

FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE

Malaria Control in War Areas FIELD BULLETIN

Martin D. Young



INSECTARY REARING OF *ANOPHELES QUADRIMAGULATUS*

THE IMPORTANCE OF ADEQUATE MALARIA CASE REPORTING

ATLANTA, GEORGIA

APRIL, 1945



TABLE I
MCWA LARVICIDE, MINOR & MAJOR DRAINAGE WORK
MARCH 1 - 31, 1945

STATE	Areas in Operation	Residual Number Houses Sprayed	Spraying Pounds DDT Used	LARVICIDAL WORK			DRAINAGE OPERATIONS							Total				
				Larvicide Used		Surfaces Treated		Cleaning Removal Surf. Veg. Acres	Cleaning Stumping Grubbing Acres	Cleaning Hundred Sq. Ft.	Hand Lin. Ft. Mach.	New Ditching Dynamite	Total Cu. Yds.	Ditch Lining Lin. Ft.	Underground Drainage Lin. Ft.	Fill C.Y.	Water Surf. Eliminated Acres	Man Hours
				Oil Gals.	Peris Green Lbs.	Oiled Acres	Dusted Acres											
Alabama	5	90	35	---	---	---	---	4,944	2,800	---	---	280	---	---	---	---	2	6,878
Arkansas	17	7,054	1,795	458	---	29	---	12,500	132,390	200	---	3,700	---	---	---	---	18	47,807
California	4	---	---	284	---	17	---	2,432	3,000	---	---	100	---	---	---	---	10	3,841
District I	1	---	---	---	---	---	---	136	1,720	505	---	991	---	---	---	---	2	962
Florida	16	243	206	900	15	39	18	38,794	47,111	---	6,133	8,290	2,485	72	7,076	45	31,690	
Georgia	12	144	126	---	151	---	101	4,524	15,299	---	7,030	1,285	---	---	1,437	7	21,249	
Kentucky	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1,112
Louisiana	9	---	---	25,753	782	1,266	60	25,381	70,891	---	---	5,352	---	---	74	26	53,233	
Maryland	1	---	---	---	---	---	---	13,890	400	---	---	48	---	300	---	---	---	2,608
Mississippi	14	493	296	3,346	---	187	---	11,552	23,274	---	---	2,341	---	---	23	22	25,718	
Missouri	4	---	---	---	---	---	---	---	3,500	---	---	---	---	---	800	---	---	4,254
North Carolina	10	40	23	---	---	---	---	6,773	57,775	---	3,900	7,899	---	32	271	---	---	28,304
Oklahoma	5	---	---	---	---	---	---	211	5,396	---	---	448	---	---	---	10	9,061	
Puerto Rico	6	---	---	523	2,428	49	2,200	9,932	8,070	---	---	3,211	54	444	---	---	---	46,442
South Carolina	19	---	---	3,089	3	198	3	16,880	46,421	---	---	12,188	410	409	63	36	65,780	
Tennessee	3	553	251	---	---	---	---	3,857	6,106	---	---	1,850	1,333	---	296	3	17,078	
Texas	14	142	61	211	---	12	---	4,373	44,969	---	---	4,671	701	---	154	36	44,733	
Virginia	4	---	---	---	---	---	---	1,012	78,274	---	2,712	4,690	720	---	325	---	19,795	
Total	145	8,759	2,793	34,564	3,379	1,797	2,382	157,171	547,396	705	19,775	57,314	5,703	1,293	10,769	217	430,515	
February Total	139	---	---	1,531	4,016	121	3,236	129,785	319,512	6,870	15,237	59,884	5,611	568	8,037	611	334,047	

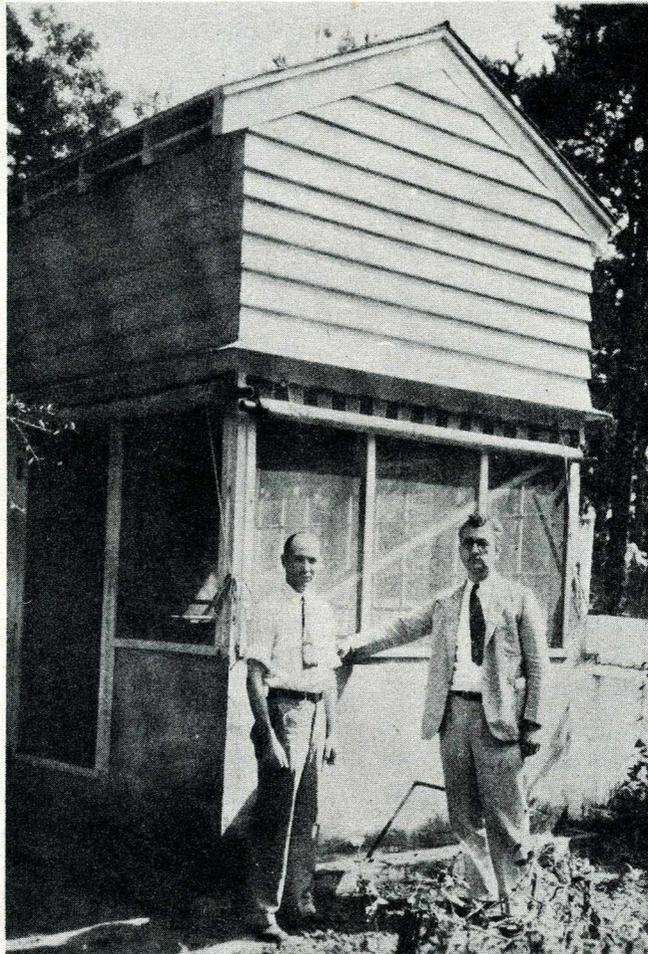
INSECTARY REARING

of *Anopheles quadrimaculatus*

By P. A. San. (R) M. H. Goodwin

Interest in insectary rearing of *Anopheles* has been stimulated recently by increased research on disease transmission. Colonies maintained in connection with Malaria Control in War Areas activities supply *Anopheles* for use in imported malaria studies and toxicity investigations on insecticides. Other U. S. Public Health Service Programs employ insectary reared specimens for chemotherapy experiments and in treatment of general paresis by malaria inoculation. In view of the possibility of Malaria Control in War Areas personnel participating in the establishment of mosquito

insectaries, a brief review of insectary rearing methods and an outline of successful operation procedures is presented. We are indebted to the various laboratories from which information regarding large-scale rearing has been obtained, especially to Sanitarian (R) Martin D. Young and Robert Burgess of the Malaria Investigations Laboratory of the National Institute of Health at Columbia, S.C., and to Major Stanley Carpenter and his associates at the Fourth Service Command Laboratory, Fort McPherson, Georgia,



Outdoor Insectary of Mark F. Boyd

where a majority of the photographs were taken.

The development of suitable rearing methods for *Anopheles quadrimaculatus* has been based, to a large extent, upon trial and error. The comparative ease with which existing colonies of *Anopheles* are maintained gives no indication of the difficulties which were met and overcome during the early stages of establishing colonies. Boyd and his associates (1926, 1930, 1932, 1935, 1937) were pioneers in large-scale insectary rearing of *Anopheles* species in this country.

Methods described here are related pri-

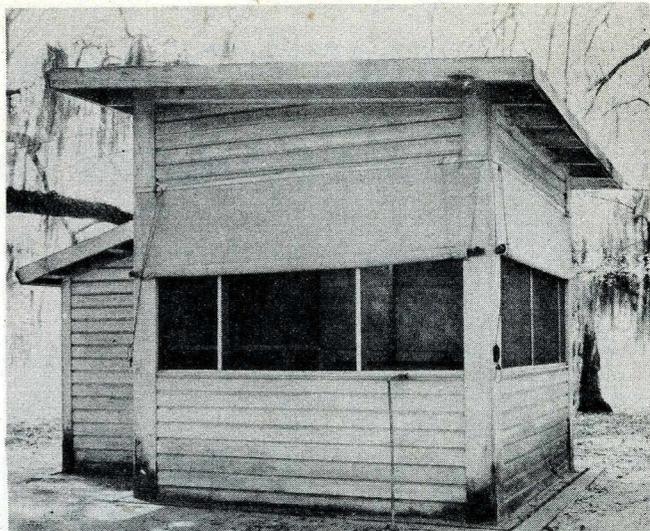
marily to *Anopheles quadrimaculatus* but have been employed successfully, sometimes with slight modification, to rearing other *Anopheles* which occur in the United States. The basic requirements for rearing any insect are:

1. Maintenance of physical environmental conditions which will permit normal longevity and development of all stages in the life cycle.
2. An adequate supply of nutritional material to insure proper development and reproduction.
3. Conditions which permit mating.

