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Cooperative Effect of *Microplitis* sp and a Nuclear Polyhedrosis Virus on the Larvae of *Spodoptera litura*

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Relationships among survival rate of *Microplitis sp*, developmental duration of *Microplitis sp* in bodies of *Spodoptera litura* larvae , exposure time of host larvae to *Spodoptera litura* nuclear polyhedrosis virus(SlNPV) and concentration of inoculation virus were studied. Meanwhile, efficiency of *Microplitis sp*'s transmitting virus was also determined in this study .The results showed that: 1) SlNPV didn't affect significantly developmental period of parasitic larvae; 2) Parasitic wasps in bodies of *Spodoptera litura* larvae could complete their development before their hosts died of virus infection. The survival proportion of parasites varied with the concentration of inoculation virus and the exposure time of host larvae to virus. *Spodoptera litura* larvae were inoculated with SlNPV after they have been parasited by the wasps, the percent of wasps which could complete their development, increase as the parasitizing time goes, and decrease with the increase of inoculation virus concentrations. However, the exposure time to virus was the primary influcing factor; 3) The female parasitic wasps which developed or oviposited in bodies of virus-infected host larvae , and the parasitic wasps which were manually contaminated their ovipositor with virus suspension, could all carry a number of SlNPV; 4) Adults of *Microplitis sp* could transmit the virus among host larvae through oviposition. Although parasitic wasps oviposited in bodies of virus- infected host larvae , they must certainly carry this sort of virus , then they could averagely transmit the virus to 2.14 healthy host larvae. Meanwhile, those parasitic wasps which developed in bodies of virus-infected host larvae could averagely transmit the virus to 2.45 healthy host larvae. 5) The ovipositors of parasitic wasps might be contaminated with SlNPV by two methods, i.e., emerging their cocoons in the virus suspension or raising adults of wasp on mixture of virus and honey , and their efficiency of transmitting virus increased with the increase of concentrations of inoculation virus; parasitic wasps from the first method, i.e., emerging cocoons could transmit infective doses of the virus to an average of 1.45 healthy host larvae, and wasps from the second method, i.e., raising wasps on mixture could also transfer virus to an average of 0.94 larvae.

Key words: *Spodoptera litura*; *Microplitis sp*; *Spodoptera litura* Nuclear polyhedrosis virus; virus transmission.

Virus influences pest population in its special way. Once they are introduced in pest habitat, the epidemic disease will occur. However, whether virus does harm to parasitic natural enemy or not is a widely concerned question when it

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decreases pest population. Up till now, there were about two opinions that pathogen microorganism of insect influenced populations of parasitic wasp: one is that pathogen microorganism can directly infect parasitic wasp and propagate in its body (Beegle ,Oatman 1974) or produce toxin which does harm to the development of wasp (Jiang, Liang ,Pang 1999); the other is that pathogen microorganism does not directly invade parasitic wasp, and whether parasitic wasp can accomplish its development or not in body of host is determined by the time of host larva infected by pathogen microorganism. The longer the distance of parasitic time is, the more the proportion of parasitic wasps will be, which finish their growth (Issi , Maslennikova, 1964; Kaya , Tanada,1973; Zhu *et al.* 1983; Jiang *et al*. 2000a; Xu ,Yiang 1983). However, there hasn't been further quantitative research of the dosage of raising toxin.

Spodoptera litura nuclear polyhedrosis virus (SlNPV) is an important regulating factor of population density of *Spodoptera Litura*. While fed in field or room, they are found to have very strong virulence (Beegle 1975; Levin *et al.*1979; Irabagon , Brooks 1974) and have been exploited into virus pesticide. This sort of virus pesticide has been widely applied in field and the total area of prevention and cure is about 6000 hectares with 89.4% of prevention effect (Jiang *et al.* 2000b). However after SlNPV is used in field, whether it has a disadvantage effect on *Microplitis sp*, whether *Microplitis sp* spread the virus, how about the efficiency of transmitting virus is, and whether cooperative effect occurs between virus and *Microplitis sp* etc. are the important contents, which must be studied on utilization and protection of *Microplitis sp*. Nevertheless, there have not been any reports in this field until now. The authors studied the cooperative effect of *Nuclear Polyhedrosis Virus* (NPV) and *Microplitis sp* to *Spodoptera litura* for the sake of exploring the influence of SlNPV on population of *Microplitis sp* and the function of parasitic wasp's transmitting virus.

