

INFLUENCE OF TEMPERATURE ON THE LIFE-HISTORY PARAMETERS OF THE YELLOW GRAPE-VINE MITE *EOTETRANYCHUS CARPINI* (Oudemans) (ACARI: TETRANYCHIDAE)

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ABSTRACT - The life-history parameters of *Eotetranychus carpini* (Oudemans), a rarely studied species, were determined in the laboratory at five temperatures ranging from $15 \pm 0.5^{\circ}\text{C}$ to $30 \pm 0.5^{\circ}\text{C}$ (temperatures at the surface of the plant). Experiments were carried out in an air-conditioned room with relative humidity maintained at $60 \pm 10\%$, and a photoperiod of 16L/9D (illuminance 3,500 to 4,000 lx). The experimental conditions were monitored very precisely (thermocouple for temperature, electronic hygrometer for relative humidity, and a silicon detector for illuminance).

The total development time decreased from 28.4 days to 9.7 days as the temperature increased from 15.0 to 30.3°C . There was no significant difference between the development times at 26.0 and 30.3°C . The lower thermal threshold of development was calculated to be $7 \pm 1^{\circ}\text{C}$. Mean daily oviposition increased with temperature between 15.0 and 30.3°C . The maximum value of 3.2 eggs per day was obtained between 26.0 and 30.3°C . The intrinsic rate of natural increase (r_m), which ranged from 0.058 to 0.153, rose between 15.0 and 26.0°C and then decreased at 30.3°C . The maximum r_m value (0.153) was obtained at 26.0°C , which can be assumed to be approximately the optimum temperature for *E. carpini*.

INTRODUCTION

The phytophagous mite *Eotetranychus carpini* (Oudemans) is present in all the vineyards of southern Europe and North Africa. It poses serious problems to

found that temperatures of live leaf surfaces were not different from the ambient, but that temperature of detached leaves on wet substrates were always lower than the ambient. Depending on rearing techniques, the use of wet substrates may cause a temperature dif-

plants grown in pots in a greenhouse, and placed on water-soaked cotton. Mites were raised on the underside of the leaves.

Experimental conditions - Temperature was measured at the leaf surface in each experiment, using a thermocouple (copper-constantan) connected to a digital multimeter (Keithley No. 197) accurate to within a microvolt. We found noticeable differences between leaf surface and ambient temperatures. In the room at 15^o C, the ambient mean temperature (= a t) measured 1 cm above the leaf surface was 15.5 ± 1.3^o C and the leaf surface mean temperature (= l s t) 15.0 ± 0.6^o C. Similarly, in the room at 20^o C, a t was 20.6 ± 2.4^o C and l s t 19.8 ± 0.9^o C; in the room at 25^o C, a t was 23.0 ± 3.6^o C and l s t 22.7 ± 3.0^o C; in the room at 30^o C a t was 26.8 ± 1.5^o C and l s t 26.0 ± 1.0^o C; in the room at 35^o C, a t was 32.5 ± 2.0^o C and l s t 30.3 ± 2.0^o C. In this study we used the leaf surface mean temperature as indicated in the tables. All experiments were carried out in air-conditioned rooms with relative humidity regulated at 60 ± 10%, since this appears to favor mite growth (Bonato *et al.* in preparation). Lighting was provided by fluorescent tubes in a photoperiod of 16L/9D. The illuminance was 3,500 to 4,000 lx. This level was controlled using a silicon cell (MACAM SD 101 Q) connected to the multimeter and calibrated to the visible range.

Survival rate and development - Ten fertilized females from a breeding chamber were placed on leaf disks (4 cm²). After 1 hour, the leaf disks with only one egg were kept. The females as well as excess eggs were killed to obtain one egg per disk. The eggs were monitored to determine the development and survival rate of the immature stages. Each individual was ex-

amined 3 times a day (at 7 a.m., 1 p.m., and 7 p.m.) and the transition from one stage to another was noted. The leaf disks were replaced every 2 days (at 26 and 30.3^o C) or every 5 to 6 days (at 15, 19.8 and 22.7^o C). The number of eggs monitored at each temperature is indicated in Table 1.

Oviposition - One female teliochrysalis (C3) and two males were taken from the breeding chamber and placed on a leaf disk. Forty-eight hours after the female emerged, the males were killed. The date on which the female emerged was noted as well as the number of eggs laid per day. Disks were changed every 4 days.

Sex ratio - The sex ratio was determined at a single temperature, 19.8^o C, which is the mean temperature during the vine growing period (from mid-April to mid-October). The method was the same as that used for oviposition, except that the females were placed on a new leaf disk every day and disks with eggs were maintained under the same experimental conditions (breeding conditions for the females). The sex ratio was determined on the basis of adults originating from the eggs.

