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INFLUENCE OF TEMPERATURE AND RELATIVE HUMIDITY ON THE BIOLOGY AND LIFE TABLE PARAMETERS OF *PHYLLOCOPTRUTA OLEIVORA* AND *ACULOPS PELEKASSI* (ACARI : ERIOPHYIDAE) ON "HAMLIN" ORANGE IN CENTRAL FLORIDA

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Abstract

The influence of temperature and relative humidity on life table parameters of *Phyllocoptruta oleivora* (Ashmead) CRM and *Aculops pelekassi* (Keifer) PRM was determined in outside condition tests. Both eriophyoid mites developed and reproduced readily when fed on "Hamlin" orange *Citrus sinensis* (L.). Life table parameters were calculated at 17°C and 78% RH; 22°C and 75% RH; 27°C and 77% RH for PRM and continue to 30°C and 84% RH; and 32°C and 88% RH for CRM. The developmental time for female immature stages averaged 3.2±0.673 days at 32°C, with the intrinsic rate of increase (r_m) value of 0.350 for CRM; and 6.4±1.122 days at 27°C, with the intrinsic rate of increase (r_m) values of 0.192 for PRM. The time threshold of development was 11°C and oviposition ceased at 10°C for both eriophyoid mites. Mortality from egg to adult stages was high (53.06%) at 17°C and decreased to 25.81% and 26% at 30°C and 32°C for CRM, respectively, while, the opposite occurred with PRM, the highest mortality was 48.59% at 27°C and decreased to 32.25% at 17°C. The optimum temperature for CRM to develop and increase on "Hamlin" orange was 30°C to 32°C, while, that for PRM was 22°C to 27°C.

INTRODUCTION

The pink citrus rust mite (PRM), *Aculops pelekassi* (Keifer) occurs on Florida citrus. No data are available concerning its relative abundance compared with citrus rust mite (CRM), *Phyllocoptruta oleivora* (Ashmead) (Childers 1987). PRM is potentially capable to cause greater damage to citrus than CRM (Jeppson *et al.* 1975). Besides causing rusting of fruits and leaves, PRM causes mild to severe distortion of new growth.

The only study in Japan on mandrine saga has shown that PRM to be the most important eriophyoid on citrus there with heavy infestation causing serious leaf distortion (Seki, 1979). CRM is the most important arthropod pest on Florida citrus that causes rusting of fruits associated with loss in fruit quality and yield (McCoy and Albrigo 1975; Allen 1976, 1978, 1979; McCoy *et al.* 1976). In Egypt, it was found that it causes rusting of orange fruits, while it causes silver or grey appearance to lemon fruits (Ismail, 1954).

Seki (1979 and 1981) revealed that egg incubation period of the PRM was 3.4, 5.0 and 9.1 days; the development time was 6.3, 7.8 and 14.9 days and the generation time (from egg to egg) was 7.5 days, 10.0 days at 25°C and 16.0 days at 30, 25 and 20°C, respectively. The threshold of development was 10.7°C.

Swirski *et al,* (1958) reported that on lemon in Israel the CRM incubation period at temperatures 24-26°C was 2-3.5 day, whereas at low temperature of 12-13°C it reached 18-23 days. At high temperature 24-26°C the period of nymphal stages lasted 2-5 days, while at low temperature, 11-12°C, it reached 37 days. The theortical threshold of development from egg to adult was 9.2°C. Although, in Egypt (Ismail, 1954) had found that the incubation period varied from 3.4 to 4.3 days according to the temperature.

Brussel (1975) Surinam noted in the difference between the development time of CRM on grapefruit during the rainy season (9.3 days) and the dry season (8.0 days). The duration from egg to adult was 7.8 days. Maximum egg production was 26 eggs over a period of 16 days.

For CRM, daily egg production amounted 1 or 2 in Florida (Yothers and Mason 1930). In California, 2-3 eggs were laid per female per day (Binney 1934). A maximum egg production for CRM was 26 eggs over 20 days in Israel (Swirski and Amitai 1959).

Effect of relative humidity was also mentioned by some authors. Dean (1959) and Reed *et al,* (1964) reported that high relative humidity favoured CRM mite development (60-100% RH).

Its theoretical optimal temperature was 24.5°C and limiting degrees 17.6°C to 31.4°C as well as limiting humidity levels 15-90% RH. Temperatures excess of 32°C to 37°C caused complete mortality of CRM mites in a few hours in a closed greenhouse on green lemon fruits (Hobza and Jeppson 1974).

