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BIOLOGICAL AND ECOLOGICAL STUDIES ON THE SOIL PREDATORY MITE *HOLASPINA SOLIMANI* (METWALI) (PARHOLASPIDAE : GAMASIDA)

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Abstract

An ecological and biological study was carried out on the predaceous soil mite *Holaspina solimani* (*Metwali*), (*Parholaspidae :* Gamasida). Seven types of diets were used. Results showed that developmental duration between female and male did not vary much. Female life cycle ranged between 11.9 and 15.7 days, while it was 11 to 14 days for male. *Rhabditis scanica* was the most suitable diet, as it gave the highest fecundity of 41 eggs / female.

Increase of temperature from 20 to 30°C reduced developmental duration of all stages and the life cycle as well. Total egg deposition and daily rate were higher at 25°C than at 20 or 30°C, while longevity and life span were shorter at 25°C than the other two aforementioned degrees.

Exposure to alternating temperature 10 / 20 and 15 / 20 was studied. Life cycle increased by 64 % and 47 % when the 2 regimes were used, respectively, compared with obtained values at only 20°C. Life span prolonged by 29 % and 17 %. Fecundity per female was reduced to 47 % and 61 % under the two regimes. Exposing eggs to the same alternating temperature degrees increased gradually the incubation period, while hatchability decreased from 96.9 to 26.7 %. Presence of males did not affect longevity, while absence of males resulted in production of only males and lowest fecundity (16.4 eggs / female). Presence of the male (once every 5 days) or allover female longevity gave high fecundity and female sex ratio.

INTRODUCTION

Mesostigmatic mites represents one of the most important groups living in soil. They are numerous and differ in their feeding behaviour as some are predators of small soil animals (e.g. insects, mites, nematodes and housefly larvae), while others are fungivorous. Evans (1956) divided the family Macrochelidae into 2 subfamilies, one of which was Parholoaspidae : Gamasidae, which was raised by Krantz in 1960 to family

level as Parholaspidae and described some new generae and species including the genus *Holaspina*.

Nawar *et al.* (1990) reared *Lasioseius bispinosus* at 20, 25 and 30°C on five different diets, whowing its female life cycle, longevity, oviposition period and female fecundity. They also reported that *Dorosofila melanogaster* eggs was the most suitable diet giving the highest fecundity value 98.4 eggs / female and 25°C was the optimum temperature.

Therefore, the present study was undertaken to investigate the most suitable prey for the soil predatory mite *Holaspina solimani* (Metwali), usually found in lawn grasses in Egypt. Also, effect of some biotic and abiotic factors on its biology was investigated.

MATERIALS AND METHODS

Individuals of *H. solimani* were extracted from soil and debris under ficus trees in Orman garden, Giza by using modified Tullgren funnels. Some adult speciments were cleared in Nesbittis solution, mounted in Hoyer's medium then microscopically examined.

For culturing mites, identified adult females were placed in plastic cells 2.8 cm in diameter and 2 cm in depth filled up to 0.5 cm with mixture of 9 : 1 plaster of Paris and charcol. Drops of water were added daily to maintain suitable relative humidity. Cells were supplied with food and kept at 25°C for reproduction.

For individual rearing, newly deposited eggs of identified females were transferred singly (by using a camel hairbrush) one to a rearing cell. Each newly hatched larva was supplied with known amount of prey individuals and devoured ones were replaced daily by fresh ones till reaching maturity. Emerged females were allowed to mate and kept for oviposition. Observations concerning all biological aspects were recorded during the predator life span. Mites were examined twice daily. Rearing experiment began with more than 25 newly hatched larvae.

Seven sources of food as prey were used for *H. solimani* : immature stages of the acarid bulb mite, *Rhizaglyphus robini* Clararede, the acarid stored product mite, *Ty-*

rophagus putrescentiae Schrank, eggs and larvae of housefly, *Musca domestica.* L., free living nematodes *Rhabditis scanica* Allgen, the soil fungi, *Aspergillus niger* Roper and the collembola, the *Lepeidocyrtinus incertus* (Hand). Mixture of diets was used as well.

