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Plant Pollen as an Alternative Food Source for Rearing *Euseius scutalis* (Acari: Phytoseiidae) in Hail, Saudi Arabia

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ABSTRACT

Four kinds of plant pollen were tested as an alternative food source for rearing the predatory mite *Euseius scutalis* (Athias-Henriot) under laboratory conditions of 26°C and 70%RH. Pollen grains were extracted from date palm *Pheonyx dactylefira* L., sour orange *Citrus aurantium* L., castor bean *Ricinus communis* L. and alfalfa *Medicago sativa* L. Individuals of the predatory mite were collected from leaves of eggplant in Hail district during spring 2010. Mite individuals were provided and reared on the aforementioned pollens for their whole life span. Total developmental period significantly affected by kind of pollen. Date palm pollen highly shortened the development followed by alfalfa, citrus and castor bean. Feeding on date palm pollen caused the highest rate of survival (94%) and gradually declined to 92, 90 and 89% when mites were provided with citrus, alfalfa and castor bean pollen, respectively. During adulthood, female deposited 42.62, 30.22, 21.16 and 13.46 eggs in approximately 12.42, 10.82, 9.44 and 7.22 days when fed date palm, alfalfa, castor bean and citrus pollen, respectively. Mean generation time (T) averaged 17.19, 17.86, 19.08 and 20.47 days; net reproductive rate (R_0) 34.93, 30.81, 15.59 and 18.51 female/female/day; intrinsic rate of natural increase (r_m) 0.20, 0.192, 0.134 and 0.153; finite rate of increase e^{rm} (λ) 1.22, 1.21, 1.14 and 1.15 when mites fed the same kinds of pollen, respectively. The tested plant pollen is considered a suitable alternative food source and meet the nutritional requirements of *E. scutalis* in Hail, Saudi Arabia.

Key words: Biology, *Euseius scuatlis*, plant pollen, life table parameters

INTRODUCTION

Understanding how natural enemies utilize plant-based food resources is useful in population and community studies as it could help biologists in explaining why predator populations persist or become extinct during prey scarcity and the extent to which this affects biological pest control (Fouly, 1997; Van Baalen *et al*., 2001; Emmert *et al*., 2008; Fouly *et al*., 2011). Beneficial mites of the family phytoseiidae are known to have diverse dietary regimes-some species feed, develop and reproduce only on phytophagous mites and others live on various pollens, plant fluids, honeydew, artificial diets, etc. (Ochieng *et al*., 1987; Yue *et al*., 1994; Fouly *et al*., 1995; Al-Shammery, 2010). Based on their diet breadth, phytoseiid mites can be classified into several groups, ranging from specialist to generalist (Zhang and Croft, 1994; McMurtry and Croft, 1997; Luh and Croft, 2001). The role of specialist and generalist predators in the control of herbivorous arthropod populations has been reviewed extensively (Schausberger and Walzer, 2001).

In other words, obligatory predators (specialists) such as *Phytoseiulus persimilis* Athias-Henriot and *Galendromus helveolus* (Chant) living only on spider mites of the family Tetranychidae (Caceres and Childers, 1991; Fouly *et al*., 1995; McMurtry and Croft, 1997; Al-Shammery, 2010;

