

REVIEWS AND ABSTRACTS

RESIDUAL SPRAY APPLICATIONS TO SALT-MARSH AND JUNGLE VEGETATION FOR CONTROL OF MOSQUITOS. By A. H. Madden, H. O. Schroeder, and A. W. Lindquist. *J. Econ. Ent.* 40(1):119-123, 1947. Preliminary tests with residual-type spray applications on open marsh and jungle vegetation for control of adult salt-marsh mosquitoes are reported.

On the salt-marsh vegetation, DDT was applied in three forms; 5 per cent oil solution, 5 per cent xylene-water emulsion, and 5 per cent aqueous suspension, and at rates ranging from 5 to 30 gallons per acre. The effectiveness of the treatments was determined by exposing houseflies and mosquitoes to samples of vegetation collected from the plots, supplemented by observations and trapping records. The results of the tests were somewhat erratic and apparently were influenced by the factor of foliage injury from heavy applications of the solution and the emulsion. There was sufficient evidence, however, to support the conclusion that such treatments offer promising possibilities for mosquito control in salt-marsh areas.

On jungle vegetation, tests were made with DDT in two forms and with pyrethrum and benzene hexachloride. DDT was applied as a 5 per cent oil solution and a 5 per cent aqueous suspension. Pyrethrum was applied as a solution of 1 per cent pyrethrins and 5 per cent piperonyl cyclo-hexenone in kerosene. Benzene hexachloride was applied as a benzene-water emulsion containing 5 per cent of the crude product of 12 per cent gamma isomer content. All treatments were made at the rate of 5 gallons per acre. Results were determined by landing-rate counts of mosquitoes in the treated areas and confirmed by tests with houseflies on vegetation collected from the field. The DDT suspension was the most effective application. It was concluded, however, that benzene hexachloride at a higher concentration might be equal to or better than the DDT suspension.

A comparison of the results with the DDT treatments in the two vegetation areas reveals that the treatments on the jungle growths were more effective than those on the salt-marsh. This is explained on the basis that the density and physical properties of the marsh vegetation prevents so thorough a treatment as is possible in the jungle.

Further work on a large scale is recommended to properly evaluate this method of mosquito control as to effectiveness and cost.—R. E. HEAL, Merck and Co., Rahway, N. J.

A STUDY OF MOSQUITO BEHAVIOR. An Experimental Laboratory Study of the Mating Behavior

of *Aedes aegypti* (Linnaeus). By Louis M. Roth. (in press, American Midland Naturalist, January (?) 1948).

Experimental evidence is presented to confirm Johnston's and Mayer's hypothesis that in Culicidae Johnson's organ is aural in function, an assumption previously based chiefly on morphological evidence. Experiments also proved that the males perceive vibratory stimuli as had been hypothesized in the literature.

The sound produced by the female of *A. aegypti* in flight is the external stimulus which attracts and induces the male to copulate. Odor and sounds other than those made by the female in flight play no rôle in the mating behavior. The male attempts to copulate when a sufficient number of antennal fibrillae are extended making possible the perception of the sound of the flying female. This occurs about 15 to 24 hours after emergence and by this time the hypopygium has rotated sufficiently so that copulation can be successfully completed. Copulation occurs only when the female begins to fly voluntarily at least several hours after emergence. By this time she becomes "attractive" because the sound she makes in flight falls within the range which will stimulate the male. Very young females are "unattractive" since the sound produced by them in flight falls outside of the range which will attract the male. Sexually active males cannot differentiate between recently emerged males and old females since the sounds made by very young males in flight fall within the spectrum which will induce older males to copulate. The male responds to a range of sound frequencies rather than to a single fixed frequency; thus *aegypti* males attempt to copulate with males and females of several different species of Culicidae because the sounds made by these mosquitoes fall within a stimulating range.

