3. CRAIG, GEORGE B., JR., ET AL. Genetic variability in populations of *Aedes aegypti*. Bull. Wld. Hlth. Org. 24:527–539.
4. CHRISTOPHERS. *Aedes aegypti*: Life history, bionomics and structure. Cambridge University Press, 1960.
5. STRODE, GEORGE K. Yellow fever. McGraw-Hill, 1951.
6. *Anopheles gambiae* in Brazil, 1930–1940. New York: The Rockefeller Foundation, 1942.
7. Archives of Public Health Service. Leopoldville: Belgian Congo.
8. KAHN, N. H. ET. AL. Genetical studies on dieldrin-resistance in *Aedes aegypti* and its cross-resistance to DDT. Bull. Wld. Hlth. Org. 24:519–526.

THE USE OF BAYTEX AS A MIDGE LARVICIDE[1]

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Both BHC and EPN were used extensively in Florida as midge larvicides in the early 1950's according to Lieux and Mulrennan (1956). Following apparent failures with these insecticides, control measures were shifted from the use of larvicides to adulticides, utilizing thermal aerosol fogging. This has been very effective, but fogging has its limitations for controlling these insects.

In the intervening years since the apparent failures of BHC and EPN, numerous other chemicals have been screened as midge larvicides. Of these, Baytex (o, o-Dimethyl o-[4-(methylthio)-m-tolyl] phosphorothioate) has shown the most promise in Florida.

It was reported by Patterson and von Windeguth (1964) that Baytex, applied at the rate of 0.2 pound per acre in a one percent granular formulation to small ponds with water depth of about 3 feet, gave excellent control of midge larvae for about 2 months. This granular formulation exhibited no overt toxic effect on fresh water copepods, ostracods, Hydra, annelid worms, snails, clams, or the mosquito fish *Gambusia affinis;* however, it was very toxic to Cladocera. The Baytex did not affect the pH of the water, nor did it influence the speciation or production of fresh water algae.

Tests designed for the determination of effective dosage and insecticide coverage were conducted in 55-gallon containers placed in a lake. Results from these tests indicated that a 1 percent Baytex sand-core granule gave a quicker kill and was slightly more effective than a 1 percent clay granule. A 5 percent Baytex granular clay formulation was only about half as effective at the same dosage rate per acre as the 1 percent formulation, apparently owing to the greater distribution and degree of contact for the latter. The dosage rate found most effective was between 0.20 and 0.25 pound of technical Baytex per acre. This dosage results in a Baytex concentration of about 4 p.p.b. in a lake having an average depth of about 17 feet.

Following these preliminary studies, granular Baytex was applied to Little Lake Winterset at Winter Haven and to Lake Barton at Orlando, Florida for control of the midge *Glyptotendipes paripes*. This is a report of the results of these lake tests.

METHODS. Granular formulations of Baytex were applied twice to Little Lake Winterset, which is a 50-acre bay of a larger lake, but well isolated. The inlet between the two bodies of water is only

[1] Contribution of the Entomological Research Center, Florida State Board of Health.

about 50 feet wide and 5 feet deep, whereas the average depth of Little Lake Winterset is about 20 feet. Most of the chironomid larval population was concentrated in the sandy bottom areas of the lake at a water depth of between 10 and 15 feet.

The insecticide was applied the first time as a 1 percent sand-core granule at the rate of 0.27 pound Baytex per acre. For the second application, a 1 percent clay granule was applied at the rate of 0.24 pound Baytex per acre. Originally it was planned to treat the lake at a rate of 0.2 to 0.25 pound per acre; however, the head pressure of the full load in the hopper of the airplane caused the material to flow much faster than was anticipated in the first treatment. The granules were distributed by a Swathmaster attached to a 450 h.p. Stearman biplane.

The predominant midge species in Lake Winterset was *Glyptotendipes paripes;* it comprised 97 percent of the population. Copepods, ostracods, and *Chaoborus* were found in all the plankton samples taken in the pretreatment counts. Also, water mites, amphipods, tubifex worms, heleid larvae, fresh water shrimp, dragonfly and damselfly naiads, plus various aquatic Coleoptera and Hemiptera were observed in the dredge and net samples.

