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**ADDITIONAL STUDIES ON CLOTHING
TREATMENTS FOR PERSONAL PROTECTION
AGAINST BITING FLIES**

by

I.S. Lindsay and J.M. McAndless



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(6) ADDITIONAL STUDIES ON CLOTHING TREATMENTS
FOR PERSONAL PROTECTION AGAINST BITING FLIES.

(10) Ian S/Lindsay ^{John} M/McAndless

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ABSTRACT

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~~The experiments described in this report are a continuation~~
 of field studies of repellent or insecticide treated mesh clothing items conducted at DREO between 1975 and 1977. Several small tests were carried out at Canadian Forces Base Petawawa to evaluate various mesh jackets with hoods, or separate hoods, against adult mosquitoes or blackflies. The items had been treated with diethyltoluamide, a repellent, or permethrin, an insecticide.

RÉSUMÉ

Les expériences décrites dans ce présent rapport font suite aux études effectuées entre 1975 et 1977 sur des survêtements de filet à grandes mailles imprégnés d'insecticide ou d'insectifuge. Plusieurs courts essais furent réalisés en conditions réelles d'utilisation, à la Base des Forces canadiennes de Petawawa, pour évaluer l'efficacité des survêtements avec capuchon et des capuchons séparés, contre les moustiques adultes et les mouches noires. Les survêtements et capuchons avaient préalablement été traités avec un insectifuge, du diethyltoluamide, ou avec un insecticide, de perméthrine.

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INTRODUCTION

In 1977 and 1978 McAndless and Lindsay (1) and (2) reported the results of a series of field tests where wide mesh jackets treated with either a quick-insect-knockdown insecticide, permethrin (permethrin-jackets), or the standard Canadian Forces repellent N,N-diethyl-m-toluamide (deet) (deet-jackets), were compared against several Canadian species of adult blackflies and mosquitoes. Although the permethrin-jackets did not appear to be as efficacious as the deet-jackets, their other beneficial characteristics such as probable reduction of the insect swarm around the wearer, longer effective period without need for retreatment, and indication of providing a degree of area control of biting flies were considered to warrant additional study in 1978.

As reported previously, the concept of using wide-mesh, treated jackets for personal biting-fly protection, plus the possibility of using insecticide rather than repellent, was communicated to the Defence Research Establishment Ottawa (DREO) through the US Armed Forces Pest Control Board (3) and the US Department of Agriculture Laboratory at Gainesville, Florida (4). The original objective of the DREO studies was to obtain data on the protective qualities of the repellent- or insecticide-treated wide-mesh jackets with attached hoods against Canadian species of biting flies with particular emphasis on blackflies. The preliminary assessment of the prototype jackets was reported by Lindsay (5) in 1975. The jackets were based on the concept developed by the USA Medical Field Research Laboratory (6). The assessment of deet-treated jackets was also reported by Frommer (7). Recently, it was brought to our attention that the US Army had studied the concept of a mosquito-repellent jacket at a very early stage (8). The 1977 DREO report (1) also included the results of the assessment of repellent-treated hoods alone, a concept that originated with the Protective Sciences Division at DREO. As in the waist-length jackets with attached hoods, the separate hoods were made of mesh fabric consisting of polyester filaments that give some abrasion resistance and cotton strands to absorb the fluid repellent, usually deet. Figure 1 illustrates the jacket with hood and Figure 2 the separate hood.

The 1978 studies were conducted at Canadian Forces Base Petawawa, Petawawa, Ontario, an area that often has high populations of biting flies in the spring and early summer. The tests were done on a limited scale because of the availability of only a small test team.

MATERIALS AND METHODOLOGY

The experimental jackets and hoods were constructed at DREO using the S-1624 wide-mesh material obtained from Polylox Corp., New York, N.Y. The repellent-jackets and hoods were treated with 0.25 g of 75% deet per gram of fabric and the insecticide-jackets with 0.07 g permethrin per gram of textile. The process was identical to that used in preparing the test items for the 1977 program (1).

The test team consisted of six persons. Most assessments were performed using four test and two control subjects. As in 1977, the majority of the tests involved the following routine:

- 1) Subjects were transported to a site and were issued appropriate test items.
- 2) The subjects sat in prearranged pairs for a period of time and each subject recorded the number of insect landings which occurred on the face and hands of his partner using two hand-held counters. A landing was defined as one in which an insect alighted and began to probe or bite. When testing permethrin-treated jackets, landing counts were taken on the face and front portion of the jacket from neck to waist but excluding the sleeves.
- 3) A rotation of subject pairing occurred, along with an exchange of control and test items. This exchange was followed by a second session of sitting in pairs and recording insect landings.
- 4) During each test, measurement of ambient conditions was carried out using a sling psychrometer and anemometer to give data on dry-bulb temperature, relative humidity and wind speed. Insect specimens which landed on subjects were collected using an aspirator. Appendix A lists the identifications.