MATERIALS AND METHODS

Materials

The tested virus was Chengzhou line of SlNPV. After being propagated two times in larva host, body of worm was then stored in refrigerator (<4°C) . When they were tested, the authors took worm body to make a pulp and then drew roughly out of it. After the crude liquid underwent difference centrifuge, the centrifugal liquid was diluted to five gradient concentrations' virus suspended liquids by distilled water. *Microplitis sp* were adults of parasitic wasp after propagating several generations in room.

Experimental designs and methods

Influence of virus on growth of parasitic wasps in host

Even design was adopted. 5 sorts of virus doses were set up i.e. 7.74×10^7, 7.74×10^6, 7.74×10^5, 7.74×10^4, 7.74×10^3 PIBs•mL^{-1} and 5 sorts of time for feeding virus after parasitizing i.e. 0,1,2,3,4 days as different combination treatments. During the experiment, according to experimental request, the authors used 5 doses' virus suspended liquids respectively to immerse clean leaves of *Ipomoea reptans* at different time of feeding virus, and then aired them to raise the parasitized larva. Two days later, clean leaves of cabbage were exchanged without virus to feed single worm in culture bottle. In addition, we set up the parasitized larva of the same day-age as control. 15~20 larvae in the first stage of age 3 were observed for each combination and treatment with 3 replications. Number of cocoons of parasitic wasps and number of larva dying of virus were observed during every combination of experiment and in every day. They were statistically analysed including the surviving rate, the mortality, the parasitic period of parasitic wasps and the death period of larva in all treatments. $U_5(54)$(Xu,1996)of even design table was adopted for designing.

Observation of virus delivery of parasitic wasp in bodies of infected larvae in different treatments

Two plants of *Ipomoea reptans* were put in toothpick box with cover which was filled with water to keep fresh, 30-40 larvae of *Spodoptera Litura* in the first stage of age 3 were raised on leaves of *Ipomoea reptans* which were cultivated in basin. After it was covered by transparent plastic barrel with a diameter of 15 cm and height of 40cm, a couple of female and male wasps which were copulatory and eclosion from bodies of infected larvae (came from experiment 1) were introduced into the barrel with a white cloth on the tip to prevent the escape of wasps and larvae. There

were 5 treatments, 6-10 couple of wasps were observed for each treatment so as to additionally set up the control. After keeping the wasps under 28±1°C for 24 hours and under illumination for 12 hours to lay eggs and parasitize, the authors then wiped off wasps, and put larvae in sterilized glass urn (diameter 12 cm, high 38 cm) respectively according to different treatments, and fed wasp populations under conditions of natural various temperature of room with a limited number of feeding 10 larvae in a urn. At the same time, it was necessary to replace fresh and clean leaves of cabbage each day. To identify whether it was killed by virus according to the illness characteristics of SlNPV and the results of worm body's checking under microscope, the authors then recorded the died larval number day by day and investigated the rate of female wasp transmitting virus and the number of host larvae which were transferred virus by per female wasp.

Observation of virus delivery of parasitic wasp laid eggs in bodies of infected larvae

Taking the larvae of *Spodoptera Litura* which were at age 2 or 3 after they were fed virus 1, 2, 3 days respectively on the leaves of cabbage without virus, then introducing adults of parasitic wasp into it, while observed adults of parasitic wasp had laid eggs in bodys of host larvae , aspirated parasitic wasps by using aspirator, then put these parasitic wasps into culture bottle which were loaded healthy larvae at age 2; Once observed host larvae had been parasitized, they should be taken out of bottle and be fed singly. The items of observation were the same as the experiment 2.

Effect of transmitting virus of parasitic wasps which were eclosion from cocoons of the wasps carrying virus.

