

## SUSCEPTIBILITY OF THE HUMAN HEAD AND BODY LOUSE, *PEDICULUS HUMANUS* (ANOPLURA: PEDICULIDAE) TO INSECTICIDES

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**Abstract**—The susceptibility of head lice, *Pediculus humanus capitis* collected from children in Israel and that of a laboratory colony of body lice, *Pediculus humanus humanus* to the insecticides malathion, deltamethrin, permethrin, fenitrothion and dieldrin has been evaluated using standard WHO papers. The  $LT_{50}$  and  $LT_{95}$  were established using different exposure times. Deltamethrin had the highest “knock-down” effect, followed by permethrin and malathion. All insecticides except dieldrin gave higher mortality for body lice than for head lice. No differences in the susceptibility between adult and nymph lice could be observed.

**Key Words:** *Pediculus humanus*, human lice, base-line, susceptibility, insecticides

**Résumé**—L’activité d’insecticides, malathion, deltaméthrine, perméthrine, fenitrothion et diéldrine a été étudiée sur les poux de tête, *Pediculus humanus capitis* ramassés chez des enfants en Israël et sur les poux de corps, *Pediculus humanus humanus* d’un élevage de laboratoire. A cet effet, les papiers standards de l’OMS ont été utilisés. Les  $DL_{50}$  et  $DL_{95}$  ont été déterminées à différents temps d’exposition. La meilleure toxicité immédiate a été obtenue avec la deltaméthrine, suivie de la perméthrine et du malathion. Tous les insecticides à l’exception de la diéldrine ont provoqué une mortalité plus élevée pour les poux de corps que pour les poux de tête. Aucune différence de sensibilité entre les poux adultes et les nymphes n’a été observée.

**Mots Clés:** *Pediculus humanus*, poux humains, toxicité, insecticides

### INTRODUCTION

The number of cases of head and body lice infestation throughout the world is estimated to run into hundreds of millions (Taplin and Meinking, 1987). Infestation with head lice has increased worldwide since the middle of sixties (Gratz, 1977a). About 6M people were infested with head lice in the USA in 1975 (Anon, 1976). A substantial rise has been noted recently in this country (Rasmussen, 1984).

Head lice infestation among children in Israel is very common: 15–20% of children between the ages of 3 and 14 are actually infested with head lice,

whereas another 40–50% show signs of previous infestation (Mumcuoglu, 1988).

Resistance of head lice to organochlorides such as DDT and lindane was described by Maunder (1971). Body lice strains have been found to be resistant to DDT, lindane and malathion (Gratz, 1977b). Cross resistance has been demonstrated between lindane and cyclodiene compounds such as dieldrin (Busvine, 1967).

In Israel malathion, carbaryl, pyrethrum or bioallethrin are used as the active ingredient in about 15 pediculocide formulations. Clinical trials here showed that some of them are not effective (Armoni

et al., 1986). It is not known whether this is due to the formulation or to resistance which developed in local lice strains.

The aim of this study was to measure the level of susceptibility of local head lice to pediculocides in use, as well as to establish the base-line susceptibility to other insecticides which may be used as future pediculocides in this country. The susceptibility of laboratory colonies of the body louse to the same insecticides was also measured.

## MATERIALS AND METHODS

### Head lice

Head lice were collected by means of a plastic lice comb from the scalp of infested children between the ages of 3 and 15 from schools and kindergartens in Beit Shemesh, a town just outside Jerusalem. The lice were immediately transferred to a pill box with netting (0.4 mm mesh) on two sides which contained a few strands of human hair (Buxton, 1951). The box was placed beneath a belt on the skin of the abdomen of one of the authors (KYM). In this way the lice received the optimum temperature and humidity and were able to take a bloodmeal whenever required, thus increasing their chance of survival. Lice were kept in this manner for transport from the field to the laboratory until the start of the experiments, and also after exposure to insecticides in those cases where the per cent mortality caused to the lice could be evaluated only after 24 hr.

