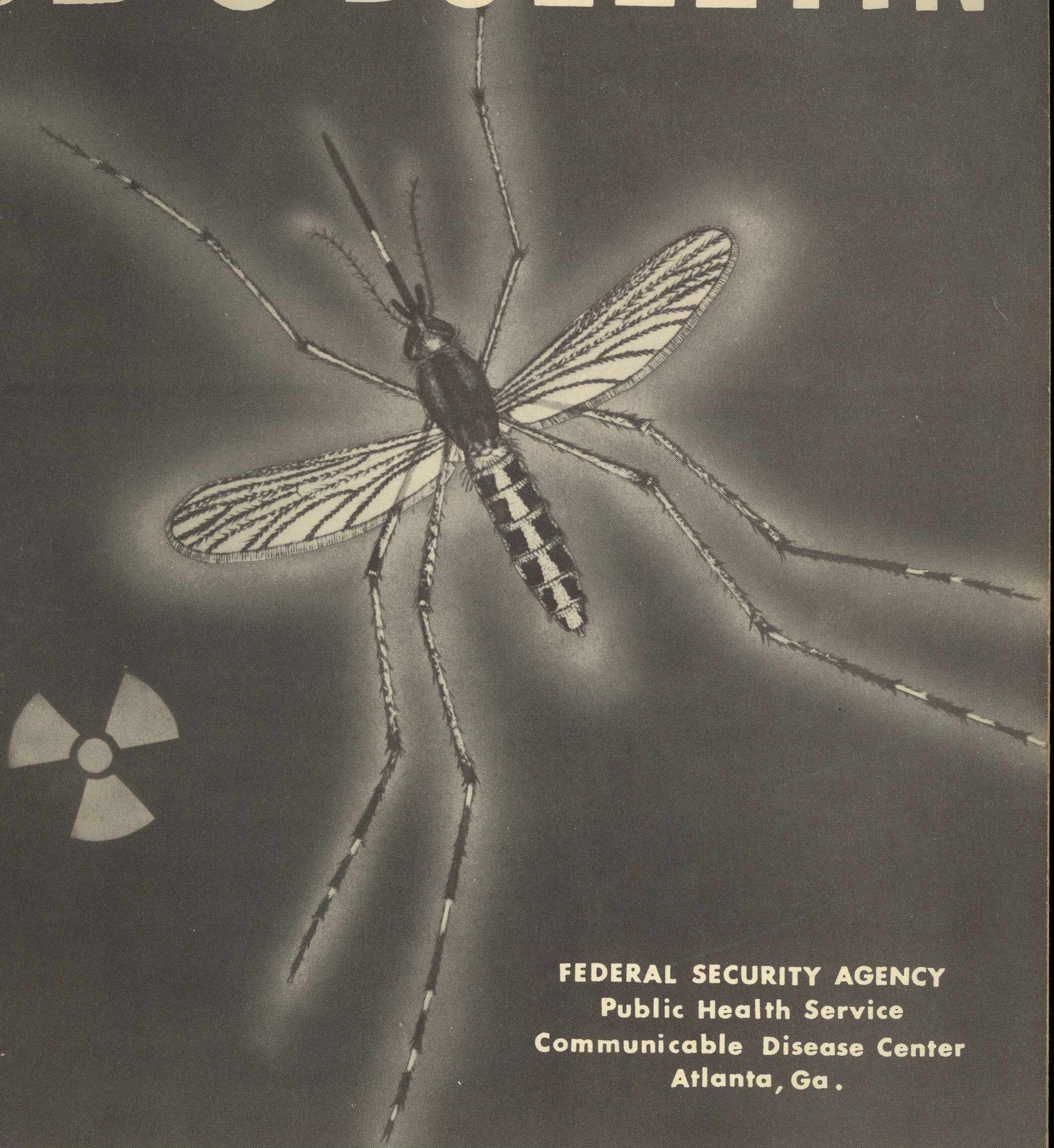
CDC BULLETIN

APRIL - 1951



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

PRELIMINARY REPORT ON MOSQUITO FLIGHT DISPERSAL STUDIES WITH RADIOISOTOPES IN CALIFORNIA, 1950

This symbol, appearing on the cover, is one with which we will probably become increasingly familiar: it is used to indicate the presence of a dangerous amount of radioactivity. *Aedes nigromaculis* mosquitoes were used in the flight dispersal studies with radioisotopes in California in 1950.

TECHNICAL DEVELOPMENT SERVICES TO BE HOST TO W H O COMMITTEE

Technical Development Services, CDC, Savannah, Ga., will be host to the third session of the Expert Committee on Insecticides of the World Health Organization, July 30 through August 4, 1951, Dr. S. W. Simmons, Chief, Technical Development Services, has announced.

In a letter to Dr. Simmons, Dr. Brock Chisholm, Director-General of the World Health Organization, accepted the invitation to hold the meeting in Savannah. An excerpt of the letter from Dr. Chisholm follows:

"I have much pleasure in accepting your kind offer of 29 January 1951 to act as host to the Expert Committee on Insecticides at its third session, which, I understand, will probably be held between 30 July and 4 August of this year.

"I feel certain that the Committee's work will be greatly facilitated by having the vast knowledge and experience of the Communicable Disease Center at its disposal."

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Vol. X, No. 4 APRIL 1951

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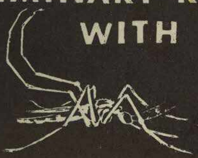
FEDERAL SECURITY AGENCY
Public Health Service
Communicable Disease Center
Atlanta, Georgia

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

TRAINING COURSE CANCELLATION

The training course on "Fly Control," which was scheduled to be held in Atlanta May 7-11, 1951, has been canceled. This subject is being covered in other scheduled insect control courses listed in the *Bulletin of Field Training Programs.*

PRELIMINARY REPORT ON MOSQUITO FLIGHT DISPERSAL STUDIES WITH RADIOISOTOPES IN CALIFORNIA, 1950*



Deed C. Thurman, Jr., S.A. Sanitarian** and
R. C. Husbands, Resident Entomologist***

INTRODUCTION

Knowledge of the flight dispersal of mosquitoes is of basic importance in the epidemiology of the diseases they transmit and in the planning of control measures. Aware of this fact, malariologists have investigated rather extensively the problem of the flight range of anopheline mosquitoes because of their known relationship to malaria. Eyles (5) has prepared a critical review of the literature related to the flight and dispersal habits of anopheline mosquitoes. Since his summary, numerous additional studies related to the flight and dispersal of anophelines have been conducted such as those of Eyles, Sabrosky, and Russell (7), Goodwin (8), and Correa, Lima, and Coda (4). Exhaustive literature comparable to that of the flight of anopheline mosquitoes does not exist with respect to culicine mosquitoes although a few highly significant studies have been conducted. Among these are the work of Stage, Gjullin, and Yates (14); Horsfall (10); Reeves, Brookman, and Hammon (13); Causey and Kumm (2); and Causey, Kumm, and Laemmert (3).

Investigations of the biology of California mosquitoes in irrigated pastures were begun in 1949†. It was early realized that studies of the flight range of these mosquitoes would be basic in establishing relationships that they might have to the transmission of disease and in allowing for better definition of the zones of importance to mosquito control. The three mosquitoes of major importance issuing from irrigated pastures are *Aedes nigromaculis* (Ludlow), *Culex tarsalis* Coquillett, and *Aedes dorsalis* (Meigen).

*A contribution of the Bureau of Vector Control, California State Department of Public Health; the Communicable Disease Center, Public Health Service; and the Turlock Mosquito Abatement District.

**From CDC, Atlanta, Ga.

***Central Valley Mosquito Ecology Studies, Turlock, Calif.

†Central Valley Mosquito Ecology Studies — a cooperative enterprise sponsored by the Turlock Mosquito Abatement District on behalf of the California Mosquito Control Association.

The studies of Reeves, Brookman, and Hammon (13) established basic information concerning the flight range of *C. tarsalis*. *A. dorsalis*, which in the years up to 1940 was the principal *Aedes* problem in the Central Valley, has been relegated, because of events of the past decade, to a position of much less importance than that of *A. nigromaculis*. Thus, the mosquito flight studies undertaken during 1950 were concentrated on investigating the range and dispersal patterns of *A. nigromaculis*.

For these studies the "release" emergence of mosquitoes was made in an irrigated pasture designated as the "Study Pasture" located in Township 5 S, Range 9E, Section 9 in Stanislaus County, Calif., about 8 miles west of Turlock. The pasture selected consisted of approximately 90 acres in an inverted L-shape and the release point for the radioactive mosquitoes was located at the southern border of the inside of the L. The closest human habitation was approximately 1/8 mile to the south and across a small field.

MATERIALS AND METHODS

A majority of the work done on anophelines and flight range up to the time of Eyles' summary involved capturing adult mosquitoes, marking them with a stain, releasing them, and recapturing marked specimens. The marking agents necessitated spraying with aqueous aniline dye solutions, or dusting with metallic bronzing powder. Another technique consisted of using dilute solutions of Giemsa's, Wright's, or methylene blue stains in which the larvae were reared. Zukel (16) developed methods for marking anopheline mosquitoes with fluorescent compounds; rhodamine B, among others, proved to be quite suitable. Reeves, Brookman, and Hammon (13) selected rhodamine B as their tagging material. Recently, with the work of Hassett and Jenkins (9), Bugher and Taylor (1), and Jenkins (11) the use of radioisotopes for tagging mosquitoes became a possibility. Lindquist and Yates (personal communication (12)) have made extensive studies of the use of radiophosphorus for tagging mosquitoes in the laboratory. After review of the work of the above authors, two methods of tagging mosquitoes were selected for use during the 1950 season. These were: (1) the use of aqueous solutions of rhodamine B applied to mosquitoes under natural conditions with a Tifa aerosol fog generator; and (2) the production of radioactive mosquitoes by allowing the larvae to develop and emerge in an aqueous solution of radiophosphorus. Results of the study using the rhodamine B dye are not available at this time.

Use of Radiophosphorus. The isotope used was secured from the Isotope Division of the Atomic Energy Commission at Oak Ridge, Tenn. Phosphorus-32 was selected as the most practical because of its extremely short half-life, approximately 14 days, and because it is an emitter of beta radiations which have a relatively short range. Both these factors contributed to personnel safety in the handling of the material. The isotope was handled through the facilities of the Western Division of Tracerlab, Inc., a commercial laboratory designed for this purpose. At this laboratory the phosphorus was converted to a neutral sodium phosphate (Na_2PO_4) solution for transportation to the field.

Mosquito larvae for tagging were collected in irrigated pastures including the one encompassing the release point. The method of collection used was that of dipping the larvae and pouring them through a funnel lined with muslin to concentrate the larvae in large quantities on the muslin. As soon as several thousand were obtained, they were transferred to two large galvanized iron rectangular tanks. These tanks were 4 by 5 ft. and were 6 in. deep. The quantity of water used in the tanks was 39.6 gal. which gave a depth of slightly under 4 in. Across the water surface of one of the tanks a seine was stretched and floated on corks to provide footing for the emerging adult mosquitoes. Floating plants were used in the other tank for the same purpose. The majority of the larvae collected (about 99 percent) were *A. nigromaculis*, except when special collections of *C. tarsalis* were made.

The isotope was added to the tanks after the larvae were introduced in their final concentration. The radioactive solution was poured into the tank slowly (figure 1) in order to allow even dispersal of the material without creating "hot" spots. The concentration of the isotope used was based on the recommendations of Mr. Lindquist from his work in Oregon and was 0.1 microcurie per ml.

Precautions in handling the isotope were necessary to prevent possible accidents to personnel in and about the release point. A fence was erected around the tanks. Workers entering the enclosure wore rubber gloves, boots, and wrist badges and were monitored in the Turlock Laboratory for possible contamination after each visit. Contaminated equipment and material were marked as such and carefully stored in containers for that purpose. The release point was selected because of its isolated position with respect to human habitat and curiosity seekers and because this same pasture was used as a study area for the extensive ecological study of irrigated pastures being conducted during 1950.

Study of Exposure Results. The results of exposure to phosphorus-32 were studied by taking

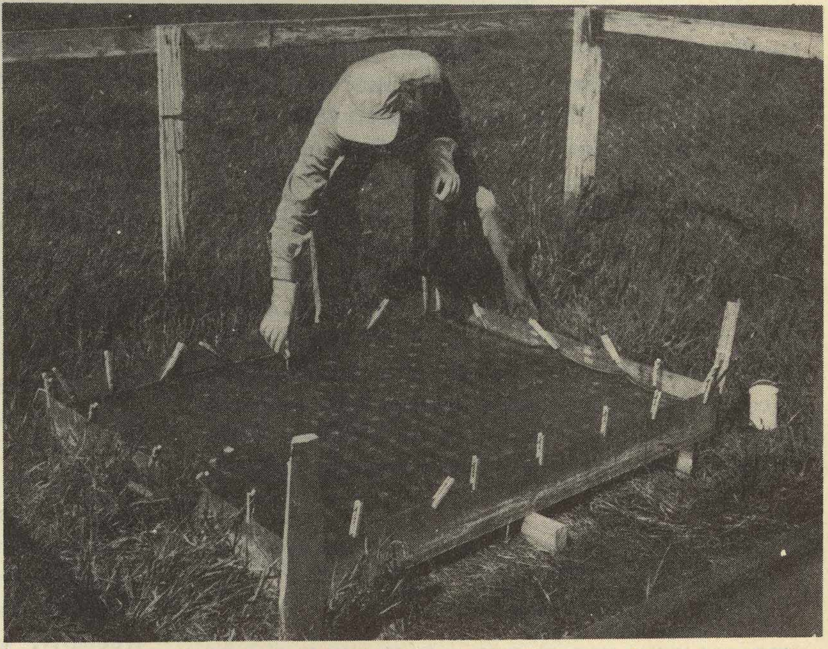


Figure 1. A radio-physicist pours the radioactive phosphorus solution into the tanks. The seine clipped to the sides of the tanks and floating on corks is for the purpose of allowing emerging adults a place to stand. *(Photo courtesy Turlock Mosquito Abatement District and Lindblom Photo Service).*

Figure 2. The Geiger counter was used to examine light trap collections for radioactive mosquitoes. *(Photo courtesy Turlock Mosquito Abatement District and Lindblom Photo Service).*

samples of larvae from the tanks, washing them several times, removing the water from their exterior surfaces, and finally monitoring them to determine how radioactive they might be.

