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Pioneer Research into Biological Pest Control Done in Zagreb in the Period 1927-1932

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SUMMARY

During the period 1927-1932 Božidar Hergula and Vale Vouk, together with their collaborators, among other achievements, published the results of the first field trials conducted in the World concerning the biological control of the European Corn Borer. In these investigations *Bacillus thuringiensis* and *Metarrhizium anisopliae* were used. The research was conducted in the Botanical Institute of the University of Zagreb. A check list of all parasites and predators found by Hergula, and a list of publications is added.

KEY WORDS

biological pest control, Corn Borer, *Ostrinia nubilalis*

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Pionirska istraživanja biološkog suzbijanja štetnika provedena u Zagrebu u razdoblju 1927.-1932.

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SAŽETAK

U razdoblju 1927.-1932. hrvatski znanstvenici Božidar Hergula i Vale Vouk prvi su u svijetu proveli istraživanja biološkog suzbijanja kukuruznoig moljca u prirodi. U ovim su istraživanjima poglavito korišteni *Bacillus thuringiensis i Metarrhizium anisoplie.* Postignuti su vrlo dobri rezultati. Istraživanja su provođena u Botaničkom institutu (laboratoriju za istraživanje kukuruznog moljca) Sveučilišta u Zagrebu, a pokusna polja bila su najčešće u Botaničkom vrtu. U istraživanjima u Zagrebu sudjelovali su i neki inozemni znanstvenici. Navodi se i popis parazita i predatora koje je Hergula utvrdio na kukuruznom moljcu, te popis 27 radova o kukuruznom moljcu proizašlih iz tih istraživanja.

KLJUČNE RIJEČI

biološko suzbijanje, kukuruzni moljac, *Ostrinia nubilalis*

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INTRODUCTION

During the summer of 1917, the European Corn Borer was first reported and identified in the United States in the vicinity of Boston, being found to cause severe damage. It is supposed that the pest entered in the U. S. with broom corn imported from Hungary and Italy in 1909 and 1910.

Soon after its discovery this insect became one of the most harmful insect pests in the U.S.,

and the International Live Stock Exposition in Chicago founded an organisation with the aim to organise extensive research into this pest. This organisation was called "International Corn Borer Investigations" and directed its activity mainly to research into natural enemies present in Europe.

The Pasteur Institute in Paris was choosen as the seat of this organisation. Scientists from Paris, St. Genis-Laval, Berlin, Lund, Budapest, Bukarest, Leningrad and Zagreb participated in the research. The Botanical Institute of the University of Zagreb, headed by Vale Vouk, and the entomologist Božidar Hergula, the principal investigator, participated in this research with many important achievements. Their efforts were supported by foreign scientists which participated in the research conducted at the Botanical Institute in Zagreb. Božidar Hergula and Vale Vouk, together with their collaborators among other achievements, published the results of the first field trials conducted in the world concerning the biological control of the European Corn Borer.

This fact is unknown to many scientists and is rarely mentioned in pertinent publications. Some recent publications of the use of *Metarrhizium anisopliae* in biological pest control do not mention that Hergula in 1928. conducted laboratory and field trials with this fungus. Similarly, the fact that Hergula used *Bacillus thuringiensis* in field trials as early as 1929 is not known or mentioned in pertinent publications. An explanation of why the important achievements of Hergula and Vouk in the field of biological pest control are unknown could be that most of them were published in the Journal "International Corn Borer Investigations" edited by the International Live Stock Exposition in Chicago, which started in 1928 and expired soon after the end of the organised research.

To inform other scientists and to pay due respect to Božidar Hergula and Vale Vouk - pioneers of biological pest control - whose results are an important milestone in the history of this science, we will review very shortly some of their achievements and cite all the publications concerning the research.

Experiments with *Metarrhizium anisopliae*

At the Second International Corn Borer Conference in Budapest, June, 1930 the task of conducting the first field experiments with *M. anisopliae* was entrusted to the Botanical Institute in Zagreb. The first experiments were carried out in 1930 by dusting plants with five different concentrations of spores. The experimental field was artifically infested with the Corn Borer. The mortality of larvae on *Metarrhizium* treated plants was 99% and on untreated plants 85.6%. The number of larvae on one plant on treated plots was 0.10-0.81, and on the untreated check 5.76 larvae per plant were present.

In 1931 these experiments were continued. On treated plants there were 0.1-0.8 (depending on the concentration of spores used) larvae per plant and on untreated check plants 3.2 larvae. In all these trials, different spore carriers were tested: the best results were achieved with the use of starch.

The influence of temperature on fungus development was investigated as well, and a suitable method for the production of this fungus established.

Some further interesting results and conclusions mentioned by the authors of pertinent publications are:

The effectivenes of *Metarrhizium* spores on Corn Borer larvae was apparent both in 1930 and 1931 although the climatic conditions during these two years were very different. The treatment of corn plants with mixtures of starch and spores in concentrations from 5 to 20% gave fairly uniform results. It was evident that by increasing the spore concentrations of the mixture, the larval mortality was greater.

The theoretical side of the problem of controlling the Corn Borer with *Metarrhizium anisopliae* is solved, but the problem of the practical application in the cornfield remains to be solved.

The use of bacteria

In the first experiments in 1929 conducted at the experimental field in Zagreb, different bacteria isolated from diseased larvae were used. It was demonstrated that plants treated with a bacterial spray withstood the attack of the Corn Borer much better than the non-treated check plants. By far the best results were achieved by *Bacillus thuringiensis*: 1.3-1.4 larvae per plant were found on treated plants and 16 larvae on the untreated check plants. Each plant was artificially infested with 50 larvae.

In experiments in 1930, treatments with *B. thuringiensis* again showed far better results than the use of other bacteria. On plants treated with B. t. the mortality was 98%, and on untreated plants 81.7-87.5%. The number of larvae on treated plants was 0.24-0.95 per plant and on the check plants 3.36 larvae per plant. Only 1.7% of treated plants were infested, compared with 15% on untreated plots.

The conclusion from these trials was "that a nearly perfect a result as one may ever obtain under field conditions was achieved".

Parasites and predators

Hergula has collected and identified the following parasites of the Corn Borer (names as in original publications):

Ichneumonidae

Limnerium alkae Ellinger & Sachtleben,
Inareolata punctoria Roman,
Exeristes roburator Fabricius,
Exetastes illusor Fabricius

Braconidae

Microbracon brevicornis Wesmael
Macrocentrus linearis Wesmael
Chellonus annulipes

Chalcididae

Eulophus viridulus Thomson
Trichogramma evanescens Westwood

Tachinidae

Ceromasia /Lydella/ senilis Meigen
Zenillia roseanae Brauer & Bergenstamm

Predators:

Trombidium fuliginosum Koch
Chrysopa vulgaris
Myrmica laevinodis Nyland
Lasius emarginatus Olivier

Publications of the results of investigations on the Corn Borer effectuated at the Botanical institute of the University in Zagreb:

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