Immersed cocoons of parasitic wasp with different concentration's virus suspended liquids for 10 seconds (30 wasps for each treatment). The authors then took them out and put them singly in the tube of finger-shape for eclosion. After eclosion, they were made partnership between female and male adults and to be mated. After that, they were put into a container which contained a number of host larvae at age 2; after 24 hours of laying eggs and parasitizing, the parasitic wasps were taken out of the container and the parasitized larvae was put into glass basin, and then they were fed and observed. The programs of observation were the same as the experiment 2.

Effect of vertical transmitting virus of parasitic wasp carrying virus

At first, 5 sorts of different concentration's virus suspended liquids were confected by using honey water of 10% (equating to the experiment 1), then the adult wasps were fed respectively which were eclosion in 24 hours by using different concentration's virus liquids for 1 day; after mating, they were put into a container which contained a number of host larvae at age 2; after 24 hours of laying eggs and parasitizing, the parasitic wasps were taken out of the container and put the parasitized larvae into glass basin, and then fed and observed them . Items of observation were the same as the experiment 2.

Statistical analysis

SPSS (2007)(Release 15.01) was used for data analyses.To exclude differences between the control groups, the raw data of the surviving rate and the mortality in all treatments were analyzed using the Generalised linear model (GLM). Repeated-measure procedure was used and compared for a test of within-subject effects. Means of three or multi-replications were used as input data. Furthermore, the raw data of the parasitic period of parasitic wasps and the death period of larva in all treatments were also analyzed and compared by using the same statistical procedures. The variance ratio and contribution rate of all regression coefficients were calculated by using quadratic regressive model (Xu, 1998).

RESULTS

Effect of SlNPV on the survival rate and the developmental duration of *Microplitis sp* parasitized in bodies of *Spodoptera Litura*'s larvae

After the larvae of *Spodoptera Litura* were parasitized, the survival rate, the eggs of *Microplitis sp* and the developmental duration of *Microplitis sp*'s larvae parasitized in host larvae which were infected in different concentrations' virus liquids and different time, were shown in table1. The survival rate of *Microplitis sp* in host was the lowest when host larvae parasitized for one day were fed by high dosage (7.74×10^6 PIBs•ml^{-1})of Nuclear Polyhedrosis Virus(NPV). The main reason was that the host had been infected to die before parasitic wasps could unthread out of host.

Table 1. Effect of SlNPV on the survival rate and developmental duration of *Microplitis sp* in parasitized host larvae under different combinations of exposure time of host larvae to virus and the doses of inoculation virus

Time of feeding virus (d)	Doses of inoculation virus (PIBs•mL^{-1})	Observed items				
		I	II	III	IV	V
0	7.74×10^4	28	22	78.57	82.14	6.59±0.50a
1	7.74×10^6	28	7	25.00	26.14	6.57±0.54a
2	7.74×10^3	26	20	76.92	80.42	6.55±0.51a
3	7.74×10^5	30	24	80.00	83.64	6.33±0.64a
4	7.74×10^7	40	34	85.00	88.87	6.35±0.70a
Control(Host parasitized, not infected virus)		52	44	95.65	—	6.73±0.55a

I: Number of larvae parasitized (larva), II: Number of cocoon(larva), III: Survival rate of parasite wasp (%) , IV: Revised survival rate of parasite wasp (%), V: Developmental duration of parasite wasp in host body (d). There are the same meanings while these glossary are appearing on the other pages of this article after this page.

Table 2. Sensitivity of host larvae to *Sl*NPV under the different combinations of inoculation virus time and virus concentrations

Time of feeding virus (d)	Inoculation virus concentrations (PIBs•mL^{-1})	Number of larvae parasitized	Number of larvae dead from virus	Mortality of host larva (%)
0	7.74×10^4	28	4	14.29
1	7.74×10^6	28	20	71.43
2	7.74×10^3	26	4	15.38
3	7.74×10^5	30	6	20.00
4	7.74×10^7	40	4	10.00
Control (Larvae both non-parasitized and non-infected)		0	0	0

Table 3. Capacity of transmitting virus of *Microplitis sp* developed in virus-infected host larvae