Exposure periods of 12 to 18 hours proved to be sufficient to tag these larvae with easily detectable amounts. It was found that pupae could not be tagged unless they remained in the solution from 48 to 60 hours. In general the best results were obtained when early fourth stage larvae were used. Samples of mosquitoes emerging from the tanks were taken to determine the amount of radiation which they emitted. It was found there was considerable variation ranging from counts just detectable above background in some individuals to counts of more than 20,000 per minute in other individuals. In all cases in which mosquitoes were introduced into the tanks as larvae, detectable counts of radiophosphorus were found in the adults.

Tagged specimens taken from the tanks were tested with a Geiger Counter, the SU-3A Laboratory Monitor issued by Tracerlab with a T G C – 2 tube (figure 2). With this monitor single specimens with about 100 counts per minute were easily detectable even when buried among thousands of other mosquitoes. Specimens with several thousand counts per minute would cause the monitor to register even though the specimens remained in ice cream cartons in which the specimens were brought from the field. The most difficult specimens to detect were those which had assimilated only a very small quantity of phosphorus (since they were exposed during the pupal stage) and the sensitivity of the monitoring equipment used was not sufficient.

Using this type monitor, a standard had to be established for deciding when radioactive specimens were located. No single specimen which did not consistently register above 50 counts per minute was included in our list of "positives" for this reason. When specimens which emitted several radiations per minute above this arbitrary background were placed in a container under the counting tube, the presence of the phosphorus could be detected frequently from the mass of specimens when radiations from single specimens were considered questionable.

Capture of Tagged Mosquitoes. In attempting to capture tagged mosquitoes two principal methods of collection were used. The first and most important was the operation of mosquito light traps. For this purpose about 70 different light trap stations were established with a greater concentration within 3 miles of the release point and the remainder distributed radially to a distance of 10 miles. The majority of the traps were distributed on a northwest-southeast line approximately in a line with the movement of the wind. The concentration of the traps within the 3-mile zone allowed for the establishment of a dispersal pattern which indicated the concentration of trapping stations that would be necessary for future dispersal studies of this type. For the 30 traps located within the 3 miles of the release point collections were made daily with a few minor exceptions. The remainder of the traps were scheduled to be collected twice each week, usually Monday and Thursday.

The second method of collection was that of hand collecting by means of aspirators and chloroform jars. Since these pasture *Aedes* will fly from surrounding vegetation onto an operator's clothes during all hours of the day, it is possible to make hand collections at any location where these mosquitoes are present. Thus random collections were made at a large number of stations up to 1 mile from the point of release and at a few more distant points. But because of the limitation of manpower available for this task, no regularly visited stations were established at more than a quarter of a mile from the release point.

RESULTS

Estimates of the number of mosquitoes which were tagged indicate there were about 400,000. The difficulties involved in making estimates of the number of tagged mosquitoes were as follows: (1) no good method could be established for counting the concentrated larvae when they were being moved from the field to the tanks; (2) while samples for estimating number of larvae could have been taken from the tanks, the difficulties of handling the radioactive material made this somewhat impractical; and (3) there was a high mortality of larvae at certain periods which reduced the number actually emerging. Larval counts were thus ignored in favor of pupal skin counts. It was found that the pupal skins would float in great mats on the surface of the water (figure 3). By estimating the areas covered by these skins and computing the number of skins per unit area, it was possible to arrive at a reasonable indication of the total number of emerged mosquitoes. This proved satisfactory for the first emergence since the mosquitoes from this group came out within a short period, leaving an even mat. The presence of untagged mosquitoes and poorly tagged mosquitoes

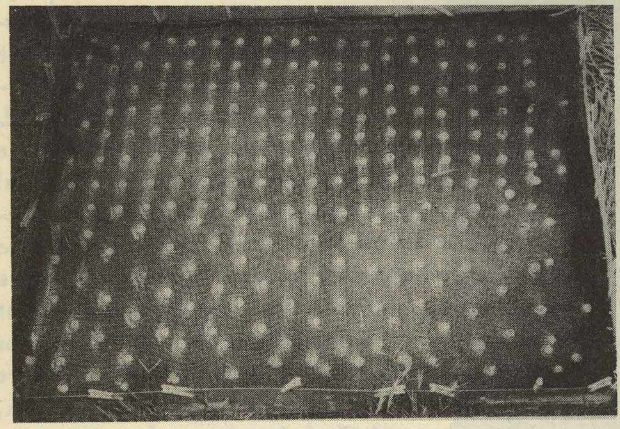


Figure 3. Photograph of tank I following the emergence of most of mosquitoes. The dark border at the edge of the tank is a floating mat containing many thousands of pupal skins.

in this emergence made the estimates more difficult. After the second and third introductions of larvae the tanks were so contaminated with algae that the pupal mats did not form properly and satisfactory estimates were impossible. Thus, the estimate that approximately 400,000 mosquitoes were tagged is influenced by several uncontrollable factors which may have introduced errors.

In connection with this study about 10,000 *C. tarsalis* were introduced into the tanks and a number of these were recovered. Special attempts were made to obtain tagged *C. tarsalis*; therefore, 5,084 specimens were taken from resting stations mostly at distances between 1 and 2 miles from the release point. No radioactive *C. tarsalis* were taken in these resting stations although approximately 170 collections were made. All radioactive *C. tarsalis* were taken in the light traps, the most distant occurring at 1 mile downwind.

Emergence Peaks. Under natural conditions, pasture *Aedes* usually emerge in very definite broods, all of the adults coming from the water in 24- to 48-hour periods. When these mosquitoes were placed in rearing tanks in the third and fourth stages, they had a tendency to emerge over a longer period, usually 4 to 5 days, with occasional stragglers remaining in the aquatic stage as long as 10 days. The radiophosphorus was introduced into the tanks on August 9. At that time about 350,000 mosquitoes were in the tanks. Of these about 200,000 are believed to have become tagged and emerged. Many of them, however, emitted only a few radiations so that the easily detected group amounted to an estimated 100,000. The peak of emergence of this group occurred on August 12 and the first recovery of a specimen in the light traps was on the morning of August 13 when a male *A. nigromaculis* was taken ¼ mile to the northwest. The second period of emergence came about following the introduction of several hundred thousand additional larvae during the period of August 19 and 20. The peak of emergence occurred about August 22. The third period of emergence reached a peak about September 2 and 3 as a result of the introduction of the third concentration of larvae several days earlier. Usually the collections of tagged mosquitoes were made about 2 to 3 days after the peak of emergence and there was no evidence to indicate that the radioactive mosquitoes existed for more than 7 or 8 days following emergence.

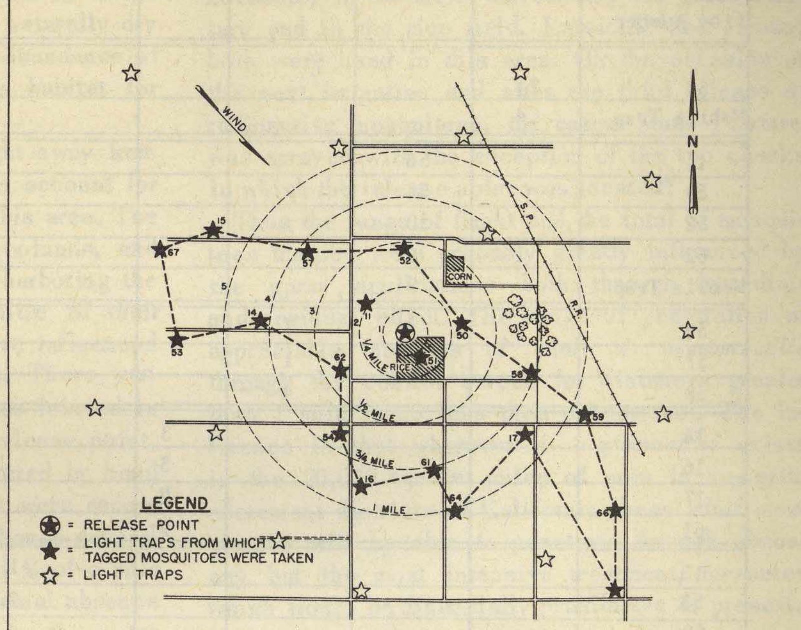
Recoveries. There was a total of 673 radioactive mosquitoes passed under the monitor at the field station laboratory. This did not include a number of low count specimens which, having only a few radiations per minute above the arbitrary background, were not easily detected unless several were present in the same box. This occurred since for the first release a large number of pupae were introduced into the tanks along with the larvae, and these pupae were either not tagged or were tagged with small quantities of P^{32}. Of the 673 radioactive mosquitoes taken, 198 were from the release point itself and collected either on the pans and tanks or on the grass surrounding the tanks.

The radioactive mosquitoes collected with aspirators amounted to 226 specimens with the most distant recovery at about ½ mile from the point of release. Results of this collecting method are shown in table 1. A total of 27,000 specimens was taken in 422 collections in which these 226 mosquitoes were included. Mosquito light traps took 1,366 collections and included an estimated 2,500,000 mosquitoes. Of these, 249 were radioactive with the most distant recovery at 1 7/8 miles from the release point. Results of this method of collecting are shown in table 2.

The recovery rate for radioactive mosquitoes (excluding 198 specimens collected at the release point) was slightly more than 0.1 percent of those released.

Pattern of Dispersal. As indicated in figure 4 it was found that there was a tendency for mos-

Figure 4



FLIGHT DISPERSAL STUDIES WITH RADIOACTIVE MOSQUITOES
Turlock Mosquito Abatement District,
Stanislaus County
California

FSA, PHS CDC-ATLANTA, GA. MARCH 1951

Table 1

RESULTS OF HAND COLLECTING AS A MEANS OF CAPTURING RADIOACTIVE MOSQUITOES, TURLOCK, CALIF., 1950

Distance from Release Point, in Feet.	First Emergence-Peak Aug. 12				Second Emergence Peak-Aug. 22	Third Emergence Peak-Sept. 2
	Before Aug. 14	Aug. 14	Aug. 15	After Aug. 15	After Aug. 22	After Sept. 2
50	16	16		6	120	1
50 - 251		27				
251 - 500		13			1	
501 - 750		4			2	2
751 - 1,000		7		1	3	
1,001 - 1,500		1	1			
1,501 - 2,000			1			
2,001 - 2,500			2			
2,501 - 3,000			2			
Total	16	68	6	7	126	3
Grand Total	226					

Table 2

RESULTS OF THE OPERATION OF LIGHT TRAPS IN CAPTURING RADIOACTIVE MOSQUITOES NEAR TURLOCK, CALIF., 1950

Traps: Location Number	Radioactive Mosquitoes Captured for Each Distance Zone Zones (Miles from Release Point)					Number of Collections with Radioactive Mosquitoes
	0–1/4	1/4–1/2	1/2–3/4	3/4–1	1–2	
51	71					13
Mobile Trap	4					1
11		56				15
50		58				12
52		10				6
62		2				2
Mobile Trap		9				2
54			7			7
57			1			1
58			4			3
14				3		3
16				3		3
17				2		2
61				9		6
13					1	1
53					2	2
59					2	2
64					1	1
65					1	1
66					3	3
Totals	75	135	12	17	10	86
Av. per Trap (Stationary traps only)	71	31	4	4.5	1.6	
Total radioactive specimens caught 249						

quitoes to disperse downwind and somewhat into the wind after they had extended themselves beyond the ½-mile zone. The collections made by hand were neither sufficiently regular nor large to establish a proper pattern, but in general they supported the evidence shown by the light trap collections.

FACTORS INFLUENCING RESULTS

The Pasture Habitat. The pasture area surrounding the release point on three sides provided conditions believed to be extremely favorable to the maintenance of the *A. nigromaculis* population. Portions of the area were covered with knee high clover, grass, and weeds which sheltered the adults during the daylight hours. Moisture on the surface of the ground was always present in some of the areas of deeper grass. Animals, mostly dairy cows but including dogs and squirrels, as well as birds, were present in the pasture. The farmer and the field workers of the study unit spent many hours in the pasture. Blood meals were thus readily available. Good oviposition sites for the females were present in every check as evidenced by the fact that larvae would hatch almost anywhere in the pasture after flooding. The wind was gentle both day and night throughout almost all the period of the study, seldom reaching more than

10 miles per hour and frequently only 1 or 2 miles per hour. This gentle wind came almost constantly from the northwest and infrequently swung to blow directly from the north. The temperature reached high peaks during the day, sometimes above 100° F., but dropped more than 30° F. during the night. Tempered by the almost complete coverage of the area with irrigation water, the naturally dry air is humid. Thus the area with its abundance of low vegetation creates a favorable habitat for the existence of pasture mosquitoes.

Most of the better reasons for flight away from the pasture, if reasons are needed to account for mosquito movement, were lacking in this area. The surrounding terrain, pasture land, croplands, and open areas were no better suited to harboring the adult *A. nigromaculis* than the place of their origin. Two significant facts may have influenced the flight pattern shown in figure 4. There was an extensive grove of eucalyptus trees located in a northeasterly direction from the release point. Only one tagged mosquito was recovered by hand collecting within this area and none were recovered in the traps beyond the grove although several were in operation only about ½ to ¾ of a mile away. The other fact noted was the virtual absence of adult *Aedes* on the borders or above the water of the rice field although the fields on all sides were uninhabitable because of biting female mosquitoes present during the early evening.

