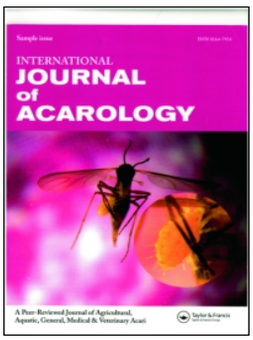

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PREY-STAGE PREFERENCE AND POPULATION INCREASE OF THE PREDACEOUS MITE *KAMPIMODROMUS ABERRANS* (OUDEMANS) (ACARI: PHYTOSEIIDAE) ON *TETRANYCHUS URTICAE* KOCH (ACARI: TETRANYCHIDAE) UNDER LABORATORY CONDITIONS

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ABSTRACT – The developmental time, survival, and fecundity of *Kampimodromus aberrans* (Oudemans) (Acari: Phytoseiidae) when feeding on *Tetranychus urticae* Koch (Acari: Tetranychidae) plus birch pollen were investigated at 16, 20, 25 and 30 ± 1°C, 65 ± 10% relative humidity, and 16:8 light:dark photoperiod in the laboratory. Also, the prey-stage preference of adult female *K. aberrans* was assessed at constant densities of different stages of *T. urticae* and *T. urticae* plus birch pollen. Experiments were carried out using bean leaf discs as substrate. Total developmental times of *K. aberrans* were 37.1, 26.6, 8.0, and 7.4 days for females and 32.1, 24.6, 7.4, and 7.3 days for males at 16, 20, 25, and 30 ± 1°C, respectively. The total egg production was highest (17.2 eggs) at 25°C, while the daily egg production was at its highest (1.1 eggs) at 30°C. The female longevity of *K. aberrans* was determined as 75.6, 58.8, 25.8, and 17.4 days at 16, 20, 25, and 30 ± 1°C, respectively. The development threshold of the eggs and pre-adult stages were 13.75 and 13.55°C for females, and 13.58 and 12.92°C for males, respectively. Total effective temperature was 33.78 and 112.35 degree-days for females and 33.44 and 113.63 for males. The mite had the highest intrinsic rate of increase, (r_m) 0.129 ♀/♀/day at 30°C, followed by 0.108 ♀/♀/day at 25°C and 0.034 ♀/♀/day at 20°C, while at 16°C, *K. aberrans* displayed the lowest r_m value (0.023 ♀/♀/day). In the prey-stage preference experiments, the adult female *K. aberrans* consumed significantly more prey larvae of *T. urticae* alone, but, when the predatory mite was offered *T. urticae* plus birch pollen, they consumed significantly more eggs.
Key words – Development, *Kampimodromus aberrans*, life table, predation, temperature.

INTRODUCTION

Predaceous mites are important natural enemies of several phytophagous mites and other pests of various crops and are known to play an important role in the natural control of these pests (Helle and Sabelis, 1985; Bounfour and McMurtry, 1987; McMurtry and Croft, 1997; Schausberger, 1997; Croft and Luh, 2004; Broufas *et al.*, 2007). Kasap and Çobanoğlu (2007) recorded the following nine species of Phytoseiidae on apple trees in Van province of the Eastern part of Turkey: *Kampimodromus aberrans* (Oudemans), *Euseius finlandicus* (Oudemans), *Neoseiulus* (*Amblyseius*) *agrestris* (Karg), *Typhlodromus cotoneastri* Wainstein, *Paraseiulus talbii* Athias-Henriot, *P. triporus* Chant and Yoshida-Shaul, *Typhlodromus* (*Anthoseius*) *kazachstanicus* Wainstein, and *Typhlodromus* (*Anthoseius*) *tranquillus* Livshitz and Kuznetsov. Among these species, *K. aberrans* was the most abundant predaceous mite and was commonly associated with *Tetranychus urticae* Koch and *Amphitetranychus viennensis* (Acari: Tetranychidae) in apple orchards. In Turkey, *K. aberrans* has been found on various species such as vines, walnuts, apple, pear, cherry, and hazelnut (Düzgüneş and Kılıç, 1983; Çobanoğlu, 1992; Ozman-Sullivan, 2006; Kasap *et al.*, 2008). This predaceous

