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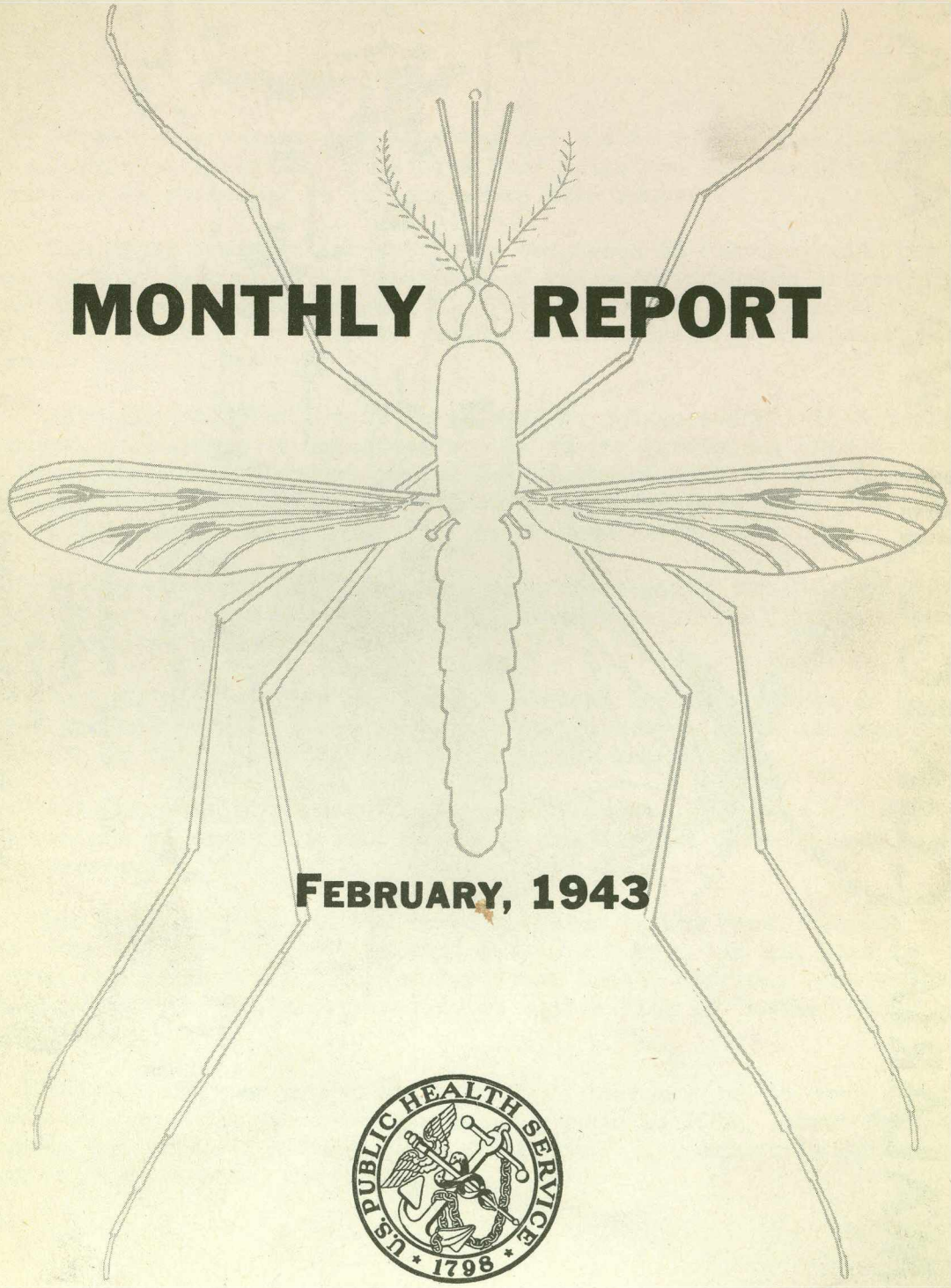
MALARIA CONTROL IN WAR AREAS



