

and with adequate slope for drainage. This elevation is not sufficiently high for property developmental purposes and the developer would have to add more fill dirt before the property would be suitable for residential property.

VERTICAL DRAINAGE. The southern tip of Florida presents many problems in mosquito control due to the rock formation encountered. The Florida Keys are composed almost entirely of rock and coral, ranging from very hard flintlike rock in the eastern and central portion of the Keys to fairly soft rock on the western end at Key West. Ditching, diking, or filling is not generally feasible due to the absence of earth. Most of the breeding areas are saucer-like in formation and drainage has been satisfactorily accomplished to a limited extent by blasting through an overlying impervious rock stratum and permitting drainage into an underlying pervious stratum. Where the elevation of the breeding area is above the tidal level the areas will drain sufficiently to prevent mosquito breeding. In those areas below the tidal elevation it is noted that fluctuation of the water level occurs with the tides although there may be some time lag.

This method holds promise for correcting a great many areas in the Florida Keys and it is expected that vertical drainage will be employed considerably in this area in the future.

DEEPENING AND FILLING. A limited amount of work is being performed with draglines and bulldozers in deepening and filling of small salt-marsh breeding areas. The principle involved is to deepen one portion of the breeding area to a depth sufficient to maintain water at all times, and to utilize the excavated material to build up the remaining area to sufficient elevation to prevent water remaining on the area.

CONCLUSION. Continual research work is being carried out throughout our nation in an effort to obtain more information on the habits of mosquitoes and the best ways of controlling them. Many ways are now employed; some of them good and some not so good. Through research and the ultimate development of means for economically and permanently controlling mosquito breeding sources, the mosquito nuisance can be greatly reduced with a saving of thousands of dollars now expended for repetitive measures.

MOSQUITO CONTROL IN NEBRASKA—PAST, PRESENT, AND FUTURE

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Nebraska claims more miles of streams of running water than any other State in the Union. It also has many lakes and marshes, with more than 2,000 lakes in the Sandhill Region alone. The first irrigation ditch in Nebraska was built in 1866 and the first irrigation district, the Farmers' Irrigation District of Scottsbluff County, was started in 1887. Today we

have approximately 750,000 acres under ditch irrigation and untold acres under well irrigation.

Not until 1939, when Dr. H. Douglas Tate joined the staff of the Department of Entomology of the Agricultural Experiment Station, was there serious interest in mosquitoes. Previous to Dr. Tate's arrival, mosquitoes were considered pests

which simply must be endured. True, the only mosquito-borne disease recognized in Nebraska previous to 1940 was malaria and that was extremely rare. Therefore, mosquitoes attracted little attention from entomologists, public health workers, or the medical profession.

In 1942, Dr. Tate and one of his students, W. W. Wirth, published the first paper on Nebraska mosquitoes entitled "Notes on Mosquitoes in Nebraska," in *Entomological News*. The 1940's proved to be important for the development of mosquito studies in Nebraska.

Dr. W. McD. Hammon and his co-workers, especially Dr. W. C. Reeves, made several trips into the State in the early 1940's studying the relationship of mosquitoes to western equine encephalomyelitis. In 1943, they succeeded in isolating the Western equine virus from a specimen of *Culex tarsalis* taken in eastern Nebraska. In addition, they found that the ring-necked pheasant was one of the reservoirs for the disease.

In June, 1944, Dr. Tate and another of his students, Doris B. Gates, published *The Mosquitoes of Nebraska* which appeared as a research bulletin of the University of Nebraska Agricultural Experiment Station. In this work, which was based on light trap records for 1942 and 43, they took approximately 250,000 mosquitoes which represented 33 species. Their work showed that *Aedes vexans* was the most abundant species, followed by *Culex tarsalis*. By and large these studies also showed that the anopheline mosquitoes were of minor importance in the State.

During the war years, the Office of Malaria Control in War Areas of the United States Public Health Service under the direction of Dr. John A. Rowe of the Kansas City Office of the United States Public Health Service, was active in Nebraska around military establishments and prisoner-of-war camps. This group was able to show that except in the extreme eastern part of the State, anopheline mosquitoes were rare or absent. However, they felt that there were sufficient numbers of *Anopheles* around Fort Crook so that

control measures were placed in operation. Their survey in the vicinity of the Alliance Air Base resulted in the city of Alliance carrying on a program to control the pest mosquitoes.

After the war years, mosquito control and interest in mosquitoes again went into a decline. Dr. Tate left the State to take another position and the interest in mosquito control at the College of Agriculture rapidly disappeared. However, during this same period, many cities and villages in the State of Nebraska had young men returning from military service and they had seen how the military services were able to bring about mosquito control or at least, temporary relief from mosquitoes. These young men were able to sell local governing bodies the idea of some type of mosquito control program. Most of these mosquito programs were rather superficial and they consisted mostly of the town purchasing a sprayer or some type of fogging machine and running up and down the streets two or three nights per month.