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mite attacks not only phytophagous mites such as tetranychid and eriophyids, but also feeds readily on the pollen and extrafoliar exudates; also, this mite likes hairy leaves (McMurtry and Croft, 1997; Croft *et al*., 2004; Broufas *et al*., 2007). Hence, this species is characterized as a specialized pollen feeder (type III) and generalist predator (McMurtry and Croft, 1997; Croft *et al*., 2004; Broufas *et al*., 2007). This study was designed to gain insight into the potential capability of *K. aberrans* to control *T. urticae* on apple, as part of an integrated pest management program. The aims of the investigation were: (1) to measure the consumption rate of *K. aberrans* on different stages of the prey offered at constant densities, (2) to estimate the effect of pollen on the consumption rate of *K. aberrans*, and (3) to determine the effect of temperature on the development and reproductive performance of *K. aberrans* when feeding on *T. urticae* plus birch pollen under laboratory conditions.

MATERIALS AND METHODS

Mite cultures – The initial population of *K. aberrans* was collected from apple trees (*Malus domestica* Borkh.) in Van province, Turkey (38°25′ N, 43°16′ E). The stock culture of *K. aberrans* was maintained using all stages of *T. urticae* and birch pollen [*Betula pendula* Roth (Betulaceae)] settled on bean leaves in a rearing chamber (25 ± 2°C, 65 ± 10% relative humidity, and 16:8 h light:dark). Two bean leaves were placed upside-down on a layer of filter paper on a 2-cm deep distilled water-saturated polystyrene pad inside a 20 × 15 × 5 cm plastic box. Water was added daily to keep the filter paper and polystyrene pad wet and to cover the base of the box to prevent the escape of mites. A surplus of various stages of *T. urticae* was brushed daily onto the leaves using a soft brush and a funnel. Birch pollen (0.5–0.10 mg) was also provided as food for the predatory mites every other day. Leaves were renewed once a week. The predatory mites were reared for at least two consecutive generations before the experiments. The *T. urticae* used as prey were reared on bean plants (*Phaseolus vulgaris* L. cv Barbunia) under the same conditions.

Consumption experiments of *T. urticae* by *K. aberrans* – The observations were carried out on bean leaf discs (diameter 30 mm) throughout the experiments. Mature, but not senescing, bean leaves were used as experimental arenas. For each arena, the leaf disc was placed on a layer of filter paper on a distilled water-saturated polystyrene pad in a 100 × 15 mm Petri dish. All experiments were conducted at 25 ± 1°C, 65 ± 10% relative humidity, and 16:8 h (light:dark) photoperiod. Adult young females were used in all the experiments when they were 6 days old after preoviposition periods. Before each test, the predators were placed individually in Petri dishes and starved for 24 h. In the consumption experiments, the predators were offered a total 64 prey items, i.e. equal number (16) of newly emerged individual eggs, larvae, protonymphs, and deutonymphs of *T. urticae*. Then, each predator was allowed to feed on the prey items for a total of 24 h; at the end of this duration I estimated the number of prey individuals consumed per predator. In the *T. urticae* + birch pollen consumption tests, pollen grains (0.2–0.3 mg/leaf arena) were also provided for the predatory mites. Each leaf arena was replicated 20 times.

Influence of different temperatures on development – In the experiments, the observations were carried out on bean leaf discs. Mature, but not senescing, bean leaves were used as experimental arenas. For each arena, a leaf was placed ventral-side up on a layer of filter paper on a distilled water-saturated polystyrene pad in a 100 × 15 mm Petri dish. Each leaf was covered with filter paper that had a 40 mm diameter opening in the center as a barrier to prevent the escape of prey and predator. A surplus of various stages of *T. urticae* was brushed daily onto the leaf arenas using a soft brush and funnel. Pollen grains were also given to the predatory mites, and the bean leaves were renewed weekly. For the experiments, approximately 30 adult *K. aberrans* females from the stock culture were transferred to each arena for egg laying and removed after 12 h; eggs were placed one per arena for subsequent observations. Males that escaped from the leaf arena or died were replaced by new ones from the stock culture. Females that escaped from the leaf arena and happened to drown in the wet filter paper were excluded from data analysis. The developmental stages of immature *K. aberrans* were observed at 12-h intervals until they became adults. The presence of an exuvium was used as the criterion for successful molting to the next developmental stage. Egg incubation period, duration of protonymphal and deutonymphal stages, adult preoviposition, oviposition, and postoviposition periods, and the sex ratios, were recorded for each temperature treatment.

