Kansas State College; *Treasurer,* F. W. Albertson, Fort Hays Kansas State College.

Executive council members are L. D. Bushnell, Kansas State College, E. O. Deere, of Bethany College, and H. H. Hall, Pittsburg. Two associate editors, chosen for three years, are J. A. Trent, Pittsburg State Teachers College; and W. H. Schoewe, of the University of Kansas. Dr. Robert Taft, of the University of Kansas, is the new editor of the "Transactions." The writer will serve the second year of his three-year appointment as representative to the academy conference at Dallas with President Gates as alternate.

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MANHATTAN, KANSAS

REPORTS

ADDITIONAL COOPERATIVE STUDIES OF THE RELATION BETWEEN MOSQUITO CONTROL AND WILDLIFE CONSERVATION[1]

A PREVIOUS report of the Technical Committee[2] outlined the mechanism for the conduct of investigations for the coordination of programs of malaria control and wildlife conservation in the impounded waters of the Tennessee Valley Authority. This report briefly outlined the studies conducted during the season of 1939. The work of this committee has continued through the summer of 1940 and it is desired at this time to make a brief progress report.

It is recognized that the production of *Anopheles quadrimaculatus* is closely associated with aquatic vegetation. It is also known that certain species of aquatic plants are objectionable, both because they favor the production of mosquito larvae and because they have no value as food for wildlife. This has led to an intensive investigation of the relative importance of various species of aquatic vegetation in the production of *A. quadrimaculatus.*

Quantitative studies were undertaken to determine the relative importance of individual aquatic species in the production of this mosquito. Twenty species of aquatic plants were studied, but emphasis was placed upon nine of these. Plots five yards square were adopted as the unit of study and usually four or more such plots were sampled for each plant species in a given area. Ten square-foot samples were collected from each plot by means of a screen dipper and strainer pan. All anopheline larvae were classified according to their instars, and species determinations were made of most fourth instar larvae. Estimates were made of the vegetative cover and the amount of flotage in each square-foot sampling station. Altogether, 3,000 individual samples were taken during the summer. The results of these studies indicate that, with the possible exception of watershield (*Brasenia schreberi*), which may inhibit larval production, factors other than the individual species of vegetation are of primary importance in determining the extent of anopheline production in a given area. It was apparent that structure and growth characteristics of the plants and the way they interact with a combination of external factors such as flotage, water-level, wind action, the amount of vegetation edge-line at the water surface, etc., were more significant in anopheline production than were mere species differences. Because of water-level fluctuations for malarial control and variations brought about by floods, navigation, and power uses, the marginal vegetation in the reservoirs of the Tennessee Valley Authority presents problems widely different from those found under more stable conditions. At high-water levels emergent vegetation was important in anopheline production, while at low-water levels submerged species became important. Floating-leaved species were important at both high- and low-water levels. In general, there was a positive correlation between the density of anopheline larvae and the abundance of flotage and frequently with the amount of vegetative cover.

Experimental studies have been conducted on the control of vegetation objectionable to malaria control and wildlife interests. Experimental applications of powdered sodium arsenite were made by airplane at monthly intervals at the rate of approximately eight pounds per acre. With the exception of lotus, the control of the various species obtained by four applications was encouraging. Coppice was particularly susceptible to sodium arsenite. While complete control can not be anticipated at present, it is felt that such applications might reduce the vegetative cover sufficiently to make the application of larvicides more effective and even reduce the need for these. A wide variety of liquid herbicides has been tested on alligator grass (*Achyranthes philoxeroides*), but no definite conclusions have been reached at this time. The utilization of an underwater weed cutter in the control of lotus (*Nelumbo lutea*) and cowlily (*Nymphaea advena*) has given very encouraging results.

Experimental plantings of sixteen species of vegetation important to wildlife have been made in the Wheeler refuge. These plantings indicate that three species suitable for waterfowl, namely, four-angled

[1] Report of the Technical Committee for 1940 by E. Harold Hinman (*chairman*), John Steenis, W. V. King, J. L. Robertson, Jr., A. H. Wiebe, Clarence Tarzwell and A. D. Hess.

