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Article

Development and reproduction of *Amblyseius largoensis* (Acari: Phytoseiidae) feeding on two eriophyoid mites

Shimaa F. Fahim*  and Amira A. Abdel-Khalek 

Pests and Plant Protection Department, National Research Centre (NRC), El-Buhouth Street, Dokki, Cairo, Egypt; E-mails: shimaa_fahiim@yahoo.com, amira_afifi777@hotmail.com

* Corresponding author

ABSTRACT

Amblyseius largoensis (Muma) is an important phytoseiid mite. The biological and life table parameters of *A. largoensis* preyed on two eriophyoid mites, *Aceria ficus* (Cotte) or *Rhyncaphytoptus ficifoliae* Keifer, were evaluated under laboratory conditions. In the present study, this predator was reared on two plant species (*Acalypha wilkesiana* Muell. and *Ficus carica* L.) and provided with *A. ficus* or *R. ficifoliae* as prey. Results showed that *A. largoensis* failed to complete its development on *F. carica* leaves and its individuals couldn't reach the adult stage. In contrast, *A. largoensis* successfully completed its development and reproduced when reared on *A. wilkesiana* leaves and fed on *A. ficus* or *R. ficifoliae*. The pre-adult development of *A. largoensis* reared on *A. wilkesiana* leaves preyed on *A. ficus* (7.70 days) was faster than for those preyed on *R. ficifoliae* (8.95 days). Females fed on *A. ficus* showed higher number of oviposition days compared with those preyed on *R. ficifoliae*. Adult longevity was shorter for *A. largoensis* individuals fed on *R. ficifoliae* (22.20 days), but longer for those fed on *A. ficus* (26.35 days). Fecundity of *A. largoensis* females fed on *A. ficus* (25.00 eggs/female) was higher than that of those fed on *R. ficifoliae* (18.40 eggs/female). *Amblyseius largoensis* fed on *A. ficus* displayed better performance in terms of its population parameters, as proved by its higher values of intrinsic rate of increase (r) (0.193 day^{-1}), finite rate of increase (λ) (1.213 day^{-1}), and net reproductive rate (R_0) (20.000 offspring) as compared to feeding on *R. ficifoliae* ($r = 0.164 \text{ day}^{-1}$, $\lambda = 1.178 \text{ day}^{-1}$, and $R_0 = 14.720$ offspring). Although *F. carica* leaves seemed to be an unsuitable surface for the development of *A. largoensis*, the current results suggested that this phytoseiid may be promising in the control of other eriophyoid mite pests.

KEY WORDS: *Aceria ficus*; fig mite pests; life table parameters; phytoseiid mites; *Rhyncaphytoptus ficifoliae*.

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INTRODUCTION

Amblyseius largoensis (Muma) (Acari: Phytoseiidae) is a cosmopolitan predatory mite that is naturally present in several tropical and subtropical countries on a great range of plants (de Moraes *et al.* 2004). It is frequently inhabits many fruit crops (Argolo *et al.* 2020). It is a generalist phytoseiid species (type III) (McMurtry *et al.* 2013) that can feed on various phytophagous mites such as tetranychid (Carrillo *et al.* 2010; Abdel-Khalek and Fahim 2018), tarsonemid (Morell *et al.* 2010), eriophyid (Melo *et al.* 2015), and tenuipalpid mites (Argolo *et al.* 2020; Lira *et al.* 2021), as well as other arthropods (Luh and Croft 2001; de Alfaia *et al.* 2018).

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Members of the superfamily Eriophyoidea are tiny phytophagous mites that can significantly reduce the production of crops (Lindquist *et al.* 1996). Eriophyoids are documented as the second greatest economically important Acari pests following the tetranychids (van Leeuwen *et al.* 2010). Mites of Diptilomiopidae and Eriophyidae families exist on trees, herbaceous plants, and shrubs causing heavy damages to buds, fruits, and leaves (Zaher 1986; Ripka 2008).

Fig (*Ficus carica* L.) is considered as an important fruit that is used commercially in many food industries (Darjazi 2011). The fig trees are attacked by many pests (Halawa 2017). *Aceria ficus* (Cotte) (Acari: Eriophyidae) is the main phytophagous mite infesting fig trees (Abo-Taka *et al.* 2014). It is very injurious because it not only harms the fig tree by feeding (Abou-Awad *et al.* 2000b), but also a vector of fig mosaic virus disease (Caglayan *et al.* 2012). *Rhyncaphytoptus ficifoliae* Keifer (Acari: Diptilomiopidae) is one of the important fig pests (Louni *et al.* 2014) attacking fig leaves (Ramezani *et al.* 2006). In severe infestation, this species causes browning symptoms on the fig leaves (Delfan *et al.* 2014).

Chemical acaricides have been extensively used for controlling mite pests on fig trees in Egypt. Bahiraei *et al.* (2019) mentioned that high populations of fig mites still existed on fig trees, even with using the acaricides. However, the broad usage of pesticides is expensive and can cause resistance in addition to their negative impact on non-target organisms (Andrade *et al.* 2019; Bergeron and Schmidt-Jeffris 2020), environment and human beings (Hoy and Ouyang 1986; Momen *et al.* 2014). Therefore, it is vital to use alternative and effective strategies to control eriophyoid fig mites. In many agro-ecosystems, the biological control methods are environmental and economic alternatives to the chemical control techniques (van Lenteren and Bueno 2003). In this regard, phytoseiid mites are the most important predators utilized in biological control of various arthropod pests (Calvo *et al.* 2011; Knapp *et al.* 2018).

