BIOLOGICAL STUDIES ON THE SOIL PREDATORY MITE *OLOLAELPAS NASRI* HASSAN (LAELAPIDAE: MESOSTIGMATA)

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Abstract

Effects of different diets and temperatures were studied. Results showed that *Ololaelaps nasri* fed, developed and oviposited successfully on 5 different diets. The soil nematode *Rhabditis scanica* was the most suitable diet, resulting in shortening the life cycle duration of female and male (9.3 and 8.9 days, respectively).

Mean female fecundity was 47.8 and 30.9 eggs when fed on *R scanica* and *Musca domestica* larvae, respectively. Presence of *R scanica* alone or mixed with other food was responsible for the high rates of reproduction. Temperature of 25°C was the best for population increase. Female consumption was higher than males.

Female life cycle duration averaged 13.8, 9.3 and 5.4 days at 20, 25 and 30°C, respectively. Fecundity and oviposition daily rate (47.8 eggs and 2.2 eggs / female / day) were the highest at 25°C, while alternating temperature reduced fecundity and development as well. Female life cycle prolonged by 75% and 60% and fecundity reduced to 60 and 79%, when alternating temperature regimes 10/20 and 15/20°C were used, respectively, compared with similar obtained values at 20°C.

Exposing eggs to alternating temperature every twelve hours 10/20°C increased gradually the incubation period and the mean time of hatchability decreased from 63.3 to 23.3% for the same exposure time. Absence of male resulted in production of only males with lowest fecundity (24.9 eggs / female) showing the importance of male presence once / five days or allover female longevity.

INTRODUCTION

Acari is considered as a large economic group of arthropods. Many species live in soil and organic manure. The role of these species in nature is greatly important, as they vary from harmful to beneficial ones. Mesostigmatic mites represent one of the most important group living in soil. They are numerous and differ in their feeding habits; some are predators of soil pests (insects, mites, nematodes); while the other are fungivores.

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Members of the genus *Ololaelaps* Berlese are cosmopolitan free-livings inhabiting soil, litter and mosses. They include forms, which show extensive sclerotization and hypertrichy of opisthosoma. Many publications described several species belong to this genus (i.e. Ryke, 1962; Bregetova and Koroleva, 1964; Evans and Till, 1966; Marais & Loots, 1972). In Egypt, Nasr (1978) and Shereef & Soliman (1978), also described two species.

Ahmed (1990) studied the rate of reproduction of *Hypoaspis solimani* (Acari: Lealapidae) at 22°C and 30°C on larvae of *M. domestica, D. melanogaster, M. phaseoli, F. oxysporum* and organic manure. Larvae of *M. domestica* as prey gave the highest predator reproduction as well at 30°C. The present study was undertaken to investigate the biology and reproduction of the laelapid mite *Ololaelaps nasri* Hassan 1989, as a newly known species in the Egyptian fauna, on different foods and temperature.

MATERIAL AND METHODS

Material and methods, technique of rearing, different types of diets and degrees of temperature were similar to that described by: Hussein *et al.* (in press) Ecological and biological studies on the predatory soil mite *Holaspina solimani* Metwali.

Individuals of *O. nasri* were extracted from soil and debris under ficus trees in Orman garden, Giza by using modified Tullgren funnels. Some adult specimens were cleared in Nesbitt's fluid, mounted in Hoyer's medium then microscopically examined.

Some prey species: immatures stages of the acarid bulb mite, *Rhizoglyphus robini* Claparede, the acarid stored product mite, *Tyropagus putrescentiae* Schrank, eggs and larvae of housefly, *M. domestica*. L., free living nematodes *Rhabditis scanica* Allgen, the soil fungi, *Aspergillus niger* Roper and the collembola, *Lepeidocyrtinus incertus* (Hand) as well as mixture of diets were used.

Rate of reproduction for the tested predacious mite was studied at 20, 25 and 30°C ±1°C by keeping 5 replicates, each of 5 newly emerged adult females and two males in a rearing plastic cage for 8 weeks with one of the seven tested food, then number of offspring was recorded. Experiments were carried out at 70 ± 5% R.H.

