Results & Discussion

RESULTS AND DISCUSSION

I. SUSCEPTIBILITY OF SCARABAEID PESTS TO INDIGENOUS AND FOREIGN ENTOMOPATHOGENIC NEMATODES:

Concentrations of three indigenous Egyptian isolates and three foreign entomopathogenic nematodes were tested against the larvae (1st and 3rd instars) as well as the adults of the scarabaeid beetles Pachnoda fasciata, Tropinota squalida and/or Pentoden bispinosus.

Mortality percentages of insects at 6 days after treatment are shown in (Tables 1-8). Medium lethal concentrations of these pests are given in (Tables 9 and 10) and were graphically illustrated in (Figures 8 to 10). From (Table 1) the first larval instar of peach beetle Pachnoda fasciata was affected by the Egyptian isolate in the natural organic soil. The isolate EBNU3 from West of nubaria induced the highest mortality especially at concentration $\leq$ 600 infective juveniles in a 100 cc cups giving 86.7% mortality. The second tested Egyptian isolate from Giza was EGB1 and gave up to 80% mortality at the concentration

of 500 infective juveniles per cup. The larvae were less susceptible to the Ismaelia isolate EIS7 and the mortality percentages were low and irregular and ranged from (6.7-26 %).

The highest concentration of nematodes used against 1st instar larvae in scarabaeid beetles induced the lowest mortality, this phenomenon was observed in the isolate EBNU3 (Table 1). This may be due to the aggregation of infective juveniles of this isolate in a rosette shape (star like clusters) as shown in Figure (2). This phenomenon reduced the movement and subsequently the virulence of nematodes as biocontrol agents of these pests. Moreover, it was observed that due to the crowding conditions of high concentrations of entomopathogenic nematodes, large numbers of infective juveniles were lumping together at the walls of the testing cups moving away from the host larvae. This behavior also reduced the infection rate at the highest concentrations (Gaugler and Kaya, 1990).

Figure 2. Aggregated infective nematode juveniles of the genus *Heterorhabditis* in a rossete shape.

Table. 1. Percent mortality of 1st instar larvae of Pachnoda fasciata infected with different concentrations of Egyptian isolates of Heterorhabditis spp.,EBNU3, EGB1 and EIS7.*+

Nematode # / pot	EBNU3	EGB1	EIS7
250	46.7	33.3	26.7
500	80.0	80.0	20.0
600	86.7	66.7	6.7
700	53.3	73.3	20.0
800	66.7	93.3	26.7
900	53.3	80.0	6.7
1000	60.0	86.7	20.0

* EBNU3 = isolated from Behera governorate, West of Nubaria. EGB1 = isolated from Giza governorate, Center of Al-Badrshane.
EIS7 = isolated from Ismaelia governorate.

+ Cumulative data of six days.

The success of the two Egyptian nematode isolates EBNU3 and EGB1 as biocontrol agents against scarabaeid pests was attributed to their natural activity and ability of invading the host either through the natural openings (spiracles, mouth and anus) or via the intersegmental membranes through the cuticle. Moreover, the microscopial examination has revealed that these nematode isolates posses a large terminal tooth which enable them to penetrate the body wall of the host.

In contrast, the foreign nematode species Steinernema glaseri, Heterorahbditis bacteriophora and Steinernema carpocapsae, had higher mortality effects on the 1st instar larvae of Pachnoda fasciata than the tested Egyptian isolates. S. glaseri seemed to be the most efficient nematode against the scarabaeid pests reaching 100% mortality with 400 IJ's of nematodes per cup of five host larvae. Meanwhile, H. bacteriophora with a lethal

Table 2. Percent mortality of 1st instar larvae of Pachnoda fasciata infected with different concentrations of Heterorhabditis bacteriophora (H. b.), Steinernema carpocapsae (S. c.) and Steinernema glaseri (S. g.).*

Nematode # / pot	H. b.	S. c.	S. g.
30	-----‡	-----	26.0
50	-----	-----	60.0
100	0	0	80.0
200	26.0	30.0	66.7
300	60.0	60.0	86.7
400	40.0	40.0	100.0
500	100.0	70.0	93.3
1000	100.0	90.0	-----
2000	100.0	100.0	-----

* Cumulative data of five days.