Eriophyoids have long been documented as prey of various phytoseiids (Lindquist *et al.* 1996). Although a number of researchers studied the biological aspects of some phytoseiids feeding on eriophyoids (Momen and Abdel-Khalek 2008; Louni *et al.* 2014; Halawa 2017), no information is available regarding the life table characteristics of *A. largoensis* when fed on eriophyoid fig mites (namely, *A. ficus* and *R. ficifoliae*). Nonetheless, the development and reproduction of phytoseiids may vary in response to the different cultivars or species of host plants (Zhang *et al.* 2016; Fahim and El-Saiedy 2021). Depending on the species of predators and host plants, leaf hairs may have positive (Loughner *et al.* 2008) or negative impact on predatory mite species (Stavriniades and Skirvin 2003; Schmidt 2014). Based on that, the present study aimed to determine the biological and life table parameters of *A. largoensis* when reared on two plant species (*Acalypha wilkesiana* Muell. and *F. carica*) and preyed on *A. ficus* and *R. ficifoliae*. Thus, studying life table features of predatory mites is necessary to evaluate their potential use in biological control strategies (McMurtry *et al.* 2013).

MATERIALS AND METHODS

Predatory mite

Individuals of *A. largoensis* were originally collected from debris under fig trees in orchards at Qalyubia Governorate, Egypt. Colonies of *A. largoensis* were maintained separately on *A. ficus* and *R. ficifoliae* in the laboratory using the rearing units. Each rearing unit consisted of an *A. wilkesiana* leaf placed on a water saturated cotton layer put inside the center of a Petri dish, leaving a space provided with water. Wet cotton strips surrounded the edge of the leaf to prevent mites from escaping. Water was added regularly to keep the cotton wet. The rearing units were kept in an incubator at 28 ± 1 °C, $75 \pm 5\%$ RH and 16L: 8D photoperiod.

Prey mites

In the present study, *A. ficus* and *R. ficifoliae* were used as food sources for *A. largoensis*. Due to the difficulty of keeping colonies of eriophyoids, small pieces of fig leaves heavily infested with

A. ficus or *R. ficifoliae* were directly introduced to leaf units once daily to feed *A. largoensis*. These tested eriophyoids were collected during 2021 from infested fig trees in orchards at Qalyubia Governorate, Egypt.

Experiments

In these experiments, the biological and life table parameters of *A. largoensis* were evaluated when reared on two plant species (*A. wilkesiana* and *F. carica*) and preyed either on *A. ficus* or on *R. ficifoliae*. The experimental units consisted of *A. wilkesiana* or *F. carica* leaf discs placed on wet cotton pads in Petri dishes, separately. Wet cotton strips surrounded the leaf discs edges to prevent mites from escaping. The experimental units were kept in an incubator at 28 ± 1 °C, $75 \pm 5\%$ RH and 16L: 8D photoperiod.

For each plant, each *A. largoensis* individual was provided daily with surplus amount of food as follows: 100–120 active stages of *A. ficus* or 50–70 active stages of *R. ficifoliae* (more than that consumed daily). One small piece of fig leaf heavily infested with *A. ficus* or *R. ficifoliae* was directly introduced to each experimental unit allocated for *A. ficus* or *R. ficifoliae*, respectively to feed *A. largoensis*. For each prey, each small piece of fig leaf was replaced once daily with a new one to ensure there was enough food. For each prey species, mated females (2–3 days old) of *A. largoensis* were transferred to new leaf units and left to oviposit for 12 h, then the females were removed. Forty newly laid eggs (0–12 h) were transferred individually to the experimental units and inspected twice daily in order to determine the durations of immature stages of predatory mite on each plant species in the case of each prey. After adult emergence, each predatory female (for each prey) was paired with an adult male. The mated females of *A. largoensis* were observed twice daily to determine their longevity, female reproductive periods and number of eggs/female. However, all adult individuals of *A. largoensis* were inspected twice daily until their death. For both prey, the number of *A. largoensis* individuals (replications) subjected to the statistical analysis in the case of *A. wilkesiana* and *F. carica* were 25 and 20, respectively.

Statistical analysis

The obtained data of *A. largoensis* were analyzed according to the age-stage, two-sex life table theory (Chi and Liu 1985) and the method of Chi (1988) using the TWOSEX-MSChart program (Chi 2017). The age-stage specific survival rate (s_{xj}) (where x = age and j = stage), the age-stage specific fecundity (f_{xj}), the age-specific survival rate (l_x), the age-specific fecundity (m_x), the age-stage specific life expectancy (e_{xj}), and the age-stage specific reproductive value (v_{xj}) were calculated. In addition, the population growth parameters including the intrinsic rate of increase (r), the net reproductive rate (R_0), the gross reproduction rate (GRR), the finite rate of increase (λ), and the mean generation time (T) were estimated consequently. The means and standard errors of the durations of developmental stages, adult pre-oviposition period (APOP), total pre-oviposition period (TPOP), oviposition days, fecundity and longevity of *A. largoensis* in addition to the population parameters (r , λ , R_0 , T , and GRR) were estimated by the Bootstrap procedure with 100000 re-sampling using the TWOSEX-MSChart program (Chi 2017); and the means were compared by the Paired Bootstrap test (Huang and Chi 2013).