For studying the effect of low temperature, thirty newly deposited eggs of *O. nasri* were collected from the laboratory cultures and kept solitary in cylindrical plastic cups (2.8 x 2cm) with a filter paper at its bottom. Relative humidity was maintained by adding few water drops on the filter paper when needed. A group of eggs was exposed to an alternating temperature of 10 and 20°C (12 hours for each, through the life span). The same technique was repeated for another group of eggs except using alternating 15 - 20°C.

Another experiment was designed to determine the female ability of multiple mating and effect on her longevity, fecundity and progeny sex ratio. Four groups each of five newly emerged females were confined singly to rearing cells. The females of 1st group were unmated and left to complete their longevity and deposit eggs. For the second group, a young male was introduced to each female until first copulation occurred, then removed. For the third group a young male was introduced to each female for 24 hours every five days during longevity. Females of the fourth group were accompanied with males allover their longevity.

RESULTS AND DISCUSSION

Effect of different diets on development of *O. nasri* at 25°C and 70% R.H. presented in Table 1 shows that it fed, developed and reproduced successfully on the free living nematode, *R. scanica*; the larvae or eggs of housefly *M. domestica*; the fungus, *A. niger*. or the collembola, *L. incretus*, while the fungus *P. viride* and the acarid bulb mite, *R. robini*, or the acarid stored mite, *T. putrescentia* were accepted diets for development to deutonumphal stage only.

Developmental duration of immatures ranged between 6.2-8.7 days for the female and 5.9-7.7 days for the male. The life cycle parameter followed similar trend, where female and male life cycle ranged 9.3-11.8 and 8.9-10.6 days, respectively. *R. scanica* was the most suitable diet resulting in the shortest life cycle for both sexes, (9.3 and 8.9 days for females and males, respectively).

Studying the biology of *Proctoloelaps bickeyi* Bram at 30°C using 4 different diets *R. scanica*, *R. solani*, *A.niger* and *Botryis fabae* Sardina. Nasr *et al* (1990b) reported that *R. scanica* was the most nourishing diet as the female longevity (22.3 days), fecundity (13.1 eggs / female) and oviposition period (12.1) days were the highest in comparison with 12 days, 6.1 eggs / female and 5.9 days when fed on *R. solani*, Also shortest female life cycle was recorded (6.6 days) when fed on *R. scanica* against 11.1 days on *R. solani*.

Table 2 shows the effect of different diets on longevity and fecundity of *O nasri* at 25°C and 70% R.H. Female longevity was 26.1, 42.2, 42.5, 43.5 and 63.0 days with average reproduction 47.8, 21.8, 6.1, 30.9 and 18.1 eggs / female when fed on *R. scanica*, *M. domestica* eggs, *L. incretus*, *M. domestica* larvae, and *A. niger*, respectively.

Rearing the laelapid mite *Proctolaelaps pygmaeus* on the 3 prey *Eutetranychus orientalis* immatures, *Chysomphalus ficus* nymphs and *Aphis duranta* adults at 25°C. Ali (1994) reported that the shortest predator female life cycle (7.47 days), highest values of longevity and fecundity (29.8 days and 26 eggs / female) were obtained when the mite fed on *E. orientalis*.

Food consumption increased as immature stages developed from proto to deutonymph and the latter to adult, while larva is a non feeding stage, Table 3.

Female consumption averaged 2.0, 6.2, 29.7, 47.9 and 56.1 *M. domestica* larvae or 4.8, 23.8, 37.4, 146.1 and 174.7 eggs for predator protonymph, deutonymph and during adult oviposition period, longevity and life span, respectively. Female consumption generally was higher than male, Table 3.

Effect of different temperatures on developmental duration of the mite when fed on *R. scanica* was presented in Table 4. Increase of temperature from 20 to 30°C reduced developmental duration of all immature stages and life cycle as well. Female life cycle duration average 13.8, 9.3 and 5.4 days at the mentioned temperature, respectively. Developmental duration of females and males did not vary much. The mean male life cycle was shorter with 0.4, 0.3 and 0.1 days than the female values at 20, 25, respectively and similar at 30°C, respectively.