Rate of reproduction for the tested predacious mite was studied at 20, 25 and 30°C ± 1°C by Keeping 5 newly emerged adult females together with two males in a rearing plastic cage (8 cm x 3 cm) for 8 weeks, then number of offspring was counted. The seven prementioned foods were used. Experiments were carried out at 70 ± 5 % R.H. using NaCl solt solution as R.H. modifier, and replicated 5 times.

Calculations based on the formula :

$\lambda = e^{rm}$ and $R_o = \lambda^t$, could be rewritten as $\lambda = R^{(1/t)}$ and $rm = \ln \lambda$

where : rm is the rate of multiplication, λ is the number of mites after one day of rearing, t is time of rearing (days), Ro : is the number of multiplications which based on dividing the final number of mites in the reared cultures on the initial number starting the culture (7 : 2 males + 5 females), ln : natural logarithm.

An experiment was designed to study effect of low temperature. Thirty newly deposited eggs of *H. solimani* were collected from the laboratory cultures and kept in cylindrical plastic cup (2.8 x 2 cm) 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.

Other seven groups each of 30 solitary eggs were kept in a rearing cell. All were introduced to alternating temperatures of 10 and 20°C every 12 hours. This period of alternating temperatures lasted for 1, 2, 3, 4, 5, 6 and 7 days for the 7 groups, respectively, then were kept on a constant temperature of 20°C. A similar experiment was conducted with the same technique except using 15 and 20°C through the whole life span from egg to death of adults.

An experiment was designed to determine effect of male presence on female longevity, fecundity and progeny sex ratio. Four groups were used. Five newly emerged

females for every group were confined solitary to rearing cells. The 5 newly emerged unmated females of the first group were kept to complete their longevity and fecundity. For the second group, a young male was introduced to each female until first copulation occurred, then males were 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 accompamied with males allover their longevity. This experiment was carried out at 25 ± 1°C and 70 ± 5 % relative humidity.

RESULTS AND DISCUSSION

Table 1 shows that population increase at temperature of 25°C was better than at 30°C. Generally presence of *R. scanica* alone or mixed with other food types was responsible for the highest rates of increase. Multiplication rates for both respectively were 75.57 and 82.57 at 25°C and 61.43 and 72.71 at 30°C. Feeding on *M. domestica* larvae or eggs resulted in lower reproduction values than *R. scanica,* but better than for other tested foods.

Effect of different diets on developmental duration, longevity and fecundity of *H. solimani* was studied and indicated in Tables 2 & 3 and Fig. 1. Results show that duration of total immatures of *H. Solimani* ranged between 8.8 - 12.3 days for female and 7.9 - 11.0 days for male. The life cycle parameter followed similar trend where female life cycle ranged between 11.9 - 15.7 days and 11.0 - 14.0 days for the male. Here again, *R. scanica* was the most suitable diet, which resulted in the shortest life cycle for both sexes (i.e. 11.9 and 11.0 days for the female and male, respectively). The rest of tested diets gave longer life cycle.

Studying the reproduction rate of *Cosmolaelaps keni* (Fam. Laelapidae), Ali 1994 reported that the most favorable diet was a mixture of free living nematodes and some fungi species at 30°C, as reached 173.5 individuals after 8 weeks of starting with 3 newly emerged females and two males. In respect of female longevity and fecundity, the shortest duration was obtained when *H. solimani* was fed on *M. domestica* larvae; while the longest duration was obtained on *L. incretus.* Female longevity was 27.4, 28.9, 29.2, 29.8, and 32.8 days, when *H. solimani* fed on *A. niger, T. putrescentiae, R. scanica, M. domestica* eggs and *R. robini,* respectively, Table 3.

