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THE USE OF *BACILLUS THURINGIENSIS* VAR. *ISRAELENSIS* IN THE BIOLOGICAL CONTROL OF BLACKFLIES IN CZECHOSLOVAKIA

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The discovery of *Bacillus thuringiensis* var. *israelensis* (*B.t.i.*) brought about great changes in the control of nematocerous haematophagous flies. Industrial production of preparations based on *B.t.i.* provided the first practicable, highly effective biological preparation for the control of mosquitoes and blackflies. In Czechoslovakia, the application of insecticides is undesirable in the cultivated landscape, and the use of microbial preparations is as urgent here as in the tropics due to increasing contamination of the soil and stream with insecticides, mainly in the neighbourhood of drinking water reservoirs. Therefore, a number of tests to ascertain factors limiting *B.t.i.* efficacy in the temperate zone were performed.

Methods

Field observations were performed from February 1983 to May 1984 in two brooks (Dubský and Rachačka), in the district of České Budějovice (southern Bohemia). Both brooks were canalized streams with a partially paved channel; sites were covered by dense vegetation. The width of the channels is about 1.5 m, depth 5 cm, stream velocity ranged from 40 to 90 cm/s.

Laboratory tests to ascertain the effect of temperature were performed using larvae from the same localities in which field observations were performed, but larvae were not collected from *B.t.i.*-treated sites. The larvae were kept in a laboratory, in aerated tanks filled with 200 cm^3 of brook water, 0.1 - 2.9°C or 17 - 19°C.

In our experiments, lyophylized *B.t.i.* spores, produced by Roger Bellon, and Moskytur, a preparation manufactured by the Unified Agriculture Cooperative at Slušovice, were used. An aqueous suspension of

lyophylized spores was then prepared (final concentration 1×10^5 spores/cm^3). A watering-can was then filled with the suspension and emptied into the brooks during 10 min. Mortalities were observed 48 h after application.

Results and Discussion

In all field experiments performed in the period when the water temperature exceeded 10°C, the mortality of blackfly larvae (both the mortality observed at control sites in the localities and that in control samples brought back to the laboratory) was 95 - 100% at sites 0 - 400 m distant from the treatment point. The species *Prosimulium tomosvaryi* (Enderlein, 1921), *Cnetha verna* (Macquart, 1926) and *Odagmia ornata* (Meigen, 1818) were found in the material. The above species occurred in different numbers at control sites in individual localities. At a site 700 m distant from the treatment point mortality ranged from 20 to 40%; however, there was a conspicuous increase in the proportion of the last instar larvae when compared to younger larvae (8% prior to treatment and up to 54% 48 h after *B.t.i.* application). A site 1000 m downstream from the treatment point was not affected. The situation at the site 700 m distant from the treatment point corresponds with the data published by Molloy and Jamnback (1981), Molloy et al. (1981) and Guillet and Escaffree (1979) who reported a higher susceptibility of young instar larvae. The spore suspension in the brook moves as a relatively homogenous cloud, which gets longer and thinner as the distance from the treatment point increases; Matha et al. (1985) reported that dense water vegetation may capture over 50% of the drifting spores. As demonstrated by some authors (Lawrence and Undeen, 1984), decreased concentration leads to decreasing efficacy, and this decrease is not overcome even with a prolonged period during which a thin cloud moves past the site. Some of the results obtained in these experiments are discussed in detail by Olejníček et al. (in press).

In Dubský Brook recolonization of sites where blackflies had been eradicated was observed. On day 12 after treatment the number of blackfly larvae was, in contrast to their numbers prior to treatment, as follows: — 5 m (control) 70%, 5 m 70%, 50 m 50%, 100 m 5%, 200 m 10%, 400 m 0%, and within 22 days their numbers had reached nearly the same level as prior to *B.t.i.* treatment. During that period, the first instar larvae began to occur, but it is uncertain whether these were migrants or larvae hatched from eggs at the treated site.

In the field tests with *B.t.i.* conducted in winter when the water temperature was about 2°C, the efficacy of the suspension was conspi-

cuously low. Therefore, additional lab tests were performed (Olejníček et al. 1985). Tests with *O. ornata* showed that at temperatures below 4°C the usual doses had no effect. The experiment was repeated using *Prosimulium tomosvaryi* which was supposed to be adaptable to a cool environment. The results were nearly identical with those obtained with *O. ornata*. A decreased *B.t.i.* efficacy connected with lower temperature was reported by Lacey et al. (1978) and Molloy et al. (1981). Its mechanism has not been elucidated. It is interesting to note that similar phenomena have been observed with some chemical insecticides (e.g. Rodrigues and Kaushik, 1984).

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UŻYCIE *BACILLUS THURINGIENSIS* VAR. *ISRAELENSIS* DO BIOLOGICZNEGO ZWALCZANIA MESZEK (*SIMULIIDAE*) W CZECHOSŁOWACJI

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Badano w warunkach laboratoryjnych i terenowych oddziaływanie zawiesiny zarodników *B.t.i.* na larwy środkowoeuropejskiego gatunku meszki. Stosowano liofilizowane zarodniki (Roger Belon) oraz preparat Moskytur (produkcji: ČSSR).

W stężeniu końcowym 1×10^5 zarodników ml^{-1} uzyskano 90 - 100% śmiertelności larw *Prosimulium tomosvaryi*, *Eusimulium vernum* i *Odagmia ornata* w strefie odległej o ponad 500 m od miejsca zastosowania (zbiornik na uregulowanym potoku, temp. wody 11,4°C). Znacznie większy odsetek larw ostatniego stadium przeżywał w strefie obniżonej skuteczności zawiesiny zarodników (700 - 1000 m od miejsca zastosowania), co wskazuje na większą wrażliwość młodych larw. Skuteczność zawiesiny *B.t.i.* była badana w temp. 0,1 - 2,9°C i 17 - 19°C zarówno w warunkach terenowych, jak i laboratoryjnych. Larwy *O. ornata* i *P. tomosvaryi* były zdolne pobrać letalną dawkę preparatu nawet w temp. poniżej 2,9°C, jednakże w porównaniu z grupą kontrolną nie stwierdzono w niskich temperaturach wyraźnych różnic w śmiertelności. W temp. poniżej 2,9°C uzyskiwano 99% śmiertelności po 48 godz. przebywania larw w zawiesinie zarodników.