Fouly *et al.,* 2011). On the other hand, the persistence of generalist predatory mites on plants with a scarcity or absence of prey is a requirement for successful biocontrol strategies of herbivore mites. These mites feed not only on plant feeding mites but they have also the ability to feed on other sources of food and reproduce more rapidly on a wide range of plant pollens (Abou-Setta and Childers, 1987; Yue *et al.,* 1994; Fouly, 1997; Gnanvossou *et al.,* 2005; Emmert *et al.,* 2008; Fouly *et al.,* 2011). Therefore, certain plant pollens have been easily used for mass-rearing phytoseiids in the laboratory for experimental purposes or field release. McMurtry and Croft (1997) evaluated feeding and oviposition of *Euseius hibisci* (Chant) on 14 different plant pollens, while Shakaya *et al.* (2009) studied the effect of strawberry pollen on the development, survivorship and reproduction of *Neoseiulus cucumeris* and found that it may be an alternative food source for the predatory mite. Moreover, Fouly (1997) studied the effect of date palm pollen *Pheonyx dactylefira* L. on different biological aspects of the phytoseiid mite *Proprioseiopsis asetus* (Chant) and found that it had life table parameters feeding on the two-spotted mite *Tetranychus urticae* Koch as good as on pollen and much better than feeding on the citrus brown mite *Eutetranychus orientalis* (Klein) or broad mite *Polyphagotarsonemus latus*. Nomikou *et al.* (2001) proved that *Neoseiulus barkeri* Hughes, *Typhlodromips swirskii* (Athias-Henriot), *Typhlodromus athiasae* (Porath and Swirskii) and *E. scutalis* (A.-H.) can survive and reproduce on a diet of broad bean pollen.

In previous studies in Kingdom of Saudi Arabia, Fouly and AL-Rehyiani (2011) recorded *E. scutalis* on eggplant leaves for the first time, while Al-Shammery (2010) evaluated the effect of three tetranychid mites as preys on different biological aspects of *E. scutalis* under laboratory conditions. Biology and life tables of *Typhlodromips swirskii* (A.H.) fed on whitefly *Bemicia tabaci* (Genn.) were also studied (Fouly *et al.,* 2011). The ultimate objective of the present study to understand how differential utilization of plant-based food might have affected the establishment and persistence of *E. scutalis* in Hail, Saudi Arabia. Therefore, this study aims to determine the suitability of four different plant pollen in meeting the nutritional requirements of the predatory mite *E. scutalis* to know if it could use such alternative food sources, available in the same environment in Saudi Arabia and that may promote mite persistence even the natural prey is scarce.

MATERIALS AND METHODS

All experiments were conducted in the laboratory at College of Science (Girl's Sections), Hail University, Saudi Arabia during summer period in 2010.

Collection and preparation of Pollen: Pollen of four plant species growing in Hail were used, date palm *Pheonyx dactylefira* L., citrus (sour orange) *Citrus aurantium* L., castor bean *Ricinu communis* L. and alfalfa *Medicago sativa* L. Flowers of each of the tested plants were collected where pollen were collected by using a manual shaker to release the pollen and left for 3 h in an incubator at 35°C. Pollen grains were kept in small glass vials in a refrigerator until use.

Culture of *Euseius scutalis*: Predatory mite individuals were collected from eggplant leaves growing in a private farm at Hail province, KSA in 2010. A pure culture of the predatory mite was maintained on the two-spotted spider mite *T. urticae* as a prey and reared on eggplant leaves under laboratory conditions. Adult males and females of *E. scutalis* were left together where the deposited eggs were daily extracted for seven days and singly transferred into small discs of

eggplant leaves (2 cm in diameter) and limited with tangle foot of a mixture of Canada balsam, citronella oil and castor bean oil to prevent mites from escaping. Five of these discs were placed together on a layer of cotton wool soaked in water in a petridish (10 cm in diameter). Suitable moisture was daily maintained to the cotton layer. Eggs were left to hatch where the percentages of hatchability and incubation period were counted.

Approximately of 100 newly hatched larvae of nearly the same age were divided into four groups (treatments), twenty five larvae each, where they fed on citrus, alfalfa, castor bean and date palm pollen during their whole life span. Pollen grains were replaced by fresh pollen every three days in amount exceeding mite consumption.

