SHORT REPORT: PREVENTION OF SCHISTOSOMA MANSONI INFECTIONS IN MICE BY THE INSECT REPELLENTS AI3–37220 AND N,N-DIETHYL-3-METHYLBENZAMIDE

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Abstract. N,N-diethyl-3-methylbenzamide (DEET) has recently been reported to kill cercariae of Schistosoma mansoni in vitro. In addition, it blocked cercarial entry into mouse tail skin. We confirmed these results and compared the efficacy of DEET to a second insect repellent, 1-(3-Cyclohexen-1-yl-carbonyl)-2-methylpiperidine (AI3–37220), in preventing S. mansoni infections in mice. Both AI3–37220 and DEET conferred 100% protection against S. mansoni infection via percutaneous exposure to cercariae.

Prevention of infection by schistosomes can only be guaranteed by avoiding contact with water containing infectious cercariae. However, the concept of topical agents that can reduce the likelihood of infection when contact with infectious water is unavoidable has elicited research into chemical compounds that could provide such protection. Several compounds have been shown to have anti-cercarial effects in vitro or in experimental infections,1–4 and niclosamide has been shown to have a limited prophylactic efficacy for humans.5

Recently, N,N-diethyl-3-methylbenzamide (DEET, N,N-diethyl-m-toluamide), the active ingredient of most insect repellents, was demonstrated to be a potent cercariacide and an effective agent at preventing cercarial penetration into treated mouse tail skin.6 We evaluated 1-(3-Cyclohexen-1-yl-carbonyl)-2-methylpiperidine (AI3–37220), which has similar efficacy to DEET in insect repellent studies,7–9 for its ability to prevent Schistosoma mansoni infections in mice.

Male, 6–8-week old, CBA/J mice (Jackson Laboratories, Bar Harbor, ME) were housed in the American Association for Accreditation of Laboratory Animal Care–approved Animal Care Facility of the Centers for Disease Control and Prevention and maintained on standard laboratory chow and water ad libitum. Groups of 10 animals were anesthetized by intraperitoneal injection of 0.5 ml of a solution of 32 mg/ml of ketamine HCl and 2 mg/ml of xylazine. The abdomens of experimental animals were shaved and exposed to a 7.5% (v/v in isopropanol) solution of DEET (Aldrich Chemical Co., Milwaukee, WI), a 7.5% solution of AI3–37220 (S. C. Johnson & Son, Inc., Racine, WI), or isopropanol carrier for 5 min. The abdomens were allowed to air-dry and were washed with water using a gauze sponge. Animals were then exposed to 150 cercariae of a Puerto Rican strain of S. mansoni by the ring method for 30 min.10 At six weeks after cercarial exposure, animals were killed by intraperitoneal injection of 0.5 ml of sodium pentobarbitol (13 mg/ml) and were perfused. Livers and intestines were also closely examined for the presence of worms. Total worms for each mouse were counted and group means were determined.

The results of two separate experiments are shown in Table 1. In both experiments, there was complete protection of animals that had been treated with DEET or AI3–37220 before cercarial exposure. In contrast, animals that had received isopropanol carrier treatment alone demonstrated an average of 28.1 worms in the first experiment and 27.4 worms in the second experiment. Thus, as in insect repellent studies, pretreatment of mice with AI3–37220 produced similar results to DEET, although it is a different class of compound. In the previous study,6 cercariae were found to die in the skin of animals pretreated with DEET. We did not evaluate the location of parasite attrition in this study.

Neither DEET nor AI3–37220 are likely to comprise a major arm of a control strategy for schistosomiasis. However, the results presented here, coupled with the excellent repellent activity of DEET and AI3–37220 for vectors of other parasitic diseases, warrant further investigation into the possible prophylactic activity of these compounds in given situations in tropical environments where contact with infectious water is unavoidable or there is a high risk of accidental exposure. Further investigation should include studies using other experimental host species as well as other schistosome species to verify these results.

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REFERENCES

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<th>Pre-exposure treatment</th>
<th>Experiment 1</th>
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<tr>
<td>Isopropanol carrier</td>
<td>28.1 ± 2.0</td>
<td>27.4 ± 4.6</td>
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<tr>
<td>DEET</td>
<td>0 ± 0</td>
<td>0 ± 0</td>
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<tr>
<td>AI3–37220</td>
<td>0 ± 0</td>
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* Data are the mean ± SEM. There were 10 mice per group for each experiment. DEET = N,N-diethyl-3-methylbenzamide.
4. Naples JM, Schiff CJ, Rosler KA, 1992. *Schistosoma mansoni*: cercaricidal effects of cedarwood oil and various of its com-
409.
828–834.

**ERRATUM**

In the *Am J Trop Med Hyg* 60: 10, 14, the Mucosal Immunity Supplement to Volume 60(4), the author’s name, Marcus Götteke is misspelled in the article title and in the author’s addresses. The error was missed by both the authors and the Journal Staff. We sincerely apologize for this error.