

SUSCEPTIBILITY OF THE PSOCID PEST
LIPOSCELIS BOSTRYCHOPHILUS TO METHOPRENE
AND TO A NEW JUVENOID

Zuzana KUCEROVA and Jan ZUSKA

Research Institute of the Food Industry
Department of Pest Control

Radiova 7, CS-102 31 Prague 10, Czechoslovakia

ABSTRACT

Adult females, or last instar nymphs, of Liposcelis bostrychophilus were kept on food containing 0.1 to 1,000 ppm of methoprene or ethyl 2-(4-(14-dioxaspiro(4,5)dec-6-yl) methyl) phenoxy) ethoxy carbamate (W 328). Their F1 progeny were counted. Methoprene inhibited the development of the F1 generation at a concentration of 1,000 ppm; no nymphs completed their metamorphosis to the adult stage. The colonies fed with food containing lower concentrations of methoprene did not differ from the reference populations. The psocids were markedly more susceptible to W 328 than to methoprene : 1 ppm completely inhibited the development of last instar nymphs into adults. As little as 0.1 ppm was sufficient to cause defects in adult pigmentation and in the sculpture of the cuticle.

INTRODUCTION

The effect of juvenoids has been tested on a number of stored-product pests (e.g. Strong and Diekman, 1973; Silhacek and Oberlander, 1975; Baker and Lum, 1976; Amos et al., 1977; Mian and Mulla, 1982; Edwards and Short, 1984; Klein and Burkholder, 1984; Benezet and Helms, 1985; Vick et al., 1985; Fava, 1987). However, the efficacy of juvenoids on synanthropic psocids has not been investigated, though many of them, particularly the very common parthenogenetic species Liposcelis bostrychophilus Badonnel, 1931, are associated with stored products, food- processing factories and

grain stores.

We therefore decided to test the susceptibility of *L. bostrychophilus* to two compounds with juvenile hormone activity. One of them was methoprene, manufactured by the Research Institute of Organic Syntheses in Pardubice, Czechoslovakia. The other chemical was the compound W 328, or ethyl 2-[4-((1,4-dioxaspiro (4,5)dec-6-yl) methyl) phenoxy] ethoxy carbamate, a new juvenoid first synthesized in Czechoslovakia, also at the above-mentioned institute.

MATERIALS AND METHODS

The experimental individuals of *L. bostrychophilus* were obtained from a long-established laboratory culture maintained on wheat germ at 27°C and 75 % RH.

All experiments were simple tests of the influence of juvenoids contained in food upon the rate of increase of populations in small laboratory colonies. Groups of 5 last-instar nymphs (1 to 2 days before ecdysis) or 5 adults (1 to 3 days old) were used as colony founders. Each group was transferred to a 25 ml wide-mouth glass container, which contained 2 g of experimental food, and which was closed with a rubber stopper pierced by a glass tube that was covered by gauze across its inner end.

The food consisted of a standard sterilized insect rearing diet composed of ground soft wheat (cv. Sparta), ground oat flakes and dried brewer's yeast, in the ratio 5 : 5 : 1, to which one of the tested juvenoids was added at concentrations of 0.1; 1; 10; 100; or 1,000 ppm. The experimental foods were prepared as follows. The appropriate amount of pure juvenoid was dissolved in 1 ml of acetone (analytical grade, freshly re-distilled), and further diluted with 50 ml of diethyl ether (analytical grade). The final solution was then mixed with 100 g of the standard diet. This mixture was placed in a fume cupboard for 24 hours, being stirred occasionally to let all residues of the ether and acetone evaporate. In the case of the reference food (untreated control), only acetone and diethyl ether were applied.

Each treatment was replicated five times. The tests were carried out in a climatized container at 27°C and 75 % RH. After 45 days the resulting F1 progeny (adult females and nymphs) were extracted from the remaining food with help of Berlese funnels and counted. Microscopic slides of adults and nymphs to study morphological malformations were also made for each treatment.