Status of host larvae treated	Observed items						
	A	B	C	D	E	F	G
Inoculated virus of 7.74×10^4 PIBs/mL in the 0 day after being parasitized	6	5	83.33	162	20	12.35	3.33
Inoculated virus of 7.74×10^6 PIBs/mL in the 1st day after being parasitized	7	5	71.43	150	27	18.00	3.86
Inoculated virus of 7.74×10^3 PIBs/mL in the 2nd day after being parasitized	9	4	44.44	284	12	4.23	1.33
Inoculated virus of 7.74×10^5 PIBs/mL in the 3rd day after being parasitized	8	3	37.50	228	4	1.75	0.50
Inoculated virus of 7.74×10^7 PIBs/mL in the 4th day after being parasitized	10	8	80.00	280	35	12.50	3.5
CK	10	0	0	204	0	0	—

Notes: A) Number of female wasp used; B) Number of female wasp transmitting virus; C) Percentage of female wasp transferred virus (%); D)Number of accepter-host larvae; E)Number of host larvae died of virus infection; F) Mortality of larvae infected virus (%); G) Number of larvae transmitted virus by each female wasp. There are the same meanings while these proper nouns appear on the other pages of this article after this page.

Meanwhile, parasitic wasps were at the egg stage. However, there was no significant difference between the amount of host larvae's taking food and the un-parasitized larvae. After host larvae were parasitized for 4 days, no significant influence on parasitic wasps even with the highest dosage virus (7.74×10^7 PIBs•mL^{-1}) was utilized to inoculate. The survival rate of parasitic wasps reached 85%, and at that time, the larvae of *Microplitis sp* had developed to the later stage and the parasitized host larvae almost stopped taking food. The above results showed that the survival rate of the larvae of *Microplitis sp* in larvae bodies of *Spodoptera Litura* were determined mainly by the time of inoculating virus after they were inoculated the NPV. However, there was not significant effect between the dosage of virus and the survival rate of the larvae of *Microplitis sp*. There was not significant difference between the life period of parasitic wasps in all treatments and the life duration of control. It showed that after the larvae of *Spodoptera Litura* were parasitized, while they were fed on different concentration's virus in different time, the virus could not produce any effects on the life period of the larvae of parasitic wasps in bodies of host and the eggs of parasitic wasps.

The regression equation of the results

Table 4. Efficiency of transmitting virus of *Microplitis sp* ovipositing in virus-infected host larvae

Status of host larvae treated	Observed items			
	A	D	E	F
24h past virus-inoculation	6	76	11	14.47
48h past virus-inoculation	7	70	18	25.71
72h past virus-inoculation	8	65	16	24.62
CK(non-infected with virus)	8	84	0	0

Table 5. Efficiency of transmitting virus of the *Microplitis* sp derived from the cocoons contaminated with SlNPV of different concentrations

Inoculation virus concentrations (PIBs.mL^{-1})	Observed items				
	A	D	E	F	G
7.74×10^3	6	66	6	9.09	1
7.74×10^4	6	72	4	5.55	0.67
7.74×10^5	6	66	10	15.15	1.67
7.74×10^6	9	100	16	16.00	1.77
7.74×10^7	6	72	12	16.67	1.71
Control	6	42	0	0	—

Table 6. Efficiency of transmitting virus of *Microplitis sp* raised by the mixture of different dosages' virus and 10% honey-water solution

Inoculation virus concentration(PIBs•mL^{-1})	Observed items			
	A	D	E	F
7.74×10^3	8	62	1	1.61
7.74×10^4	8	74	1	1.35
7.74×10^5	8	116	12	10.35
7.74×10^6	6	68	8	11.76
7.74×10^7	5	67	11	16.42
Control	6	104	0	0

from table 1 showed non-linear relationship model among the survival rate of parasitic wasps in bodies of host, the time of feeding virus and the dosage of feeding virus:

$$Y=79.0608+23.4426x_1^2+0.1289x_2^2-11.9387x_1x_2 \quad (1)$$

F test of model (1) was at the significant level. t test of the parameters of model 1 showed all the parameters were at significant level. The equation fit the data well ($R^2=1.0000$). It showed the model could preferably describe the relationships between the survival rate of parasitic wasp in the larva bodies of host and the time or dosage of feeding virus to host.

