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The Effect of the Nuclear Polyhedrosis Viruses (NPVs) of Some Noctuidae Species on the Longevity of *Bracon hebetor* Say (Hymenoptera: Braconidae)

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Abstract

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The consequences of the viral infection on the longevity of the parasitoid *Bracon hebetor* Say (Hymenoptera: Braconidae) were evaluated in two experiments - in presence and absence of hosts.

In the first experiment females and males parasitoids were infected *"per os"* with viral suspension of different nuclear polyhedrosis viruses (NPVs) of the species *Autographa gamma* L., *Mamestra brassicae* L. and *Lacanobia oleraceae* L. (Lapidoptera: Noctuidae).

In the second experiment five Noctuidae species (*A. gamma* L., *Xantia c-nigrum* L., *M. brassica*e L.,*L. oleraceae* L. and *Helicoverpa armigera* Hubn.) were infected with their native NPVs and every one larva was isolated with a couple of parasitoids for parasitation.

The results of these two experiments showed that: 1) The nuclear polyhedrosis viruses of *X. nigrum* (XcNPV), *L. oleraceae* (LoNPV), *M. brassicae* (MbNPV) and *A. gamma* (AgNPV) didn't impact directly on the longevity of both females and males of the parasitod *B. hebetor*.; 2) The longevity of the parasitoid *B. hebetor* didn't decrease when the males and females parasitized hosts infected with AgNPV, MbNPV and LoNPV.

Key words: *Bracon hebetor,* longevity, nuclear polyhedrosis viruses (NPVs), Noctuidae species

Abbreviations: NPV – nuclear polyhedrosis virus, AgNPV – *Autogratha gamma* nuclear polyhedrosis virus, MbNPV – *Mamestra brassicae* nuclear polyhedrosis virus, LoNPV – *lacanobia oleraceae* nuclear polyhedrosis virus, XcNPV – *Xantia c-nigrum* nuclear polyhedrosis virus, HaNPV – *Helicoverpa armigera* nuclear polyhedrosis virus

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Introduction

Parasitoids and pathogens are the major natural control components of most lepidopterian pests in their terrestrial ecosystems. Although pathogens and parasitoids of insects represent different biological entities, they are ecological homologs, exploiting the same host resource and having similar effects on host populations (May and Hassell, 1988; Hassel and Anderson, 1989; Chilcutt and Tabashnik, 1997).

Interactions between parasitoids and baculoviruses are known to occur during simultaneous parasitism when they utilize a common host resource for their existence (Harper, 1986). Although these natural enemies are considered to play a major role in pest management, their effective integration into parasitoid-pathogen systems depends on their compatibility.

Some authors have reported that immature parasitoids often perish if their hosts are infected with a virus. If the host insect dies prematurely due to viral infection, the parasitoids are unable to complete development and die (Brooks, 1993; Nakai et al., 1997; Nakai and Kunimi, 1998). Alternatively, some baculoviruses and an entomopoxvirus induce the infected host to produce a substance that adversely affects the development and survival of the parasitoids (Brooks, 1993; Kyei-Poku and Kunimi, 1998; Kunimi et al., 1999).

Virion-free plasma from MyseEPV–infected host larvae is lethal to parasitoid larvae when injected intrahemocoelically into the host larvae, suggesting that the haemolymph of the MyseEPV-infected host contains factor(s) causing parasitoid death (Kyei-Poku and Kunimi, 1998).

When female *Cotesia kariyai* parasitize entomopoxvirus (MyseEPV)-infected *Mythimna separate* larvae, the parasitoid progeny never emerge from the host, dying within it (Kyei-Poku and Kunimi, 1998).

Beegle and Oatman (1975) showed that the relative timing of attacks between the parasitoid, *Hyposoter exiguae* (Viereck), and a NPV in hosts of *Trichoplusia ni* (Hubner) determined the ultimate outcome of competition. If the NPV infected the lepidopterious host prior to parasitation, then the parasitoid larvae always died. But, if the virus entered the host after the parasitoid, then some or all of the parasitoids could survive. The likelihood of survival of the parasitoid increased as the time between oviposition of the parasitoid egg and ingestion of the virus by the host increased.

Other studies denoted that no direct mortality of any insect parasitoid by infection with a host's baculovirus has been cited, whereas parasitoid larvae were indirectly affected by their development in baculovirus-infected hosts (Groner, 1990; Brooks, 1993).

Host treatment with LoGV after parasitation had occurred had no pronounced effects on parasitoid larval or pupal developmental times or on the weight of the parasitoids' cocoon after egression from the host. There were also no indications of direct infection or toxic effects of LoGV on the developing larva (Matthews at al, 2004).

