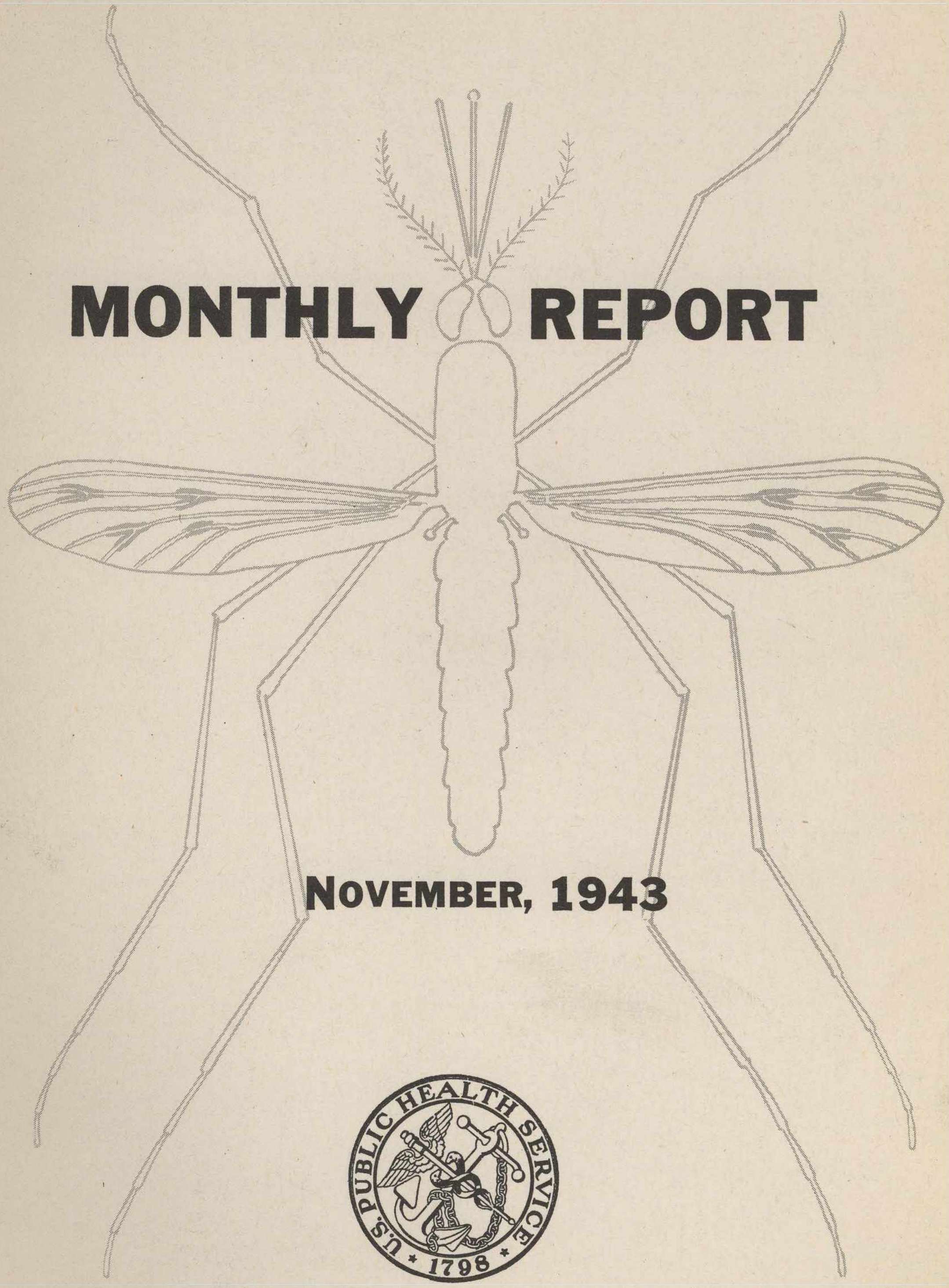
MALARIA CONTROL IN WAR AREAS



MONTHLY REPORT

NOVEMBER, 1943

U.S. PUBLIC HEALTH SERVICE • 1798 •

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

TABLE I — MCWA LARVICIDE AND MINOR DRAINAGE PROJECTS — NOVEMBER 1 - 30, 1943

STATE	Areas in Operation	War Establishments Protected	LARVICIDAL WORK: Larvicide Used: Oil Gals.	Larvicide Used: Paris Green Lbs.	Surfaces Treated: Acres	OTHER WORK: Ditching: Cu.Yds.	Ditching: Lin.Ft.	Cleaning: Lin.Ft.	Clearing: Acres	Water Surf. Eliminated Acres	Total Man Hours	Total Men Employed
Alabama	4	64	---	---	---	542	6,042	19,685	1.3	2.3	3,982	20
Arkansas	10	63	137	---	4.7	5,889	43,292	63,746	3.2	39.5	16,527	84
California	3	11	932	---	79.5	---	100	33,035	8.7	---	3,774	20
D.C.	1	23	---	---	---	619	6,668	5,315	0.4	0.2	2,117	14
Florida	16	91	2,205	30	59.3	7,485	40,227	152,178	17.4	73.8	31,536	178
Georgia	13	93	80	829	920.7	3,112	17,778	62,343	57.8	18.3	25,011	119
Illinois	1	54	---	---	---	---	---	10,355	---	---	1,540	7
Kentucky	3	48	6	---	0.4	39	1,100	16,302	0.4	0.1	3,336	17
Louisiana	8	71	44,015	3,578	4,575.0	6,738	63,781	180,552	106.3	21.8	63,549	357
Maryland	1	21	---	---	---	1,063	7,180	6,230	1.6	4.4	3,850	17
Mississippi	7	50	147	---	6.5	1,987	19,646	41,594	35.1	3.4	10,524	60
Missouri	4	24	---	---	---	408	2,410	2,787	0.1	1.6	2,800	14
North Carolina	10	69	---	---	---	2,285	21,285	229,523	6.9	17.6	26,373	144
Oklahoma	2	21	---	---	---	---	---	29,083	2.6	---	3,200	16
Puerto Rico	5	22	1,582	7,421	10,501.6	306	128,601	246,056	32.6	2.3	74,848	442
South Carolina	12	101	1,179	41	104.1	3,004	49,523	422,665	25.1	6.8	23,578	140
Tennessee	4	69	2,690	---	71.1	1,510	10,091	15,567	15.6	5.9	8,668	48
Texas	14	119	7,574	198	559.0	3,241	23,067	245,577	96.3	30.8	41,095	214
Virginia	4	83	---	---	---	6,294	109,516	6,885	50.8	6.0	25,549	145
Total	122	1,137	60,547	12,097	16,881.9	44,522	550,307	1,789,478	462.2	234.8	371,857	2,056
October Total	151	1,137	176,841	15,192	27,673.5	24,215	283,332	2,164,819	756.5	192.9	439,534	2,408

