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Susceptibilities of Adult *Hippelates* Eye Gnats[1] to Insecticidal Deposits[2]

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ABSTRACT

Susceptibilities of eye gnats, *Hippelates pusio* Loew and *H. pallipes* (Loew), to deposits of 17 insecticides were determined under laboratory conditions. The two species exhibited similar susceptibilities. The most toxic chemicals were Dursban® (*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate), ronnel, fenthion, diazinon, malathion, dimethoate, naled, and dieldrin. Gardona® (2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate) was moderately toxic. Lower toxicity was exhibited by dimetilan, propoxur, crotoxyphos and trichlorofon. Very low toxicity was exhibited by lindane and DDT and extremely low toxicity by Abate® (*O,O*-dimethyl phosphorothioate *O,O*-diester with 4,4′-thiodiphenol) and methoxychlor.

Hippelates eye gnats are readily attracted to man and animals, can be extremely annoying, and are possible vectors of eye diseases. Temporary relief from the annoyance may be obtained by the use of repellents (Axtell 1967). With the proper insecticides, perhaps control of adult gnats could be obtained with sprays applied to the resting sites of the gnats in and around an area to be protected. Gnat control with insecticide-bait combinations, fogging and aerial applications may be possible.

The major pestiferous species in the southeastern United States are *H. pusio* Loew and *H. pallipes* (Loew). This report presents the results of evaluating the susceptibilities of these species to deposits of 17 insecticides under laboratory conditions.

Materials and Methods.—Gnats were from colonies (maintained at 26.7°C and 55% RH) which were established from several hundred adult individuals collected in North Carolina in 1963–64. The larvae were reared in a mixture of CSMA (Chemical Specialties Manufacturers Association) medium (obtained from Ralston Purina Co.) and vermiculite. The adult's food consisted of dried beef blood, honey, and strained prunes. Details of rearing and handling have been described (Axtell 1964) and were modifications of the techniques used by Bay and Legner (1964). The adult gnats were exposed to the insecticide 3–5 days after they had emerged from the puparia. Prior to exposure, the gnats were held (with food) in a screened cage ($0.13m^3$).

A modified Georghiou and Mulla (1961a) method of insecticide testing was used. Technical grade insecticides were dissolved in reagent grade acetone to make stock solutions (1000 μg/ml) on a wt/v basis. Dilutions from the stock solutions were prepared on a vol/vol basis. One ml of the desired dilution was pipetted into a 25-ml Erlenmeyer flask. This volume covered the bottom of the flask (12.4 cm^2). The acetone was then evaporated from the flasks for 45 min in an exhaust hood. The gnats were aspirated from the holding cage and 50 were released into each flask. The flask opening was covered with fine-mesh cloth and the inverted flasks were held in racks inside a glass-topped insulated box for 1 hr at 29.5°C. A fluorescent lamp above the box caused the phototactic gnats to remain on the treated portion of the flask nearly all of the time. At the end of the exposure period, the gnats in each flask were anesthetized with CO_2 and transferred into 150-ml glass jars. Cotton soaked in 10% sucrose solution was placed on the screen (50 mesh) tops of these jars. The dead gnats (those unable to move) were counted after holding these jars for 24 hr in the dark in a controlled-temperature cabinet at 21.2°C.

Each insecticide was evaluated at 6 concentrations in each of 2 tests. Each test included 3 replications/concentration of insecticide and 3 replications of the control (acetone-treated flasks). The 2 tests were generally in close agreement and the results were averaged. The maximum mortality in the controls was 2%, and usually there was no mortality. Therefore, the treatment mortalities were not corrected for control mortalities. The average percentage mortality in probits was plotted against the log of the insecticide concentration, and the regression line was fitted by eye.

