

in ant-guards. It is necessary that the para-dichlorobenzene be used in powdered form and be well scattered in the guards.

About two grams of powdered para-dichlorobenzene, or the same amount of camphor (either lump or powdered) was found very effective in preventing the breeding of yellow fever mosquitoes in flower vases and similar receptacles. It should be repeated every fifteen days, or each time the water is changed. For holy-water urns, especially in churches, lump camphor is recommended.

The use of these insecticides should be considered obligatory, and if, after due notice has been given, breeding is found, especially pupæ, then the offender should be dealt with severely and to the full extent of the law, particularly so if yellow fever exists in the community.

The central station of the sanitary corps should have these insecticides on hand and sell them to the public at, or nearly at cost.

MOSQUITO CONTROL IN A SOUTHERN ARMY CAMP

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Early in the spring of 1918, the writer, then an enlisted man in the Signal Corps, U. S. A., was transferred to the Medical Corps at his request, and assigned to the problem of insect control at Kelley Field, the large aviation camp located about six miles southwest of the City of San Antonio, Texas. The most important feature of the insect problem was that of mosquito control and the prevention of the breeding of the house fly. This paper will be limited to that phase of the work dealing with mosquito control.

As it would have been rather unwise to devote the entire efforts to removing breeding places in the camp proper and to pay no attention to the surrounding country where the insects might breed unmolested and fly to the camp, it was decided to cover a territory embracing the camp itself and a zone around the camp of about three miles, for unless conditions are especially favorable fresh water mosquitoes will not fly such a long distance. Exclusive of a portion of the City of San Antonio, which comes within this three mile zone, the population outside of the reservation is a little more than 450, with almost 80 per cent of them living in the small "emergency" town east of the camp, known as South San Antonio. The remainder live on scattered farms east and south of the reservation, while to the west there are practically no houses.

The camp site was originally an immense cotton field, having a deep clay soil with only an occasional bed of sand or gravel protruding above this clay formation; and while it was almost uniformly level there were depressions of varying sizes which, owing to the nature of the

soil, retained water for some time after a rain. In the three mile zone the terrain to the north, east, and southeast is similar to that of the camp but devoted to the growing of cotton and truck garden crops, while to the west and southwest the rolling country is covered with mesquites and cacti.

Upon commencing the work of mosquito control in April, 1918, the necessary work of becoming familiar with conditions within the camp and the territory adjacent to it, within a radius of three miles in all directions, was quickly completed. Each and every source of mosquito breeding, hidden or exposed, within the limits of the reservation was carefully noted for future action. Kelley Field, like all other army camps built during the recent emergency, was constructed in great haste. Consequently it caused no surprise to find gutterless roads, depressions under buildings, hollows in the open, leaky fire hydrants and underground pipes, etc. Since it was impossible to remedy all these defects at once, periodical trips of inspection were made throughout the season; all the apparent dangerous sources being visited every nine or ten days, while no effort was spared to cover the camp in its entirety at least once a month. An oiling crew of three men, one of whom was thoroughly instructed in the objects and methods of spraying and who was always in charge of the crew, would spray all temporary pools of water in which mosquitoes were found breeding. Under prevailing atmospheric conditions it was found that a combination of crude oil (70 per cent) and kerosene oil (30 per cent) gave the most desirable consistency and the best results. Because oil interferes with the proper functioning of sewage disposal plants, no oiling was done on the surface of waters which would eventually find their way into the disposal plants. Several times during the early season mosquito larvæ were found breeding in the flushing tanks of unused sanitary latrines. Since no oiling could be done in these places a man was detailed to flush weekly all temporarily unused latrines.

One of the duties of the camp entomologist was to collect, bi-weekly, specimens of mosquitoes found in the reservation for shipment to the Army Medical Museum, Washington, D. C. (as required by army orders), for a study of the relation between disease-bearing mosquitoes and local prevailing diseases. The effectiveness of the above method of inspection and subsequent treatment is testified to by the complete absence in Kelley Field of the yellow fever mosquito, *Aedes calopus* (which is known to breed in chance water in receptacles about buildings), during the entire season of 1918, although several specimens were collected in San Antonio. The following is a complete list of the species of mosquitoes found at Kelley Field during 1918, as identified by the Army Medical Museum, Washington, D. C.

Culex tarsalis; *C. fatigans*; *C. spissipes*; *C. chrysonotum*; *C. similis*; *Psorophora jamaicensis*; *P. texanum*; *P. signipennis*; *Mansonia* spp.; *Anopheles crucians*; *A. punctipennis*; *A. pseudopunctipennis*.

The most prolific of the above mosquitoes was *Culex fatigans*, having been found breeding from April to December inclusive; while of the Anophelinæ the commonest was *Anopheles pseudopunctipennis*, which was found breeding throughout the summer months.