Spraying Operations. Throughout the period of the flight studies the active work of the Turlock Mosquito Abatement District was being conducted. This program was chiefly one of larviciding with jeeps on which spray booms are mounted. The larvicide which was usually applied at the rate of 0.2 to 0.4 lb. per acre on pasture land was a DDT emulsion. During August it is frequently necessary to apply about twice as much as during the spring months because of the lessened effectiveness of the DDT due to higher temperatures. All sources within the Mosquito Abatement District are treated as often as mosquito larvae are found; in irrigated pastures, this generally occurs with each irrigation at 10- to 20-day intervals. The Study Pasture was surrounded by the Turlock and East Side Mosquito Abatement Districts on the east for a distance of about 20 miles and to the north for at least 15 miles. On the west the active control program extended to the western foothills about 8 or 9 miles distant. The San Joaquin River bisects this western area on a north-south line at about 3½ miles from the release point.

Before the first emergence peak, August 12, the spraying approached only to the outer border of the study area and did not include the rice fields. Just before the second release, August 22, the adult mosquito population in surrounding areas reached such a peak that airplane control was necessary in all areas surrounding the Study Pasture and in the rice field. Larvicide and aerosol both were used in this area. On the occasion of the next irrigation and after the third release of radioactive mosquitoes, the entire Study Pasture was sprayed with the exception of the two checks in which the release point was located*.

Thus the range of flight and the total of mosquitoes trapped were probably greatly influenced by the spray applications both through immediate and residual effect. The range of penetration of appreciable numbers of adult *A. nigromaculis* through the control screen for distances greater than 1 mile is no less than phenomenal. The inference is that wherever *A. nigromaculis* exists in the 20,000 square miles of area in mosquito abatement districts of California these adult mosquitoes will be able to penetrate through almost any but the most intensive treatment, measures which would be financially prohibitive at present.

Influence of Crowding Larvae. Preliminary experiments with rearing larvae of *A. nigromaculis* in the large tanks under crowded conditions, before the isotope was added, resulted in slowing up development of the larvae and a more extended emergence period than occurs in natural water. A large proportion of the adults which emerged was very small. Naturally the question arises as to the probability that differences in the dispersal pattern and distance of flight may exist between these tank-reared and naturally developing pasture-reared *A. nigromaculis*.

Influence of the Isotope. To determine the influence of this factor, larvae and pupae in small enamel pans were reared separately from the large tanks but within the release point enclosure (figure 5). Into four of these pans a concentration of 0.1 microcurie of P^{32} per milliliter of solution was introduced; into the next group of four, 0.01 microcurie per ml.; third group, 0.001 microcurie

*Through the courtesy of Mr. G. E. Washburn, Manager, Turlock Mosquito Abatement District, the mosquito control operations were modified and delayed whenever possible to allow for emergence and dispersion of the radioactive mosquitoes. Control work was necessitated through public pressure on the District, however.

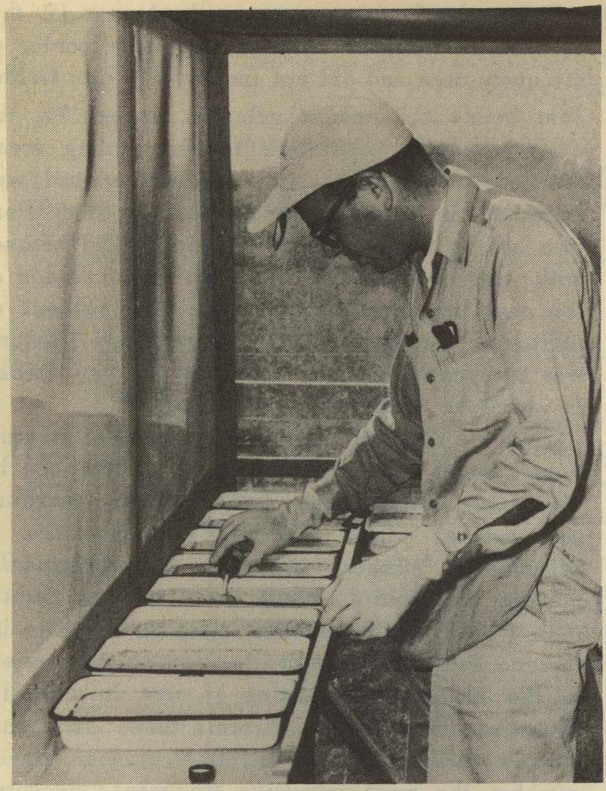


Figure 5. For the purpose of determining the effect of radioisotopes on the mosquito larvae, a number of small pan tests were run containing various concentrations of the isotope. Results of the emergence data from these pans were compared with emergence data from pans in which no isotope was present. *(Photo courtesy Turlock Mosquito Abatement District and Lindblom Photo Service.)*

per ml.; fourth group, 0.0001 microcurie per ml.; and several pans were left as checks. The larvae used were almost all late fourth stage. No differences in development and emergence between the pans without the P^{32} and those containing even the greatest concentration were observed under the conditions of the test.

Comparison with Other Studies. Eyles (5) gives a tabular summary of distances of flight for *Anopheles* showing the greatest flight distance experimentally demonstrated to be 8.7 miles (Swellengrebel and Nykamp, (15)) for *Anopheles maculipennis atroparvus.* Correa, Lima, and Coda (4) found *Anopheles albitarsis* flew 12-13 km. (7.45 to 8.07 miles) under conditions existing near Iguape, Brazil. For the North American species *Anopheles quadrimaculatus* Eyles and Bishop (6) had found tagged mosquitoes as far as 2.5 miles from the point from which they were released. Eyles, Sabrosky, and Russell (7) later found that this mosquito ranged 3.63 miles under certain conditions.

In Arkansas, Horsfall (10) found *Psorophora confinnis* could fly as far as 9 miles. Stage, Gjullin, and Yates (14) recovered an *Aedes vexans* female at 3 miles and several *Aedes sticticus* females 5 miles from where they were stained.

In more recent studies by Causey and Kumm (2), tagged *Aedes scapularis* were recovered after flights of 4 km. (2.48 miles) while species recovered at distances over 1 km. (0.62 mile) were *Aedes serratus, Psorophora ferox, Aedes crinifer,* and *Chagasia fajardoi.* Later Causey, Kumm, and Laemmert (3) found, among others, *Haemogogus spegazzini* to fly 11.5 km. (7.13 miles), *Aedes leucocelaneus* 5.7 km. (3.534 miles), *A. serratus* 11.5 km. (7.13 miles), *P. ferox* 10.8 km. (6.696 miles), and *Aedes terrens* 5.6 km. (3.472 miles).

Reeves, Brookman, and Hammon (13) found the following maximum distances of flight in their studies for the following California species: *Culex quinquefasciatus,* 2.5 miles; *Culiseta incidens, Anopheles psuedopunctipennis franciscanus,* 0.6 miles; *C. tarsalis,* 2.5 miles; and *Culex stigmatosoma,* 1.0 mile.

In the present study of pasture mosquitoes in California, radioactive *A. nigromaculis* were recovered at 1 7/8 miles downwind and 1½ miles up but slightly crosswind indicating that these mosquitoes were, under the conditions of the experiment, either limited in capabilities or in stimulus to make greater flights. The factors which may have influenced the flights of these individuals are given above.

PREDATORS

Insects and other predators on both the larval and adult mosquitoes devoured large numbers of the experimental specimens. Water beetles and water bugs of several species inadvertently introduced with the larvae or entering the tanks later from nearby sources consumed larvae throughout the study. Several of these emitted radiations of more than 20,000 counts per minute.

Emerging adults were attacked by myriads of ferocious spiders that took a heavy toll. Spiders taken in the vicinity of the tank were highly radioactive. Small frogs also participated in eating the mosquitoes as they crawled from the tanks. Some frogs even jumped in the tanks.

Several dragonflies, captured in the vicinity, failed to cause any reaction under the Geiger tube.

CONCLUSIONS

1. Phosphorus-32 is a valuable isotope for biological tracer work and well suited to use in

mosquito dispersal studies.

2. Methods of tagging large numbers of mosquito larvae using P^{32} under field conditions proved both feasible and practical for biological investigations.

3. The flight range of radioactive *A. nigromaculis* allowed to emerge in mosquito abatement district using larvicides and aerosols for mosquito control, during midsummer in California, may be as much as 1 7/8 miles, while significant numbers of flights of 1 mile were noted.

4. A large number, 475 specimens, of radioactive tagged mosquitoes were recovered. This is believed to be only a very small portion, about 0.1 percent, of the estimated number of specimens allowed to emerge.

5. The flight range of *A. nigromaculis*, unhampered by insecticide applications, was not established, nor can the potential effects of large untreated sources (contiguous sections of irrigated pasture lands) on neighboring abatement districts be determined without additional study.

ACKNOWLEDGMENTS

The participation of member districts of the California Mosquito Control Association was of great value; special mention is made of the assistance given by the Consolidated, Delta, East Side, Merced County, and Tulare Mosquito Abatement Districts. Much usable guidance has been received from the California Mosquito Control Association Committee on Operational Investigations.

Mr. Lawrence Schmelzer of the Bureau of Adult Health, California State Department of Public Health, assumed responsibility for health physics monitoring. All members of the Bureau of Vector Control participated to varying extents in the completion of the study and made its success possible.

Acknowledgment is made of the special consultant assistance of Mr. James Terrill and Mr. Harvey Ludwig in planning certain aspects of the use of isotopes in biological work.

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THE IMPORTANCE OF SANITARY REFUSE HANDLING IN FLY CONTROL

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THE PUBLIC HEALTH PROBLEM

Large sums of money, good management, and engineering principles have greatly improved the quality of milk and public water supplies. However, until the last few years, little attention has been given to refuse handling, particularly the planned and economical sanitary storage, collection, and disposal of food wastes – garbage. These wastes provide food for flies, cockroaches, and domestic rats, and often create disagreeable odors and nuisances. If refuse is left accessible to insects, rodents, birds, dogs, and other animals, there is a constant danger of pathogenic organisms being transmitted to humans.

In Hidalgo County, Tex., it was proved that a reduction of the fly density lowered the number of cases of diarrheal diseases (1). Flies may also transmit typhoid fever, cholera, yaws, and possibly many other diseases (2). The fly's body surface, especially the hairs on its feet and legs, is ideal for picking up and carrying filth. The fly regurgitates and deposits feces while feeding on sputum, human excrement, garbage, or human food. Certain species of blowflies have been found to carry over 3,500,000 bacteria per specimen, with 8 to 10 times as many bacteria found inside as on the surface of the fly (3). Flies are annoying to animals as well as to humans, and are responsible for yearly economic losses of several million dollars to the livestock and dairy industries (4).

Although this discussion stresses fly control, the points considered are applicable to rat control as well. The importance of refuse handling in both insect and rodent control is expressed in two well-known Public Health Service manuals:

"The elimination of fly breeding sources through a sound program of environmental sanitation is of prime importance in all fly control operations. The principles of good sanitation apply whether the program is operated on a community-wide basis or in an individual industry, farm, or household...The extent of fly breeding in garbage may be held to a minimum only when all three operations – storage, collection, and disposal – are properly coordinated and executed." (4)

"Good sanitation practices may comprise from 50 to 75 percent of the activity required to free an area of rats. Proper sanitation, consisting chiefly of adequate refuse storage, collection, and disposal practices, is believed by most authorities to be the most effective measure available for controlling rats. In any given area, it is useless to try to reduce the rat population if garbage and rubbish are everywhere available to the rats." (5)

Exposed rubbish is a fire hazard, and it provides harborage for rats, allowing them to live and reproduce where food, especially garbage, is available. Domestic rats, with their fleas and other ectoparasites, may transmit plague, murine typhus fever, salmonellosis, Weil's disease, and rat-bite fever (5). In addition, the loss to the public is estimated at $250,000,000 per year just to feed rats in the United States; and fowls, grain, and other valuable food and merchandise they destroy may amount to 10 times this figure (6). This estimated economic loss ranges from $1.60 to $16.00 per person per year.

Exposed rubbish such as open cans and bottles catch and hold water in which mosquitoes may breed. These mosquitoes are pests to both man and animals, and certain species are carriers of diseases such as dengue and yellow fever (2).

Mr. J. C. Dawes, Ministry of Health, London, points out that it is possible that the wind may spread some disease organisms from exposed garbage (7), and that "In Great Britain raw garbage is known to be a carrier of virus of foot and mouth disease and, in the past, large numbers of infected cattle and hogs have had to be slaughtered as a result...raw garbage is also known to be a carrier of the virus of fowl pest, and is capable of transmitting other diseases as well." (8)

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Insect and rodent control projects sponsored by Federal, State, and local health departments are now emphasizing this neglected municipal responsibility — sanitary refuse handling — and in many communities it has been found that planned, sanitary handling of refuse costs little more than the customary insanitary handling. For example, a city (population 28,000) in Tennessee which recently converted its method of disposal from the "open dump" to a sanitary landfill, reported: "Cost data show that collecting, hauling, and complete disposal is costing 4% less per load than the cost of collecting and hauling to the open dump." (9) Improved sanitary handling may, in some cases, significantly increase refuse costs, but health officials must realize and in turn inform the public of the benefits that will be derived.

