THE EFFECT OF TEMPERATURE ON DEVELOPMENT, FECUNDITY AND FOOD CONSUMPTION OF *AMBLYSEIUS CYDNODACTYLON* SHEHATA & ZAHER

OMAR, NABIL A. [1] **and AMIRA E. MESBAH**[2]

1. *Faculty of Technology & Development, Zagazig University, Egypt*
2. *Plant Protection Research Institute, ARC, Dokki, Giza, Egypt.*

(Manuscript received 19 January 2014)

Abstract

The present work was conducted to study the effect of temperature on development, fecundity and food consumpution of *Amblyseius cydnodactylon* (Shehata & Zaher) under laboratory conditions. The biology of *A. cydnodactylon* may be a considerable value for controlling *P. tritici* in Egypt. The results showed that the developmental period increased with temperature decrease. Fecundity, longevity and lifespan were longer at 25°C and lower at 35°C. At 25°C developmental period was short with higher fecundity and maximum longevity, where as it was the most suitable temperature for development of *A. cydnodactylon* , while 35°C was the least suitable.The results on food consumption showed a significant effect of temperature on developmental stages of *A. cydnodactylon* . The larvae of this predator did not feed during the experiment, and predation activity started just after the mites entered the protonymphal downloaded stage. Feeding capacities of protonymph and deutonymphal stages were in a similar trend. These were increased with increasing temperature from 20◦C to 25◦C, and then decreased at 30◦C and finally, increased again at 35◦C. The highest means for total prey consumption of females were recorded during oviposition, when they devoured an average of 103.0, 189.3, 109.0 and 79.0 prey at 20, 25, 30, and 35◦C, respectively. The highest and lowest values of the mean prey consumption by postoviposited females was observed at 25◦C (6.4 prey) and 20◦C (2.1 prey), respectively. During adulthood, the highest number of prey consumed was at 25◦C (201.9 prey), which decreased to 116.6, 110.8 and 86.9 individuals at 30, 20 and 35◦C، respectively.

INTRODUCTION

Wheat (*Triticum aestivum* L., Graminae) is a worldwide cultivated food crop and the king of all cereal crops owing to its easy cultivation, ecological suitable and contain high amount of nutrient. It is rich in protein (7-22%), carbohydrate, calcium, lysine, iron, gluten, vitamin and minerals (Farzad, *et al*. 2013).

Genus *Petrobia* Murray (F:Tetranychidae) contains more than 30 species of which several polyphagous species are important pests. Kandeel *et al*.(2007) collected and described the new tetranychid mite, *Petrobia tritici* Kandeel, EL-Naggar&Mohamed

from El-Salheia region from wheat leaves . It damages wheat plants by destroying plant cells when it feeds, causing a silvery flecking of the leaves.

The predacious mite, *Amblyseius cydnodactylon* Shehata & Zaher (Phytoseiidae) is a common natural enemy inhabiting low growing plants like cucumber in Egypt. This species is considered a generalist predator and it was preying on several pests including tetranychid, eriophyid mites, nymphs of white flies and thrips (El-Banhawy, *et. al.*,2001).

However, the present study was conducted to evaluate the effect of constant temperature on developmental life stages,life cycle, longevity, fecundity, lifespan and prey consumption of *A. cydnodactylon* as abicontrol agent for *P. tritici*.

MATERIALS AND METHODS

Prey culture :

The tetranychid mite, *Petrobia tritici* was found on leaves of naturally infested wheat plants, *Triticum aestivum* L. at Hehia District, El-Sharkia Governorate, Egypt. Samples were taken for mite collection and reared on castor leaves, *Ricinus communis* under laboratory conditions, Faculty of Technology & Development, Zagazig University, Egypt.

Predator culture:

A laboratory colony of *Amblyseius cydnodactylon* was selected from wheat plant leaves at the same area . It was mass cultured in the laboratory on castor leaves infested with *Tetranychus. urticae* as prey. The experiment was under the same conditions.