OUTDOOR TYPE INSECTARIES

As might be expected, it is very difficult to simulate natural conditions in any type of vivarium. In the case of *Anopheles* the microclimate of the habitat is extremely important. It is impossible to take into account all of the pertinent variable factors in establishing a colony. The important ones can only be known by trying various methods under different conditions. For instance, it was formerly thought that a great deal of space was necessary for mating of *Anopheles*. When Boyd (1930) presented the first report of successful cage rearing he employed a cage 8 feet square and 12 feet high. Cultivation had been unsuccessful in a cage 8 feet square and 7 feet high. After several generations had been reared in the large cage it was possible for the strain of *quadrifasciatus* which had been under propagation to be reared successfully in a small cage about one meter cube. Most, if not all, of the *quadrifasciatus* colonies in this country have been derived from the colony first established by Boyd. The insectary developed in this work is an interesting example of an outdoor type.

The places where this type is practical are limited because of climatic conditions. It cannot be used where extreme atmospheric conditions occur. A colony kept out of doors does not maintain a uniform rate of production throughout the year unless heat is provided during the cold months. In Boyd's insectary a constant temperature water bath is used to hold the larvae rearing pans. The water bath is large enough to contain six circular cream pans about 12 inches in diameter and 3 inches deep. Heating and cooling units maintain a temperature of 70°F. No special apparatus is provided for the maintenance of atmospheric temperature and humidity. The screened sides of the cage are provided with curtains which can be lowered to prevent excessive dehydration and strong breezes. The humidity inside is usually fairly high, but if necessary the floor may be flooded to provide additional evaporation surface. In the cold months supplemental heat is provided with electric heaters.



Outdoor Insectary for Summer Use

Between 3,000 and 5,000 adult mosquitoes are kept in the cage, the larger number being kept in the winter months when a greater adult population is necessary to furnish the desired number of ova. Adults are allowed the freedom of the entire cage and obtain blood from the insectary attendant. The proportion of sexes is about two males to each female. An aquarium containing aquatic plants is provided for oviposition. Eggs are collected from the aquarium by skimming the water surface with a cereal bowl and are then transferred to the rearing pans in the water bath. Larvae are reared in a wheat infusion culture to which fresh yeast is added daily.

Good results have been obtained with this type of insectary in north Florida. The same type has proved satisfactory for seasonal work during the summer months in more northern regions, when no attempt is made to carry the colony through the cold months. Outdoor insectaries which contain no heating or cooling facilities have been employed by the writer for oviposition preference studies and for other experimental procedures which were conducted during the summer months. This type of insectary probably more nearly simulates natural conditions and has the advantage of simplicity. It can be used when fluctuations in production are not important and when large numbers of reared adults are not necessary. But experimental work involving *Anopheles* usually requires many

specimens. This necessitates carefully controlled conditions which will maintain as many factors as possible within the optimum ranges for development.

LARGE SCALE REARING UNDER CONTROLLED CONDITIONS

The following account outlines procedures for large-scale rearing. Methods described have been obtained from the literature, from personal visits to a majority of insectaries in operation in this country, and from personal experience in insectary rearing. An attempt has been made to indicate all of the basic requirements for successful rearing and to avoid unessential, more elaborate or complicated procedures or equipment, which may be desirable under ideal circumstances.

SIZE AND PHYSICAL EQUIPMENT

The insectary is preferably housed in an inside insulated room. Facilities are necessary for automatic control of atmospheric temperature and humidity. Several types of commercial air-conditioning equipment are available for this purpose. It is desirable to have separate temperature control and humidifying apparatus so that temperature and humidity may be controlled independently of each other. Much more precise control is possible with this arrangement. Heaters should be electric. Thermostatically controlled steam radiators may be employed but the range of operation is much less critical than when

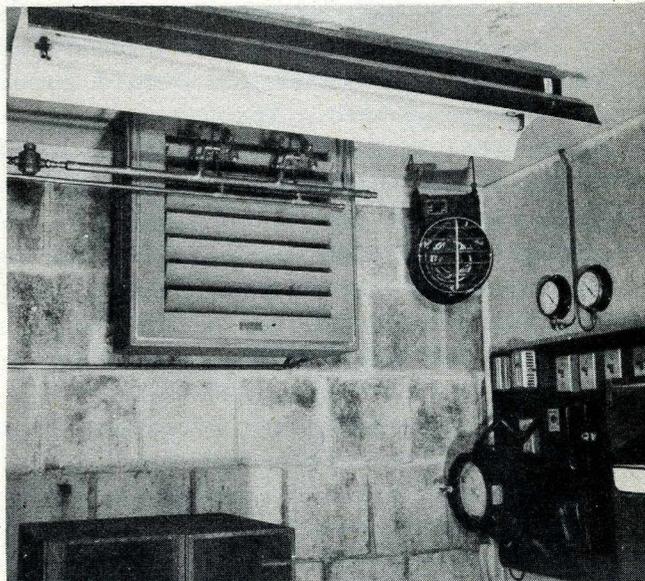
electric heaters are used. Humidifying and cooling apparatus may be of any type, provided it does not cause violent wind movements. Some workers believe that if adequate conditions of temperature are maintained, specific control of humidity is not important. They contend that the large surface of water ordinarily exposed in an insectary will provide enough evaporation surface to keep the humidity sufficiently high. Temperature should be kept between 70 and 75°F. and relative humidity should be about 80 per cent. A maximum and a minimum thermometer, or preferably a recording hygrothermograph, should be kept in the insectary so that a close check may be had of atmospheric conditions.

The size of the insectary will depend upon the number of adults needed for experimental uses. Adequate space must be furnished for the storage of rearing pans for larvae. About 400 eggs are placed in each pan. Allowing for 25 per cent mortality, 300 adults can be obtained from one pan. Thus three or four pans of pupae will be necessary each day to supply 1,000 adults. The maximum periods for development of the various stages which can be expected under satisfactory operating conditions are as follows:

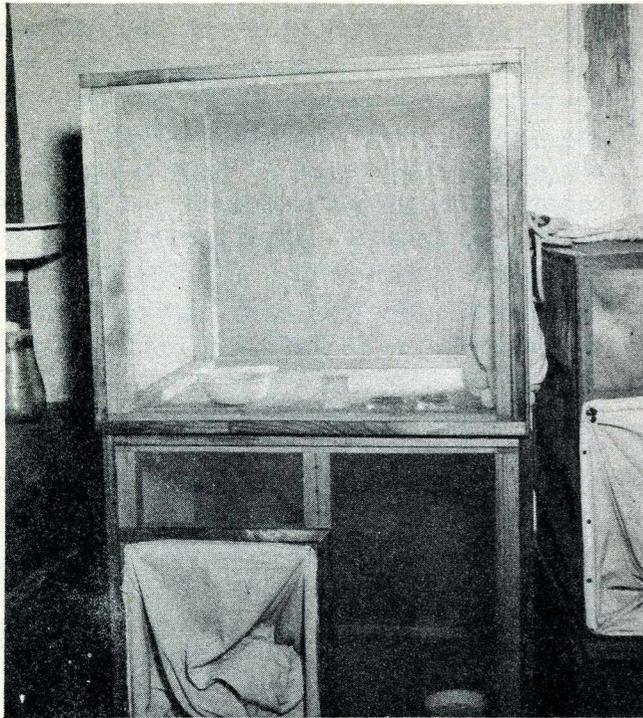
Egg stage 2 to 3 days. First instar 3 to 5 days. Second instar 4 to 6 days. Third instar 4 to 6 days. Fourth instar 5 to 7 days. Pupal stage 2 to 3 days.