The instinctive mating behavior of *aegypti* males whether elicited by a female mosquito or by mechanically produced sounds is basically the same. These coordinated reflex actions, depending upon the source of the stimulus, may be tabulated as follows:

Source of Stimulus	Behavior of Male
A. Female in flight	1. Flight
	2. Attraction
	3. Seizure of female
	4. Claspings female's genitalia
B. Tuning fork (e.g. 480vps.)	1. Flight
	2. Attraction
	3. Seizing response
	4. Claspings response

The seizing response elicited by the sounds of the tuning forks or an audio oscillator speaker consists of clinging with the front and middle legs to the cloth of the cage, and vibrating the wings rapidly. The clasping response usually follows the seizing response and consists of flexing the abdomen ventrad.

The upper and lower limits of sound frequencies which will induce a mating response from *aegypti* males are about 100 and 800 cycles per second. The limits vary with the age and virginity or non-virginity of the males. With increase in age both virgin and non-virgin males respond to a wider range of sound but the range of non-virgins which have copulated repeatedly is narrower than that of virgin males kept isolated from females. The practical application of the response of mosquitoes to sound is discussed and it is concluded, that, at present, it appears unlikely that a killing device employing sound as an attractant would be a more efficient or economical substitute than the present methods of mosquito control.

The front and middle tarsi of the male are structurally suited for seizing and holding the female. The hind tarsi take little part in mating. The female tarsi are not suited for seizing and she does not cling to the male or hold him to her during copulation. Knab's hypothesis that the positions assumed by mosquitoes during copulation are correlated with the female tarsal claws is unfounded and apparently was based on the erroneous field observation that the female clings to the male. The hypothesis is suggested that the face to face and end to end positions assumed by different species of mosquitoes during copulation might be correlated with the degree of development of the last tarsal segments and claws of the male's front and middle legs.—LOUIS M. ROTH, Entomology Laboratory, U. S. Army Quartermaster Depot, Philadelphia 45, Pa.

THE MOSQUITOES OF BWAMBA COUNTY, UGANDA; PART V. "VERTICAL DISTRIBUTION AND BITING-CYCLE OF MOSQUITOES IN RAIN-FOREST, WITH FURTHER OBSERVATIONS ON MICROCLIMATE." By A. J. Haddow, J. D. Gillett, and R. B. Highton. Bull. Ent. Res. 37(Pt. 3):301-330. 1947.

Since 1937, field investigations on the epidemiology of yellow fever have been carried on in Bwamba County, a small heavily-forested area in the extreme west of Uganda. Yellow fever virus was isolated in 1941 from one human case and from *Aedes (Stegomyia) simpsoni* Theo. and other *Aedes*, however *A. simpsoni* was not considered the principal vector since it is a sylvan mosquito. It was concluded that an arboreal mosquito was the most likely transmitter because it is known that yellow fever is endemic among the monkeys of the Bwamba forests, especially since a high rate of immunity is shown by certain species that rarely descend to the ground. Although several *Aedes* species show arboreal

tendencies it is the belief of the authors that *Aedes africanus* may play a large part in the transmission of yellow fever among monkeys. Evidence in support of this theory is given.

Some 57 mosquito species were collected although many Culicine were not identified. *Anopheles gambiae*, in unusually heavy concentration, was found to be by far the most common mosquito at all levels of elevation, over 93 per cent of all mosquitoes collected being *A. gambiae*.

Information relative to the occurrence of mosquitoes at different elevations and contrasting forest cover is discussed at some length. Biting habits at these levels and at different times of day and season are given.

It was interesting to note that certain species were collected principally at heights over 50 feet while other species were in the lower stratum.

A discussion of investigational methods at the various forest levels, description of the forest areas chosen and an interesting description of the forest microclimate encountered is given.—G. EDWIN WASHBURN, Turlock Mosquito Abatement District, Turlock, Calif.

A MALARIA RECONNAISSANCE OF THE REPUBLIC OF HAITI. By J. H. Paul and Athemas Bellerive. Jour. Nat. Mal. Soc. 6(1):41-67. 1947.

1. A total of 31,285 spleen palpations were made in 826 schools of Haiti. Splenic enlargement was noted in 18.4 per cent of the children.

2. The most malarious areas are the arrondissements of Aquin, Hinche, Mirebalais, Trou, Nippes, Tiburon, Coteaux, Fort Liberté, Leogane, and Cayes—all with spleen rates higher than 30 per cent. The few areas of Haiti that are malaria free, are the higher mountain valleys and the southwest slopes where the rainfall is very low.