Experimental procedure:

The experiments were conducted at four constant temperatures (20, 25, 30 and 35±1ºC)with relative humidity of 70±5%. Thirty gravid females of *A. cydnodactylon* were taken randomly and transferred to rearing substrates. Females were left 24 hours and their oviposited eggs were used to start biological aspects. Thereafter, when a sufficient number of eggs were laid , the adult females were removed and eggs from the same age were obtained to start the experiment. Observations were made at 6 hourly intervals to see if the eggs had hatched. After the eggs hatching to larvae, the larval individuals of larvae were transferred very carefully onto leaf disks of castor leaves (3 cm in diameter). Leaf discs were placed with the upper surface facing down on cotton layer in a Petri-dishes(6 cm in diameter). Water was added when needed to maintain the suitable moisture. The leaf margin was surrounded by a cotton strip to prevent the mites escaping. A few cotton threads were placed on the surface of leaves to serve as shelter and oviposition sites. Ten replicates were maintained for each temperature, so 40 Petri dishes were maintained simultaneously. All the Petri dishes were kept in incubators maintaining the desired temperature. Immature stages of *P. tritici* which was given as food for the predatory mite, *A. cydnodactylon* . Duration of the developmental stages, preoviposition, oviposition, postoviposition periods, longevity, fecundity, lifespan and food consumption were recorded by taking observations using the stereomicroscope.

Statistical analysis:

Data were statistically analyzed by using the analysis of variance according to Sendecor and Cochron (1982) using the computer program SPS_S (2006).

RESULTS AND DISCUSSION

Data in Tables 1&2 show that developmental of different life stages by *Amblyseius cydnodactylon* on a diet of immature stages of *Petrobia tritici* at different temperatures. Data reveal that there were significant effects of temperature on all developmental life stages.

Table 1. Development (in days± S.D.) of different life stages of *Amblyseius cydnodactylon* at four constant temperatures.

Temperature (º C)	Incubation Period	Duration			Total development period	Longevity	Life span
		Larva	Protonymph	Deutonymph			
20	1.70^a±0.08	2.03^a±0.11	1.75^a±0.08	3.80^a±0.08	9.28^a±0.25	21.35^b±0.46	30.63^a±0.48
25	1.30^b±0.08	1.50^b±0.00	1.60^a±0.07	3.20^b±0.19	7.60^b±0.29	23.06^a±0.42	30.66^a±0.36
30	0.90^c±0.04	1.20^c±0.08	1.25^b±0.08	2.80^b±0.19	6.15^c±0.2 0	15.50^c±0.52	21.70^b±0.63
35	1.00^c±0.00	0.85^d±0.04	1.14^b±0.06	2.20^c±0.13	5.19^d±0.16	14.15^d±0.38	19.34^c±0.36
Sig.	**	**	**	**	**	**	**

Means with different superscripts in the same row differ significantly ($P < 0.05$).

Incubation period:

The incubation period varied with temperature differences. The maximum period (1.7 days) was seen at 20◦C and the minimum (0.9 days) at 30◦C. The incubation period was 1.1 days at 25◦C while it was 0.9 days at 30◦C .

Larval period:

The larval period was longest (2.03 days) at 20◦C and shortest (0.85 days) at 35◦C, while it lasted 1.5 and 1.2days at 25 and 30◦C, respectively. The duration of this period decreased with the temperature increasing.

Protonymphal period:

The maximum and minimum protonymphal period were 1.75 days at 20 but it was 1.14 days at 35◦C, respectively. The duration of this period varied inversely with temperature.

Deutonymphal period:

This period was longest (3.8 days) at 20◦C and shortest (2.2days) at 35◦C. The duration was 3.2 and 2.8 at 25 and 30◦C, respectively. It was apparent that the deutonymphal period was longer at lower temperatures and shorter at higher temperatures.

Total developmental period:

The total developmental period was a maximum (9.28 days) at 20◦C and a minimum (5.19 days) at 35◦C. This period was 7.6 and 6.15 days at 25and 30◦C, respectively. Duration of preoviposition, oviposition, and postoviposition periods, fecundity and daily rate of egg production of offspring of *A. cydnodactylon* at different temperatures are presented in Tables 2. Data analysis showed a significant effect of temperature on all duration.