TERMINOLOGY

The terms used in discussing household and other wastes vary from one community to another, and to avoid confusion the definitions given in *Refuse Collection Practice* (10) are used by the Public Health Service as well as by many State and local health departments. Some of these simplified definitions are:

1. **Wastes** — Unwanted solid, liquid, and/or gaseous materials.
2. **Refuse** — Solid wastes (including garbage and rubbish).
3. **Garbage** — Wastes resulting from the handling, preparation, cooking, and consumption of food.
4. **Rubbish** — Refuse other than garbage and ashes (tin cans, bottles, papers, cardboard, and similar materials).
5. **Refuse storage** — The temporary premises storage of garbage and rubbish by the householder or business establishment.
6. **Refuse collection** — The removal of refuse from temporary storage points to disposal sites by municipal forces, contractors, or others.
7. **Refuse disposal** — The burying, dumping, incineration, or other means used to dispose of garbage and rubbish.
8. **Refuse handling** — The storage, collection, and disposal of solid wastes, primarily garbage and rubbish.

REFUSE STORAGE

From the public health viewpoint the proper storage of refuse, particularly garbage, at the doors of homes, restaurants, and markets is the most important part of refuse handling. Proper storage of refuse cannot be accomplished, however, unless adequate collection service is provided so containers will not overflow with garbage and rubbish. Refuse storage is the responsibility of the householder and business establishment and can be accomplished only through education — convincing all citizens that flies, rats, and disagreeable odors at their doorsteps are unhealthy and undesirable.

The cost of a good 20-gal. hot dipped galvanized corrugated steel refuse container with a tight-fitting lid is only about $3.00 or $4.00, but often the most difficult job is to get householders to place their refuse inside the can and replace the lid. This is particularly true at homes and business establishments where many people use the same refuse containers and no one assumes the responsibility of keeping them and the storage site clean.

Uncovered garbage cans and garbage scattered on the ground attract flies and provide excellent breeding media. Such exposed garbage also provides the necessary food for large rat populations. Wet garbage which sticks in the bottom or on the

Refuse storage need not be unsightly.

side of a container after it is emptied may produce hundreds of flies at the householder's back door. Providing a simple elevated stand (which will not harbor rats) for refuse containers keeps dogs from tipping them over and keeps the cans dry, preventing corrosion. Draining and wrapping garbage in several thicknesses of paper before placing in the cans greatly reduces fly breeding, prolongs the life of containers, makes them easier to keep clean, and reduces unpleasant odors. The wrapping of garbage is being stressed on all fly control projects, and can be accomplished only by an informed and educated public.

Topeka, Kans., was selected in 1948 as one of several cities which the Public Health Service, together with State and local health departments, would operate fly control projects for the purpose of learning more about fly habits and their role in the transmission of disease. At Topeka, as well as at other fly control projects, considerable emphasis is being placed on environmental sanitation. Improved refuse storage, collection, and disposal; elimination and regular cleaning of animal pens; and improved handling of industrial wastes is a part of the daily operations. Civic organizations did most of the actual promotional work. Newspapers, radios, and fly control pamphlets were used in the sanitation and educational program. Refuse collection schedules, types of containers required, and the local refuse ordinance were publicized. Personal interviews with householders were used as a follow-up to eliminate or correct insanitary conditions and practices. Excellent results were obtained by working through public grade schools. Pamphlets, describing the biology of the fly, its breeding habits, and pointing out the necessity for proper storage of garbage and rubbish, were distributed to school children for them to take home and talk about.

During the week of July 17-23, 1949, a campaign was conducted to improve insanitary storage conditions at households and business establishments. An active civic organization contacted all firms selling garbage containers and persuaded them to participate in the week's advertising program. During 3 days of this week all refuse containers were inspected by 22 health department personnel, and red warning tags placed on about 10,000 unsatisfactory containers. This included leaky cans or those with no lids and unapproved containers such as bins, boxes, and tubs. The red tags were of the shipping type which could be wired to unsatisfactory containers and had a removable stub for health department records. A list of unsatisfactory items was printed on the tags and the applicable deficiencies checked on inspection. A request for providing a standard fly-tight metal can to replace the old or missing container was also printed on the tag. This sanitation educational and information program to improve garbage storage conditions was very successful, and "adequate premises storage" was raised from about 30 percent to 90 percent, with 7,500 to 8,000 new refuse containers sold by local merchants during this week. Such a campaign for adequate storage containers, together with a concentrated effort to stress sanitary refuse handling throughout the year, has proved to be very effective in reducing fly breeding at the householder's door.

REFUSE COLLECTION

As previously stated, proper storage of refuse cannot be accomplished unless adequate collection service is provided. In many cities, refuse is collected from the better residential areas several times a week, whereas the substandard homes receive little or no collection service; collection routes may not have been planned properly; and refuse nuisance complaints may consume much of the time and effort of health department personnel. Detailed planning, scheduling, and publicizing of collection routes and proper use of equipment will give the community better service as well as a cleaner environment.

Refuse may be collected separately or together, depending on the method of disposal used. For example, if garbage is used for hog feed, separate containers for garbage and rubbish are required, and one pick-up is then required for the garbage and another for the rubbish. When refuse is collected separately, it is difficult to get citizens to keep all putrescible matter out of rubbish because of the trouble involved in washing tin cans and removing all food particles from paper. Combined collection is more convenient and economical (10).

Refuse should be picked up from alleys, when they exist, and the refuse containers placed within a few feet of the alley by the householder. If it is necessary that collectors operate from the street, and it is desired to keep collection costs at a minimum, each householder should be required to set his containers adjacent to the street curb. This is somewhat unsightly on collection days, but if adequate containers are provided, there should be little scattering of rubbish. The necessary handling of the cans in placing them at the curb tends to make the man-of-the-house see that they are kept in better condition and that refuse is placed inside the can to facilitate handling. Some individuals may desire special service, and are willing to pay for the extra cost of having the collectors come on their premises to pick up refuse. The cost of such extra service should be accurately determined so as to equalize collection costs with other citizens.

Enclosed packer-type trucks are preferable for most refuse collections but, if only open trucks are available, they can be utilized in a sanitary manner by careful loading and by covering the refuse with tarpaulins to avoid scattering.

The minimum time required for flies to develop from eggs to larvae should be used as a basis for determining frequency of collection (4). It is usually recommended that garbage and combined refuse be collected at least twice a week in residential areas; even more frequent collection may be required during warm weather (11). Daily collections are usually made at business establishments due to the large amount of refuse accumulated each day, and such collections, especially in the larger cities, are often more conveniently made at night.

The cost of collection varies, depending on the length of haul necessary for disposal, the topography, street and alley lay-out and, as mentioned previously, the planning and management involved. A city (population 423,000) in Texas reports the following collection service in 1946 (12):

Residential areas — twice a week, businesses in residential areas — four times a week, and main business areas — daily. Eighty percent of the pick-ups were from alleys; and 20 percent were made by collectors going to the rear of the property and carrying the refuse to the street. The annual per capita operating cost was $0.98 for collection and $0.43 for disposal at six sanitary landfills located within the city limits.

The average citizen is probably more aware of refuse collection than any other public service. The collectors with their trucks are seen every few days by most citizens, and the caliber of those employed in refuse handling, the quality of their performance, and their attitudes and manners are closely related to the public's reaction to the municipal government. The American Public Works Association states:

"The importance of personal contacts between citizens and employees is perhaps nowhere greater than in the refuse collection service. It is here that the city, as an institution, or the policies of the city as such, make their impression on most citizens. Because in the eyes of the citizen every public employee represents the city, what any employee does is of vital importance to the maintenance of good public relations."

REFUSE DISPOSAL

In the past the "open dump" has served, in an inferior way, as the commonly accepted method of refuse disposal, particularly in many of the smaller cities and towns of the United States. As these cities grew and expanded, the land adjacent to open dumps became more valuable, resulting in a demand for sanitary refuse disposal. Flies, rats, and mosquitoes often migrate from such dumps to adjacent cities. Even when the open dump is located a sufficient distance from populated areas to prevent this migration, the cost of the long haul for collection vehicles may be increased to the extent that sanitary disposal could be provided for about the same cost.

There are several sanitary methods of refuse disposal. If a community provides satisfactory disposal, it has generally given attention to all phases of refuse handling — and storage and collection are usually carried out in a sanitary and economical manner. Actually, the refuse handling problem should be approached with an engineering viewpoint and should cover all phases of handling together, i.e., the storage, collection, and disposal.

Complete incineration is generally more feasible in large cities (over 100,000 people) where considerable quantities of refuse are produced, where sanitary landfill sites are not available nearby, and where financial resources are available to construct and properly operate incineration plants. However, provision must be made for proper operation to obtain complete burning of combustibles and for final disposal of noncombustibles and ash which amount to 15 to 50 percent by weight of the material burned (11).

One city of 218,000 people in Texas is building a modern incinerator in a central location (replacing two old inefficient incinerators) which will serve the central business district. In the residential areas, where disposal sites are available, several sanitary landfills will be used — thus keeping the haul required for collection vehicles to a minimum. The Superintendent of Waste Disposal Service of this same city reports that "disposal by sanitary fill can consistently be done for not more than one-half the cost for incineration with present type (old) incinerators." Operating costs for a few months showed $1.12 per ton for incineration as compared to $0.38 per ton for sanitary landfill disposal (13). Generally, the complete cost for disposal by incineration – operation plus amortization of the original construction – ranges from $1.50 to $2.50 per ton of refuse (14).

The electrically driven household garbage grinder is becoming more popluar because of the convenience to the housewife. It provides her with an easy way to get rid of garbage in the sink – the place where most of it first accumulates. Studies on the household garbage grinder indicate that its operation is dependable; that properly designed sewers can handle this additional macerated garbage; that the volume of sewage flow is increased only about 1 percent; and that, with more digester capacity, "food wastes are amenable to treatment in plants conventionally used today without difficulty." (15) Also, the cost of the grinder and its installation, which runs about $175 for individual installation, can be cut in half if large-scale or community-wide installation is arranged.

One estimate of the amount of refuse produced per person per day is 2 lb. with about ½ lb. being garbage and 1½ lb. being rubbish (15). The home grinder eliminates collection and disposal of garbage only. Other arrangements must be made for removing rubbish. However, most of the public health problem will be eliminated by getting rid of the putrescible part of refuse; and if all food wastes are removed from the rubbish, less frequent collection will be necessary. This will result in a saving in the cost of collection service, and make refuse handling less obnoxious for the collectors.

In many cities in the United States garbage is partially disposed of by feeding to hogs. The U.S. Department of Agriculture, however, recommends that garbage used for animal feed be preserved as carefully as human food, and that it be cooked before being fed to hogs to prevent the spread of trichinosis and other diseases (16). The feeding of raw garbage to hogs is regarded as the primary factor in the high incidence of trichinosis, and studies have indicated that an average of one person in six in the United States has some trichina infection (14). If garbage is to be used for hog feed, it is the responsibility of the municipality concerned to see that it is not mishandled. Only about 50 or 60 percent of most garbage is actually consumed by hogs; and this uneaten portion, together with the hog excrement, creates an insanitary condition unless removed frequently and disposed of in a sanitary manner. The Department of Agriculture has a mimeographed bulletin dated February 1943, *Feeding Garbage to Hogs*, which includes sections on methods of feeding and essential sanitary conditions (17). The Division of Sanitation of the Public Health Service also contemplates a joint study to determine satisfactory methods for feeding food wastes to hogs.

When care is taken to see that water supplies are not being contaminated, and other sanitary practices are followed, the upper few feet of earth has proved to be a safe place for small towns and farms to dispose of human excrement through the use of sanitary pit privies and septic tank tile fields. Likewise, both garbage and rubbish are even more satisfactorily and economically disposed of by burial. This method of disposal is known as the "sanitary landfill" and refers to the disposal of refuse by properly compacting it and covering with earth frequently enough to eliminate odors, smoke, and disease-bearing insects and rodents. In contrast, an "open dump" may be defined as a disposal site where refuse is dumped over a bank, into a ditch, or in the open with no attempt made to cover it with earth.

Since World War II, and prior to that time in England, many cities and towns in the United States have used the sanitary landfill method of refuse disposal. It is not always the best method, but in many cases has proved to be the answer to safe, economical refuse disposal – particularly in cities and towns with less than 100,000 people.

For example, a city of 28,000 people in Tennessee reports the sanitary landfill which they operated was so located that it was possible to haul 36 percent more refuse with the same equipment and crew previously used to haul to an open dump. The City Manager also stated that several invitations have been received from citizens to use their unimproved property for a sanitary landfill to save them the expense of filling and grading (9).

Probably no two sanitary landfills are operated exactly alike, but the three principles involved in ideal operation require that (18): (1) refuse be well-compacted in about 1-ft. layers, (2) each cell not exceed 6 or 8 ft. in depth, and (3) the entire fill be sealed with proper cover frequently enough to eliminate insects, rodents, and odors.

The site for a sanitary landfill should be located within or very near the area served. By

Sanitary trucks placing refuse for spreading and compaction. (Inset) Refuse being covered. Note proximity to residential area. *(Photos courtesy International Harvester Company)*

planning and scheduling the collection service, based on time and motion studies, manpower and equipment costs for collection can be reduced to a minimum. It has been found that about 1 acre of land per year is required for each 10,000 people when refuse is well-compacted to a 6-ft. depth (11). The amount and availability of proper cover for a seal should be considered along with other items such as the cost of the site, availability of access roads and bridges, and avoidance of heavy traffic. The possible future use of disposal sites should be studied, since the area may be later utilized for recreation, open storage, auto parking, or other use involving light loading.

Regardless of the type of earth-moving equipment used at the sanitary landfill, it must be operated and maintained by competent personnel. The training and instructions given the equipment operators often determine whether the disposal site will be operated as a sanitary landfill or merely as a "covered dump."

The main shortcoming of the sanitary landfill method of disposal is that improper operation may revert the site to a covered dump, resulting in only limited insect and rodent control, untidiness, erosion of cover, and surface cracking. Also, collection trucks may become bogged down in wet weather unless a road cover is used or an alternate "wet-weather" sanitary disposal site is made available at all times. Scavengers may interfere with the operations unless properly managed; and, if drainage is not properly planned, the seepage from fills may contribute to pollution of adjacent streams. However, it is obvious that most of these shortcomings are due to poor operation.