Rearing Pans for Larvae



Temperature and Humidity Control Equipment



Stock Colony Cage

Thus an average of 25 days is the longest period of development to be anticipated. To furnish 1,000 adults each day it is then necessary to have a maximum of 75 to 90 pans containing larvae in the various stages of development. The period of 25 days is rather long for complete development and it is likely that this can be reduced in the operation of most insectaries.

Shelving or racks are most satisfactory for holding the rearing pans. The pans should be about 14 to 18 inches long, 10 inches wide and 1½ to 2 inches deep. Rectangular pans have proved most satisfactory but in some instances round pans about 12 inches in diameter and .3 to 4 inches deep are preferred. The pans are placed on the shelves and are not moved unnecessarily during the period of larval development. Pans may be placed very close together on the shelves but the shelves should be at least 10 inches apart to allow adequate room for inspection and feeding. In addition to the shelves and rearing pans the insectary should be provided with a large sink and a work table. It must also contain table space for holding the stock colony and storage cages. In some insectaries it has proved desirable to isolate the stock cages in a separate screened portion of the room. This is

very desirable to reduce the possibility of mixing species when more than one species of mosquito is reared in the same insectary.

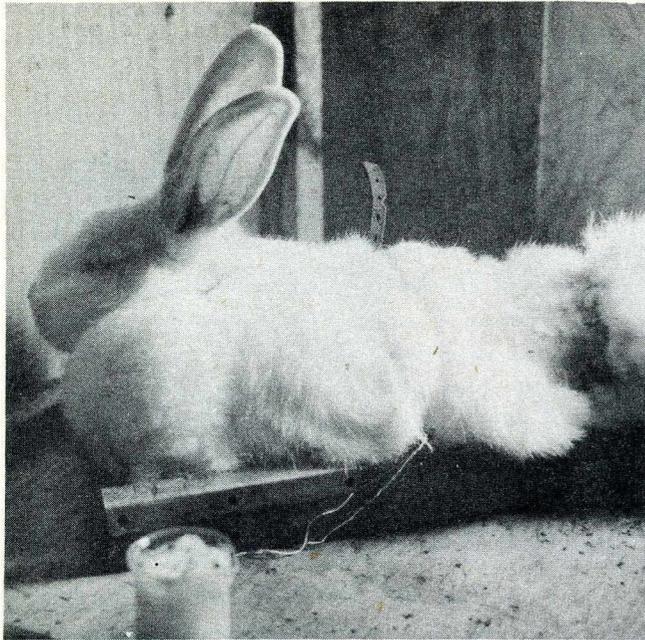
The stock cages may be of any convenient size. It is desirable that at least five cubic inches of space be provided for each adult mosquito. Thus a cage 2 feet cube would be capable of accommodating about 2700 mosquitoes. A colony of this size should furnish between 1,500 and 2,000 eggs per day. Usually the proportion of sexes is about equal but some workers believe that it is desirable to maintain a preponderance of males in the stock cages. This, of course, involves additional manipulation. The type of cage is not particularly important. The usual type of screened insect cage having a screened side and front with plywood covering the other surfaces is usually satisfactory. One quadrant of the front is equipped with a cloth sleeve type opening to permit access to the cage.

OBTAINING ORIGINAL STOCK

Eggs for starting the colony are most conveniently obtained from one already established. This is much simpler than obtaining eggs from wild-caught specimens, and the initial phases of rearing are more likely to succeed. Many strains of *Anopheles* species are very difficult to domesticate. *A. quadrimaculatus* may usually be obtained from existing colonies without difficulty, but other *Anopheles* species must usually be obtained from wild-caught specimens.

The eggs obtained for starting the colony are put in rearing pans and treated in the manner described subsequently. Adults which emerge are transferred to the stock colony cage. It is desirable that at least 1,000 adult specimens be placed in the stock colony cage for starting the colony.

If the original eggs are to be obtained from wild-caught specimens the following procedure should be followed: Females from collections are placed in lantern globe type cages and held over an oviposition bowl of the type described later. Not more than 25 adults should be put in one

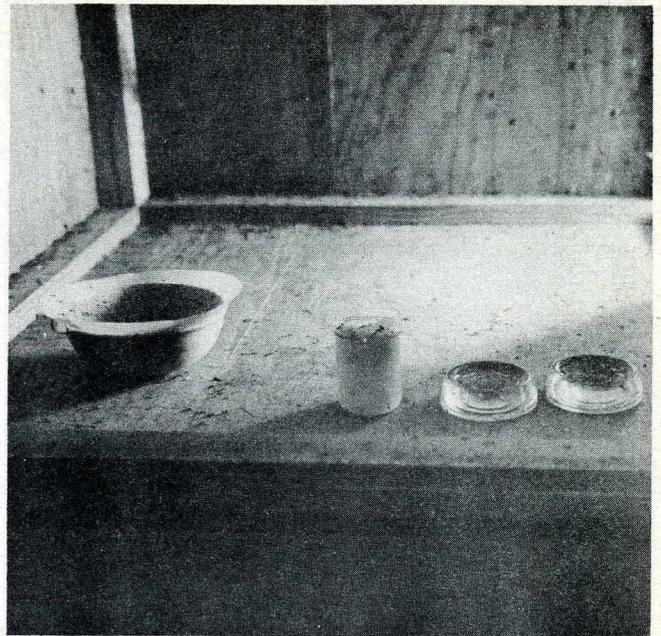


Mosquitoes Feeding on Rabbit

cage. The globe cage should be placed directly over the oviposition bowl. A large cage should not be used as it is sometimes difficult to obtain eggs from wild-caught specimens held in a large cage when the eggs must be oviposited in a small container. It is advisable to give the captured mosquitoes an opportunity to feed on a laboratory animal before being placed over the oviposition bowl. A majority of the eggs obtainable will be oviposited within 3 or 4 days.

CARE OF ADULTS IN STOCK COLONY

Females in the colony obtain blood from a laboratory animal, usually a rabbit. The back of the animal is clipped to permit mosquitoes easy access to the skin. The animal is strapped to a retaining board and placed inside the cage for a period of one to two hours every day. Zoophilism is obtained without undue difficulty in most cases. It is advisable that human feeding not be given to the stock colony as the insects are sometimes reluctant after this to take animal blood. Honey or 10 per cent glucose solution provides food for males and supplemental food for females. This may be placed on cotton pads or is preferably furnished in watch glasses which are covered with pieces of screen to prevent mosquitoes from becoming entangled in the solution. It is also advisable that a large piece of cotton satu-



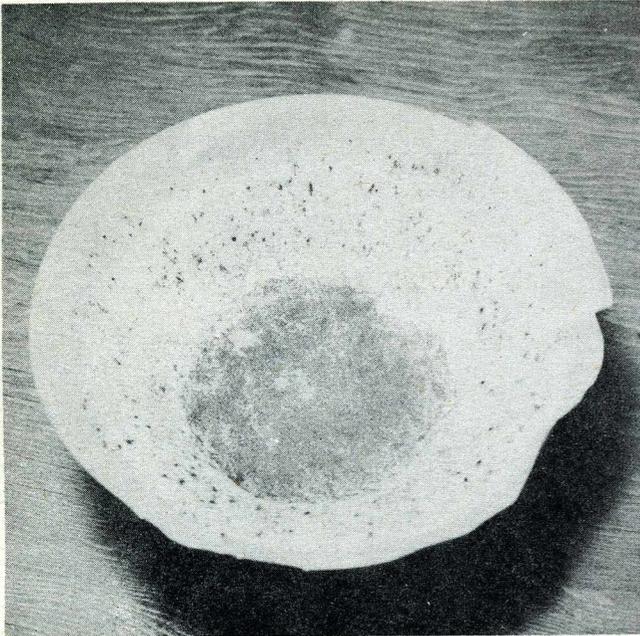
Egg Bowl with Filter Paper Cone - Left

rated with water be kept inside the cage to provide additional moisture for the insects. About enough cotton to fill a 100 ml. beaker is sufficient. The beaker with the moist cotton is placed on the floor of the cage. The water and feeding solution should be renewed daily to prevent the formation of mold.

Dead insects should be removed from the cage each day and enough pupae placed in the cage to replace the number which died. It is well to keep the stock cage out of bright light.