The observation that developmental period decreased with increasing temperature was also observed in *A. fallacis* (Garman) by Smith &Newsom (1970), *A. citrifolius* (Denmark and Muma) by Moraes and McMurtry (1982), *A. swirskii* Athias-Henriot by Yousef *et al*. (1982) and Onzo *et al*. (2012) and in *A. coccosocius* Ghai &Menon by Saha *et al*.(2001). Incubation period was a maximum at 20˚C and minimum at 30˚C, and these findings are in agreement with the findings of Sharma&Sadana (1984).

Preoviposition period:

This period was shortest (0.95 days) at 35◦C and longest (1.6 days) at 30 and 35◦C. It was 0.99 days at 25◦C. This indicated that 25◦C was the most favored temperature for this predator as it started laying eggs within the shortest period.

Oviposition period:

The oviposition period was longest (21.1 days) at 25◦C and shortest (11.9 days) at 35◦C. It was 18.3 and 13.0 days at 20◦C and 30◦C, respectively. This period increased with an increase of temperature from 20 to 25◦C and decreased with an increase of temperature thereafter. The longest period showed again that this was the most favorable temperature.The increase of oviposition period with increasing temperature is a common phenomenon in phytoseiids , Saha *et al.*(2001).

Post oviposition period:

The postoviposition period was ranged between a minimum (0.9 days) at 30°C and maximum (1.5 days) at 20°C.

Fecundity:

The highest fecundity (42.1 eggs/female) was seen at 25◦C, followed by 34.8 eggs at 30°C, 16.5 eggs at 20°C and a minimum of 10.2 eggs/female at 35°C . Fecundity increased when the temperature increased from 20 to 25°C and decreased with an increase of temperature thereafter.

Daily rate of egg production:

The fecundity per day as following (2.72 eggs) at 30°C, 2.05 at 25°C, 0.91 at 20°C and 0.86 at 35°C.

Longevity and lifespan:

Adult female longevity and lifespan of *A. cydnodactylon* at different temperatures are presented in Table1. The maximum longevity was 23.06 days at 25°C, and the minimum corresponding figures was 14.15 days at 35°C. This stage increased with an increase of temperature from 20 to 25°C but decreased with the increase of temperature thereafter. Total lifespan followed a similar trend as longevity, these were 30.63, 30.66, 21.7 and 19.34 days at 20, 25, 30 and 35°C, respectively.

Table 2. Duration of preoviposition, oviposition, and postoviposition periods (in days± S.D.), fecundity and daily rate of egg production of offspring of *A. cydnodactylon* at different temperatures.

Temperature (º C)	Preoviposition	Oviposition	Postoviposition	Fecundity (♀)	Daily Rate
20	1.60^a±0.01	18.30^b±.4.23	1.45^a±0.12	16.50^c±0.86	0.91^c±0.06
25	0.99^b±0.03	21.10^a±.4.07	1.00^b±0.00	42.10^a±0.91	2.05^b±0.06
30	1.60^a± 0.05	13.00^c±.5.16	0.90^b±0.04	34.80^b±1.31	2.72^a±0.15
35	0.95^b±0.03	11.90^c±.3.14	1.50^a±0.07	10.20^d±0.53	0.86^c±0.04
Sig.	**	**	**	**	**

Means with different superscripts in the same row differ significantly (P < 0.05).

Means for the total prey consumption by *A. cydnodactylon* on a diet of *P. tritici* immatures at constant temperatures are presented in Table 3. The larvae of this predator did not feed during the experiment, and predation activity started just after.

Data analysis revealed a significant effect of temperature on total food consumption by *A. cydnodactylon* except larval stage where there was no significant effect. The total number of prey consumed by the protonymphs increased with increasing temperature from 2.6 prey at 20°C to 4.4 prey at 25°C, and then decreased to 1.8 prey at 30°C and finally, increased again to 2.1 prey at 35°C. Feeding capacities of deutonymphs followed a similar trend as protonymphs. It was ranged from 3.2 prey at 30°C to 11.3 prey at 25°C. The highest mean number of total prey consumed by protonymphs and deutonymphs was 15.7 prey which was obtained at 25°C.