Statistical analyses: Data was statistically analyzed by ANOVA test to compare means of each treatment (LSD test, where $p>0.05$). Duration of immature stages, mortality, sex ratio and total number of deposited eggs/females of *E. scutalis* were counted daily and used in calculation of life table parameters. Life table parameters of *E. scutalis* fed on four kinds of plant pollens were calculated according to Birch (1948) and by using the Basic Computer Program (Abou-Setta *et al.*, 1986) where the intrinsic rate of natural increase, r_m was estimated from the equation:

$$\Sigma e^{-r_m} l_x m_x = 1$$

where, x is the age in days, l_x the age-specific survival rate (proportion of females alive at age x) x (survival rate during the immature stage) X (hatchability%) and m_x the oviposition rate at age x {(age-specific oviposition) x (proportion of females)}. The net reproductive rate (R_0), is given as $R_0=\Sigma l_x m_x$. The mean generation time (T), in days, is given by $T = \ln R_O / r_m$. The hatchability and developmental rate at lab conditions of 26°C and 70% RH were used for l_x. The proportions of females (number of females/females+males) were used for calculating the m_x values.

RESULTS

Data in Table 1 showed that incubation period of *Euseius scutalis* eggs ranged from 1.66 to 2.12 days and from 1.46 to 1.64 days for female and male, respectively. As in other phytoseiid mites, it was clear that males completed their development before females, where total immature stages generally averaged 6.38 and 7.59 days for male and female at 26°C and 70% RH, respectively. It was also noticed that immature stages fed date palm and alfalfa pollen completed their development significantly in shorter time in comparison with those subjected to citrus and castor bean pollen. On the other hand, an approximately 94, 92, 90 and 89% of immature stages succeeded to reach adulthood as shown in Table 2. These results clearly showed that date palm was the most suitable pollen because of its acceleration the development and immature stages survivorship of *E. scutalis* and followed by citrus and alfalfa and castor bean pollen.

In adulthood, data in Table 2 proved that the differences between adult longevity and life span of female mites provided with any of plant pollen were not significant, while pollen significantly affected the duration of egg-laying time in which adult female laid its eggs. It was clear that date palm pollen had the most positive effect in prolongation of female oviposition period, where female mite lasted an average of 12.42, 10.82, 9.44 and 7.22 days, during which it laid an average of 42.62, 36.22, 28.16 and 26.46 eggs female, when it was provided with date palm, alfalfa, citrus and castor bean pollen, respectively. In other word, each female laid an average of 3.43, 2.79, 2.24 and 1.86 eggs per female per day when predatory mite female was subjected to the aforementioned

Table 1: Duration (in day) of immature stages of *Euseius scutalis* fed on four different plant pollen grains at 26°C and 70% RH

Stage	Sex	Citrus	Alfalfa	Castor bean	Date palm	LSD (p>0.05)
Egg	♀	1.82±0.07	1.66±0.02	2.12±0.03	1.84±0.04	--
	♂	1.64±0.06	1.54±0.01	1.62±0.01	1.46±0.05	--
Larva	♀	2.02±0.10	1.68±0.02	2.26±0.02	1.64±0.02	--
	♂	1.84±0.7	1.46±0.01	1.82±0.01	1.24±0.01	--
Protonymph	♀	2.62±0.24	2.46±0.24	2.86±0.02	2.26±0.02	0.48
	♂	2.26±0.21	1.94±0.84	2.56±0.02	1.62±0.02	0.62
Deutonymph	♀	3.26±0.34	2.84±0.34	3.82±0.03	2.64±0.04	0.84
	♂	2.84±0.25	2.46±0.26	3.24±0.03	2.26±0.06	0.64
Total	♀	7.90±1.05	6.98±1.06	8.94±1.10	6.54±1.08	1.22
	♂	6.94±1.02	5.86±1.02	7.62±1.11	5.12±1.05	1.16

Values are represented as Mean±SE

Table 2: Survivorship % (egg to adult), duration of female oviposition period (in day) of adult females of *Euseius scutalis* fed on four different plant pollen grains at 26°C and 70% RH