Life tables – Newly mated *K. aberrans* females were confined individually per leaf arena and were fed as described above. Eggs were collected daily and reared to the adult stage. Sex ratios were then determined visually. Observations were conducted on a daily basis. Life tables were constructed using the data collected on developmental and adult characteristics at 16, 20, 25 and 30 ± 1°C, 65 ± 10% relative humidity and 16:8 h (light:dark) photoperiod. The constant temperatures used in the experiments were chosen according to the average summer temperatures in Van province, Turkey, which may rise above 32°C in

summer and negatively affect the population development of *K. aberrans*.

Statistical analysis – Data on developmental time, longevity, fecundity, and prey consumption tests were analysed by one-way analysis of variance (ANOVA) followed by the Student–Newman–Keuls sequential test. The thermal threshold of the egg stage and the developmental time (egg to adult) were computed by employing a linear technique that uses growth rate (per day) data as the dependent variable and the temperature treatments as independent variables. The lower developmental threshold temperature was determined as the *x*-intercept of the linear equation and the degree-day (DD) requirements were determined as the inverse of the slope of the linear equation. Population growth rates at different temperatures were calculated by constructing life tables (Birch, 1948). Age-specific survival rates (l_x) and number of female offspring per female (m_x) for each age interval (x) were used for the life-table data. From these data, net reproductive rate (R_0 = ♀/♀/generation), intrinsic rate of natural increase (r_m = ♀/♀/day) and mean generation time [$T_0 + \ln(R_0/r)$, in days] were estimated (Laing, 1968). After r_m was computed for the original data (r_{all}) the differences in r_m values were tested for significance by estimating the variance using the jack-knife method which facilitated the calculation of the standard errors of r_m estimates. The jack-knife pseudo-value r_j was calculated for the n samples using the following equation (Sokal and Rohlf, 1981; Krebs, 1998): $r_j = n\ x\ r_{a11} - (n-1)\ x\ r_{i.}$ The mean values of $(n-1)$ jack-knife pseudo-values for the mean growth rate in each treatment were subjected to ANOVA followed by Student–Newman–Keuls sequential test. Each of the above mentioned analyses were conducted using SAS statistical software (SAS Institute, 1998).

RESULTS

Consumption of *T. urticae* by *K. aberrans* – The mean consumption rates of *K. aberrans* females differed between the various prey stages, but not between protonymphs and deutonymphs for both *T. urticae* alone (Table 1; $F_{3,76} = 21.57$; $P = 0.0001$) and *T. urticae* plus birch pollen experiments (Table 1; $F_{3,76} = 23.88$; $P = 0.0001$). The *K. aberrans* females consumed mostly larvae (7.15 items/day), followed by prey deutonymphs (4.40), protonymphs (4.20), and lastly eggs (2.85) when given *T. urticae* alone but consumed mostly eggs (5.10), followed by prey larvae (4.15), protonymphs (2.65), and deutonymphs (1.90) when given *T. urticae* plus birch pollen (Table 1). The consumption rate of *K. aberrans* was less in the *T. urticae* plus birch pollen experiments than in the *T. urticae* alone experiments, except for eggs (Table 1; t-test = 3.47; $P > 0.005$).

Influence of different temperature on development time of *K. aberrans* – The development time decreased as temperature increased from 16 to 30°C (Table 2; $F_{3,65} = 762.08$; $P = 0.0001$) but, there were no statistical differences between 25 and 30°C. The order of decrease in development time at different temperatures was the same for males and females (Table 2; $F_{3,39} = 550.72$; $P = 0.0001$). However, the overall development time of *K. aberrans* was shorter in males than in females. With the exception of larvae feeding at 25°C and the total development time at 16°C, differences were not significant (Table 2; $T_{31} = 3.25$;

Table 1. *Kampimodromus aberrans* consumption of immature stages of *Tetranychus urticae*: mean consumption (numbers of items per day) and proportion consumed (N_a/N_0; where N_a, prey number attacked per predator; N_0, initial prey number).