Although oviposition period decreased as temperature increased from 20°C (28.3 days) to 25°C (22.1 days) then to 30°C (14.4 days), yet female fecundity increased only from 20°C (20.5 eggs) to 25°C (47.8 eggs), yet decreased at 30°C (29.9 eggs). The decrease of average number of deposited eggs at 30°C reached more than 60% of that at 25°C. In the mean time adult female, longevity and life span were the shortest at 30°C.

Rearing *Proctolaelaps deleoni* on *R. scanica* as a prey at 20, 25 and 28°C, Nawar (1992) reported that 28°C was the optimum temperature as it was associated with the shortest female life cycle (6.5 days) and highest values of longevity (31.8 days), oviposition period (19 days) and fecundity (28.8 eggs / female). Also, Gomaa (1998) stated that when reared *Androlaelaps reticulatus* on 4 different prey at 18°, 25° and 30°C, the shortest female life cycle (8.6 days) and the highest fecundity (57.3 eggs / female) were obtained when the mite fed on *R robini* eggs at 30°C.

With regard to reproduction of *O. nasri* in relation to temperature, results indicate that 25°C was better than 30°C, Table 5. Multiplication rate of 5 females and 2 males after 8 weeks reached an average of 76.43 and 85.56 at 25°C and 47.0 and 54.0 at 30°C when fed on *R. scanica* and a mixture of diets, respectively. Thus, 30°C accelerated development more than 25°C, but this did not compensate the increase of fecundity at 25°C more than 30°C and this consequently resulted in higher population increase.

Feeding on *A. niger*, larvae or eggs of *M. domestica* resulted in lower values than on *R. scanica* (multiplication rate of 20.43, 19.29 and 16.0 at 25°C and 17.43, 17.29 and 14.0 at 30°C, intrinsic rate of increase 0.054, 0.053 and 0.049 at 25°C and 0.051, 0.051 and 0.47 at 30°C, respectively. Feeding on *R. robini* or *L. incertus* resulted in multiplication rate of 10.14 and 8.14 at 25°C and 8.0 and 6.57 at 30°C and intrinsic rate of increase 0.041 and 0.037 at 25°C and 0.037 and 0.034 at 30°C, respectively. On the opposite, feeding on *P. viridi* resulted in population decrease (multiplication rate of 0.86 and 0.57, intrinsic rates of increase as -0.003 and -0.010 at 25 and 30°C, respectively).

Most of soil mite biological studies were conducted at the range from 18 to 30°C (Nawar *et al.*, 1990; Gomaa, 1992; Nawar, 1992; Mowafi, 1993; Ali, 1994; Gomaa, 1998). Some reported that 25°C was more appropriate for higher fecundity (Nawar *et al.* 1990; Mowafi, 1993), while other reported 30°C to be better than 25°C (Nawar, 1992; Gomaa, 1998). These results may reflect different degrees of environment stability in each species nich.

Table 6 shows the effect of alternating temperature on the mite biology. It was noticeable that exposure to alternating temperature of 12 hours each reduced developmental speed of all stages and reduced fecundity as well. Life cycle increased by 75% and 60% at 10/20 & 15/20°C regimes respectively, compared with values obtained at 20°C (constant temperature). Life span also, prolonged by 29% and 12% under the same regimes compared with constant temperature. Oviposition period was similar, but fecundity per female reduced to 60 and 79%, at the two regimes, respectively.

Table 7 indicates the effect of exposing only eggs to alternating temperature of 12 hours each on the other following stages when fed on *R. scanica*. Results show that exposing eggs to alternating 10/20°C, increased gradually the incubation period from 4.3 to 7.3 days as time of exposure increased from one to seven days. In the mean time, hatchability decreased from 63.3% to 23.3%. All other stages showed similar pattern, as life cycle prolonged from 14.8 to 20.9 days.

Exposing eggs to alternating temperature of 15/20°C, similar trend was obtained, but with higher values of hatchability and less duration of life cycle. Studying the influence of cold storage on *Amblyseius swirskii* at 5 and 9°C, Ali (1994) found that it prolonged egg incubation period and decreased hatchability as well as female survivability.