TABLE II — MCWA MAJOR DRAINAGE PROJECTS — NOVEMBER 1 - 30, 1943

STATE	No. of Projects	Clearing Brushing Acres	Channel or Ditch Cleaning Lin.Ft.	New Ditching: Lin.Ft. Hand	New Ditching: Lin.Ft. Mach.	New Ditching: Dynamite	New Ditching: Total Cu.Yds.	Fill Cu.Yds.	Ditch Lining Placed: Sq.Ft.	Ditch Lining Placed: Lin.Ft.	Underground Drains Lin.Ft.	Water Surf. Eliminated Acres	Total Man Hours
Alabama	1	---	500	500	---	---	---	---	---	---	---	---	4,441
Arkansas	3	13.5	200	194	2,425	5,274	18,044	---	---	---	---	6.7	3,214
Florida	1	---	4,600	---	---	---	---	---	---	---	---	---	2,608
Indiana	1	0.8	---	895	---	---	551	---	---	---	---	---	984
Mississippi	1	---	---	710	---	---	26	126	2,777	945	20	0.1	1,650
Missouri	1	---	---	550	---	5,200	12,540	---	---	---	---	35.0	1,712
North Carolina	6	7.8	17,510	33,548	1,108	5,075	17,217	1,006	40	---	82	59.7	13,030
Oklahoma	1	2.3	---	1,100	---	1,700	1,574	---	---	---	---	7.8	1,192
Puerto Rico	3	1.4	200	1,675	---	500	4,370	175	650	---	---	---	47,906
South Carolina	12	17.2	7,260	16,833	2,240	2,300	14,183	735	---	---	---	84.2	21,552
Tennessee	2	---	---	300	---	---	160	81	2,750	1,350	177	---	1,200
Texas	5	1.4	---	5,785	750	---	2,728	490	600	---	---	29.2	4,505
Total	37	44.4	30,270	62,090	6,523	20,049	71,393	2,613	6,817	2,295	279	222.7	103,994
October Total	18	21.5	46,179	22,227	5,170	1,050	38,337	756	1,389	826	512	28.0	84.455

TABLE III — MCWA PERSONNEL ON DUTY ON NOVEMBER 30, 1943 AND TOTAL PAYROLL FOR MONTH OF NOVEMBER — NOVEMBER 1 - 30, 1943

STATE	Commissioned		Prof. & Sci.		Sub-Prof. (1)		C. A. F.		Custodial		Total		Percent of Total	
	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay	No.	Pay
Alabama	5	1,382	1	264	1	213	2	247	41	5,346	50	7,452	1.6	1.8
Arkansas	6	1,719	3	952	23	4,426	4	738	80	11,888	116	19,723	3.6	4.7
California	2	567	---	---	5	1,044	3	458	20	2,904	30	4,973	0.9	1.2
D. C.	1	332	1	319	4	559	2	367	8	1,151	16	2,728	0.5	0.6
Florida	5	1,286	6	1,792	20	4,122	5	971	176	23,327	212	31,498	6.7	7.5
Georgia	4	1,183	4	1,038	34	6,520	4	721	92	12,119	138	21,581	4.3	5.1
Illinois	3	863	3	900	2	416	3	641	2	683	13	3,503	0.4	0.8
Indiana	1	284	1	103	---	67	1	55	7	920	10	1,429	0.3	0.3
Kentucky	2	567	4	1,110	4	781	3	556	18	2,572	31	5,586	1.0	1.3
Louisiana	11	3,220	8	2,086	44	8,379	5	915	313	40,939	381	55,539	12.0	13.2
Maryland	2	580	---	---	2	365	2	410	18	2,346	24	3,701	0.8	0.9
Mississippi	4	1,183	1	264	12	2,435	3	410	52	7,397	72	11,689	2.3	2.8
Missouri	3	899	1	395	13	2,886	4	1,221	14	2,075	35	7,476	1.1	1.8
North Carolina	6	1,710	9	2,635	8	1,717	3	574	214	27,633	240	34,269	7.5	8.2
Oklahoma	2	576	4	1,049	6	1,267	1	146	13	2,963	26	6,001	0.8	1.4
Puerto Rico	6	2,061	---	---	11	2,194	5	951	740	34,541	762	39,747	24.0	9.5
South Carolina	4	1,183	5	1,336	23	4,812	4	724	252	32,058	288	40,113	9.0	9.5
Tennessee	4	1,135	2	477	6	1,558	2	419	51	6,950	65	10,539	2.0	2.5
Texas	7	2,082	5	1,534	27	5,829	3	474	214	27,474	256	37,393	8.0	8.9
Virginia	3	851	2	688	11	2,218	2	428	137	16,969	155	21,154	4.9	5.0
AEDES AEGYPTI														
Florida	--	284	---	---	27	4,454	1	164	2	341	30	5,243	0.9	1.2
Georgia	2	616	1	319	9	1,741	1	164	---	---	13	2,840	0.4	0.7
Louisiana	1	85	---	---	18	3,308	--	39	---	---	19	3,432	0.6	0.8
South Carolina	1	284	---	---	12	1,825	1	146	2	250	16	2,505	0.5	0.6
Texas	5	1,418	1	183	9	1,928	1	146	20	2,972	36	6,647	1.1	1.6
H.Q. & Dist.(2)	47	14,531	7	1,990	13	2,558	77	13,823	9	1,051	153	33,951	4.8	8.1
Total	137	40,881	69	19,434	344	67,622	142	25,908	2,495	266,869	3,187	420,712	100.0	100.0
Percent of Total	4.3	9.7	2.2	4.6	10.8	16.1	4.4	6.2	78.3	63.4	100.0	100.0		

(1) Includes Entomological inspectors
(2) Includes Headquarters and District Offices, malaria survey, special investigations, and employees temporarily attached to Headquarters pending assignment to states.

