Use of Temperature and Water Immersion to Control the Human Body Louse (Anoplura: Pediculidae)

K. Y. MUMCUOGLU,1 M. FRIGER,2 AND R. COHEN1


ABSTRACT  Physical methods such as high and low temperatures were used in the past for the control of human body louse, Pediculus humanus humanus L. (Anoplura: Pediculidae). In the current study, the minimum time necessary to kill all lice after exposing them to temperatures other than those described in the literature, the mortality of lice after immersing them in water, and the survival of lice whose legs were amputated were studied. All lice died after 6 d at 6°C, after 11 d at 24°C, and after 9 d at 31°C. At −17°C, all lice were dead after 35 min, whereas at −70°C, all lice were dead after 1 min. All lice died after immersion in water within 19 h. The differences in mortality were significant but borderline between controls and lice whose two legs were amputated immediately or 24 h after feeding (3.3 versus 13.3% and 8.3 versus 21.7%). For lice whose leg was amputated 48 h after feeding, significant differences were found between controls and lice with one amputated leg (13.3 versus 48.3%), between controls and lice with two amputated legs (13.3 versus 68.3%), and between lice with one and two amputated legs (48.3 versus 68.3%).

KEY WORDS  Pediculus humanus humanus, Pediculus humanus capitis, control, alternative

Different chemical, physical, and mechanical methods are being used for the control of human lice. Use of insecticides is the treatment of choice in most cases. However, it is not recommended to use chemicals to treat clothes and bedding after the treatment of an infested individual with pediculicides.

In the past, physical methods such as heat and cold have been used for the control of human body lice, Pediculus humanus humanus L. Buxton (1950) used high temperatures, and Busvine (1944) used low temperatures to kill lice in garments. To our knowledge the water immersion survival of human lice after immersion in water has never been reported.

Head lice, Pediculus humanus capitis De Geer, and their eggs can be removed with the help of a fine-toothed louse comb. According to Mauder (1983) the loss of a leg is a common injury in head lice and is invariably fatal. Lice apparently loose their legs while combing or by scratching with fingers; however, this claim was not substantiated by clinical or experimental testing.

The aim of this study was to study the affect of temperature, immersion in water, and amputation of one or two legs on body lice.

Materials and Methods

Body Lice. A human body louse colony originating from Culpepper (1944) was obtained from Dr. J. Mauder (London School of Tropical Medicine and Hygiene, London, United Kingdom) and has been maintained in our laboratory since 1983 according to the technique of Cole (1966). Ten males and females each, either immediately after feeding or after starvation for 24 and 48 h, were used for the amputation studies. During the entire period of each experiment, lice were kept on 3- by 5-cm large corduroy. Each experiment was conducted in triplicate.

Bioassays. Twenty-five lice (five males, five females, and 15 nymphs from the three developmental stages) fed 24 h previously were introduced to a refrigerator or a deep-freezer at temperatures of 6, −17, or −70°C and removed at regular intervals, i.e., every day, every 5 min, and every 1 min, respectively. For the experiments examining exposure of lice to higher temperatures, lice were introduced into two different incubators set at a temperature of 24 or 31°C, and the mortality was monitored daily.

Fifteen males and 15 females starved for 24 h were used for the immersion of lice in water. Twenty groups of lice were submerged each in 10 ml of tap water at 24°C in a 12-ml Eppendorf tube. To observe the mortality, every hour a group of lice were removed from water, dried, and transferred to an incubator.

The first left leg or the first left and the second right leg of male and female lice were amputated with the help of a scalpel under the stereomicroscope. After each intervention, lice were transferred to an incu-

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1 Department of Parasitology, Hebrew University-Hadassah Medical School, Jerusalem 91120, Israel.
2 Epidemiology and Health Services Evaluation Department, Faculty of Health Sciences, Ben-Gurion University of the Negev, Beer-Sheva 84120, Israel.
bator at 31°C and 60 ± 10% RH, and the percentage of mortality was observed after 24 and 48 h. A louse was considered dead if it did not move when exposed to light, or moribund if it was not able to turn over when placed on it back.

