CONTROL OF *CULICOIDES* (DIPTERA: HELEIDAE) IN SMALL PLOTS ON CAPE COD, MASSACHUSETTS [1]

W. J. WALL, JR.[2]
Cape Cod Mosquito Control Project

Introduction

Three species of bloodsucking gnats are known to breed in large numbers in salt water habitats along the eastern seaboard. The larvae of two species, *Culicoides canithorax* Hoffman and *C. furens* (Poey) have been found breeding in the mud of tidal marshes, and the third, *C. melleus* (Coq.), has been taken from intertidal sand on Cape Cod (Wall and Doane 1960).

During the past decade, a variety of chemical compounds have been employed in attempts to control *C. canithorax* and *C. furens* in Florida. These compounds include: dieldrin, aldrin, chlordane, malathion, heptachlor, ansenites, arsenates, benzene hexachloride and oils (Goulding *et al.*, 1953, Keller *et al.*, 1954, Labrecque 1954, Smith *et al.*, 1959). Jamnback *et al.*

---

[1] From the Proceedings of the 16th Annual Meeting of the AMCA, March 27–30, 1960, in Boston, Massachusetts.

[2] Permanent address: State Teachers College, Bridgewater, Massachusetts.

(1958) have reported control of *C. melleus* larvae in small plots on Long Island using DDT emulsion. Smith *et al.* (1959) used dieldrin on a large scale against this same species in Florida.

Considerable success in temporary control of all three species has been reported by most of the above cited individuals. In many instances, however, particularly in recent years, heavy dosages of insecticides were found essential to achieve this success. It is quite apparent, as shown by Smith *et al.* (1959) that in areas such as Florida, where large scale insecticidal control programs have been in progress for many years, resistance to certain insecticides is present in the sand fly populations.

Our approach to undertaking a large scale *Culicoides* control program on Cape Cod was influenced by the following factors: (1) a consideration of the probability of insecticidal resistance appearing in the future; (2) the continual pressure of conservation agencies to limit or prohibit the use of large scale aircraft insecticidal applications because of possible damage to other fauna; and (3) the limited funds available to our control project.

Before any large scale control of our annoying species of *Culicoides* was undertaken, therefore, we set out to determine the minimum effective dosage of insecticide that would prove successful in reducing larval population at a minimum cost without causing undue damage to other fauna.

CONTROL OF *C. melleus*

METHODS AND MATERIALS. The original test sites were located on protected sandy beaches having high and relatively uniform *C. melleus* populations. The width of each plot extended from low tide level to above high tide level and uniform plots 25 yards in length and 8 yards in width were employed. The insecticides were distributed at about low tide. Chemicals used in spray form were put on from a 2.5 gallon spray can and the granular material (Attaclay) was broadcast by hand. The plots were sprayed along one axis only to simulate conditions of aerial application. Sampling procedure was that employed by Jamnback and Wall (1958) and larval samples were taken immediately before treatment, one or two days after treatment and fourteen days after treatment. The results of these tests are summarized in Table 1.

RESULTS AND DISCUSSION. Dieldrin appeared to be the most effective of the chemicals employed at a dosage of 0.1 pound per acre.[3] In emulsion form at 0.1 to 0.2 pounds per acre, dieldrin produced better results than the granular form at 0.4 pound per acre, although we believe that this was due to difficulties in obtaining uniform distribution by hand broadcasting the granular material.

The results of larval control with fuel oil appeared very encouraging during the first few days following spray application. By the end of two weeks, however, it was obvious that only about 50 percent control had been attained with the oil spray. When DDT in oil was employed at the minimum dosage of 0.5 pound per acre, excellent control was noted by the second week following spray application. It is rather difficult to account for the complete control recorded the second day following spray application when 0.5 pound of DDT oil was applied as compared to 78.6 percent control at 1.0 pound of DDT-oil per acre. It is possible that better distribution of the spray was obtained or better penetration of the sand was realized in the former case. DDT emulsion was also very effective at 1.0 pound per acre although not so effective as the DDT-oil mixtures. BHC emulsion applied at the rate of 0.1 pound of gamma isomer per acre was very effective, but it was much less effective at one half this dosage.

Chlordane applied as a wettable powder at the rate of 1.0 pound per acre provided satisfactory control while malathion applied in this same form at the rate of 0.5 pound per acre was relatively ineffective. Each of these materials might have been more satisfactory in emulsion form.

[3] All dosages given refer to the amount of technical insecticide applied.