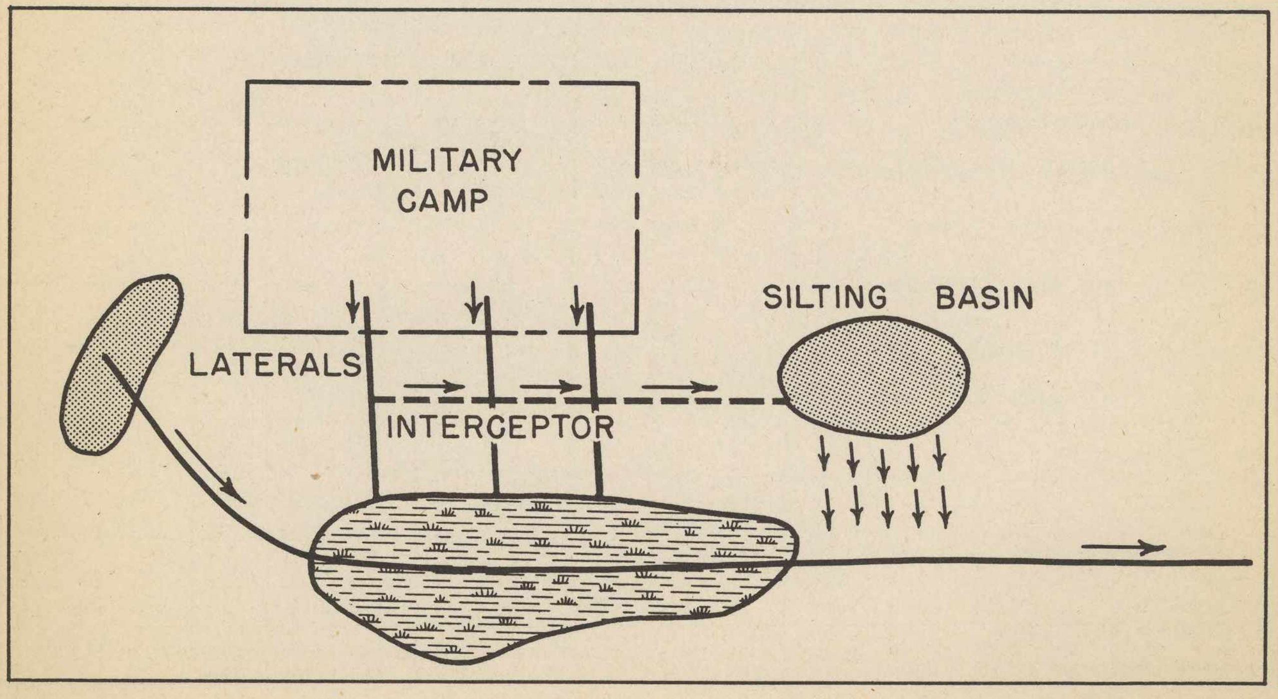
MALARIA CONTROL IN WAR AREAS NOV. 1943

Monthly Report

USE OF SILTING BASIN ILLUSTRATED

With an increased manpower shortage facing MCWA, and the proposed extension of the program to include Army general hospitals and prisoner of war camps, it has become more than ever important that as many places as possible be eliminated by drainage during the winter season.

A good example of planning for future effectiveness was recently demonstrated with the completion of a large dynamite ditch near Deland, Florida, which drained two important *Anopheles quadrimaculatus* breeding areas. Three laterals entering the ditch from a nearby military establishment were carrying a heavy load of silt and sand which would have eventually filled it and made it useless for malaria control purposes. To combat this, an interceptor ditch was dug to a nearby pond, which was itself a quad breeding place. The pond acts as a silting basin, so that only overflow water reaches the main ditch. The pond will eventually be filled with the silt and sand, which will eliminate it as a breeding place, and the main ditch in turn is kept free and in good operating condition.



SPECIAL INSPECTIONS AT AIRPORTS OF ENTRY

Five MCWA entomologists have recently completed training at the Miami USPHS Quarantine Station for special inspection work at airports of entry, and two are in training at the present time. Their function will be to prevent introduction into this country of insect disease vectors arriving by airplane, and to immediately detect the presence of such pests in areas adjacent to the airports should any inadvertantly escape from the planes.

Of the five entomologists who have completed training, two have been retained at Miami. One has been sent to New Orleans, Louisiana, one to Brownsville, Texas and one is shortly to be assigned to Fort Worth, Texas.

Procedures followed in this work include the spraying of airplanes on arrival at a port of entry, and subsequent inspection of each plane. The dead and dying insects found are identified either at the station or sent to specialists. Reports of the findings of each inspection are prepared daily on special forms for the information of the local Medical Officer in Charge, and summary reports are made at monthly intervals. In the survey work adjacent to the airport, insect traps are operated at strategic points, and also likely looking breeding places of mosquitoes and flies are kept under surveillance for the detection of exotic disease vectors.

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Table IV

MCWA Encumbrances and Liquidations by Major Items
For the Month of November 1943

	Continental U.S.	Percentage of Total	Puerto Rico	Percentage of Total
.01 Personal Services	$ 380,965.74	82.17	39,746.46	91.04
.02 Travel	12,814.17	2.76	253.95	.58
.03 Transportation	6,044.93	1.30	--------	-----
.04 Communication Services	1,363.30	.29	25.00	.05
.05 Rents and Utilities	1,940.00	.42	--------	-----
.06 Printing and Binding	--------	----	--------	-----
.07 Other Contractual Services	9,057.90	1.95	--------	-----
.08 Supplies and Materials	44,046.24	9.52	3,506.83	8.04
.09 Equipment	7,385.92	1.59	129.00	.29
Total	463,618.20	100.00	43,661.24	100.00
Expenses Other Than Personal Services	82,652.46	17.83	3,914.78	8.96

"ADULT STATIONS"

Glen C. Prock, New Orleans, Louisiana, has been commissioned Assistant Sanitarian (R), and will continue as supervisor of the New Orleans *Aedes aegypti* Control Unit.

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Robert H. Pearson, recently commissioned Assistant Engineer (R), is assigned to the Leesburg, Louisiana area.

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Charles E. Kohler, in charge of entomological work at Walnut Ridge, Arkansas, has been commissioned Assistant Sanitarian (R), and will remain at Walnut Ridge.

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Kenneth A. Ford, Junior Administrative Assistant, has been transferred from Louisville, Kentucky to Austin, Texas.

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George H. Bradley, Senior Entomologist (R) was elected President of the National Malaria Society at the annual meeting held in Cincinnati, Ohio, November 16 - 18.