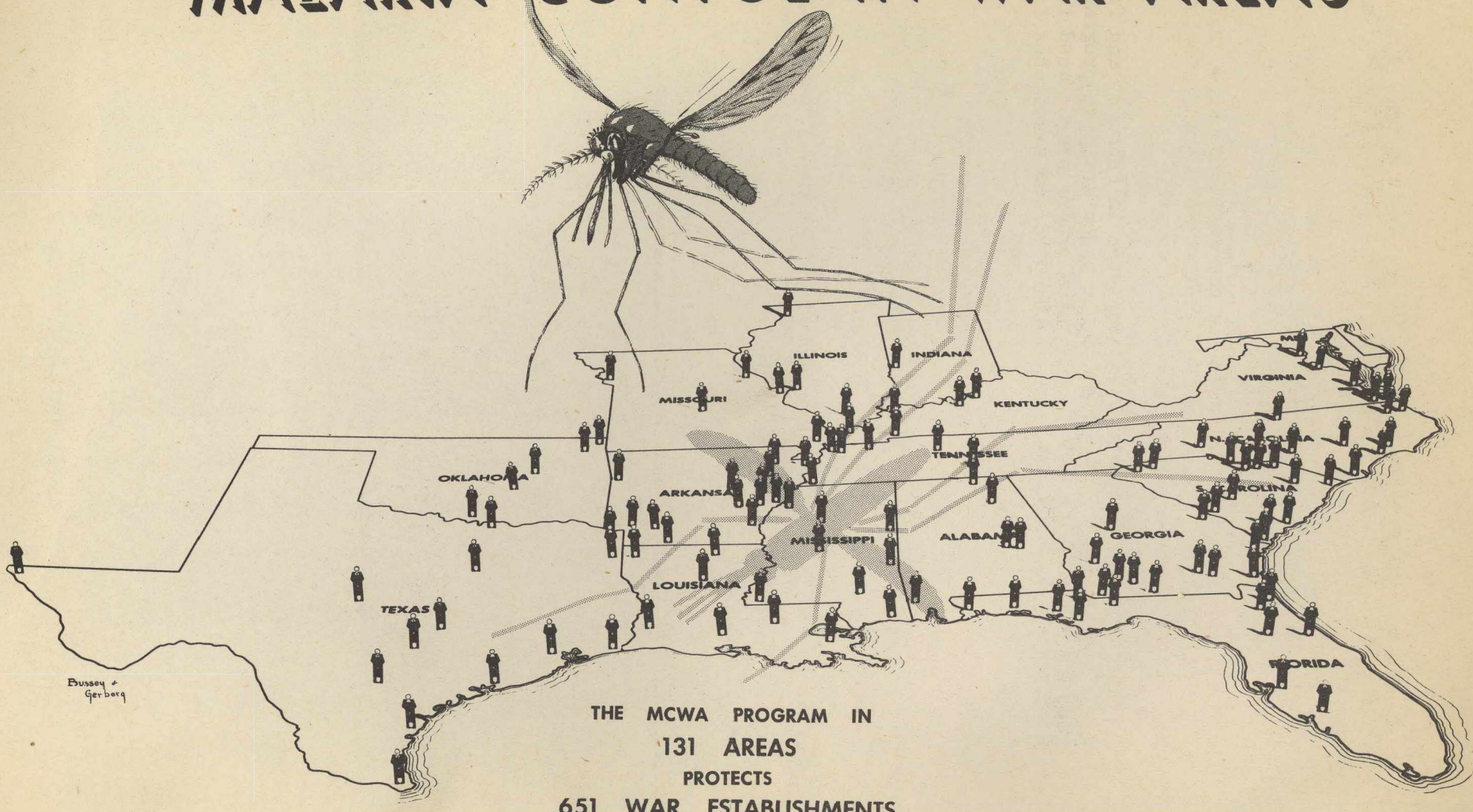
MONTHLY REPORT

FEBRUARY, 1943

FEDERAL SECURITY AGENCY
U. S. PUBLIC HEALTH SERVICE
ATLANTA, GEORGIA

U. S. PUBLIC HEALTH SERVICE

MALARIA CONTOL IN WAR AREAS



THE MCWA PROGRAM IN

131 AREAS

PROTECTS

651 WAR ESTABLISHMENTS

WITH MORE THAN

3,000,000 FIGHTING MEN AND WAR WORKERS

ATLANTA, GEORGIA

FEBRUARY, 1943

MONTHLY REPORT
Malaria Control in War Areas
February, 1943

SYLLABUS

Three new areas, two in Oklahoma and one in Puerto Rico, were added to the larvicidal program. Bids have been solicited for the airplane dusting work to be conducted in various areas this summer.

Two major drainage projects were completed in February and forty-nine others were in operation. A breakdown of the major drainage program at the end of the month is given on page 3. Purchase orders were placed for 88,250 pounds of dynamite to be used in construction of drainage ditches for malaria control.

Although every effort is being made to obtain sufficient automotive equipment, a shortage is expected for the coming larvicidal season. Bids have been sent out and orders placed for equipment such as hand dusters and sprayers that cannot be readily secured by transfer from other Federal agencies. A dragline was purchased this month from the W.P.A.

Twenty-one zone maps were completed or prepared for field checking. A complete set of maps covering all military areas in the Fourth Service Command was also prepared.

Scripts were written for three technical moving pictures on malaria control and one popular short on Aedes aegypti control. It is expected that production of these pictures will start in the near future.

All Manual Letters were revised and brought up to date and the Manual of Operations so organized that it can be readily and quickly used for reference purposes.

The Aedes aegypti general breeding index in Key West, Florida remained near the one percent level established in January. An all time low of less than one percent was reported for Miami Beach, Florida. The work in Texas continued to be aimed primarily at elimination of "mother foci" breeding places.

The payroll was exceptionally high in February due to receipt of supplemental payrolls for overtime from December 1, 1942. About $514,400 of Public Health Service funds were encumbered. Approximately 85% of this amount was for personal services.