3. Blood smears were made on 11,841 children, and the parasite rate, adjusted to all those given spleen examinations, was 31 per cent.

4. The most common type of parasite was found to be *P. falciparum*, which was responsible for 86.6 per cent of the total infections; *P. malariae* accounted for 8.9 per cent, and *P. vivax* for only 1.9 per cent.

5. Three species of *Anopheles* were found in Haiti. *A. albimanus*, the important local vector, was present in 24 out of 27 arrondissements. *A. grabhami* was also widely distributed, being found in 19 arrondissements. *A. vestitipennis* was discovered in only one locality and is reported for the first time.—Author's summary and conclusions.

SOME RECORDS OF MOSQUITO DISSECTIONS IN NORTHERN NEW GUINEA. By J. P. Toffaleti and Willard V. King. Jour. Nat. Mal. Soc. 6(1):32-36. 1947.

Sporozoites of malaria parasites were found in the salivary glands of two specimens of the "intermediate" form of the *punctulatus* series of *Anopheles*, among 138 gland dissections of specimens of this form collected in native villages in the Hol-

landia area of northern New Guinea. This is the first record so far as known of infection in this form, which was the predominating one in these villages. Gland examinations of 12 specimens of subspecies *punctulatus* and 36 *juraiti* (formerly known as *moluccensis*) were negative. No infections were found in a series of 119 *A. karuuri* obtained from a military camp located several miles from any native village.

Filaria infections were found in the thoracic muscles or head of 20 of 203 specimens of the *punctulatus* series, for an infection rate of about 10 per cent. Seven of the specimens (representing each of the three forms) contained matured larvae. Six individuals among 268 *Armigeres obturbans* and one among 13 *Aedes* (*Aedes*) sp. contained immature filariae in the thoracic muscles. Small numbers of nine other culicine species were negative.—Authors' summary.

CONTROL OF THE GREENHEAD FLY (*Tabanus nigrovittatus*) IN MASSACHUSETTS. By Bertram I. Gerry and Norman S. Bailey (Massachusetts Public Health Department and State Reclamation Board). Legislative Report S-429, 1948.

Brief studies of the life history and habits of the Greenhead Fly were conducted as a preliminary to the control program. Although the larvae were found scattered generally over the salt marsh, the greatest density occurred in areas where the sod contained about 70 per cent moisture, a 6 per cent chloride content, and supported a dense ground cover. The adults began to emerge about the first of July and continued over a period of approximately four weeks. The flies migrated inland from the marsh for a distance of one mile but returned to rest on the marsh grass overnight or during periods unfavorable for flight. For all practical purposes, it may be assumed that the Greenheads produce one generation per year. It was found that control methods, directed at the fly stage, were the most effective.

Recreational centers and summer colonies were relieved of the Greenhead nuisance by establish-

ing treated barrier zones on the marsh land adjacent to the areas to be protected. Spraying operations were conducted with various types of equipment but airplane spraying proved to be the most effective and most economical. The dosage was scheduled with a maximum limit of 2 lbs. of DDT per acre because of information gained from DDT tolerance experiments conducted by the U. S. Fish and Wildlife Service in 1945 and 1946. Aluminum stearate, at the rate of 1 per cent by weight, was added to the Xylene-oil-DDT spray to determine its efficacy in prolonging the residual effect. Data acquired from cage tests showed that spray made up in the proportions as follows: Xylene, 1 qt.; DDT, 1 lb.; No. 2 Fuel oil, 3 qts.; and aluminum stearate, 1 per cent by weight, and applied at the rate of 1.6 lbs. of DDT per acre, provided a 12 day residual. Spray in the same proportions, but lacking the aluminum stearate and applied at the rate of 1.77 lbs. of DDT per acre, was less potent and lost its residual effect in less than 12 days. The operational costs indicated that effective Greenhead Fly control may be accomplished with DDT, applied by airplane, at not more than \$2.50 per acre.—B. I. GERRY