**Statistics.** Statistical analyses were performed using the chi-square test with Yates correction and the Fisher exact test were appropriate. The results were considered significant when \( P < 0.05 \), whereas \( P < 0.1 \) indicated borderline significance.

**Results**

All lice died after 6 d at 6°C, after 11 d at 24°C, and after 9 d at 31°C (Fig. 1). At −17°C, all lice were dead after 35 min, whereas at −70°C all lice were dead after 1 min.

All lice died after immersion in water within 19 h (Fig. 2).

The differences were significant but borderline between controls and lice whose two legs were amputated immediately or 24 h after feeding (3.3% [2/60] versus 13.3% [8/60], \( P = 0.0986 \) and 8.3% [5/60] versus 21.7% [13/60], \( P = 0.073 \)).

For lice whose leg was amputated 48 h after feeding, significant differences were found between controls and lice with one amputated leg (13.3% [8/60] versus 48.3% [29/60], \( P < 0.001 \)), between controls and lice with two amputated legs (13.3% [8/60] versus 68.3% [41/60] \( P < 0.001 \)), and between lice with one and two amputated legs (48.3 versus 68.3%) \( P = 0.041 \) (Fig. 3).

**Discussion**

Buxton (1950) showed that all body lice are killed after 5 min at 51.5°C, after 10 d at 15°C, and after 7 d at 10°C. In this study, it was found that all lice were dead after 6 d at temperatures of 6°C, after 11 d at 24°C, and after 9 d at 31°C. Accordingly, temperatures above 50°C most effectively kill lice.

Busvine (1944) found that all lice are killed at −20°C after 45 min, at −17°C after 2 h, and at −15°C after 5 h. In the current study, lice kept at −17°C were dead after 35 min, whereas at −70°C, all lice were dead after 1 min. Lice evaluated in previous studies were insects taken from the wild, which were likely to have been able to feed more regularly on volunteers and thus have smaller gut capacity that the laboratory-reared lice tested in this study. Wild lice also would have been subjected to greater variation in temperature before the testing regimen set up in the cited studies, so they may have shown greater tolerance of variations in environmental temperatures.

In this study, all body lice that were immersed in water at 24°C died after 19 h. Accordingly, clothes and bedding infested with body lice should be left for ~24 h soaked in water to kill lice. To our knowledge, the only immersion studies with insects were carried out with larvae of free-living beetles. Hoback et al. (2002) showed that the LT_{90} after immersion of the third instars of *Diabrotica undecimpunctata howardi* Barber at 25°C was 9 h, whereas the LT_{90} for the third instars of *Tenebrio molitor* L. immersed in anoxic water was 10.1 ± 3.2 h and that of tiger beetle *Cicindela togata* Laferte was 85.9 ± 23.5 h (Hoback et al. 1998).

Maunder (1983) reported that the loss of a leg is a common injury, usually caused by combing with a louse comb or scratching with fingers, and is invariably fatal. Chunge et al. (1991) found no statistical differences in the number of injured head lice removed from the scalp with the fingers or by using forceps and those removed by rigorous brushing of the hair. However, significant differences were found in the survival of lice in the two groups (29 and 17 h, respectively).
To our knowledge, removing lice by rigorous brushing is not a common practice, and it is not known what kind of injury the brushing can cause to lice. Our study shows that loosening one or two legs does not cause significant mortality in lice, at least in those fed immediately before the amputation or 24 h after feeding. Although these experiments were carried out with body lice, we assume that similar results also would be obtained with head lice. Accordingly, fine-toothed combs should be used to physically remove head lice from the scalp of infested individuals. Although significant mortality was observed in those starved for 48 h, this might be only of theoretical interest because human lice feed every 4 to 5 h.

In conclusion, temperatures above 50°C and below −17°C are lethal to lice within minutes, whereas lice can survive up to 19 h when immersed under water. Accordingly, immersion of the infested material in water for 24 h could be used as alternatives to insecticides, for eliminating body lice from infested clothes and bedding. It is also of practical importance to know that lice could survive for approximately a week at 24–31°C and even up to 10 d at 15°C.

References Cited


Received 9 January 2006; accepted 26 January 2006.