Biological aspect	Citrus	Alfalfa	Castor bean	Date palm	LSD (p>0.05)
No. mites	18	16	17	18	--
% survivorship (egg to adult)	92	90	89	94	--
Duration of oviposition period (days)	9.44±1.3	10.82±1.4	7.22±1.2	12.42±1.2	2.84
Total egg|female	21.16±3.2	30.22±4.2	13.46±3.6	42.62±4.8	6.42
Longevity♀	19.12±2.6	16.82±2.2	18.16±1.8	18.22±1.8	--
Life span ♀	28.84±3.4	25.46±2.8	26.88±2.8	26.60±2.6	--

Values are represented as Mean±SE

Table 3: Life table parameters of *Euseius scutalis* fed on four kinds of plant pollens at 26°C and 70% RH

	Pollen			
Life table parameters	Date palm	Castor bean	Alfalfa	Citrus
Proportion of females (sex ratio)	0.64	0.56	0.59	0.62
Mean generation time (days) (T)	17.19	20.47	19.08	17.86
Net reproductive rate (female egg/female) (R_0)	34.93	15.59	18.51	30.81
Intrinsic rate of natural increase (r_m)	0.206	0.134	0.153	0.192
Finite rate of increase e^{rm} (λ)	1.22	1.14	1.15	1.21

plant pollen, respectively. That means plant pollen had significant positive effect on not only the duration of oviposition period but also the egg production of *E. scutalis* (Table 2).

Studying the life table parameters of the predatory mite *E. scutalis* can support these findings. Table 3 showed that sex ratio was not affected by food source, where females percentages (females/females+males) averaged 62, 58, 56 and 64% when predatory mites were provided with citrus, alfalfa, castor bean and date palm pollen, respectively. These values were subsequently used in calculation the specific rate of fecundity (M_x). Survival curves (L_x) (Fig 1) of *E. scutalis* fed on the previously mentioned mite preys followed a type I in which most eggs developed to maturity (92, 90, 89 and 94% when they fed the aforementioned pollen, respectively) and most female death occurred gradually after extended ovipositional period. Table 3 also showed that date palm pollen is the most preferable tested food source because it caused a shorter mean generation time (T) of only 17.19 days, while it was prolonged when the predatory mite was subjected to citrus, alfalfa and castor bean pollen to reach 17.86, 19.08 and 20.47 days, respectively.