‡ Doses with dotted lines were not tested.

tested, nematode concentrations up to 4000 IJ's per cup did not affect the third instar larvae (Table 3). The same isolate gave a 60% mortality when 8000 IJ's were used per cup. However, the same instar was susceptible to relatively low concentrations of the foreign species of S. glaseri and only 1000 IJ's per cup induced 100% mortality. All cadavers were examined for nematode development (Fig. 3). Using different concentrations of IJ's of S. glaseri , against 3rd instar larvae, migrated infective juveniles from one cadaver per each concentration were counted and recorded (Table 4).

Resistance of 3rd instar larvae of P. fasciata to the infection by most of the tested entomopathogenic nematodes could be explained by some related histological studies on the scarab Phyllophaga hirticula which revealed the fact that some mechanical barriers such as the narrow opening of the spiracles (6 x 3 um)

Table 3. Percent mortality of 3rd instar larvae of Pachnoda fasciata infected with different doses of Heterorhabditis sp. (ESS1)[+] and Steinernema glaseri (S. g.).[*]

Nematode # / pot	ESS1	S. g.
100	-----[ϕ]	0
200	-----	33.3
400	-----	50.0
600	-----	83.3
800	-----	66.7
1000	0	100.0
2000	0	-----
4000	0	-----
6000	50.0	-----
8000	60.0	-----

[+] ESS1 = isolated from governorate of Southern Sinai.

[*] Cumulative data of six days.

[ϕ] Doses with dotted lines were not tested.

Figure 3. A white grub hemolymph with different developmental stages of the nematode Steinernema glaseri

Table 4. Rate of migration of infective juveniles (IJ's) of Steinernema glaseri emerging from 3rd instar larvae of Pachnoda fasciata within six days post-infection.

Nematode # / larva	# of nematodes emerging from one insect cadaver
250	57,500
500	45,500
1000	68,000
2000	129,466
3000	89,000
5000	165,000
6000	317,000
7000	436,000

prevented the entrance of the infective juveniles (25 um in dimeter) (Forschler and Gardner, 1991c). The structure of the tightly closed spiracles in 3rd instar larvae of Pachnoda fasciata is a cribiform type with a spiracle plate punctured with aeropyles that are the only openings to the trachea (Fig. 4).

Gaugler (1988) has provided a discussion on strategies evolved by soil insects to avoid or minimize the infection by entomopathogenic nematodes such as high defecation rate which reduce the infection via the anus in scarabaeidae. Another behavior was recorded to explain the escape of infection by nematodes such as preening to remove the infective juveniles from the scarab body or boring into the plant roots to escape from the infective juveniles in the soil. Under laboratory observations, it was noticed that the grub attacks the infective juveniles of S. glaseri (Fig. 5). Also during the rearing of third

Figure 4. External morphology of a group of cribiform spiracles in a third instar larva of peach grub Pachnoda fasciata

Figure 5. The third instar larva of *P. fasciata* attacks an infectve juvenile of *Steinernema glaseri*.

instar larvae of P. fasciata large numbers of mites were found on its entire body (Fig. 6). It is beleived that the presence of such a mite may prevent the infection by these nematodes. The immune responses in 3rd instar larvae of a chrysomelid root worm against entomopathogenic nematodes were recorded and encapsulated nematodes were observed when exposed to the infection by Steinernema feltiae. Meanwhile, the internal anatomy of larval scarabaeids has been examined and a thick peritrophic membrane was found (Berbert and Helms, 1972). This membrane consider as a large barrier to microbial infection (Brandt et al.,1977).

Third instar larvae of Pentodon bispinosus (Coleoptera: Scarabaeidae) were treated by S. glaseri. The grubs were susceptible to nematode infection reaching 100% mortality with the concentration of 400 IJ's per cup (Table 5).