RESULTS

The effect of methoprene on the populations of *L. bostrychophilus* is shown in Fig.1. The colonies fed with food containing 100 ppm or less of methoprene did not differ from reference colonies in population density. However, certain morphological changes were noticed in the adults treated with 100 ppm. Their antennal segments lacked annular ridges, thus resembling nymphal antennae. The concentration of 1,000 ppm inhibited full development of the F1 generation. No nymphs completed their metamorphosis to the adult stage and the number of nymphs decreased by 30 % when compared with the control.

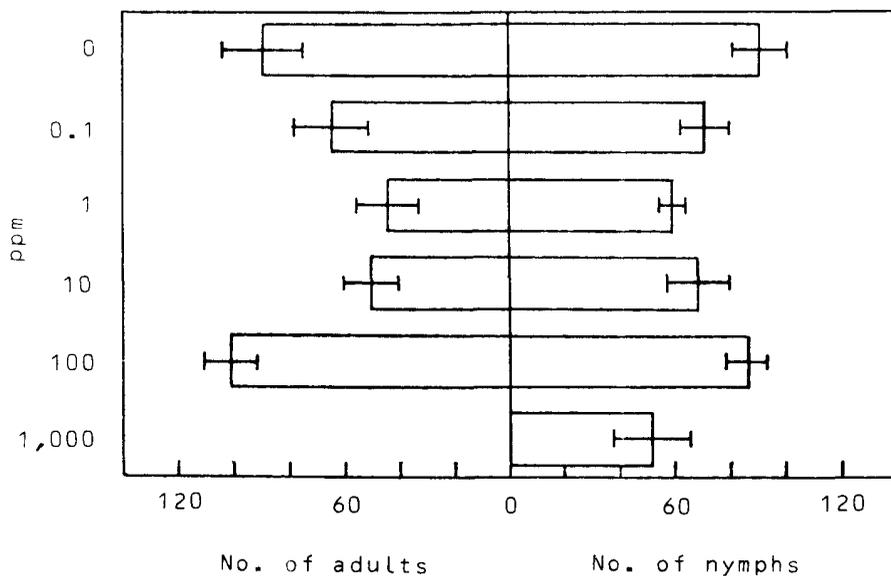


Fig. 1. Influence of dietary methoprene upon population size in laboratory colonies of *L. bostrychophilus* /mean \pm SEM; each colony was founded with 5 fully-grown nymphs/.

The compound W 328 (Figs 2, 3) completely inhibited the development of nymphs into adults at concentrations as low as 1 or 10 ppm, irrespective of whether the colony founders were fully-grown last instar nymphs or adult females. About one half of the nymphs probably belonged to a supernumerary nymphal instar. They were slightly larger than adult females and their abdomens contained from 2 to 7 eggs. Concentrations of 100 and 1,000 ppm not only produced an absence of adults, but nymphs were also almost completely absent. We suspect that these concentrations were ovicidal. At the lowest concentration tested, i.e. 0.1 ppm, the last instar nymphs of the F1 generation always developed into adults. However, all these adults showed various defects in the pigmentation and sculpture of their cuticle. They had non-pigmented irregular spots on the head, thorax, and abdominal terga 8 to 10; abdominal terga 1 to 7 completely lacked pigmentation, which is a condition normally found only in the nymphs. The antennal segments also were of nymphal form, lacking the annular ridges.

