has been adapted to the preparation of diagnostic antigens, to large-scale production of vaccines, to analysis of factors related to immunity, and to biological assay of therapeutic agents.

The film depicts the materials, equipment, procedures, observations, and theory necessary to enable technicians to perform and understand the following techniques:

(1) incubating and candling; (2) drilling and opening shells; (3) inoculation procedures for the five main areas (chorioallantois, chorioallantoic sac, amniotic sac, yolk, and the embryo itself); (4) windowing; (5) further incubation; and (6) harvesting chorioallantois, allantoic fluid, amniotic fluid, yolk, and embryo.



An early step in chick embryo inoculation is candling to determine location of vein structures directly beneath shell.

COMMENT

The film demonstration was performed by G. John Buddingh, M.D., Louisiana State University School of Medicine.

Fall 1951 Communicable Disease Center Annual Meeting

The ninth annual meeting of field and headquarters personnel of the Communicable Disease Center was held in Atlanta during the week of October 15, 1951. Some 33 States and territories were represented among the registrants, as well as eight regional offices, four river basins, all of the armed services except the Navy, a number of Public Health Service Washington offices (Bureau of State Services, National Institutes of Health, Office of Health Emergency Planning, and others), Tennessee Valley Authority; and there even was one visitor from as far as Japan.

The aim of the meeting this year was to emphasize all phases of CDC activities, so as to give the attendants a better realization of the broad extent of CDC programs and interests. Considerably more than 300 persons attended the meeting, which consisted of 3 days of formal presentations, followed by more specialized meetings during the last 2 days of the week on such subjects as fly control, malaria control, training, veterinary public health, and epidemiology.

On the first evening of the formal meeting a social hour, followed by an excellent buffet supper, was enjoyed by 275 persons. The formal meetings were held in the auditorium of the Fulton County Medical Society, which is near the CDC Headquarters offices.

These meetings are directed primarily toward CDC field and headquarters personnel, in many cases giving these individuals the only opportunity during the year to meet with their associates. However, individuals from States, particularly those in which CDC is conducting research or operational work, as well as any other individuals interested in public health activities, are welcome to attend.

Have you read...?

INSECTICIDES

Holloway, Richard T.: Recent developments in the chemical control of insects. Medical Technicians Bull. (Supplement to U. S. Armed Forces Medical Journal). 2(3): 93-105 (1951). This article describes the capabilities and limitations of the various insecticides, including formulations and combinations, and discusses methods of dispersal.

