

Table 1. Malathion ULV droplet size distribution 20 mph discharge rates.

Fl. oz./min.	P.S.I.	Temp.	Droplet Size (Microns)			Max.
			Mean	-5.85	+23.40	
6.0	4.5	105° F.	10.3	18.2%	1.9%	38.0
8.6	4.5	95° F.	10.5	15.5%	3.3%	35.1

Operational cost per acre was \$0.066 at 20 mph compared to \$0.120 per acre at 10 mph during 1977.

On September 26, 1977, the experimental vehicle, capable of operating at either 20 mph or 10 mph, began regular ULV treatments. Over the next 17 days, this vehicle was utilized on 8 nights, treating 9,814.5 acres. The cost was \$0.066 per acre, or slightly more than half the cost of treating at 10 mph.

The experimental unit was always dispatched to the areas with the highest adult densities because it was assumed that better control would result from treating nearly twice the area during the mosquitoes' peak activity period. All applications were evaluated by the Commission's usual surveillance methods. Good results were noted with sharp reductions in the numbers of biting adult mosquitoes in all treated areas. There were no noticeable differences in the mosquito landing rate counts,

light traps, and complaints between areas treated by the experimental unit and those treated at the normal 10 mph.

This Special Local Need Registration has proven to be very beneficial in controlling mosquitoes in Georgia. Other products labeled for ULV application were less costly to use because their labels permitted speeds greater than 10 mph during application. Malathion is a safe and proven adult mosquito control insecticide. Its continued use as an economical and competitive adult mosquito control measure is now possible in Georgia.

ACKNOWLEDGMENT. The authors are indebted to Mr. Darrell R. Maddock for his critical review and assistance in the preparation of this operational paper.

OBSERVATIONS ON THE BITING BEHAVIOR OF *PROSIMULIUM* SPP.¹, and *SIMULIUM VENUSTUM*^{1,2}

C. E. SCHRECK, N. SMITH, K. POSEY AND D. SMITH

Insects Affecting Man and Animals Research Laboratory, Agricultural Research, Science and Education Administration, USDA, Gainesville, Florida 32604

While evaluating black fly repellents in the Kidney Pond area at Baxter State Park, Maine, during June 1977 and 1978, we observed that certain species of black fly were more aggressive in their biting than others. Both years, *Prosimulium mixtum* Syme & Davies or other species of *Prosimulium* bit repellent-treated skin

¹ Diptera: Simuliidae.

² The research reported in this manuscript was conducted in part with contract funds transferred from the Medical Research and Development Command, Office of the Surgeon General, U.S. Army.

more readily than did *Simulium venustum* Say, a species complex that comprised about two-thirds of the total population in the area (Schreck 1979; and our unpublished data). DeFoliart (1951), after testing repellents in the Adirondack region of New York, stated, "*Prosimulium hirtipes* (Fries) was apparently repelled for a shorter time than the other species, since the first bites usually were received from it." According to Jamnback (1969), *P. hirtipes* is actually a group of 3 or more very similar-appearing species of which *P. mixtum* is "the first of the pest species to attack man in the spring." He also stated that the other species in

this group are believed to be less important pests of man than *P. mixtum*.

After evaluating repellents in the Adirondack Mountains against these species, Travis et al. (1951), said, "*P. hirtipes* (Fries) and *S. venustum* (Say) were numerous enough to give up to 60 bites in a 10-minute exposure of untreated arms". On the basis of Jamnback's 1969 report, it is reasonable to assume the *P. hirtipes* referred to by Travis et al. (1951) was *P. mixtum*. Unfortunately, Travis et al. (1951) did not report whether there were differences in the biting of the 2 species.

All of the above investigators reported that *S. venustum* is a vicious biter of man; however, McDaniel (1971) stated, "*S. venustum* appears to prefer to feed on man in some localities while in other areas it appears to ignore man. It is possible that a complex of several closely related species or distinct genetic strains are involved."

Our observations generally agree with those previously reported; however, our studies at Baxter State Park revealed some interesting occurrences that we feel need to be recorded. Also, we hope this discussion will encourage further interest in the biting behavior of these and other species of black flies. We make our generalizations based on data collected in field studies during June 1977 and 1978 at Baxter State Park, Maine:

1. Both *S. venustum* and *P. mixtum* were attracted to human subjects at rest throughout the daylight hours. Numbers of flies on or flying near subjects ranged from 0 initially to several hundred 15 min later. This attraction process was repeated whenever subjects changed locations.
2. Black flies are attracted to carbon dioxide, host odors, and certain colors of clothing (Davies 1978). Dark clothing was more attractive than light clothing, and some subjects were more attractive than others, even though they wore the same color of clothing.
3. The "white-stockinged" *S. venustum* was most often observed on the lower legs of subjects, hurriedly crawling upward, then flying, landing, and again crawling upward, but rarely attempting to feed. In contrast, *P. mixtum* did not have the pronounced busy crawling habits of *S. venustum*, but was more often found to land, crawl a short distance, probe, and fly, repeating this behavior until it located a suitable feeding site.

4. Up to ca. 200 black flies were observed crawling on the clothing of a single subject in 1 min. Though they were not individually identified, the majority appeared to be *S. venustum*.
5. *Prosimulium mixtum* bit untreated skin far more often than *S. venustum*, though the latter species was visibly more abundant. Of 107 flies collected when actually biting untreated skin of arms or legs of 4 subjects, only 25 were *S. venustum*; the rest were *Prosimulium* species.
6. On the basis of collections we made, *P. mixtum* or other *Prosimulium* spp. were the first species to bite repellent-treated skin; *S. venustum* was often the most easily repelled species.

Based on the relatively few published accounts of the biting habits of black flies and on our recent observations, we submit that *S. venustum* may have received undue notoriety for being a vicious biter when one or more other, more retiring species were actually doing the biting.