### Body lice

Colonies of human body lice were maintained at  $30 \pm 1^\circ\text{C}$  and  $70 \pm 5\%$  r. h. Every second day, lice

were placed on the shaved abdomen of a restrained rabbit and allowed to feed to satiety.

### Insecticides

Standard WHO filter papers impregnated with 5% malathion, 0.025% deltamethrin, 0.25% permethrin, 1% fenitrothion and 1% dieldrin were used.

### Screening

Batches of ca. 20 head or body lice consisting of 10 adults and 10 second and third stage nymphs were exposed to insecticides on filter paper when confined in half of a Petri dish (dia. 9 cm). Weights were placed on top of the Petri dish to prevent the lice from escaping. At the end of the exposure period mortality was recorded for malathion, deltamethrin, permethrin and fenitrothion. For dieldrin treatment, head lice were placed in a pill box on untreated hairs and kept on the human body for another 24 hr when mortality was recorded. Body lice treated with this insecticide were transferred after exposure to clean filter papers and then incubated at optimum temperature and humidity conditions for a further 24 hr.

Controls on papers impregnated with the solvent only were used for each group of experiments using the longest exposure time for the treated group. Each experiment was repeated at least four times. Where control mortality was between 5 and 20%, percentage mortality was corrected by Abbott's formula (WHO, 1981).

Preliminary studies were carried out on a batch of head or body lice. Observations were made every 15–30 min and the dead lice were removed. This was used to determine exposure time needed to kill 50% and 95% of the lice ( $LT_{50}$  and  $LT_{95}$ ) for the different insecticides.

Table 1. Susceptibility of field-collected head lice and a laboratory colony of body lice to five insecticides

Insecticides and concentrations (%)	Head lice		Body lice	
	$LT_{50}$	$LT_{95}$	$LT_{50}$	$LT_{95}$
Malathion 5	1 hr 40'	3 hr	55'	1 hr 30'
Deltamethrin 0.025	1 hr	1 hr 40'	30'	40'
Permethrin 0.25	1 hr 30'	3 hr	45'	1 hr 15'
Fenitrothion 1	4 hr	8 hr 20'	2 hr 45'	5 hr 30'
Dieldrin 1	2 hr 50'	8 hr	4 hr	7 hr 30'