There are several advantages to a well-operated sanitary landfill. Primarily, (1) it is economical, and (2) insect and rodent breeding is eliminated. It is economical because all refuse can be stored and collected together, the length of haul of collection trucks is often reduced, operating costs are low, cost of equipment is not excessive, equipment may sometimes be used for other purposes, and this method of disposal may be quickly organized and put into use. Old open dumps may be covered, useless land may be reclaimed, several disposal sites may be used simultaneously, and variations in amount and type of refuse affect operation only to a minor extent.

Due to differences in topography, cover, available equipment, necessary drainage, and other factors, sanitary landfill operations vary somewhat. Many modifications may be made, particularly in small towns of only a few thousand people. For instance, it is often practical and economical for small communities to contract for and have a trench excavated in advance to handle several months' accumulation of refuse. A small bulldozer, even a motor grader or laborers with hand shovels, can then compact the refuse and cover it frequently enough to maintain sanitary disposal. Wheel-type tractors are not recommended; but if nothing else is available, an improvement can be made over the open dump.

However, to be successful – and obtain rat and fly control, eliminate odor, smoke, and nuisance – this disposal method must be given proper attention and operated as an engineering project.

CONCLUSIONS

It is suggested that the direct responsibility for refuse handling be given to the public works department if the health department is allowed to actively assist, advise, and assume their responsibility for this public service.

Two good reasons why many health officials do not desire to accept direct responsibility for refuse handling are:

1. The public works, or similar department, is best qualified to purchase and maintain collection and disposal equipment since it usually has the necessary shop facilities, mechanics, and operators.
2. It is not desirable to include this part of the municipal budget within that of the health department inasmuch as refuse handling is primarily an operating or service-type function.

The health department does have a public responsibility of seeing that sanitary refuse handling is carried out. Therefore, this department should provide technical assistance for those phases affecting the health of the community.

The health department is the logical one to carry on the necessary educational and information program. Sanitarians, nurses, and other health department personnel can do much to improve refuse handling and sanitation in the community through their contacts with citizens. These workers enter homes and business establishments and can emphasize the importance of proper storage, as well as point out the need for sanitary collection and disposal. The health department should insist that refuse collectors be paid a sufficient salary to attract good workers, that collectors realize the importance of good public relations, and that complaints on refuse handling be courteously and competently received and answered.

Inasmuch as there are also other city departments interested in refuse handling, it may be desirable to organize an advisory board from available city officials representing the various fields of interest. Such a board could be composed of the superintendent of public works, the health officer, and other city officials such as the city manager, the city engineer, the fire chief, chief of police, and the superintendent of the planning or zoning board. Individual board members could then be called upon for advice concerning their particular interests in refuse handling. The superintendent of public works, with the assistance of the health officer, should then operate and administer the program as defined by the advisory board.

It can readily be seen that the cost of sanitary refuse handling varies greatly, although combined collection with sanitary landfill disposal – which is the most economical – should not be more than about $2.00 to $3.00 per person per year. The direct cost to each householder for refuse containers and a stand at his residence should not be more than $1.00 or $2.00 per year.

Although a good sanitary refuse handling program should be accomplished largely through education and cooperation of the public, it should be backed up by a good refuse ordinance or sanitary code. It would be impossible to prescribe a detailed ordinance covering storage, collection, and disposal that would be suitable for all communities. Each town or city presents a somewhat different problem, and the State health department concerned will be of assistance in preparing such an ordinance. *Refuse Collection Practice* (10) contains a good general discussion on "Provisions of Typical Refuse Collection Ordinances" suggested by the American Public Works Association.

Many local health departments (or other city departments charged with refuse handling) spend much time and money answering nuisance complaints. Often a good share of these are refuse complaints. Studies of the inspection services of two eastern city health departments were made in 1940 and 1941, and a tabulation of all complaints showed that refuse complaints made up nearly one-half the total in one city and about one-fourth in the second city (19). Improved refuse handling would, in many cases, relieve troublesome nuisance complaints, allowing local health departments to concentrate on other public health activities.

Cooperation in the city or community is a matter of public education, and the extent of this cooperation will determine the success or failure of a good refuse program. A well-organized, informative, educational-sanitation program stating the economic advantages and the health aims and benefits will provide this necessary cooperation. This cannot be accomplished with a 1-week campaign, but must be a continuing day-to-day activity.

Several tools are now available or are being prepared to assist local communities with their educational-sanitation activities. These include:

1. A manual on *The Control of Domestic Flies*, by J. H. Coffey and H. F. Schoof, FSA, PHS, CDC.
2. An environmental sanitary survey form to be used in obtaining information on the basic sanitary factors for a given area.
3. An educational-sanitation operations outline for a typical city or town with a June to September fly breeding season.
4. A series of 14 pamphlets covering refuse handling and fly biology.
5. A set of about 40 2- by 2-in. slides with a detailed outline on sanitary landfill operations to be used as a basis for talks to local officials and civic organizations.
6. A set of 14 suggested press releases on fly control and sanitation.
7. A list of available films on environmental sanitation and fly control.

This material should provide interested cities and communities with a sound basis for future fly control programs.

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PRESENT-DAY KNOWLEDGE CONCERNING COCCIDIOIDES IMMITIS

Libero Ajello, Scientist

Of the fungi pathogenic to man, perhaps more is known about *Coccidioides immitis* than any other. This knowledge which has been accumulated within the past 50 years has brought the following facts to light.

C. immitis is a dimorphic organism, i.e., it exists in two separate and distinct phases, one in living tissue and the other in laboratory media. In animal tissue it occurs in the form of spherical bodies known as spherules or sporangia (figure 1). These structures at maturity are filled with a varying number of endospores that are released through rupture of the sporangial wall. The liberated spores may each, in turn, develop into new sporangia and by this method the fungus may continue to multiply within the animal body.

On artificial media, *C. immitis* develops in the form of a mold-like fungus not unlike that of many nonpathogenic fungi. The white cottony colonies, however, from numerous small, more or less rectangular thick-walled arthrospores that are of diagnostic importance (figure 2). When spores or mycelial fragments are inoculated onto suitable media, the mold-like colony again develops. On the other hand, sporangia appear when the same cultural elements are injected into animals. At the present time, the tissue phase of *C. immitis* cannot be obtained with any degree of regularity on artificial media.

The disease induced by *C. immitis* is known as coccidioidomycosis and was formerly believed to be rare and invariably fatal. Today it is known that millions of people have been infected in several of our western States; and although fatal manifestations are rare, the symptoms induced

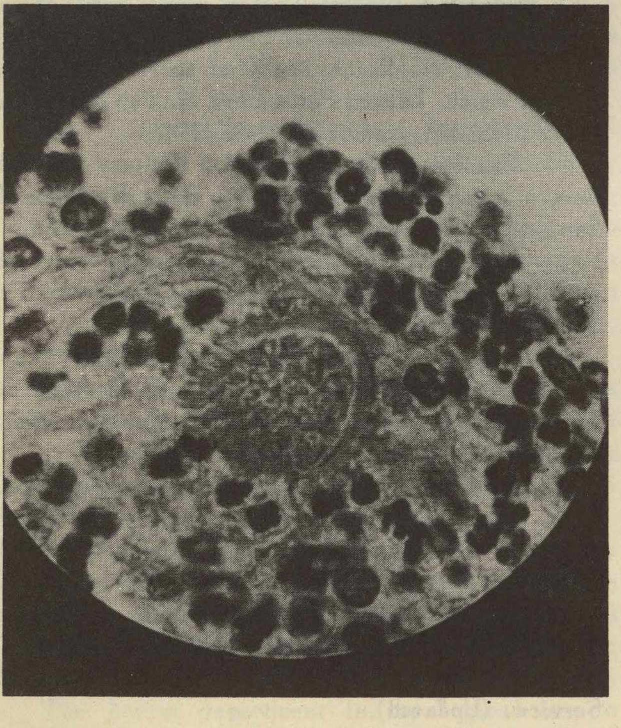

Figure 1. Mature sporangium of *C. immitis* in animal tissue.

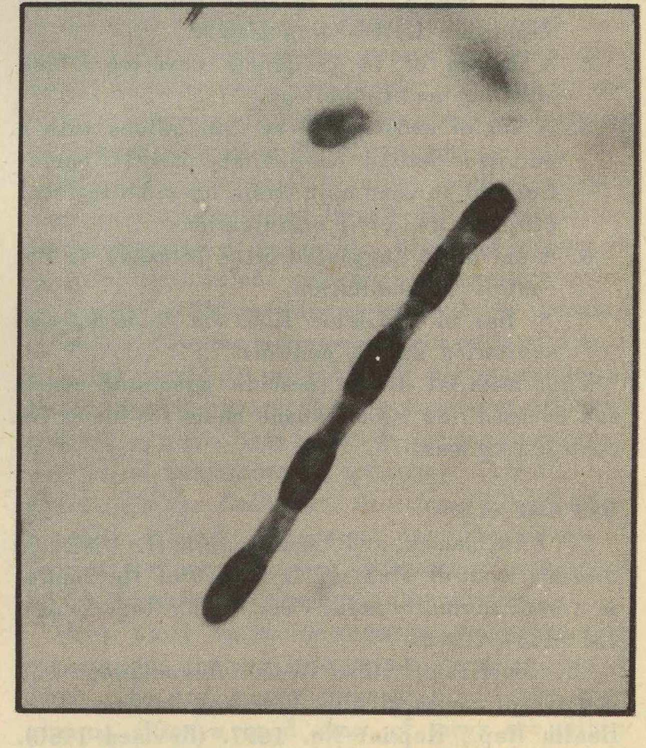

Figure 2. Chain of arthrospores from a culture of *C. immitis*.

*Laboratory Services, CDC.

may be quite severe.

Skin testing surveys and clinical records show that more than 99 percent of all infections are mild and self-limited. In fact, about 60 percent of all infections are either completely asymptomatic or are accompanied by vague, insignificant symptoms. The remaining nonfatal infections are characterized either by respiratory disturbances resembling those of influenza and pneumonia or by the development of a variety of more or less severe symptoms.

In white persons, progressive disease develops in only 0.2 percent or less of all infections, but in these disseminated cases mortality averages 50 percent. The incidence of severe infections appears to be higher in other racial groups, but not enough data has been accumulated to substantiate this impression. Although these statistics, gathered principally from California, would indicate that coccidioidomycosis is not the invariably fatal disease it was once considered to be, we lack morbidity and mortality data from all the endemic areas.

From an epidemiological point of view, *C. immitis* is a highly interesting organism. It has a markedly limited geographic distribution for reasons that are not yet understood. At the present time, *C. immitis* is known to exist solely in several arid regions of North and South America with a possible small endemic focus in Italy. In the United States, it has been found in portions of California, Arizona, New Mexico, Nevada, Utah, and Texas.

Until recently, Argentina was the only South American country where cases of coccidioidomycosis were known to occur. Recent findings, however, show that the organism exists in Paraguay, Bolivia, Venezuela, and Mexico. It is not unreasonable to expect that, in time, *C. immitis* will be found to be distributed in suitable environments elsewhere.

C. immitis probably exists as a saprophyte in nature. In fact, it has been isolated from soil by several workers. All evidence indicates that coccidioidomycosis is essentially an air-borne disease. Incidence of infection is highest during dry, dusty periods and lowest during rainy seasons. Recent studies have shown that dust control measures significantly reduce the incidence of infection of humans by *C. immitis*. There are no records of person-to-person transmission.

SUMMARY

This presentation has summarized briefly some of the knowledge of *Coccidioides immitis* that has been accumulated since Posadas, of Argentina, described the first case of coccidioidomycosis in 1892 and Ophuls (1900) showed, by successful isolation, that the etiologic agent was a fungus and not a protozoan.

To medical and public health workers, *C. immitis* still presents many problems. Because coccidioidomycosis is a protean disease which simulates syphilis, pneumonia, measles, tuberculosis, and other diseases, differential diagnosis in this infection is an important problem for the physician. Competent mycological laboratory work is necessary to guide the physician in his diagnosis.

It is unfortunate that, at the present time, once a correct diagnosis of coccidioidomycosis has been made there is available little besides supportive measures to aid the patient. No immunological or chemotherapeutic tools are yet available to control the disease. In the prevention and therapy of this and most other mycoses, the microbiologist, chemist, and immunologist have an unlimited field for investigation.

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ORIENTATION OF PUBLIC HEALTH NURSES WHO ARE TO PARTICIPATE IN EPIDEMIOLOGICAL FIELD INVESTIGATIONS*

L. Dorothy Carroll, Senior Nurse Officer**

As part of their routine activities, public health nurses have participated in local communicable disease control programs for many years. More recently they have been members of special field research teams. Their duties have included collecting epidemiological and clinical data; administering medications and immunizing agents under medical supervision; and observing and reporting results. They also have been responsible for a variety of detailed activities that may or may not be what has been considered customary nursing responsibilities. The necessary orientation to these assignments has usually taken the form of on-the-job or in-service training. Following World War II and the establishment of the Communicable Disease Center in the Bureau of State Services of the Public Health Service, the services of public health nurses were requested for epidemiological field programs in which the nurse was to play a somewhat different role.

MALARIA CONTROL

Malaria control activities during the War pointed up the need for determining where malaria was occuring. The transmission of human malaria could be prevented if adequate control measures were applied to residual foci. The possibility of eradicating a disease that had annually cost millions of dollars and untold human misery seemed possible. Carefully applied eradication measures and epidemiological evaluation by trained personnel were necessary, if the progress made during the War was to be maintained and the new goal of eradication accomplished. Nursing assistance in the epidemiological phases of the malaria eradication program was needed.