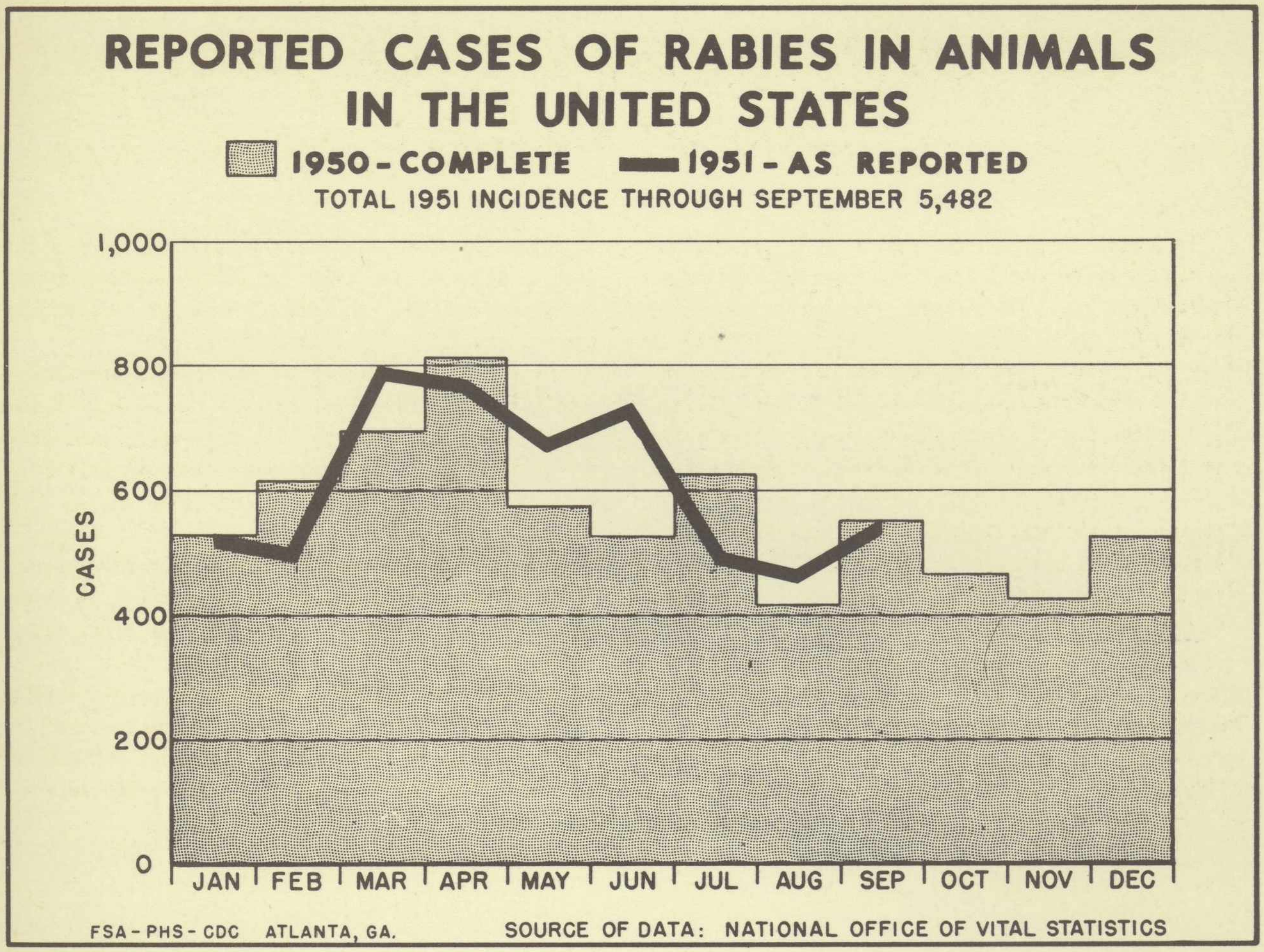
BENZENE HEXACHLORIDE

Council on Pharmacy and Chemistry: Toxic effects of technical benzene hexachloride and its principal isomers. J.A.M.A. 147(6): 571-574 (1951). This article is the third in a series on aspects of pesticides of immediate medical interests. It includes a description of the chemical, its pharmacology, and toxicology. Some clinical experiences are also described.

ENCEPHALITIS

Reeves, William C.: The encephalitis problem in the United States. Am. J. Pub. Health 41(6): 678–686 (1951). This paper includes discussions of the causative agents of encephalitis, the public health problem in connection with the disease, its geographic distribution, method of transmission, and control measures.

☆ U. S. GOVERNMENT PRINTING OFFICE 1952 O—951993



Recent Publications by CDC Personnel

Chamberlain, R. W., Rubin, Harry, Kissling, R. E., and Eidson, M. E.: Recovery of virus of Eastern equine encephalomyelitis from a mosquito, *Culiseta melanura* (Coquillett). Proc. Soc. Exper. Biol. & Med. 77(3): 396-397 (1951).

Coleman, R. D.: California mosquito control studies: Cooperative drainage of irrigation lands. Section of the Operations Manual of the Calif. Mosq. Cont. A. (August 1951).

Hayes, W. J., Jr., Ferguson, F. F., and Cass, J. S.: The toxicology of dieldrin and its bearing on field use of the compound. Am. J. Trop. Med. 31(4): 519-522 (1951).

Jensen, J. A., and Fay, R. W.: Tagging of adult house flies and flesh flies with radioactive phosphorus. Am. J. Trop. Med. 31(4): 523-530 (1951).

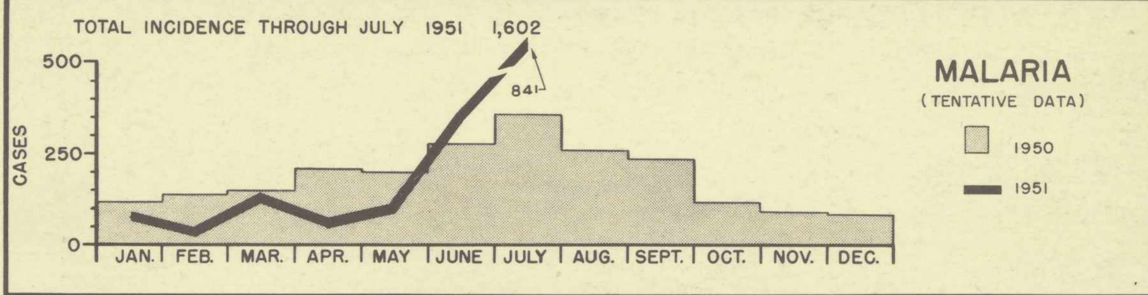
Johnson, R. J., and Buck, R. W.: Housing programs and the health department. Ohio's Health 3(8): 5-10 (1951).