Table 5. Percent mortality of 3rd instar larvae of Pentoden bispinosus infected with different doses of Steinernema glaseri (S. g.).*

Nematode # / pot	S. g.
100	33.3
200	66.7
400	100.0

* Cumulative data of four days.

These grubs are characterized by the biting behavior. Wounds (Fig. 7) existed due to this behavior may facilitate the invasion of nematodes into body cavities of this insect.

First instar larvae of Tropinota squalida proved to be susceptible to the infection by S. glaseri which induced up to 80% mortality with a nematode concentration of 1000 IJ's per cup. In contrast, H. bacteriophora had less effect on the grubs causing 53.3% in a nematode concentration of 800 IJ's per cup. The Egyptian isolates of

Figure 6. Aggregation of mites on the body of P. fasciata grub.

Table 6. Percent mortality of 1st instar larvae of Tropinota squalida infected with different concentrations of Heterorhabditis bacteriophora (H. b.), Steinernema glaseri (S. g.) and the Egyptian isolates of heterorhabditid nematodes EBNU3 and ESS1.*+

Nematode # / pot	H. b. (HP88)	S. g.	EBNU3	ESS1
100	40.0	----!	26.6	-----
200	20.0	20.0	-----	11.0
300	-----	-----	13.3	-----
400	26.7	40.0	13.3	55.5
500	-----	-----	40.0	22.2
600	53.3	66.7	-----	-----
800	53.3	66.7	-----	-----
1000	-----	80.0	-----	-----

* Cumulative data of five days.

+ EBNU3 = isolated from Behera governorate, West of Nubaria.

ESS1 = isolated from governorate of Southern Sainai.

! Doses with dotted lines were not tested.

Figure 7. Wounded 3rd instar larva of sugar-cane grub Pentoden bispinosus.

entomopathogenic nematodes had a relatively poor effect on this insect (Table 6).

The third instar larvae of T. squalida were affected by H. bacteriophora and a complete mortality of 100% was obtained with concentration of 4000 IJ's per cup. Steinernema glaseri was used against the same instar and 100% mortality was obtained by a concentration of 6000 IJ's per cup. Meanwhile, the nematode S. carpocapsae had the least effect on this grub (Table 7).

The recent outbreak of Tropinota Squalida, P. fasciata in different parts of Egypt and the increase in crop losses in Orchards caused by thse scarabaeid beetles especially in newly reclaimed areas, have driven us to apply entomopathogenic nematodes as biocontrol agents of such destructive pests.

Table 7. Percent mortality of 3rd instar larvae of Tropinota squalida infected with different concentrations of Heterorhabditis bacteriophora (H. b.), Steinernema glaseri (S. g.) and Steinernema carpocapsae (S.c.).*

Nematode # / pot	H. b.	S. g.	S. c.
1000	87.5	87.5	62.5
2000	87.5	62.5	37.5
4000	100.0	87.5	50.0
6000	75.0	100.0	62.5
8000	75.0	100.0	62.5

* Cumulative data of six days.

Although adults of these insects feed on flowers, pollen grains and soft fruits (Kamel, 1988) our field observations showed that the adult beetles leave their host plants to overnight in shallow pits constructed in the soil by males and females. Also they oviposit in the soil rich in organic matter around the trees were larvae and pupae undergo subterranean life.

Accordingly, the control measures of these pests should be directed mainly to soil treatment where all the insect stages are existed. Data presented in Table (8) are comparing between the infectivity of foreign and indigenous nematode isolates and species against adults of P. fasciata. The beetles were affected in different degrees according to the nematode used. Steinernema carpocapsae had the highest effect with a rate of 60,000 IJ's per pot which caused a 100% mortality followed by S. glaseri which caused complete mortality with 40,000 IJ's per pot. However, all tested Heterorhabditis spp. have less effect on this beetle with a mortality percent of 23.3, 26.6 and 60.0% when 1000 IJ's of EBNU3, EGB1 and H. bacteriophora were used respectively.