		T. urticae alone**		*T. urticae* plus birch pollen**		
	n	Mean ± SE*	N_a/N_0	Mean ± SE*	N_a/N_0	*T*-value
Egg	20	2.85 ± 0.36 a	0.178	5.10 ± 0.30 a	0.319	3.47
Larvae	20	7.15 ± 0.47 b	0.447	4.15 ± 0.38 b	0.259	3.60
Protonymph	20	4.20 ± 0.31 c	0.262	2.65 ± 0.26 c	0.165	2.75
Deutonymph	20	4.40 ± 0.39 c	0.275	1.90 ± 0.22 c	0.119	4.10
F ratio		21.57		23.88		

Notes: *n*, numbers of replicates included in analysis.
*Means in a column followed by same letter are not statistically different (Student–Newman–Keuls test $P \leq 0.05$).
**For both experiments (*T. urticae* alone and *T. urticae* plus birch pollen), within a row, all of the means are significantly different (t-test; $P > 0.005$).

Table 2. Duration in days of the various stages and reproductive rate of *Kampimodromus aberrans* at four different temperatures (mean ± SD).

	16 ± 1°C	20 ± 1°C	25 ± 1°C	30 ± 1°C	*F*-ratio
n					
♀	9	11	14	9	
♂	15	18	19	17	
Egg					
♀	9.8 ± 0.40 d	7.5 ± 0.27 c	2.7 ± 0.09 b	2.1 ± 0.03 a	323.87
♂	10.8 ± 0.35 c	7.7 ± 0.26 b	2.7 ± 0.11 a	2.1 ± 0.04 a	318.36
Larvae					
♀	2.1 ± 0.23 b	1.6 ± 0.15 b	0.8 ± 0.06 a*	0.8 ± 0.05 a	25.87
♂	2.6 ± 0.13 c	1.9 ± 0.10 b	1.0 ± 0.03 a*	0.8 ± 0.05 a	88.16
Protonymph					
♀	9.5 ± 0.66 c	7.2 ± 0.47 b	2.2 ± 0.19 a	2.5 ± 0.26 a	77.49
♂	10.5 ± 0.45 c	7.8 ± 0.52 b	2.1 ± 0.16 a	3.0 ± 0.23 a	116.88
Deutonymph					
♀	10.8 ± 0.45 c	8.2 ± 0.40 b	2.3 ± 0.19 a	2.0 ± 0.19 a	189.07
♂	13.3 ± 0.56 c	9.2 ± 0.35 b	2.2 ± 0.15 a	1.4 ± 0.21 a	278.30
Total Dev. T.					
♀	32.1 ± 0.76 c*	24.6 ± 0.70 b	7.4 ± 0.29 a	7.3 ± 0.32 a	550.72
♂	37.1 ± 0.69 c*	26.6 ± 0.71 b	8.0 ± 0.25 a	7.4 ± 0.30 a	762.08
N	12	14	14	17	
Preoviposition	17.1 ± 1.71 b	14.6 ± 1.27 b	4.5 ± 0.29 a	3.2 ± 0.24 a	51.16
Oviposition	48.1 ± 4.01 c	34.8 ± 3.22 b	18.4 ± 1.18 a	11.7 ± 1.10 a	42.99
Postoviposition	10.5 ± 1.41 b	9.4 ± 1.30 b	2.9 ± 0.38 a	2.5 ± 0.34 a	21.31
Total	75.6 ± 4.13 d	58.8 ± 3.79 c	25.8 ± 1.27 b	17.4 ± 1.14 a	100.67
Total fecundity	8.7 ± 0.78 c	10.4 ± 0.84 bc	17.2 ± 1.28 a	13.2 ± 1.30 b	10.25
Daily fecundity	0.2 ± 0.02 d	0.3 ± 0.04 c	1.0 ± 0.05 b	1.1 ± 0.03 a	135.46

Notes: *n*, numbers of replicates included in analysis; Total Dev. T, total development time (egg to adult).
Means in a row followed by the same letter are not statistically different (Student–Newman–Keuls test $P \leq 0.05$).
*For both sexes, within column, means are significantly different (*t*-test; $P < 0.005$).