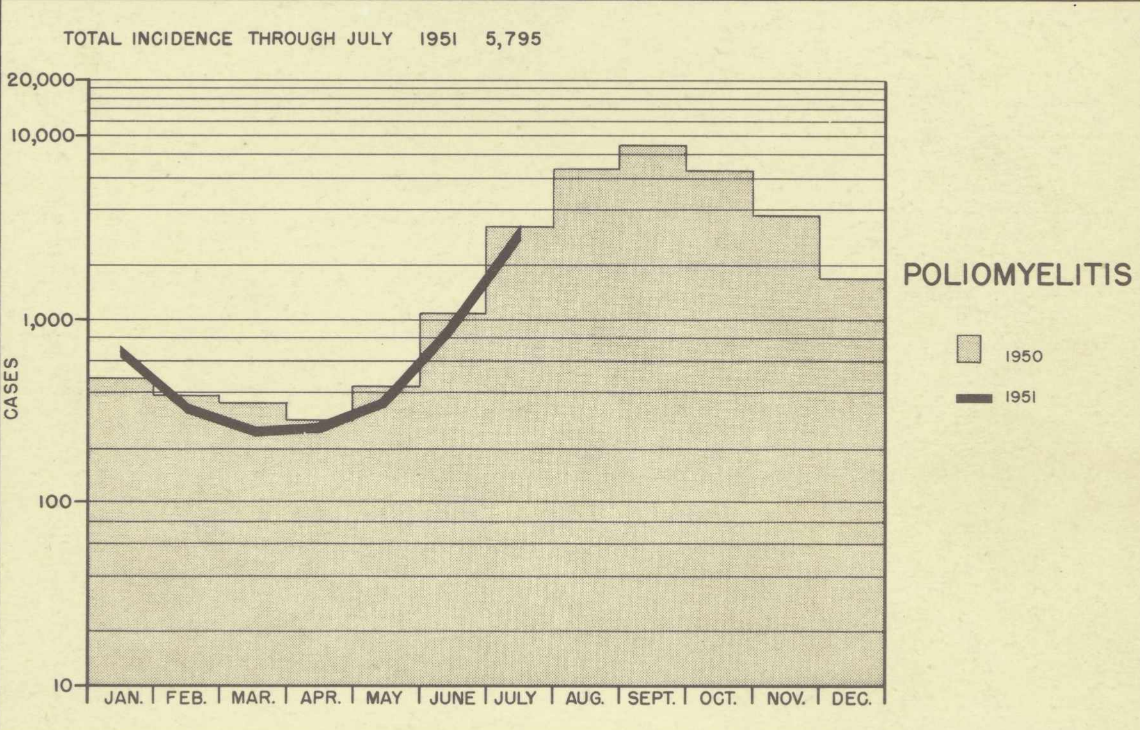
Kissling, R. E., Rubin, Harry, Chamberlain, R. W., and Eidson, M. E.: Recovery of virus of Eastern equine encephalomyelitis from the blood of a purple grackle. Proc. Soc. Exper. Biol. & Med. 77(3): 398-399 (1951).

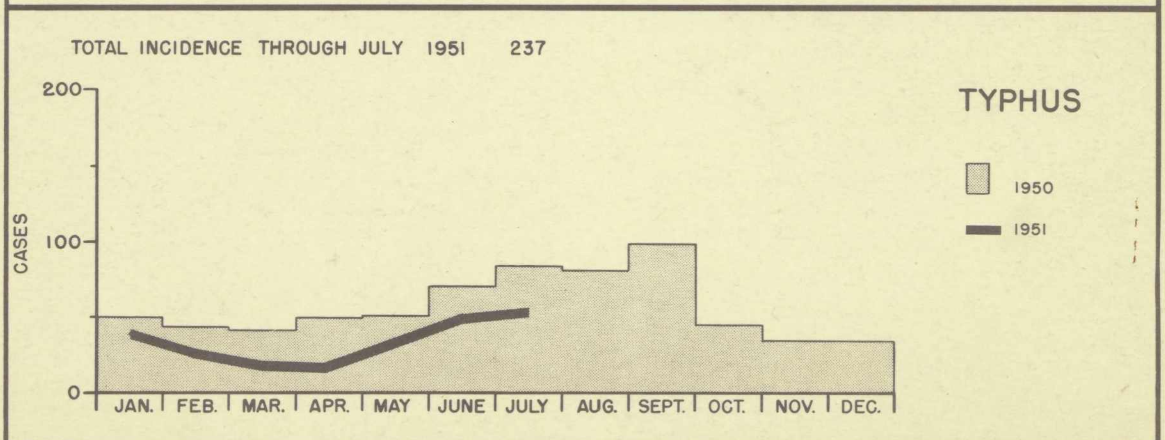
Maier, P. P., and Baker, W. C.: Municipal fly control by environmental sanitation. Mod. San. 3(8): 20-23 (1951).

Simmons, S. W.: Health hazards of economic poisons and related substances. Am. J. Trop. Med. 31(4): 514-518 (1951).

MORBIDITY TOTALS FOR THE UNITED STATES *
MALARIA, POLIOMYELITIS, TYPHUS
1950 - COMPLETE 1951 - AS REPORTED







FSA-PHS-CDC ATLANTA, GA.

*SOURCE OF DATA: NATIONAL OFFICE OF VITAL STATISTICS