MATERIALS AND METHODS

Experiment unit: Immature fruits of "Hamlin" orange free from rust mite infestations were collected. Each fruit was dipped in melted parafin wax leaving a round area about 1-3 cm in diameter free from wax. The edge of the wax surface was ringed with a thin layer of Canda Balsam-Castor bean oil mixture (ratio 1.5:1) as tangle food (Childers and Peregrine 1986). Each fruit was also placed on a pvc pipe disc in glass jar 10x8 cm. A small amount of water was added to each jar without touching the surface of fruit to prevent possible fruit dehydration. The unit of experiment was held in wooden frame cages 90x80cm, with nylon mesh screened sides. A hygrothermograph (Bendex model No. 594 serial No. 16645, Baltimore, Maryland) was placed inside each of the two cages to record temperature and relative humidity.

Initial attempts: A series of preliminary experiments were conducted before starting the life table studies of the two eriophyid mite species. Preliminary studies indicated that 50% mortality of motile stages occurred under laboratory conditions compared with no mortality of motile stages in cages in outside conditions. So, outside conditions for experiment was chosen. Also, a preliminary study showed that the effect of heat emitted from light of microscope caused injury to eggs and motile stages of *P.oleivora* and *A.pelekassi* at distance from 1-10 cm. So, care was taken to ensure that the light source was not high to cause injury either to eggs or motile stages of the two eriophyid mites.

Stock culture: Stock cultures of *P.oleivora* and *A.pelekassi* were obtained from fruits collected from the grove. Both pecies were separately transferred from the surface of infested fruit to the rearing area of culture fruits. These fruits were kept inside plastic box isolated in cages (90x80x60 cm).

Immature green fruits 3.0-5.0 cm. in diameter were successfully used for rearing both species of eriophyid mites. Individual mites were transferred using a 5-0 brush with a single hair. The old green to yellowish fruits used to maintain the eriopyid mite cultures were removed every 5-6 weeks and replaced with new immature green fruits.

Life history: Twenty mated females of each eriophyoid species were transferred from culture fruits to each of ten fruits (i.e., total of 200 female) per species. A sixty to 120 eggs were produced for each experiment (i.e., 6-12 eggs per fruit). The location of each egg was marked by indian ink and examined three times a day at

0600, 1800, and 2200 hours. Newly hatched nymphs reared in the same fruit arena until reaching adult hood. This was necessary to reduce mortality.

Newly emerged adults were moved each to a rearing ring on a fruit; each fruit might have more than one ring. Examination was undertaken twice daily and when about 50% of adults laid eggs, they were known to be femles and moved to ring free from eggs after picking up their individuals which are considered to be males. These solitary females were fertilized by spermatophores of the removed males and were kept in these new rings to complete oviposition. Complete oviposition period and sex ratio of F_1 progeny were recorded.

Actual mean RH ranged from 40%-100% and temperature from 5°C-35°C was measured by hygrothermograph. Mean RH was 42% at 10°C; 52% at 11°C ; 78% at 17°C (range 68-89.9%); 75% at 22°C (range 60.9-89.6%); 77% at 27°C (range 64.5-94.8%); 84% at 30°C (range 70-99%) and 88% at 32°C (range 76-100%). Life table parameters were calculated using the life 48 computer programme (Abou-Setta *et al.*, 1986).

RESULTS

Citrus rust mite, *Phyllocoptruta oleivora* (CRM)

Developmental time: The data on duration of different stages in table 1. reveal that the rate of development is greately influenced by temperature. The mean duration of each stage decreased with the rise in temperature.

Duration of the egg stage of CRM females and males was minimum 1.2±0.464 and 1.1±0.319 days at 32°C and maximum 9.6±1.345 and 9.2±1.138 days at 17°C, respectively. 1st nymph, nymphchrysalis, 2nd nymph and imagochrysalis of CRM females and males were minimum at 32°C averaged 0.7 ± 0.191 and 0.4±0.186; 0.3 ± 0.122 and 0.3±0.068; 0.7±0.192 and 0.5±0.228; and 0.3±0.125 and 0.2±0.051 days, respectively and maximum at 17°C was 2.7±0.524 and 2.4±0.334; 1.8±0.386 and 1.6±0.246; 2.1±0.597 and 1.7±0.257; and 1.5±0.348 and 1.1±0.226 days, respectively. A similar trend was also observed in total developmental time of CRM females and males. It was observed to be minimum at 32°C being 3.2±0.673 and 2.8±0.504 days and maximum at 17°C being 17.9±3.157 and 16.0±3.107 days for female and male, respectively. The threshold of development time was 11.0°C.