$P > 0.003$). Linear regression analysis showed that development rates for the egg stage ($r_{[Te]}$) of *K. aberrans* increased linearly with an increase in temperature from 16 to 30°C. The theoretical lower developmental threshold of the egg stage was estimated to be 13.8°C for females and 13.6°C for males, and hatching required 33.8 degree-days for females and 33.4 degree-days for males. The overall developmental rate ($r_{[Tl]}$) of *K. aberrans* increased linearly with increases in temperature (Fig. 1). The theoretical lower development threshold was estimated to be 13.6°C for females and 12.9°C for males. Based on these developmental thresholds, complete development from egg to adult required 112.4 degree-days for females and 113.6 degree-days for males (Fig. 2).

The preoviposition period was longer at 16 and 20°C than at 25 and 30°C. There were no statistical differences in the durations of the preoviposition period between 25 and 30°C, and between 16 and 20°C (Table 2; $F_{3,53} = 51.15$; $P = 0.0001$). The oviposition period was longer at 16°C than at 20, 25, and 30°C. But, the oviposition periods at 25 and 30°C were not statistically different from each other (Table 2; $F_{3,53} = 42.99$; $P = 0.0001$). The postoviposition period was longer at 16 and 20°C than at 25 and 30°C (Table 2; $F_{3,53} = 21.309$; $P = 0.0001$). The shortest female longevity for *K. aberrans* was 17.4 days at 30°C, followed by 25.8 and 58.8 days at 25 and 20°C. It was longest at 16°C (Table 2; $F_{3,53} = 100.67$; $P < 0.0001$).

The mean total and daily fecundity of *K. aberrans* are given in Table 2. Mean total fecundities of *K. aberrans* were 8.7, 10.4, 17.2, and 13.2 eggs at 16, 20, 25 and 30°C, respectively. Mean total fecundity at 25°C was statistically different from those obtained at 16, 20, and 30°C (Table 2; $F_{3,53} = 10.24$; $P = 0.0001$). The daily fecundity of *K. aberrans* was