The variance ratio and contribution rate of all regression coefficients were calculated by using quadratic regressive model (Xu, 1998). It was known by the contribution rate that the effect of all factors on the target function was $x_1>x_2$, In other words, the time of feeding virus was the major factor to influence the survival rate of parasitic wasps in bodies of host larvae. The longer the difference of the time of inoculating virus and the time of parasitizing was , the higher the eggs of parasitic wasps –survival rate of wasps larvae would be.

In order to investigate the influence of feeding time and dosage on the survival rate of parasitic wasps in the host body, a simulation analysis was made for the model (1). The overall trend was shown in figure 1: under the same dosage level, the much more delayed the feeding time was, the higher the survival rate of parasitic wasps in host bodies was. Although fed on virus at the same time, the survival rate of parasitic wasps decreased along with the increase of feeding virus' dosage.

The sensitivity of host larvae parasitized to virus

When the host were fed by virus of 7.74×10^6 PIBs•mL^{-1} after they were parasitized for one day, the host had the highest mortality. Meanwhile, the host were fed by virus of high dosage (7.74×10^7 PIBs•mL^{-1})after they were

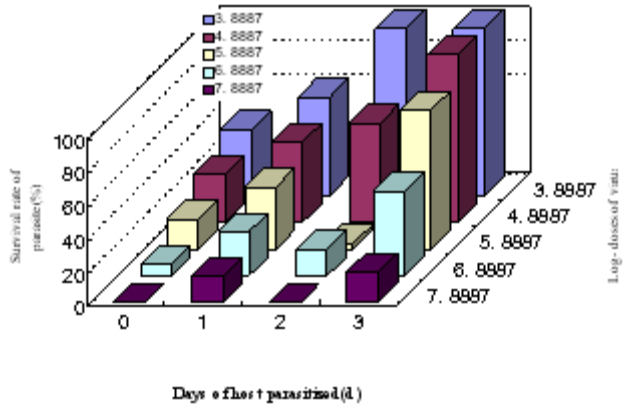

Fig. 1. Relationships between the survival rate of *Microplitis sp* in host larvae and the time and doses of inoculation virus

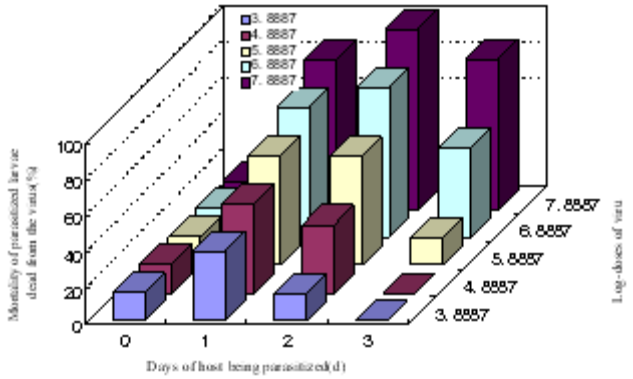

Fig. 2. Relationships between the virus-caused mortality of host larvae parasitized by *Microplitis sp* and the time and doses of inoculation virus

parasitized for four days, and the mortality of host larvae was only 10%. Nevertheless, if the dosage was low, even if the host larvae were fed by virus on the same day when they were parasitized, the mortality of the host larvae was not high too.

The quadratic regressive model of the mortality of the larvae parasitized and the feeding time and concentrations might be obtained by quadratic stepwise regressive analysis to the data of table 2:

$$Y = 16.1421 - 22.4879 x_1^2 + 11.4042 x_1 x_2 \quad ...(2)$$

Statistical test of model (2) showed that F and T test of all parameters of model were at significant level. The simulating value of model fit highly the actual measuring data (R^2= 1.0000)

According to the variance ratio of the regression coefficients in model (2), the contribution rate Δ (Xu, 1998) of all factors to the target function might be acquired, Δ_1=1.370, Δ_2=0.4549. With the comparison of the value of contribution rate, the effect of each factor to the target function was: $x_1 > x_2$, i.e., the feeding time was the major factor to induce the death of host larvae. While the parasitized larvae were inoculated the virus, the longer the feeding time deviating from the time of being parasitized was , the lower the mortality of host larvae was. This showed that the sensitivity of the parasitized host larvae to virus were dropped along the development of the parasite wasps' larvae in bodies of host larvae. The results of simulation analysis to model 2 were showed on figure 2.