RESULTS

Development, longevity, and fecundity of *Amblyseius largoensis*

The results showed that *A. largoensis* failed to complete its development on *F. carica* leaves and the predator cannot reach to the adult stage (Table 1). In contrast, *A. largoensis* successfully completed its development and reproduced when reared on *A. wilkesiana* leaves and fed on *A. ficus* or *R. ficifoliae* (Table 1). The pre-adult development of *A. largoensis* reared on *A. wilkesiana* leaves

was statistically faster for individuals preyed on *A. ficus* than for those preyed on *R. ficifoliae* (Table 1).

Table 1. Developmental periods (days) of *Amblyseius largoensis* reared on two plant species (*Acalypha wilkesiana* and *Ficus carica*) and fed on *Aceria ficus* and *Rhyncaphytoptus ficifoliae*.

Parameters	Plant species			
	<i>A. wilkesiana</i>		<i>F. carica</i>	
	<i>A. ficus</i>	<i>R. ficifoliae</i>	<i>A. ficus</i>	<i>R. ficifoliae</i>
Egg	2.00 ± 0.00b	2.30 ± 0.11a	2.45 ± 0.11a	2.35 ± 0.11b
Larva	1.00 ± 0.00b	1.40 ± 0.11a	1.35 ± 0.11a	1.00 ± 0.00b
Protonymph	2.30 ± 0.11b	2.55 ± 0.11a	2.30 ± 0.11a	2.00 ± 0.00b
Deutonymph	2.40 ± 0.11b	2.70 ± 0.11a	1.30 ± 0.11b	1.40 ± 0.11a
Pre-adult	7.70 ± 0.18b	8.95 ± 0.18a	-	-

Means in each row for each plant species followed by different letters are statistically different ($P < 0.05$; Paired Bootstrap test with 100000 re-sampling).

Table 2. Longevity (days) and fecundity of *Amblyseius largoensis* reared on *Acalypha wilkesiana* and fed on *Aceria ficus* and *Rhyncaphytoptus ficifoliae*.

Parameters	eriophyoid mites	
	<i>A. ficus</i>	<i>R. ficifoliae</i>
APOP (days)	1.45 ± 0.11b	1.70 ± 0.11a
TPOP (days)	9.15 ± 0.22b	10.65 ± 0.18a
Oviposition days	18.80 ± 0.22a	14.4 ± 0.21b
Adult female (days)	26.35 ± 0.29a	22.20 ± 0.30b
Total fecundity (eggs/female)	25.00 ± 0.26a	18.40 ± 0.37b
Life span (days)	34.05 ± 0.34a	31.15 ± 0.41b

Means in each row followed by different letters are statistically different ($P < 0.05$; Paired Bootstrap test with 100000 re-sampling).

The tested diets significantly affected the adult pre-oviposition (APOP), and total pre-oviposition periods (TPOP) of *A. largoensis* (all $P < 0.05$) (Table 2). Females fed on *A. ficus* showed a significantly higher number of oviposition days compared with those preyed on *R. ficifoliae* ($P < 0.05$). The adult longevity was shorter for *A. largoensis* females fed on *R. ficifoliae* (22.20 days), but significantly longer for those fed on *A. ficus* (26.35 days; $P < 0.05$). Life span of *A. largoensis* was also influenced by the diet type, in which individuals fed on *A. ficus* lived statistically longer (34.05 days) compared with those preyed on *R. ficifoliae* (31.15 days; $P < 0.05$). Fecundity of *A. largoensis* females fed on *A. ficus* (25.00 eggs/female) was significantly higher than that of those fed on *R. ficifoliae* (18.40 eggs/female; $P < 0.05$) (Table 2).

The age-stage, two-sex life table

The age-stage specific survival rate (s_{xj}) of *A. largoensis* reared on *A. wilkesiana* leaves (the probability that a newly laid egg of *A. largoensis* will survive to age x and stage j) was showed for each prey in Figure 1. As a result of the differences in developmental rates of *A. largoensis* individuals, an overlapping among different predator stages was observed. The maximum probability that a newborn egg of *A. largoensis* survived to adult stage was 0.80 for females and 0.20 for males for both prey.

The age-stage-specific fecundity (f_{xj}), age-specific fecundity (m_x), and age-specific survivorship (l_x) of *A. largoensis* reared on *A. wilkesiana* leaves, feeding on *A. ficus* and *R. ficifoliae* are shown in Figure 2. The f_{xj} of *A. largoensis* displays the number of eggs oviopsited by *A. largoensis* individuals of age x and stage j /day. Presently, the f_{xj} peaks occurred on the 11th day for *A. ficus* (1.80 eggs/day),

and on the 12th day for *R. ficifoliae* (1.70 eggs/day). However, the first egg deposition occurred at the ages of 8 and 9 days for *A. largoensis* fed on *A. ficus* and *R. ficifoliae*, respectively.

