than 300 microns diameter. However, in the wake of an airplane, there exists a pronounced downdraft which imparts to spray particles settling velocities which are greatly in excess of the velocities indicated by Stokes' law. A 50-micron droplet of 5 per cent DDT solution will settle in still air at about 17 feet per minute, while in the wake of an airplane it has a downdraft of 600 feet per minute. This factor is of greatest importance in the deposition of fine spray droplets. Satisfactory spray results with minimum dosages can be secured only under the proper meteorological conditions of still air existing at dawn and dusk, when breezes are at a minimum and inversion conditions exist.

Starting last year, ground markers were placed indicating areas and swaths so the pilot can locate areas and treat them with minimum loss of time. Radios have also been installed in the aircraft so that they can be in communication with the tower and also with a Bureau automobile which, too, is equipped with radio, eliminating the necessity of employing flagmen. This arrangement provides an increased measure of safety, as in an emergency the pilot can communicate directly with the Bureau and vice versa.

We have had a very successful mosquito control this past season and hope to achieve the same degree of control this coming year.

EQUIPMENT AND MATERIALS USED IN CONTROL OF GNATS IN CLEAR LAKE, CALIFORNIA

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The Clear Lake gnat, *Chaoborus asictopus* D. & S., has been a source of annoyance to the residents near Clear Lake in California for many years. The gnats do not bite, but enormous numbers flying around lights and into houses on summer evenings cause distress and discomfort. Outdoor gatherings and activities are all but impossible.

Research by the Corvallis, Oreg., laboratory of the Bureau of Entomology and Plant Quarantine indicated that several of the chlorinated hydrocarbon insecticides were effective in killing gnat larvae. One of the compounds, TDE (dichlorodiphenyl dichloroethane) was selected as having exceptional promise because it was relatively nontoxic to fish. Tests in two small lakes (Lindquist and Roth, 1950) gave encouragement that a TDE emulsion could be used safely and that the gnat might be controlled in Clear Lake. The emulsion concentrate contained 30 grams of TDE, 10 ml. of Triton X-100, and 72 ml. of xylene.

The Board of Trustees of the Lake County Mosquito Abatement District were willing to proceed with a control project on Clear Lake. The County district financed the operation with assistance from the State of California through the Bureau of Vector Control. The writers worked out plans for applying 14,000 gallons of the insecticide over the lake.

Clear Lake covers an area of approximately 40,000 acres, and has a water depth up to about 65 feet in a few places. The shore line is about 150 miles and the greatest distance across is about 8 miles. Frequent storms creating heavy wave action had to be considered in making plans for size of boats and barges to be used.

Studies by the writers had shown pronounced subsurface currents running in a somewhat circular pattern in the large arm

of the lake. The submerged currents could be detected when the lake was calm, and were probably set in motion by evening winds striking an exposed 5-mile section of the southeast shore line obliquely. Even small waves striking other parts of the shore caused outward moving currents. These findings plus the knowledge that the emulsion would disperse naturally in water led to a belief that if the insecticide was applied in narrow swaths separated by several hundred feet it would be rapidly dispersed throughout the water and stay suspended for several days before sinking. The larvae are embedded in the bottom mud during the daytime, but at night they migrate into the upper water. It was therefore believed that they would receive a toxic dose of the insecticide over several nights' exposure.

In order to have the maximum concentration of insecticide on the large arm of the lake, it was necessary to apply the material in one day. If application would be made over several days' time, the required concentration would never be reached because of settling out and deterioration of the toxicant. This arm of the lake was laid out in six sections, each 1 mile wide. Four round trips, or eight swaths approximately 700 feet apart, were made on each section. The insecticide was discharged by gravity flow direct from 50-gallon drums. A discharge rate of one drum in 20 minutes was obtained by laying the drum on its side and allowing the fluid to run through a 3-foot length of ⅜-inch plastic hose fitted with a thin metal spout.

Markers to establish the boundaries of each section were set out several days prior to the treatment. The ends of some of the courses were marked with 10- by 10-foot cloth-covered panels attached to piles driven into the bottom mud. The boundary lines along each course were marked by anchored wooden floats carrying flags that were visible for several hundred feet. This elaborate marking system was necessary to keep the boats on the course, especially on hazy days.