- 5) At the conclusion of the test, all equipment was collected and the subjects were transported from the site.

Four field tests were conducted to evaluate various combinations of deet treated or permethrin treated items against either blackflies or mixed populations of mosquitoes and blackflies. Table I summarizes these tests, the experimental garments used and the insects encountered.

TABLE I

Treated Clothing Item Tests against Biting
Flies at CFB Petawawa, 1978

Test	Deet Hoods	Permethrin-Jacket-Hood	Permethrin-Jacket Deet-Hood	Insect	Location
1	X	X		Mosquitoes Blackflies	Near Gas Training Huts
2	X	X		Blackflies	Bostwick Lake
3		X	X	Blackflies	Burnt Bridge Bay
4	X	X		Blackflies	Burnt Bridge Bay

The basic clothing worn by all personnel included dark green coveralls and cotton gloves. The control subjects wore standard untreated headnets (not mesh hoods) during the tests.

Tests 5, 6, 7 and 8 were carried out to determine whether there were any indications of residual insect control in the area resulting from exposure to the permethrin treated clothing. Firstly, insect population levels were measured at selected sites. Then, in Test 5, initially, the effectiveness of deet-hood, permethrin-jacket combinations was compared with permethrin-jacket, permethrin hood ensembles against blackflies. This was followed immediately by blackfly counts at the same site. In Test 6 there was a period of insect counts by subjects wearing permethrin treated ensembles accompanied by individuals

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without the experimental items. Then in Test 7, unprotected control subjects moved into the areas just vacated by personnel wearing permethrin-jackets and continued to measure blackfly and mosquito levels. Insect landing counts were recorded for each subject's face, jacket front and, in some cases, legs. In Test 8 two teams, each consisting of three subjects wearing various combinations of protective clothing items, took mosquito and blackfly counts at separate sites for thirty minutes. Then the six personnel, now wearing standard untreated head nets and coveralls, repeated the insect sampling at the two locations.

Weather conditions during the field experiments included air temperature ranging from 20°C to 25°C, skies ranging from sunny to overcast and with relative humidities varying from 45% to 90%. Winds varied from 5 to 15 km/hr. The most active mosquito periods were in the evening while the highest blackfly counts occurred in the afternoons when there was high relative humidity and light winds.

The data for the individual tests were recorded, analysed and given an "effectiveness rating (ER)", using the formula:

$$ER = \frac{(N_c - N_1) \times 100}{N_c}$$

where N_c = the average landing count per control subject, and

N_1 = the average landing count per subject wearing a treated item.

RESULTS

The effectiveness ratings (ERs) calculated for Tests 1 to 4 are given in Table II. The averaged data from which the ERs were calculated are included.

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TABLE II

Effectiveness Ratings for Treated Clothing Items against
Blackflies at CFB Petawawa, 1978

Test	Average Landings			Deet-hood	Permethrin Jacket Hood	Permethrin Jacket Deet hood	Insect
	Face	Hands	Jackets				
1	5(195)	7(95)	-	97.0	93.0	-	Blackflies Mosquitoes
2	2(28)	-	8(29)	89.5	72.5	-	Blackflies
3	5(19)	-	1(23)	-	72.0, face 96.0, jacket	81.0, face 92.0, jacket	Blackflies
4	1(10)	-	7(59)	98.0	88.0	-	Blackflies

(Control averaged insect landings shown in brackets)

In Test 5, which was primarily an "area control" test, the permethrin-jacket-hood ER was 71.5 and the ER for the permethrin-jacket-deet hood was 77.5 against blackflies.

The results for the area insect-effect tests were not as clear cut. Test 6 was aimed at determining whether the wearing of a permethrin-jacket-hood would provide any increased protection for the legs when compared with control subjects wearing untreated clothing. Average mosquito and blackfly landing counts for four test subjects and two controls are shown in Table III. The control subjects were wearing headnets so insect landing counts were taken for the portion of the headnet which covered the wearer's face.

TABLE III

Average 20-Minute Mosquito or Blackfly Counts for Personnel
Wearing Treated Jackets and Hoods with Untreated Trousers

	Permethrin-Jacket and Hood	Permethrin-Jacket and dect-hood	Control
Wearer's Face	35	19	11
Jacket Front	1	20	122
Legs	164	96	116

These results confirmed that the deet-treated hood is more effective for protecting the wearer's face than the permethrin-hood for at least the first twenty minutes of exposure. The data also indicated that the wearing of a permethrin jacket-hood ensemble caused some reduction in insect landing counts on the legs but, at least for the period of this test, not enough protection to be practical. The protection afforded by permethrin jackets to the wearer's frontal area was confirmed.

Tests 7 and 8 were preliminary studies of the local area insect control which might occur as the result of personnel with permethrin jacket-hoods being stationary at a site for at least a short period of time. In Test 7 the six subjects wore untreated clothing for 30 minutes to establish biting fly landing counts. Two of these subjects wore deet-treated hoods. For the next 30 minutes the team was divided into 3 pairs, spaced about thirty feet apart, with each pair consisting of one of the subjects with the untreated clothing and, five feet away, a second subject wearing a protective test item. The results are shown in Table IV.

