Pesticidal effects of SevinR (1-naphthyl-n-methyl carbamate) on the survivability and abundance of earthworm Pontoscolex corethrurus

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Abstract. The influence of different concentrations of SevinR (1-naphthyl-n-methyl carbamate) a carbamate, was experimented on population of Pontoscolex corethrurus under laboratory conditions. The survivability, activity and fecundity of the worms are greatly influenced by the residue concentrations. The concentrations uptoa level of 100 ppm favours the life activities of individuals whereas beyond this level the residual effect showed an adverse effect on the population.

Keywords. SevinR ; pesticidal effect; Pontoscolex corethrurus; earthworm.

1. Introduction
Carbamates as neurotoxins produce systemic changes in insects and mites (Haynes et al 1957; Georghian and Metcalf 1962). From this point of view, the carbamates find their use as insecticides in place of organochlorides and organophosphates, for which many insect pests develop resistance (Hueck et al 1952; Knutson 1955, 1959; Afifi and Knutson 1956, Gratz 1966; Mardzhanyan et al 1969). In nature conservationists' point of view, any pesticide application should not be toxic to non-target species. Organophosphates and organochlorides are known to be toxic to several nontarget individuals (Davis 1968; Gish 1970). Toxicity of carbamates on nontarget species are not fully elucidated. However, possible effects of carbamate applications on nontarget invertebrate populations like earthworms have been mentioned by Kring (1969), Thompson (1970) and Stenersen et al (1973). In this paper, some of the pesticidal effects of SevinR (1-naphthyl-n-methyl-carbamate) on the survivability and abundance of earthworms have been described.

2. Materials and methods
2.1. Collection and stock maintenance
Earthworms belonging to the species Pontoscolex corethrurus were collected by excavating garden soils. Only adult worms weighing 1.0–1.6 g with well-
developed clitellar region were selected for experiments and maintained in the laboratory in earthen-ware troughs containing the garden soil.

2.1a. **Experimental pots**: Glass jars (2074 cu.cm. capacity) were filled first with 6 kg fine sand which was washed and dried earlier. Tap water was sprinkled over so that it attained moisture content between 2.8 and 3.0%. Over the sand layer 2 kg clay loam soil (1.5% organic carbon, 2% total carbon, 2.8-3.0% moisture) was spread out. For experiments to study the effects of Sevin® the compound obtained from Union Carbide India Limited, was weighed and mixed thoroughly with clay loam before wetting and spreading over sand layer. Sand layer was found essential for settlement of earthworms during their activity (Kale et al 1977). Experiments conducted in pots without sand layer resulted in death of worms in two to three weeks. It was discernible, that sand layer acted as a bedding material for worms.

2.2. **Weight changes and survivability of worms**

Pots as described above, were prepared with soils containing different concentrations of Sevin®. One hundred worms were weighed and introduced into each pot and left undisturbed for 30 days. After the experimental period the worms were separated, counted and weighed to examine the loss or gain of weight due to their sojourn in the pot. The percentage of worms survived in each pot was calculated to note the effect of Sevin® concentrations in the soil.

2.3. **Changes in worm activity**

Worm casts in each pot were carefully collected by hand sorting, dried in an oven and weighed. The weight of casts in the pot containing 0 ppm of Sevin® (control) was considered to be 100% activity. The percentage of weight of the casts obtained from each pot relative to control pot was calculated and compared.

2.4. **Changes in fecundity**

Also, the number of cocoons laid in each pot was noted after collecting all the cocoons from the pots.

2.5. **Hatchability of cocoons**

Cocoons were harvested from the laboratory stocks. The cocoons obtained from different pots were left in separate pots containing normal soil. At regular intervals the contents of each pot was examined to find out the number of cocoons hatched. The per cent cocoon hatched was calculated and compared.

3. **Results**

Figure 1 demonstrates the survivability of the adult worms when cultured for one month in soils with ranging concentration of Sevin®. Even in the control soil which is devoid of the pesticide residues, the 6% mortality noticed may be due to transfer of worms to experimental media. However, there was a significant (r = -0.8886) linear reduction in the survivability of the worms with increasing con-
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Figure 1. Survivability of earthworms exposed to different concentrations of Sevin®.

Figure 2. Weight changes in the earthworms exposed to different concentrations of Sevin®.

centres of Sevin® in soil. It was predicted from this relationship that a 50% survivability would occur at a concentration of 375 ppm of Sevin® in soil.