Table 1. Duration in days of different stages of *Phyllocoptruta oleivora* (Ashmead) at constant temperatures and relative humidities.

R.H. %	Temp. °C	Female Min	Female Max	Female Mean	Female SD	Female N	Male Min	Male Max	Male Mean	Male SD	Male N
						Egg					
52%	11	Threshold									
78%	17	8.0	12.0	9.6	1.345	34	8.0	11.0	9.2	1.138	12
75%	22	3.9	7.8	5.7	1.382	38	3.9	6.9	5.2	1.059	12
77%	27	2.4	4.7	4.0	0.674	40	2.4	4.2	3.4	0.540	14
84%	30	1.0	3.5	2.8	0.541	70	1.0	3.0	2.1	0.595	22
88%	32	0.5	2.0	1.2	0.464	59	0.5	1.5	1.1	0.319	15
						1st Nymph					
78%	17	2.0	3.5	2.7	0.524	34	2.0	3.0	2.4	0.334	12
75%	22	1.0	2.9	1.8	0.560	38	1.0	2.0	1.4	0.358	12
77%	27	1.0	1.5	1.3	0.192	40	1.0	1.4	1.1	0.174	14
84%	30	0.7	1.5	1.0	0.236	70	0.7	1.0	0.9	0.125	22
88%	32	0.5	1.0	0.7	0.191	59	0.3	0.7	0.4	0.186	15
						Nymph Chrysalis					
78%	17	1.5	2.5	1.8	0.386	34	1.5	2.0	1.6	0.246	12
75%	22	0.7	2.5	0.9	0.331	38	0.7	1.5	0.8	0.226	12
77%	27	0.2	0.7	0.5	0.452	40	0.2	0.5	0.4	0.087	14
84%	30	0.2	0.5	0.4	0.099	70	0.2	0.4	0.3	0.076	22
88%	32	0.2	0.5	0.3	0.122	59	0.2	0.4	0.3	0.068	15
						2 nd Nymph					
78%	17	1.5	3.0	2.1	0.597	34	1.5	2.0	1.7	0.257	12
75%	22	1.0	2.9	1.5	0.593	38	0.7	2.0	1.1	0.453	12
77%	27	0.6	1.3	0.8	0.212	40	0.6	0.9	0.7	0.104	14
84%	30	0.7	1.5	0.9	0.237	70	0.5	0.8	0.7	0.193	22
88%	32	0.5	1.0	0.7	0.192	59	0.3	0.7	0.5	0.228	15
						Imago Chrysalis					
78%	17	1.0	2.0	1.5	0.348	34	1.0	1.5	1.1	0.226	12
75%	22	0.7	1.7	1.1	0.283	38	0.7	1.5	0.9	0.278	12
77%	27	0.3	0.6	0.5	0.128	40	0.2	0.5	0.4	0.109	14
84%	30	0.3	0.5	0.4	0.069	70	0.2	0.4	0.3	0.071	22
88%	32	0.2	0.5	0.3	0.125	59	0.2	0.3	0.2	0.051	15
						Development time					
78%	17	14.0	23.0	17.9	3.157	34	14.0	19.5	16.0	3.107	12
75%	22	7.4	17.9	11.1	1.949	38	7.2	13.9	9.6	1.774	12
77%	27	4.6	9.0	7.1	1.384	40	4.6	7.7	6.1	1.166	14
84%	30	3.1	7.5	5.5	1.105	70	2.7	5.6	4.5	1.186	22
88%	32	2.0	5.0	3.2	0.673	59	1.6	3.7	2.8	0.504	15

Table 2. Effect of temperature and relative humidity on life table parameters of *P.oleivora* (Ashmead).

Parameter Temp. °C	17	22	27	30	32
R.H. %	78	75	77	84	88
Generation time (days)	20.03	13.66	9.12	6.26	4.00
Preoviposition period (days)	2.08	2.50	2.00	0.78	0.75
Oviposition period (days)	10.52	10.28	10.69	14.98	8.89
Time to 50% mortality (days)	27.50	14.00	9.50	11.30	8.23
Mean total fecundity (egg/♀)	13.26	13.44	15.25	16.14	12.62
Maximum fecundity rate (egg/♀ /day)	1.20	1.20	1.22	1.82	1.89
Net reproductive rate (R_o)	6.96	5.00	5.41	9.07	7.48
Mean age of female	23.51	18.24	15.30	9.33	5.74
Mean age of male	10.33	8.02	8.94	8.54	4.25
Intrinsic rate of increase (r_m)	0.082	0.088	0.110	0.236	0.350
Finite rate of increase (e^r)	1.086	1.092	1.116	1.266	1.419
Sex ratio (females/ total)	0.74	0.76	0.74	0.76	0.80
Max. life span of female	41.46	29.40	22.42	14.81	8.99
Max.life span of male	26.48	17.70	15.07	13.46	7.13

Table 3. Data on the development of *P.oleivora* showing viability of eggs and mortality at different temperatures and relative humidities.

