T. Pl.-ziekten 68 (1962): 143–146

CONTROL OF TENT CATERPILLARS (*MALACOSOMA NEUSTRIUM*) WITH *BACILLUS THURINGIENSIS* IN THE CITY OF AMSTERDAM[1]

Met een samenvatting: Bestrijding van ringelrupsen met Bacillus thuringiensis *in de stad Amsterdam*

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Outbreaks of high populations of caterpillars have been noticed in Amsterdam for more than one hundred years (KALSHOVEN, 1959). About 10,000 elm trees (mainly *Ulmus hollandica* var. *belgica*) are growing along the canals and, moreover, as Amsterdam has been a "green city" for years, numerous trees and shrubs are present in parks and in public as well as in private gardens. Defoliation is not yet the most serious trouble here, as the outbreaks do not occur every year. There is only a temporary retardation of growth to fear and hardly any tree in Amsterdam really dies from caterpillar attack.

It is the nuisance to the inhabitants, in the streets as well as in the houses, which causes the main trouble. The control of caterpillars is therefore attended by a special Commission from the Municipality which was created in 1936. The work of the Commission resulted in the organization of a regular control which is done every spring by dusting all elm trees once or twice with Derris powder (KALSHOVEN, 1959).

Originally two species occurred, the Tent Caterpillar, *Malacosoma neustrium* (L.), and the Brown Tail Moth, *Euproctis chrysorrhoea* (Don.). However, the latter one disappeared from the picture in later years and we shall therefore restrict ourselves to *M. neustrium*.

When after the war numerous new insecticides became available, it was seriously considered whether any of them could replace Derris powder. However, the Public Health Authorities as well as the biologists decided against using DDT, BHC, parathion, malathion or any of the other insecticides, because 1) treatment in the centre of a large city with more or less poisonous materials is too risky for men and animals, 2) using an all-over insecticide may also destroy a lot of useful and pleasant lower and higher animals (butterflies, birds, etc.) in the parks, public and private gardens.

In the course of the years, it became apparent that Derris powder had certain disadvantages. After all, it is not so harmless as had been thought formerly, rotenone being relatively toxic; sometimes labourers were allergic to the dust and were not able to work with it. Also the high toxicity to fishes is a drawback; sometimes complaints were received that goldfishes in ponds in private gardens were dying after treatments of neighbouring trees.

Therefore, we sought for a highly specific insecticide which is toxic only to the caterpillars and leaves the environment intact. We believe to have found it,

[1] Accepted for publication 26 January, 1962.

using products derived from the insect-pathogenic bacterium, *Bacillus thuringiensis* Berliner.

This bacterium, isolated by BERLINER (1915) from larvae of the Mediterranean Flour Moth, *Anagasta kühniella* (Zell.), produces a toxin which has a lethal effect on some Lepidopterous larvae, but which is harmless to other insects, higher animals and man (HEIMPEL & ANGUS, 1960; KRIEG, 1961).

Laboratory and field experiments, already published before (VAN DAMME & VAN DER LAAN, 1959), showed that *M. neustrium* was very susceptible to *B. thuringiensis*-suspensions. This paper reports the results of some experiments done to compare the activity of Derris powder with those of several commercial products derived from *B. thuringiensis* and *M. neustrium* in the laboratory.

MATERIALS AND METHODS

The caterpillars were bred out-doors in cages from egg-rings, gathered from the elm trees in the city. We failed to breed the specimens under conditioned circumstances in the laboratory, as in that case a polyedric virus disease kills most of the larvae in due time. Per series 2 × 20 specimens were used.

The apparatus used for dusting was a high wooden closed box (30 × 30 × × 120 cm), wherein a weighed amount of powder was blown through a bent glass tube from underneath. Twenty larvae were placed in the box on a small elm branch with leaves and dusted with fixed amounts of the dust mixture. After the treatment, the branch with the caterpillars was placed in a plastic box at 12–20°C and 95–100 % R.H. Because of the high humidity, the leaves remained fresh for one week and were then replaced by fresh untreated leaves. The series treated with talc only (control) needed replenishment much sooner.

The insecticides used were:

Derris dust mixture with 2.1 % rotenone as commonly used for control and three commercial products, based on *Bacillus thuringiensis:*

1) Bactospeine I.P. 54, diluted with talc to a 10 % dust mixture, containing 900,000 Unités biologiques (Cf. BURGERJON, 1959) per g, 2) Thuricide dust, containing 3×10^9 spores per g, and 3) Hoechst 2802, Biospor, wettable powder, 3×10^9 spores per g, both diluted with talc to 10 % and used as a dust.

Two series of experiments were done with second instar larvae, 22 days old, using a dose of 4 mg/cm^2; three experiments were done with third instar larvae, 30 to 37 days old, using a dose of 8 mg; two experiments were done with fourth instar larvae, about 50 days old, using same dose, and one experiment with the full-grown fifth instar larvae. The mortality was determined 10 to 12 days after treatment (table 1).