Adult of *A. cydnodactylon* started prey consumption after emergence at all temperatures tested. During the preoviposition period, predators devoured an average of 5.7 , 6.2, 4.3 and 2.7 prey at 20, 25, 30, and 35°C,respectively. The maximum means for total food consumption of the predator was recorded during the oviposition period, it consumes an average of 103.0, 189.3, 109.0 and 79.0 prey at the same temperatures. The highest and lowest values for the mean prey consumption by postoviposited females were observed at 25°C (6.4 prey) and 20°C (2.1 prey).

During adulthood, the highest number of prey consumed was at 25°C (201.9 prey), which decreased to 116.6, 110.8 and 86.9 individuals at 30, 20 and 35°C، respectively.

The present study showed that temperature affects the feeding capacity of all life stages of *A. cydnodactylon* except the larval stage where it developed to the protonymphal stage without feeding. Non feeding larval behavior may be a mechanism to avoid sibling cannibalism. Similar findings have been reported for other phytoseiid species by (El-Banhawy *et al*. 2000, Kouhjani *et al*., 2009 and Fatemeh *et al*.2011).

During immature stages of *A. cydnodactylon*, food consumption increased with increasing temperature from 20 to 25°C. Therefore, it could be concluded that the optimal temperature for predation of this predator was about 25°C. A clear reduction was observed in the mean number of prey consumption from 25 to 30°C. The findings of (Metwally *et al.* 2005 and Fatemeh *et al.*2011) support my results.

Table 3. Total prey consumption of different life stages of *A. cydnodactylon* fed on immature stages of *P. tritici* at four constant temperatures.

Temperature (º C)	Larva	prtonymph	Deutonymph	Total immature	Preoviposition	oviposition	Postoviposition	Longevity
20	0.0± 0.0	2.60^{bc}± 0.16	3.20^{b}± 0.29	5.80 ^{b}± 0.39	5.70^{a}± 0.26	103.00^{b}± 4.41	2.10^{d} ± 0.23	110.80^{b} ± 4.44
25	0.0± 0.0	4.40^{a}± 0.31	11.30^{a}± 0.60	15.70^{a}±0.60	6.20^{a}± 0.29	189.30^{a}± 5.84	6.40^{a} ± 0.37	201.90^{a} ± 5.90
30	0.0± 0.0	1.80^{c}± 0.13	3.20^{b}± 0.22	5.20^{b}±0.29	4.30^{b}± 0.15	109.00^{b}± 2.85	3.30^{c} ± 0.21	116.60^{b} ± 2.81
35	0.0± 0.0	2.10^{b}± 0.10	3.40^{b}± 0.23	5.20^{b}±0.20	2.70^{c}± o.21	79.00^{c}± 2.80	5.20^{b} ± 0.25	86.90^{c} ± 2.56
Sig.	NS	**	**	**	**	**	**	**

Means with different superscripts in the same row differ significantly ($P < 0.05$).

Although we observed the same trend in all experiments, the obtained values were different because of different prey and predator species were used in the experiments. Furthermore, several other factors, such as relative humidity, photoperiod, presence of pollen, and the type of experimental arena may also affect a predator's feeding (Fernando& Hassell,1980).

The females during oviposition consumed a significantly higher number of prey, suggesting that females need extra food for egg production during this period. This new information is in agreement with other findings (Kouhjani *et al.*,2009).

To the best of my knowledge, little previous study has been made concerning the predation of this species, therefore we could not compare the results with previous published studies. However, there are numerous investigations on other phytoseiid species, revealing the effect of temperature on these predators food consumption.