TABLE I

MALARIA CONTROL IN WAR AREAS

USPHS LARVICIDE AND MINOR DRAINAGE PROJECTS

February 1 - 28, 1943

STATE	Areas in Operation	War Establishments Protected	LARVICIDAL WORK			OTHER WORK			Total Man Hours	Total Men Employed
			Larvicide Used		Surfaces Treated	Ditching & Cleaning Lin.Ft.	Clearing			
			Oil Gals.	Paris Green Lbs.	Acres		Ditches Lin.Ft.	Ponds Acres		
Alabama	4	25	---	---	---	21,491	7,861	---	7,035	40
Arkansas	10	36	---	---	---	53,294	118,984	163.5	24,377	146
California	2	4	340	---	106.4	27,052	21,925	1.4	2,382	15
D. C.	1	17	---	---	---	9,936	19,453	---	3,216	21
Florida	10	58	---	---	---	256,323	43,395	11.8	33,175	189
Georgia	10	57	---	41	32.3	86,274	11,864	34.2	20,992	116
Indiana	1	4	---	---	---	3,230	---	1.3	1,475	12
Kentucky	2	16	---	---	---	---	---	0.4	588	23
Louisiana	8	42	13,027	75	920.3	654,910	121,285	72.5	81,967	480
Maryland	2	7	---	---	---	8,040	---	2.5	3,624	22
Mississippi	6	9	---	---	---	47,589	230,106	37.6	13,015	89
Missouri	2	14	---	---	---	600	700	1.2	887	6
North Carolina	9	48	---	---	---	193,136	18,555	32.4	28,280	189
Oklahoma	4	10	---	---	---	28,880	105,750	19.8	3,480	25
Puerto Rico	7	17	185	6,016	2,645.3	235,580	51,330	13.3	52,486	345
South Carolina	1	43	---	---	---	4,893	15,438	---	1,688	19
Tennessee	5	40	---	---	---	11,288	285	7.7	9,628	55
Texas	14	153	8,970	90	287.6	265,118	87,699	9.1	48,537	263
Virginia	4	21	---	---	---	114,157	608,918	7.4	21,131	138
Total	102	621	22,522	6,222	3,991.9	2,021,791	1,463,548	416.1	357,963	2,193
January Total	105	631	16,608	6,187	3,633.5	1,462,528	1,622,725	602.3	344,406	2,183
Total July 1 - February 28	---	---	1,415,434	89,243	127,653.1	15,848,852	24,215,850	6,636.8	3,248,567	---

TABLE II

MALARIA CONTROL IN WAR AREAS

USPHS MAJOR DRAINAGE PROJECTS

FEBRUARY 1 - 28, 1943

STATE	No. of Projects	Clearing Brushing Acres	Channel or Ditch Cleaning Lin. Ft.	New Ditching		Fill Cu.Yds.	Ditch Lining		Underground Drains Lin.Ft.	Water Surf. Eliminated Acres	Total Man Hours
				Lin.Ft.	Cu.Yds.		Sq.Ft.	Lin.Ft.			
Alabama	3	7.3	500	6,439	2,464	250	---		---	12.75	7,670
Arkansas	2	36.7	2,384	---	---	---	---		---	---	7,246
Illinois	2	0.1	9,054	1,010	---	---	---		---	2.9	2,136
Kentucky	3	1.0	3,000	7,325	1,539	370	---		---	28.0	8,491
Mississippi	4	0.7	2,860	13,383	2,888	1,402	---		---	27.16	11,386
Missouri	3	3.3	400	1,150	595	26	---		---	6.25	3,128
North Carolina	4	22.3	21,988	12,250	4,679	2,399	---		---	18.9	20,947
Oklahoma	2	---	---	2,040	1,441	50	---		---	12.0	3,786
Puerto Rico *	3	3.48	1,800	1,000	3,319	---	---		---	---	20,361
South Carolina	19	77.7	113,221	31,608	13,197	8,879	---		---	98.66	75,943
Tennessee	2	1.4	1,700	10,576	1,813	219	---		---	7.0	3,787
Texas	1	---	---	486	144	---	---		---	---	228
Virginia	2	3.7	25,385	3,334	17,954	---	---		---	0.6	3,988
Total	50	157.68	182,292	90,601	50,033	13,595	---		---	214.22	169,097
January Total	40	119.3	107,892	76,458	27,488	5,791	---		---	466.2	144,174
Total July 1 - February 28	--	746.53	1,209,569	336,809	250,867	34,136	---		---	929.7	622,963

* Estimated same as January

TABLE III

MALARIA CONTROL IN WAR AREAS

NUMBER OF PERSONNEL ON DUTY ON FEBRUARY 28, 1943 AND TOTAL PAYROLL FOR MONTH OF FEBRUARY

STATE	TYPE OF PERSONNEL												Percent of Total	
	Commissioned		Prof. & Sci.		Sub-Prof. (1)		C. A. F.		Custodial		Total			
	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay
Alabama	1	281	5	1,318	2	347	2	410	78	10,136	88	12,492	2.3	2.7
Arkansas	3	843	2	709	19	3,594	4	683	157	19,309	185	25,138	5.0	5.5
California	1	242	2	406	4	872	2	440	13	1,838	22	3,802	0.6	0.8
D. C.	2	610	1	212	4	742	2	438	15	1,869	24	3,871	0.6	0.8
Florida	3	808	5	1,588	14	2,920	4	750	220	25,436	246	31,502	6.6	6.8
Georgia	1	130	4	1,004	28	5,000	5	848	89	11,369	127	18,351	3.4	4.0
Illinois	1	281	4	854	2	319	3	512	16	1,859	26	3,825	0.7	0.8
Indiana	1	281	1	240	--	---	1	133	12	1,330	15	1,984	0.4	0.4
Kentucky	1	281	4	1,049	5	1,150	3	556	51	6,464	64	9,500	1.7	2.6
Louisiana	9	2,515	5	1,302	40	6,860	5	886	421	51,498	480	63,061	12.9	13.6
Maryland	--	---	--	---	3	629	2	410	10	1,881	15	2,920	0.4	0.6
Mississippi	3	939	2	528	13	2,778	2	410	131	16,338	151	20,993	4.0	4.5
Missouri	2	610	3	917	7	1,434	1	152	18	2,218	31	5,331	0.8	1.2
North Carolina	3	843	8	2,436	10	2,028	3	556	293	34,563	317	40,426	8.5	8.7
Oklahoma	1	291	5	1,313	5	1,024	1	112	43	4,678	55	7,418	1.5	1.6
Puerto Rico	5	*	1	*	9	*	6	*	516	*	537	23,360	14.4	5.1
South Carolina	5	1,418	4	1,109	27	5,512	2	592	489	56,075	527	64,706	14.1	14.0
Tennessee	3	681	2	478	7	1,521	2	428	71	8,862	85	11,970	2.3	2.5
Texas	3	843	6	1,742	32	6,558	4	720	254	32,179	299	42,042	8.0	9.1
Virginia	2	400	2	775	8	1,492	2	428	176	19,339	190	22,434	5.1	4.8
Aedes aegypti														
Florida	--	---	1	319	45	7,877	3	456	27	3,651	76	12,303	2.0	2.6
South Carolina	--	---	--	---	13	2,070	1	146	5	671	19	2,887	0.5	0.6
Texas	--	---	3	682	10	2,094	7	973	--	---	20	3,749	0.6	0.8
H.Q. & Dist. (2)	30	9,593	11	2,157	20	4,029	65	10,825	6	696	132	27,300	3.6	5.9
Total	80	21,894	81	21,138	327	60,850	132	21,864	3,111	312,259	3,731	438,005	100.0	100.0
Percent of Total	2.1	5.0	2.2	4.8	8.8	13.9	3.5	5.0	83.4	71.3	100.0	100.0		