TABLE 1.—Results of insecticide tests against *C. melleus* larvae in small plots

Insecticide	Dosage (technical) lbs./acre	No. days after treatment	Average number of larvae		Percent reduction*
			Treated plot	Check plot	
Malathion (wettable)	0.5	(before tr.)	26.0(3)†	21(1)	——
		2	11.0(3)	21(1)	57.7
		14	23.0(6)	13(1)	(increase)
Chlordane (wettable)	1.0	(before tr.)	40.6(3)	33(1)	——
		2	9.3(3)	33(1)	77.1
		14	7.0(3)	41(1)	86.1
Dieldrin (granular)	0.4	(before tr.)	24.3(3)	34(1)	——
		2	3.0(3)	36(1)	88.3
		14	3.7(3)	31(1)	83.3
Dieldrin (emulsion)	0.2	(before tr.)	39.5(2)	28(1)	——
		2	0.5(4)	24(2)	98.5
		14	0.3(3)	14(1)	98.5
Dieldrin (emulsion)	0.1	(before tr.)	50.0(3)	50(1)	——
		1	0.0(3)	50(1)	100.0
		14	0.0(3)	50(1)	100.0
Fuel Oil (#2)	(1 quart)	(before tr.)	30.0(3)	50(1)	——
		2	5.0(3)	43(1)	80.6
		14	15.3(3)	50(1)	49.0
DDT in Fuel Oil	1.0 (1 quart)	(before tr.)	46.7(3)	50(1)	——
		2	10.0(3)	50(1)	78.6
		14	0.3(3)	50(1)	99.4
DDT in Fuel Oil	0.5 (1 quart)	(before tr.)	48.3(3)	50(1)	——
		1	0.0(3)	50(1)	100.0
		14	0.3(3)	50(1)	99.4
DDT (emulsion)	1.0	(before tr.)	50.0(3)	50(1)	——
		1	0.0(3)	50(1)	100.0
		14	4.0(3)	50(1)	92.0
BHC (emulsion)	0.1 (gamma isomer)	(before tr.)	28.0(3)	40(1)	——
		2	0.0(3)	48(1)	100.0
		14	0.3(3)	25(1)	98.3
BHC (emulsion)	0.05 (gamma isomer)	(before tr.)	50.0(3)	50(1)	——
		2	25.7(3)	50(1)	48.6
		14	30.6(3)	50(1)	38.8

* Abbott's formula.
† Number of samples averaged given in parentheses.

Many active annelids, insects and crustaceans were present in the treated areas up to 14 days following treatment. Oil-treated areas were also carefully observed, and it was noted that all traces of oil had disappeared from the beach sand by the end of the first to second weeks following application.

Two large stretches of intertidal sand were sprayed by helicopter with DDT emulsion and two with DDT oil spray to determine the feasibility of this method of application. Excellent distribution of the spray material resulted in all cases even when large numbers of small boats and sailing craft were anchored in the immediate vicinity of the treated areas.

CONTROL OF *C. canithorax* AND *C. furens*

MATERIALS AND METHODS. In the second series of experiments, plots 25 by 8 yards were selected in a salt marsh where prior sampling gave good larval counts. The sites selected included mosquito ditches

and bay front areas where previous investigation indicated the majority of larvae are located (Wall and Doane 1960). The sampling procedure employed was that of Bidlingmayer (1959) as modified by Wall and Doane (1960). The plots were sprayed from a 2.5 gallon spray can along one axis only. The results of the tests are given in Table 2.

uniform distribution of spray materials on the marsh soil. We feel, therefore, that similar dosages of insecticides applied in granular form would prove more effective in penetrating the marsh grass cover and contacting the larvae.

Annelids of the family Naididae were active in the treated plots up to 14 days following treatment and no noticeable

TABLE 2.—Results of insecticide tests against *C. canithorax* and *C. furens* larvae in small plots

Insecticide	Dosage (technical) lbs./acre	No. days after treatment	Average number of larvae		Percent reduction*
			Treated plot	Check plot	
Dieldrin (emulsion)	0.1	(before tr.)	19.3(3)†	50.0(1)	——
		1	3.0(3)	44.5(2)	82.5
		14	2.8(5)	50.0(1)	85.5
BHC (emulsion)	0.1 (gamma isomer)	(before tr.)	30.5(2)	50.0(1)	——
		1	2.3(3)	44.5(2)	91.5
		14	4.4(5)	50.0(1)	85.6
DDT (emulsion)	1.0	(before tr.)	14.6(3)	50.0(1)	——
		1	0.0(3)	44.5(2)	100.0
		14	1.6(3)	50.0(1)	89.0

* Abbott's formula.
† Number of samples averaged given in parentheses.