OBTAINING AND MANIPULATING EGGS

Eggs are obtained by folding a piece of filter paper about six to eight inches in diameter in the shape of a cone and placing this inside a bowl or evaporating dish about four inches in diameter. The container is filled with water and placed inside the stock cage. The following morning the container and filter paper are removed from the cage. Any adult mosquitoes trapped in the egg masses are removed, taking care to remove as few ova with them as possible. It is essential that these dead insects be removed as a mass of fungus may develop around them. A hole is punched through the apex of the cone of filter paper which is then lifted slowly from the container. The water runs out through the cone and the eggs are left sticking to the filter paper. After the

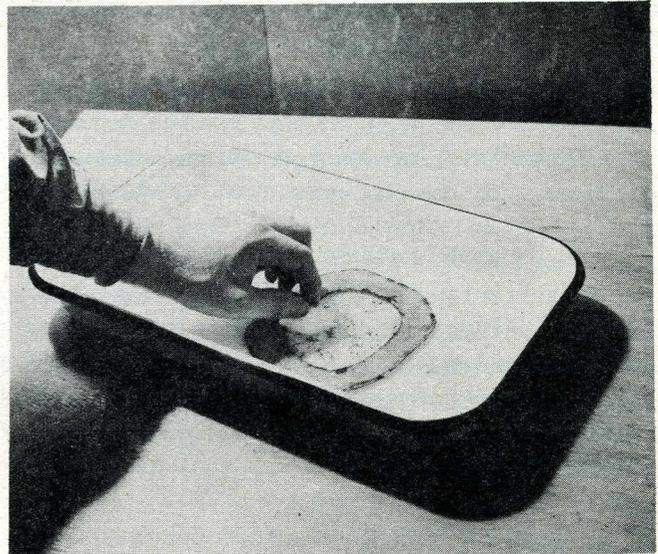


Eggs in Filter Paper Cone

filter paper is unfolded, segments containing the desired numbers of eggs can be cut off with scissors. If it is desired to store the entire collection of eggs the whole piece of filter paper may be placed in a large covered petri dish and held in the refrigerator at about 40°F. If the filter paper remains moist the eggs will be viable for several weeks. Eggs may be shipped by placing a segment of the filter paper containing the desired number of eggs in a tightly stoppered glass bottle the inside of which has been thoroughly moistened by filling the bottle with water

and emptying. The glass container should be shipped inside of a metal container with packing.

Eggs are transferred to the rearing pans by floating them off the segments of filter paper into water in the rearing pans. The eggs transferred to the rearing pans are placed inside a cork or waxed paper ring which is floated on the water. This ring retains the eggs and prevents their being stranded on the sides of the pan. About 400 eggs are placed in each pan. In handling the eggs, care should be taken to prevent drying. If the filter paper shows any signs of drying which is especially noticeable around the edges, a few drops of water should be added with a pipette. If it is necessary to manipulate the eggs

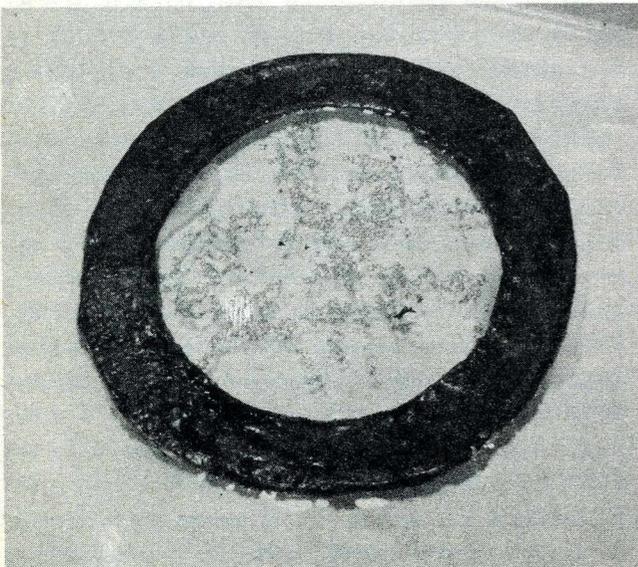


Removing Egg Shells

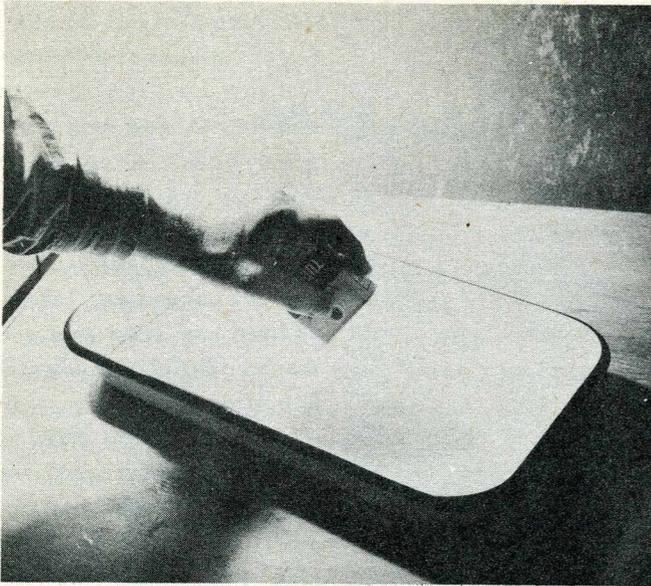
a camel's hair artist's brush should be used. Although tap water in many localities is suitable for use in insectaries, it is much better practice to use distilled water exclusively.

CARE OF LARVAE

After the eggs have hatched, usually in two or three days, the empty shells are removed by dabbing with small pieces of cotton. After the eggs are removed the ring which contains them is taken out of the pan. It is necessary that the water in the pan be fairly shallow, usually not more than ¼ inch deep. This is particularly important with third and fourth instars. Finely ground dog biscuits have proved to be the most satisfactory



Eggs Floating within Waxed Paper Ring

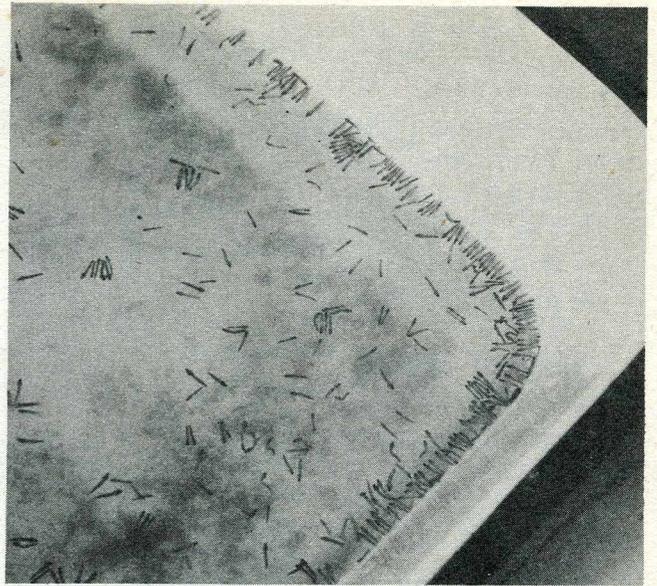


Applying Food for Larvae

larval food for all instars. In some laboratories pulverized brewer's yeast is used for the first and second instars. Some workers prefer a mixture of finely ground baby food and dog biscuit for all stages. The use of brewer's yeast for the young instars and dog biscuits alone for the latter stages probably gives more uniform results than other types of food. This is applied sparingly to the pans by shaking from an ordinary pepper shaker. It is better to feed several times a day than to add an excess of food at any one time. A good indication of the amount of food to be added is the rate at which it spreads over the surface. If the first few particles sprinkled do not spread over the surface at once, it is desirable to postpone feeding until later.

There is usually little trouble with scum forming on the pan's surface. However, if this does occur, the pans should be filled with water and then siphoned off to the proper level. After the pans have been in use for several days some sediment accumulates on the bottom of the pans and the water appears a dirty yellow color. This does not interfere with the larval development and requires no special attention.

Care should be taken to keep enough water in the pans but not to add so much that the larvae cannot feed on the bottom. If an excess of food is avoided it is unnecessary to wash down the sides of the pan or handle the larvae in any way.

