

EVALUATION OF REPELLENTS AGAINST LAND LEECHES—PART II

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(Received 11 Apr. 1967; revised 8 Dec. 1967)

Field trials were carried out with five leech repellents using two different methods. N, N-diethyl-*m*-toluamide (DEET), synthesised in Defence Research Laboratory (Materials), Kanpur, was found to be most effective and satisfactory against leech bite.

In part I of this investigation¹, results of laboratory and field trials on the evaluation of some repellents against land leeches *Heamadipsa sylvestris* Blanchard have been given. In the laboratory trials, repellents were smeared on fore-arms and/or lower portion of the legs of human subjects. The treated fore-arms/legs were introduced inside the cages containing land leeches and observations were taken on the number of leeches climbing and biting on the exposed fore-arms/legs. In field trials, the repellents were smeared on the neck, fore-arms and lower portion of legs. After this treatment, the subjects were asked to put on their socks, boots and anklets, and roll down their sleeves. The field trials were carried out in a forest infested with land leeches. The subjects were kept moving inside the forest during the period of the trial and allowed to halt at regular intervals only to count the number of leeches attached to their body. Citronella oil, Cinnamon (Cassia) oil, 1:1 mixture of *Acorus* oil and synthetic pine oil, and 1:1 mixture of *Acorus* oil and turmeric oil, were found to be effective for 5 to 6 hours (the duration of the trials). DMP was found to be effective for 2 to 3 hours and 1:1 mixture of DMP and synthetic pine oil for 1 hour.

Since it may not be desirable for the personnel walking in leech-infested areas to apply the repellents on the body every day, Saxena & Khalsa² carried out laboratory investigations on the persistence of leech repellents on cloth, with a view to use the repellents for the treatment of uniforms. Ribbands' method³ was modified and used for this purpose. Strips of drill OG treated with various repellents were placed in the form of a box and the behaviour of leeches in crossing over this barrier was observed. It was found that at the rate of 4 ml/sq ft, N, N-diethyl-*m*-toluamide (DEET) was effective for 19 days; Citronella oil for 10 days; Cinnamon oil for 8 days; and DMP, 1:1 mixture of *Acorus* oil and synthetic pine oil, 1:1 mixture of *Acorus* oil and turmeric oil, for 6 days each after treatment.

The present paper assesses the duration of the effectiveness of the above-mentioned leech repellents in actual field conditions when applied (i) directly on the body parts, and (ii) on boots and anklets in addition to arms, legs, neck and face.

Chemicals

- (a) Citronella oil
- (b) Cinnamon (Cassia) oil
- (c) Dimethyl phthalate (DMP)
- (d) N,N-diethyl-*m*-toluamide (DEET)

(e) 1:1 mixture of *Acorus* oil and synthetic pine oil.

Items (a) and (b) were obtained from trade, item (c) from Army sources and items (d) and (e) from Defence Research Laboratory (Materials), Kanpur.

Sprayers

Flit-gun type LUCKY brand hand sprayers were used for the treatment of uniforms.

Subjects

Trial subjects consisted of Army men in their summer uniform (black boots, OG woollen socks, OG drill trousers, OG anklets of canvas, OG shirts of cellular cloth with sleeves rolled down and OG jungle hat).

Site

The trials were conducted in reserve forests near the foothills of Assam. These forests have thick vegetation and heavy infestation of land leeches, which were identified by Zoological Survey of India, Calcutta, to be *Haemadipsa sylvestris* Blanchard.

EXPERIMENTAL PROCEDURE

When repellents were smeared only on the body

The method adopted by Dixit *et al*¹ was followed in this trial. Four ml of repellent was smeared on lower portion of legs, forearms and neck. Methylated spirit was used on control subjects to prevent their demoralisation. There were 3 replicates for each repellent and for the control. After smearing the repellent and putting on their socks, boots and anklets, the subjects moved inside leech infested forest for a period of 3 hours, with break at intervals to check up the number of leeches attached to their bodies. During movements inside the forest, leeches found on the uniform above the knee were removed so that they might not attack in the region of groin or on the scrotum. Final observations were taken 8 hours after treatment by inserting their bare legs up to knee in the leech cages in the Laboratory for 15 minutes. Control subjects were not tested in the Laboratory, since they were demoralised due to leech attack in the field trials in the morning.

When boots and anklets were treated with repellents

Three ml of the repellent was applied on each boot (*i.e.* 6 ml per pair) with the help of a cotton swab. Each pair of anklets was sprayed with 4 ml of repellent. In addition to the treatment of boots and anklets, fore-arms, neck and face of the subjects were also treated with 2 ml of the repellent. Methylated spirit was used on control subjects. There were 3 replicates for each repellent and for the control. After the treatment, the subjects moved in the leech infested forest for 1½ hours, after which they were checked up for the number of leeches on their body. Next day, the subjects again moved inside the leech infested forest with the same treated boots and anklets, with forearms, face and neck freshly treated, and remained inside the forest for 2½ hours, after which they were checked up for the number of leeches on their body. Since the control subjects had been severely attacked by leeches on the first day, they were not tested on the next day, as they were not willing. During movements in the forest some leeches were found to have actually crawled up the treated boots and anklets; these were removed when they were noticed moving up the trousers.

