benefits of mosquito control, and especially to change some of their basic habits in general sanitation. Under American occupation a start is being made toward more healthful and comfortable living in both urban and rural regions.

THE NONSPREADING OF LARVICIDAL OILS ON FLORIDA WATERS

R. W. BURRELL, C. C. DEONIER, AND C. B. WISECUP
U. S. D. A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine *

During the summer of 1943 intensive small-scale field tests were conducted in central Florida to determine the effectiveness of various DDT formulations on the control of anopheline larvae (1). These tests showed that a promising treatment consisted of spot applications of solutions containing 5 per cent of DDT in fuel oil or used crankcase oil. In September, shortly after the summer rainy season, it was found that the oils were not spreading on many of the roadside ditches, borrow pits, and small ponds in which anopheline breeding was still continuing at a high level.

A preliminary survey indicated that oil would not spread in one out of every four ponds. No particular condition, plant association, or other characteristic could be observed which seemed to be associated with this phenomenon. The oils spread freely in ditches on one side of the road and not on the other side, and on some parts of a pond and not on others. Frequently spreading would occur in the center of an open pond, but as the wind drifted the oil film into the vegetation and flotage where breeding was taking place the oil collected into ropelike masses. In one place, where oil from a drip can was slowly collecting on the water surface, many large larvae were found in the grass only 18 inches from the point where the oil was released.

A more extensive survey was made in early December to determine how widespread and how prevalent such areas were, and to investigate the possibility of overcoming this condition by the addition of spreading agents to the solutions. Four rivers, including the famous Suwannee, 2 cypress swamps, 4 roadside ditch margins of 2 springs, and 10 ponds or small lakes, were treated with kerosene, fuel oil, and used crankcase oil. The spreading properties of these oils were determined by measuring the area covered by a single uniform drop of oil. The results are shown in Table 1.

Kerosene did not spread well on any of the areas, and fuel oil gave a fair spread (13 to 24 inches) on only two of them. Although spreading was fair on 14 of the locations treated with used crankcase oil, on only 5 did this material spread as freely as it had during the summer. The spreading ability of all the oils was greatly improved by disturbing the water surface. This would indicate that some type of inhibiting biological film had formed since the cessation of the almost daily rains.

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TABLE 1. Spreading Properties of Different Oils Applied to 22 Water Areas in Central Florida. December 1943.

Treatment	Number of Areas on Which There Was No Spread of Oil	Number of Areas on Which Oil Spread			
		0–6 inches	6–12 inches	12–24 inches	More Than 24 inches
Kerosene	7	12	3	..	..
Fuel oil	7	9	4	2	..
Used crankcase oil	5	1	2	9	5

A series of 18 wetting agents, at 2 per cent concentrations, were made up with kerosene, fuel oil, and used crankcase oil and tested in a lily-covered pond, a grassy pond, a mossy pond, and a weedy stagnant ditch. In general, marked increases in coverage resulted from the addition of most of these agents to kerosene and to fuel oil, but in only a few of these tests was the spread satisfactory. Used crankcase oil, which spread satisfactorily without additional agents in two locations and showed some spread in the other two, failed to show so decided a response to most of the auxiliary agents as did the lighter oils. The following agents gave most consistent increases in coverage with all three types of oil: Triton X-100 (an aralkyl polyether alcohol); Vatsol OT (a dioctyl ester of sodium sulfosuccinic acid); Nopco 1216 (sulfonated sperm oil); and Triton B-1956 (polyglyceride of a glyptal resin).

In subsequent tests the spreading property of fuel oil was greatly increased by the addition of small quantities of vegetable oils. Castor oil appeared to be the best, closely followed by linseed oil. Unused lubricating oil is normally non-spreading, but when 1 per cent of sulfuric acid was added the mixture covered at least as large areas as did used crankcase oil. The sulfonated products of combustion are probably involved in the spread of used crankcase oil.

A more extensive comparison of the better spreading agents with No. 2 fuel oil was made on 16 ponds at the beginning of the rainy season in 1944. Table 2 shows that better spreading over a greater number of ponds was obtained with the three best synthetic compounds than with the vegetable oils. The action of the spreading agents was rather erratic, different ones spreading more effectively on some ponds than on others.

TABLE 2. Effect of Adding Various Emulsifiers and Other Materials on the Spreading Quality of No. 2 Fuel Oil. July 19–21, 1944

Spreading Agent (2 per cent)	Number of Ponds on Which Oil Spread			
	0–12 inches	12–24 inches	24–36 inches	36–48 inches
None	16	..	..	..
Triton X-100	2	5	4	5
Triton B-1956	2	7	4	3
Nopco 1216	2	6	6	2
Castor oil	3	5	6	2
Linseed oil, washed	4	6	6	..
Oleic acid	4	8	4	..
Tung oil	7	6	3	..
Linseed oil, raw	9	4	3	..
Pine oil (Yarmor 350)	8	8	..	..

The spreading powers of Triton X-100 and of a Span 20 + Tween 20 mixture (equal parts) were compared when used in No. 2 fuel oil alone and in an emulsion concentrate diluted with No. 2 fuel oil. The emulsion concentrate contains 10 per cent of the emulsifying agent and when diluted at the rate of 1 part to 4 parts of No. 2 fuel oil gives a solution containing 2 per cent of the emulsifier. The results of this experiment are presented in Table 3. The pond with stagnant water thick with algae showed the greatest inhibition to spreading. The spread on the permanent pool with old brown grass and smartweed was somewhat better, but for some unknown reason a similar pool with smartweed and float-

TABLE 3. Effect of Adding Various Concentrations of Triton X-100 and Span 20 Plus Tween 20 on the Spread of No. 2 Fuel Oil. Figures Represent Diameter (in Inches) of the Oil Film Resulting from the Application of One Drop of Material. October 1944.

Treatment	Stagnant Water Thick With Algae	Permanent Pools		Temporary Pools		
		Old Brown Grass and Smartweed	Smartweed and Floating Grass	Fresh Clean Water, Grass and Weeds	No Grass	Roadside Ditch Grass and Weeds
Fuel oil alone	2	8	10	4	3	6
Fuel oil plus 2% of emulsifier:						
Triton X-100	6	30	24	24	30	20
Span 20 plus Tween 20 (equal parts)	12	24	30	24	40	36
Fuel oil (4 parts) plus emulsion concentrate (1 part):						
Triton X-100	8	18	30	36	30	18
Span 20 plus Tween 20 (equal parts)	12	20	40	24	36	36
Used crankcase oil	8	12	30	36	24	24

ing grass showed the best spread. The temporary pools with fresh, clean water gave good spread with the wetting agents or the used crankcase oil. The fuel oil failed to spread well on any pond. Equal parts of Span 20 and Tween 20 gave more satisfactory spreading to fuel oil than did Triton X-100.

When this work was in progress, the failure to secure satisfactory spreading of oils appeared to be a definite limitation to the use of DDT-oil solutions. It was quickly shown, however, that light applications of finely divided sprays from aerosol bombs or hand sprayers gave complete coverage and produced highly satisfactory control of anophelines in similar situations (2, 3). It has since been learned that there are many areas in the tropical and subtropical regions of the world where oils spread poorly at certain seasons. In such areas it would be hazardous to depend upon pouring or squirting the small amounts of oil containing DDT that are needed for controlling mosquito larvae, but dependence could be placed on the use of hand sprayers.

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