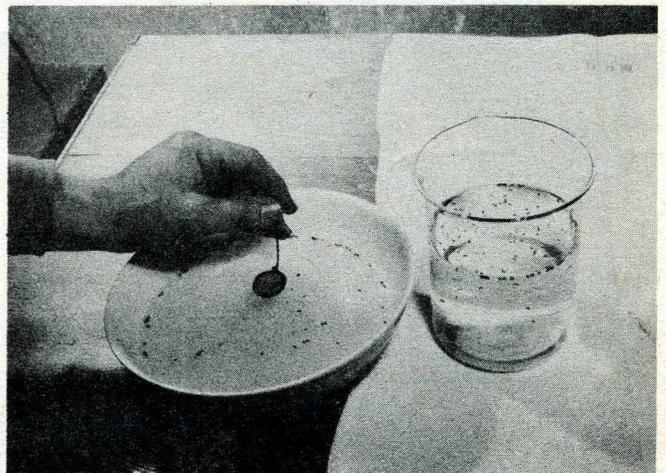


Fourth Stage Larvae Feeding

CARE OF PUPAE

After the larvae have pupated in the rearing pans they are transferred to a large bowl of clean water. The pupae are not transferred directly to emergence containers since a large amount of food culture in the rearing pans would carry over and a pellicle would form in the container of non-feeding pupae. By transferring them first to a bowl of clean water the amount of material carried over from the rearing pans is diluted. Pupae are transferred from the rearing pans with a wide mouth pipette and are transferred from this container to the emergence container by the use of a small screened dipper.

The pupae should be placed either in 500 ml. beakers or biological specimen dishes about 125 mm. in diameter. The container of pupae is covered with a lan-

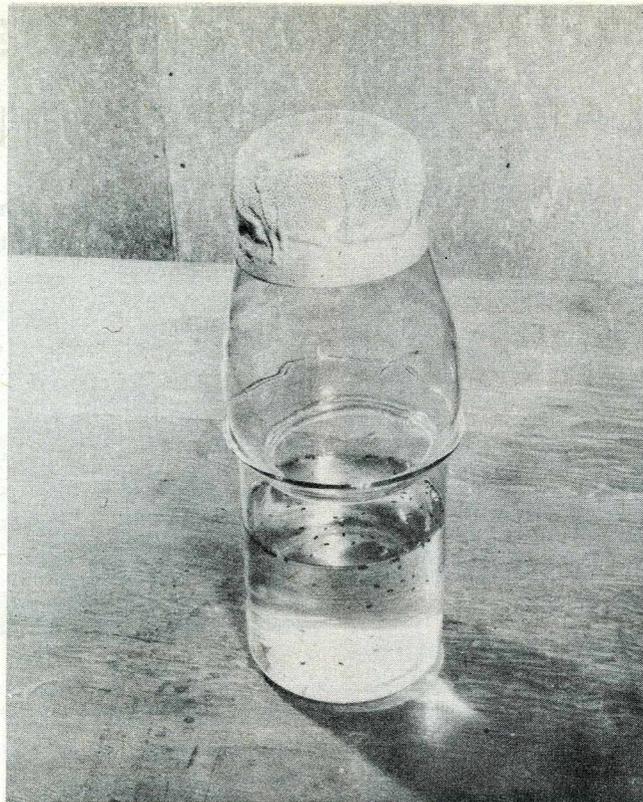


Transferring Pupae to Emergence Container

tern and globe type cage until emergence has occurred. The globe type cages are used even when the pupae are placed inside the stock cage to prevent oviposition in the pupae container.

STORAGE OF ADULTS

Adult specimens are most conveniently stored in a cage of the same type as the stock cage and the care of individuals is the same if they are held for appreciable lengths of time. Of course, the blood feeding is omitted and no provision is made for collecting eggs. The specimens are usually removed from the stock cage with an ordinary aspirator type collecting tube. The storage of specimens will, of course, be determined by the use which is to be made of them. The globe type cage is satisfactory



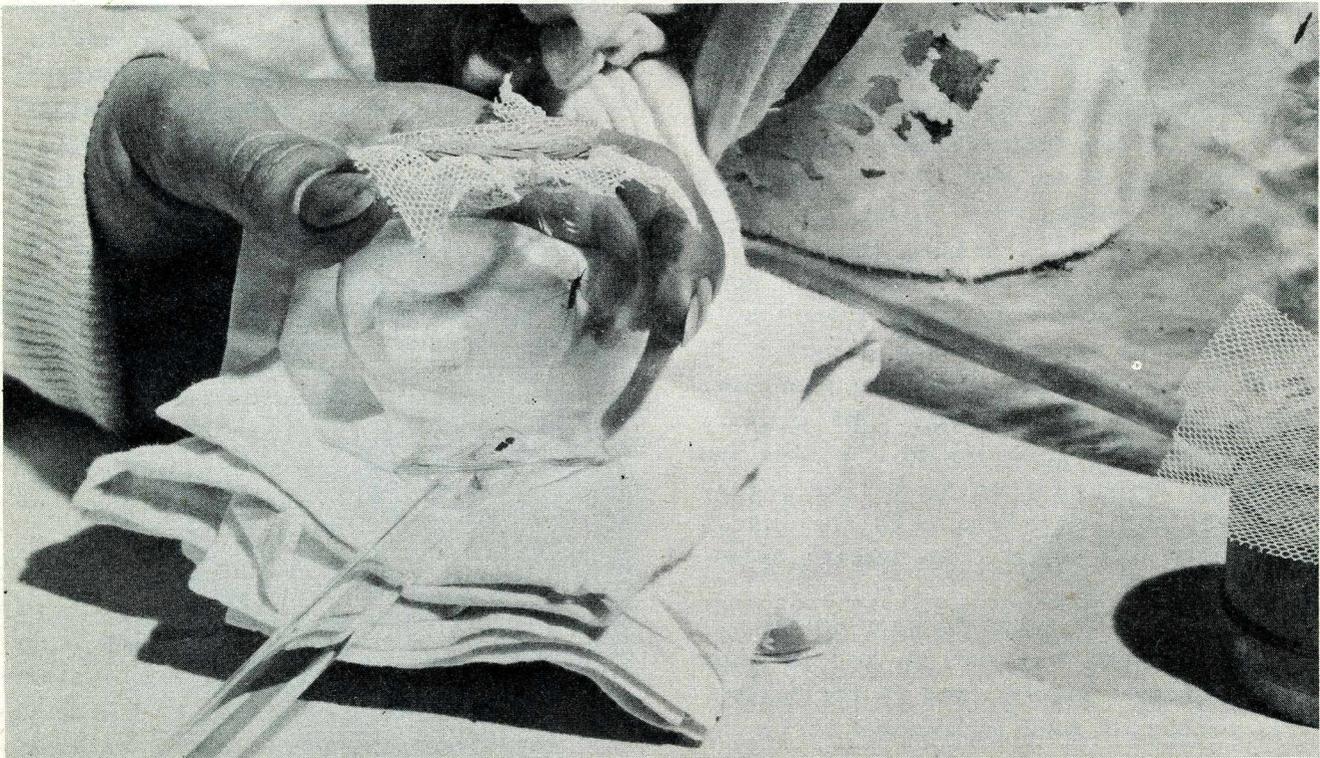
Globe Type Emergence Cage

for holding 100 or fewer specimens. For infection studies usually a few mosquitoes are placed in a smaller type cage.

CONCLUSIONS

The apparent simplicity of the procedures outlined above is deceptive. In maintaining an *Anopheles* colony a routine is developed which requires constant daily attention. Neglect of seemingly minor details will result in retarding development of the insects or complete destruction of the colony. The importance of daily atten-

tion cannot be stressed too much. Many of the failures in insectary rearing are directly attributable to inconsistent attention rather than inadequacy of methods or equipment.



Small Container for Use in Malaria Transmission Studies

THE IMPORTANCE OF ADEQUATE MALARIA CASE REPORTING

It is an axiom of public health administration that effective control of a communicable disease must be predicated on the knowledge of when, where, among whom, and under what conditions the disease is being transmitted. It is clearly evident that without such epidemiological information, control procedures are apt to become "shot-gun" in principle, rule of thumb in application, expensive in execution and of questionable efficiency.