Table 1. Effect of different diets on population increase of *H. solimani* (Metwali) over 8 weeks period.

Diet type	25°C			30°C		
	Population	Multiplication rate (Ro)	Daily rate of increase (rm)	Population	Multiplication rate	Daily rate of increase (rm)
Rhabditis scanica	529.00	75.57	0.077	430.00	61.43	0.074
Rhizoglyphus robini	70.00	10.00	0.041	61.00	8.71	0.039
Tyrophagus putrescentiae	93.00	13.29	0.046	75.00	10.71	0.042
Musca domestica larvae	207.00	29.57	0.060	164.00	23.43	0.056
Musca domestica eggs	177.00	25.29	0.058	133.00	19.00	0.053
Lepeidocyrtinus incertus	120.00	17.14	0.051	103.00	14.71	0.048
Aspergillus niger	111.00	15.86	0.049	96.00	13.71	0.047
Mixture of diets	578.00	82.57	0.079	509.00	72.71	0.077

Pre-oviposition period ranged between 2.3 and 3.4 days on the tested diets except for *L. incretus* where it was 7.0 days. Mean of female fecundity was 10.8, 13.8, 19.7, 21.3, 26.3, 27.7 and 41.0 eggs / female when fed on *A. niger, L. incretus, R. robini, M. domestica* larvae, *T. putrescentiae, M. domestica* eggs and *R. scanica,* respectively. Post-oviposition period ranged between 4.8 and 11.5 days on the tested diets except for *L. incretus* where it was 31.8 days. Life span followed similar trend and ranged between 38.2 and 45.5 days on *M. domestica* larvae and eggs, respectively, but was extremely longer (98.9 days) on *L. incretus.*

Ali (1994) reared the same prementioned of mites *C. keni* on free living nematodes at 20, 25 and 30°C. It was reported that the shortest female life cycle and longevity 6.6 and 36.8 days recorded at 30°C. The oviposition period prolonged with temperature decrease, up to 40 days at 20°C.

Effect of different temperatures was shown in Table 4. Developmental duration as well as life cycle did not vary much between female and male. On the other hand, increase of temperature from 20 to 30°C reduced these durations. Mean female life cycle duration was 19.2, 11.9 and 8.4 days at 20, 25 and 30°C, respectively. In respect of longevity and fecundity data show that pre-oviposition period decreased as temperature increased from 20 to 30°C. Fecundity and oviposition daily rates were highest (41 eggs / female with 2.17 eggs / day, respectively) at 25°C than at 20 or 30°C. In the mean time oviposition period, longevity and life span were shorter (19.1, 22.2 and 41.1 days) at 25°C than at 20°C or 30°C. Gomaa (1998) reared *Partogamasellus discorus* Mansom at 18, 25 and 30°C using various diets e.g. *R. robini* eggs, *M. domesticae* larvae, free-living nematodes and the fungi *F. oxyeporium, A. niger* and *P. notatum.* They reported that the shortest female life cycle 8.8 days was recorded when mite fed on *P. notatum* at 30°C, but fecundity increased up to 63 eggs / female on *R. robini* eggs at 30°C.

Table 5 shows that exposure to alternating temperatures reduced developmental speed of all stages and reduced fecundity as well. Life cycle duration increased by 64 % and 47 % at 10 / 20 and 15 / 20°C regimes used, respectively, when the obtained values compared with data at 20°C (constant temperature). In the mean time, life span prolonged 29 and 17 % under the two regimes compared with constant temperature.

Table 2. Effect of different diets on life span of *H. solimani* (Metwali) at 25°C and 70 % R.H.