The results from the current study would help us to gain a better insight into the efficiency and practical application techniques of a predator in biological control programs of spider mites. According to the findings, *A. cydnodactylon* could be a beneficial biocontrol agent in both greenhouses and field when temperature is above 20°C, however, to optimize results, additional experiments should be performed. From an overall evaluation of results it appeared that 25°C was the most suitable temperature for the growth of *A. cydnodactylon*. At this temperature the total developmental period was moderated with a longer ovipositional period, higher fecundity and longer longevity.

REFERENCES

1. El-Banhawy E.M., S.M. Hafez and S.A. Saber. 2001. Response of *Amblyseius cydnodactylon* (Phytoseiidae)to increasing prey density of *Tetranychus urticae* (Tetranychidae) in absence or presence of nymphs of *Bemesia tabaci* (Homoptera) in Egypt. Int. J.AcaroL, Vol. 27, : 241-244.
2. El-Banhawy, E.M., S.A.A. Amer and S.A. Saber. 2000. Development and reproduction of the predacious mite, *Amblyseius cydnodactylon* on different prey species, effect of plant leaf texture on the behaviour and reproduction of the predator. J. Plant Diseases and Protection, Vol. 107, No.2: 218-224.
3. Faith, J.T., A.U. Edward, D.T. Pieter and K. Markus. 2009. The tetranychid mites(Acari:Tetranychidae) of Kenya and a redescription of species *Peltanobia erasmusi* Meyer (Acari: Tetranychidae) based on males. Zootaxa 2176:33-47.
4. Farzad, K.E., S.M. Sayyed and R.A. Mohammad. 2013. Genetic diversity and heritability of some suitable morpho- physiological traits in Bread Wheat *Triticum aestivum* L.) under terminal moisture stress. Adv Crop Sci. Vol.3 No.5: 376-388.
5. Fatemeh G., F. Yaghoub and K. Karim. 2011. Effect of temperature on prey consumption of *Typhlodromus bagdasarjani* (acari: phytoseiidae) on *Tetranychus urticae* (acari: tetranychidae). Int. J.AcaroL. Vol. 37, No.6:556–560.
6. Fernando, M. H. J. P. and M. P. Hassell. 1980. Predator-prey responses in an acarine system. Res. Popul. Ecol. 22: 301–322.
7. Kandeel, M.M.H., M.E. El-Naggar and O.M.O. Mohamed. 2007. A new species of Petrobia Murray from wheat and other crop plants in Egypt (Acari:Tetranychidae). Egypt. J. Agric. Res., 85(3): 885-892.
8. Kouhjani G. M., Y. Fathipour and K. Kamali. 2009. The effect of temperature on the functional response and prey consumption of *Phytoseius plumifer* (Acari: Phytoseiidae) on the two-spotted spider mite. Acarina 17(2): 231–237.
9. Metwally, A.M., B.A. Abou-Awad and M.M.A. Al-Azzazy. 2005. Life table and prey consumption of the predatory mite *Neoseiulus cydnodactylon* Shehata and Zaher (Acari: Phytoseiidae) with three mite species as prey. Z. Pflanzenk. Pflanzen.112: 276–286.
10. Moraes, G.J. and J.A. McMurtry. 1982. Biology of *Amblyseius citrifolius* (Denmark and Muma) (Acarina – Phytoseiidae). Hilgardia 49 (1), 1–29.
11. Onzo A., A.F. Houedokoho and R. Hanna. 2012. Potential of the predatory mite, *Amblyseius swirskii* to suppress the broad mite, Polyphagotarsonemus latus on the gboma eggplant, *Solanum macrocarpon*. J.Insect Sci. 12(7):1-11.