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Four members of the staff of Malaria Control in War Areas presented papers at the annual meeting of the National Malaria Society, held in Cincinnati, Ohio, November 16 - 18: "Educational Factors in the Ultimate Control of Malaria," Trawick H. Stubbs, Passed Assistant Surgeon; "A Discussion of the Entomological Phases of Antimalaria Programs," George H. Bradley, Senior Entomologist (R); "The Selection of Anti-mosquito Methods to Fit Specific Malaria Control Programs," Nelson H. Rector, Sanitary Engineer (R); "The Malaria Control Program of the U. S. Public Health Service among Civilians in Extra-Military Areas," Stanley B. Freeborn, Senior Surgeon (R).

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In the "Symposium on War and Post-war Tropical Medicine" at the Annual Meeting of the American Society of Tropical Medicine, Cincinnati, Ohio, November 17, 1943, Robert L. Usinger, Passed Assistant Sanitarian (R) presented a paper on "Entomological Phases of the Recent Dengue Epidemic in Honolulu."

The headquarters office is desirous of obtaining articles on malaria control by MCWA personnel for possible inclusion in the Monthly Report. Write-ups of unusual projects, or efficient methods of control are especially solicited. Credit will be given to the writer in all instances where such articles are published.

MISSOURI SOLVES UNUSUAL CONTROL PROBLEM

By Robert J. Sikorski, Assistant Sanitary Engineer (R)

For the past two seasons, Larval Stations 7a and 7b, or the Number 2 ditch at Sikeston, Missouri has afforded an interesting problem in *Anopheles quadrimaculatus* control. This ditch is about 30 feet wide, with an average depth of three feet to four feet at the center. It also has a very rapid flow (about one foot per second) and rises rapidly after rains. It is part of the large drainage system which has transformed southeast Missouri from a swampy region into one of valuable farm land having thousands of acres of rich soil. During the mosquito breeding season Ceratophyllum, a submerged aquatic plant grows luxuriantly in ditch Number 2, as is the case in many of the ditches in this area, and in that respect it could be called a typical ditch.

The rapid flow in the ditch causes patches of Ceratophyllum to tear loose and float downstream. Malaria control personnel have been able to stand waist deep in the center of this stream and dip regularly all stages of larvae from such patches floating downstream. The conventional method of larviciding in the control area did not produce the desired results, because *Anopheles* larvae were carried into the control zone by the floating patches which would lodge in the control area, the larvae subsequently producing adult mosquitoes.

In order to combat this condition, two ordinary six inch mesh wire fences about 100 feet apart were placed across the stream above the control area to catch the floating Ceratophyllum before it reached the larvicided zone. After each of these fences had caught a semi-circle of Ceratophyllum totalling about 100 square feet, the mass of plants was removed, the floating mass having first been oiled. The wire mesh extended to the bottom of the stream, and from two inches to two feet above the water, depending on the water level. Frequent cleaning (twice daily) was necessary because as the plant mass increased in area a strong undercurrent developed which carried the plants underwater and through the fence openings.

For next year's control program it is planned to clean about two and a half miles of this vegetation from the sides of the stream just prior to larviciding and then put up fences about 60 feet apart at a point just above the control area and clean them twice daily. In addition, it will be necessary to oil the side pockets of the stream to obtain complete control.

ENTOMOLOGICAL PHASES OF THE RECENT DENGUE EPIDEMIC IN HONOLULU*

INTRODUCTION

Mosquitoes are recent immigrants in Hawaii. Although numbering countless millions of individuals, only three species are represented. The night mosquito, *Culex quinquefasciatus* Say, was the first to arrive in the mosquito free Hawaiian paradise. It came aboard the "Wellington" from Mexico in 1826. The day mosquitoes, *Aedes aegypti* (Linn.) and *Aedes albopictus* (Skuse), arrived somewhat later. *Aegypti* was widespread in Hawaii when R.C.L. Perkins started his collecting for the "Fauna Hawaiiensis" in 1892, whereas *albopictus* "did not come to notice during the earlier days of (his) collecting," but was "very numerous and conspicuous" by 1902. Fortunately no *Anopheles* mosquitoes have become established in Hawaii.

HISTORY OF MOSQUITO BORNE DISEASES IN HAWAII

Mosquito borne diseases have not played an important part in the health history of Hawaii. Extreme isolation, rigid quarantine, and a limited mosquito fauna are responsible for this happy situation. In spite of this combination of circumstances, dengue broke out in Honolulu in 1903, having probably been introduced by a passenger from Hong Kong. The disease spread to all the islands and it is estimated that one third of the population or 30,000 cases occurred, although most of these were not officially reported.

On October 21, 1911, the "Hong Kong Maru" arrived from Mexico with yellow fever aboard and a local watchman who went aboard the ship came down with the disease at Kalihi Camp on October 30th. That there were no secondary cases is doubtless due to the prompt and vigorous action of health officers.

Meanwhile, in 1912, dengue again broke out in Honolulu. Older residents and doctors state that most of the population had dengue, but reports are fragmentary, only 108 cases being reported officially in 1912 when the epidemic must have been at its height. Twenty cases were reported in 1913, eleven in 1914, and seven in 1915.

The present dengue outbreak is of doubtful origin but the first two cases were reported on July 24, 1943, one in the Waikiki District and one in Nuuanu Valley. One story relates that commercial fliers arrived from the South Pacific early in July and occupied an apartment at a Waikiki rooming house. The maids at this house later came down with what was subsequently suspected of being dengue. By August 8th, Waikiki had become such a focus of infection that it was restricted to military personnel. Most of the early cases apparently originated in Waikiki but by September 13th larvicidal work and thorough spraying of adults had practically eliminated *Aedes* mosquitoes from this district so the restriction was lifted. Cases were no longer originating there whereas

*Abstracted by Herbert C. Knutson, Assistant Sanitarian (R) from a paper by Robert L. Usinger, Passed Assistant Sanitarian (R), which was presented in the "Symposium on War and Post-War Tropical Medicine," at the Annual Meeting of the American Society of Tropical Medicine, Cincinnati, Ohio, November 17, 1943.

cases were occurring in all other parts of the city. Late in September another major focus developed in the Kakaako District near the center of the city. This grew out of the negligence of a prominent laundry in following up the larvicidal work with regular adult spraying. Only after 70 employees were absent on a single day was action taken. By this time a major focus had developed and cases were reported for the city as a whole at the rate of 100 per week where 10 per week had been the previous average.

CONSIDERATION OF THE DENGUE VECTORS OF HAWAII

Aedes aegypti (Linn.) and *albopictus* (Skuse) have been incriminated in various parts of the world as vectors of yellow fever, dengue, equine encephalomyelitis, bird malaria, hemogregarines of geckoes, and filariasis of man and dogs.