The capacity of transmitting virus of *Microplitis sp*

The efficiency of transmitting virus of the parasite wasps developed in the infected larvae

The capacity of transmitting virus of *Microplitis sp* developed in the infected larvae were shown in table 3. The results showed that the parasite wasps developed from the host larvae successfully carried virus, and that the high efficiency of transmitting virus appeared in the female wasps which were developed in bodies of the infected larvae when they were fed early or fed with virus of high dosage. The percentage of transmitting virus was among 37.50%-83.33%. The number of larvae transmitted virus by each female wasp was 0.5-3.86 of larvae.

Efficiency of transmitting virus of *Microplitis sp* ovipositing in virus-infected host larvae

Efficiency of transmitting virus of *Microplitis sp* ovipositing in virus-infected host larvae were shown in table 4.

The results showed that *Microplitis sp* could deliver virus to the health host when they had laid eggs on the *Spodoptera Litura's* larvae after being fed with virus for 24~72h. Averagely, each female wasp could pass the virus to 2.14 larvae. The *Microplitis sp* which laid eggs on the virus-supplied larvae in different virus-infected time could induce different number of acceptor-larvae to be died of this sort of virus; at the same time, *Microplitis sp* laid eggs on the virus-supplied larvae which were infected virus to be excess for 48hs could evidently cause more death of larva than that of 24h and the control. Therefore, the capacity of transmitting virus was related to the time of larvae infected virus. After 24hs of inoculating virus, while the virus did not propagated abundantly in the body of larvae, the efficiency of transferred virus of *Microplitis sp* was lower. However, after 48hs, while the virus had a great deal of accumulation in the body of larvae, the efficiency of transmitting virus of parasitic wasps reached to the most value (Table 4).

Efficiency of transferring virus of *Microplitis sp* derived from the cocoons contaminated with SlNPV

Efficiency of transferring virus of the female wasps derived from the cocoons contaminated with different concentrations' virus suspended liquids for 10 seconds was shown in table 5.

Results showed that efficiency of transferring virus of the parasite wasps derived from the cocoons infected with virus increased along with the increase of virus dosage. The higher the concentration of virus to immerse the cocoons was, the higher the mortality of the acceptor larvae would be. When the virus suspended liquids of 7.74×10^3~7.74×10^7 PIBs•mL^{-1} were adopted to immerse the cocoons, each female wasp could pass the virus on to 0.67~1.77 host larvae.

Efficiency of transferring virus of *Microplitis sp* fed by mixture of honey and virus

Efficiency of transferring virus of *Microplitis sp* fed by mixture of different doses virus and 10% honey-water solution were shown in table 6.

Table 6 showed that parasitic wasps could transmit virus through feeding the adult wasps with virus. The transferring efficiency varied

with the feeding dosage of virus. The higher the dosage amount was, the higher the mortality of the acceptor larvae brought by *Microplitis sp's* ovipositting would be. In the range of the virus dosage being tested, each female wasp might transmit the virus to 0.13~2.20 larvae.