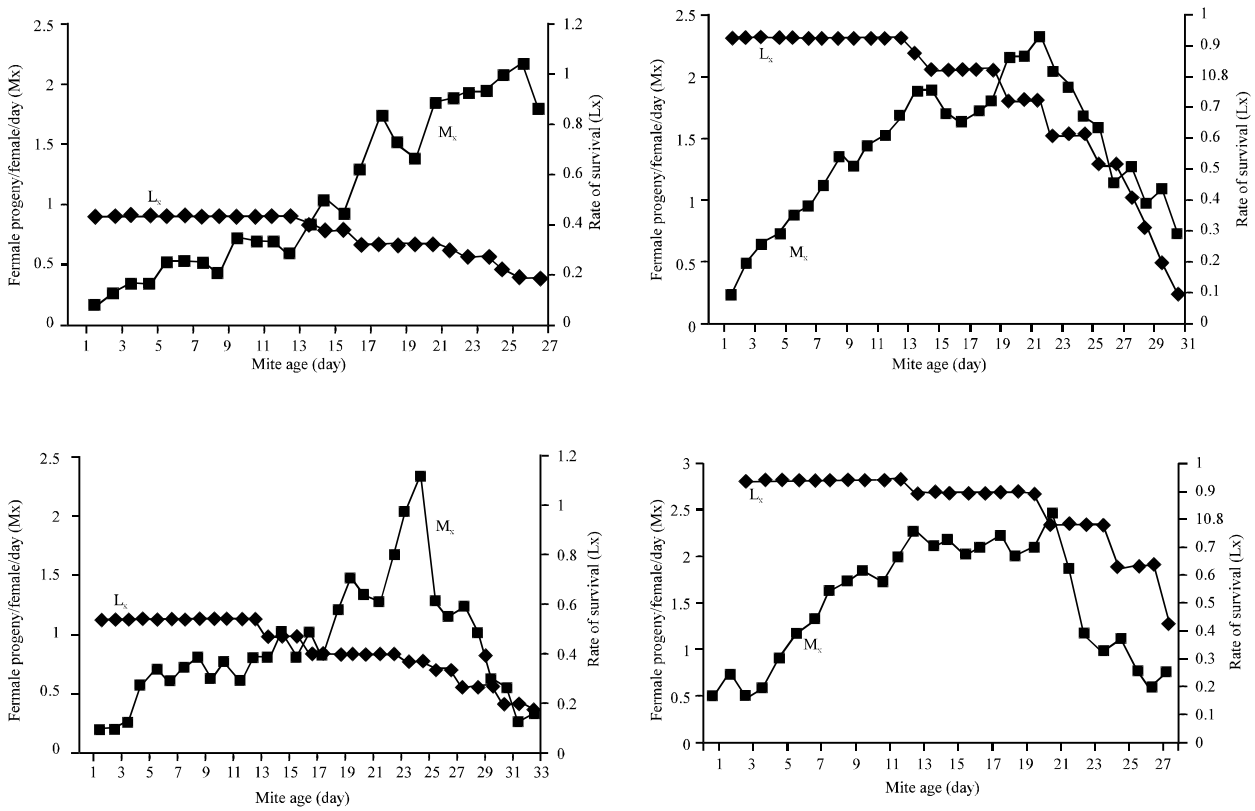

Fig. 1: Age-specific fecundity (M_x) and rate of survival (L_x) of *Euseius scutalis* fed on four different plant pollen grains at 26°C and 70% RH

From Table 2 and Fig. 1, it was clear that date palm pollen caused the highest value of net reproductive rates ($R_0 = \Sigma L_x M_x$) of 34.93 expected female daughters per female. These values slightly declined by feeding on citrus pollen (30.81) and sharply decreased to 18.51 and 15.59 female eggs/female when the predatory mite fed alfalfa and castor bean pollen, respectively. That means alfalfa or castor been pollen resulted in R_0 about 50-60% of that obtained by feeding on date palm or citrus pollen.

Concerning the intrinsic rate of increase (r_m) (female/female/day), tested plant pollen obviously affected the intrinsic rate of increase of *E. scutalis* where it was 0.206 female progeny/female/day when predatory mite fed date palm pollen and then declined to 0.192 while decreased sharply to reach 0.153 and 0.134 when mites fed citrus, alfalfa and castor bean pollen, respectively as shown in Table 3. It was also noticed that the finite rate of increase e^{rm} (λ) (population multiplications in a unit of time) was at its highest level (1.22) when *E. scutalis* individuals fed date palm pollen and slightly declined to 1.21 with citrus pollen. These values sharply decreased to 1.15 and 1.14 after feeding on alfalfa and castor bean pollen, respectively (Table 3).

DISCUSSION

Life history of *Euseius scutalis*: The present results showed that immature stages of *E. scutalis* fed date palm and alfalfa pollen completed their development significantly in shorter time in comparison with those subjected to citrus and castor bean pollen. That means the tested phytoseiid