Lake Barton was treated on December 2, 1963 with the 1 percent Baytex clay granules. The material was applied at the rate of 0.27 pound per acre. As reported by Patterson (1964), the midge population (*G. paripes*) in this particular lake had been subjected to repeated applications of EPN during the summer prior to the time of the Baytex application.

RESULTS. As shown in Table 1, the two applications in Lake Winterset were very successful in controlling midge larvae. However, these treatments did not control the midge larvae of the subfamily Tanypodinae, which only comprised about 1 percent of the total midge population in the pretreatment counts. Except for the apparent loss of most of the immature Odonata, no other adverse side effects of the treatments were observed. Based on the plankton samples, neither the copepod nor ostracod population seemed to be affected; also the amphipods, water mites and tubifex worms seemed as numerous as before, as did the number and kinds of aquatic bugs and beetles. Although fresh water shrimp were very scarce in the pretreatment counts, at least a few were found in all the post treatment counts up to six weeks after the treatment. There was a sharp drop in the number of heleids, and few dead

TABLE 1.—Effect of Baytex on chironomid midge larvae in Little Lake Winterset.

Date	Treatment	Average number of larvae per sample[1]
9–3–63 pretreatment[2]	0.27 lb./A Baytex sand granules	27.0
9–6–63		0
9–10–63		0
9–18–63		0
9–25–63		0.5
10–2–63		0.4
10–9–63		2.0
10–16–63		0
10–23–63		17.0
10–30–63		23.0
11–6–63		26.0
11–14–63		14.0
11–20–63		17.0
12–4–63 pretreatment[2]	0.24 lb./A Baytex clay granules	15.0
12–7–63		6.5
12–11–63		1.0
12–20–63		0.5
12–26–63		0.6
1–2–64		0.7
1–9–64		0.5
1–16–64		1.5
1–22–64		1.5
1–30–64		1.3
2–7–64		2.0
2–13–64		5.4
2–20–64		4.5
2–27–64		5.2
3–6–64		5.0
3–12–64		2.5
3–19–64		4.4
3–25–64		4.0

[1] An average based on 50 dredge samples taken at set intervals throughout the lake.
[2] Larval samples taken immediately prior to insecticide application.

larvae were observed in the dredge samples.

The *Chaoborus* population dropped sharply within a week following the first application and none were found in the plankton samples two weeks after the treatment, even though an extensive search was made for them. *Chaoborus* larvae did not reappear until 6 weeks later. The second Baytex application had little, if any, effect on the *Chaoborus* population. This could possibly have resulted from a difference in the rate of release of Baytex from the two types of granules.

The shore line of the lake was carefully checked for dead birds; however, none of the numerous aquatic, shore or song birds exhibited any obvious symptoms of poisoning. There were no adverse effects observed in the fish, amphibians or reptiles present in and about the lake during or after the Baytex application.

Results of the Baytex treatment of Lake Barton, which has a surface area of 120 acres, are given in Table 2. As in Lake Winterset, the 1 percent granular clay formulation was very effective as a larvicide against the midge *Glyptotendipes paripes*. The insecticide did not seem to affect the *Chaoborus* or other aquatic organisms except the chironomids and Odonata. The high sensitivity of Odonata to this chemical was previously reported by Whitsel *et al.* (1963).

TABLE 2.—Effect of Baytex on chironomid midge larvae in Lake Barton

Date	Treatment (lb./acre)	Average number of larvae per sample
11–19–63		52.0
12–2–63 pretreatment[1]	Baytex 0.27	51.0
12–6–63		0.3
12–10–63		0.2
12–18–63		0.1
12–23–63		0.1
1–6–64		0.4
1–15–64		0.6
1–21–64		1.0
1–29–64		0.4
2–5–64		1.5
2–10–64		2.0
2–17–64		2.4
2–24–64		2.2
3–2–64		2.0
3–17–64		0.5
3–24–64		0.75

[1] Larval samples taken 12–2–63 immediately prior to insecticide application. The predominant midge species was *Glyptotendipes paripes*.