In general, much of the information concerning cases and deaths of malaria originates with the practicing physician through the reports he makes which are usually required by law. It is suspected, though by no means always demonstrated as a fact, that in many traditionally malarious areas numerous illnesses and deaths which are not actually due to malaria are reported as such. It is also recognized that many cases and deaths of malaria remain unreported to health agencies. For example, there are instances where it can be shown that a greater number of deaths than cases was reported from the same area during the same period of time.

However, in spite of the obvious deficiencies of malaria reporting, there has been accumulated enough information during the present century to establish certain areas of the Southeastern United States as malarious. On the basis of these data, large amounts of money and effort have been expended on control of the disease. Using the same type of information, it can be shown that the disease is steadily becoming less prevalent throughout the southeast.

As a result, malaria has reached a critical stage in its life history in this country. In a sense, it may be said to have reached, or at least is approaching, a crossroad. We may hope that it will continue to recede in prevalence. On the other hand, as a result of the impetus given by the presence of a great number of carriers among returning servicemen, the disease may again assume a place of pri-

mary public health importance. During the next few years, therefore, more precise and accurate epidemiological information concerning when, where, among whom, and under what conditions malaria is occurring becomes of considerable practical importance.

If the disease continues to decline with the impetus of current control measures, there is every *theoretical* reason for believing that it is susceptible of eradication in the sense of becoming no longer of public health importance. This theoretical goal, however, as a practical achievement is predicated on an ability to delineate accurately the specific foci in which transmission is taking place. The MCWA program has demonstrated that vector control, but not vector eradication, is attainable in most of the situations encountered. It is not feasible to extend vector control to all areas of the Southeast because of its cost. It has been estimated that such extensive control would require initially an outlay of \$200,000,000 and that such a program would achieve only reduction in anopheline populations and not eradication of the principal American vector. For this reason, control efforts must continue to be emphasized in those areas where malaria is most frequently transmitted.

Whether malaria continues to decline or reverses its present trend and tends to become again an important public health problem detracts little from the need for more accurate information concerning the exact areas of its transmission. Information is required to base control efforts directed at wiping out the remaining malarious foci, and this information is vital to the prompt recognition of areas where malaria is beginning to assume public health importance so that control efforts may be started. Early institution of control measures is always less expensive than similar efforts made after the disease is well established.

In either case, one of the most important sources of epidemiological information remains the reporting of cases and deaths by physicians. The factors which govern the adequacy and accuracy of communicable disease reporting are too numerous and diverse for consideration here. Physicians generally consider it an unpleasant, legally imposed chore to contribute to a mass of dry statistics. Often however, reporting of communicable diseases is considerably better where there is a service offered by the health department as a result of such reporting. For example, physicians might be more interested in reporting future malaria if they know that residual spraying of the patient's home would subsequently be carried out by the health department.

MCWA personnel are in a position to assist in the improvement of the collection of epidemiological information about malaria. Their contacts with professional and lay people afford many opportunities for service in this respect. It must always be remembered, however, that reporting of disease is a duty of the physician and that this responsibility is to the duly constituted local authorities. Any lay person who intrudes in this relationship is out of line ethically and may be contributing to a disruption of relationships which have been built up slowly over a long period of time. However, MCWA personnel are not stepping out of line if they offer their services to the local or state health department and determine how they may be useful in helping to better the reporting of malaria cases and deaths in the area in which they are working.

The Medical Division of MCWA is particularly anxious to have its attention called to any situation where facts support the belief that a carrier among demobilized servicemen has been responsible for an outbreak of malaria. MCWA field personnel may be of considerable aid to the Headquarters Office if, upon learning of such instances, they inform proper local or state health agencies for referral to Atlanta -- Medical Division, MCWA.

LITERATURE REVIEW

Manual of Tropical Medicine by Colonel Thomas T. Mackie, M.C.; A.U.S.; Major George W. Hunter, III, Sn.C.; A.U.S., Captain C. Brooke Worth, M.C. A.U.S., 1945

This book contains 727 pages and 287 illustrations (6 in color) and is published by W. B. Saunders Company, Philadelphia & London, price \$6.00.

The introduction to this manual states:

"This volume is one of a series developed under the auspices of the Division of Medical Sciences of the National Research Council to furnish the Medical Departments of the United States Army and Navy with compact presentations of necessary information in the field of military medicine."

The manual's general usefulness and wide scope is indicated in the Author's Preface where it is stated that the book was compiled for use not only for medical officers in the armed forces but for physicians in practice in the tropics, students entering the field of tropical medicine, practitioners in the temperate zones treating returned personnel, public health workers, epidemiologists and parasitologists in the field as well as in laboratories and schools.

In spite of the comprehensive subject matter covering a wide variety of the communicable diseases of the tropics, the authors have succeeded in their avowed purpose of presenting a "concise statement of the most recent available and authoritative information concerning the more important tropical diseases." They have not attempted to supplement them. As a result the material presented is concise, convenient and compact. There are many excellent charts, tables, and summaries as well as numerous photographs illustrating pathology "which are used wherever possible in order to present the textual material in succinct form." Little doubt is left in the reader's mind as to the value of this work as an addition to his library.

--- Surg. Vernon B. Link

DIVISION NOTES

COOPERATIVE LARVICIDE STUDIES WITH TVA

Two Stearman PT-17 biplanes are being equipped for use on experimental larvicidal studies. These airplanes are single engine, medium power (220 h.p.) planes and were formerly used by the Army as primary trainers.

An exhaust generator has been installed in one plane for the distribution of DDT, as a thermal aerosol. This equipment consists of a 4½ inch exhaust pipe, with a venturi discharge, mounted along one side of the plane. Two jets are fitted for discharging the DDT solution into the generator under high pressure. The DDT solution is carried in a tank located in the forward cockpit. The pressure is generated by a pump driven by a small propeller. Control of the aerosol droplet size is obtained by a pressure regulator and by varying the r.p.m. of the airplane engine.

The other plane is being equipped for application of paris green and DDT as dusts and will also carry equipment for application of thermal aerosols. A removable hopper of welded aluminum construction is being designed to fit into the forward cockpit. This hopper will have about 10½ cu. ft. capacity. It will be possible to remove the hopper quickly and replace it with a tank for carrying DDT in solution. This airplane will be used as a stand-by to meet exigencies which may arise on the regular MCWA larviciding program and it will also be used for larvicidal experiments on rice fields.

GRAND CAYMAN MOSQUITO SURVEY

At the request of the Coast Guard, a survey was made by P. A. San. (R) Roy Fritz of mosquito breeding conditions on Grand Cayman Island, B.W.I. It was found that the main cause of annoyance was the salt-marsh pest mosquito, *Aedes taeniorhynchus* Wied. Breeding areas were so extensive in relation to the area to be protected that general control measures were not practical. Consequently it was recommended that personnel be protected by the use of adequate screening, DDT residual sprays, and by employing repellents when needed.

CARTER LABORATORY NOTES

The Anopheline Larvicide Project reports tests of DDT in various larvicidal forms. Samples of technical DDT from eleven different sources were compared to each other and to two samples of recrystallized DDT, DDT paste, and two commercial by-products of DDT. In an effort to obtain uniform and complete oil film, twenty-two proprietary materials were tested for relative spreading pressures.

A project has been set up to determine the effects of the routine use of DDT as a mosquito larvicide on fish and associated aquatic organisms. Four types of work are being conducted: (1) A study of the effects on fish; (2) A determination of changes in the surface organisms; (3) Investigations of the influence exerted on plankton organisms; and (4) Studies of the effects on bottom dwelling organisms.

Tests of residual sprays included releases of insectary-reared "quads" in an unoccupied room sprayed *one year previously at 200 mg. DDT/sq. ft.* The room showed a 50 per cent knockdown of the less susceptible mosquitoes in two hours and 99 per cent mortality in five hours.

The Equipment Project reported completion of a new model power mixer for preparation of DDT-xylene-triton concentrate.