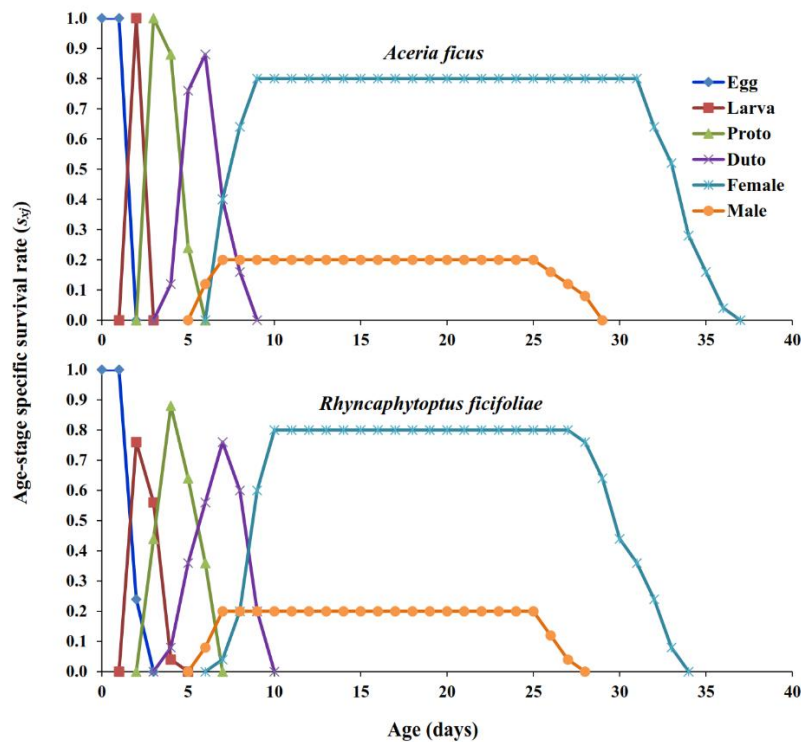


Figure 1. Age-stage specific survival rates (s_{xj}) of *Amblyseius largoensis* reared on *Acalypha wilkesiana* and fed on *Aceria ficus* and *Rhyncaphytoptus ficifoliae*.

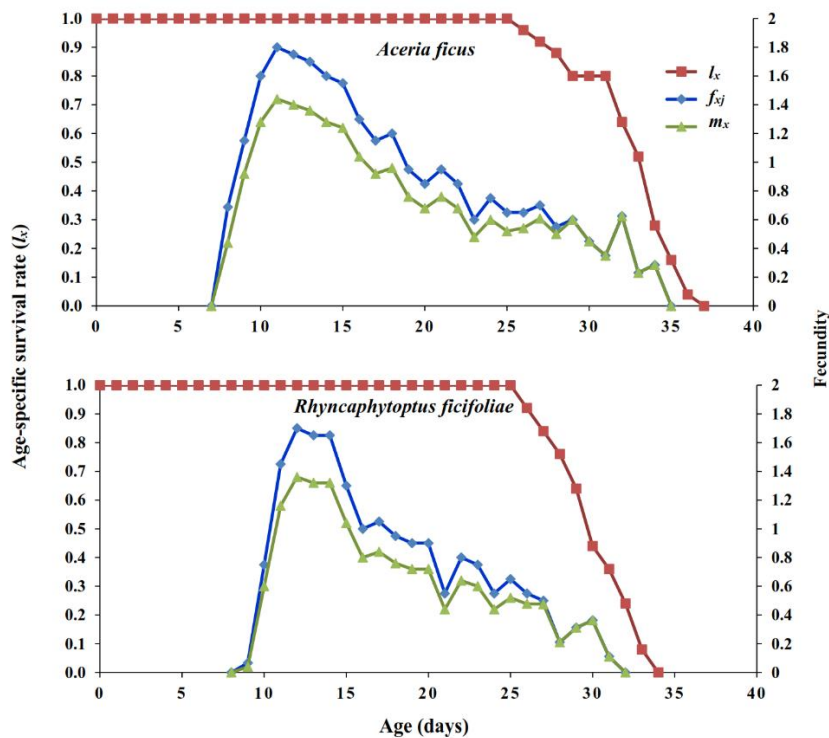


Figure 2. Age-specific survival rate (l_x), age-stage specific fecundity (f_{xj}), and age-specific fecundity (m_x) of *Amblyseius largoensis* reared on *Acalypha wilkesiana* and fed on *Aceria ficus* and *Rhyncaphytoptus ficifoliae*.

Age-stage specific reproductive value (v_{xj}) of *A. largoensis* reared on *A. wilkesiana* leaves, feeding on *A. ficus*, and *R. ficifoliae* are shown in Figure 3. The v_{xj} of *A. largoensis* presents the contribution of *A. largoensis* individuals of age x and stage j to the future population. The highest v_{xj} of *A. largoensis* occurred at the age of 10 and 11 days for *A. ficus* and *R. ficifoliae*, respectively. The abovementioned days displayed the age at which *A. largoensis* females showed the greatest contribution to future offspring when they fed on *A. ficus* and *R. ficifoliae*, respectively.