* Figures not available
(1) Includes Entomological Inspectors
(2) Includes Headquarters and District offices, malaria survey, special investigations and employees temporarily attached to Headquarters pending assignment to States.

MONTHLY REPORT
Malaria Control in War Areas
February, 1943

Three new areas were added to the larvicidal program in February. These were the McAlester and Ardmore areas in Oklahoma and the Salinas Maneuver Area in Puerto Rico. Data on the larvicidal minor drainage work for this month are presented in Table I.

Bids were solicited for the airplane dusting work to be carried on in various areas during the summer months. Contract forms were mailed to the respective bidders who were notified to submit their bids to the Headquarters Office by March 1.

Major Drainage - By the end of February a total of 117 major drainage projects from twelve states and Puerto Rico had been reviewed by this office and 86, totaling $982,179, had been approved. Forty-nine projects were in operation and two others, Columbus, Mississippi and Cape Girardeau, Missouri, were completed during the month. Progress of the major drainage work is shown in Table II. Table IV presents a breakdown of the major drainage program as of February 28, 1943.

TABLE IV
Status of MCWA Major Drainage Projects
February 28, 1943

State	No.of Proj. Reviewed	No.of Proj. Approved	Estimated Cost of Proj. Appv'd.	Cost of Projects in Operation or Completed
Alabama	9	8	$102,197	$ 68,773
Arkansas	5	5	50,327	38,831
Illinois	4	2	23,463	23,463
Kentucky	5	5	19,455	5,858
Mississippi	5	5	56,467	56,467
Missouri	3	3	12,557	12,557
N. Carolina	6	6	176,590	158,150
Oklahoma	2	2	17,426	17,426
Puerto Rico	3	3	81,559	78,324
S. Carolina	43	33	348,147	325,639
Tennessee	3	3	30,933	16,766
Texas	24	8	51,590	
Virginia	5	3	11,468	7,263
Total	117	86	$982,179	$809,477

Purchase orders were placed this month for 88,250 pounds of dynamite. Since the first of September, 148,400 pounds of dynamite have been purchased for the construction of malaria control ditches.

Equipment - Considerable difficulty is being encountered in obtaining sufficient automotive equipment for the coming larvicidal season and a short-

age is anticipated. Requests have been submitted to the Fourth and Eighth Service Commands for the transfer of vehicles, but no information has yet been received as to what action is being taken. In Florida enough automotive equipment and small tool supplies were secured from the Work Projects Administration to meet the needs of the MCWA program in that state. Bids have been sent out and/or orders placed for most of the equipment needed this summer which is not obtainable by transfer from other Federal agencies. This equipment is primarily hand dusters and sprayers.

During the month, Mr. Harold Beech, a representative of the War Production Board who handles Federal Security Agency priority applications, visited the Headquarters Office. The opportunity arose to acquaint Mr. Beech with the purposes and activities of MCWA and also with some of the needs and difficulties of securing essential equipment.

Maps - An attempt is being made to prepare standard form maps of the more important areas where maps suitable for office and report uses are not now available. Three zone maps of Area No. 9, Florida, were field checked and completed in February. Eighteen zone maps from areas in Florida, Mississippi, Arkansas and Oklahoma were sent to the field for checking but have not been returned for completion. In addition, a complete set of maps covering all military areas in the Fourth Service Command in which MCWA work is in operation was prepared and furnished to the Army officials responsible for malaria control within the various military reservations.

Educational Program - It should be only a matter of a few weeks until production can begin on a number of units of moving picture and film strip materials for both malaria and dengue-yellow fever control. Four scripts prepared this month are:

"Clinical Malaria" - A full length technical film (25 min.)
"Dynamite" - A full length technical film (25 min.)
"Life Cycle of the Quad" - A full length technical film (20 min.)
"Bottoms Up" - A popular short on *Aedes aegypti* control.

Payroll and Personnel - Encumberance for personal services was exceptionally heavy in February due to receipt of supplemental payrolls for overtime from December 1, 1942. War bond and victory tax deductions have increased the load of work and necessitated the use of individual record cards. A considerable amount of posting is still necessary to bring up to date the two month's backlog of entries and adjustments. Delay in the receipt of salary checks in some instances has apparently been the result of overloaded mail service in certain parts of the country. Table III summarizes data on the number of employees and the payroll by states.