A. aegypti (Linn.) has spread throughout the tropics and most of the subtropics. Because of its domestic habits and its preference for urban environments, it is the dominant species in cities far away from its original African home. *Albopictus*, on the other hand, is confined to the Oriental Region with extensions to Madascar on the southwest and New Guinea and North Australia on the southeast. The discontinuous eastward extension of this species to Hawaii is remarkable and doubtless came about through transpacific shipping.

HABITS. Since the time of Carlos Finlay and Walter Reed, a vast amount of detailed information has been accumulated on the life history, habits, and ecologic limits of *aegypti*. Unfortunately, knowledge of the related day mosquitoes of the Australasian and Oriental Regions has not kept pace. *A. albopictus* and *A. scutellaris*, which have often been confused in dengue literature, have simply been compared in a general way to *aegypti* and at least *albopictus* has been described as resembling *aegypti* so closely as to be considered identical from the standpoint of control. Actually Hawaiian *albopictus* resembles *aegypti* in the following points:

1- URBAN BREEDING HABITS. In Honolulu, *aegypti* was found to outnumber *albopictus* two to one in 1913, the two species were equal in 1911 and *albopictus* was dominant four to one in 1912, and up to twelve to one in 1914. The ratio of twelve to one continued in 1915. In 1926, a survey showed *albopictus* to completely dominate the picture, 42.56% as compared with 0.34% *aegypti*. During the present epidemic 85% of the day mosquitoes were found to be *albopictus*, only 15% being *aegypti*. *Albopictus* was found breeding in town in ant cups, flower pots, tin cans, bottles, a paper box, jars, tires, tanks and in water plants.

2- DAY BITING. A day and night spent up on Mt. Tantalus at 1700 feet elevation where *albopictus* occurred exclusively and in great numbers proved that this species is a persistent day biter but does not bite at night.

3- EGG LAYING. Eggs were most commonly observed at or above the waters edge but specimens of *albopictus* in captivity showed a greater tendency than *aegypti* to oviposit on the surface of the water.

4- SHORT FLIGHT RANGE. Senior-White records a short flight range for *albopictus* in India. [Abstractor's Note: King, Bradley and McNeel (1942) state that "the usual flight range (of *Aedes aegypti*) is considered to be not more than a few hundred feet"]. In the Hawaiian Islands wind trap collections taken by Mr. Sakimura at Kunia, Oahu during the last three weeks of September and the first week in October 1943, showed a total of 62 mosquitoes, all of which were *Culex*, no *Aedes* having ventured forth where the wind could pick them up and blow them into traps.

Albopictus also resembles *aegypti* in (5) its silent flight; (6) macroscopic larval appearance and habits and (7) preference for human blood, Toumanoff having found human blood by means of precipitin tests even in mosquitoes which were resting in cattle stables.

Differences between the two species are slight but are very important. *Albopictus* was found to have a scarcely longer life cycle (18 days) than *aegypti* (17 days) in the summer season in Shanghai but *albopictus* had a shorter life cycle (24 days) than *aegypti* (27 days) in the winter (Robertson and Hu). In India, Sen found that *albopictus* will bite at a lower temperature (13°C). This greater tolerance for cold weather enables *albopictus* to range upward to approximately 2000 feet in the mountains of the Hawaiian Islands. It is a severe pest throughout the lower forest area, breeding in tree holes and in water at the bases of leaves of plants. I have found it commonly at 1700 feet but I find no records of day mosquitoes above the 2000 foot level. *Aegypti* was once reported from 1500 feet in the Waianae Mountains (Grimshaw), but the record seems doubtful considering the present distribution of this species. Since *albopictus* is so perfectly adapted to life in the extensive lower forest zone it may be considered a practical impossibility to eradicate the species from the Hawaiian Islands.

To summarize, *albopictus* is actually dominant over *aegypti* in the city of Honolulu and also thrives beyond the range of *aegypti* in the forest area up to 2000 feet. Strangely enough, the dominant species where both occur in the Orient appears to be *aegypti* (Senior-White) so we may assume that large Oriental cities on the costal plain are particularly suitable for *aegypti* Honolulu is situated at the foot of the Koolau Mountain range with ridges actually entending down into the city. Thus *albopictus*, although breeding in the city, is actually quite close to the mountain forests and is particularly favored in the better residential districts at the moist heads of Nuuanu and Manoa Valleys.

CONTROL. Control of *Aedes* mosquitoes in Hawaii follows the standard practice of routine inspection and correction of all breeding places throughout the city, each premise being covered every ten days. This is a basic but rather slow procedure which increases in effectiveness as inspectors become more experienced and as the cumulative effect of clean-up of many premises begins to show results.

Meanwhile, under epidemic conditions, adult spraying inside and out of all premises in and around a focus of several dengue cases became necessary to prevent explosion of cases. Outside of houses where foliage had to be sprayed a pyrethrum and oil spray was used at the rate of three parts per 100 of water with Vatsol as an emulsifying agent. Commercial fly spray was used inside houses.

MOSQUITOES IN RELATION TO DENGUE

The relation of *Aedes* mosquitoes to the present epidemic is rather unique. First, the fallacy of a city-wide index as an indication of possible dengue epidemics is evident. Mosquito breeding is very low in certain districts of Honolulu. The general breeding index of 1.7% for the first two weeks of inspection is, of course, unusually low because of inexperienced inspectors but a spot survey of various districts throughout the city indicates that it was less than 10% during the month of September. This was near the end of the dry season so more breeding places may be expected with the onset of winter rains. Yearly rainfall averages within the city limits range from less than 25 inches to over 100 inches. The breeding index was found to be 83% in a spot survey of a very wet district at the head of Nuuanu Valley whereas it was less than 4% in a dry and relatively clean area at Waikiki. Such conspicuous variations are concealed by a city wide index.

Curiously, the dengue cases occur in nearly inverse proportion to the general mosquito breeding index. This apparent anomaly is especially noticeable in the presence of better homes with large gardens and extensive grounds in the wet, mosquito ridden heads of the Valleys, in contrast to small unscreened houses in densely populated areas in the drier parts of the city. Dengue died out without secondary cases under the former conditions in the Nuuanu Valley whereas it flourished under congested conditions in the Kakaako District. The correlation of dengue cases with density of human population rather than with density of mosquitoes is due to the short flight range of the mosquitoes, to the presence of more people to be infected in a populous area and to the dilution factor in mosquito bites when people are few and mosquitoes are present by the thousands.