The most authors involve endoparasitoids in their investigations on interactions between viruses and parasitoids on insect pests. There are no any studies involving ectoparasitoids in this kind of investigations.

In this study the aim was to evaluate the effect of the nucleopolyhedroviruses of some Noctuidae species on the longevity of the ectoparasitoid *B. hebetor* Say.

Materials and Methods

Test insects

Larvae from the test species used in the experiments - *Mamestra brassicae, Lacanobia oleraceae, Autographa gamma, Helicoverpa armigera* and *Xantia c-nigrum* were obtained from; (a) imagoes collected by light traps in the experimental fields of PPI, Kostinbrod, department of Biological and Integrated Pest Control, Sofia and (b) larvae collected from vegetable crops in the regions of Sandanski and Petrich and reared to imagoes.

The larvae were reared under laboratory conditions, t° 23 – 25^{0}C and RH 70 - 80 %, photoperiod 18L:6D on artificial diet developed by (Pencheva and Videnova, 1988).

Ectoparasitoids

The laboratory population of females and males of the parasitoid *B. hebetor* used in the experiments was maintained in a climatic room on the host *Galleria mellonella* (Pyralidae) (Balevski, 1996).

The Baculoviruses

The nuclear polyhedrosis viruses of *X. c-nigrum, A. Gamma, L. oleraceae, M. brassicae and H. armigera* (XcNPV, AgNPV, LoNPV, MbNPV and HaNPV respectively) used in the experiments were Bulgarian genotypes obtained from the laboratory of Assoc. prof. Dr. Maria Velichkova, Department of Biological and Integrated Pest Control of the PPI, Sofia.

Experimentation

The survival of the parasitoids infected with the viral suspension was observed in two different sets of experiments.

The first set of experiments every one consisting of 2 variants was conducted to determine the direct impact (*per os* accepting) of the AgNPV, MbNPV and LoNPV on the longevity of the females and males parasitoids. Newly emerged couples (males and females) parasitoids were isolated in vials, where some droplets of suspension of AgNPV, MbNPV and LoNPV were put by a brush on the top of the vial (first variant). In the second variant viral suspension and 20 % honey solution (1:1) were added following the same method. In the control of the both variants the parasitoids were allowed to drink water and 20 % honey solution without virus. Thirty couples were used in every experiment and its control.

The second set of experiments was conducted to determine the longevity of *B. hebetor* that parasitized virus-infected host. Five experiments, every in two replications were performed with 15 3rd and 4th instar larvae and 15 couples's parasitoids per replication.

Larvae of the five Noctuidae species *M. brassicae, L. oleraceae, H. armigera, A. gamma* and *X. c-nigrum* were fed with artificial diet containing their viruses for 24 hours and then individually exposed to *B. hebetor* couples. The control variants were fed with non-contaminated with virus artificial diet and then exposed to the parasitoids.

The the longevity of the parasitoids was daily checked.

Parameteres and statistics

The obtained results were determined for the parametere longevity. Confidential probability, P = 0.05 (Student's t-test) is accepted as criterion for significant difference between experiments and controls.

Results and Discussion

The average longevity of the females and males of the parasitoid, in the first set of experiments, treated with suspension containing MbNPV (first variant), was not significantly different from that of the control (Table 1). The average longevity of the males was 6.80 ± 1.16 and those of the females - 8.33 ± 1.47.The parasitoids from the control showed average longevity 7.43 ± 1.27 and 7.67 ± 1.33 for the males and females respectively. The second variant, where the parasitoids were treated with MbNPV and honey solution, the average longevity of the males was 6.73 ± 1.38 and that of the females - 7.97 ± 1.46, in comparison with the control – 8.00 ± 1.41 for the males and 8.57 ± 1.53 for the females. Similar results showed the other experiments involved the MoNPV and AgNPV in the two variants (Table 1).

In the second set of experiments it hasn't been established significant difference of the average longevity between the males and females parasitized infected hosts and the control variants for the five Noctuidae species (Table 2). The average longevity of the males and females parasitized infected with MbNPV *M. brassicae* larvae was 9.00 ± 1.59 and 7.70 ± 1.36 for the males and females respectively and the longevity of the control was 8.27 ± 1.48 for the males and 8.17 ± 1.46 for the females. The results for the other experiments, where the parasitoids parasitized infected with X.c-nigrumNPV, LoNPV, HaNPV and AgNPV hosts, were similar to the control (Table 2).