RESULTS AND DISCUSSION. During the late spring, summer and early fall, the breeding areas of *C. canithorax* and *C. furens* are characterized by the presence of heavy stands of marsh grasses, principally *Spartina alterniflora* and *S. patens*. The former becomes very long and dense along the ditches, creeks and bay fronts, and the presence of the marsh grasses makes it very difficult for the spray application to reach the soil surface. In addition to the grasses, the uneven surface and numerous fiddler crab holes create further barriers to uniform spray distribution and larval contact with the insecticide.

In spite of these factors, however, it can readily be seen from Table 2 that all three insecticides at low concentrations were quite effective in temporarily reducing the larval populations in the marsh mud for a period of 14 days. Although the insecticides employed were not so effective as they were against the *C. melleus* larvae, it is our opinion that this was due to the difficulties encountered in obtaining damage to other fauna such as fiddler crabs was apparent.

A total of 684 *Culicoides* larvae taken from the salt marsh test sites during the summers of 1958–59 were identified and of this number, approximately 96 percent were *C. canithorax* and 4 percent *C. furens*. These findings were further substantiated by collecting adult dark winged gnats biting or walking on the body during the daytime and early evening in or adjacent to the marshes during these same two summers. A total of 337 specimens were identified and the results were identical to those above.

SUMMARY

Control of *Culicoides melleus* in small intertidal plots was carried out on Cape Cod. Dieldrin in emulsion form was completely effective when applied at 0.1 pound per acre, but in granular form at the rate of 0.4 pound per acre it was somewhat less effective. Fuel

oil cut larval populations approximately in half and DDT oil mixtures at 1.0 and 0.5 pounds per acre produced excellent results. DDT emulsion at 1.0 pound per acre and BHC emulsion applied at a dosage of 0.1 pound of gamma isomer were also very effective. Chlordane wettable powder gave good results at 1.0 pound per acre while malathion wettable powder applied at the rate of 0.5 pound per acre was rather ineffective.

Many annelids, insects and crustaceans were active in treated plots following spray application and oil residues had disappeared by the end of the first to second week after treatment. Large stretches of intertidal sand were sprayed by helicopter and excellent distribution was obtained.

Small plots in a salt marsh were treated with dieldrin and BHC emulsions at 0.1 pound and DDT at 1.0 pound per acre. DDT appeared to be the most effective larvicide although all three gave good larval control under conditions of summer application. Larval samples taken from the test plots were 96 percent *C. canithorax* and 4 percent *C. furens*. These findings were substantiated by counts taken of adults biting or walking on the body surface. Naidid worms and fiddler crabs were active in the salt marsh test plots up to 14 days following treatment.

ACKNOWLEDGMENT

Thanks are expressed to Mr. O. W. Doane, Jr., Cape Cod Mosquito Control Project for his assistance in collecting the adult *Culicoides*, to Dr. A. W. Bell, Los Angeles City College for his identification of the naidid worms, and to Dr. W. W. Wirth, United States Department of Agriculture for his identification of representative larvae and adult *Culicoides*.

References Cited

BIDLINGMAYER, A. L. 1957. Studies on *Culicoides furens* (Poey) at Vero Beach. Mosquito News 17(4):292–294.

GOULDING, R. L., CURRAN, R. F., and LABRECQUE, G. C. 1953. Insecticides for control of salt-marsh sand flies in Florida. Jour. Econ. Ent. 46(1):37–43.

JAMNBACK, H., and WALL, W. J. 1958. A sampling procedure for *Culicoides melleus* (Coq.) (Diptera: Heleidae) with observations on the life history of two coastal *Culicoides*. Mosq. News 18 (2):85–88.

———, WALL, W. J., and COLLINS, D. L. 1958. Control of *Culicoides melleus* (Coq.) (Diptera: Heleidae) in small plots, with brief descriptions of the larvae and pupae of two coastal *Culicoides*. Mosq. News 18(2):64–70.

KELLER, J. C., LABRECQUE, G. C. and GOULDING, R. L. 1954. Tests with heptachlor and dieldrin for the control of sand fly larvae. Proc. Florida Anti-Mosquito Assoc. 25th Ann. Meeting, pp. 95–99.

LABRECQUE, G. C. 1954. Tests with granulated BHC and dieldrin for controlling sand fly larvae. Mosq. News 14(1):20–22.

SMITH, C. N., DAVIS, A. N., WEIDHAAS, D. E., and SEABROOK, E. L. 1959. Insecticide resistance in the salt-marsh sand fly, *Culicoides furens*. Jour. Econ. Ent. 52(2):352–353.

WALL, W. J., and DOANE, O. W. 1960. A preliminary study of the bloodsucking Diptera on Cape Cod, Massachusetts. Mosq. News 20(1): 39–44.