

# THE SUSCEPTIBILITY OF ADULTS OF *CULICOIDES IMPUNCTATUS* GOETGHEBUER AND *C. OBSOLETUS* (MEIGEN) TO DDT AND DIELDRIN

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The midges, *Culicoides impunctatus* and *C. obsoletus*, have a very wide holarctic distribution and in many regions they constitute major pests because of their man-biting activities. In Britain *C. obsoletus* is probably the most widely distributed and abundant midge, while *C. impunctatus* is the most troublesome biter in highland parts of Britain. In Dorset these two species were responsible for the greater part of the biting nuisance caused by *Culicoides* species (Service, 1969), and in several areas they caused more annoyance than any other biting Diptera. Despite this there is no information on their susceptibilities to insecticides. The present paper presents the first information on the susceptibilities of adult *Culicoides* to DDT and dieldrin.

**METHODS.** Although recommended methods exist for determining the insecticide susceptibility of adult Phlebotominae and other equally small insects of medical importance (WHO, 1963), no methods

have been proposed for testing Ceratopogonidae. The following technique was therefore devised. Human bait catches were performed in Dorset, southern England, on both Brownsea Island, which is situated in Poole harbour, and on the Isle of Purbeck, on the mainland to the south of the island in order to obtain midges for testing. Unfed *C. impunctatus* and *C. obsoletus* were collected in a small aspirator, of the type that has a reservoir to retain the captured insects (*vide* Southwood, 1966), as they settled on the author. To avoid high mortalities it was essential to suck up the midges into the aspirator as gently as possible, and to avoid collecting too many in the aspirator since repeated sucking resulted in those that were already collected being blown about and damaged. It was further discovered that the survival rate of midges was greater if the reservoir of the aspirator was made of pliable plastic and not glass.

In the laboratory they were anaesthetised with carbon dioxide and tipped out onto filter paper. Adults of *C. impunctatus* and *C. obsoletus* were identified and batches of about 25-30 of each species transferred to plastic tubes (125 x 44 mm.) lined with

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clean paper which are issued with the standard WHO kit for determining the insecticide susceptibility of mosquitoes. They differed, however, in that the plastic 16-mesh screens originally fitted to one of their ends were replaced with pieces of very fine nylon stockings. A wad of cotton wool wetted with tap water was placed on top of the tubes and after a 2-hour holding period dead and moribund individuals were removed. Those alive were then gently blown from these tubes into similar ones lined with insecticide impregnated papers and kept in diffuse daylight. Some adults of both species were initially exposed for 1 hour, but as high mortalities resulted with the lowest insecticide concentrations, exposure periods were shortened to 30 minutes.

After insecticidal exposure the adults were transferred to holding tubes lined with paper and, as previously, supplied with cotton wool wetted with water. Care was taken not to get these pieces of cotton wool too wet, otherwise condensation sometimes occurred on the plastic slides at the bottom of the tubes, and this tended to entangle the midges. After a 24-hour holding period dead individuals were removed by partially opening the slide tray and tapping the tubes so that dead specimens fell onto a sheet of white paper. The live adults remaining in the tubes were killed. Both groups were counted and their identification checked. This procedure was necessary because of difficulties encountered in identifying live midges when they were being placed in the tubes; as a consequence a few midges of other species were sometimes included in the tests; these were omitted from the results.

Controls consisted of keeping adults for the duration of the insecticidal exposure period in tubes lined with paper impregnated with Risella oil, and then transferring them to paper lined tubes. Mortalities were assessed after a 24-hour holding period.

All tests were made in May-July in 1965 and 1966 at a mean test temperature of 19.2° C. (18.1-19.9° C.) and at relative

humidities of 78-87 percent. At least four replicates were made at each concentration, and in some instances as many as nine were made.

RESULTS. Preliminary tests showed that a 1-hour exposure of *C. impunctatus* to the lowest concentrations of DDT (0.25 percent) and dieldrin (0.05 percent) paper resulted in corrected mortalities of 78 and 42 percent. Complete mortalities occurred with 1 percent DDT and 0.4 percent dieldrin. With *C. obsoletus* a 1-hour exposure to 0.25 percent DDT papers gave a mortality of 40 percent, complete mortality occurred after exposure to 1 percent papers.

In both species control mortalities were high. During the 30-minute exposure trials mortalities of *C. impunctatus* varied from 7.7-27.3 percent in individual replicates, the mean mortality was 18.6 percent. Mortalities of *C. obsoletus* ranged from 7.7-30.4 percent with a mean value of 18.2 percent. Corrected mortalities are plotted on logarithmic dosage/probit paper and regression lines fitted (Figs. 1, 2). The values of the LC 50, with its lower and upper confidence limits with 95 percent probability, and values of the LC 90 were obtained from these figures. The values of the LC 50 with its confidence limits in parentheses and the LC 90 of *C. impunctatus* are 0.34 percent (0.29-0.40 percent) and 1.10 percent DDT, and 0.21 percent (0.18-0.24 percent) and 0.80 percent dieldrin. For *C. obsoletus* these values are 0.65 percent (0.58-0.73 percent) and 1.70 percent DDT, and 0.21 percent (0.19-0.24 percent) and 0.51 percent dieldrin.