Dengue epidemics may be eliminated in three ways. In temperate regions the first frost kills all adults outside and stops the epidemic. In many tropical regions most of the population contracts dengue during an epidemic and the disease gradually disappears, probably because of individual immunity. Finally, dengue may be eliminated by reducing mosquitoes below the threshold of sanitary importance. Since frost does not occur in Honolulu and since it is imperative that we avoid such a general involvement of the whole population as in 1903 and 1912 for military reasons, we are committed to the third and most difficult in the present epidemic. Spontaneous elimination of dengue depends upon a general lowering of mosquito breeding below the level of sanitary importance. This is the point beyond which mosquitoes are so scarce that, with their short flight range, they do not reach dengue cases during the short pereiod of infectivity of the disease.

At the moment it would appear that prompt reporting and isolation of patients and emergency spraying of local foci to kill infected adults should hold the epidemic at its present relatively low level. Meanwhile, the basic inspectional and correctional program with coincident education of the public should gradually increase in effectiveness so that dengue may possibly be eliminated from Honolulu without having to subject the entire population to the painful and costly process of developing a temporary immunity to the disease.

ANTIMALARIA DITCHING BY DYNAMITE

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The blasting of open earth ditches in wet or marshy ground has had long and successful practice at the hands of landowners, public health agencies, railroad companies, highway departments, contractors, and the U.S. Government. This nation is now engaged in an all-out war effort and it is, therefore, highly important that quick, direct, and economical methods of ditching be employed. Blasting is quick, when time is such an important factor. It requires little labor, when there is such a decided shortage of labor. It eliminates the use of equipment, when the materials required to produce equipment necessary to drainage work are so critically needed in the prosecution of the war effort.

Ditching with dynamite, where indicated, has numerous advantages which make it useful for war work. It is generally the least expensive method for ditching in soft mucky soils or through heavily wooded swamps. It permits ditching in ground too boggy to be shoveled or through ground so soft that there is no footing for a horse or support for wheels. (Although dynamite canbe used for ditching in dry soils the unit cost is generally higher.) To the malaria control engineer it is particularly valuable as it is the quickest known means of constructing an open earth ditch - after the right-of-way has been cut, a crew of three to ten men can blast 750 to 3000 feet of channel in one day. With all of its advantages, drainage by dynamite is unquestionably a specialized work and it is imperative that an experienced blaster supervise the operation.

The blasted ditch is produced by the explosion of a series of charges of dynamite placed in a single line of holes or in several lines of holes at given intervals and depths. By placing equal charges at the proper depth and correct spacings, and by detonating at the same time, it is possibel to blast a ditch with regular width and depth. Following this principle, an experienced blaster can accurately construct a ditch of the desired dimensions. A blasted ditch is usually two to three times as wide as it is deep and the sides slope to the ratio of one to one (45 degrees).

If the charge is of the correct size and is placed properly, in most instances, the only work required after the blast is to remove a few drifts, and cut roots and logs remaining in the bottom and sides of the ditch.

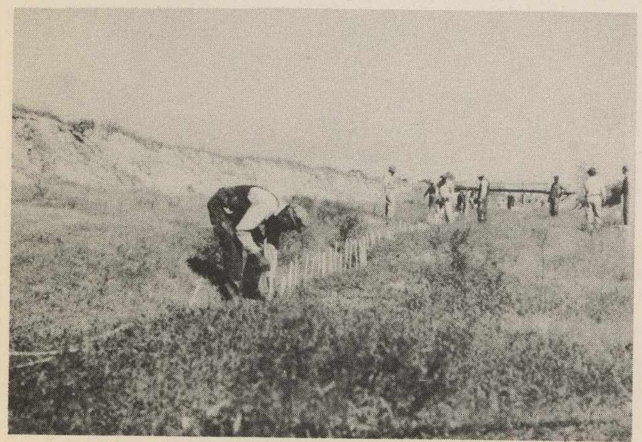
The blasting method of constructing ditches may be employed for making almost any size open ditch in any type of soil except very thin muck, dry sand or gravel. About the smallest ditch that can be economically blasted is one two feet deep and three feet wide, and the largest, ten feet deep and thirty feet wide. The size or capacity of the ditch required, the grades, the depth and the line should be selected by a qualified engineer. In general, the line should be as straight as possible, but should remain on low ground. A fall varying from 0.1 to 0.5 feet per 100 feet has been found to be satisfactory.

There are two distinct methods of ditching with dynamite, the propagation and the electric. The propagation method can only be used in wet soils, while the electric can be used in either wet or dry soils. The explosives and blasting supplies needed and the methods of loading vary considerably in the two methods. In the propagation method, a line of holes is put down and loaded with 50 to 60% straight nitro-glycerin dynamite. Only one hole is primed and fired, either with an ordinary blasting cap and fuse or with an electric blasting cap. Since accidents have happened by the use of fuses, this method has been largely discontinued and instead the electric blasting machine is used for the detonation of shots. If the charge fails to explode, the machine can be disconnected and no danger results when steps are taken to determine why the explosion did not occur as planned. The shock from the explosion of the primed cartridge is sufficient to detonate the others. Frequently, one-half mile of ditch is shot at one time.

Making holes into which dynamite will be placed.

In the electric method, each hole is primed with an electric blasting cap, connected in a circuit and fired with an electric blasting machine of sufficient capacity.

Before blasting the ditch a test shot of eight to ten holes should be made to determine the size of charge and the proper method of loading. The type of soil, moisture content, temperature, the kind of trees, and other factors must be considered as the success of the blasting operation depends largely on the results of these test shots. If the loading is satisfactory, the soil will be lifted 200 feet in the air and scattered over the adjoining territory for 150 feet on each side of the ditch, leaving a good clean ditch. If these objectives are not obtained different loadings must be used. In swamps, for example, the ditch is usually two to three feet deeper than the depth of charge. In different soils it is sometimes necessary to load to the proposed grade of the ditch. An experienced blaster can estimate accurately the amount of dynamite and the depth of charge required for specific soil conditions. If a test shot demonstrates that the resulting ditch is larger than needed, the distance between holes may be increased, but should seldom be greater than twenty-four inches.



Placing dynamite sticks along lines of proposed ditch.

After the engineer has determined that sufficient fall is available and has staked the center line of the ditch, a right-of-way, varying from ten feet to fifteen feet wider than the ditch is cleared.

All standing timber and logs must be removed, although it is not necessary to remove stumps. The reason that logs are removed is because they generally fall back in the ditch, and hence, can be carried off the right-of-way much easier before the ditch is blown. When the ditch is located in soil covered with a heavy sod, it is advisable to cut the sod on both sides of the ditch with a spade or plow before the blast.