TABLE IV

Effect of Wearing Permethrin-Jacket-Hoods
on Mosquito Levels at Small Field Sites

A) Primary Insect Counts (30 minute totals)

	No Treated Clothing (4 subjects)	With deet-Hoods (2 subjects)
Jacket Front	172	47
Trouser Legs	561	116

B) Secondary Insect Counts (30-minute averages)

	Pretest Controls	Control Adjacent to Permethrin- Jacket Hoods	Permethrin- Jacket-hoods	Control Adjacent to Permethrin Jacket, Deet Hoods	Permethrin Jackets Deet Hoods
Jacket Front	37	19	5	11	1
Trouser Legs	113	52	59	88	50

Table V summarizes the data for Test 8. Insect landing counts were averaged for this table.

TABLE V

Comparison of Biting Fly Landings on Treated
Clothing Items at Two Sites (30-minute counts)

Landing Counts, location 1/location 2

Subjects Wearing:	Jacket Front	Trouser Legs	Face
Permethrin-Jacket	1/0	18/34	2/1
Permethrin-Jacket Deet-Hood	1/0	14/17	0/0
Deet-Hood	27/20	35/50	2/2
Replacement Subjects (averages)	24/15	60/36	0/0

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The Test 8 data suggested that the control counts were reduced for at least a short time in small areas vacated a few minutes previously by subjects wearing permethrin treated ensembles. However, the insects may simply have followed the first test subjects when they left the test site.

DISCUSSION

The results confirmed the previous conclusions (1) that mesh jackets with hoods treated with the insecticide permethrin do provide an acceptable level of protection for the wearer against several species of mosquitoes and blackflies. Whether this protection is the result of insecticidal activity, i.e., actual knockdown and killing of the insects, or whether it is caused by an insect repellent factor in the insecticide is not yet clear. Certainly, the degree of personal protection given by the permethrin-ensemble plus the fact that retreatment is not needed as frequently as with the deet treated jackets suggests that for Canadian Forces purposes the permethrin system may be the better of the two. Also, the permethrin treated items had a more natural feel with less odor than the deet-clothing. The deet-jackets give approximately thirty days of biting-fly protection provided they are kept in a plastic pouch when not in use whereas the effective period for the permethrin items has not been established.

The field data, plus direct observation, confirmed the potential of the separate deet-hoods for giving face protection to the wearer. They were particularly useful when worn with insect bite-proof clothing, take up little space when not in use and can be expected to be effective for at least as long as the deet-jackets.

The studies on possible temporary area control of biting flies caused by exposure to the permethrin-jacket-hoods were not conclusive. It was shown that the needed evidence would require the use of considerably more test subjects than six so that a reasonably large experimental area could be assessed. Such studies would probably require the test personnel to subject the mosquito and blackfly population in an area to periods of treated clothing exposure for at least two hours to give a significant level of reduction.

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It is interesting that both the permethrin clothing system and the separate deet treated hood seem to be effective against a fairly wide range of species of both mosquito and blackfly adults. It would be useful to, (a) compare the protective qualities of separate deet-hoods and permethrin-hoods, (b) observe the effects of the two hood treatments on Tabanidae (horse and deer flies), and (c) determine the duration of effectiveness of permethrin-treated jackets with attached hoods or separate hoods.

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CONCLUSIONS

1. It is confirmed that:
 - (a) permethrin treated jackets with hoods will provide an acceptable level of protection to the wearer against the species of blackflies and mosquitoes that were present during the field studies *and*
 - (b) initially, at least, the permethrin treated hoods do not give the level of face protection against biting flies that deet repellent treated hoods will.
2. Although the results gave an indication of small area biting fly control when the subjects wore permethrin-jacket-hoods, larger numbers of subjects and larger experimental areas are needed to provide reasonable evidence.
3. Separate deet treated hoods, when worn with insect-bite-proof clothing, provide excellent protection to the wearer's face from mosquito and blackfly bites.

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APPENDIX A

The following identifications were made on insects collected at three sites at CFB Petawawa in June, 1978:

i) Blackfly adults (Simuliidae)

Simulium venustum (Say)

Simulium decorum (Wlk)

ii) Mosquito adults (Culicidae)

Aedes sticticus (Mg)

Aedes stimulans (Wlk)*

Aedes vexans (Mg)

Aedes communis (DeG)*

Aedes intrudens (Dyar)

Aedes punctor (Kirby)

Anopheles walkeri (Theob)

Mansonia perturbans (Wlk)

* Probable



Fig. 1: Insect repellent treated jacket and hood.



Fig. 2: Subject wearing the separate insect repellent treated hood.

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KEY WORDS

Personal protection
 Mosquitoes and blackflies
 Treated mesh garments
 Repellent or insecticide

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