The adults of hairy beetle T. squalida were affected mostly by H. bacteriophora and the Egyptian heterorhabditid isolate of EBNU3

Table 8. Percent mortality of adults Pachnoda fasciata infected with different concentrations of Heterorhabditis bacteriophora (H. b.- HP88), Steinernema carpocapsae (S. c.), Steinernema glaseri (S. g.) and the Egyptian heterorhabditid isolates of EBNU3 and EGB1.* -

Nematode # / pot	H.b. (HP88)	S.c.	S. g.	EBNU3	EGB1
1000	60.0	56.6	6.6	20.0	3.3
2000	60.0	20.0	53.3	6.7	3.3
3000	----[¢]	----	-----	-----	----
4000	----	60.0	53.0	13.3	23.3
5000	60.0	----	----	----	----
6000	----	70.0	50.0	6.7	10.0
8000	----	73.3	90.0	46.7	30.0
10000	60.0	86.6	80.0	23.3	26.6
20000	60.0	80.0	86.0	----	----
40000	66.0	86.6	90.0	----	----
60000	80.0	100	----	----	----

* Cumulative data of seven days.

- EBNU3 = isolated from Behera governorate, West of Nubaria.

EGB1 = isolated from Giza governorate, center of Badrshane.

¢ Doses with dotted lines were not tested.

followed by S. glaseri and finally by S. carpocapsae. When 4000 IJ's were used per pot against this insect a 100% mortality was obtained with H. bacteriophora and EBNU3. The same nematode concentration has given 85.7 and 46.7% mortality with S. glaseri and S. carpocapsae respectively (Table 9).

Results of the present study indicate that virulence of the entomopathogenic nematodes against adult stages of these pests could be ranked as follows, S. glaseri, H. bacteriophora, S. carpocapsae and the Egyptian Heterorhabditis sp. (EBNU3) respectively where S. glaseri is the most virulent (Table 4 and Table 8). Poinar (1978) has a similar conclusion and consider S. glaseri to be the best adapted nematode among other steinernematids against soil inhabiting insects. These data are reasonable enough, since this nematode species is isolated originally from the scarab beetle Popillia japonica which is a soil insect (Glaser, 1930). This was also supported by the fact

Table 9. Percent mortality of adults Tropinota squalida infected with different concentrations of Heterorhabditis bacteriophora (H. b.), Steinernema glaseri (S. g.), Steinernema carpocapsae (S.c.) and an Egyptian isolate of Heterorhabditis sp. (EBNU3).*-

Nematode # / pot	H. b.	S. g.	S. c.	EBNU3
500	----ᵍ	37.1	----	----
1000	53.3	42.9	20.0	50.0
2000	66.7	88.6	66.7	66.7
4000	100.0	85.7	46.7	100.0
6000	100.0	100.0	46.7	----
8000	100.0	----	100.0	----

* Cumulative data of six days.

- EBNU3 = isolated from Behera governorate, West of Nubaria.

ᵍ Doses with dotted lines were not tested.

that S. glaseri is more active and lives longer under natural field conditions than S. carpocapsae (Schroeder and Beavers, 1987).

Table (10) shows the LD_{50} values resulting from testing six foreign and Egyptian nematodes against the larvae of three scarabaeids. These data are graphically illustrated in Figures (8 , 9 and 10). The data in this table indicate that, the first instar larvae of the tested scarabaeids were more susceptible to all nematodes than the third instar larvae. The LD_{50} values of the first instar larvae ranged between 37 and 1512 IJ's / cup while those of the third instar larvae ranged between 77 and > 2000 IJ's / cup. The first instar larvae of the peach beetle, P. fasciata were more susceptible to all tested nematodes than those of the 1st instar larvae of the hairy beetle, T. squalida. The LD_{50} values of P. fasciata first instar larvae were between 37 and 300 IJ's per cup while those of T. squalida were between 518 and 1512 IJ's / cup. The most

Table 10. Medium lethal dose (LD_{50}) of entomopathogenic nematodes, Steinernema glaseri (S.g.), Steinernema carpocapsae (S. c.), Heterorhabditis bacteriophora (H. b.) and the Egyptian isolates of Heterorhabditis sp. (EBNU3 and EGB1) tested against Pachnoda fasciata (P. f.), Tropinota squalida (T. s.) and Pentoden bispinosus (P. b.) larvae (Coleoptera :Scarabaeidae).