Food		Egg	Larvae	Protonymph	Deutonymph	Total immature	Life cycle	Life span
Rhabditis scanica	F	3.1±0.32	1.0±0.00	2.40±0.52	5.4±1.78	8.8±1.42	11.9±1.78	41.1±3.26
	M	3.1±0.32	1.1±0.32	2.20±0.65	4.6±1.65	7.9±1.79	11.0±1.83	
Rhizoglyphus robini	F	3.2±0.40	1.4±0.48	2.60±0.48	5.9±0.94	9.9±1.04	13.1±0.94	45.9±4.24
	M	3.0±0.00	1.3±0.45	2.10±0.30	5.4±0.49	8.8±0.87	11.8±0.87	
Tyrophagus putrescentiae	F	3.2±0.42	1.4±0.52	2.10±0.35	7.4±1.29	10.9±2.12	14.1±1.73	43.0±4.92
	M	3.1±0.32	1.2±0.42	2.20±0.42	6.3±1.06	9.7±1.57	12.8±1.67	
Musca domestica larvae	F	3.1±0.30	1.0±0.00	3.20±0.87	6.8±2.09	11.0±2.05	14.1±2.07	38.2±4.96
	M	3.0±0.00	1.0±0.00	3.10±0.83	6.9±1.51	11.0±2.24	14.0±2.39	
Musca domestica eggs	F	3.4±0.49	1.4±0.48	3.50±0.81	7.4±1.20	12.3±1.35	15.7±1.55	45.5±3.19
	M	3.1±0.30	1.2±0.40	2.90±0.54	6.5±1.20	10.6±1.49	13.7±1.55	
Lepeidocyrtinus incertus	F	3.0±0.00	1.3±0.45	2.20±0.40	7.8±0.60	11.3±0.46	14.3±0.46	98.9±3.76
	M	3.2±0.40	1.2±0.40	2.20±0.40	6.9±1.54	10.3±0.60	13.5±0.66	
Aspergillus niger	F	3.1±0.30	1.3±0.45	2.10±0.54	7.6±0.80	11.0±1.40	14.1±0.98	41.5±3.26
	M	3.0±0.00	1.2±0.40	2.00±0.63	7.6±0.66	10.0±0.89	13.8±1.30	