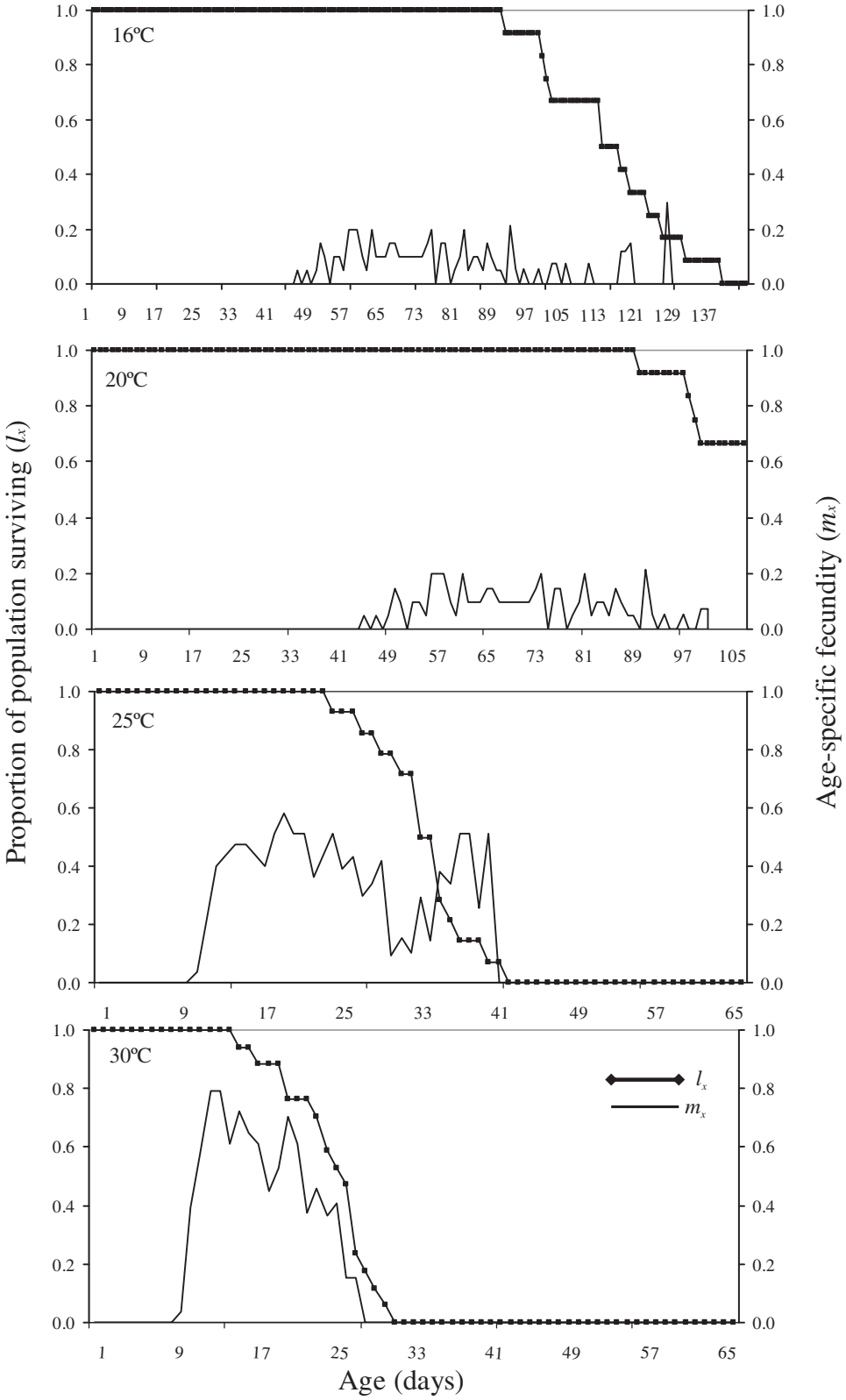

Fig. 1. Adult survival *(l_x)* and age-specific fecundity rate *(m_x)* of *Kampimodromus aberrans* at four different temperatures.