Nematode used	LD_{50}+ FL = 95%				
	P. f.		T. s.		P. b.
	L_1	L_3	L_1	L_3	L_3
S. g. (NC)	37	334	518	291	77
S. c.	221	*•	-	*	-
H.b. (HP88)	174	*	612	*	-
H. sp. (EBNU3)	300	*	1512	-	-
H. sp. (EGB1)	198	*	-	-	-

+ Cup = 100 cc cup containing 50 g of soil (sand : clay : organic matter) (1 : 1 : 1).

* Not effective (LD_{50} > 2000).

- Not tested.

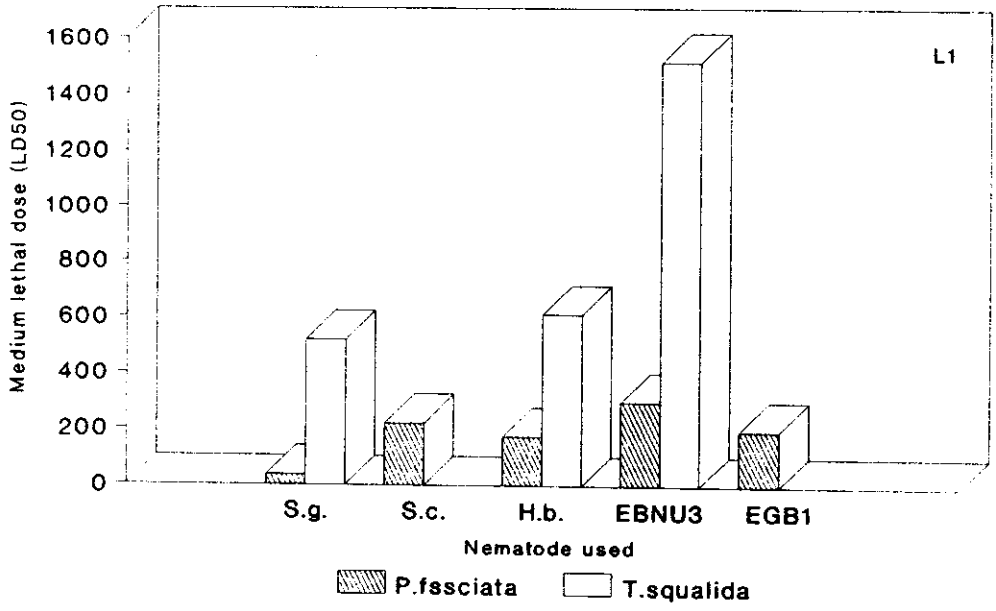

Figure 8. Medium lethal doses of the nematodes tested against 1st instar larvae of Pachnoda fasciata and Tropinota squalida