Male presence has an effect on female longevity, fecundity and progeny sex ratio. Table 8 shows that female longevity was not greatly affective by male presence. Absence of male resulted in production of only males and lowest fecundity (24.9 eggs / female). On the other hand, male presence for one day resulted in lowest fecundity and sex ratio, compared with presence 24 hours every five days or allover female longevity (i.e. 26.2 compared with 39.2 and 47.8 eggs / female and 0.54 compared with 0.70 and 0.70 females / total, respectively). Presence of male for more than once increased chance of mating which resulted in increase female progeny. This was emphasized by many authors (Ali, 1994; Ibrahim, 1997; Momen, 1997).

Table1. Effect of different diets on life cycle duration of *Ololaelaps nasri* Hassan at 25°C.

Diet		Egg	Larva	Protonymph	Deutonymph	Total immature	Life cycle
Rhabditis scanica	F	3.1 ± 0.32	1.0 ± 0.00	2.9 ± 0.99	2.3 ± 0.67	6.2 ± 1.45	9.3 ± 1.45
	M	3.0 ± 0.00	1.1 ± 0.32	2.6 ± 0.69	2.2 ± 0.92	5.9 ± 0.99	8.9 ± 1.03
Musca domestica larvae	F	3.0 ± 0.00	1.2 ± 0.40	1.3 ± 0.45	5.2 ± 0.98	7.7 ± 1.00	10.7 ± 1.00
	M	3.1 ± 0.30	1.1 ± 0.30	1.1 ± 0.30	5.0 ± 0.63	7.7 ± 0.60	10.3 ± 0.78
Musca domestica eggs	F	3.2 ± 0.40	1.2 ± 0.40	1.2 ± 0.40	6.0 ± 0.77	8.4 ± 0.92	11.6 ± 0.80
	M	3.1 ± 0.30	1.1 ± 0.30	1.2 ± 0.40	5.2 ± 0.75	7.5 ± 0.81	10.6 ± 0.92
Lipidocyrtinus incertus	F	3.1 ± 0.30	1.6 ± 0.48	2.9 ± 0.30	4.2 ± 1.66	8.7 ± 1.67	11.8 ± 1.68
	M	3.1 ± 0.30	1.2 ± 0.40	2.3 ± 0.46	4.0 ± 0.89	7.5 ± 1.02	10.5 ± 1.02
Aspergillus niger	F	3.1 ± 0.30	1.1 ± 0.30	1.3 ± 0.64	5.4 ± 0.66	7.8 ± 0.75	10.9 ± 0.83
	M	3.1 ± 0.30	1.1 ± 0.30	1.3 ± 0.46	5.0 ± 0.77	7.4 ± 1.02	10.5 ± 0.92

F: Female M: Male

Table 2. Effect of different diets on *Ololaelaps nasri* Hassan female longevity and fecundity at 25°C and 70% R.H.

Diet	Pre-oviposition	Oviposition	Post-oviposition	Longevity	Life span	No. of eggs	Daily rate
Rhabditis scanica	1.7 ± 0.48	22.1 ± 2.47	2.3 ± 0.90	26.1 ± 2.16	35.4 ± 2.80	47.8 ± 8.41	2.2 ± 0.41
Musca domestica larvae	1.4 ± 0.49	21.5 ± 2.06	20.6 ± 2.20	43.5 ± 3.96	54.2 ± 3.37	30.9 ± 4.28	1.4 ± 0.22
Musca domestica eggs	2.4 ± 0.49	17.9 ± 1.58	21.9 ± 2.74	42.2 ± 9.56	53.8 ± 3.60	21.1 ± 2.95	1.2 ± 0.16
Lepeidocyrtinus incretus	2.6 ± 0.66	12.3 ± 2.53	27.6 ± 3.85	42.5 ± 4.52	54.3 ± 4.47	6.1 ± 1.44	0.5 ± 0.13
Aspergillus niger	3.9 ± 9.4	28.1 ± 5.68	31.0 ± 3.44	63.0 ± 6.77	73.9 ± 6.48	18.1 ± 4.11	0.7 ± 0.19

