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THERMAL ADAPTATION OF ENTOMOPATHOGENIC NEMATODES FOR INFECTION AND REPRODUCTION

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Abstract

To establish the optimal temperature of infection of insect-host with nematodes, their death-rate and maximal reproduction, thermal adaptation of entomopathogenic nematodes distributed in various regions of Georgia of species *Steinernema carpocapsae, Steinernema feltiae, Heterorhabditis bacteriophora* and *Steinernema* sp. in the range of 10-40°C was studied. As a result of experiment it was concluded that various species of entomopathogenic nematodes have well defined thermal breadth, on which their development and reproduction is greatly depended.

Key words: infective juveniles, thermal breadth, Steinernematidae, Heterorhabditidae, Tenebrio molitor, symbiotic association

Introduction

Temperature is a significant factor for development and reproduction of living organisms. Thermal adaptation has an important role for animals, and especially for ectothermal organisms [Cossins & Bowler, 1987]. Entomopathogenic nematodes (EPN) (Rhabditida: Steinernematidae and Heterorhabditidae) are soil inhabitant insect parasites, which have potential of biocontrol agents [Gaugler & Kaya, 1990]. Symbiotic association with bacteria xenorhabdus and phoxorhabdus favors development and reproduction of nematode parasite forms [Poinar, 1990].

Parasitic cycle of EPN begins from infective juveniles, when organism of insect-host as a nutrition matrix is entirely assimilated by nematodes. At this stage infective juveniles pass into environment - in soil, and begin free vital activity, where their main function is to find a new insect-host, to infest them and to develop new population.

In unfavorable conditions infective juveniles are provided with survival mechanism. Their stability in soil, maintaining the infesting ability, development and reproduction in new insect organism is entirely determined by temperature effect [Grewal, 1994; Kaya & Gaugler, 1993].

The goal of our research was to study thermal adaptation of EPNs *Steinernema carpocapsae, Steinernema feltiae, Heterorhabditis bacteriophora* and *Steinernema* sp. collected in various regions of Georgia.

Materials and Methods

The aim of our study was to establish thermal breadth of EPN for insect-host infection and for maximal reproduction.

We used the following species: 1. Steinernema carpocapsae, 2. Steinernema feltiae, 3. Heterorhabditis bacteriophora and 4. Steinernema sp.

Cultivation of those species was carried out on pupa and larvae of bread beetle *Tenebrio molitor* at 25°C by Dutky method [Dutky et al., 1964]. Age of nematodes received after cultivation was 1-2 months.

Experiment 1. From every species of EPN noted above we prepared suspension: 200 ml distilled water / 50 nematodes, sprayed into Petri dishes, where several larva of *Tenebrio molitor* (10-12 ones) were prepared for preinfection, closed with polyethylene film and placed in thermostat at different temperature regimes, in range +10 - +40°C. Infection of insects by nematodes and their death rate were detected 4 hours after beginning of experiment, at every 10 hours with increasing the temperature one-by-one degree.

Dead pupa of *Tenebrio molitor* were taken from sand, washed in distilled water and cut under microscope. Then nematode number in every dead pupa at definite temperature was determined. Duration of experiment was about 1 month (Fig. 1).