In soft, swampy soils, the bore holes can be made with a round stick marked off in feet. If many roots are encountered, it will be advisable to make a punch bar of one and one-quarter inch galvanized pipe with a sharpened point and a cross bar. Two men using this bar can punch holes very quickly on the center line to the proper depth. Small ditches (for instance, about 2 ft. deep and 4 ft. wide) in soils containing few roots can be constructed with half cartridge charges. A cartridge or stick of dynamite weighs ½ pound. When using small loads, the space between holes can seldom exceed 18" to 20". Larger ditches can be dug by using one, two, or more cartridges per hole, and a second or third row of holes may be put down four or five feet from the original line and loaded in the same manner. When two or three holes are used, it will be necessary to prime the center hole in each line with an electric blasting cap and connect them in series, or to put one or two extra charges between the rows to insure simultaneous detonation of all of the charges. When large stumps lie on the right-of-way, it is necessary to load them separately and connect these charges with the center line in order to insure propagation of these charges. Considerable judgment is necessary for the proper loading of large stumps.

If sections of the ditch are in relatively dry soil, the holes should be filled with water.

A good system to follow when blasting large and long ditches is to fire the charges at noon and in the afternoon after the men quit work. This system eliminates loss of time and increases the safety of the operation. Before firing, all tools and blasting supplies should be removed to a safe distance.

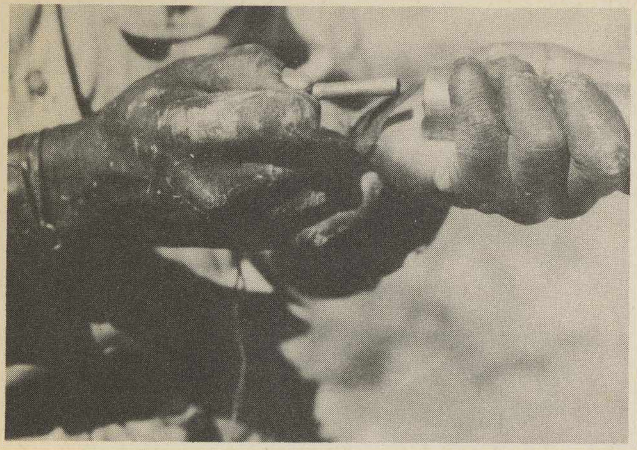
It is a good practice to increase the estimate of dynamite needed by from five to ten percent to take care of a few stumps and extra loadings. If large stumps are thick on the right-of-way, a separate estimate for blowing stumps should be included.

When the propagation method is used, a common practice is to place the primed cartridge in the center of the charge. However, it can be shot from the end. If a blasting machine is used, the lead wire to the primed cartridge must be at least 250 feet long.

Dynamite may be used to advantage to clean out old ditches, but it is not advisable to use this method if the top width is less than twice the depth. Care must be exercised in placing the charge to prevent the force of the explosion from caving in the original sides and filling up the ditch. As it costs money to move water, it is not considered feasible to clean out ditches that contain more than two feet of water.

Under ordinary conditions, approximately one pound of dynamite is required to move one cubic yard of soft mucky material. For example, if it were desired to construct a ditch having a three foot bottom, a depth of 3.0

feet, and a top width of 9.0 feet, through mucky soil with few stumps, one cartridge (½ pound) placed in holes eighteen inches apart will give the desired results. However, this amount should be increased if the soil is full of roots, if the ditch exceeds three feet in depth, or if unusual soil conditions prevail.



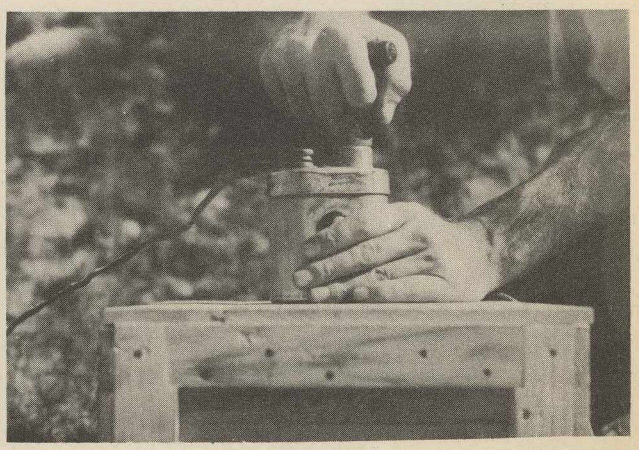
Inserting percussion cap into a stick of dynamite.

Sometimes it is necessary to construct an outlet ditch across bends in an old natural channel in order to increase the flow and thereby effect better drainage. These cut-offs can be made very economically if a relatively large amount of water flows through the ditch. This method consists of the construction of a small cut-off ditch with dynamite, and then depending or the rapid motion of the water to scour and erode the ditch to the proper size. Instances have been reported where the size of ditches has been increased three or four times by the running water.

If this method is used, a dam must be built in the upper end of each cut-off in order to prevent the water from following its natural course, and steps must be taken to fill the old run to a grade so that no water will remain to breed mosquitoes after the ditch has been constructed.

Vertical drainage can be used to advantage when a pond is underlaid by a strata of hardpan on top of a water bearing strata. This method is accomplished by drilling a hole almost through the hardpan and loading it with a sufficient amount of twenty or forty percent ammonia dynamite distributed along the bore hole to shatter the entire layer of hardpan. If the hardpan is of a gritty nature, no further treatment is necessary; but when it is slimy or silty, the loading must be heavy enough to create a rough well or crater. This crater is then filled with any sort of available rubbish such as brush or boulders and stump fragments. This debris prevents clogging of the drain.

Vertical drainage is practical for draining clay pits, road and railroad borrow pits, and small isolated ponds where horizontal drainage would be extremely costly. It must be kept in mind that this method should never be used unless prior approval for the project has been obtained from the State sanitary engineer or the State Board of Health,

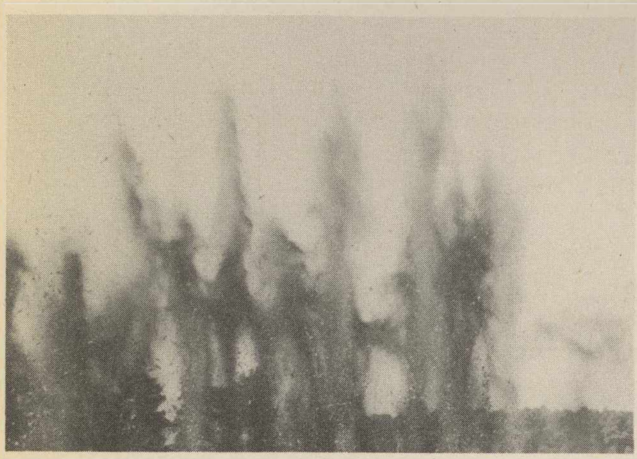


A blasting machine

as the ground water might become contaminated.