Table 3. Food consumption of Ololaelaps nasri Hassan during different stages when fed on larvae (L) and eggs (E) of *Musca domestica.*

Stage and / or Parameter	Die	Female		Male	
		Consumption	Daily rate	Consumption	Daily rate
Protonymph	L	2.0 ± 0.63	1	1.5 ± 0.50	0.86
	E	4.8 ± 1.54	2.4	3.5 ± 1.50	1.75
Deutonymph	L	6.2 ± 1.40	1.2	4.3 ± 1.10	1.08
	E	23.8 ± 3.89	2.9	14.4 ± 1.66	2.7
Oviposition	L	29.7 ± 4.43	1.44	-	-
	E	37.4 ± 7.23	3.97	-	-
Longevity	L	47.9 ± 5.17	1.1	25.3 ± 2.33	0.85
	E	146.1 ± 9.28	3.31	59.8 ± 10.49	2.6
Life span	L	56.1 ± 4.89	1.02	31.1 ± 1.81	0.78
	E	174.7 ± 6.21	2.6	77.7 ± 10.95	2.4

Table 4. Effect of temperature on developmental duration, female longevity (days) and fecundity (eggs / female) of *Ololaelaps nasri* Hassan fed on *Rhabditis scanica.*

Stage and / or parameter	20°C		25°C		30°C	
	F	M	F	M	F	M
Egg	4.1 ± 0.30	3.9 ± 0.30	3.1 ± 0.32	3.1 ± 0.00	2.0 ± 0.00	2.0 ± 0.45
Larvae	1.2 ± 0.40	1.2 ± 0.40	1.0 ± 0.00	1.1 ± 0.32	1.0 ± 0.00	1.0 ± 0.00
Protonymph	3.2 ± 0.60	3.2 ± 0.40	2.9 ± 0.99	2.6 ± 0.69	1.2 ± 0.40	1.3 ± 0.45
Deutonymph	5.3 ± 0.64	5.1 ± 0.54	2.3 ± 0.76	2.2 ± 0.92	1.2 ± 0.40	1.2 ± 0.40
Total immature	9.7 ± 0.78	9.5 ± 0.81	6.2 ± 1.45	5.9 ± 0.99	3.4 ± 0.66	3.5 ± 0.50
Life cycle	13.8 ± 0.87	13.4 ± 0.92	9.3 ± 1.03	9.0 ± 1.45	5.4 ± 0.56	5.5 ± 0.60
Preoviposition	6.1 ± 1.30	-	1.7 ± 0.48	-	1.3 ± 0.46	-
Oviposition	28.3 ± 3.90	-	22.1 ± 2.47	-	14.4 ± 1.91	-
Post oviposition	22.2 ± 2.09	-	3.3 ± 0.90	-	6.7 ± 1.00	-
Longevity	56.6 ± 4.34	-	27.1 ± 2.9	-	22.4 ± 2.49	-
Life span	70.4 ± 6.54	-	36.4 ± 2.8	-	27.8 ± 2.56	-
No. of eggs	20.5 ± 1.86	-	47.8 ± 5.0	-	29.9 ± 4.85	-
Daily rate	0.7 ± 0.11	-	2.2 ± 0.41	-	2.1 ± 0.39	-

Table 5. Effect of different diets on population increase of 5 females and 2 males of *Ololaelaps nasri* Hassan over 8 weeks

Diet Type	25°C			30°C		
	Population	**Multiplication rate**	**Daily rate of increase (rm)**	**Population**	**Multiplication rate**	**Daily rate of increase (rm)**
Rhabditis scanica	535	76.43	0.077	329	47	0.069
Rhizoglyphus robini	71	10.14	0.041	56	8	0.037
Tyrophagus putrescentiae	15	2.14	0.014	11	1.57	0.008
Musca domestica eggs	112	16	0.049	98	14	0.047
Musca domestica larvae	135	19.29	0.053	121	17.29	0.051
Lepeidocyrtinus incertus	57	8.14	0.037	46	6.57	0.034
Aspergillus niger	143	20.43	0.054	122	17.43	0.051
Penicillium viride	6	0.86	-0.003	4	0.57	-0.01
Mixture of diets	601	85.56	0.079	378	54	0.071

Table 6. Effect of alternating temperature on life span of *Ololaelaps nasri* Hassan (days) when fed on *Rhabditis scanica*.