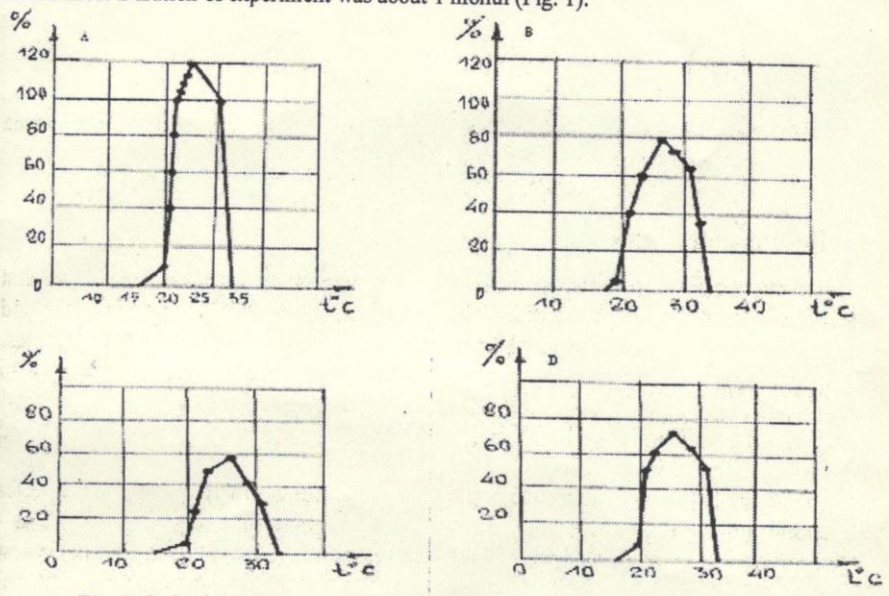

Fig. 1. Optimal temperature of EPN reproduction. A – Steinernema caprocapsae; B –Steinernema Sp.; C – Heterorhabditue bacteriophora; D – Steinernema feltiae.

Experiment 2. Potential of maximal reproduction of nematodes was studied at various temperature regimes, within the range 10-40°C. For this aim along with 5 larva of *Tenebrio molitor* 500 infective juveniles of every species noted above were placed on Petri dishes. 8-12 hours after larva died they were put into Petri dishes covered with filter paper and placed into water traps to obtain new infective juveniles. Traps were put in thermostat at various temperatures. Cultivation of nematodes lasted 12-14 days. Nematode suspension was pumped out every day from water traps and nematode number was determined under microscope according to Abbott method [Abbott, 1925]. To receive new infective juveniles distilled water was added in water traps. By this method total number of infected juveniles cultivated in insect-host at each temperature increased by one degree was determined. As a result of experiment optimal temperature for maximal reproduction of nematodes was established (Fig. 2).

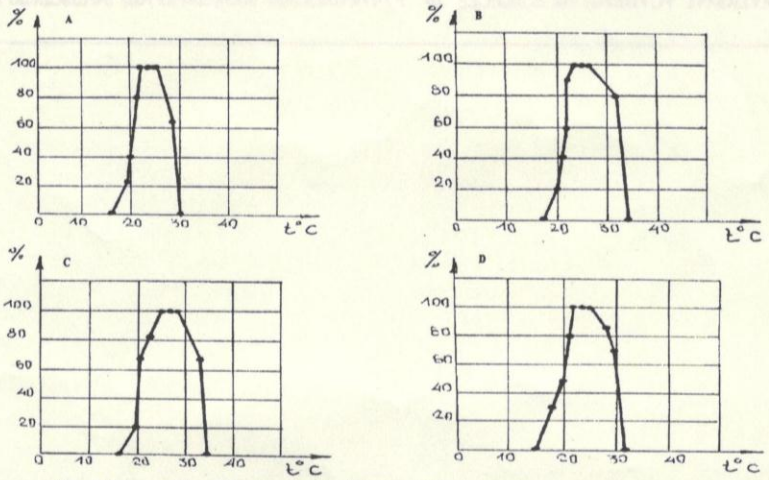

Fig. 2. Thermal breadth of nematode infection (%). A – Steinernema caprocapsae; B –Steinernema Sp.; C – Heterorhabditue bacteriophora; D – Steinernema feltiae.

Results and Discussion

Various species have different infection temperatures (Fig. 1). It was found out that *S.carpocapsae* is characterized by the widest temperature range - 16-36°C for host infection and mortality, while the most narrow temperature range 17-32°C was detected in case of *S. feltiae*. Temperature breadth for *Heterorhabditis bacteriophora* (HRb) was relatively high - from 18°C to 34°C, and for *Steinernema* sp. - 16-33°C, which is close to that of *S. feltiae*.

Optimal temperature at which *S.carpocapsae* and HRb infest the host was 23-24°C, and for *S. feltae* and *Steinernema sp.* - 21-22°C.

As is seen from Fig. 2 cultivation potential of nematodes at different temperatures varies among studied species. The highest index of reproduction was noted in case of *S. carpocapsae* - 120 000 nematodes at 22-25°C, for HRb - 80 000 nematodes at 24-26°C. *S. feltiae* has the lowest index - 60 000 nematodes at 23-25°C and *Steinernema* sp. 70 000 nematodes at optimal temperature 22-26°C. In whole duration of cultivation lasted two weeks.

As a result of the experiment it was shown that development cycle of nematodes is depended greatly on temperature. Different species of EPN differ by potential of insect-host infection, death-rate and degree of reproduction. On the basis of those facts we conclude that EPNs have well-defined thermal breadths for their development and reproduction.

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