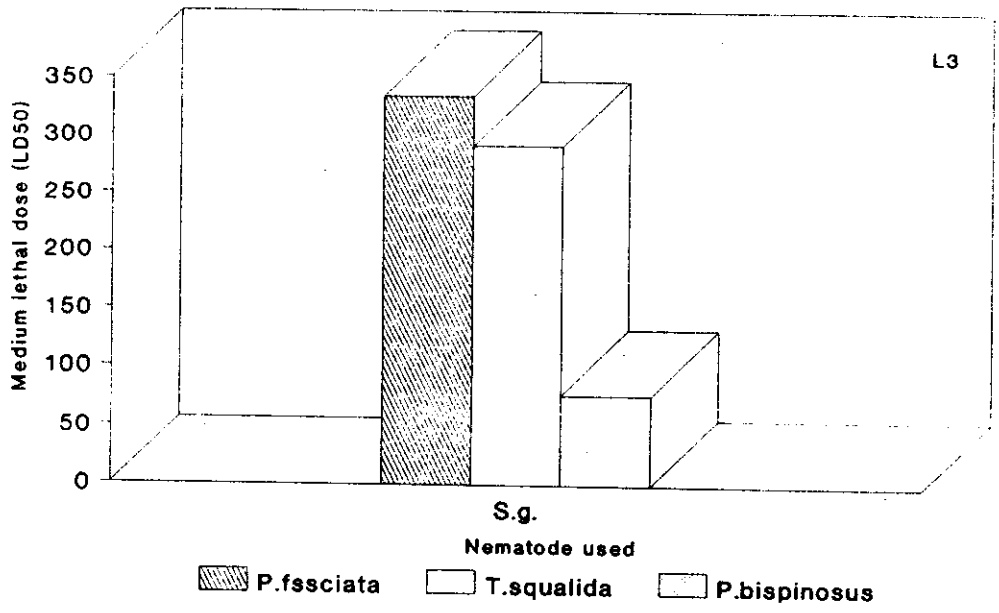

Figure 9. Medium lethal doses of Steinernema glaseri (NC) tested against the 3rd instar larvae of Pachnoda fasciata, Tropinota squalida and Pentoden bispinosus.

Table 11. Medium lethal dose (LD_{50}) of entomopathogenic nematodes, Steinernema glaseri (S.g.), Steinernema carpocapsae (S. c.), Heterorhabditis bacteriophora (H. b.) and the Egyptian isolates of Heterorhabditis sp. (EBNU3 and EGB1) tested against Pachnoda fasciata (P. f.) and Tropinota squalida (T. s.) adults (Coleoptera :Scarabaeidae).

Nematode used	LD_{50}+ FL = 95%	
	P. f.	T. s.
S. g. (NC)	2,888	406
S. c.	2,238	2,421
H.b. (HP88)	3,949	342
H. sp. (EBNU3)	20,620	-----*
H. sp. (EGB1)	36,729	-----

+ 500 cc pot containing 200 g of soil (sand : clay : organic matter) (1 : 1 : 1).

* Not tested.

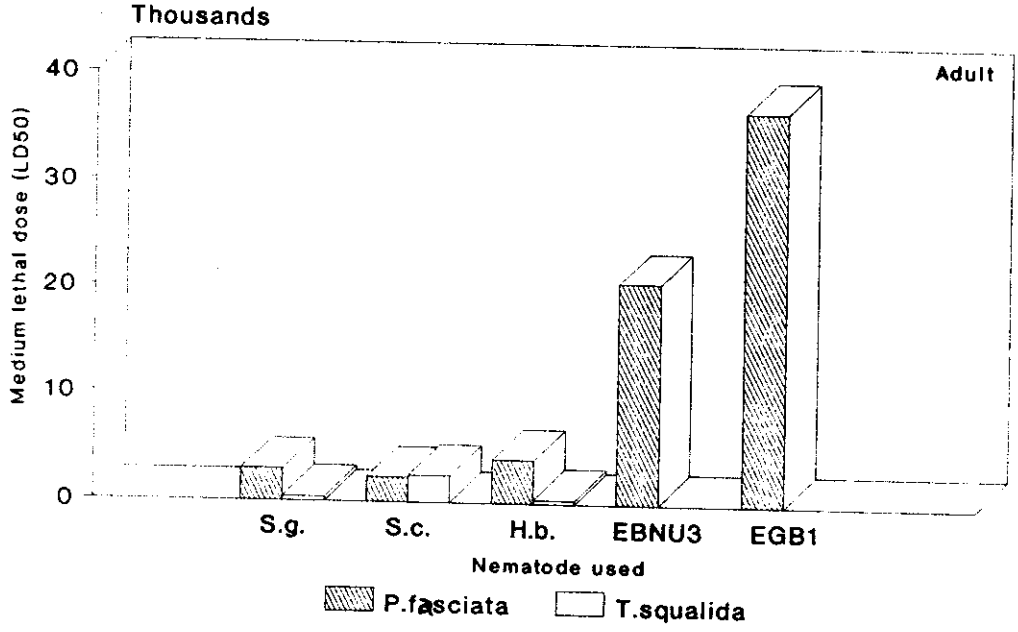

Figure 10. Medium lethal doses of entomopathogenic nematodes tested against the adult Pachnoda fasciata and Tropinota squalida