Stage and / or Parameter	Alternating temp. of 12 hours each	
	10 / 20°C	15 / 20°C
Egg	8.1 ± 0.64	7.6 ± 0.48
Hatchability %	23.3	23.3
Larva	4.4 ± 0.49	4.0 ± 0.00
Protonymph	4.7 ± 0.45	4.3 ± 0.43
Deutonymph	6.9 ± 0.64	6.3 ± 0.43
Life cycle	24.1 ± 1.12	22.1 ± 0.59
Preoviposition	14.8 ± 1.17	10.0 ± 1.73
Oviposition	27.4 ± 3.93	22.6 ± 3.16
Postoviposition	24.6 ± 2.06	23.9 ± 2.57
Longevity	66.8 ± 4.00	56.5 ± 4.85
Life span	90.9 ± 4.87	78.6 ± 4.72
No. of eggs	12.2 ± 0.41	16.2 ± 0.49

Table 7. Effect of exposing eggs of *Ololaelaps nasri* Hassan eggs to alternating temperature 10/20°C and 15/20°C on other stages duration when fed on *Rhabditis scanica*.

Exposure time	Alternating temp. every 12 hours	Egg	Hatchability%	Larva	Protonymph	Deutonymph	Life cycle
One day	10 / 20°C	4.3 ± 0.56	63.3	1.7 ± 0.64	3.8 ± 0.68	5.0 ± 0.77	14.8 ± 0.98
	15 / 20°C	4.2 ± 0.38	93.3	1.5 ± 0.50	2.7 ± 0.47	4.4 ± 0.56	12.8 ± 0.78
Two days	10 / 20°C	4.4 ± 0.49	46.7	1.5 ± 0.49	3.9 ± 0.76	5.1 ± 0.49	14.9 ± 1.04
	15 / 20°C	4.3 ± 0.43	80	2.2 ± 0.55	2.7 ± 0.61	4.3 ± 0.68	13.5 ± 0.62
Three days	10 / 20°C	4.8 ± 0.67	46.7	2.1 ± 0.47	3.5 ± 0.75	5.1 ± 0.92	15.5 ± 1.45
	15 / 20°C	4.4 ± 0.59	63.3	1.8 ± 0.36	2.7 ± 0.57	4.4 ± 0.49	13.3 ± 0.78
Four days	10 / 20°C	5.0 ± 0.58	40	2.3 ± 0.47	3.7 ± 0.62	5.3 ± 0.72	16.3 ± 0.92
	15 / 20°C	4.7 ± 0.59	46.7	2.2 ± 0.41	2.8 ± 0.41	4.5 ± 0.50	14.2 ± 0.86
Five days	10 / 20°C	5.5 ± 0.50	30	2.7 ± 0.47	4.0 ± 0.82	5.5 ± 0.76	17.7 ± 1.15
	15 / 20°C	5.4 ± 0.62	43.3	2.5 ± 0.49	2.9 ± 0.47	4.7 ± 0.61	15.5 ± 0.93
Six days	10 / 20°C	6.4 ± 0.48	26.7	3.0 ± 0.71	3.6 ± 0.49	6.4 ± 0.73	19.4 ± 1.05
	15 / 20°C	6.2 ± 0.63	30	3.0 ± 0.47	3.1 ± 0.57	4.4 ± 0.49	16.7 ± 1.39
Seven days	10 / 20°C	7.6 ± 0.73	23.3	3.3 ± 0.45	3.9 ± 0.64	6.1 ± 0.83	20.9 ± 0.99
	15 / 20°C	8.3 ± 1.03	23.3	3.1 ± 0.35	3.4 ± 0.49	4.9 ± 0.64	19.7 ± 1.39

Table 8. Effect of male presence on *Ololaelaps nasri* Hassan female fecundity, longevity and sex ratio when fed on *Rhabditis scanica* at 25°C and 70% R.H.