The following statements are based on data collected for 2 weeks in each of 2 years at the Kidney Pond area. We feel, however, that the observations made and the conclusions drawn need to be confirmed or refuted, thus this presentation.

We believe the *S. venustum* complex is attracted to humans for reasons already mentioned. We believe this species is, in some habitats at least, a very timid biter, and, in fact, may not commonly bite humans. We believe that, in early summer at the above location, the major pest species is *P. mixtum*, a species usually less numerous than *S. venustum*, less likely to be found crawling on the clothing, and thus less likely to be observed when it feeds. We believe the high population of *S. venustum* may be the reason for their apparently undeserved reputation for fierce biting, when, in fact, the biting is done by *P. mixtum* or closely related species of *Prosimulium* at this time of year.

ACKNOWLEDGMENT. The authors wish to thank Dr. F. C. Thompson, Systematic Entomology Laboratory, AR, SEA, USDA, for identifying the black fly species in these studies.

References Cited

- Davies, D. M. 1978. Ecology and behavior of adult blackflies (Simuliidae): A review. *Questiones Entomol.* 14:3-12.

- DeFoliart, G. R. 1951. A comparison of several repellents against blackflies. *J. Econ. Entomol.* 44:265-266.
- Jamnbach, H. 1969. Bloodsucking flies and other outdoor nuisance arthropods of New York State. N.Y. State Mus. Sci. Serv. Mem. 19, pp. 1-89.
- McDaniel, I. N. 1971. Research on the black fly problem in Maine. Univ. of Maine Misc. Rpt. 131, Jan. 1971. pp. 1-7.
- Schreck, C. E., N. Smith, T. P. McGovern, D. Smith and K. Posey. 1979. Repellency of selected compounds against black flies (Diptera: Simuliidae). *J. Med. Entomol.* 15:526-528.
- Travis, B. V., A. L. Smith and A. H. Madden. 1951. Effectiveness of insect repellents against blackflies. *J. Econ. Entomol.* 44:8-13.

MERMITHID PARASITES OF CANADIAN ANOPHELINES

R. A. ELLIS

Winnipeg Insect Control Branch, 2799 Roblin Boulevard, Winnipeg, Canada R3R 0B8

H. C. CHAPMAN

Gulf Coast Mosquito Research, Agricultural Research, Science and Education Administration, U.S.D.A., Lake Charles, Louisiana 70601

Mermithid parasites of mosquitoes in Canada have been reported sporadically in the literature (e.g., Steiner 1924, Hearle 1926, Jenkins & West 1954, Beckel & Coppins 1955, Welch 1960, Trpis et al. 1968, Trpis 1971, Brust & Smith 1972, Ellis and Brust 1973, Ross & Smith 1976, and Galloway & Brust 1976). Whereas many of these records have excited mosquito researchers, a thorough survey of Canada has yet to be made. We hope that publication of these records will stimulate such a national survey.

While collecting study material in July, 1973, for a handbook on the "Mosquitoes of Canada" (Wood, Dang & Ellis, in press), the senior author chanced upon a shallow permanent farm pond (approximately 10x20m) fed by artesian springs near St-Francois-de-Masham (45°38'N, 76°6'W), Quebec. Second, 3rd & 4th stage larvae and pupae of several *Anopheles* species were collected. In attempting associated rearings, developing nematodes became apparent, but

efforts to rear these through to adults were not successful.

The nematodes parasitizing *Anopheles walkeri* Theobald *An. earlei* Vargas and *An. punctipennis* (Say) were identified by J. J. Petersen of the Lake Charles laboratory as *Diximermis*, probably *petersemi* Nickle, the only known species in the genus. *D. petersemi* is known to parasitize *An. crucians* Wiedemann (LA, FL), *An. quadrimaculatus* Say (LA) and *An. punctipennis* (LA, NY) (Petersen 1973). Our Canadian records represent an unsuspected northern range of the nematode and are the 1st records of its presence in *An. earlei* and *An. walkeri*. Indeed, it is the 1st instance of any nematode being reported as a parasite in these 2 species. Although multiple infections and encapsulated nematodes were present, the high level of parasitism (50-60%) observed in all 3 species suggests some potential for their biological control.

In addition to the nematodes, a microsporidian, *Parathelphania* sp., parasitized some larvae of *An. earlei*. This also is a new Canadian and host record.

Considering the fortuitous nature of these observations, we can only hope that they will provide the needed stimulus for a comprehensive Canadian survey to determine the distribution and importance of mermithids as agents of biological control.

Literature Cited

- Beckel, W. E. and T. P. Coppins. 1955. Laboratory rearing of adults of northern *Aedes* mosquitoes (Culicidae). Rpt. Defence Res. Bd. Can. DRNL 7.
- Brust, R. A. and S. M. Smith. 1972. Mosquito intersexes in arctic Canada (Diptera: Culicidae). Proc. XIII Internat. Congr. Entomol., Moscow (1968) 3:135-136.
- Ellis, R. A. and R. A. Brust. 1973. Sibling species delimitation in the *Aedes communis* (DeGeer) aggregate (Diptera: Culicidae). Can. J. Zool. 51:915-959.
- Galloway, T. D. and R. A. Brust. 1976. Observations on mermithid parasites of mosquitoes in Manitoba. Proc. 1st Internat. Colloq. Invert. Pathol., Kingston, Ontario, p. 227-231.
- Hearle, E. 1926. The mosquitoes of the Lower Fraser Valley, British Columbia and their control. Nat. Res. Council Can. Rpt. 17:1-94.
- Jenkins, D. W. and A. S. West. 1954. Mermithid nematode parasites in mosquitoes. Mosquito News 14:138-143.