Manual Letters - All Manual Letters, concerning policies and procedures of Malaria Control in War Areas, have been revised and brought up to date by the various units. Letters pertaining to related matters have been grouped together and the Manual of Operations so organized that it can be quickly and readily used for reference purposes. The revised Manual Letters probably will be distributed in April.

Aedes aegypti Control - In Key West, Florida, where elimination is the goal of the program, the general breeding index hovered around one percent with infestation about equally divided between outdoor and indoor sources. Small boats in the harbor continued to constitute a puzzling source of breeding which thus far has not been reduced in proportion to the reduction within the city. At Miami Beach, Florida, where most of the hotels and large apartment houses have been taken over by the Army for training purposes, a thorough outside and inside inspection showed a reduction of aegypti breeding to an all time low of less than one percent.

An example of cooperation and man power conservation was reported from Corpus Christi this month. Five abandoned cisterns (one as large as 18,000 gallons capacity) were to be sealed, filled or otherwise mosquito-proofed. The services of the city fire department were secured to pump them dry. The city street sweepers then dumped their sweepings into the dry cisterns for a few days. The cisterns were quickly filled and eliminated as "mother foci" for Aedes aegypti mosquitoes. The problem of abandoned wooden water tanks is also being handled in a unique manner in Corpus Christi. A complete list of such tanks was made and then turned over to a used lumber dealer. The dealer buys the tanks, dismantles them and from the salvaged parts builds mosquito-proof tanks for resale.

Expenditures - About $514,420 of Public Health Service funds were encumbered during February, of which nearly 85 per cent was for personal services. The approximate amounts were as follows:

.01 Personal Services	$438,000
.02 Travel	20,450
.03 Transportation	440
.04 Communication Services	1,210
.05 Rent	1,180
.06 Printing and Binding	730
.07 Other Contractual Services	10,550
.08 Supplies and Materials	29,210
.09 Equipment	12,650
Total	$514,420

LARVICIDES AND THEIR APPLICATION

Part I - Contact Poisons - In January Report
Part II - Stomach Poisons - In February Report
Part III - Application of Larvicides - In February Report

PART II - STOMACH POISONS

Paris Green

Paris green (copper acetoarsenite) is the only stomach poison widely utilized in mosquito control work. It is used as a dust consisting of from one to fifty parts per hundred of paris green mixed with some inert diluent such as soapstone, hydrated lime, finely powdered talc, road dust, etc. The degree of dilution of the paris green should vary with the maximum distance that the limits of the breeding area lie from the point of liberation of the dust and with the width of lethal path desired. When it is required that the dust be effective against mosquito breeding at some considerable distance from the duster, a more concentrated mixture should be used, and the mixture should become progressively more dilute as the extent of necessary dust cloud coverage decreases. For example, hand casting can be used to dust a radius of about 20 feet from the duster and a one to two per cent paris green mixture (one to two parts paris green to 99 or 98 parts inert diluent) is recommended for this method of distribution. The mixture for use with a hand blower, effective up to 200 feet, should be five to ten percent; for a power duster effective up to 500 feet, it should be ten to fifteen percent, and for dusting from an airplane, 25 to 50 percent.

The amount of paris green necessary per acre varies with the type of area being treated and successful results have been obtained with from one-quarter pound to two pounds per acre, and as high as four pounds where the water surface was thickly covered with water hyacinths. This refers to the actual quantity of paris green in the mixture. As an indication of the toxicity of this material to anopheline larvae and the minute amounts required under ideal conditions, it has been found in the laboratory that an application of paris green equivalent to one-half ounce per acre would produce a mortality of 80 percent. In this connection it has also been found that the finer the particle size the more efficient the powder as a larvicide. In general, an application of approximately one pound of paris green per acre is satisfactory for anopheline control.

Paris green conforming to the following specifications is an effective larvicide: It should contain a minimum of 50 percent arsenious oxide, no more than 2½ percent being soluble in water. At least 95 percent should pass a 325 mesh sieve in a machine or hand shaking test without preliminary desiccation. Pan tests of the dust, in the same paris green-diluent mixture and the same rate of application as that to be used in the field, should give a complete kill on second, third, and fourth stage anopheline larvae in two hours.

Paris green is an arsenical compound and is, therefore, poisonous to warm blooded animals, including man. Due care must be taken when handling this material and every precaution should be taken to prevent the powder from entering the mouth or from accumulating in crevices in the skin. When dusting, the laborer should stand on the windward side of the duster. However, when applied in the minute quantities required for mosquito control, paris green has not been observed to have a poisonous effect on aquatic plants, live stock or other animal life; repeated applications do not appear to result in any cumulative effect of arsenical poisoning in the area treated.

Advantages

1. May be applied to areas for anopheline control where application of liquid larvicides is not practical.

Disadvantages

1. When applied to the water surface as a dust, second, third, and fourth stage Anopheles larvae are killed but all pupae and many first stage larvae escape.

Advantages	Disadvantages
2. Use can be made of favorable wind currents to carry the dust cloud over an area otherwise inaccessible.	2. As used for the control of anophelines, paris green is not effective against the pest mosquitoes.
3. Can effectively treat areas covered with emergent vegetation.	3. Difficult to use under adverse wind and weather conditions.
4. Is easy to store and transport.	