R.H. %	Temp. °C	No. of eggs examined	No. of adults developed	Total mortality %
52	10	67	Nil	Nil
78	17	96	46	53.06
75	22	102	50	50.98
77	27	112	54	51.78
84	30	124	92	25.81
88	32	100	74	26.00

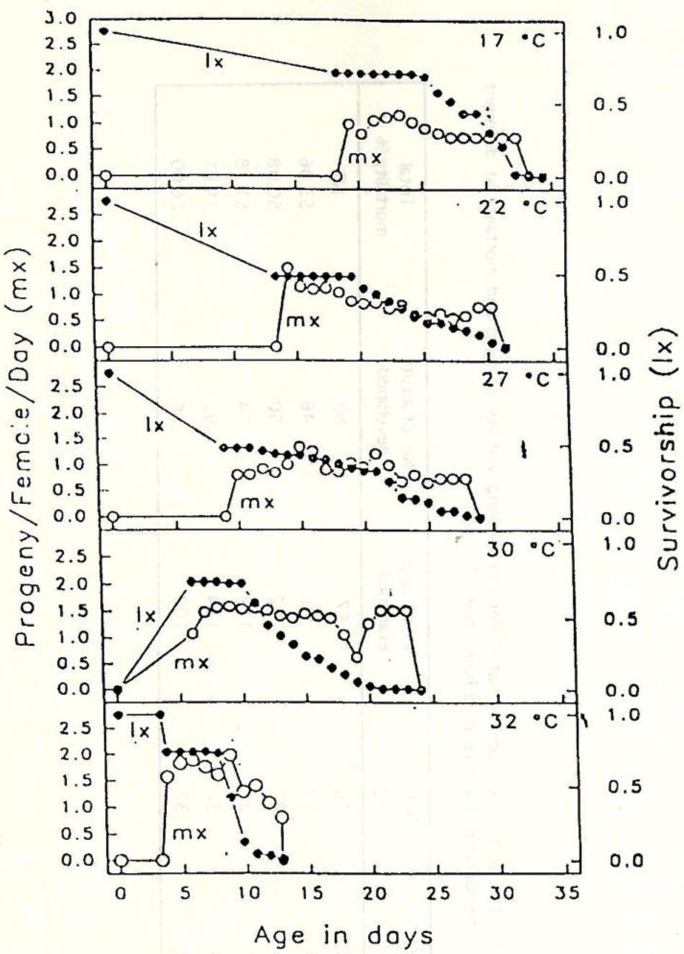

Fig. 1. Age- specific survival and age-specific fecundity rates of *P.oleivora* (Ashmead) at different temperatures.

Life table parameters: The data on generation time in table 2 indicated that this period occupied 20.03, 13.66, 9.12, 6.26 and 4.00 days at 17°C, 22°C, 27°C, 30°C, and 32°C for CRM, respectively. It was evident that with increase in temperature the corresponding periods decreased in duration of generation time. The highest mean total fecunidty per female was 16.14 eggs per female at 30°C for CRM. The maximum mean adult age time for females and males CRM population was 23.51 and 10.33 days at 17°C compared with 5.74 and 4.25 days at 32°C, respectively. The intrinsic rate of increase (r_m) was lowest with 0.082 at 17°C and increased to maximum of 0.350 at 32°C. The highest net rate of reproduction (R_O) was 9.07 at 30°C followed by 7.48 at 32°C. The daily rate of egg production was affected considerably at different levels of temperatures. The number of eggs laid per female per day at 17°C, 22°C, 27°C, 30°C and 32°C was 1.20, 1.20, 1.22, 1.82 and 1.89, respectively, Table 2.

The maximum life span for female and male adult CRM was 41.46 and 26.48 days at 17°C compared with 8.99 and 7.13 days at 32°C. The average sex ratio of CRM was approximately 1 male to 3 females and this ratio was fairly constant throughout the different temperatures except at 32°C as sex ratio was 1 male to 4 females. The sex ratio (females per total) was 0.74, 0.76, 0.74, 0.76 and 0.80 at 17°C, 22°C, 27°C, 30°C and 32°C.