In the latter part of 1940, the United States Public Health Service became interested in several mosquito problems in Nebraska. Most of their interest derived from the building of large dams for the impoundment of water for irrigation purposes or for flood control purposes, with the result that several entomologists of the United States Public Health Service were detailed to Nebraska to make surveys in various river basins so that they could make recommendations to federal agencies building these dams. Mr. George A. Thompson was one of the first entomologists of the Public Health Service to work in Nebraska. Mr. George Keener also did some of the early work in Nebraska. This material was summarized in various publications of the Public Health Service. Around 1950, the Public Health Service became interested in irrigation and its relationship to water management, and a laboratory was established at Mitchell, Nebraska. In early 1954, it was discontinued, and its personnel was moved to Logan, Utah. This laboratory started many projects, some of which were left uncompleted. Most of

the work was related to the problems associated with irrigation. They were able to show that the most serious mosquito breeding areas in the grass lands were the seepage areas along the large irrigation ditches and the practice of flooding pastures. In addition, some basic biological studies on grass-land mosquitoes were made. The workers at this laboratory collected large live samples of *Culex tarsalis* and were able to show that the virus of western equine encephalitis is present in the mosquitoes found throughout the North Platte valley.

In 1952, the author was hired by the Nebraska State Department of Health. Among the duties assigned to him were studies in vector control. Unfortunately, only a small portion of his time can be devoted to mosquito control, but several surveys have been made, and still others are in operation.

To sum up the mosquito problem as it exists in Nebraska at the present time, the problem must first be related to a specific section of the State. The most serious mosquito problems existing are in the irrigated lands of the western portion of the State. The number one problem area is the North Platte valley, from the head waters of Lake C. W. McConaughy to the Wyoming line. This is a large irrigated area. All the irrigation is by ditches. Throughout this area are many large seepages, and the practice of pasture is widespread. This area has a well-known history of encephalitis.

The number two area would probably be the Republican valley in the southern part of the State. This is also an irrigated area. However, it is just starting its importance as an irrigated area with the completion of a large dam near Trenton by the Bureau of Reclamation. This area is of great interest at the present time, because in 1954, we had over twenty-two cases of encephalitis reported from Red Willow County, Nebraska. There are also other areas throughout the State where mosquitoes are a local problem. The Missouri valley has a large population of mosquitoes from the Kansas line to the South

Dakota line. However, most of these mosquitoes are strictly pest mosquitoes and are not concerned in disease transmission. In other areas of the State, there are smaller irrigation districts. Some are in good condition, while others are in poor condition and present mosquito breeding problems.

Another area where we have done a limited amount of work is in the oil producing areas of the State. Two years ago, a study was conducted in Richardson County, Nebraska, which has the oldest oil fields in Nebraska. All the oil fields in Richardson County produce large quantities of salt water as well as oil. The salt water is separated by chemical means and placed in ponds. Some of these ponds have become fairly large and have shorelines with emerging vegetation which produce large numbers of mosquitoes. So far, we have not found any of the typical salt-marsh mosquitoes coming into these areas, although they do have fairly high salt content. We are in the process of finishing a study on this subject and hope to have it published within the next year. Some of the largest wet land areas of Nebraska lie in the Sand Hills area of Nebraska, where mosquito production is very high. However, since this area has an extremely low human population, mosquitoes have never become a problem, at least as far as man is concerned, although they do have a minor effect upon beef cattle.

Now let us take a look into the future as far as mosquito control in Nebraska is concerned. Studies by the Nebraska State Department of Health seem to indicate that human cases of encephalitis are on the upswing. It is rather difficult to determine whether or not we actually have more cases of encephalitis than we had ten or fifteen years ago, because it is well known that many cases of encephalitis were diagnosed as polio or some other disease. With the new Salk vaccine, this picture will probably change, and we may arrive at a more accurate picture. The knowledge that encephalitis is a mosquito-borne disease is becoming more widespread

throughout the State, and people are beginning to realize that the only satisfactory control of encephalitis is through mosquito control. Also, they are learning that mosquitoes can be controlled. As in many other areas, one handicap that has faced mosquito control in Nebraska is the widespread idea expressed in the words, "mosquitoes were here when my grandfather was here, and they are going to be here in my children's day." This need not be true, for it is possible to bring about satisfactory mosquito control and eventual eradication of the mosquito from many populated areas of the State. We already have an active group in the North Platte valley, who are attempting to interest their neighbors in a mosquito abatement district bill, and it is my understanding that this group will have their local representative at the Nebraska Unicameral present such a bill to the 1957 Legislature. In addition, more and more towns are becoming conscious of the fact that satisfactory mosquito control can be done. Although at the present time, most towns and villages feel that they do not have the right

to carry their control measures beyond corporate limits, many of them are also realizing that it is impossible to control mosquitoes simply by running a sprayer or fogger up and down the streets and alleys of a given village or town. Therefore, they are going outside the limits of the city and attempting to do some work. However, this type of program is best handled through a mosquito abatement district, rather than by a single municipality attempting to put on a control program. It is my personal feeling that an educational program of the State Department of Health can eventually explain to the citizens the objective of mosquito abatement districts, and how they can make living a little more healthful and pleasant in any given area. Through this, we hope eventually to have mosquito abatement districts in many of the major valleys of Nebraska's rivers. Although the history of mosquitoes and mosquito control in Nebraska is short, we have gone a long way in a short time, and in the coming years we hope to be among the leaders in mosquito control in this country.

AMCA BULLETINS STILL AVAILABLE

No. 2—Ground Equipment and Insecticides for Mosquito Control.

No. 3—Mosquito Culture Techniques and Experimental Procedures.

Priced at \$2.00 each.

Obtainable from C. T. Williamson, Business Manager,
Yaphank, N. Y.