F: Female M: Male

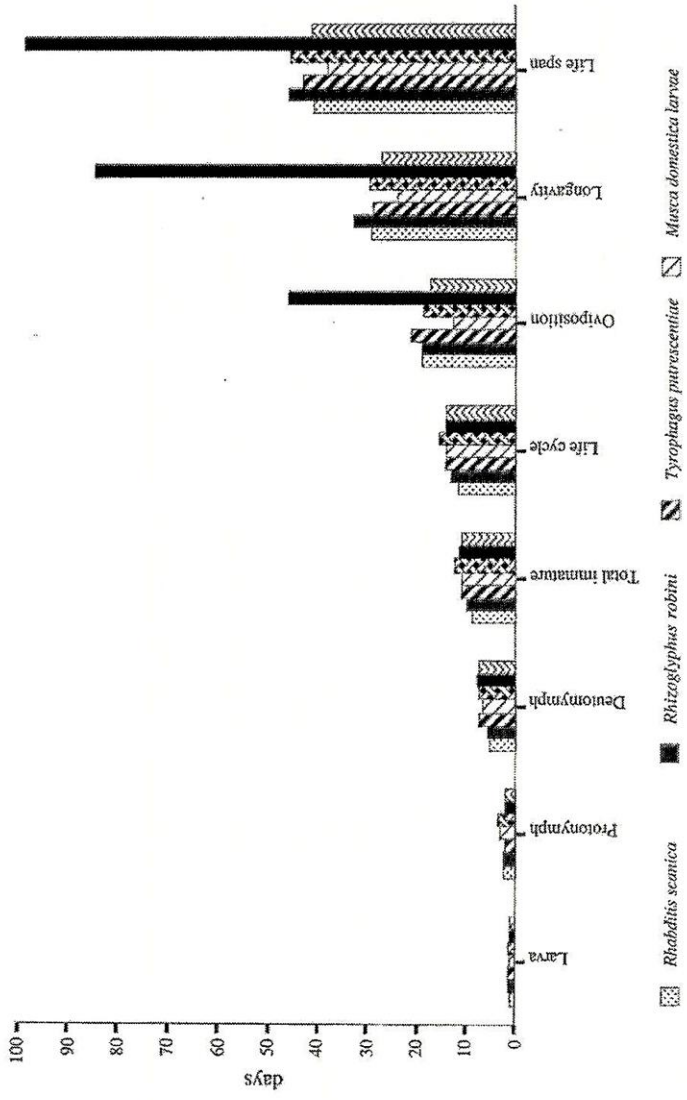

Fig. 1. Effect of different diets on duration of developmental stages of the predaceous mite *H. solimani*, (Metwali) when fed on *R. rabini* at 25°C and 70% R.H.

Table 3. Effect of different diets on female longevity and fecundity of *H. solimani* (Metwali) at 25°C and 70 % R.H.

Stage and/or parameter	Pre-oviposition	Oviposition	Post-oviposition	Longevity	No. of eggs	Daily rate
Rhabditis scanica	3.1±1.23	19.10±2.59	7.00±2.73	29.20±3.71	41.0±3.97	2.17±0.27
Rhizoglyphus robini	2.3±0.45	19.00±3.29	11.50±2.69	23.80±4.47	19.7±4.58	1.02±0.19
Tyrophagus putrescentiae	2.7±1.06	21.40±4.29	4.80±1.28	28.90±4.49	26.3±6.21	1.20±0.34
Musca domestica larvae	2.6±0.66	12.70±2.00	8.80±2.23	24.10±2.89	21.3±4.34	1.69±0.32
Musca domestica eggs	3.4±0.66	18.70±1.86	7.70±1.68	29.80±2.32	27.7±3.79	1.48±0.15
Lepeidocyrtinus incertus	7.0±1.26	45.80±5.86	31.80±2.89	84.60±3.75	13.8±1.25	0.31±0.06
Aspergillus niger	45.8±5.86	17.30±1.79	7.80±1.54	27.40±2.49	10.8±2.52	0.63±0.16

Table 4. Effect of temperature on developmental duration, female longevity (days) and fecundity (eggs/female) of *H. solimani* (Metwali) at 70 % R.H.

Stage and/or parameter	20°C		25°C		30°C	
	F	M	F	M	F	M
Egg	3.9±0.3	3.9±0.30	3.1±0.32	3.1±0.32	2.8±0.40	2.5±0.50
Larvae	2.4±0.49	2.3±0.46	1.0±0.00	1.1±0.32	1.1±0.30	1.0±0.00
Protonymph	3.5±0.50	3.5±0.46	2.4±0.52	2.2±0.56	1.7±0.45	1.9±0.54
Deutonymph	9.4±1.49	9.3±1.35	5.4±1.78	4.6±1.65	2.8±0.75	2.4±0.49
Total immature	15.3±1.02	15.1±1.47	8.8±1.79	7.9±1.42	5.6±0.49	5.3±0.49
Life cycle	19.2±1.10	19.0±1.45	11.9±1.83	11.0±1.78	8.4±0.49	7.8±0.75
Pre-oviposition	7.5±1.36	-	3.1±1.23	-	1.5±0.50	-
Oviposition	41.8±5.36	-	19.1±2.59	-	23.0±2.32	-
Post-oviposition	11.2±1.40	-	7.0±2.37	-	16.4±2.06	-
Longevity	60.3±5.14	-	29.2±3.71	-	40.9±2.12	-
Life span	79.7±6.28	-	41.1±3.26	-	49.3±2.95	-
No. of eggs	24.3±4.24	-	41.0±3.97	-	30.3±3.93	-
Daily rate	0.58±0.08	-	2.17±0.27	-	1.34±0.29	-

F: Female M: Male

Table 5. Effect of alternating temperature on the duration of *H. solimani* (Metwali) (days) on different stages fed on *R. scanica* nematodes.