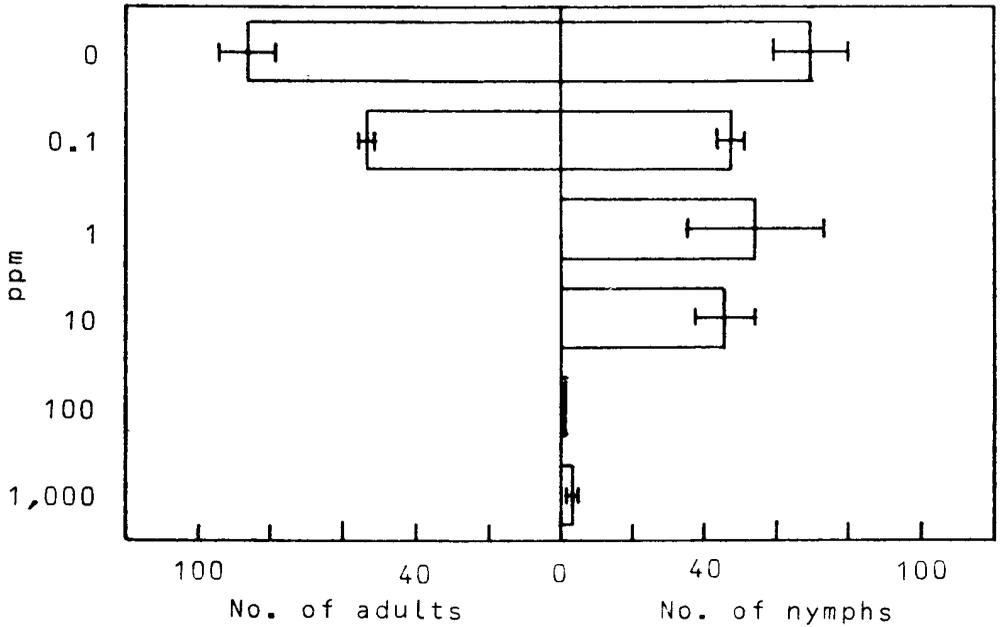


Fig. 2. Influence of dietary juvenoid W 328 upon population size in laboratory colonies of *L. bostrychophilus* /mean \pm SEM; each colony was founded with 5 fully-grown nymphs/.

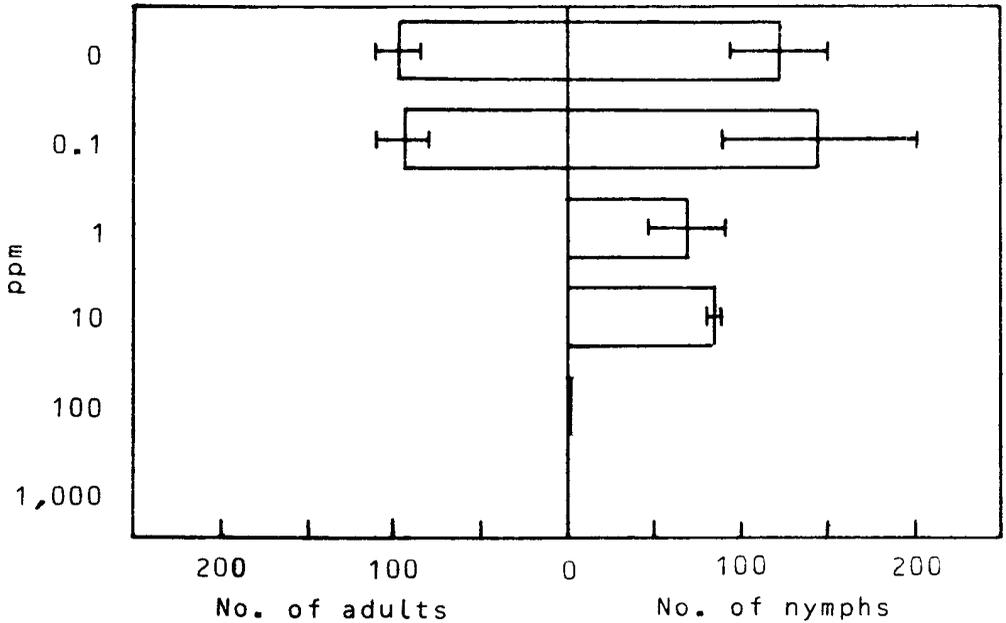


Fig. 3. Influence of dietary juvenoid W 328 upon population size in laboratory colonies of *L. bostrychophilus* /mean \pm SEM; each colony was founded with 5 adult females/.