efficient nematode against the tested scarabaeid larvae was S. glaseri. This nematode scored LD_{50} values against 1st larval instar of P. fasciata and T. squalida of 37 and 518 IJ's / cup, respectively. Although the first instar larvae of P. fasciata were more susceptible than those of T. squalida to S. glaseri, the third instars of the latter were more susceptible than those of the former (LD_{50} = 334). Also, S. glaseri proved to be more effective against the third instars of the sugar-cane beetles P. bispinosus recording LD_{50} of 77 IJ's / cup. This nematode was the sole among the tested nematodes which affected the third instars of scarabaeid beetles. All other nematodes had no or little effect on the third instars of this scarabaeid beetle (LD_{50} > 2000IJ's / cup).

The second effective nematode against scarabaeid larvae was H. bacteriophora giving LD_{50} of 174 IJ's / cup against first instars

of P. fasciata. The Egyptian isolate (EGB1) ranked in the third position with a LD_{50} of 198 IJ's / cup. Steinernema carpocapsae followed with a LD_{50} of 221 IJ's / cup. Finally the Egyptian isolate of EBNU3 came last with a LD_{50} of 300 IJ's / cup.

Table (11) shows that adults P. fasciata and T. squalida were affected by the entomopathogenic nematodes applied in the natural soil of these beetles. Tropinota squalida beetles seemed to be more susceptible to tested nematodes than P. fascaita. The LD_{50} values for T. squalida ranged between 342 and 2421 IJ's / pot. While the LD_{50} values for P. fascaita treated with the same nematodes ranged between 2238 and 3949 IJ's / pot. Tropinota squalida adults were affected mostly by H. bacteriophora with a LD_{50} 342 IJ's / pot. It was followed by S. glaseri with a LD_{50} of 406 IJ's / pot and finally by S. carpocapsae

with a LD_{50} of 242 IJ's / pot. While P. fasciata adults were affected mostly by S. carpocapsae with a LD_{50} of 2238 IJ's / pot and was followed by S. glaseri with LD_{50} of 2888 IJ's / pot and finally by H. bacteriophora with a LD_{50} of 3949 IJ's / pot. The two Egyptian isolates of EBNU3 and EBG1 were tested against P. fasciata adults and they seemed to be less effective than the foreign nematodes and the LD_{50} values were so high (over 20,000 IJ's / pot).

II. COMPARATIVE DISPERSAL OF A FOREIGN AND AN EGYPTIAN ENTOMOPATHOGENIC NEMATODE:

Vertical movement of Steinernema glaseri and an Egyptian nematode isolate (EBNU3) of Heterorhabditis sp. in organic and sandy loam soils were presented in Table (12). Steinernematid and heterorhabditid nematodes show great promise as biological control agents of insect pests especially against soil inhabiting insects. It was reported that Steinernema carpocapsae was effective against

Table 12. Vertical dispersal of infective juveniles (IJ's) of *Steinernema glaseri* (*S. g.*) and an Egyptian isolate of *Heterorhabditis* sp. (EBNU3)* in relation to percent mortality of *Galleria mellonella* pupae at different levels in old manure and sandy loam soil.

Depth (cm)	% Mort.-			
	S. g.		(EBNU3)	
	Manure	S. loam	Manure	S. loam
4	100.0	100.0	100.0	100.0
8	100.0	100.0	100.0	100.0
12	----+	100.0	100.0	100.0
16	----	----	66.7	100.0
20	----	----	----	100.0

* EBNU3 = isolated from Behera governorate, West of Nubaria.

- % Mort.= Mortality percentage.