RESULTS

When repellents were smeared only on the body

The results of this trial have been summarised in Table 1. Observations taken after 3 hours' trial show that except DMP, all other repellents (*viz.* Citronella oil, Cinnamon

TABLE 1

RESULTS OF FIELD TRIALS ON LEECH REPELLENTS SMEARED ON FORE-ARMS, LOWER PORTIONS OF LEGS AND NECK

Repellent	Observations after 3 hours*		Observations after 8 hours†	
	No. of leeches found climbing the uniform	No. of leeches found adhering to the body	No. of leeches found climbing the legs	No. of leeches found adhering to the legs
Citronella oil	3	Nil	Nil	Nil
Cinnamon oil	2	Nil	6	2
Dimethyl phthalate	3	2**	2	1
N-N-diethyl- <i>m</i> -toluamide	1	Nil	Nil	1
1 : 1 mixture of <i>Acorus</i> oil + synthetic pine oil	Nil	Nil	6	..
Control	13	7***

*Observations taken after the subjects had moved inside the forest for 3 hours.

**In between toes and on ankle.

***Majority on the lower portion of legs.

†Observations taken in the laboratory after treatment by inserting legs (upto knee) inside leech cages.

oil, DEET and 1:1 mixture of *Acorus* oil and synthetic pine oil) proved effective, as very few leeches had climbed up the uniforms of the subjects and there was no leech bite. Among the subjects treated with DMP, there were 2 leech bites on the treated portion of leg.

Observations taken 8 hours after treatment show that no leech even climbed on the subjects treated with Citronella oil and DEET. Among the subjects treated with DMP, 2 leeches climbed of which 1 attacked. Among the subjects treated with 1:1 mixture of *Acorus* oil and synthetic pine oil and those treated with Cinnamon oil 6 leeches climbed in each case, of which 1 and 2 respectively attacked.

It may be inferred from these results that Citronella oil and DEET, when smeared on fore-arms, lower portion of legs, neck and face, afford protection against leech bite up to at least 8 hours after treatment.

When boots and anklets were treated with repellents

The results of this trial have been summarised in Table 2. Observations taken 1½ hours after treatment (on the first day) show that there was no leech bite in any of the treatments used, though some leeches were collected off the uniforms in all the treatments. In spite of the removal of 49 leeches noticed on the uniforms of 3 control subjects, 10 leeches attacked them.

Observations taken on the second day show that many more leeches were successful in crawling up the treated boots and anklets of the subjects in all cases. Further, subjects with boots and anklets treated with DMP had 3 leech bites; in the case of Cinnamon oil, and 1:1 mixture of *Acorus* oil and synthetic pine oil, there were 2 leech bites, and in the case of Citronella oil there was 1 leech bite. In the case of treatment with DEET though there

TABLE 2

RESULTS OF FIELD TRIALS ON LEECH REPELLENTS APPLIED ON BOOTS AND ANKLETS

Repellent	Observations after 1½ hours of trial on first day*		Observations after 2½ hours of trial on second day	
	No. of leeches found climbing the uniform	No. of leeches found adhering to the body	No. of leeches found climbing the uniform	No. of leeches found adhering to the lower portion of legs
Citronella oil	4	Nil	21	1
Cinnamon oil	3	Nil	19	2
Dimethyl phthalate	6	Nil	7	3
N-N-diethyl- <i>m</i> -toluamide	5	Nil	13	Nil
1 : 1 mixture of <i>Acorus</i> oil + synthetic pine oil	5	Nil	8	2
Control	49	10**

*Observations taken after the subjects had moved inside the forest for these periods.

**Majority on lower portions of legs.

was not even a single bite, 13 leeches were found to have climbed the treated boots and anklets and had to be removed.

DISCUSSION

A comparative assessment of the results, obtained in the two trials with two different methods of use of repellents, shows that in the initial stages, both the methods afford protection against leech bite. But treatment of boots and anklets soon loses its effectiveness evidently due to abrasion and wetting in slush, mud, etc. To ensure effective protection against leeches, boots and anklets would have to be treated every time the troops enter forest, which would require larger quantities of repellents than required for smearing on forearms, lower portions of legs, face and neck. The quantity of repellent required to treat a pair of boots is 6 ml, for a pair of anklets, 4 ml, and 2 ml for smearing fore-arms neck and face. Thus, 12 ml of a repellent are required for each subject each day. But, when the repellent is applied directly on forearms, lower portions of legs, neck and face, the quantity of repellent required for one subject is only 4 ml per day.

Out of 5 repellents tested in these trials, DEET has been found to be most effective against leech bite, both when applied directly on the body and when applied on boots and anklets. There has been no leech bite in any subject treated with DEET, during the period of the trials.

ACKNOWLEDGEMENTS

Thanks are due to Sarvashri N.S. Sengar, A.K. Chaudhuri and S.C. Ghosh for their assistance in carrying out the field trials.

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