Stage and/or parameter	10/20°C	15/20°C
Egg	8.43±0.49	8.00±0.82
Hatchability %	23.33	30
Larva	4.43±0.49	3.89±0.31
Protonymph	5.00±0.53	4.56±0.49
Deutonymph	13.71±0.69	11.56±0.83
Life cycle	31.57±0.73	28.01±1.25
Pre-oviposition	12.71±1.67	10.77±1.87
Oviposition	42.00±32.7	40.75±2.68
Post-oviposition	16.67±1.25	14.25±1.29
Longevity	71.38±2.62	65.77±1.48
Life span	120.95±2.62	93.78±1.22
No. of eggs	11.33±1.25	14.75±1.48

Although oviposition period was nearly similar, but female fecundity was reduced to 47 and 61 %.

Table 6 shows that exposing *H. solimani* eggs of the mite to alternating temperatures 10 / 20°C, increased gradually the incubation period from 4.1 days to 7.9 days as the time increased from one to seven days. Egg hatchability also decreased from 93.3 % to 33.3 % for the same exposure time. While larval and protonymphal stages were less affected, (duration ranged between 2.2 and 3.6 days for the larva and 3.2 to 3.7 days for the protonymph), the deutonymph was the most affected. Exposure time of one to seven days resulted in duration increase from 8.4 to 12.4 days, respectively. The increase in the egg incubation period as well as deutonymphal developmental duration contributed the most of increase in the life cycle. Exposing eggs of *H. solimani* to alternating 15 / 20°C resulted in similar trend.

Presence of male did not obviously affect female longevity, Table 7 as ranged between 23.4 to 29.2 days regardless of male presence. However, absence of male resulted in production of only males (arrhenotoky) and lowest fecundity (16.4 eggs / female). Presence of a male for one day resulted in lower fecundity and sex ratio, compared with its presence every five days or allover female longevity (i.e. 20.4 compared with 38.2 and 41.0 eggs per female, and 57 % compared with 71 % and 74 % females / total progeny, respectively). Shoeib (1996) concluded that multiple mating increased female fecundity. This phenomenon assured that presence of sufficient males in rearing cultures or in nature results in mite population increase.

Table 6. Effect of exposing *H. solimani* (Metwali) eggs to alternating temperatures 10/20°C and 15/20°C on immatures duration (days) when fed on *R. scanica* free-living nematodes.

Exposure time	Alternating temperature regimes	Egg	Hatchability %	Larva	Protonymph	Deutonymph	Life cyle
One day	10/20	4.1±0.19	93.3	2.2±0.38	3.2±0.41	8.4±1.17	17.9±1.46
	15/20	4.1±0.40	96.7	2.2±0.46	2.9±0.52	7.8±0.91	17.0±1.32
Two days	10/20	4.3±0.44	83.3	2.2±0.38	3.2±0.48	8.6±1.17	18.3±1.40
	15/20	4.1±0.32	93.3	2.4±0.49	3.0±0.60	7.7±0.70	17.2±0.99
Three days	10/20	4.3±0.47	76.7	2.3±0.45	3.4±0.57	8.7±0.97	18.7±1.32
	15/20	4.4±0.57	83.3	2.4±0.49	3.1±0.48	8.3±0.89	18.2±1.19
Four days	10/20	4.8±0.83	66.7	2.8±0.42	3.6±0.59	10.4±0.97	21.6±1.68
	15/20	4.6±0.59	60.0	2.7±0.58	3.4±0.49	9.0±1.15	19.7±1.97
Five days	10/20	5.2±0.39	53.3	3.5±0.50	3.5±0.61	12.0±0.94	24.2±1.11
	15/20	5.7±0.79	46.7	3.2±0.41	3.5±0.50	9.0±0.76	21.4±0.97
Six days	10/20	6.1±0.47	43.3	3.5±0.49	3.7±0.61	12.1±1.07	25.4±1.44
	15/20	6.4±0.72	46.7	3.3±0.45	3.4±0.49	9.9±0.91	23.0±1.39
Seven days	10/20	7.9±0.64	33.3	3.6±0.49	3.7±0.45	12.4±1.05	27.6±1.29
	15/20	8.4±1.11	26.7	3.4±0.48	3.4±0.48	11.0±0.71	26.2±1.45