DISCUSSION. One of the greatest difficulties encountered in these tests was keeping the midges alive for any length of time so as to avoid excessively high control mortalities. There appear to be no published results on the insecticidal susceptibility of adult *Culicoides* species, consequently the present values cannot be compared with any others. However, as adults were collected from areas which have not experienced insecticidal spraying

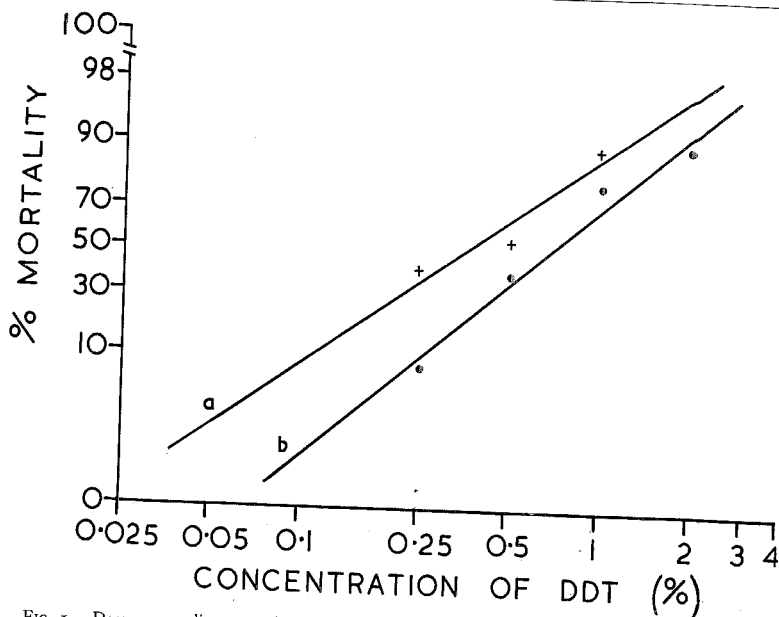


FIG. 1.—Dosage-mortality regression lines for adults of *C. impunctatus* (a) and *C. obsoletus* (b) exposed to DDT.

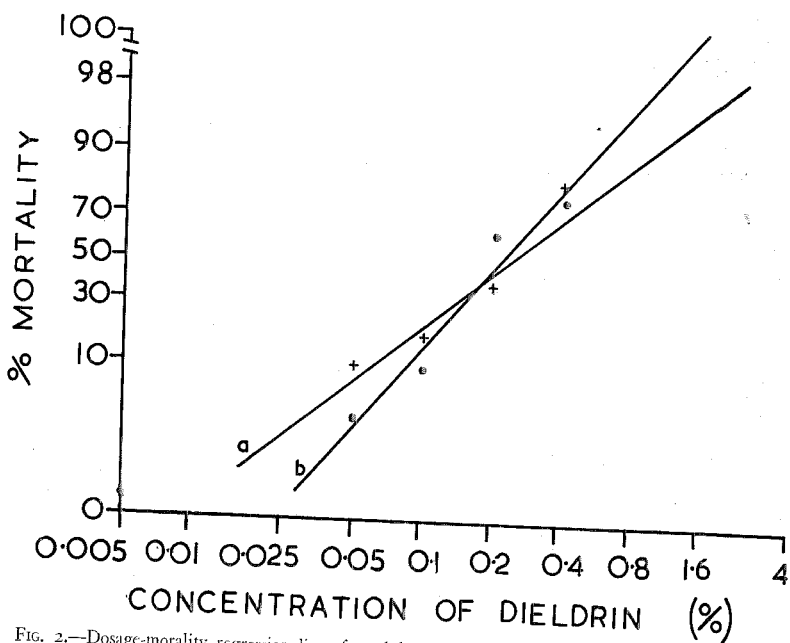


FIG. 2.—Dosage-mortality regression lines for adults of *C. impunctatus* (a) and *C. obsoletus* (b) exposed to dieldrin.

the results can be taken as representing normal susceptibility levels. Both species are very susceptible to both insecticides, but whereas *C. impunctatus* and *C. obsoletus* are equally susceptible to dieldrin, *C. impunctatus* is more susceptible than *C. obsoletus* to DDT. Although it was necessary to use half-hour exposure periods in the present trials to avoid high mortalities at the lowest insecticidal concentrations, it is possible that other species, or even different geographical populations of *C. impunctatus* and *C. obsoletus*, will be less susceptible than the present adults and 1 hour exposures may prove more suitable.

**SUMMARY.** The susceptibilities of unfed *Culicoides impunctatus* Goetghebuer and *C. obsoletus* (Meigen) caught at human bait catches from unsprayed areas in southern England were determined at a mean temperature of 19.2° C. to DDT and dieldrin. In the absence of any previous insecticidal tests with *Culicoides* species, a method of testing adults with the standard WHO kit issued for determining the insecticide susceptibilities of

adult mosquitoes was devised. The plastic mesh ends of the tubes were replaced with pieces of very fine nylon mesh stockings. Because 1 hour exposures gave high mortalities with the lowest insecticidal concentrations, 30-minute exposure periods were used. The values of the 30 minute LC 50 and LC 90 of adult *C. impunctatus* were 0.34 and 1.10 percent DDT and 0.21 and 0.80 percent dieldrin. With *C. obsoletus* these values were 0.65 and 1.70 percent DDT and 0.21 and 0.51 percent dieldrin. Control mortalities were high, about 18-19 percent.

#### References

- SERVICE, M. W. 1969. Studies on the biting habits of *Culicoides impunctatus* Goetghebuer, *C. obsoletus* (Meigen) and *C. punctatus* (Meigen) (Diptera: Ceratopogonidae) in southern England. Proc. R. Ent. Soc. Lond. (A). (In press).
- SOUTHWOOD, T. R. E. 1966. Ecological methods with particular reference to the study of insect populations. London, Methuen & Co., 391 pp.
- WORLD HEALTH ORGANIZATION 1963. (Insecticide resistance and vector control. (Wld. Hlth. Org. Techn. Rep. Ser. 265, 277 pp.