mite and may other phytoseiids, prefer plant pollen over others. Similarly, Abou-Setta *et al.* (1986) found that ice plant pollen *Malephora crocea* (Jacq.) was much preferred than Spanish needle pollen *Bidens pilosa* L. offered to *E. mesembrinus* (Dean) under laboratory conditions. Contradictory, Gnanvossou *et al.* (2005) found that *Neoseiulus idaeus* Denmark and Muma didn't complete development (hence no reproduction occurred) when it was fed upon pollens of corn *Zea mays* L., *Leuena leucoephala* (Lam) and castor bean *R. communis*, while *Typhlodromalus aripo* De Leon successfully completed their development on pollen of castor bean. On the other hand, Nguyen and Shih (2010) found that the longevity of *Neoseiulus womersleyi* (Shicha) males and females feeding on *T. urticae, T. kanzawi* or maize pollen was longer than the longevity when they were subjected to *Oligonychus mangiferus, P. citri* or loofah pollen. They also found that *E. ovalis* (Evanz) feeding on *O. mangiferus, T. urticae* or maize pollen lived longer than those feeding on *T. kanzawi, P. citri* of loofah pollen. Therefore, it can be concluded that prey consumption or feeding preference of a generalist phytoseiid mite might be dependant mainly on predator species and kind of pollen.

An approximately 94, 92, 90 and 89% of immature stages succeeded to reach adulthood. These results showed that date palm again was the most suitable pollen because of its acceleration the development and immature stages survivorship of *E. scutalis* and followed by citrus and alfalfa and castor bean pollen. These results agree with those of Fouly (1997) who mentioned that 90 to 95% of eggs of the phytoseiid mite *Proprioseiopsis asetus* (Chant) fed on date pollen of *Frankliniella occidentalis* and *Thrips palmi* hatched and 75 to 95% of hatched larvae developed to adults. These results are not incorporated with those of Villanueva and Childers (2007) who obtained lower survival value (36%) of larvae of *Iphiseiodes quadripilis* (Banks) and then increased to 48, 60 and 68% after feeding on spider mite *P. citri, Eutetranychus banksi*, ice plant and oak pollen, respectively. They mentioned that the reason of the lower survival rates may be the webbing produced by citrus spider mite *P. citri* seemed to inhibit foraging behavior of *I. quadripilis* larvae and nymphs. Fouly *et al.* (2011) also noticed that the survivorship of immature stages ranged from 87 to 92% when *Typhlodromips swirskii* fed eggs of whitefly, *Bemicia tabaci*. Moreover, Al-Shammery (2010) confirmed the present observations where she found that feeding on *T. urticae, E. orientalis* and *O. afrasiaticus* caused similar survival values of an average of 92, 9 and 91%, of *E. scutalis* kept at the same environmental conditions, respectively. On the other hand, all immature stages including larvae were observed feeding on different kinds of pollen. Larval feeding behavior was extensively discussed by Zhang and Croft (1994), Fouly *et al.* (2011) who stated that phytoseiid larvae can be divided into three categories: non-feeding larvae, facultative feeding larvae and obligatory feeding larvae. Therefore, larvae of *E. scutalis* can be considered as facultative feeders. The evolution of larval feeding probably due to the relative size of eggs (ratio of egg size to the size of active larval stage) as well as the morphology of chelicerae. Furthermore, this hypothesis should be tested for most phytoseiid mites by morphological analyses of the chelicerae and size of larvae.

In adulthood, data showed that, although there were no significant differences between duration of adult longevity and life span of female mites subjected to the four tested pollens, while pollen kind significantly affected the duration of oviposition period. It was clear that date palm pollen had the most positive effect in prolongation this period and followed by alfalfa, citrus and castor bean pollen. Moreover, plant pollen had significant positive effects on not only the duration of oviposition period but also the egg production of *E. scutalis*. Comparing the present data with those obtained by Al-Shammery (2010), it is clear that feeding on immature stages of *T. urticae*

significantly prolonged the oviposition period (18.6 days) as compared with date palm pollen (12.42 days). While date palm pollen caused a higher egg production where each female laid an average of 42.62 eggs as compared with 30.66 eggs when the food was immature stages of the two-spotted spider mite. There are many researches proved that the prey feeding capacity of a predatory mite may decrease in the presence of alternative food sources such as pollen but it may also accompany by a considerable increase in oviposiotion and fertility. Fouly (1997) found that even the overall average of 58.8% reduction in prey consumption of *P. asetus* in the presence of date palm pollen was accompanied by 79.3% increase in fecundity. Even though prey consumption could be decreased when pollen is available, but higher reproductive capacity induced by pollen feeding should result in a higher predator density, thus increasing the total number of prey attacked by the predator. These results agree with those of McMurtry and Croft (1997) who mentioned that for some predatory mites, pollen feeding results in higher reproduction than preying upon spider mites.