In 1947 when the malaria appraisal program was started, no special preassignment training was provided. During the following year individual in-service training was given to the nurses in the program by their Federal and State supervisors. The individualized training was sandwiched between other duties and although reasonably effective, was not always well organized nor complete. It soon became apparent that if the public health nurses assigned to this program were to function effectively, special training for the assignments was essential.

In 1949 the two nurses assigned to the program were given a preassignment orientation in the basic epidemiological principles in malaria appraisal. This training yielded encouraging dividends in quality of the service rendered.

Administrators responsible for the malaria eradication program have recommended that each of the 13 traditionally malaria States develop a surveillance and prevention program. A team which would be composed of an epidemiologist, an entomologist, and an engineer would be responsible for the investigation and confirmation of malaria transmission. Where transmission is established, control activities will be applied to knock out the focus of infection. Since the nurses already participating in the epidemiological phase of the malaria eradication program have made a substantial contribution, it was proposed that qualified nurses be recruited and trained for assignment in the extended program. One medical officer is now assigned to the program. It is expected that others will be recruited. Public health biologists with some special training also may be utilized, but the nurses probably will be responsible for carrying a considerable amount of the epidemiological activities.

NEED FOR EPIDEMIOLOGICAL TRAINING

Requests were received from two State health departments for training in field epidemiology for two of their nurses. As all public health nurses in the Communicable Disease Center are subject to participate in the investigation of epidemics, training in this area is necessary for new appointees. Requests also have been received from

*Presented at the APHA meeting in St. Louis, Mo., Oct. 29-Nov. 3, 1950.
**Executive Office, CDC.

State health departments that the appraisal and investigational services now being applied to malaria be extended to other significant disease problems, since malaria reporting has continued to decline. This tendency to broaden programs of communicable disease appraisal combined with the need for expanding the geographical scope of the malaria surveillance program has pointed up the need for a larger number of nurses with special training in communicable disease control. Hence, during 1950 plans for a more formal training course in the principles and practices of epidemiological investigations were drawn up and are currently being carried out.

FIELD TRAINING PROGRAM

The first field training program for public health nurses was started October 2 at the Communicable Disease Center. The objectives of the course are: (1) To train public health nurses in the epidemiological investigations of the individual cases of significant communicable diseases. (2) To train public health nurses in the effective participation in the investigation of epidemics. (3) To train public health nurses in the use of epidemiological techniques in communicable disease appraisal programs.

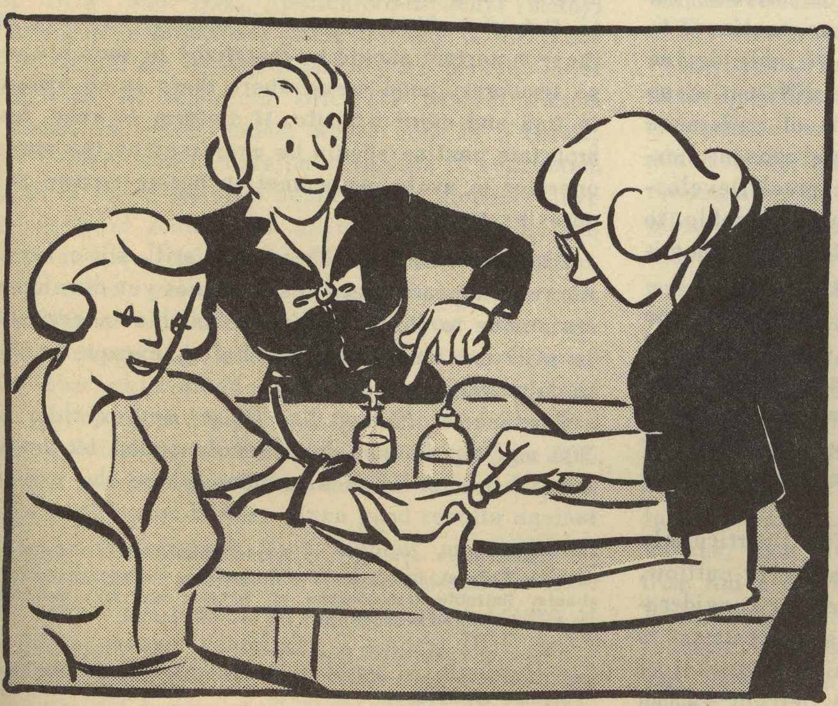
The course is set up on a 3-month basis and includes 3 weeks of academic work in the headquarters office and 9 weeks of supervised experience in the field. The first section of the course attempts to present selected pertinent principles and practices in the fields of epidemiology, laboratory diagnosis, engineering and entomological control operations, and public health veterinary medicine. One of the 3 weeks of academic work is spent in the laboratory, learning through demonstration and practice, specimen collection, the principles of laboratory tests, and the interpretation of laboratory reports. Other student activities during this first academic session include a guided review of the literature available on one infectious disease, the study and analysis of epidemiological records, and a laboratory problem in handling pertinent statistical data and in solving a disease outbreak problem.

The second period of the course, composed of 9 weeks of supervised field training, is devoted to the investigation of individual cases of communicable diseases. The students also participate in the investigation of any epidemic which occurs during their period in the field. A study of a local county health department's immunization records is made, the problem defined, and recommendations outlined on the emphasis the control program should have in the future. This section of the course was supervised by the State epidemiologist in the Mississippi Board of Health and by a Communicable Disease Center nursing consultant assigned to this program.

We hope to learn through the student and faculty evaluation of this first course how to plan succeeding courses, so that they will fulfill the needs of nurse epidemiologists for practical in-service orientation.

SUMMARY

In presenting this discussion, the writer has attempted to outline the events leading up to the development of a specialized field training program for public health nurses. In developing the program, we have tried to make it as practical as possible. Modifications of this type of practical field training in communicable disease control to meet the needs of other programs may develop at a later date.



RECOMMENDATIONS FOR THE USE OF INSECTICIDES AND RODENTICIDES IN COMMUNICABLE DISEASE CONTROL OPERATIONS IN 1951

Staff - Technical Development Services, CDC

INTRODUCTION

Conducting of laboratory and field investigations to determine the effectiveness and toxic hazards of various economic poisons which offer promise for use in communicable disease control operations is one of the projects of Technical Development Services. The results of these investigations are used as a basis for recommendations on materials, dosages, and application techniques to be used in field operations. On the following pages recommendations for the 1951 season are briefly summarized. More detailed information concerning the individual insecticides and rodenticides may be obtained from the Operational and the Clinical Memoranda on Economic Poisons which are released by Technical Development Services. These memoranda and recommendations are kept up to date by modification from time to time as indicated by the results of current investigations.

INSECTICIDES

The problem of recommending insecticides for use in operational control programs continues to be a difficult one because of the variable degree of fly resistance to insecticides in different areas and the constantly changing status of resistance where it is encountered. For these reasons, experimental work conducted by Technical Development Services is not universally applicable to field conditions and recommendations for insecticidal usage must be somewhat generalized.

Mosquito Insecticides. Present indications are that *Anopheles quadrimaculatus* has developed little or no resistance to DDT under field conditions. Consequently, no changes are suggested in the present residual spraying operations for malaria mosquito control, nor in the short-term larviciding practices.

In situations where it is feasible, particularly in ponded areas with very little inflow or outflow, residual larviciding is recommended for consideration. If fish are present, the suggested treatment is the application of a water emulsion of technical benzene hexachloride (BHC) (12 percent gamma isomer) applied at the rate of 1 lb. BHC per acre. This may be conveniently accomplished by preparing a xylene concentrate containing 1 lb. of technical BHC and 2 percent emulsifier (Triton X-100 or X-155) per gallon of finished concentrate, mixing this concentrate with an equal volume of water, and applying the finished spray at the rate of 2 gal. per acre, using the equipment and spraying techniques normally used in larviciding operations. If there are no fish present, treatment may be made on an experimental basis, with dieldrin * at the rate of 1 lb. per acre or DDT at the rate of 3 lb. per acre, following the procedure outlined above for BHC, except that the DDT concentrate can be prepared to contain 3 lb. of DDT per gallon of concentrate. Based on experimental work on small landlocked ponds in the Savannah, Ga., areas, the suggested dosages of the above chemicals may be expected to give the following periods of effective control of mosquito breeding: BHC – 5 to 8 weeks; DDT – 13 to 20 weeks; and dieldrin 1 to 2 years. **DDT or dieldrin is highly destructive to fish and other aquatic organisms, and use of these materials should be restricted to such places as temporary pond areas where there is no hazard to fish and other wildlife. If dieldrin is used, appropriate caution should be exercised by the spray operator to avoid contamination during mixing and spraying.****

Fly Insecticides. There are still some areas where it appears that flies have not yet developed resistance to DDT. In such areas this insecticide is still the insecticide of choice, except for use in dairy barns.

Lindane at 25 mg./sq. ft. or methoxychlor at 200 mg./sq. ft. has been recommended for use in dairy barns or other situations where the use of

*Dieldrin is available in ample quantities for restricted use by Federal, State, and local agencies on an experimental basis. Suitable formulations of dieldrin are also permitted to be distributed commercially for use on cotton.

**See *Recommended Procedures for the Field Testing of Dieldrin in 1950*, Technical Development Services, February 15, 1950.

DDT, chlordan, or dieldrin might result in the contamination of milk. Both of these materials have given rather erratic results, particularly in situations where flies have become resistant to DDT or other chlorinated hydrocarbons.

In situations where flies have become resistant to DDT residual sprays, it is suggested that substitutes be used in accordance with the following recommendations:

1. Chlordan is recommended for selective spot treatment at the rate of 200 mg./sq. ft. inside dwellings and on porches, the insides of outbuildings, and other situations relatively protected from the weather. It should not be used for over-all interior house spraying, particularly in bedrooms.

2. Dieldrin is recommended for use by State and Federal health agencies as an outdoor residual spray only (including the inside of privies and the lower walls of other rural outbuildings not used in connection with milk production). It should be applied at the rate of 50 mg./sq. ft. of treated surface. The precautions recommended for the experimental operations of the past season should continue in effect and should be strictly observed.

3. In situations where flies have become resistant to all of the above residual chlorinated hydrocarbons, it is recommended that consideration be given to the use of space sprays of pyrethrum and piperonyl butoxide, BHC, or a 5 to 1 combination of DDT and DMC (p-dichloro-diphenyl methyl carbinol). In situations where the odor of the crude BHC would not be objectionable, a 5 percent water emulsion of technical BHC (12 percent gamma isomer) is recommended. Where odor is a factor, a 2 percent water emulsion of lindane is suggested. Both of these benzene hexachloride products have given good results as space sprays for a time against flies resistant to DDT, dieldrin, chlordan, and other chlorinated hydrocarbons. However, resistance to BHC is likely to occur after continued usage of it in areas where flies are resistant to other chlorinated hydrocarbons. Space sprays of pyrethrum and piperonyl butoxide when applied as emulsions or oil solutions containing from 0.05 to 0.1 percent pyrethrins and 0.5 to 1.0 percent piperonyl butoxide have given good results against insecticide-resistant flies without any apparent development of resistance to these materials. Late in 1950, field tests with outdoor space sprays of water emulsions containing 5 percent DDT and 1 percent DMC gave good results against both resistant and nonresistant flies. This 5 to 1 combination may be tried on an experimental basis on operational programs if it is deemed desirable. It is believed that further testing at Savannah may make it possible to recommend a combination containing lesser quantities of DMC. No data are presently available on the possible development of resistance to the DDT-DMC combination. (This combination was not effective in field tests as a residual spray against resistant flies at the same time that it proved effective as a space spray.)

4. Chlordan or technical BHC (12 percent gamma isomer) at 200 mg./sq. ft., and dieldrin or lindane at 50 mg./sq. ft. are recommended for limited use as fly larvicides, such as to treat garbage cans or the soil beneath them in municipal fly control operations, or to treat packing-house wastes and similar fly breeding materials as a temporary expedient pending the initiation of appropriate sanitation measures.

5. In situations where flies become resistant to all of the available residual and space sprays, do what should have been done originally — clean up. **Insecticides are only a supplement to and not a substitute for sanitation!**

RODENTICIDES

No new problems, such as resistance, have appeared in the control of rodents, but the old problems of primary bait refusal, bait shyness, cost of operation, and hazard to man and useful animals remain.

The recommendations for the use of the older rodenticides, including 1080, remain essentially unchanged; but the addition of one completely new rodenticide can now be recommended. This new material, warfarin, differs from all earlier effective rodenticides in two ways; (a) it will not kill rats effectively when given in a single dose, and (b) it induces no bait shyness. These characteristics make it necessary to use entirely new techniques when employing warfarin as a rodenticide. The following recommendations are made for the field use of rodenticides during the 1951 season:

Sodium Fluoroacetate (1080). Recommendations for this material are unchanged. It may be used for rat and mouse control on ships and in military installations, guarded municipal dumps, warehouses, and such other business establishments from which children and irresponsible persons may be excluded during exposure of the poison. This rodenticide should never be used in dwellings. It may be used in farm buildings only with bait stations and with particular attention to the danger of secondary poisoning to farm animals and pets. Preparation and distribution of poisoned baits should be done by persons who are adequately trained and completely aware of the hazards to themselves and others where sodium fluoroacetate is used. It is preferable that all persons who have any direct contact with this material be regular employees who have received training or apprenticeship in rodent control for at least 3 weeks. Detailed instructions for labeling, storage, distribution, and disposal of this poison have been prepared and are available on request from Technical Development Services.

Only liquid bait, prepared by dissolving 12 gm. of rodenticide in 1 gal. of water, is recommended.

