Malaya that it is a vector of human disease though adults can be found in houses."

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AN EFFECTIVE REPELLENT FOR *Leptoconops kerteszi* KIEFFER (DIPTERA:CERATOPOGONIDAE)

R. D. SJOGREN [1]

The problem of human annoyance caused by the attack of the Bodega Black Gnat *Leptoconops kerteszi* Kieffer has been related by a number of workers (Smith and Lowe, 1948; Rees and Smith, 1950; Foulk and Sjogren, 1967; and Foulk, 1969).

This insect has been a particular problem since 1965 along the Santa Ana River in Southern California. Extensive breeding areas have been created by floods which eliminated a well defined river channel, forming damp sand bars suitable for immature gnat development. Gnat populations have increased in direct proportion to an increase in the available breeding grounds of this insect. In 1969 attack rates of 200–300 female gnats/minute were common within the river bottom and adjacent residential areas. Peak attack rates as high as 1,813 gnats/minute were recorded using the standard sampling method reported by Foulk and Sjogren (*op. cit.*).

Until recently, scarves or bandannas were used on the head for protection. These were applied holding opposite corners in each hand and passing the straight line over the head to the nape of the neck, then pulling the ends forward over the ears to tie above the forehead. If the bandannas were used with a hat and glasses, little annoyance was experienced even during periods of heavy attack. The intermediate valley strain of this insect which occurs along the Santa Ana River attacks primarily around the head and neck, in contrast to the desert strain which appears to prefer the head but will also feed on other hirsute portions of the body. The attack behavior of the former strain is characterized by repeated sequences of landing, crawling and taking flight again, with only an occasional female remaining to feed. Efforts to obtain numerical data based on landing rates met with difficulty due to the minute size of the gnat and its rapid movement prior to flight. Since the crawling sensation is as annoying to most humans as the bite, the criterion for effectiveness was established as one which prevented the gnats from landing on the treated area.

In 1966, all known commercially available insect repellent formulations were tested for their efficacy against this insect. Due to the habit of the local strain to preferentially attack the human head around the nape of the neck and ears, candidate materials were applied on one side of the head, the opposite side serving as a control. Evaluations were performed on two persons, each applying a material to be tested on three successive days. Attack rates during the testing periods averaged 300 females/minute on untreated human hosts. Initial efforts to locate a repellent which prevented the gnats from landing were unsuccessful. Several cream base materials, if applied heavily, gave the wearer the impression of relief; however the gnats only became stuck on the skin.

Commercially available insect repellents were again tested during the summer of 1969. Solutions containing 25, 50 and 75 percent N,N-diethyl-metatoluamide (Deet), dimethyl phthalate and Indalone in isopropyl alcohol were also tested. The latter two materials have been reported to be of value against *Culicoides*, a blood sucking genus in the same family as *Leptoconops*, by Pijoan *et al.* (1946), Cameron (1946), Peacock *et al.* (1948), Travis and Morton (1950), Applewhite and Smith (1950), and Applewhite and Cross (1951). None of the commercial formulations employing Deet or 2-ethyl- 1,3 hexanediol as the primary active

[1] Formerly Manager-Entomologist, Northwest Mosquito Abatement District, Riverside, California, presently Entomologist, Kern Mosquito Abatement District, P.O. Box 907, Bakersfield, California 93302.

ingredients had any repellent effect. Similarly, the alcohol base solutions of the above three mosquito repellent materials, at any of the three concentrations, failed to provide protection for over 5–10 minutes after application.

A formulation developed by McLaughlin Gormley King Company of Minneapolis, Minnesota, Intermediate 5734, however, was found to be effective in preventing the gnat from landing on treated surfaces for periods of two hours and longer. The formulation contains the active ingredients Deet and other isomers, N-octyl bicycloheptene dicarboximide, 2,3:4,5-bis (2-butylene) tetrahydro-2-furaldehyde and di-n-propyl isocinchomeronate. The repellent is marketed by the Canaan Products Division of Colgate Palmolive Company under the name, Wash 'n Dri® "Insect Repellent Towelette," and by the Fuller Brush Company as "Insect Repellent Gel."[2] The former product, an alcohol base towelette, has been used for the last two years when working near the breeding grounds and has proven effective and comfortable in routine use.

Due to the close taxonomic association between *L. kerteszi, L. torrens* (Townsend), *L. bequaerti* (Kieffer), and *L. nipponensis* Tokunaga, the same repellent formulation may also be useful against these species. No published records of repellents effective against the latter three species have been found.

The wide distribution of *L. kerteszi* in western United States, its persistent attack behavior, and the difficulty in obtaining control of the immature and adult stages of this insect, make the availability of an effective repellent noteworthy.

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[2] Mention of these commercial products does not imply endorsement.

A PROCEDURE FOR DETERMINING THE ONSET OF DIAPAUSE IN *Aedes vexans* (MEIGEN)

FERNE COOK[1] AND A. W. BUZICKY[1]

Metropolitan Mosquito Control District, 797 Raymond Avenue, St. Paul, Minn 55114

Diapause, that unique mechanism for survival, is displayed in the eggs of *Aedes vexans*. Whether the initiating stimulus for this species is reduction of temperature, photoperiod, or a combination of both has not been fully established. We do know that embryonic development stops just short of hatching in the fall, and the eggs will not hatch no matter how favorable environmental conditions may be. This reduction in hatchability is a gradual and somewhat labile phenomenon, beginning as early as the middle of August at 45° north latitude, and diapause is not completely established until the middle of October (Table 1).

TABLE 1.—Percent hatch of *Aedes vexans eggs* in relation to date.

Date	1966	1967	1968	1969	1970
18 Aug.	79.8	....	....	94.2	93
25 Aug.	36.7	47.3	64.3	88.0	84
1 Sept.	54.3	35.9	58.5	83.0	28
8 Sept.	39.2	25.7	29.9	53.3	25
15 Sept.	26.9	26.8	24.3	61.3	11
22 Sept.	5.6	31.7	31.6	54.9	18.7
29 Sept.	4.0	0	17.2	12.5	9.0
3 Oct.	2.7	0	11.8	24.1	1.9
13 Oct.	0.5	0	0	2.0	0

[1] Entomologist and Director-Entomologist respectively.