Six boats were selected to tow the barges carrying the drums of insecticide. These boats varied in length from 30 to 50 feet and were powered with various sized motors. Each boat was manned by a captain and two or more assistants. The boat speed was set at 5 mph, and this figure was used in calculating the number of drums needed on each area. The six barges were of two types—army surplus LCVP (landing craft, vehicle and personnel) 36 feet long, and heavy plank-type work barges. On the landing craft heavy decks were installed on the aft section to hold two or three drums containing the insecticide. A ramp sloped from the deck to the fore section of each craft. Drums were laid on the ramp and rolled up the deck as needed. The landing craft proved excellent barges for this work and did not require large towing boats, but the plank-type barges were cumbersome and required boats with considerable horsepower to move them.

The two men on the barges set the drums in place and made the necessary adjustments so that the fluid discharged properly. The amount to be dispersed on each section of the lake was determined by calculating the approximate water depth and surface area. One drum was discharging constantly, but over deep water one or more additional drums were set to discharging.

The large arm of the lake was treated with 8,800 gallons of insecticide before nightfall on September 15, 1949. Treatment of the two small arms was finished the following day. The entire operation proceeded according to plan, and the only mishap was the grounding of one of the barges on a submerged rock. Removal of some of the drums, however, released the barge.

It is believed this is one of the largest control operations that has been completed in 1½ days' time. The amount of TDE used was approximately 36,000 pounds, or 18 tons. This would be sufficient to treat about 175,000 acres for mosquito control at the rate of 0.2 pound per acre. Fortunately the concentrate

could be used undiluted. If a 5 per cent solution had been necessary, 70,000 gallons, weighing about 600,000 pounds, would have been required. It is estimated that the boats traveled 1,000 miles in preparing for and dispersing the insecticide.

The cooperation and work of the numerous people involved in the program was excellent. This was an event both the operators and citizens of Lake County had been looking towards for a long time. Most of the people had complete confidence that the gnat problem was solved even before the lake was treated. The community celebrated the event as G-E (gnat eradication) Day (Knipling 1950). There apparently were some doubters, however, since it was rumored wagers were made that Clear Lake gnats would be found the next July! However, after the first few weeks no gnat larvae could be found in Clear Lake by any known means of sampling, and not a single Clear Lake gnat was observed during the summer of 1950.

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IMPORTANT SPECIES OF MOSQUITOES AND CONTROL WORK IN WYOMING

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The purpose of this report is to present the results of our studies on the mosquitoes of Wyoming and also to give a summary of mosquito control activities in the state.

For a number of years we have been accumulating information on the species of mosquitoes found in the state, their distribution and the biology of each species. Many phases of the study are still incomplete. Much remains to be learned about the biology of many of the less common species. The total number of species recorded for Wyoming is now 42, as follows:

AEDES: campestris, canadensis cataphylla, cinereus, communis, diantaeus, dorsalis, excrucians, fitchii, flavescens, idahoensis, impiger, increpitus, intrudens, nearcticus, nigromaculis, pionips, pullatus, punctor, riparius, schizopinax, spencerii, sticticus, stimulans, triseriatus, trivittatus, vexans.

ANOPHELES: franciscanus, freeborni, occidentalis, punctipennis.

CULEX: apicalis, pipiens, restuans, salinarius, tarsalis.

CULISETA: alaskaensis, impatiens, incidens, inornata.

MANSONIA: perturbans.

PSOROPHORA: signipennis.

Twelve species were selected as the most important on the basis of numbers of individuals and distribution in the state: *AEDES: campestris, cataphylla, communis, dorsalis, excrucians, fitchii, idahoensis, increpitus, pullatus, vexans; CULEX tarsalis* and *CULISETA inornata.* Many of the other species are troublesome locally. If we were to name the most annoying mosquito to the greatest number of people I think *Aedes dorsalis* would win the honor.

LIFE ZONES. A discussion of the distribution and abundance of mosquitoes in a given area must take into account topography, weather conditions and a