+ Nematodes did not reach this depth (some pupae died due to natural causes).

the scarabaeid beetles Sericesltis geminata Boisduval, and Othnonius batesi Olliff, under laboratory conditions, but no mortality could be attributed to S. carpocapsae in field trials (Reed and Carne, 1967). So the behavior of this nematode in soil requires more investigations. In the present study, vertical movement in two entomopathogenic nematodes were determined in organic and sandy loam soils. The first served as the natural habitat for scarabaeid larvae while the second is the most suitable habitat for entomopathogenic nematodes. The puape of the greater wax moth Galleria mellonella were used as an attractive host to the nematodes. Data showed that S. glaseri migrated for a depth of 12 cm in sandy loam soil and 8 cm in organic soil. Meanwhile, the Egyptian Heterorhabditis sp. (EBNU3) moved to the depth of 20 cm in sandy loam soil and 16 cm in organic soil (Table 12). The vertical distribution of the nematodes were detected by the infection of G. mellonella pupae placed at 4 cm intervals. These data are in agreement

with those obtained by (Georgis and Poinar, 1983a). They applied the infective juveniles of S. glaseri to the soil surface and noted that most juveniles remained within 2-6 cm of the surface but some were able to penetrate in pure sand and coarse sandy loam infecting all the pupae of the greater wax moth that were placed at the bottom (12 - 14 cm). It was also noticed that, the presence of the host insect pupae resulted in a significant increase of the nematode movement. When the host pupae were placed in pure sand, 3.3% of the nematodes were found at 12 - 14 cm depth, compared to 0.3% in the absence of the host. No nematodes were recovered below 6 cm in clay soil and hosts below this level were not infected by nematodes. The movement of Heterorhabditis bacteriophora infective juveniles showed a deeper tendency downwards in contrast with Steinernema carpocapsae (Georgis and Poinar, 1983b).

Meanwhile, our data on the vertical dispersal of Steinernema glaseri are similar to the data presented for Steinernema scapterisci. When the movement of infective juveniles of the latter species were determined, it was noticed that, they moved downward through 6 cm of soil to infect and kill some of the mole crickets (Nguyen and Smart, 1990).

III. SURVIVAL POTENTIAL OF TWO ENTOMOPATHOGENIC NEMATODES:

Table (13) is presenting the survival of entomopathogenic nematodes, S. glaseri and H. bacteriophora at different types of soil. The infective juveniles of these nematodes were introduced into two groups of soil to determine the survival ability of the IJ's of these nematodes. When the data were collected on S. glaseri, it was noticed that, it persisted for five days after their application to the organic clay soil surface. While it persisted for 30 days in sandy soil. The same results were obtained with the nematode H. bacteriophora.

The present results (Table 13) fully coincide with the conclusion of Nabil (1982). He stated that it is better to apply nematodes simultaneously with the presence of the last instar larvae of insects than to expose the insect larvae to a one, three and five days old nematode suspension. Croll and Matthews (1977) have shown that, the clay loam and pure clay soil have small pore sizes and high moisture potentials, providing poor aeration environment for nematode activities and when a nematode exposed to poor aeration consume the stored carbohydrates in food reserves ineffeciently. Conversely, sand and sandy loam have large pore sizes with low moisture potentials, providing good aeration environment for nematodes. With good conditions of aeration, nematodes will use the stored lipids in their food reserves efficiently, resulting in enhanced survival in sandy soil. Also Molyneux and Bedding (1984) have given a demonstration which agrees with

Table 13. Persistence and infectivity of inoculated Steinernema glaseri (S. g.) and Heterorhabditis bacteriophora (H. b.) related to percent mortality of sixth instar larvae of Spodoptera littoralis exposed to nematode infection at different time intervals in natural sandy loam soil of reclaimed land and old manure.

Time (days)	% Mort.*			
	S. g.		H. b.	
	Manure	S.loam	Manure	S. loam
1	100.0	100.0	100.0	100.0
5	50.0	100.0	100.0	100.0
10	0	100.0	0	100.0
15	25.0*	100.0	0	100.0
20	0	100.0	0	100.0
25	0	100.0	0	75.0
30	0	100.0	0	50.0

* Mortality was not due to nematode infection (nematodes were not found inside the dissected insect cadavers).

our conclusions. they succeeded in infecting blowfly larvae with S. glaseri in sandy soils while the same infection rate was low when clay loam soil was used. Generally, pathogenicity of nematodes decreases as clay content in soil increases.