Table 1
Longevity of the parasitoid *B. hebetor* Say allowed to drink viral suspension without presence of a host

NPVs	Longevity, (days)					
	♂♂♂♂♂			♀♀♀♀♀		
	min.	max.	mean ± s.e.	min.	max.	mean ± s.e.
AgNPV	6	9	7.73 ± 1.21	6	11	7.16 ± 1.32
Control	6	10	7.93 ± 1.36	6	11	9.07 ± 1.59
MbNPV	5	12	6.80 ± 1.16	6	12	8.33 ± 1.47
Control	6	10	7.43 ± 1.27	6	11	7.67 ± 1.33
LoNPV	6	12	7.90 ± 1.38	6	12	10.80 ± 1.94
Control	6	12	8.13 ± 1.51	6	12	8.73 ± 1.57
AgNPV+honey	6	12	6.23 ± 1.06	8	12	10.27 ± 1.81
Control	5	14	8.27 ± 1.35	6	18	10.9 ± 1.92
MbNPV+honey	5	9	6.73 ± 1.38	6	12	7.97 ± 1.46
Control	6	12	8.00 ± 1.41	6	12	8.57 ± 1.53
LoNPV+honey	5	12	7.87 ± 1.41	5	12	7.00 ± 1.24
Control	5	12	9.13 ±1.66	5	12	8.83 ± 1.59

There were no significant differences in percentage of longevity of experimental and control parasitoids (P > 0. 05).

Table 2
Longevity of the parasitoid *B. hebetor* Say parasitized virus-infected hosts

Host	NPVs	Longevity, (days)					
		♂♂♂♂♂			♀♀♀♀♀		
		min.	max.	mean ± s.e.	min.	max.	mean ± s.e.
X. c-nigrum	XcNPV	6	11	8.06 ± 1.43	6	12	8.83 ± 1.58
Control	Control	6	11	7.80 ± 1.37	6	12	7.93 ± 1.39
L. oleraceae	LoNPV	6	12	7.23 ± 1.25	6	12	7.93 ± 1.40
Control	Control	5	12	8.30 ± 1.47	5	12	7.90 ± 1.41
H. armigera	HaNPV	6	11	6.97 ± 1.21	6	13	9.27 ± 1.67
Control	Control	6	12	7.47 ± 1.32	6	12	8.53 ± 1.54
M. brassicae	MbNPV	6	12	9.00 ± 1.59	6	12	7.70 ± 1.36
Control	Control	6	12	8.27 ± 1.48	6	18	8.17 ± 1.46
A. gamma	AgNPV	5	11	7.71 ± 1.07	6	13	8.18 ± 1.15
Control	Control	5	11	8.44 ± 1.21	5	14	10.89 ± 1.61

There were no significant differences in percentage of longevity of experimental and control parasitoids ($P > 0.05$).

The lack of significant differences between the average longevity of the parasitoids in the experiments and controls in the two sets of experiments proved that the studied viruses didn't impact on the longevity of the parasitoids

The obtained results are similar to those of some authors declined that during simultaneous parasitism with viral pathogen, when they compete for a common host resourse, no direct mortality of the parasitoids by infection with host's viruses occurs (Laigo and Tamashiro, 1966; Irabagon and Brooks, 1974; Beegle and Oatman, 1975; Vail, 1981).

Assessment of these natural enemies on the populations of some Noctuidae species in their habitants must therefore take cognizance of the possible interaction and interference between these different natural enemies. This information is of great importance essentially for basic ecological understanding and for attempts to converse threatened communities or to control pests with natural enemies (Watt, 1965; Ricklefts, 1979; Ehrlich and Ehrlich, 1981; Hochberg et al., 1990).

The previous studies investigate the impact of the entomopathogenic viruses on the survival of the endoparasitoids. In this study the effect of nuclear polyhedrosis viruses of 5 Noctuidae species on the longevity of an ectoparasitoid parasitizes the same species in the Bulgarian agricultural ecosystems was examinated. A possible reason of using only endoparasitoids and the absence of ectoparasitoids in the author's studies is that both endoparasitoid's progeny development and the virus reproductive cycle occur inside of the host and in a condition of attacking the same host, the competition between the two bioagents will be stronger than the competition between an ectoparasitoid and a virus competing for the same host resource. Despite that, it is of interest to be studied the interactions between ectoparasitoid *B. hebetor* and the NPVs of some Noctuidae species and using of the benefits of these interactions in the biological and integrated pest control.

Conclusions

The nuclear polyhedrosis viruses of *X. c-nigrum*, *L. oleraceae*, *M. brassicae* and *gamma* don't impact directly on the longevity of the females and males of the parasitod *B. hebetor*.

The longevity of the parasitoid *B. hebetor* didn't decrease when the males and females parasitized hosts infected with AgNPV, MbNPV and LoNPV.

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