DISCUSSION

The results showed that while the larvae of *Spodoptera Litura* had been infected by SlNPV after they were parasitized by the wasps, the developed duration of parasitic wasps in bodies of host was not significantly affected by SlNPV. This opinion was disaccord to the conclusions of Beegle (Beegle, 1975) who reported that the developed duration of the *Hyposoter exiguae* in bodies of the host infected by NPV of the *Trichoplusia ni* was obviously shorten. With regards to the influence of the parasitic wasps' survival rate, it was various along with the time of infecting virus and dosage of feeding virus to the parasitized larvae. *Spodoptera Litura* was inoculated by using SlNPV after it had been parasitized by *Microplistis sp*. The longer the distance of the parasitic time was and the lower the dose of feeding virus was, the higher the proportion of the parasitic wasps would be, which could finish growth. However, the time of feeding virus was the major influencing factor. Even if the dosage of feeding virus was as high as 7.74×10^7 PIBs•mL^{-1}in the last stage of parasitic wasps' growth**,** the survival rate of parasitic wasps was still very high. The host larvae parasitized by *Microplistis sp* had lower sensitivity to virus, and the decreased degree of sensitivity was related mainly to the developed degree of the *Microplistis sp's* larvae in the body of host when they infected with the virus, and it was also related to the dosage. The above results were similar to the reports by Beegle (Beegle 1974,1975) and Zhu et al (Zhu, 1983)on the influence of *Trichoplusia ni's* NPV to *Hyposoter exiguae* and *Pieris rapae* GV to *Apanteles rubecula*. However, the quantitative researches on the concentrations of feeding virus were not reported by them.

This study also showed that *Microplistis sp* was the major propagator of SlNPV, and it might play an important role in the natural propagation of SlNPV. When *Microplistis sp* were developed from the infected larvae or when they laid eggs on the infected host or they were contaminated ovipositor with virus by artificial method, they could carry a certain number of virus and could pass the virus in the host while they laid sequentially eggs on the larvae of health host. *Sarcophaga aldrichi* - the parasitic fly of *Velarium caterpillar, Apanteles rubecula* and *Soft cocoon wasp* parasitizing in *Vegetable pink butterfly, Hyposoter exiguae* parasitizing in *Sugar beet noctuid* and *Campletis sonorensis* parasitizing in *Tobacco bud noctuid* etc.(Irabagon, Brooks 1974) had the similar propagating mechanism in the spread of NPV or GV.

In conclusion, there were complicated relationships among *Spodoptera litura*, NPV and *Microplitis sp*. When the virus decreased the quantity of host population, it had disadvantageous influence on the *Microplitis sp to some extent. However,* if the host was infected by virus at the right time and did not die early, the cocoon wasps could still finish their growth in the body of infected larvae, and the adult wasps could copulate normally and lay eggs. Meanwhile, it provided a survival probability of quite a part of wasps after the hosts were infected by virus along with the decrease of sensitivity of the parasitized larvae to virus.

Microplitis sp was the dominant parasitic wasp of *Spodoptera litura's* young larvae, and it accounted to 96.5% of the total parasitic wasp population (Xu, Yang 1983). The rate of parasitized larva in the field was very higher, and the most of it might reach 47.7%. Thus, *Microplitis sp* played an important role in the increase and decrease of the *Spodoptera litura's* populations in a whole year (Jiang et al.1999). So it was the parasitic natural enemy which was the most valuable to be protected and utilized in the integrative prevention of *Spodoptera litura*. On all accounts, the effects of transmitting virus of *Microplitis sp* should be fully considered in the course of continuous control to *Spodoptera litura*'s populations, and the following measures should be adopted: 1. infected with virus to the larvae while the wasps were at the contemporary generation being released, the host larvae which were still taking food were fed by the fit quantity of virus such as the virus liquids of 7.74×10^5~ 7.74×10^7 PIBs•ml^{-1} after the wasps were inoculated for 3~4days, so the adult wasps could

carry and transfer virus. In addition, when the *Microplitis sp* were released in the field, it promoted probably the virus disease to prevail in the field by means of artificial transmitting virus such as using the virus liquids to immerse the cocoons of wasp or utilizing the mixture of honey and virus to feed the adult wasps etc. 2. *Microplitis sp* were released at the larvae peak stage of *Spodoptera litura* while the larvae were at age 1-2. Once the larvae of *Spodoptera litura* were at age 3, the SlNPV was sprayed (here *Microplitis sp* in the body of host were at the middle or later stage, and most of them could complete theirs growth). The populations of contemporary generation could be successfully controlled, and could induce the populations of next generation to make the virus epidemics occur, and increase the chance of population rise of parasitic wasps. Thereby, the pest could be continually controlled.

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