Male presence	**No. of eggs**	**Longevity**	**Sex ratio***
No male	24.9 ± 5.3	23.0 ± 2.9	0
One day	26.2 ± 1.9	18.6 ± 2.1	0.54
Every five days	39.2 ± 5.7	26.0 ± 2.6	0.7
Allover longevity	47.8 ± 5.0	27.1 ± 2.9	0.7

* Females / total

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دراسة بيولوجية لأكاروس التربة المفترس اولوليلابس نصرى من ذوات الثغر المتوسط

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شملت الدراسة البيولوجية للأكاروس المفترس *Ololaelaps nasri* Berlese (Laelapidae) اختبار ثمانية أنواع من الغذاء (الفرائس) علاوة على خليط منها وتبين أن الغذاء الأفضل هو النيماتودا حرة المعيشة إذ تعمل على تقليل فترة الأطوار غير الكاملة وإطالة فترة الأطوار الكاملة مع زيادة كفاءة الإناث لوضع البيض خلال فترة حياتها إلى ٤١ بيضة / أنثى.

كما درس تأثير الحرارة ونوع الغذاء على التكاثر حيث ترك ٥ إناث مع ذكرين لمدة ٨ أسابيع على حرارة ٢٥، ٣٠م حيث وصل إجمالى عدد العشيرة إلى ٥٣٥، ٣٢٩ فرداً على درجة حرارة ٢٥م وإلى ٦٠١ و ٣٧٨ فرداً على درجة حرارة ٣٠م عند التغذية على النيماتودا الحرة *R. Scanica* وعلى خليط من الأغذية المختارة على التوالى.

وبدراسة تأثير درجات الحرارة على سرعة نمو وطول فترة حياة الأنثى وخصوبتها وجد أنه بزيادة درجة الحرارة من ٢٠م إلى ٢٥م ثم إلى ٣٠م كان متوسط دورة حياة الأنثى ٨.١٣ و٣.٩ و ٤.٥ يوماً وفترة حياة الطور البالغ ٥٦,٦ و ٢٧,١ و ٢٢,٤ يوماً كما كان متوسط وضع البيض للأنثى الواحدة هو ٢٠.٥ و ٤٧.٨ و ٢٩.٩ بيضة عند درجات الحرارة المذكورة على الترتيب، كما درس أثر تبادل تعريض الأفراد غير الكاملة والكاملة لمدة ١٢ ساعة على حرارة ١٠م ثم ٢٠م أو درجتى ١٥ °م ثم ٢٠°م مما أدى إلى طول فترة حضانة البيض وقلة نسبة الفقس وكذلك طول فترة دورة حياة الأنثى وقلة خصوبتها حيث بلغ متوسط وضع البيض للأنثى تحت ظروف هذين النظامين ١٢,٢ و ١٦,٢ بيضة على التوالى.

وبتعريض البيض لحرارة ١٠/ ٢٠م لمدة ١٢ ساعة ليوم واحد فقط ثم تثبيته بعد ذلك على ٢٠°م وتكرار ذلك مع زيادة مدة التعريض لهذا النظام إلى ٢ و٣ و٤..... حتى سبعة أيام لوحظ طول فترة حضانة البيض ودورة حياة الأنثى وانخفاض النسبة المئوية للفقس من ٦٣,٣٪ إلى ٢٣,٣٪ مع زيادة فترة التعريض. وعند تكرار النظام السابق على درجتى ١٥ / ٢٠م أدى إلى نفس الاتجاه السابق وانخفاض النسبة المئوية للفقس من ٩٣.٣ إلى ٢٣,٣% بزيادة فترة تعريض البيض من يوم إلى سبعة أيام.

وبدراسة تأثير وجود الذكر مع الأنثى أدت لنتائج مضمونها أن تواجد الذكر مع الأنثى طوال فترة حياتها لازم لتضع أكبر معدل للبيض (٤٧,٨ بيضة / أنثى) كذلك النسبة الجنسية (إناث : العدد الكلى) حيث زاد من صفر عند غياب الذكر حتى ٧٠% عند تكرار عملية التلقيح.