The prolonged control of midge larvae following both the Lake Barton and the second Lake Winterset applications may have been due to the time of year when the insecticide was applied. Apparently with the cooling of the water in the lakes in winter, midge production is greatly reduced. Usually, there are only a few small broods of adult midges from the latter part of December to March.

DISCUSSION. Applications of a 1 percent granular Baytex formulation proved to be very successful as a larvicide against the chironomid midge *Glyptotendipes paripes* in water up to 30 feet deep. When the material was applied at a rate of 0.24 to 0.27 pound of technical Baytex per surface acre, excellent control of the larvae was obtained for at least 6 weeks during the summer, a period of intense midge activity. Control lasted much longer when the insecticide was applied in December, probably owing to a natural reduction in midge populations in the winter.

Although in previous tests in small containers the clay formulation of Baytex appeared to be slightly less effective within a 38-hour period than a corresponding sand formulation, the results from three lake treatments utilizing these two granular formulations indicate that both are equally effective over a long duration.

There was an apparent loss of the immature Odonata and a reduction in the heleid larval population in the lakes following the insecticide applications. Other aquatic organisms, including fresh water shrimp, appeared to be unaffected by the insecticide in these tests. The dosage used, 0.24 to 0.27 pound per acre, resulted in a concentration of about 4.5

p.p.b. of Baytex in the lakes since they have an average depth of about 20 feet.

References

LIEUX, D. B., and MULRENNAN, J. A. 1956. Investigation of the biology and control of midges in Florida (Diptera: Tendipedidae). Mosq. News 16(2):201–204.

PATTERSON, R. S. 1964. Recent investigations on the use of BHC and EPN to control chironomid midges in Central Florida. Paper Presented 20th Ann. Mtg. Amer. Mosq. Con. Assoc. (Unpublished).

———, and VON WINDEGUTH, D. L. 1964. The effects of Baytex on some aquatic organisms. Mosq. News 24(1):46–49.

WHITSEL, R. H., VICKERY, C. A., Jr., ROGERS, C. J., and GRANT, C. D. 1963. Studies on the biology and control of chironomid midges in the San Francisco Bay region. Proc. and Papers 31st Ann. Conf., Calif. Mosq. Con. Assoc. Inc., 83–94.

AN ANALYSIS OF AIRCRAFT APPLICATIONS OF MEDITERRANEAN FRUIT FLY SPRAY ON INDICES OF *AEDES AEGYPTI* (L.)

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There has been considerable interest expressed and questions have been raised about the possible beneficial effects on domestic mosquito control of insecticides dispensed from spray booms on aircraft. Stutz (1945) made some of the first general observations regarding the effectiveness of this method for controlling *Culex* spp. and *Aedes aegypti* breeding in artificial receptacles. They were not altogether encouraging.

Since 1956, widespread aircraft applications of insecticide baits for the control of the Mediterranean fruit fly, *Ceratitis capitata* Wiedemann have been made in south Florida. The 1956, 1958 and 1962 control campaigns were the most extensive and extended into several counties. No observations were made in these years with respect to the effects of these insecticidal treatments on mosquitoes.

The most recent occurrence of the Mediterranean fruit fly was in the Greater Miami, Florida area in 1963. It was most opportune then that sprays were applied, in part, to areas which had been routinely inspected for several years by personnel from the Dade County Mosquito Control Division and the Public Health Service, Division of Foreign Quarantine *Aedes aegypti* Detection and Control Program. Inspections made in August, 1963, first indicated an apparent correlation between the use of the Mediterranean fruit fly sprays and mosquito reduction. At this time a heavily and regularly infested area, which had been sprayed from the air, was found negative to *A. aegypti* while in adjoining unsprayed blocks *A. aegypti* breeding was still somewhat as in previous inspections. It was then that one of the inspectors observed particles of insecticidal bait drifting into a receptacle filled with water containing *A. aegypti* larvae. Samples were taken from this container but the larvae appeared agitated and soon died. This sudden drop in the *A. aegypti* index in association with the aerial spray program in progress at the time intrigued

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