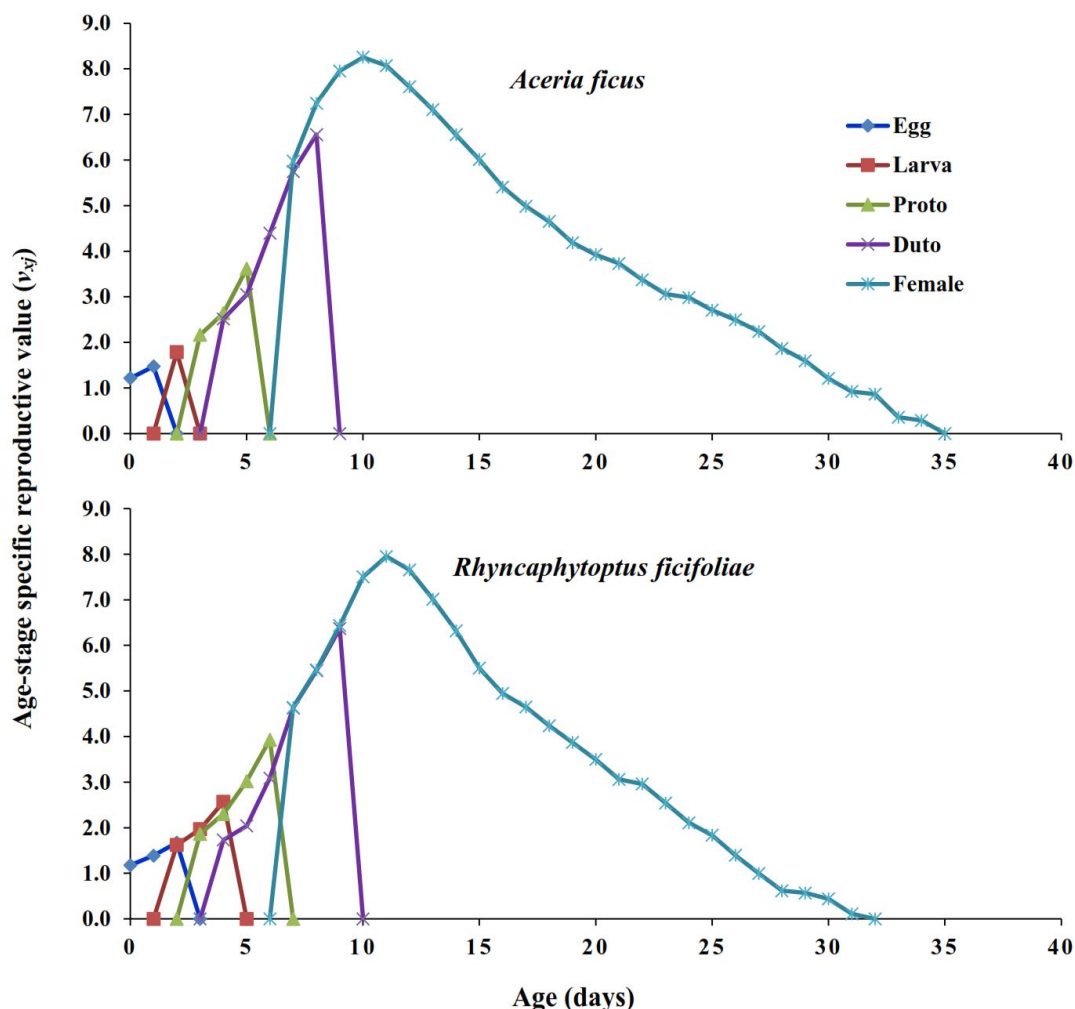


Figure 3. Age-stage specific reproductive value (v_{xj}) of *Amblyseius largoensis* reared on *Acalypha wilkesiana* and fed on *Aceria ficus* and *Rhyncaphytoptus ficifoliae*.

Table 3. Life table parameters (Mean \pm SE) of *Amblyseius largoensis* reared on *Acalypha wilkesiana* and fed on *Aceria ficus* and *Rhyncaphytoptus ficifoliae*.

Life table parameters	eriphyoid mites	
	<i>A. ficus</i>	<i>R. ficifoliae</i>
Intrinsic rate of increase (r)	0.193 \pm 0.008a	0.164 \pm 0.006b
Finite rate of increase (λ)	1.213 \pm 0.010a	1.178 \pm 0.008 b
Net reproductive rate (R_0)	20.000 \pm 2.020a	14.720 \pm 1.401b
Mean generation time (T)	15.514 \pm 0.251b	16.437 \pm 0.230a
Gross reproductive rate (GRR)	20.950 \pm 1.768a	15.270 \pm 1.315b

Means in each row followed by different letters are statistically different ($P < 0.05$; Paired Bootstrap test with 100000 re-sampling).