12. Saha K., A.K. Somchoudhury, P.K. Sarkar and S.K. Gupta. 2001. Effect of temperature on the rate of development, fecundity, longevity, sex ratio and mortality of *Amblyseius coccosocius* ghai and menon (acari: phytoseiidae), an important biocontrol agent against tea red spider mite in India. Acarology: Proc.10th Intern. Congress,470-472.
13. Sharma, K. N. and G. L. Sadana. 1984. Influence of temperature on the development of the predatory mite, *Amblyseius finlandicus* (Acari: Phytoseiidae). Indian J. Acarol. 9, 57–62.
14. Smith, J.C., and L.D. Newsom. 1970. The biology of *Amblyseius fallacies* (Acarina: Phytoseiidae) at various temperature and photoperiod regions. Ann. Entomol. Soc. America 63, 460–462.
15. Snedecor, G.W. and W.G. Cochran. 1982. Statistical Methods.7thEdition, Iowa State University, Press Ames, USA.
16. Yousef, A.E.T.A., A.H. El-Keifer and A.M. Metawally. 1982. On the effect of temperature and photoperiod on the development, nutrition and oviposition of the predatory mite, *Amblyseius swirskii* Athias–Henriot (Acari: Gamasida: Phytoseiidae). Anzeiger fur Schadlingskunde Pflanzenschutz Umweltschutz 55, 107–109.

تأثير درجات الحرارة على التطور والخصوبة ومعدل الافتراس للمفترس الأكاروسى *Amblyseius cydnodactylon* (Shehata & Zaher) (أكارى:فايتوسيدى)

نبيل عبد الله عمر[1] و أميرة الدسوقى مصباح[2]

١. *كلية التكنولوجيا والتنمية – جامعة الزقازيق– مصر*
٢. *معهد بحوث وقاية النباتات– الدقى – مصر*

أثبتت الدراسات المعملية أن المفترس الأكاروسى *Amblyseius cydnodactylon* (Shehata & Zaher) *له* قدرة وفاعلية فى القضاء على الحلم النباتى التغذية *Petrobia tritici* (Kandeel, EL-Naggar&Mohamed) والذى يعتبر آفة خطيرة تصيب القمح فى الحقل وذلك عند دراسة تأثير درجات الحرارة المختلفة ٢٠،٢٥، ٣٠ ،٣٥°م و رطوبة نسبية ٧٠±٥%على المفترس الأكاروسى. اتضح من النتائج أن فترة النمو زادت عندما تقل درجة الحرارة بينما فترة الخصوبة وفترة طول العمر وفترة حياة المفترس الأكاروسى كانت أطول عند درجة حرارة ٢٥°م وقلت عند درجة حرارة ٣٥°م.عندما تقل فترة النمو تزداد الخصوبة وكذلك فترة طول العمر حيث تعتبر درجة حرارة ٢٥°م الأفضل لتطور المفترس الأكاروسى على الرغم من أن درجة الحرارة ٣٥°م كانت الأقل.

أظهرت نتائج معدل الافتراس وجود فروق معنوية عند دراسة تأثير درجة الحرارة على مراحل التطور والخصوبة للمفترس. وقد لوحظ أن اليرقة لا تتغذى خلال فترة التجربة وأن المفترسى يبدأ فى التغذية بمجرد دخوله فى مرحلة الحورية الأولى والثانية. معدل التغذية للحورية الاولى والثانية كان بنفس المعدل تقريبا حيث زاد مع زيادة الحرارة من ٢٠ الى ٢٥°م ، وعندئذ قل المعدل عند ٣٠°م وأخيرا زادت مرة اخرى عند ٣٥°م.

تم تسجيل أعلى قيم لمعدل الافتراس الكلى للإناث خلال فترة وضع البيض حيث تم استهلاك ١٠٣،١٨٩.٣، ١٠٩، ٧٩ فريسة عند التغذية على درجات حرارة ٢٠، ٣٥,٣٠،٢٥°م على التوالى. كانت القيم الأعلى والأقل لمتوسط معدل الافتراس للإناث فى فترة ما بعد وضع البيض ٦.٤ فريسة عند ٢٥°م بينما كانت ٢.١ فريسة عند ٢٠°م على التوالى. سجل أعلى معدل لاستهلاك الفرائس خلال فترة الجيل ٢٠١.٩ فريسة عند ٢٥°م والتى انخفضت حتى وصلت الى ١١٦.٦ و ١١٠.٨و٨٦.٩ فريسة عند درجات حرارة ٣٠و٢٠ و٣٥°م على التوالى .