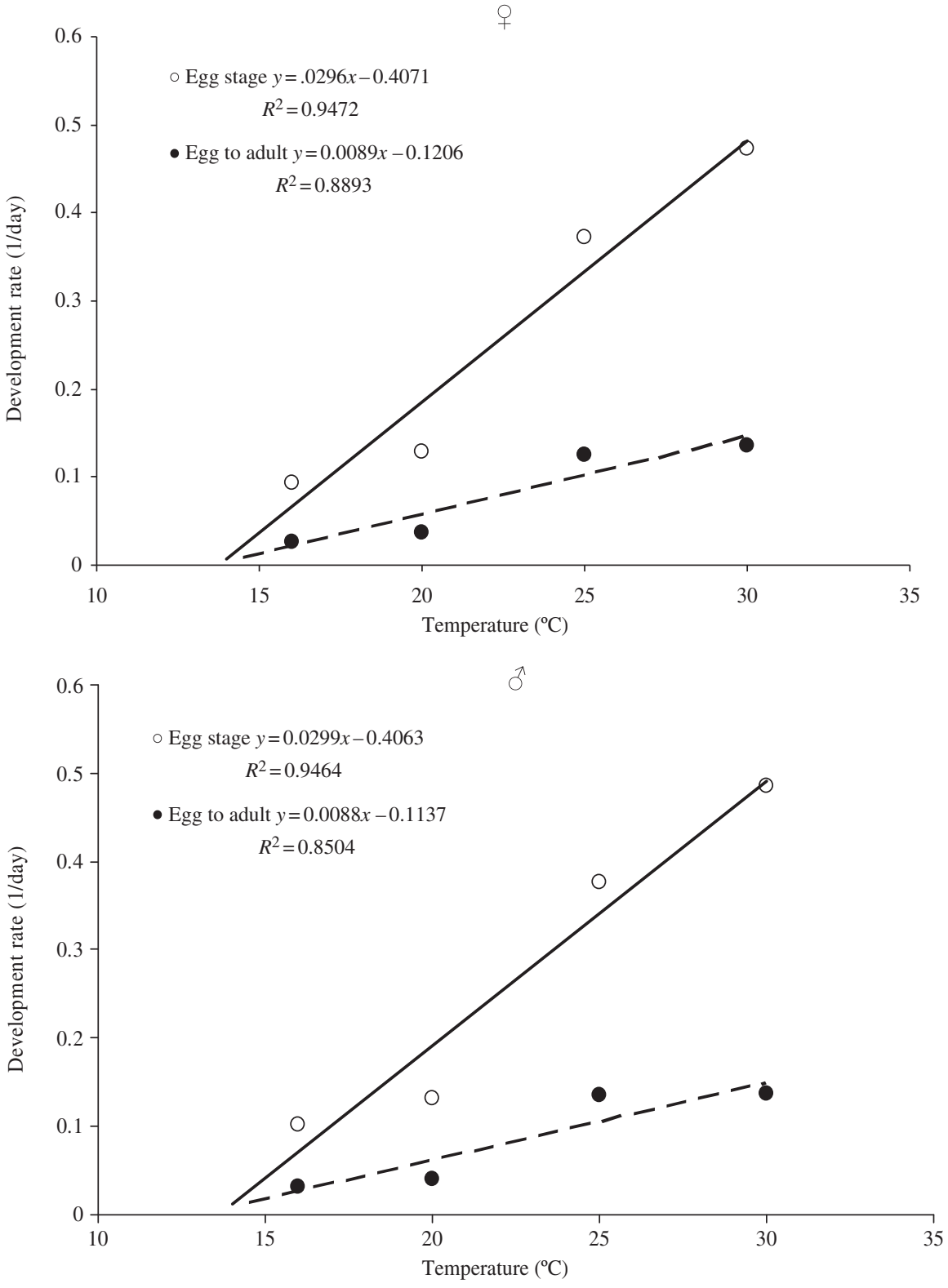

Fig. 2. Developmental rate of eggs $(r_{[Te]})$ and total developmental rate (eggs to adult) $(r_{[Tt]})$ of *Kampimodromus aberrans* (Females and Males). Lines represent linear regressions of developmental rates on temperature within the range of 16–30°C.

Table 3. Net reproductive rate (R_0), intrinsic rate of increase (r_m), generation time (T_0), doubling time (DT), and sex ratio of *Kampimodromus aberrans* at four temperatures (°C).

Temp. (°C)	Net reproductive rate (R_0) (female/female)	Intrinsic rate of increase (r_m) (female/female/day)	Generation time (T_0) (days)	Sex ratio (♀/(♀+♂))	Doubling time (DT) (days)
16 ± 1	5.11	0.023 ± 0.00012 d	69.68	0.60	30.14
20 ± 1	6.53	0.034 ± 0.00011 c	54.80	0.61	20.39
25 ± 1	8.78	0.108 ± 0.00017 b	20.12	0.51	6.42
30 ± 1	8.04	0.129 ± 0.00027 a	16.31	0.61	5.37
F ratio		71675.0			

Note: r_m values followed by different letters are significantly different within columns (Student–Newman–Keuls test $P \leq 0.05$).

lowest at 16°C and highest at 30°C (Table 2; $F_{3,163} = 135.46$; $P < 0.0001$). Daily egg production peaked on day 58 (0.20 eggs/♀/day), day 48 (0.36 eggs/♀/day), day 20 (0.58 eggs/♀/day), and day 13 (0.79 eggs/♀/day) at 16, 20, 25, and 30°C, respectively, and gradually decreased thereafter. However, the daily egg production at 16°C reached a similar peak several times during the ovipositional period (Fig. 2). The sex ratio (♀/(♀ + ♂)%) of *K. aberrans* was biased towards females and varied with temperature from 51 to 61% (Table 3).

Life tables – Life table data for *K. aberrans* at the four temperatures are shown in Table 3. The intrinsic rate of natural increase (r_m) of *K. aberrans* increased from 0.023 at 16°C to 0.034 at 20°C, 0.108 at 25°C, and 0.129 at 30°C. Differences in the intrinsic rates of natural increase at the four temperatures were statistically significant (Table 3; $F_{3,53} = 71{,}675.01$; $P < 0.0001$). Population doubling times were 30.14, 20.39, 6.42, and 5.37 days at 16, 20, 25, and 30°C, respectively (Table 3). The longest mean generation time (T_0) of *K. aberrans* occurred at 16°C and the shortest mean generation time of *K. aberrans* was recorded at 30°C (Table 3). The net reproductive rate (R_0) increased from 5.11 ♀/♀ at 16°C to 6.53 ♀/♀ at 20°C and 8.78 ♀/♀ at 25°C; however, it decreased to 8.04 ♀/♀ at 30°C (Table 3).