The importance of a knowledge of the biology of the various mosquito species is well illustrated in connection with the use of paris green. Culicine larvae hang head downward from the surface of the water and feed there at a subsurface level or at the bottom of the breeding place. Anopheline larvae, on the other hand, rest parallel to and just below the surface film of the water. In feeding, they set up small currents with their mouth parts which bring into their mouths any small particles lying on the surface. Paris green dust, which consists of very fine particles, settles and remains on the surface of the water, and is ingested by anopheline larvae with fatal results. Mosquito pupae take no food, and therefore are not affected.

PART III - APPLICATION OF LARVICIDES

Although the control of mosquitoes through the use of larvicides is superficially a simple matter, it requires a well coordinated organization calling for intelligent well trained inspectors, conscientious oilers or dusters and competent, energetic supervision. The effectiveness of larvicidal operations cannot be judged on the quantitative basis of oil sprayed or paris green dusted or the extent of water surface covered per man daily, but rather on the control of mosquito production achieved. This should serve as the criterion for judging the effectiveness of the program, although the efficiency factors should certainly not be disregarded.

Given effective toxic agents and an understanding of their uses and limitations, the success of a larvicidal program depends on the proper application of these materials to the breeding areas. Since water surface and breeding area are not synonomous, water surfaces in the zone under control must be divided into those which breed mosquitoes and those which do not. In addition, on this program, it is necessary to further differentiate areas which breed Anopheles quadrimaculatus or, in some areas, A. maculipennis freeborni or A. albimanus. The first requisites to an effective larvicidal program are, therefore, adequate entomological surveys and inspection.

The two most common faults of field larvicidal operations are: (1) overtreatment of the area in general, i.e., too heavy an application per unit area; and (2) undertreatment, or complete lack of treatment, of some portions of the area. The correction of these faults requires intelligent, energetic supervision at the breeding area being treated. To avoid double application to some spots and none to others, the larvicidal crew should be so organized that each man has a specific area to treat. The form of such organization would depend on the topography and whether oil or dust is being used. In larvicideing extensive swamps the crew may be formed into a row, the men a certain distance apart and all moving forward together as they apply the larvicide. When the end of the breeding area has been reached, the row of men wheels on the outside man and again moves forward, treating the adjacent lane. When treating shoreline, ditches, or small isolated pools and ponds, each man may be assigned a specific segment to treat.

Overtreatment may be corrected by demonstrating to the members of each larvicidal crew just how much larvicide should be applied so that they can recognize overtreatment. They should be instructed to keep moving steadily as they are applying the larvicide. The foreman and other supervisory personnel should check the laborers frequently as they are working and correct them if necessary. It is a very natural impulse, even among high-type personnel, to apply a larvicide until its presence is clearly indicated on the surface. Overtreatment is indicated by a green color on the water when using paris green, a milky color when using pyrethrum-oil emulsion, or a strongly oily appearance when using oil.

Using knapsack or orchard type hand sprayers, one man may be able to distribute from 10 to 50 gallons of oil per day depending on the character of the area. If the water areas are fairly continuous and in open country, then the greater amount of oil can be sprayed. If the breeding spots are smaller and further apart and the underbrush is heavy, then it may be expected that an oiler will spray the minimum amount.

Similarly, using a hand rotary duster, the amount of dust that a laborer can distribute is conditioned by the nature of the terrain. Where breeding areas are continuous, or nearly so, and the going easy, one man may distribute 100 or more pounds of dust per day. Under adverse conditions, the distribution of 35 to 50 pounds of dust may represent a good day's work.

Methods of applying larvicides vary from such crude means as the hand casting of paris green to the use of airplanes for dusting or spraying. Hand casting of paris green or the application of oil or other liquid larvicides from a sprinkling can are methods which may be used where more efficient means are not available.

The most usual method of application involves the use of hand sprayers or dusters. Hand sprayers are of the compressed air or knapsack types. The compressed air sprayer differs from the knapsack type in that an actual pressure is built up within the tank, and the oiler must stop at fairly frequent intervals to build up depleted pressure in the tank. This type of sprayer has but one strap which is looped over a shoulder of the oiler. It is not a preferred type because of the frequent stops necessary for repumping and because any damage to the tank may destroy its usability. This sprayer has one advantage when being used on treacherous terrain where it is possible that the oiler may fall into the water or into a hole in the ground, since under such circumstances the one strap can be thrown off quite easily. When using this sprayer, it should not be allowed to stay in the sun for any considerable period of time without allowing the pressure to escape. During lunch time, and overnight, the pressure should be released.

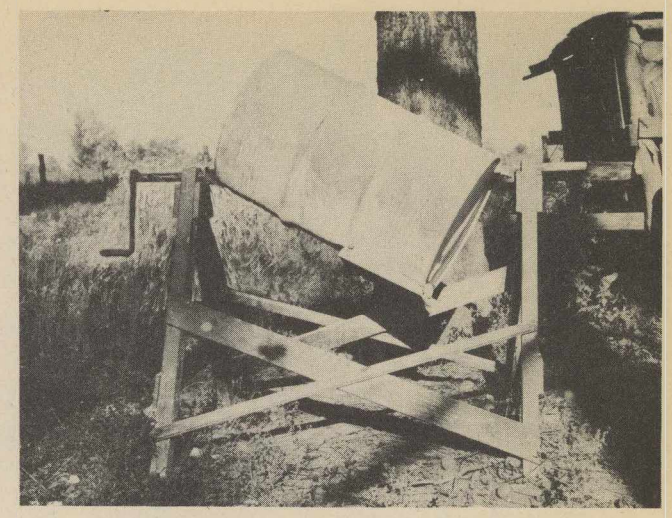
There are three types of knapsack sprayers. The first and preferred type is that which has a piston type pump. The pumping handle in this type may be overhead or under the arm. The former is often preferred in open country, while the latter is generally more useful when working in dense underbrush or in wooded areas. The second type of knapsack sprayer has a diaphragm pump, which formerly was not very suitable for oiling because the rubber diaphragm quickly deteriorated when exposed to oil. It is understood, however, that manufacturers of this type of sprayer are now using a synthetic oil-resistant rubber and such sprayers may prove more satisfactory in the future. The third type of knapsack sprayer, originally developed for fighting forest fires, is the so-called trombone type, which has the pump in the handle just behind the nozzle.