The Chemistry Project tested a number of industrial solvents for percent solubility of DDT. Tests on the explosiveness of xylene and of xylene-water emulsions indicated that under conditions tested 2.5 ml. of liquid xylene will give an explosive mixture when completely vaporized in one cu. ft. of air.

Additional tests are under way using mine safety appliances for measuring concentrations of solvent vapors in terms of percent of explosive limits under normal spraying conditions.

Tests of the specificity of antisera used in determining blood meals of mosquitoes showed pigeon, sparrow and duck blood as positive when checked with chicken antiserum; sheep blood was positive with bovine antiserum; and mule blood was positive with equine antiserum.

HEADQUARTERS NOTES

DDT-MALARIA FIELD STUDY

During April the first thick films for the year were taken in an experimental area where a test is to be made of the effectiveness of DDT residual spray in reducing malaria incidence. This field study is being conducted in cooperation with the South Carolina State health department. The area selected has shown a high parasitemia rate on previous surveys. It has been divided into two parts - one-half sprayed with DDT and the other half left unsprayed as a check. The changes in parasitemia rates will be closely followed by thick film surveys every two months throughout the experimental area. Further field studies in the use of the complement-fixation test for malaria will also be undertaken.

Entomological studies in the experimental area include precipitin tests to determine the percentage of *quadrifasciatus* having human blood meals and mosquito dissections to determine the infection rate among mosquitoes in the sprayed and unsprayed areas.

MALARIA CONTROL IN IMPOUNDED WATERS

Arrangements have been completed by the Division of Sanitary Engineering of the Public Health Service for providing the Corps of Engineers of the War Department with consultation on the potential malaria problem at proposed water impoundments and flood control reservoirs. Requests for assistance will be directed to the Stream Sanitation Office in Cincinnati, Ohio which in turn will request technical assistance on malaria control from MCWA. The work will be carried on in collaboration with the States. The agreement provides reimbursement by the Corps of Engineers to cover costs of the malaria studies.

FOLLOW-UP OF MALARIA CASES WITH DDT RESIDUAL SPRAY

As a partial solution to the problem of malaria control outside of the Extended Program areas, a system of spot spraying of premises where malaria cases occur was

proposed several months ago by Sr. Ent. (R) G. H. Bradley at a meeting of representatives of Extended Program States. The Medical Division favors this proposal. Follow-up of reported malaria cases might well become routine procedure and would do much to reduce the chances of transmission of the disease. At least two States are proceeding with this "spot spraying" plan.

PERSONNEL

Officers newly commissioned during April include Asst. Eng. (R) Marvin B. Scherr, assigned to Nashville, Tenn.; Asst. San. (R) Howard B. Hollander, assigned to PHS District 7; Asst. San. (R) Will S. DeLoach assigned to Savannah, Georgia; Asst. San. (R) Everett L. Bishop, Jr., assigned to Savannah, Georgia; and Asst. Eng. (R) Verdor L. Dix and Jr. Asst. Eng. (R) Vincent S. Roggeveen and Wallace E. Frank, as yet unassigned.

Transfers include P. A. San. (R) Leslie D. Beadle from Parsons, Kansas to Denison, Texas; Asst. San. (R) Charles E. Kohler from Moncks Corner, S. C. to Dyersburg, Tenn.; Asst. San. (R) Wilbur H. Duncan from Atlanta, Georgia to Paducah, Kentucky; Asst. San. (R) Willis V. Mathis from Greenville, Miss. to Savannah, Georgia; Asst. San. Eng. (R) Russell G. Ludwig from Atlanta, Georgia to Savannah, Georgia; Asst. Eng. (R) Sam G. Segal from Dyersburg, Tenn. to Herrin, Ill., and Asst. Eng. (R) E. F. Coffin from Nashville, Tenn. to Jacksonville, Florida.

CONSOLIDATION OF THE AEGYPTI PROGRAM

On April 9 the *Aedes aegypti* Division was consolidated with the Engineering Division. San. Eng. (R) Francis Jacocks becomes head of the new Aegypti Section to replace Sr. San. Eng. (R) Carl Schwob, who is now on a special assignment with the States Relations Division in Washington in connection with the stream pollution program. Hereafter, anti-*aegypti* operations will be under the supervision of the Engineering Division, reports will be kept by the Records and Statistics Unit, entomological investigations will be conducted by the Entomology Division, and educational and training materials will be produced by the Training and Education Division.

Table II

MCWA Expenditures And Liquidations By Major Items

March 1945

	Continental U. S.	Percentage of Total	Puerto Rico	Percentage of Total
.01 Personal Services	\$ 436,995.79	74.08	17,939.19	93.10
.02 Travel	23,630.22	4.00	100.75	.52
.03 Transportation of Things	5,670.82	.96	-----	-----
.04 Communication Services	477.68	.08	4.55	.03
.05 Rents and Utilities	2,297.13	.39	-----	-----
.06 Printing and Binding	3,362.63*	.56*	-----	-----
.07 Other Contractual Services	2,914.48	.49	34.00	.18
.08 Supplies and Materials	84,513.51	14.32	1,149.85	5.96
.09 Equipment	36,790.61	6.24	38.13	.21
Total	\$ 589,927.71	100.00	19,266.47	100.00
*Represents a credit				
Expenses other than Personal Services	152,931.92	25.92	1,327.28	6.90