On the other hand, the present data showed that *E. scutalis* achieved better results feeding on citrus pollen than on castor bean. Contradictory, Yue *et al.* (1994) found that pollen extracted from castor been accelerated and improved the fecundity of *E. mesembrinus* as compared with grape fruit(citrus) pollen *Citrus paradisi* L. On the other hand, some phytoseiids achieved successful development and reproduced normally on artificial diets. Therefore, Ochieng *et al.* (1987) obtained 25 generations of the phytoseiid mite *Amblyseius teke* Pritchard, after feeding on the artificial liquid diet ICD 286 based on commercial bee honey, milk powder, egg yolk, Wessons salt and water.

Life table parameters: The present results showed that sex ratio was not highly affected by food source, where females proportion (%) ranged from 56 to 64%. Similar values were obtained by Abou-Setta *et al.* (1997) who noticed that female proportions of *Proprioseiopsis rotendus* (Dean) ranged from 56-58% after feeding on different kinds of food. Also, Fouly (1997) found that female progeny of *P. asetus* presented only 52% in the first generation when fed on *E. orientalis*. These findings are not incorporated with those obtained by Fouly *et al.* (2011) who found that female proportions of *T. swirskii* fed a diet of whitefly eggs exceeded 70% from the total populations in the next generation. In all cases, values of sex ratio were subsequently used in calculation the life table parameters. Survival curves (L_x) of *E. scutalis* followed a type I (Fig. 1), in which most eggs developed to maturity and most female death occurred gradually after extended oviposition period. On the other hand, data showed that date palm pollen shortened the mean generation time (T) (17.19 days), while it was prolonged when the predatory mite was subjected to citrus, alfalfa and castor bean pollen (17.86, 19.08 and 20.47 days), respectively. Equal generation time was obtained by El-Laithy and Fouly (1992), Van Rijn and Tanigoshi (1999), Kasap and Lu (2004) and Al-Shammery (2010) with *E. scutalis, Neoseiulus cucumeris, Iphesius degenrans* (Berlese) and *E. scutalis*, respectively.

Concerning the net reproductive rate (R_0), it was clear that date palm caused 34.93 expected female daughters per female, while it slightly declined by feeding on citrus pollen (30.81) and then sharply decreased to 18.51 and 15.59 female eggs/female for alfalfa and castor bean pollen. That means alfalfa or castor been pollen resulted in R_0 about 50-60% of that obtained by feeding on date palm or citrus pollen. These findings agree with those obtained by Van Rijn and Tanigoshi (1999) who found that *I. degenrans* had a R_0 value of 27.9 and 22.5 female/female after feeding on broad bean and castor bean pollens, respectively. The previous results don't agree with the findings of Kasap and Lu (2004) who found a lower net reproductive rate (R_0) of *E. scutalis* fed *P. citri* which averaged only 26.03. Also R_0 averaged 26.73, 13.24 and 13.60 when the predatory mite *E. scutalis*

fed immature stages of the three tetranychid mites *T. urticae, E. orientalis* and *O. afrasiaticus*, respectively (Al-Shammery, 2010). Furthermore, Momen and El-Sawi (2008) provided *E. scutalis* with eggs of two lepidopterous insects and achieved the lowest R_0 of *E. scutalis* ever seen in phytoseiid mites. R_0 averaged only 10.94 and 5.40 expected females/female after feeding on eggs of *Spodoptera littoralis* Boisduval and *Agrotis ipsilon* (Hufunagal), respectively.