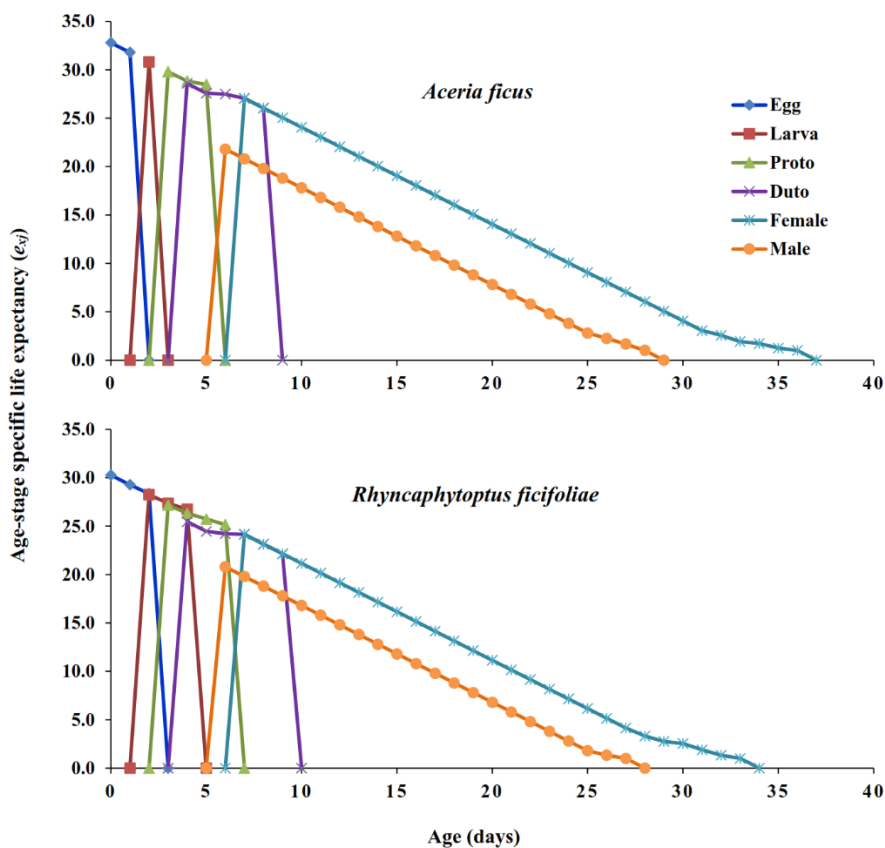


Figure 4. Age-stage specific life expectancy (e_{xj}) of *Amblyseius largoensis* reared on *Acalypha wilkesiana* and fed on *Aceria ficus* and *Rhyncaphytoptus ficifoliae*.

Age-stage specific life expectancy (e_{xj}) of *A. largoensis* reared on *A. wilkesiana* leaves, feeding on *A. ficus* and *R. ficifoliae* were exhibited in Figure 4. The e_{xj} of *A. largoensis* presented the expected length of time that *A. largoensis* individual of age x and stage j will survive. The highest e_{xj} of *A. largoensis* female was 27.05 days for *A. ficus* and 24.15 days for *R. ficifoliae*. In addition, the maximum e_{xj} of *A. largoensis* male were 21.80 days for *A. ficus* and 20.80 days for *R. ficifoliae*.

Population growth parameters

Amblyseius largoensis reared on *A. wilkesiana* leaves and fed on *A. ficus* displayed better performance in terms of its population parameters (Table 3), as proved by its statistically higher values of intrinsic rate of increase (r), finite rate of increase (λ), net reproductive rate (R_0), and gross reproductive rate (GRR) as compared to feeding on *R. ficifoliae*. In addition, the mean generation time (T) of *A. largoensis* was significantly longer in the case of feeding on *R. ficifoliae* than on *A. ficus* (Table 3).

DISCUSSION

Phytoseiids are very important predatory mites due to their impact on biological control of various mite and insect pests infesting several plant species (Mandape and Shukla 2017). However, phytoseiids appear to be sensitive to the structures of plant leaf surface (Walter 1996; Romero and Benson 2005). In the present study, *A. largoensis* can develop and reproduce when reared on *A. wilkesiana* leaves, but failed to complete its development on *F. carica* leaves. However, leaf surfaces

of *F. carica* are more hairy compared to *A. wilkesiana* leaves. In this context, the dense hairy fig leaves as rearing substrate were found to be negatively affecting development and reproduction of phytoseiids as compared to the smooth glabrous leaves of other plants (Saber and Momen 2005; Zaher *et al.* 2007). Also, previous studies displayed that the higher density of leaf hairs had negative impact on population growth of the predatory mites (Rezaie *et al.* 2017; Fahim and El-Saiedy 2021). Herein, the hairs of fig leaves may impede the different activities of immature stages of *A. largoensis* as well as causing physical stress especially for the larger immature stage (deutonymphs) of this predator. However, increasing the density of leaf hairs predominantly hampered tiny arthropods walking (Sato *et al.* 2011); which subsequently can reduce the predation rate and movement speed of phytoseiid mites (Krips *et al.* 1999); and adversely influence the predator development.