Table III

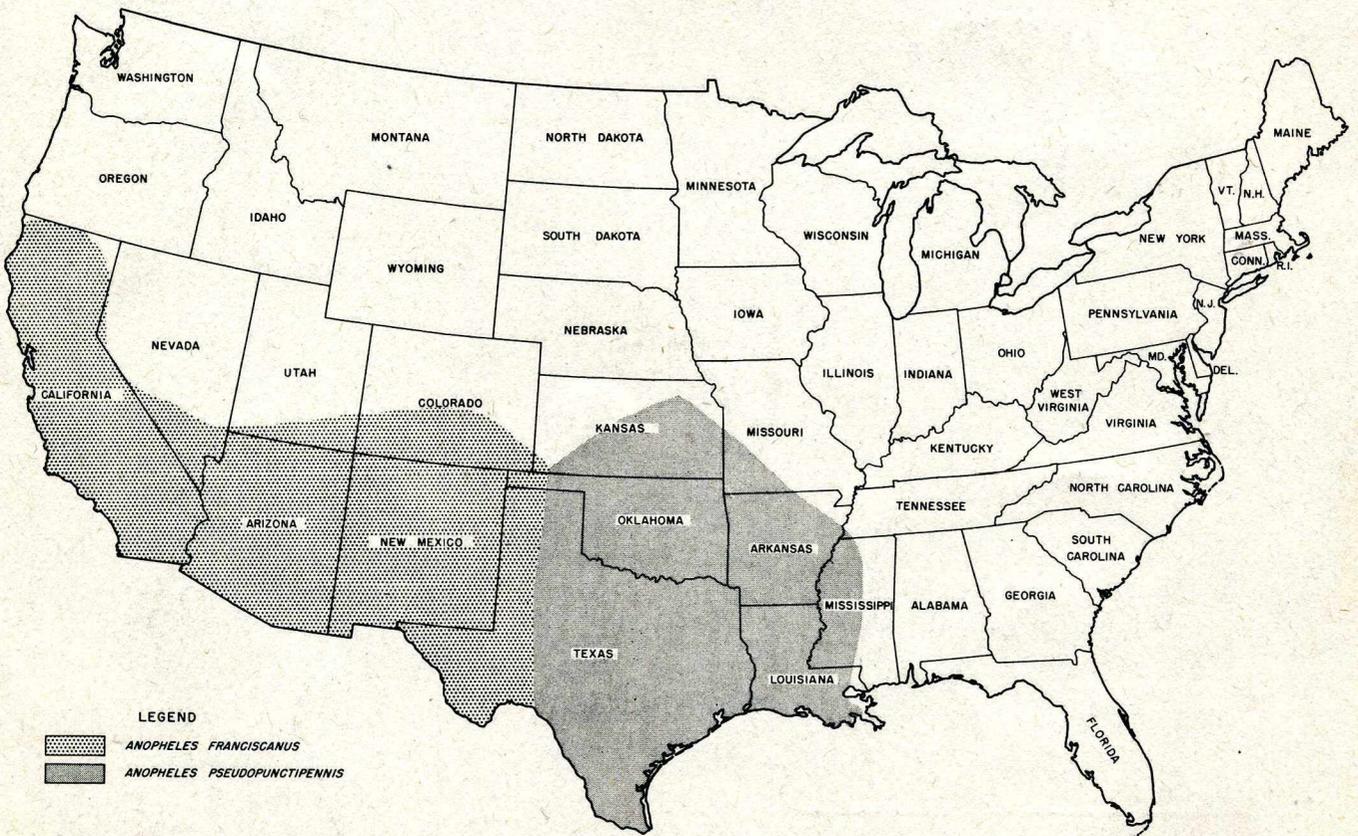
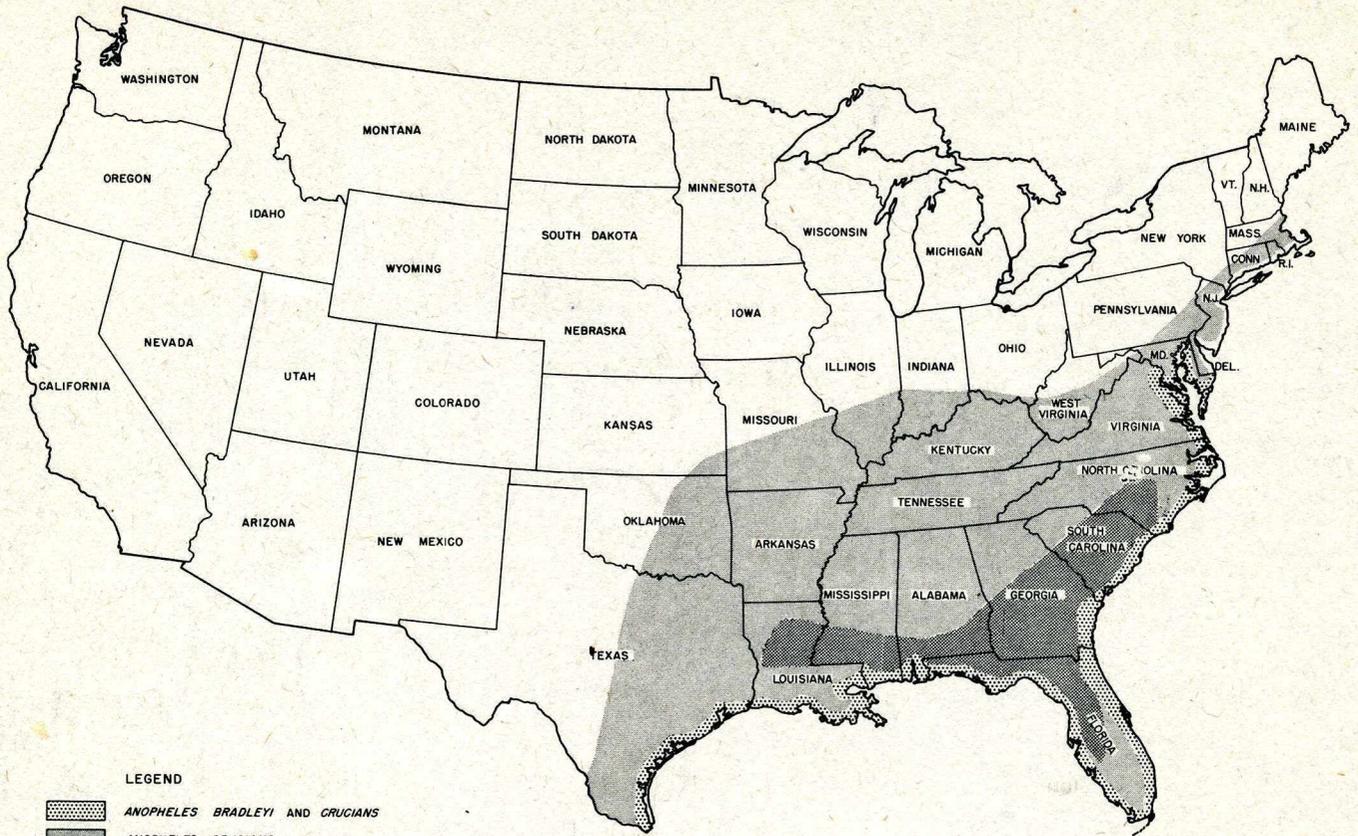
MCWA Personnel On Duty And Total Payroll

March 1945

State	Commissioned		Prof. & Sci.		Sub-Prof. (1)		C. A. F.		Custodial and Per Hour		Total		Percent of Total	
	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay
Alabama	4	1,140	2	527	23	1,969	2	324	53	4,353	84	8,313	2.59	1.83
Arkansas	9	2,608	5	1,421	39	6,979	7	1,145	305	33,530	365	45,683	11.22	10.04
California	4	1,103	---	---	4	851	3	623	16	3,134	27	5,711	.83	1.26
Dist. of Columbia	1	333	---	---	---	---	1	233	---	---	2	566	.06	.12
Florida	9	2,672	6	1,874	43	7,483	7	1,271	148	18,843	213	32,143	6.56	7.07
Georgia	9	2,728	3	790	48	7,610	6	1,006	74	9,559	140	21,693	4.31	4.77
Illinois	4	1,163	1	202	---	---	1	164	---	---	6	1,529	.19	.34
Kentucky	4	1,046	2	547	7	1,152	3	440	19	684	35	3,869	1.07	.86
Louisiana	11	3,158	4	1,245	47	9,176	6	1,060	262	31,670	330	46,309	10.15	10.18
Maryland	1	248	---	---	2	385	2	438	11	1,468	16	2,539	.50	.56
Mississippi	8	2,308	6	1,409	29	4,125	4	638	96	11,666	143	20,146	4.39	4.43
Missouri	1	333	---	---	12	2,202	1	82	54	5,427	68	8,044	2.09	1.77
North Carolina	6	1,818	5	1,534	8	1,445	4	732	137	17,248	160	22,777	4.92	5.00
Oklahoma	4	1,215	2	476	13	2,644	1	164	51	5,323	71	9,822	2.18	2.16
Oregon	---	---	---	---	1	203	---	---	---	---	1	203	.04	.05
South Carolina	5	1,691	6	1,820	36	7,374	8	1,081	336	42,189	391	54,155	12.03	11.90
Tennessee	4	1,188	2	638	11	2,072	3	584	87	9,469	107	13,951	3.29	3.07
Texas	8	2,288	4	1,316	50	7,767	9	1,381	210	25,342	281	38,094	8.64	8.37
Virginia	2	618	2	696	10	2,023	3	602	99	13,489	116	17,428	3.57	3.83
AEDES AEGYPTI														
Alabama	1	285	---	---	8	1,626	1	146	---	---	10	2,057	.30	.45
Florida	1	160	---	---	20	4,023	1	219	---	---	22	4,402	.67	.97
Georgia	---	---	---	---	5	1,079	---	---	---	---	5	1,079	.15	.24
Louisiana	1	285	1	274	7	1,551	1	164	---	---	10	2,274	.30	.49
South Carolina	1	285	---	---	7	1,298	1	164	---	---	9	1,747	.27	.39
Texas	4	1,140	1	153	30	5,334	2	311	4	603	41	7,541	1.27	1.64
Hq. & Dist. (2)	71	24,252	10	2,509	32	5,469	136	23,204	41	5,084	290	60,518	8.92	13.31
Mobile Units	7	2,244	3	669	1	182	3	604	4	705	18	4,404	.56	.96
Puerto Rico	7	2,123	1	307	4	840	5	1,096	273	13,572	290	17,938	8.93	3.94
Total	187	58,432	66	18,407	497	86,862	221	37,876	2,280	253,358	3,251	454,935	100.00	100.00
Percent of Total	5.75	12.84	2.03	4.05	15.29	19.09	6.80	8.33	70.13	55.69	100.00	100.00		

(1) Includes Entomological Inspectors

(2) Includes Headquarters and District Offices, malaria survey, Imported Malaria Control, special investigations, and employees temporarily attached to Headquarters pending assignment to states



ANOPHELINE DISTRIBUTION MAPS