Sevin® residues in soil also affect the growth of the worms (figure 2). Control worms, soon after transfer to laboratory culture pots, lose weight, perhaps due to changes in the composition of culture soil. After one month sojourn in Sevin® containing soils, the worms lost weight curvilinearly ($r = 0.9792$) against the increasing concentration of the residues (figure 2). This curvilinearity significantly yields a slight weight improving effect up to residue concentrations equivalent to 150·0 ppm, and above this level the loss of weight was steady and steep with further increase in residue concentrations.

Another measure of earthworm activity with reference to Sevin® residues in the soil was attempted. Figure 3 summarises these data. The worm casts in experimental pots containing varying residue concentrations were collected and weighed after one month and compared with that of control, without the residues. The amount of cast output increased by 67% at 50·0 ppm. Concentrations over 50·0 ppm decreased the cast output exponentially. It is clear from this figure that increasing concentrations of Sevin® residues are inhibitory of cast output by worms.

The cocoon laying was increased by three-fold from those of controls in 37·5 ppm and 75·0 ppm whereas no cocoons could be made out in higher concentrations.

P. (B)—2
The low concentrations of Sevin\textsuperscript{R} has induced the fecundity of the worms significantly and also hastened the hatchability of cocoons (figure 4).

4. Discussion

Sevin\textsuperscript{R} (1-naphthyl-\textit{n}-methyl-carbamate) is insoluble in water. It has been estimated to be quite stable in soil as far as 40 days (Tilak \textit{et al} 1978) and on biological decomposition it yields inactive naphthal and carbamic acids. Like any other organophosphates, carbamates act as neurotoxins on insects and other arthropods, producing systemic changes (Hueck \textit{et al} 1952; Knutson 1955, 1959; Afifi and Knutson 1956; Gratz 1966, Mardzhanyan \textit{et al} 1969). It is interesting to note that the present results show that Sevin\textsuperscript{R} affect the growth and abundance of earthworms in a different way.

Tolerance of earthworms to different fungicides, herbicides and insecticides are known (Edwards 1964, 1970, 1973; Legg 1968; Voronova 1968, Kring 1969;
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Thompson 1970, Stenersen et al 1973; Edwards and Jeffs 1974). Worms develop resistance to many of them. Under field and laboratory conditions, worms develop resistance to DDT and Aldrin (Edwards and Jeffs 1974). Edwards (1973) suggested that earthworms by their activity redistribute these pesticides to lower soil layers. Herbicide atrazine (Edwards 1970) carbaryl, aldicarb, carbofuran affected the earthworm populations either by reducing immobility in worms or causing heavy mortality (Kring 1969; Thompson 1970; Edwards 1973; Tomlin and Gore 1974, Stenersen et al 1973). The present results suggest that Pontoscolex corethrurus has greater degree of tolerance when compared to these findings. However, the changes observed such as loss of weight, survivability, reduction in casting activity, and fecundity are residue concentration-dependent; higher pesticide concentrations effecting heavy mortalities.

The hyperactivity exhibited at the lower concentrations of Sevin® were very much similar to those observed in the insect groups that have developed resistance to DDT and dieldrin. In Drosophila malanogaster (Knutson 1955) Spidermite Metarachus ului (Hueck et al 1952) and in house fly Musca domestica (Affi and Knutson 1956; Knutson 1959) the sublethal doses of DDT and dieldrin increased longevity, feeding rate and fecundity of the survivors of the chemical treatment. The influence of the pesticide treatment could be traced out in the succeeding progenies (Affi and Knutson 1956).

The carbamates Sevin® a neurotoxin like any other organophosphate or carbamate, in the lower dosages of 37.5 to 75 ppm has stimulatory effect rather than an inhibitory effect on the growth and survivability of the worms. Overdose however, retards the growth and survival of the individuals.

The hyperactivity of the individuals at lower pesticide contamination and the lethargy developed at the higher concentrations in the survivors may have great influence on the population dynamics of earthworms. When the worms are exposed to a concentration above 150 ppm, the reactions observed are similar to those observed by Georghion (1965) in house flies. These reactions were implied in the repression of food intake, locomotion and reproduction. Such worms apart from losing capacity in increasing the population, can even become easy preys to predators. This may lead to slow dwindling of numbers, when occurred in an ecosystem. It is therefore advisable in nature’s conservationist point of view to minimize the Sevin® contaminations in soils to a low degree where the influences are acceleratory. The cases of autotoxicity produced in insects by hyperactivity on exposure to insecticides are also available in literature (Georghion 1972). Whether the worms develop autotoxicity on repeated applications of Sevin® in an agroecosystem is yet to be investigated.

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