ANTU. This material is less effective than 1080 but offers less danger to man and domestic animals. Baits containing ANTU in concentrations of 2 to 3 percent are recommended for Norway rats but are considerably less effective for roof rats and cannot be recommended for their control. Norway rats that take the compound and are not killed by it develop bait shyness that lasts at least 4 months. Young Norway rats are less susceptible than adults.

Warfarin. Warfarin is a new anticoagulant, slow-acting rodenticide. Effective control with it can be expected in about 2 weeks from the time that baits are placed. Concentrations of poison used should be 0.10 mg./gm. (0.010 percent) for Norway rats and 0.25 mg./gm. (0.025 percent) for roof rats. Concentrations as low as 0.05 mg./gm. (0.005 percent) have proved effective against Norway rats in limited field tests and should be used for that species whenever facilities for proper evaluation are available. Yellow corn meal of a cooking grade is the bait of choice. Whole meal is slightly preferable, but the degerminated meal that can easily be obtained from grocery stores is quite satisfactory. Corn meal should be used in preference to all other baits unless the rats in question are definitely known to prefer some other bait or if success with corn meal is not achieved after fair trial.

Thorough mixing of the bait and poison is of the utmost importance. The use of an electric mixer is recommended. Bait should be distributed in bowls or wooden trays about 4 in. across and 2 in. high. Any baits that are placed where they may be found by children or domestic animals should be protected by a bait station. Bait should remain in place for a minimum of 2 weeks. There is no maximum for the baiting period. No kill should be expected before the 3d to 5th day. Baits must be inspected as frequently as is necessary to maintain an adequate supply of fresh bait. Daily or almost daily inspections may be required at first. Later, inspection every 4 to 6 weeks may be sufficient. If it becomes necessary to employ perishable baits, then, of course, they must be removed daily as long as they are used. Baits should be placed as near to runs and harborages as circumstances permit. It must be remembered that the home range of rodents is small and that an area as small as a city block may contain many entirely separate home ranges.

Warfarin offers the advantage of being highly effective if used properly. It also offers a considerable degree of safety although the hazard of its use should not be underestimated. Because it does not induce bait shyness, it may be used as a residual rodenticide to maintain control in an area subject to constant population pressure from the outside. This compound, then, offers a sort of chemical ratproofing in places where a conventional ratproofing is impractical for economic or other reasons.

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Ecke, Dean H., and Johnson, Clifford W.: Sylvatic plague in Park County, Colorado. Transactions of the Fifteenth North American Wildlife Conference. pp. 191-197 (March 1950).

Hayes, Wayland Jr., and Gaines, Thomas B.: Control of Norway rats with residual rodenticide warfarin. Pub. Health Rep. 65(47): 1537-1555 (1950).

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PICTORIAL REVIEW

COMMUNITY FLY CONTROL SERIES

FLY CONTROL THROUGH BASIC SANITATION

PRODUCTION NO.: CDC 4-090, released 1950
DATA: Motion picture; 16 mm., sound, color, 9 minutes, 316 ft.

PURPOSE

To show how basic sanitation can help to eliminate flies in a community fly control program.

AUDIENCE

Professional and subprofessional public health personnel and those who will utilize or teach others to utilize basic sanitation in fly control.

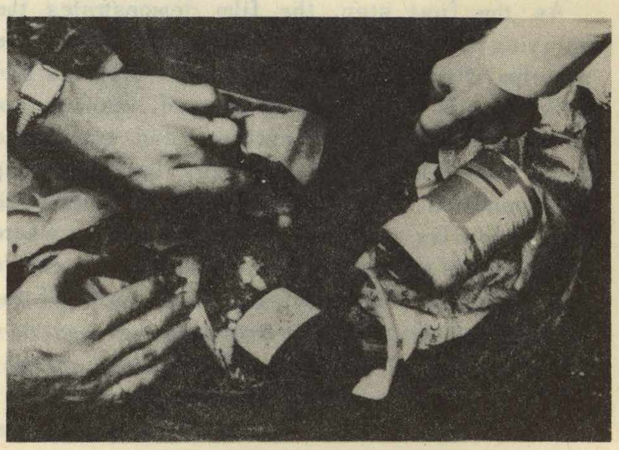
CONTENT

The introduction shows that flies will breed in open garbage cans, in open garbage dumps, and around open pit privies – in fact, anywhere there is filth, warmth, moisture, and an undisturbed condition of the breeding medium for sufficient time to allow the breeding and developmental stages of the fly to occur. The film points out that basic sanitation, the elimination of all of these fly breeding sources, is the foundation of all successful fly control operations.

A community program in basic sanitation, backed by local ordinances, should provide for and enforce the following: (a) the storage of all garbage and refuse in covered and well-cared-for garbage cans kept on concrete bases or, in the case of industrial refuse, in concrete bins; (b) collection of combined garbage and rubbish in closed collection units (daily in business sections and biweekly in residential areas); and (c) disposal of the collected wastes in sanitary landfills or incinerators.

In rural areas, the film points out, basic sanitation procedures parallel those of urban areas except that the disposal of garbage is the problem of each individual family. Screens on windows and doors aid in excluding flies from homes. Garbage should be wrapped in newspapers and stored in flyproof garbage cans until it can be burned or buried. On stock farms, manure should be spread thinly on the field at least twice a week or kept in flyproof storage bins. Sanitary pit privies keep flies away from human excreta.

In the recapitulation, it is emphasized that basic sanitation is the foundation of all successful fly control operations.



An important step in community fly control through basic sanitation is the elimination of all possible fly breeding sources.

SPRAYING EQUIPMENT AND PROCEDURES, Part I, RESIDUAL SPRAYING

PRODUCTION NO.: CDC 4-091.0, released 1951
DATA: Motion picture, 16 mm., sound, color, 9 minutes, 333 ft.

PURPOSE

To depict the use of hand and of power spraying equipment in the specific situations for which each can be most effectively used in residual spraying for fly control.

AUDIENCE

Professional and subprofessional public health personnel and others who will either use or teach others to use residual and space spraying equipment.

CONTENT

In rural areas and small communities, the number of flies and diseases which they carry can be reduced by the efficient and methodical use of residual spraying. This type of spraying leaves a deposit of insecticide which remains toxic to flies and other insects for weeks. Residual spray equipment is varied in structure. A common type is the 2- or 3-gal. compressed-air hand sprayer consisting of tank, pump cylinder and valve, two gaskets, a 5-ft. hose, cut-off valve, spray wand, and nozzle.

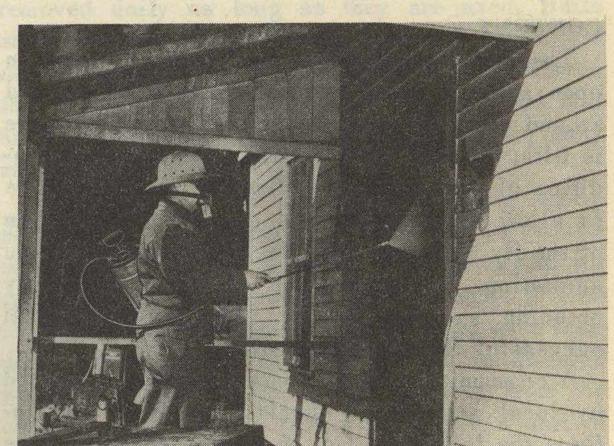
Public health sanitarians can easily teach farmers how to use these sprayers for residual spraying. The pressure is pumped to 50 lb./sq. in. and the nozzle moved steadily up and down at a distance of 18 in. from the surface to be treated.

As the first step, the film demonstrates the spraying of the exterior of the milk house, the principal fly attractant. The interior surfaces and milk utensils should not be sprayed. Other points to be sprayed are the surfaces and around the doors and windows of the dairy barn (avoiding contamination of livestock feed and water); the cattle loading platform and other places where farm animals congregate; the chicken house, inside and out; the privy; and the back porch of the house, including the door screens.

In towns and small cities, trained crews and mechanized equipment do a much faster job than is possible with the hand sprayers, although the latter should be used for spraying surfaces not easily reached by power equipment. In business areas, fly attractants and nearby resting places should be treated. The pressure should be kept between 30 and 50 lb./sq. in. because lower pressure causes undertreatment and higher pressure causes much of the material to bounce from the surfaces to be treated.

In residential areas, fly attractants and resting places such as back porches of homes and narrow alleys should be treated.

All important fly breeding sites in the community should be sprayed. The power equipment should be supplemented by hand sprayers for places inaccessible to hoses. All surfaces and edges should be treated from the ground up to a height of 8 ft. The community should supplement its spraying program by careful storage, collection, and disposal of fly attracting refuse.



Residual spraying of back porches and screen doors is an essential part of the fly control program in rural areas.

SPRAYING EQUIPMENT AND PROCEDURES, Part II, SPACE SPRAYING

PRODUCTION NO.: CDC 4-110, released 1950
DATA: Motion picture; 16 mm., sound, color, 7 minutes, 227 ft.

PURPOSE

To aid in teaching public health personnel the effectiveness of space spraying equipment in community fly control programs.

AUDIENCE

Professional and subprofessional public health personnel and others dealing with community fly control programs.

CONTENT

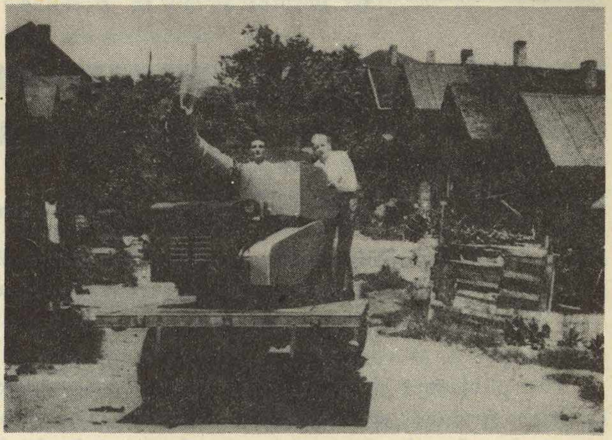
The introduction shows exterior space spraying which kills flies on the wing, but which has no residual effect. This film shows improvements recently made possible by the development of new liquid insecticides and special spraying equipment.

It is pointed out that clean residential areas may require bimonthly treatment, while substandard and business areas may need spraying every week. Periodic measurements of fly density reveal where and how often spraying operations are required.

Mist applicators that distribute a mist of insecticide particles which fall uniformly over attractants and kill flies at a distance of up to 200 ft. are described.

The fog applicator, because it is less likely to harm shrubbery and lawns, is better suited to spraying parks and better residential areas than are mist applicators. The effective range of the fog, which may be up to 200 ft., is tested at frequent intervals by the use of clean glass slides placed within range of the spray machines.

In the conclusion, it is pointed out that successful community fly control can be maintained by the use of modern spray equipment and effective insecticides, supplemented by a sound basic sanitation program.



A mist applicator, by making possible the rapid spraying of large areas, increases the effectiveness of the community fly control program.

Have you read---?

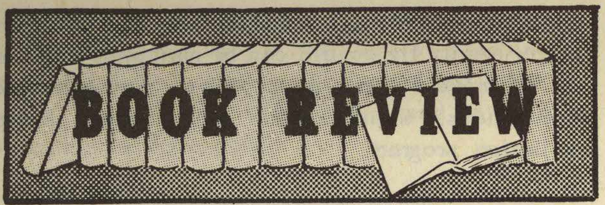
MALARIA . . .

Russell, Paul F.: Malaria and society. J. Nat. Malaria Soc. 10(1): 1-7 (1951).

This article, "The President's Address, delivered at the 33rd Annual Meeting of the National Malaria Society, Savannah, Georgia, 7 November 1950," describes the progress made in malaria control over the years. Under the headings "Pessimism," "Optimism," and "Hope," the trends in the general attitude toward malaria and public health as a whole are described.

DDT . . .

Pharmacologic and toxicologic aspects of DDT (Chlorophenothane U.S.P.). J.A.M.A. 145(10): 728-733 (1951). This very complete review of the pharmacologic and toxicologic aspects of DDT constitutes a report of the Committee on Pesticides, a standing committee of the Council on Pharmacy and Chemistry, American Medical Association.



BRUCELLOSIS (UNDULANT FEVER), CLINICAL AND SUBCLINICAL

HAROLD J. HARRIS, with the assistance of BLANCHE L. STEVENSON.

Second Edition, pp. i-xxi and 1-617 (1950), illustrated by Paul B. Hoeber, Inc., Medical Book Department of Harper Bros., 49 E. 33d St., New York, N. Y.

The publisher describes the book as a second edition revised and enlarged. This is a modest statement for the large amount of material which the author has added to his first edition.

Directed, for the most part, to the general practicing physician, the second edition relates the experiences of a practitioner with more than 700 clinically observed *Brucella* infections. The book is mainly devoted to human phases of brucellosis and emphasizes the necessity of clinical skill and judgment in the diagnosis. The author presents his series of more than 700 cases as evidence that brucellosis is not a rare disease or that the prevalence is not declining because of the widespread adoption of pasteurization. He states that brucellosis is not a self-limiting disease and that an intelligent course of treatment should be based on a profound understanding of the disease. Treatment is discussed in detail. Under control and prophylaxis, the author reviews the problems which are of concern to public health officials. Some interesting points are raised about the psychological and medicolegal aspects of brucellosis. Annotations of bibliography and arrangement of material should make the volume a good reference source.

The introduction, which covers the history and nomenclature of brucellosis, is concise and interesting. Schroeder and Cotton are given credit for recognizing that *Brucella abortus* may cause infection in man. They also urged that all milk be pasteurized. *Brucella melitensis* infections were reported in man and goats in Edwards County, Tex., as early as 1911, and in Arizona in 1913. Certified raw milk was demonstrated to be infectious in 1917. The intradermal test was first described by Fleischner and Meyer in 1918. Credit is given to Meyer for proposing the generic name *Brucella* to honor David Bruce. The adoption of the terms *B. melitensis*, *B. abortus*, and *Brucella suis* in 1930 ended the controversy as to nomenclature. The name brucellosis is now accepted to describe the infection in man and animals. The definitions of acute and chronic brucellosis are not resolved so easily by the author.