Plant leaf hairs may have an impact on behavior (Kreiter *et al.* 2002), population growth (Rezaie *et al.* 2017; Fahim and El-Saiedy 2021), and existence of predatory mites on host plants (Krips *et al.* 1999). In our study, *A. largoensis* was originally collected from the debris under the fig trees. So, the dispersal of predatory mites from the neighboring fruit trees in the same orchard may explain the occurrence of *A. largoensis* under the fig trees although it is not a suitable host plant for this predator. It is known that predatory mite species can disperse by the wind, walking (Jung and Croft 2001), and agricultural practices (Tixier 2018).

Both the tested eriophyoids, *A. ficus* and *R. ficifoliae*, commonly infest fig trees in Egypt (Abou El-Saad and Salem 2011; Halawa 2017). Presently, *A. largoensis* can successfully develop and reproduce when fed on *A. ficus* and *R. ficifoliae*. Similarly, *Amblyseius swirskii* Athias-Henriot and *Phytoseius finitimus* (Ribaga) (Acari: Phytoseiidae) can feed and develop when reared on these fig eriophyoids (Abou-Awad *et al.* 2000a; Abou-Awad *et al.* 2018). In our study, *A. largoensis* presented longer pre-adult development than that reported for the same predator preyed on *Raoiella indica* Hirst (Acari: Tenuipalpidae) (Galvao *et al.* 2007; Carrillo *et al.* 2010; Domingos *et al.* 2013), *Tetranychus gloveri* Banks (Acari: Tetranychidae) (Carrillo *et al.* 2010), and *Aleurodicus cocois* (Curtis) (Hemiptera: Aleurodidae) (de Alfaia *et al.* 2018). The pre-adult duration of the phytoseiid mites *Cydnoseius negevi* (Swirski and Amitai), *A. swirskii*, and *Neoseiulus californicus* (McGregor) fed on *A. ficus* (Abou-Awad *et al.* 1998; Abou-Awad *et al.* 2000a; Halawa 2017) was longer than the present results against the same prey. When *R. ficifoliae* was introduced as prey, pre-adult development of *A. swirskii* (Abou-Awad *et al.* 2000a) and *N. californicus* (Halawa 2017) were longer than that reported for *Euseius scutalis* (Athias-Henriot) (Momen and Abdel-Khalek 2008), *P. plumifer* (Louni *et al.* 2014), and *A. largoensis* (the present study).

Adult longevity of *A. largoensis* was relatively comparable when preyed either on *A. ficus* in the current study or on *R. indica* (Galvao *et al.* 2007). Nonetheless, shorter longevity was reported for *A. largoensis* when offered other diets such as *T. gloveri* (Carrillo *et al.* 2010) and *A. cocois* (de Alfaia *et al.* 2018). Longevity of *A. swirskii* and *N. californicus* when fed on *A. ficus* (Abou-Awad *et al.* 2000a; Halawa 2017) was shorter than that reported for *E. scutalis* (Momen and Abdel-Khalek 2008) and *A. largoensis* (the present study) against the same prey. Herein, the longevity of *A. largoensis* fed on *R. ficifoliae* was close to that determined by Momen and Abdel-Khalek (2008) for *E. scutalis* against this eriophyoid prey. However, longer longevity was reported for *A. swirskii* (Abou-Awad *et al.* 2000a) and *P. plumifer* (Louni *et al.* 2014) against *R. ficifoliae*. According to Carrillo *et al.* (2010), total oviposition of *A. largoensis* females fed on *R. indica* and *T. gloveri* was lower than our results against *A. ficus*. Presently, total fecundity of *A. largoensis* fed on *A. ficus* and *R. ficifoliae* were found to be lower than that reported for other phytoseiids preying on the same mites, including *A. swirskii* (Abou-Awad *et al.* 2000a), *E. scutalis* (Momen and Abdel-Khalek 2008), and *N. californicus* (Halawa 2017).

The intrinsic rate of increase (r) and net reproductive rate (R_0) are important population parameters describing the growth and reproduction potential of mite populations. Our results obviously showed that both eriophyoid mites are suitable food sources for *A. largoensis*, resulting in higher values of r and R_0 than that attained by a diet of *R. indica* ($r = 0.127 \text{ day}^{-1}$ and $R_0 = 12.59$

offspring), and *T. gloveri* ($r = 0.102 \text{ day}^{-1}$ and $R_0 = 5.66$ offspring) (Carrillo *et al.* 2010). When *A. ficus* was used as prey, a lower r value was recorded for *A. swirskii* as compared to the current results (Abou-Awad *et al.* 2000a). In our study, *A. largoensis* fed on *R. ficifoliae* showed a higher r value compared to other phytoseiids fed on the same prey e.g., *A. swirskii* (Abou-Awad *et al.* 2000a), and *P. plumifer* (Louni *et al.* 2014). As compared to our findings regarding *R. ficifoliae*, Momen and Abdel-Khalek (2008) reported higher r and lower R_0 values for *E. scutalis* preyed on this prey ($r = 0.216 \text{ day}^{-1}$ and $R_0 = 12.023$ offspring). Herein, the λ and T values of *A. largoensis* reared on both eriophyoids were higher than those reported by de Alfaia *et al.* (2018) for the same predator fed on *A. coccois*.