The identities and sources of the insecticides used were:
Dursban® (*O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate, Dow Chemical Co.), ronnel (Dow Chemical Co.) fenthion (Chemagro Corp.), diazinon (Geigy Chemical Co.), malathion (American Cyanamide Co.), dimethoate (American Cyanamide Co.), naled (Chevron Chemical Co.), dieldrin (Shell Chemical Co.), Gardona® (2-chloro-1-(2,4,5-trichlorophenyl vinyl dimethyl phosphate, Shell Chemical Co.), dimetilan (Geigy Chemical Co.), propoxur (Chemagro Corp.), crotoxyphos (Shell Chemical Co.), trichlorfon (Chemagro Corp.), lindane (Hooker Chemical Co.), DDT (Geigy Chemical Co.), Abate® (*O,O*-dimethyl phosphorothioate *O,O*-diester with 4,4′-thiodiphenol, American Cyanamid Co.), and methoxychlor (Geigy Chemical Co.).

Results and Discussion.—Table 1 gives the LC_{50} and LC_{95} values for each of the 17 insecticides tested against *H. pusio* and *H. pallipes*. The insecticide concentration is expressed in $\mu g/12.4\ cm^2$, which is the entire treated area available to the gnats. There was little difference in the susceptibilities of the 2 species. With the variety of chemicals tested, it is reasonable to conclude that an insecticide effective against 1 of these species will most likely be effective against the other one.

The gnats were very susceptible to the OP (organophosphorus) compounds Dursban, ronnel, fenthion, diazinon, malathion, dimethoate, and naled. They were slightly less susceptible to dieldrin, a chlorinated hydrocarbon. The gnats were moderately susceptible to the OP compound Gardona, and less susceptible to the carbamates dimetilan and propoxur. Suscepti-

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Table 1.—Susceptibilities of *H. pusio* and *H. pallipes* to insecticide residues on a glass surface. LC_{50} and LC_{95} values expressed in $\mu g/12.4\ cm^2$.

Chemical	*H. pusio*		*H. pallipes*	
	LC_{50}	LC_{95}	LC_{50}	LC_{95}
Dursban	0.11	0.19	0.13	0.19
Ronnel	.19	.39	.16	.34
Fenthion	.22	.39	.41	.86
Diazinon	.23	.70	.28	.60
Malathion	.25	.86	.17	.28
Dimethoate	.27	.72	.27	.57
Naled	.30	.55	.18	.35
Dieldrin	.34	1.4	.25	.87
Gardona	1.2	3.4	.74	1.6
Dimetilan	1.3	3.8	1.4	5.0
Propoxur	1.8	9.8	1.8	9.4
Crotoxyphos	2.0	3.5	1.6	3.0
Trichlorfon	2.9	4.6	2.7	3.7
Lindane	3.8	6.3	4.1	6.8
DDT	4.8	10.5	3.9	8.6
Abate	41.0	81.0	40.0	73.0
Methoxychlor	51.0	90.0	52.0	110.0

bility was low to crotoxyphos and trichlorfon (OP compounds) and to lindane and DDT (chlorinated hydrocarbons). The least susceptibility was to Abate, an OP compound, and methoxychlor, a chlorinated hydrocarbon. Although the OP compounds were the most toxic to the gnats, no generalization can be made about the anticipated toxicities of different OP derivatives.

Georghiou and Mulla (1961a) tested some of these insecticides against *H. collusor* (Townsend) in California. Their LC_{50} values for diazinon, ronnel, naled, and DDT were very close to those reported here. They reported higher values for malathion and dieldrin, which probably reflected some degree of resistance. Georghiou and Mulla (1961b) later showed that field populations of *H. collusor* in California developed a high level of resistance to dieldrin, lindane, and DDT. This resistance was attributed to the widespread use of insecticides in agricultural soils in which the gnats breed.

Lindane was low in toxicity, which is in disagreement with the high degree of effectiveness reported by Spielman (1961). However, his testing procedure differed markedly and involved holding the gnats in a closed treated tube. The ineffectiveness of DDT agrees with the results given in these reports (Georghiou and Mulla 1961a, Spielman 1961).

These data identify several potentially useful insecticides for adult eye gnat control. The practical effectiveness of these compounds will have to be determined under field conditions and with different application methods.

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