The sluggish Leon Creek, which for more than four miles meandered within or in close proximity to the reservation, was at the outset condemned as the place from which would come most of the mosquitoes. In parts of its course it formed pools more than an acre in area. Its course lay through a wide ravine, in places the banks rising fifty feet in height; nowhere was it entirely free from a tangled mass of weeds and tall grasses, on the whole having the general appearance of a typical jungle (Plate 6)—an ideal source for the most prolific propagation of mosquitoes. To reduce or even eliminate as much as possible mosquito breeding in this place through the period of construction, resort was made to the use of the oils. The first two attempts were local failures. In both cases frames of wire mesh were built to fit snugly into a narrow portion of the creek near the place where it first enters the reservation. These forms were boarded on the two sides which were to be placed against the banks of the creek. The bottom, the two sides facing the direction of the stream and the top cover were made of wire mesh. This rectangular frame (about 30 inches by 36 inches by 12 inches) was filled with sawdust which had been soaked in crude oil for six hours, and then placed in position in the creek. This proved unsatisfactory because of excessive oiling for 24 hours following submergence, and because its effectiveness was of comparatively short duration, and therefore demanded frequent attention. An attempt was made to overcome these difficulties by substituting excelsior for the sawdust, but with approximately similar results. The third trial, of using a large 50 gallon oil drum as a drip, was successful. This drip was placed over the channel leading from one of the sewage disposal plants into Leon Creek. Two heavy planks stretched across the channel supported the large oil drum in such a position that the nozzle pointed into the middle of the stream. To assure the complete breaking up of the oil drops at all times as they fell into the water, two or three medium sized rocks were placed in the bottom of the channel just in front of the spot where the oil drops hit the water. These rocks caused a ripple of sufficient force to break up each drop and at the same time to direct the oil to the two sides of the channel. The same proportion of crude and kerosene oils (70 per cent to 30 per cent), which was used for general spraying, was found to be satisfactory for use in

the drip. In this manner the creek was supplied, throughout the period of construction, with a steady, uniform, and a very thin film of oil. Impurities and heavy ingredients in the oils necessitated weekly adjustments of the nozzle of the drum. Extreme care was constantly exercised to drip the minimum amount of oil necessary for the prevention of mosquito breeding, to eliminate any danger to live stock using the water down stream, and to the colonies of top-minnows living within it. In several places along the banks of the creek springs caused permanent pools of fresh water, into which top-minnows were introduced to good advantage.

It was evident that the true condition of the creek was not appreciated by the authorities until their attention was called to it by the writer upon assuming the duties of camp entomologist. On May 1, 1918, only seven Mexican laborers were engaged in improving the creek, the work being to clear the banks of the vegetation. Had its real dangerous character been realized more than seven times seven men would have been employed early in the season before the advent of mosquitoes. Considerable filling, cutting and grading were necessary to secure a thoroughly sanitary condition, particularly if the improvements were to be of a permanent nature. And the ultimate object of the anti-malarial construction was the permanent eradication of mosquito breeding in the creek. Accordingly requisitions were made not only for an increase in the number of Mexican laborers but also for as large a number of enlisted men as could daily be spared from other necessary duties to work upon this project. Because of the complex military methods of procedure some little time elapsed before the number of Mexican laborers was increased from seven to an average

Nature of work	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Totals
Policing the creek (Figs. in linear ft.)	6,700	8,325	6,750	6,800	9,550	7,660	5,500	51,285 lin. ft.
Banks treated (Figs. in linear ft.)	2,100	7,300	1,200	850	575	575		12,600 lin. ft.
Re-sodding (Figs. in sq. yds.)					6,200	8,400		14,600 sq. yds.
Cuts made (Figs. in cubic yds.)	343.8	512.5	475.1	338	521.5	826	320.3	3,337.2 cu. yds.
Fills made (Figs. in cubic yds.)	826.7	1738.2	2643.6	4170.1	3281.	2099.3	2234.4	16,993.3 cu. yds.
Oil used (Figs. in gallons)	65	60	50	60	60	55	35	385 gallons
Average Labor	Soldiers 6 hours/day	17	7	4	9	3	3	7 men per day
	Mexicans 8 hours/day	10	16	27	24	25	21	21 men per day

of about twenty-five. The additions were, however, gradual. The number of enlisted men available fluctuated considerably, ranging from none to fifty men daily, but with a rather low average, as will be seen from the accompanying table.

The above table gives summaries of the work accomplished monthly during the period of extensive construction on Leon Creek. The work in certain places was expedited by the use of about 200 pounds of dynamite and 35 pounds of black powder. Such necessary implements as picks, shovels, plows, scrapers, etc., used in the project were army properties. During this period an average of four double teams (of two mules each) were used for 64 days.

Had the anti-malarial construction commenced early in the spring of the year the work would have been planned on a different basis than that actually carried out. However, due to the lateness of the season the initial work was planned to consist merely of building a narrow central channel along the entire length of the creek, to grade where necessary for a steady flow of water, to fill such pools if grading did not entirely drain them, to eliminate standing pools, and to clear the banks of vegetation and other matter which would interfere with the flowage thus giving opportunity for the propagation of mosquitoes. Following this preliminary work (Plate 7), which reduced mosquito breeding sources to a minimum, the narrow central channel was permanently graded and the banks of the creek regraded where necessary, and sodded, to withstand washouts by the heaviest rains (Plate 8). This last phase of the work was well under way and nearing completion when, the Armistice having been signed, the writer was discharged from the service late in January, 1919.

Since the jurisdiction of the army authorities was confined to the limits of the reservation our work was limited to those portions of Leon Creek which were within that area or formed parts of its boundaries. However, the United States Public Health Service, with branch headquarters in San Antonio, under the direction of Major Gardner, appropriated a sum of money sufficient for the undertaking of improving the creek outside the camp bounds. The work done by them, although of material benefit in the reduction of the pests, was of a temporary nature. The splendid coöperation between the two government departments was productive of wonderful results, as was noted by Colonel Lewis, Sanitary Officer of the Medical Department for the Air Service, while on a tour of inspection of the Flying Fields, at Kelley Field in July, 1918, by the following remark, "There are very few flies in the camp and no mosquitoes."