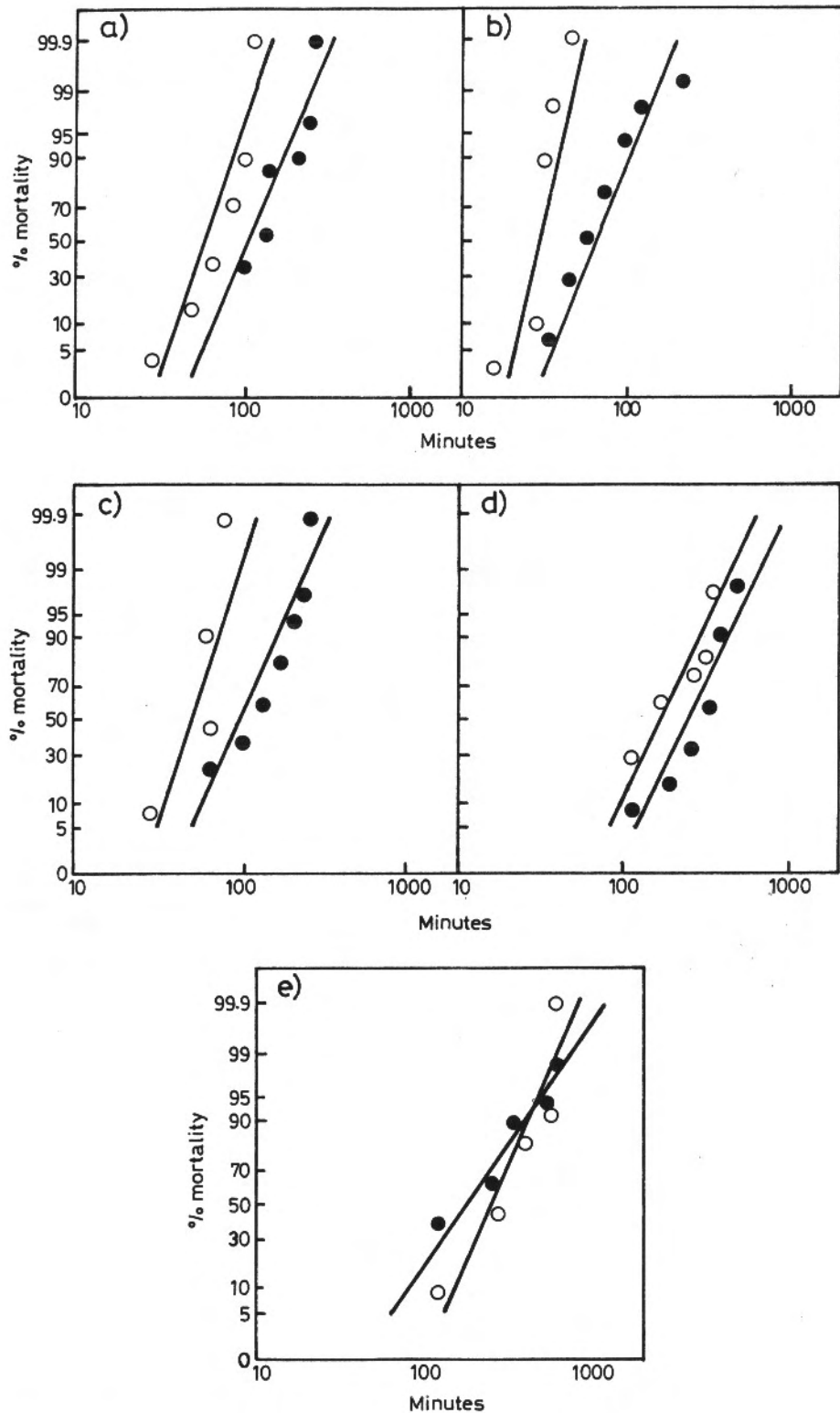


Fig. 1. Dose-response of head lice and body lice to: (a) malathion, (b) deltamethrin, (c) permethrin, (d) fenitrothion, and (e) dieldrin.

The  $LT_{50}$  and  $LT_{95}$  of malathion, deltamethrin, permethrin, fenitrothion and dieldrin on Table 1 were calculated from the dose-response curves seen on Fig. 1. Deltamethrin had the highest "knock-down" effect, followed by permethrin and malathion. All insecticides examined gave higher mortality for body lice than for head lice except for dieldrin where the susceptibilities were similar. No differences in the susceptibility of adult lice and nymphs could be observed.

## DISCUSSION

Most of the susceptibility tests carried out previously used different concentrations of a given insecticide (Maunder, 1971; Blommers and van Lennep, 1978a; Blommers, 1979, 1980), as opposed to the recent WHO recommendations that the susceptibility to insecticides be determined by using a single concentration and changing the exposure time (WHO, 1981). It is not possible to compare our results with those of previous workers because we followed the WHO recommendations.

Blommers and van Lennep (1978b) found that first instar nymphs of the Utrecht strain of head lice gave an  $LT_{50}$  of 1 hr and  $LT_{95}$  of 2 hr using malathion. He used filter papers which were impregnated in his laboratory and he claimed that his paper yielded lower susceptibility levels than those of WHO. Our results of 2 and 3.25 hr for malathion suggest that at this stage there is no resistance of head lice to malathion in the Beit Shemesh strain.

According to Maunder (1971) head lice are somewhat more susceptible to insecticides than body lice. Our laboratory colony of body lice, which originated from Dr. Maunder's colony, showed that the latter are more sensitive to the five insecticides tested than *P. h. capitis*.

Deltamethrin and permethrin are in use in other countries (Taplin and Meinking, 1987; Sasaki and Cortez, 1985) and may be good future pediculocides in Israel.

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