DISCUSSION

This study clearly shows the effect of temperature on development time, longevity, and fecundity of *K. aberrans.* Predatory mites performed best at 30°C, although the maximum total fecundity was achieved at 25°C. This was mainly the result of a short development time (7.4 days), high daily egg production (1.1 eggs), and early peak in reproduction (day 13). Since the r_m value is sensitive to changes in developmental time and an early peak in reproduction, the r_m value of *K. aberrans* was found to be highest at 30°C, for which the shortest development time and early peak in reproduction were obtained. Total developmental time of *K. aberrans* was shortened with increase in temperature for both sexes. These results are in agreement with those of Bounfour and McMurtry (1987), Rencken and Pringle (1998), Kazak *et al.* (2002), Gotoh *et al.* (2004), Kasap and Şekeroğlu (2004), Broufas *et al.* (2007). According to these results, the r_m value of *K. aberrans* was strongly affected by temperature from 16°C to a maximum at 30°C. Similar results have also been reported for a Greek population of *K. aberrans*. The r_m value increased from 0.04422 at 15°C to a maximum 0.157575 at 25°C, increasing gradually with temperature (Broufas *et al.*, 2007). Similarly, Kazak *et al.* (2002) stated that the r_m value of *Neoseiulus umbraticus* Chant feeding on *Tetranychus cinnabarinus* (Boisduval) increased from 0.123 at 20°C to 0.180 at 30°C. Gotoh *et al.* (2004) reported that the r_m value of *Neoseiulus* (*Amblyseius*) *californicus* (McGregor) feeding on *T. urticae* increased from 0.173 to 0.340 as temperature increased. Kasap and Şekeroğlu (2004) indicated that the intrinsic rate of natural increase of *Euseius scutalis* (Athias-Henriot) feeding on *Panonychus citri* (McGregor) increased from 0.166 to 0.234 to 0.295 ♀/♀/day at 20, 25, and 30°C, respectively.

There are few reports on the biology and life history traits of *K. aberrans* fed on different prey. When *K. aberrans* were fed on *Cecidophyopsis ribis* (Westwood) (Acari: Eriophyidae) they completed development in 7 days, and had an oviposition rate of 1.6 eggs/♀/day at 25 ± 1°C (Schausberger, 1992). Ozman-Sullivan (2006) reported that the mean developmental time of *K. aberrans* feeding on *Phytoptus avellana* Nal. (Phytoptidae) was 6.90 days for females and 7.10 days for males, and the female longevity and total fecundity of *K. aberrans* were 11.67 days and 12.67 eggs, respectively at 25 ± 1°C, 76% relative humidity, and 16:8 h light:dark under laboratory conditions. In the same study, the mean generation time (T_0), net reproductive

rate (R_0), and intrinsic rate of natural increase (r_m) of *K. aberrans* was 12.80 days, 7.09 ♀/generation, and 0.153 ♀/♀/day, respectively. These differences among the studies may be the result of variations in food or experimental condition, and to geographical differences among populations.

Adult female *K. aberrans* consumed significantly more *T. urticae* items in the no pollen experiments, except for eggs. Probably *K. aberrans* eats fewer *T. urticae* items in the presence of pollen because it prefers pollen to the *T. urticae*, like all generalist phytoseiid mites. Generalist phytoseiid mites have a higher reproduction rate when feeding on pollen in comparison to mite prey. For instance, Abdallah *et al.* (2001) reported that the intrinsic rate of increase (r_m) of *Euseius finlandicus* (Oudemans) was 0.110 on spider mites, 0.168 on pollen, and 0.153 per day on eriophyid mites. Kasap (2005) stated that the intrinsic rate of increase (r_m) of *K. aberrans* was higher on pollen than on spider mites. McMurtry and Scriven (1964) found a shorter development period and a higher reproduction rate of *Euseius hibisci* Chant on pollen in comparison to tetranychid mite.

This study indicated that the *K. aberrans* population exhibited a high capacity for population increase when fed all *T. urticae* stages, and so may be able to provide effective control of *T. urticae* in the field. However, *K. aberrans* is not a specialized predator of *T. urticae*, so to support this hypothesis field experiments are needed to investigate the effect of the *K. aberrans* population on *T. urticae* and other spider mite populations, either alone or in combination with other predatory mites.

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