Concerning the intrinsic rate of natural increase (r_m) (female/female/day), Birch (1948) stated that r_m is the rate of increase of an insect species under specific physical conditions, in unlimited environment where the effects of increasing density don't need to be considered. Accordingly, the tested plant pollen obviously affected the intrinsic rate of increase of *E. scutalis* where it was 0.206 female progeny/female/day when predatory mite fed date palm pollen and then declined to 0.192, while decreased sharply to reach 0.153 and 0.134 when mites fed citrus, alfalfa and castor bean pollen, respectively (Table 3). These findings are supported by those of Nomikou *et al.* (2001) also found that *E. scutalis* was able to survive and reproduce on a diet of broad bean pollen. They mentioned that the intrinsic rate of natural increase (r_m) of *E. scutalis* feeding on citrus red mite *P. citri* increased from 0.166 to 0.234 to 0.295 females/female/day as temperature increased. Moreover, Kasab (2005) noticed that *Kampimodromus aberrans* (Oudemans) was capable to feed, survive and reproduce on spider mites and pollen. It reached its highest r_m value (0.129 female/female/day) feeding on pollen extracted from birch plant (*Betula pendula*) and followed by 0.108 when it was offered *T. urticae* mite individuals. Contradicted results were obtained by Fouly (1997) who obtained a higher r_m value of *P. asetus* fed citrus brown mite E. *orienatlis* (0.28). Also, Steiner *et al.* (2003) obtained a higher r_m value for the Australian predatory mite *Typhlodromips montdorensis* (Schicha) of 0.32 when the predatory mite fed on cumbungi pollen (*Typha* sp.).

It was also noticed that the finite rate of increase e^{rm} (λ) (population multiplications in a unit of time) was at its highest level (1.22) when *E. scutalis* individuals fed date palm pollen and slightly declined to 1.21 with citrus pollen. These values sharply decreased to 1.15 and 1.14 after feeding on alfalfa and castor bean pollen, respectively. These findings incorporate with those of El-Laithy and Fouly (1992), Yue *et al.* (1994), Abou-Setta *et al.* (1997), Momen and El-Sawi (2008), Fouly *et al.* (2011) with *E. scutalis, E. mesembrinus, P. rotendus, E. scutalis* and *T. swirskii* who found that e^{rm} value ranged from 1.10 to 1.30, respectively.

The present study as well as the previous findings of Al-Shammery (2010) don't indicate a trade-off between feeding of *E. scutalis* on prey mites belonging to tetranychid mites and plant pollen. With webbing of tetranychids tested before, the performance of *E. scutalis* is obviously reduced and this may explain why in other studies reproduction and r_m-values are lower on *Tetranychus* prey than on pollen (Fouly, 1997; Van Rijn and Tanigoshi, 1999; Fouly *et al.,* 2011).

It is necessary to conclude that the ability of a predatory mite to feed on and profit from certain types of pollen may be as a result of the differences in morphological characteristics (e.g., feeding apparatus, sensory organs in mite individuals), physiology (digestive system) and behavior (e.g., feeding preferences). However, very limited information is known so far about this relationship. The studies by Flechtmann and McMurtry (1992a) showed some interesting directions, who mentioned that phytoseiid mites have especial behavior to pick up individual pollen grains, rupture the excise by their chelicerae and finally withdraw the grain content. Morphological studies of the chelicerae of 15 phytoseiid species (Flechtmann and McMurtry, 1992b) showed that only *Euseius* species, known as typical pollen feeders have a spoon-like structure on the lobe of the fixed digit. Moreover, these species show a wider deutosternal groove than other species. Functional explanations for these structures however are still needed.

In general, it can be concluded that date palm and alfalfa pollen are suitable alternative food sources for easy rearing of *E. scutalis* in laboratory to get the highest rate of survival, shortest developmental time and highest rate of egg production.

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