The chapter on etiology reviews briefly the bacteriology, including morphology, growth requirements, staining, and cultural methods. The dissociated forms of *Brucella* and methods of differentiating them are discussed, and the pathogenicity of various strains, including strain 19, is mentioned.

Chapter 3 describes the epidemiology of brucellosis. The author stresses the animal or food-of-animal-origin transmission to man and points out that water or food products may be contaminated and thus carry the organism to man. He mentions possible human-to-human infection, but indicates that even though this means of infection is suspected, it is difficult to rule out other means of exposure. His statement as to the value of agglutination tests and the number of infected cows is speculative. Swine are an important source of the disease, and although it is realized that agglutination tests are not always reliable, the author should be more cautious in pointing out the limitations of these tests in cattle. Dr. Harris does emphasize the need for pasteurization of all raw milk supplies, including certified milk and goat milk. The survival of *Brucella* in cheese for more than 100 days and in refrigerated butter for 4 months points out the need for pasteurization of all dairy products. Additional experiments with dairy products by Gilman, in which *Brucella* were found, are cited.

The excellent work of Stiles in the isolation of *B. melitensis* from goat-milk cheese is discussed. It is pointed out that most human brucellosis in Mexico is attributed to contaminated cheese. The ingestion of uncooked meat as a source of infection is mentioned. Dr. Harris is in error when he states that known infected cattle are not slaughtered and marketed for human consumption. This is the usual practice. It is difficult to ascertain that the disease is present on post-mortem examination, except occasionally in swine. The important occupational aspects of the disease among veterinarians, packing-house workers, and farmers is not given the space to which it is entitled. The author only briefly mentions air-borne infection, which may be an important means of spread among men and animals. Tables IV and V presenting the number of cases reported in the United States and various countries of the world are of interest. Italy, the United States, Spain, France, and Malta have the highest prevalence of brucellosis; no report was given on Argentina, which is known to have a high prevalence.

The pathology of brucellosis is discussed in chapter 4. The listing of organs from which *Brucella* organisms are cultured reflects the wide and varied symptomatology encountered in the human disease; there is hardly an organ of the body which is not mentioned. The resemblance of the granulomatous lesions of brucellosis to tuberculosis is mentioned, and the intracellular characteristics of the organisms are pointed out. The pneumonia and lung lesions and the rare cases of abortion in women attributed to *Brucella* are of interest.

Chapter 5 is devoted to symptomatology, incubation, and mode of onset, with the variability of all of these emphasized. The incubation period may vary from 1 week to 3 or 4 months. The acute and chronic disease in adults is described, as well as the disease in children. The respiratory symptoms of cough, pleurisy, and pneumonia are of special interest. One of the important sequelae of the disease is the orthopedic manifestations which are described in detail.

The discussion of diagnosis reviews the laboratory procedures useful in recognizing the disease and the diseases which may be mistaken for brucellosis. The statement that consistently negative results cannot be used to rule out brucellosis is open to question, although it is known that certain rare strains of *Brucella* do not behave as the books describe them. This chapter emphasizes that diagnosis of the disease in man is difficult.

Psychological studies on chronic brucellosis are discussed and case histories are presented. The necessity of psychological methods of investigation are stressed.

The prognosis of brucellosis raises the question of whether it is a self-limiting disease. The author does not believe so, especially in the chronic form. It is pointed out also that reinfection, which is difficult to differentiate from a relapse, may occur. The duration of the disease is variable, ranging from a few weeks to many months, but the mortality of brucellosis has remained low since Hughes stated it was about 2 percent in 1897, although in Argentina and Mexico it is reported to be higher.

Treatment of this disease includes the use of everything from antibiotics to vitamins. Bed rest is one thing generally agreed on, but the use of other methods is something for the clinician to decide. Many of the methods discussed by the author could have been dismissed with the simple statement that they were of no value. The results of the value of aureomycin treatment were not available at the time but are referred to in the addenda. Many investigators believe this to be the most valuable drug used at present in the treatment of brucellosis.

Prophylaxis is discussed in the last chapter of the book. The author makes some sound recommendations regarding the need of universal pasteurization and animal disease eradication. The difficulties of epidemiological investigations, unless there is a large number of cases in an area, are pointed out. Many of the old prejudices against pasteurization are cited by the author. He also states that to insure the safety of milk it should come from disease-free cows, in addition to being pasteurized.

Dr. Harris steps into a vulnerable position when he challenges the value of agglutination tests in cattle. We cannot hope to expect 100 percent accuracy in biologic phenomena, and the deviations which he cites are so rare that they are published as scientific curiosities. Agreed, cows may be negative to the first test; but on retesting in 90 or 180 days, they will be found positive. The success of state-wide modified accreditation of programs in North Carolina, New Hampshire, and Maine attest to the value of the blood agglutination test in cattle.

Brief reference is made to vaccination of man and animal. The author does not believe it will solve the human or animal problem.

The medicolegal aspects conclude the text. Considerably more could have been said about this interesting phase. The plea for uniform compensation laws for occupational brucellosis is a high point.

An addenda, including statements about trace minerals, aureomycin, and chloromycetin therapy, is furnished. He points out the value of aureomycin in acute illness but reserves opinion on chronic cases. Chloromycetin was of no value according to him. The author discusses irrelevant and unsupported data in the addenda. This is also a weakness of the book. He has tried to cover too much and has not always done it adequately or soundly.

CDC TRAINING COURSES

Listed below are some training courses sponsored by the Services of the Communicable Disease Center to be held during the ensuing several months. Further information on the courses may be obtained from the *Bulletin of Field Training Programs* and the *Bulletin of Laboratory Refresher Training Courses* issued by the Center.

TRAINING SERVICES

1. **GENERAL SANITARY ENGINEERING FIELD TRAINING.** June 18 to September 7, 1951. Twelve weeks. Bloomington, Ill.

2. **GENERAL SANITARY ENGINEERING FIELD TRAINING.** June 18 to September 7, 1951. Twelve weeks. Columbus, Ga.

3. **SPECIAL TRAINING PROGRAM IN MILK PLANT SANITATION.** May 7-11, and May 14-18, 1951. One week. Columbus, Ga.

4. **SPECIAL TRAINING PROGRAM IN RESTAURANT SANITATION.** May 28 to June 9, 1951. Two weeks. Topeka, Kans.

5. **TOPICAL SHORT COURSES – FLY AND OTHER INSECT CONTROL (DECENTRALIZED).** June 18-22, 1951. One week. Amherst, Mass.

6. **FIELD SURVEY AND EVALUATION METHODS IN HOUSING SANITATION.** June 4 to July 7, 1951. Five weeks. Atlanta, Ga.

7. **FIELD SURVEY AND EVALUATION METHODS FOR MEASURING QUALITY OF HOUSING ENVIRONMENT.** June 25-29, 1951. One week. Atlanta, Ga.

8. **INSECT AND RODENT CONTROL TRAINING FOR FOREIGN PUBLIC HEALTH PERSONNEL.** June 11-22, 1951. Two weeks. Atlanta, Ga.

9. **BASIC COURSE IN RADIOLOGICAL HEALTH INSTRUMENTATION.** May 6-25, and June 3-22, 1951. Three weeks. Cincinnati, Ohio.

LABORATORY SERVICES

1. **LABORATORY DIAGNOSIS OF VENEREAL DISEASES.** May 7-11, 1951. One week (Directors). Chamblee, Ga.

2. **LABORATORY DIAGNOSIS OF MYCOTIC DISEASES.** May 14-18, 1951. One week (Directors). Chamblee, Ga.

3. **LABORATORY DIAGNOSIS OF TUBERCULOSIS.** May 14-18, 1951. One week (Directors). Chamblee, Ga.

4. **"TREPONEMA PALLIDUM" IMMOBILIZATION.** May 14-18, 1951. One week (Directors). Chamblee, Ga.

5. **LABORATORY DIAGNOSIS OF PARASITIC DISEASES.** May 21-25, 1951. One week (Directors). Chamblee, Ga.

6. **LABORATORY DIAGNOSIS OF BACTERIAL DISEASES.** May 21-25, 1951. One week (Directors). Chamblee, Ga.

7. **LABORATORY DIAGNOSIS OF VIRUS DISEASES.** May 21-25, 1951. One week (Directors). Montgomery, Ala.

8. **LABORATORY DIAGNOSIS OF SYPHILIS.** June 4-15, 1951. Two weeks. Chamblee, Ga.

VETERINARY PUBLIC HEALTH SERVICES

LABORATORY DIAGNOSIS OF RABIES. May 14-18, 1951. One week. Montgomery, Ala.

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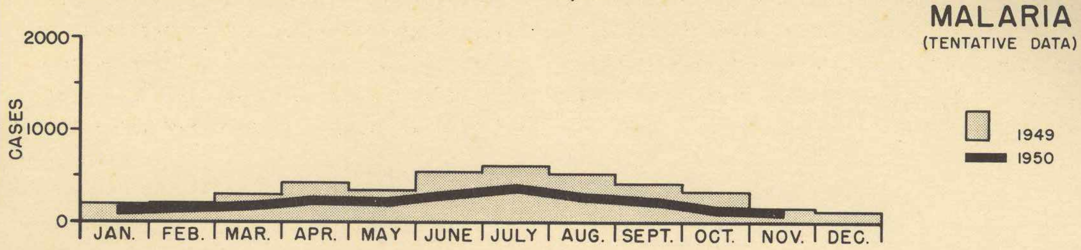
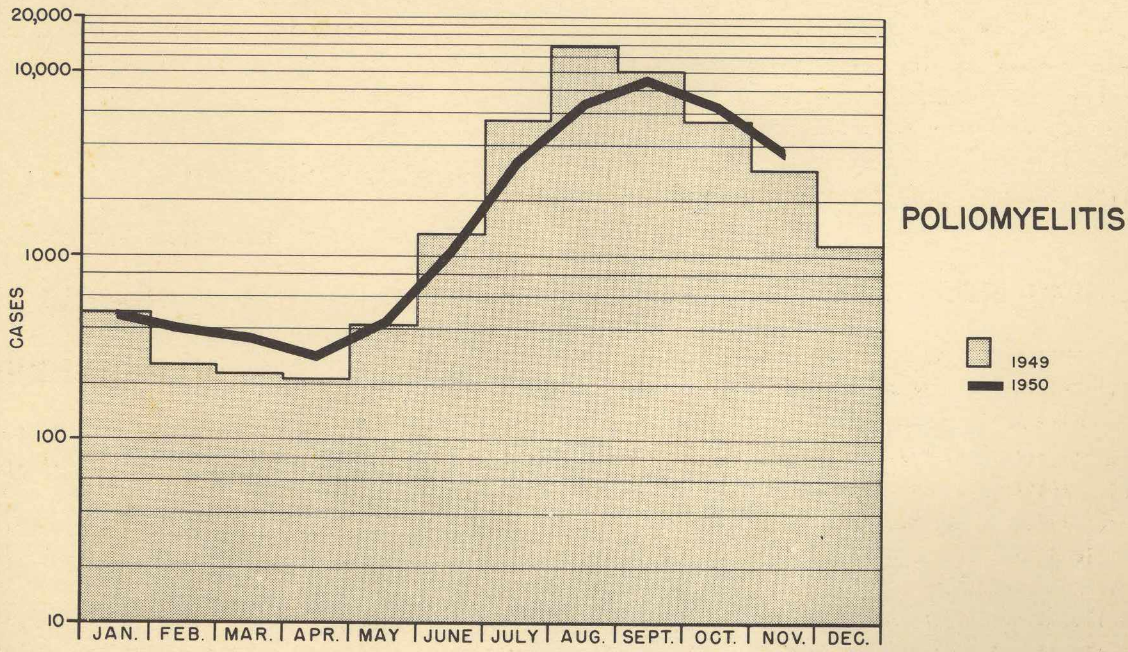
MORBIDITY TOTALS FOR THE UNITED STATES *
MALARIA, POLIOMYELITIS, TYPHUS

1949 - COMPLETE 1950 - AS REPORTED

TOTAL INCIDENCE THROUGH NOV. 1950 2,129



TOTAL INCIDENCE THROUGH NOV. 1950 31,568



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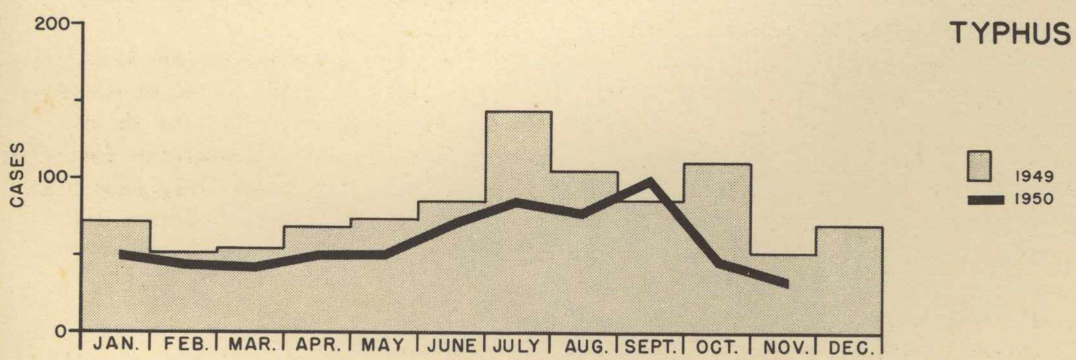

FSA-PHS-CDC ATLANTA, GA.

* SOURCE OF DATA: NATIONAL OFFICE OF VITAL STATISTICS