Especially the younger larvae seem to be not entirely resistant to treatment with talc only, as some mortality occurred in the check plots also.

In all experiments some casualties occurred by polyedric virus disease [1], in the treated as well as in the untreated plots. These individuals were discarded from the experiment and if the amount of discarded larvae rose above 20 %, the whole experiment was abolished.

It is shown from the results that in alle stages of development, the mortality

[1] This virus disease is not suitable to use as a biological control agent, because the caterpillars diseased by the virus disease become slimy and malodorous which is draw-back in the present circumstances.

TABLE 1. Effects of Derris dust (2.1% Rotenone) and products of *B. thuringiensis* on Tent Caterpillars.
Werkzaamheid van Derris-stuifmengsel (2,1% rotenon) en preparaten van B. thuringiensis *tegen ringelrupsen.*

Date *Datum* 1961	Age in days/instar *Leeftijd in dagen/stadium*	Amount of dust (mg/cm²) *Hoeveelheid poeder (mg/cm²)*	Percentage mortality after 10 to 12 days *Percentage sterfte na 10 tot 12 dagen*				
			Control *Blanco*	Derris	Bacto-speine	Thuri-cide	Biospor
17/5	22/2	4	29	73	99	87	–
18/5	22/2	4	13	49	92	94	–
25/5	30/3	8	3	50	97	95	–
31/5	36/3	8	11	22	97	86	–
1/6	37/3	8	3	18	88	66	–
7/6	?/4	8	0	41	79	–	74
15/6	51/4	8	0	35	–	–	63
30/6	?/5	–	2	39	44	–	56

due to the toxin of *B. thuringiensis* was more satisfactory than that caused by the Derris dust.

DISCUSSION

The experiences from earlier experiments, together with the facts referred to above, indicate that it is preferable to use *B. thuringiensis*-preparates for control of the tent caterpillars in Amsterdam for several reasons:

1. The effect of *B. thuringiensis* on the caterpillars is better than that of Derris powder.
2. The harmlessness of the bacterial insecticide to man and animals is a great advantage, especially in the present situation.
3. From the point of nature conservation, it is very important that in the places used for recreation of man, measures of insect control are being used which destroy exclusively those species which are a nuisance and have little or no influence on the natural environments of other insects and animals. The bacterial insecticide fulfills these conditions to a high degree.

PRACTICAL OUTLOOK

Experiments on a large scale with *B. thuringiensis* dusts have been done in some streets in the city for two years. The experiments were carried out in exactly the same way as the usual application with Derris dust. Due to adverse weather conditions, together with a very low population of the caterpillars, no reliable results came out. The results of the cage experiments (VAN DAMME & VAN DER LAAN, 1959) together with the laboratory experiments, reported above, led to the decision that this year (1962) half of the area will be dusted with bacterial powder and the other half with Derris.

SUMMARY

Laboratory experiments comparing the effect of dusts of Derris powder with

dusts of products, based on *Bacillus thuringiensis*, indicated a higher toxicity to Tent Caterpillars (*Malacosoma neustrium*) of the latter group. As, moreover, these dusts are harmless to man and higher animals, and even have a very specific action to insects, the use of the products is to be preferred above the use of Derris dust. The bacterial dusts are already used for some time in outdoor experiments, and it is proposed to use these dusts on a large scale in coming years.

The insecticides are killing through their specific action the nuisant caterpillars only, and are therefore appreciable also because of recreation and nature conservation.

Samenvatting

De iepen langs de grachten in de stad Amsterdam worden periodiek aangetast door ringelrupsen (*Malacosoma neustrium*). Jaarlijks worden de bomen bestoven met een Derris-stuifmengsel. Deze bestrijding heeft nadelen, daar Derrispoeder giftig is voor vissen, nuttige insekten en andere levende organismen.

Vergelijkende proeven in het laboratorium met Derris-stuifmengsel en preparaten op basis van *Bacillus thuringiensis* hadden tot resultaat, dat bij de gegeven concentraties de bacterie-poeders een iets betere werkzaamheid vertoonden dan Derris (tabel 1). Daar deze poeders bovendien geen gevaar opleveren voor mensen en huisdieren, en zelfs tegenover insekten zeer specifiek werken, verdient het gebruik van deze poeders de voorkeur boven dat van Derris.

Vooral uit een oogpunt van natuurbescherming zijn in deze omstandigheden de preparaten, gebaseerd op *Bacillus thuringiensis*, de beste bestrijding van deze insektenplaag in een grote stad.

Proeven in de straten van Amsterdam met *Bacillus thuringiensis*-poeder zijn tevens reeds enige jaren genomen. Zij worden in de komende jaren op grotere schaal voortgezet.

Dit onderzoek geschiedde onder aspiciën van de „Werkgroep voor Harmonische Insektenbestrijding T.N.O."

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