Hand rotary blowers are used for the application of paris green dusts. These are similar to the blowers used for dusting agricultural crops. The paris green must be thoroughly mixed with the diluent before being applied to the breeding areas. This can be accomplished in a drum mounted on an eccentric shaft, which is turned by hand. There are also several power mixers on the market.

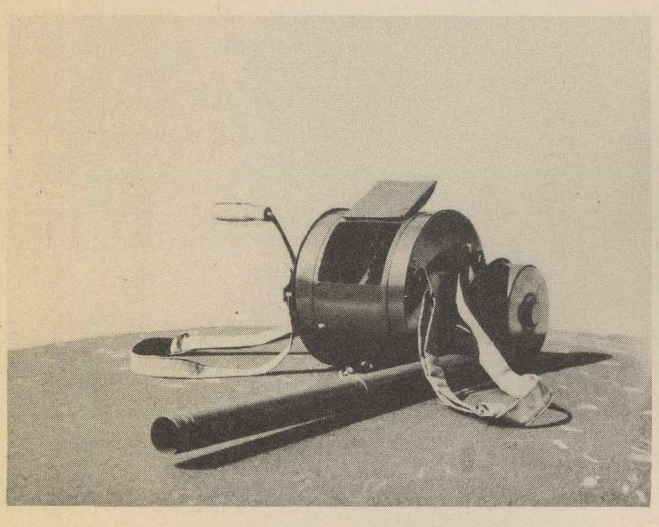
Power sprayers and power dusters, mounted in boats, airplanes or automotive equipment, can be used for the application of liquid and dust larvicides to the larger breeding areas. There are in general two types of power sprayers: namely, the high pressure piston type pump which draws the larvicide directly from the tank and sprays it over the breeding area; and the water-oil type that consists of an engine-driven centrifugal pump which draws a small portion of its discharge from the tank and the remainder from the breeding water. The latter type is always mounted in boats while the former may be mounted in motorcycles, trucks or boats.

Airplanes have been found very useful for the distribution of paris green dust over extensive breeding areas which could not otherwise be efficiently treated. Airplanes have not thus far proven very suitable for the distribution of liquid larvicides.