The lower r -value of the mite population are owing to the longer generation time and the lower R_0 value of this population (Fahim *et al.* 2020). This may explain the lower r value of *A. largoensis* population when preyed on *R. ficifoliae* comparing with feeding on *A. ficus*. Based on our results, it can be suggested that *R. ficifoliae* prey was less favorable as food source for *A. largoensis* population growth compared to *A. ficus*. Our results supported the previous studies which suggested that *A. ficus* is a good food source for some phytoseiids including *C. negevi* (Abou-Awad *et al.* 1998), *A. swirskii* (Abou-Awad *et al.* 2000a), and *P. finitimus* (Abou-Awad *et al.* 2018). However, although the current results showed that fig leaves seemed to be unsuitable surfaces for the development of *A. largoensis*, the above discussed findings suggested that this phytoseiid may be a promising predator for controlling the eriophyoid mites.

CONCLUSION

The current study could help in providing a better understanding of probability and efficiency of utilizing *A. largoensis* in the control of the eriophyoid pests. Presently, *A. largoensis* can successfully develop and reproduce when reared on *A. wilkesiana* leaves and fed on *A. ficus* or *R. ficifoliae*, but it failed to complete its development on *F. carica* leaves. Since this predator is unable to live on the fig leaves, it cannot be used to control the tested fig pests. Therefore, further investigations should be performed to study the ability of this predator to control other eriophyoid mite pests inhabiting other host plants. In addition, more work must be done on other predatory mites to determine their potential in the management of the tested fig mite pests.

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رشد و تولیدمثل *Amblyseius largoensis* (Acari: Phytoseiidae) با تغذیه از دو کنه اریوفیوئید

شیماف. فهیم* و أمیره عبدالمنعم عبدالخالق

گروه آفات و حفاظت از گیاهان، مرکز پژوهش‌های ملی (NRC)، خیابان البوحوث، دوکی، قاهره، مصر؛ رایانامه‌ها: amira_afifi777@hotmail.com shimaa_fahiim@yahoo.com

* نویسنده مسئول

چکیده

گونه *Amblyseius largoensis* (Muma) کنه گیاهی مهمی است. آماره‌های زیستی و جدول زندگی *A. largoensis* با تغذیه از دو کنه اریوفیوئید، *Aceria ficus* (Cotte) یا *Rhyncaphytoptus ficifoliae* Keifer، در شرایط آزمایشگاهی مورد ارزیابی قرار گرفت. در بررسی حاضر، این شکارگر روی دو گونه گیاهی (*Ficus carica* L. و *Acalypha wilkesiana* Muell.) یا *A. ficus* یا *R. ficifoliae* پرورش داده شد. نتایج نشان داد که *A. largoensis* نتوانست رشد خود را روی برگ *F. carica* کامل کند و افراد آن نمی‌توانند به مرحله کامل برسند. در مقابل، *A. largoensis* رشد خود را زمانی که روی برگ‌های *A. wilkesiana* پرورش یافت با موفقیت تکمیل کرد و وقتی با *A. ficus* یا *R. ficifoliae* تغذیه شد، تکثیر کرد. رشد پیش از بلوغ *A. largoensis* پرورش یافته بر روی برگ‌های *A. wilkesiana* تغذیه شده با *A. ficus* (۷/۷۰ روز) سریع‌تر از آنهایی بود که با *R. ficifoliae* (۸/۹۵ روز) تغذیه شده بودند. ماده‌های تغذیه شده با *A. ficus* تعداد روزهای تخمگذاری بیشتری را در مقایسه با شکار *R. ficifoliae* نشان دادند. طول عمر بزرگسالان برای افراد *A. largoensis* که از *R. ficifoliae* تغذیه شده بودند (۲۲/۲۰ روز) کوتاه‌تر بود، اما برای افرادی که از *A. ficus* تغذیه می‌شدند (۲۶/۳۵ روز) طولانی‌تر بود. باروری ماده‌های *A. largoensis* تغذیه شده از *A. ficus* (۲۵۰۰ تخم در ماده) بیشتر از آنهایی بود که از *R. ficifoliae* (۱۸۴۰ تخم در ماده) تغذیه شده بودند. کنه *Amblyseius largoensis* تغذیه شده با *A. ficus* عملکرد بهتری را از نظر آماره‌های جمعیتی خود نشان داد، همانطور که با مقادیر بیشتر میزان ذاتی افزایش (r) (۰/۱۹۳ در روز)، نرخ منتهای افزایش (λ) (۱/۲۱۳ در روز) و نرخ خالص تولید مثل (R_0) (۲۰۰۰۰ زاده) در مقایسه با تغذیه با *R. ficifoliae* ($r = 0.164$ در روز، $\lambda = 1.178$ در روز، و $R_0 = 14.720$ زاده) ثابت شد. اگرچه برگ‌های *F. carica* سطح نامناسبی برای رشد *A. largoensis* به نظر می‌رسید، نتایج کنونی نشان می‌دهد که این فیتوزئید ممکن است در مهار دیگر کنه‌های اریوفیوئید آفت امیدوارکننده باشد.

واژگان کلیدی: *Aceria ficus*؛ کنه‌های آفت انجیر؛ آماره‌های جدول زندگی؛ کنه‌های فیتوزئید؛ *Rhyncaphytoptus ficifoliae*

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