[2] E. L. Bishop, SCIENCE, 92: 201–202, 1940.

spike rush (*Eleocharis quadrangulata*), soft-stem bulrush (*Scirpus validus*) and three-angled bulrush (*S. americanus*) are tolerant to fluctuation and draw-down of water-level and might be effectively fitted into existing plant associations at certain contours so that they would not add materially to the malaria control problem.

A large number of soil samples for arsenic determinations were taken from the reservoirs in the spring of 1940 prior to the application of Paris green, and similar series in October at the cessation of larvicidal activities. Analyses of these samples show no significant increase in the amount of arsenic in the soil.

A study was conducted to obtain information on the feeding habits of *Gambusia* with special reference to its predation on *Anopheles* larvae. The forage ratio[3] was adopted as a measure of the feeding preference of *Gambusia* for anopheline larvae and pupae. The forage ratio is obtained by dividing the percentage of a given kind of organism in the fish stomachs by its percentage in the environment. The ratio will vary above and below one accordingly as the predator prefers or avoids the particular prey. The forage ratio may be calculated from number, weight or volume of organisms; in this study numerical forage ratios were used. Enclosing the study plots with a barrier seine made it certain that the fish whose stomachs were examined had fed in the same plot from which the samples of food organisms were collected. About 30 square-foot samples were selected at random from each plot to be investigated, and both the macroscopic and larger microscopic organisms were counted and identified. Immediately after the collection of these organisms, the *Gambusia* were collected from the plot, preserved in formalin, and taken to the laboratory for analysis of stomach contents. Three ecological conditions were studied, and in each of these, study plots were selected which contained the maximum number of larvae. One represented typical problem areas of the reservoir subjected to fluctuation; a second was a protected bay of the main reservoir dammed off so that terrestrial vegetation was flooded and the water-level kept relatively constant; the third type was an area newly impounded during the late summer after terrestrial vegetation was well advanced and when wind action had caused flotage concentration. These studies involved the collection and examination of 295 square-foot samples of surface-dwelling food organisms and the collection and examination of stomach contents of 968 *Gambusia*. The feeding preference for anophelines increased as their absolute density increased, the forage ratio being one when the larval density was about two per square foot; above this density the forage ratio increased, and below this density it decreased. The feeding preference for anophelines increased as the size of the larvae increased; no first instar larvae were found in the stomachs and the forage ratio for fourth instar larvae was greater than for second or third instar larvae. The forage ratio for pupae was greater than for any larval instar. It was concluded that predation of *Anopheles* by *Gambusia* in these areas was sufficient to reduce materially production of adults. However, this reduction is not considered sufficient, under the conditions represented in certain areas, to eliminate the need for other control measures.

Preliminary investigations have been carried on regarding the *Odonata* as predators of anopheline mosquitoes. Dr. Allan F. Archer also conducted certain investigations on the predation of spiders on adult mosquitoes.

Through the cooperation of the Fish and Wildlife Service, the Tennessee Valley Authority and the WPA, provisional plans were made to dyke off an extensive shallow area in the Wheeler Refuge as a means of eliminating a serious anopheline breeding area and at the same time providing a source of winter food for migratory waterfowl. The areas will be dyked off, connected by dragline ditches, and a single pumping structure will be utilized to dewater the area at the onset of mosquito production. The area can then be maintained in a dewatered state throughout the summer, permitting the planting of suitable species of plants for wildlife food. At the close of the mosquito breeding season the area will be flooded to provide feeding grounds for migratory waterfowl. The inclusion of two-way pumps will permit these operations even at times when the lake is at low elevations.

At a joint meeting of the Policy and Technical Committee at Knoxville, December 6, 1940, it was agreed that, since a working relationship now exists whereby a study of these problems may be continued as a part of the regular research programs of the interested agencies, the formal organization should be discontinued. It was stated further that it would be the purpose of the participating agencies to continue at the present or increasing levels the program of cooperative research which has been developed.

[3] A. D. Hess and A. Swartz, *Trans. 5th North Amer. Wildlife Conf.*, pp. 162–164, 1941.

THE CHICAGO MUSEUM OF SCIENCE AND INDUSTRY

LAST fall the Chicago branch of the American Association of Scientific Workers appointed a distinguished committee of its members to look into the problems raised in connection with the dismissal from the Museum of Science and Industry of a number of members of the scientific staff. The accompanying report by this committee has been unanimously approved by the executive committee of the association.

R. W. GERARD,
President, Chicago Branch