Hand shaker method of applying dust larvicide

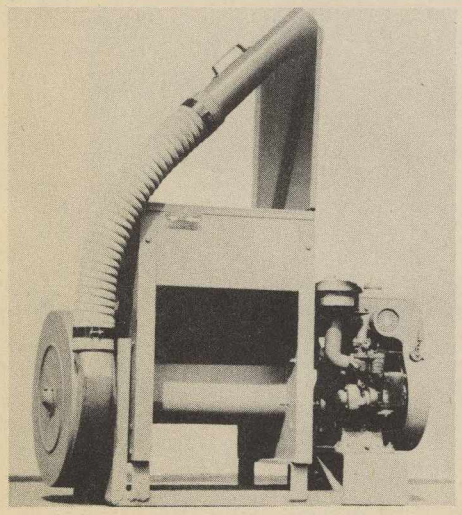


A simple hand operated paris green dust mixer



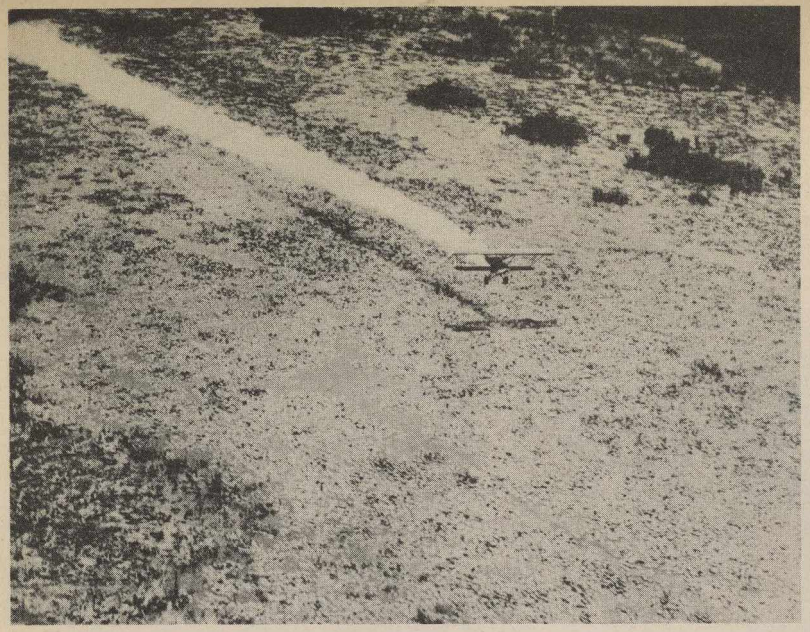
A hand rotary duster

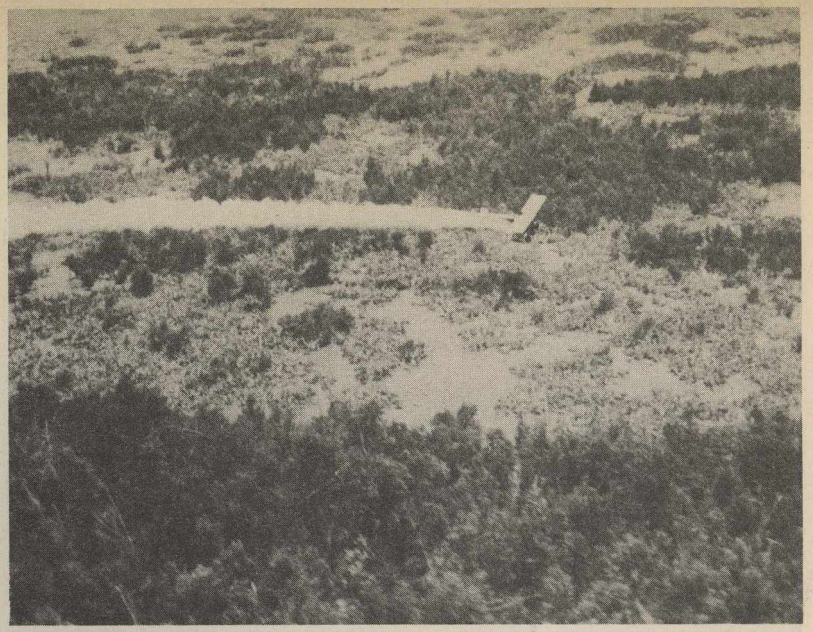
--- in use



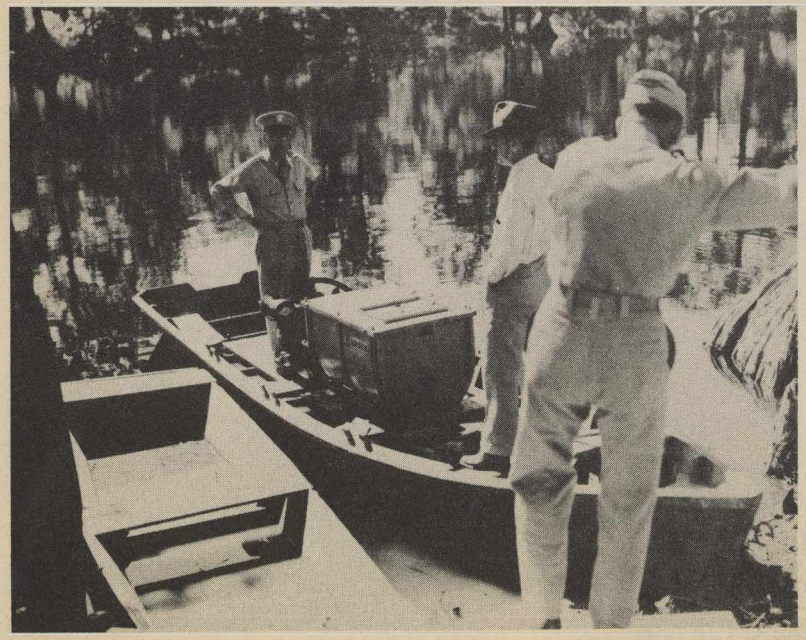
A 5-h.p., air-cooled power duster

--- in use

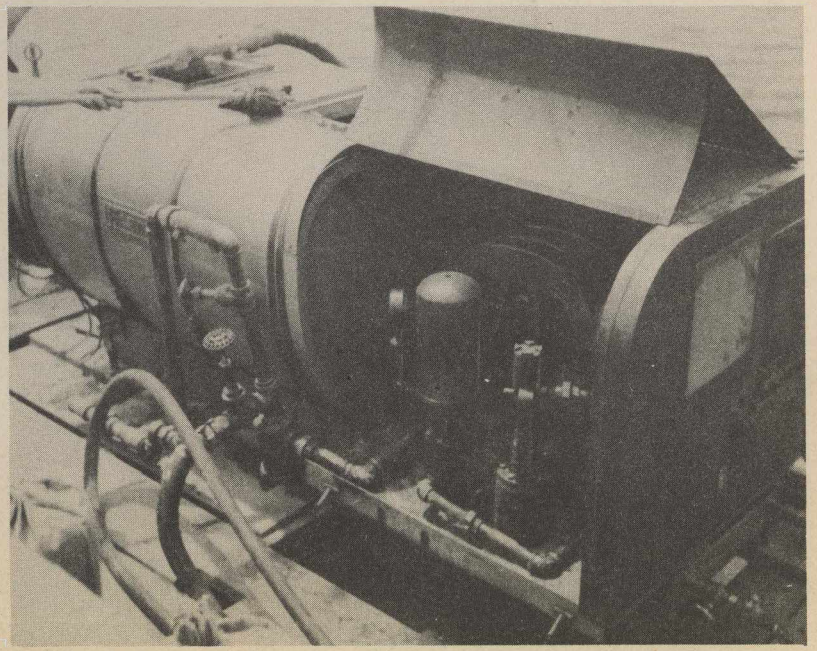




Two scenes of airplane dusting



A small, high pressure piston-type sprayer;
delivers about 4 gallons per minute



A large, high pressure piston-type sprayer;
delivers about 35 gallons per minute