Rate of population increase - The intrinsic rate of natural increase (r_m) defined by Birch (1948) is an index characterizing the maximum rate at which a population can increase under specific and constant environmental conditions, where neither space nor nourishment is limited and the cause of mortality can therefore only be physiological.

The net reproductive rate (R_0) is the sum of the $l_x m_x$ in the life tables. The mean generation time (T) is obtained here using the formula $T = \sum x l_x m_x / \sum l_x m_x$. The r_m is calculated from T and R_0 using the formula $r_m = \text{Log } R_0 / T$.

Table 1. Development times (in days) of immature stages and survival rates of *Eotetranychus carpini*.

	15.0 ± 0.6°C	19.8 ± 0.9°C	22.7 ± 3.0°C	26.0 ± 1.0°C	30.3 ± 2.0°C
Stage					
Eggs	11.9	6.3	5.0	3.8	3.6
Larva	3.3	1.7	1.7	1.3	1.9
Protochrysalis	2.2	1.0	0.9	0.8	0.6
Protonymph	2.8	1.5	1.2	1.1	1.1
Deutochrysalis	2.1	1.2	0.9	0.8	0.7
Deutonymph	3.4	2.2	1.3	1.3	1.2
Teliochrysalis	2.8	1.4	1.0	0.9	0.7
Total (Avg. ± S.E.)	28.4 ± 0.4	15.2 ± 0.2	12.0 ± 0.2	9.9 ± 0.1	9.7 ± 0.2
Number of eggs	32	32	32	31	40
Number of adults	25	22	22	22	19
Survival rate of immature stages (%)	78	69	69	71	48

RESULTS

Sex ratio - The proportion of females in 191 eggs laid by 8 females was 61.7%. This value was rounded off to 65% for the life table calculations, but it is actually

The lower thermal threshold for development (TD) was calculated by the ratio:

$TD = a/b$ where a and b were determined by linear regression of the equation: $DR = a + bt$, where DR =

Table 2. Duration in days of various adult stages of *Eotetranychus carpini*.

	n	15.0 ± 0.6°C (Avg. ± S.E)	19.8 ± 0.9°C (Avg. ± S.E)	22.7 ± 3.0°C (Avg. ± S.E)	26.0 ± 1.0°C (Avg. ± S.E)	30.3 ± 2.0°C (Avg. ± S.E)
Preoviposition	31	5.4 ± 0.5	3.3 ± 0.2	1.9 ± 0.1	2.0 ± 0.1	1.3 ± 0.1
Oviposition	31	23.9 ± 2.0	21.2 ± 1.8	18.7 ± 1.3	14.8 ± 1.3	9.1 ± 0.9
Postoviposition	31	4.3 ± 1.7	1.9 ± 0.2	1.2 ± 0.1	1.2 ± 0.1	1.6 ± 0.2
Total adult longevity	31	33.6 ± 2.9	26.4 ± 1.8	21.9 ± 1.3	18.1 ± 1.3	12.1 ± 1.1

Table 3. Ovipositional rate of *Eotetranychus carpini*.

	n	15.0 ± 0.6°C (Avg. ± S.E)	19.8 ± 0.9°C (Avg. ± S.E)	22.7 ± 3.0°C (Avg. ± S.E)	26.0 ± 1.0°C (Avg. ± S.E)	30.3 ± 2.0°C (Avg. ± S.E)
Number of eggs laid per female	31	28.6 ± 1.9	33.2 ± 2.8	43.0 ± 2.9	46.4 ± 4.2	29.3 ± 2.8
Average number of eggs laid per day during oviposition period	31	1.3 ± 0.1	1.6 ± 0.1	2.4 ± 0.1	3.1 ± 0.1	3.2 ± 0.1

Table 4. Parameters related to potential rates of population increase of *Eotetranychus carpini*.

	15.0 ± 0.6°C	19.8 ± 0.9°C	22.7 ± 3.0°C	26.0 ± 1.0°C	30.3 ± 2.0°C
Net reproductive rate, R_0	14.92	17.17	22.04	23.76	9.48
Mean generation time, T in days	46.8	30.8	24.5	20.7	17.2
Intrinsic rate of natural increase, r_m in day ⁻¹	0.058	0.092	0.126	0.153	0.130
Finite rate of increase (λ)	1.059	1.096	1.134	1.165	1.138

It was lowest at 30.3°C since longevity was shortest at this temperature and mortality highest. The mean generation time (T) decreased as the temperature increased from 15.0 to 30.3°C. The intrinsic rate of natural

temperature limit was 7 ± 1°C, whereas the upper limit appeared to be above 30°C, probably about 32 to 33°C. These hypotheses were corroborated by the analyses of development times, fecundities, and intrinsic rates of

account all the data that must be included in the calcula-

Gotoh, T. 1987. Life history parameters of two species