DISCUSSION AND CONCLUSIONS

It is clear from the literature and from our experiments that the population development of pests such as Sitophilus oryzae, Tribolium spp., Gnathocerus cornutus, Lasioderma serricorne, Rhyzopertha dominica and Ephestia cautella is inhibited by methoprene administered in food at concentrations not higher than 20 ppm (e. g. Amos et al.; 1977; Hoppe, 1981; Mian and Mulla, 1982; Benezet and Helms, 1985; Vick et al., 1985; Zuska and Cadkova, unpublished). On the other hand, Sitophilus granarius (Edwards and Short, 1984, and references) and Plodia interpunctella (Shilhacek and Oberlander, 1975) appear to be resistant to doses as high as 100 to 150 ppm. Our results show that even higher doses of methoprene are needed to lower the population size of L. bostrychophilus.

There is still very little known about the effect of the compound W 324 upon insects. Kodrik (1990) found that 1,000 ppm fed to nymphs of Blattella germanica was lethal or caused serious developmental defects. In our experiments with some species of stored-product Coleoptera, much lower doses were found to affect the laboratory populations (Kucerova and Zuska, unpublished; Zuska and Cadkova, unpublished). Surprisingly, a very low dose of the compound W 328 was found to lower population density in L. bostrychophilus significantly.

It can be concluded that methoprene can hardly be used to control L. bostrychophilus, whereas the compound W 328 clearly suppresses populations of this pest at very low doses.

ACKNOWLEDGEMENTS

We thank Z. Vrba (Pardubice, Czechoslovakia) for the supply of Juvenoids and A. C. Pont (Goring-on-Thames, UK) for improving the English of this paper.

REFERENCES

AMOS T. G., WILLIAMS P. and SEMPLE R.L. (1977) Susceptibility of malathion-resistant strains of Tribolium castaneum and T. confusum to the insect growth regulators methoprene and hydroxyurea. Ent. exp. appl. 22, 289-293.

BAKER J.E. and LUM P. T. M. (1976) Comparative effects of dietary methoprene on symbiotic and aposymbiotic rice weevils and asymbiotic granary weevils. J. Ga. Ent. Soc. 11, 213-216.

BENEZET H. J. and HELMS C. W. (1985) Reproductive potential of cigarette beetle populations exposed to methoprene. Tobacco Sci. 29, 14-15.

EDWARDS J. P. and SHORT J. E. (1984) Evaluation of three compounds with insect juvenile hormone activity as grain protectants against insecticide-susceptible and resistant strains of Sitophilus species (Coleoptera : Curculionidae). J. stored Prod. Res. 20, 11-15.

FAVA A. (1987) L'effetto del trattamento dell'analogo dell'ormone giovanile sulla

HOPPE T. (1981) Testing of methoprene in resistant strains of *Tribolium castaneum* (Herbst) (Col., Tenebrionidae). *Z. angew. Ent.* 91, 241-251.

KLEIN J. A. and BURKHOLDER W. E. (1984) Effect of Dianex (methoprene) on growth and reproduction of *Trogoderma glabrum* (Herbst) (Coleoptera : Dermestidae). *Environ. Ent.* 13, 1340-1345.

KODRIK D. (1990) Effects of a novel juvenoid on the German cockroach. In : Conf. on Insect Chemical Ecology, Tabor, Czechoslovakia, August 12-18, 1990, Abstracts of Papers, Institute of Organic Chemistry and Biochemistry of the Czechoslovak Academy of Sciences, Prague, p. 104.

MIAN L. S. and MULLA M.S. (1982) Residual activity of insect growth regulators against stored-product beetles in grain commodities. *J. econ. Ent.* 75, 599-603.

SILHACEK D. L. and OBERLANDER H. (1975) Time-dosage studies of juvenile hormone action on the development of *Plodia interpunctella*. *J. Insect Physiol.* 21, 153-161.

STRONG R. G. and DIEKMAN J. (1973) Comparative effectiveness of fifteen insect growth regulators against several pests of stored products. *J. econ. Ent.* 66, 1167-1173.

VICK K. W., COFFELT J. A., SILHACEK D. L. and OBERLANDER H. (1985) Methoprene and sex pheromone as control agents for the almond moth (Lepidoptera : Phycitidae) on peanuts stored in the shell. *J. econ. Ent.* 78, 258-262 .