Two large dynamite projects which illustrate the advantages of dynamite ditching were performed by Malaria Control in War Areas shortly after the inception of the program. The cost of partial control of mosquito production in one of these areas for one season by airplane dusting (which would have been the only possible method) would have greatly exceeded the total cost of the dynamite work. On the other project the estimated cost of drainage by machinery was $80,000.00 while the outlet ditch was constructed with dynamite for approximately $5,000.00. In both instances, it would have been impossible to complete the projects with machinery before the end of the mosquito breeding season. If control by larvicides had been feasible the recurrent cost each year would have been high; while in contrast the maintenance cost of the dynamite ditch is very low.

Some idea of the speed with which dynamite work can be done can be gained from the fact that on one of these projects, a large outlet ditch approximately two miles long was practically finished in two weeks, draining



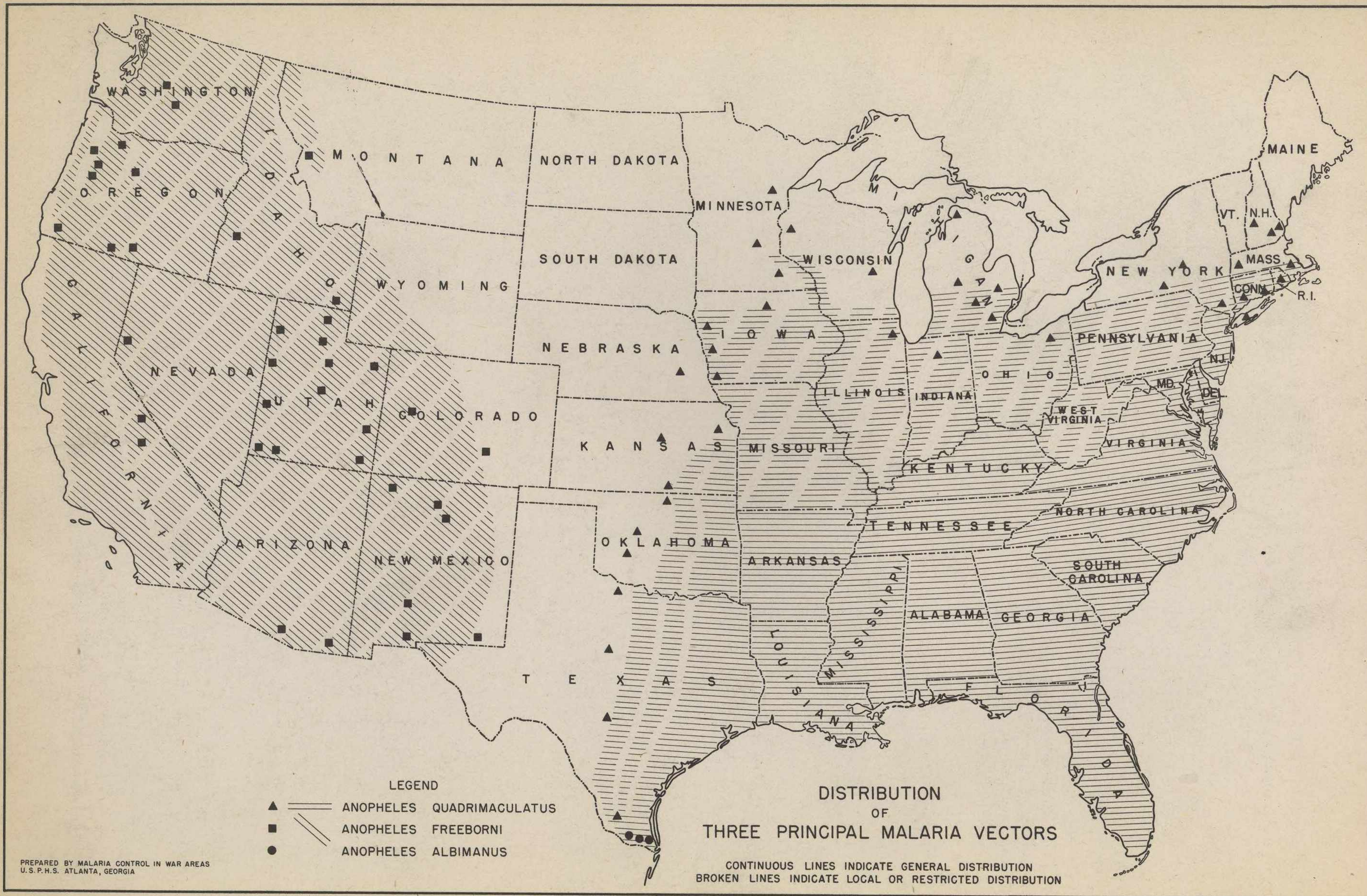
Dynamite blast.

Completed dynamited ditch.

90% of a 300 acre swamp. The excavation amounting to 16,500 cubic yards, was done at an average cost of $0.29 per cubic yard.

While it is true that this method is not dangerous if handled carefully by experienced employees, it is equally true that it is very dangerous if employed by inexperienced or careless workers. It is recommended that the fuse method never be used for the detonation of dynamite, and that the electrical blasting machine used to detonate the charges never be allowed to lay around carelessly on the right-of-way. This machine should only be intrusted to the most reliable, careful man on the project who will hold it until the ditch is properly loaded and is ready for detonation. We believe that dynamiting is a very valuable method for constructing ditches, where its use is indicated.

(This paper was presented by Mr. Rector at a meeting of the National Malaria Society in Richmond, Virginia on November 12, 1942.)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OF
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CONTINUOUS LINES INDICATE GENERAL DISTRIBUTION
BROKEN LINES INDICATE LOCAL OR RESTRICTED DISTRIBUTION
LEGEND
ANOPHELES QUADRIMACULATUS
ANOPHELES FREEBORNI
ANOPHELES ALBIMANUS
PREPARED BY MALARIA CONTROL IN WAR AREAS
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CALIFORNIA
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