Table 7. Effect of male presence on female fecundity, longevity and sex ratio of *H. solimani* (Metwali) when fed on *R. scanica* at 25°C and 70 % R.H.

Male presence	No. of eggs	Longevity	Sex ratio (progeny F. %)
No male	16.4±2.10	26.5±2.20	0.00
One day	20.4±1.49	23.4±3.01	57 %
Every five days	38.2±3.00	29.2±4.02	71 %
Allover longevity	41.0±3.97	29.2±3.71	74 %

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دراسات أحيائية وبيئية على أكاروس التربة المفترس (هولاسبينا سوليمانى) من ذوات الثغر المتوسط

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١ معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقى - جيزة
٢ قسم الحيوان والنيماتودا الزراعية - كلية الزراعة - جامعة القاهرة

تم دراسة المفترس الأكاروس *Holaspina solimani (Metwali)* من الناحية البيئية والبيولوچية من عدة نواحى : حيث درس التفضيل الغذائى باختيار سبعة أنواع من الأغذية والفرائس واتضح أن النيماتودا حرة المعيشة *Rhabditis scanica* هى أفضل غذاء أدى لتقليل فترة الأطوار غير الكاملة وإطال فترة الأطوار الكاملة وزيادة كفاءة الأنثى لوضع البيض حتى وصل المتوسط إلى ٤١ بيضة / أنثى. وقد أدى هذا لغذاء المفضل لأكبر زيادة فى التكاثر حيث وصل عدد العشيرة إلى ٥٢٩ فرد عند البدء بـ ٥ إناث وذكرين ولمدة ٨ أسابيع عندما كانت التربية على ٢٥ ± ١°م ورطوبة نسبية ٧٠ ± ٥ ٪.

ودرس المدى الحرارى الملائم للمفترس واتضح أن زيادة الحرارة من ٢٠ وحتى ٣٠°م أدت لتخفيض مدة الأطوار غير الكاملة ودورة الحياة وأن أنسب درجة حرارة لمعيشة هذا المفترس هى ٢٥ ± ١°م حيث عندها زادت خصوبة الأنثى ومعدل وضع البيض إلى ٢,١٧ بيضة / أنثى / يوم.

كما درس أثر تخفيض الحرارة إلى ١٠°م لمدة ١٢ ساعة تم تثبيتها على ٢٠°م وتكرار ذلك ليومين وثلاثة ... وحتى سبعة أيام وتكرار ذلك بالتبادل بين ١٥°م و ٢٠°م واتضح زيادة مدة دورة الحياة بنسبة ٦٤٪، ٤٧٪ على الترتيب عند تطبيق التبادل الحرارى فى النظامين السابقين، بينما قلت الخصوبة إلى ٤٧٪، ٦١٪ على الترتيب، كما زادت فترة الحضانة بالتدريج وقلت النسبة المئوية لفقس البيض من ٩٦,٩٪ إلى ٢٦,٧٪ بزيادة تعريض البيض للحرارة المنخفضة حتى ٧ أيام.

وكذلك أوضحت الدراسة أهمية وجود الذكر مع الأنثى على الأقل مرة كل خمسة أيام لتعطى أكبر عدد من البيض. كما أن عدم التلقيح نهائياً تسبب فقس البيض عن ذكور فقط (أى أنه Arrhenotokous) بينما التلقيح وتكراره يزيد النسبة الجنسية إلى ٧٤٪ إناث من مجمل البيض الموضوع.