Viability of eggs and mortality

Maximum mortality from egg to adult was observed at 17°C being 53.06% and minimum at 30°C and 32°C being 25.81% and 26.00%, respectively, Table 3. The egg of CRM kept at 10°C maintained the shape and colour as that of freshly laid eggs without hatching.

Pink citrus rust mite, *Aculops pelekassi* (PRM)

Developmental time: The mean duration of PRM female and male eggs ranged from 9.05±0.948 and 9.0±0.666 days at 17°C to 3.3±0.315 and 2.9±0.540 days at 27°C, respectively, Table 4.

1st nymph and nymphchrysalis of PRM females and males lasted a mean 2.8±0.574 and 2.6±0.516; 1.4±0.353 and 1.2±0.258 days at 17°C and at 32°C, these stages averaged 1.5±0.225 and 1.2±0.210; 0.4±0.110 and 0.3 ± 0.060 days, respectively. The duration of 2nd nymph and imagochrysalis of PRM females and males ranged from a high of 2.5±0.504 and 2.2±0.421; 1.2±0.355 and 1.3±0.241

Table 4. Duration in days of different stages of *Aculops pelekassi* (Keifer) at different temperatures and relative humidities.

R.H. %	Temp. °C	Female Min	Female Max	Female Mean	Female SD	Female N	Male Min	Male Max	Male Mean	Male SD	Male N
							Egg				
52%	11	Threshold									
78%	17	8.0	11.0	9.5	0.948	32	8.0	10.0	9.0	0.666	10
75%	22	4.0	6.9	5.2	0.858	29	3.9	5.9	4.7	0.886	8
77%	27	2.7	3.8	3.3	0.315	43	2.7	3.3	2.9	0.540	12
							1st Nymph				
78%	17	2.0	3.5	2.8	0.574	32	2.0	3.0	2.6	0.516	10
75%	22	1.6	2.9	2.3	0.509	29	1.6	2.5	1.9	0.309	8
77%	27	1.3	1.9	1.5	0.225	43	0.9	1.4	1.2	0.210	12
							Nymph Chrysalis				
78%	17	1.0	2.0	1.4	0.353	32	1.0	1.5	1.2	0.258	10
75%	22	0.7	2.5	1.2	0.500	29	0.7	1.5	1.1	0.327	8
77%	27	0.3	0.6	0.4	0.110	43	0.3	0.4	0.3	0.060	12
							2 nd Nymph				
78%	17	2.0	3.0	2.5	0.504	32	2.0	3.0	2.2	0.421	10
75%	22	1.0	2.6	2.1	0.430	29	1.0	2.0	1.8	0.339	8
77%	27	0.6	1.1	0.8	0.145	43	0.6	0.8	0.7	0.088	12
							Imago Chrysalis				
78%	17	1.0	2.0	1.2	0.355	32	1.0	1.5	1.3	0.241	10
75%	22	1.0	1.7	1.3	0.288	29	1.0	1.5	1.2	0.258	8
77%	27	0.2	0.3	0.2	0.042	43	0.2	0.3	0.2	0.031	12
							Development time				
78%	17	13.0	21.5	17.6	3.144	32	14.0	19.0	16.4	2.973	10
75%	22	8.3	16.6	12.1	1.531	29	8.3	13.4	10.6	1.410	8
77%	27	5.3	7.8	6.4	1.122	43	4.9	6.3	5.4	0.757	12

Table 5. Effect of temperature and relative humidity on life table parameters of *Aculops pelekassi* (Keifer).

Parameter Temp. °C / R.H. %	17 / 78	22 / 75	27 / 77
Generation time (days)	19.47	14.19	7.09
Preoviposition period (days)	1.87	2.13	0.65
Oviposition period (days)	9.31	10.58	8.59
Time to 50% mortality (days)	25.33	21.86	11.54
Mean total fecundity (egg/♀)	18.21	24.13	19.48
Maximum fecundity rate (egg/♀ /day)	1.90	2.22	2.26
Net reproductive rate (R_o)	9.41	10.92	7.75
Mean age of female	21.89	18.73	10.63
Mean age of male	8.70	7.21	6.07
Intrinsic rate of increase (r_m)	0.102	0.127	0.192
Finite rate of increase (e^r)	1.107	1.136	1.212
Sex ratio (females/ total)	0.76	0.78	0.78
Max.life span of female	39.49	30.79	17.07
Max.life span of male	25.13	17.90	11.50

days at 17°C, to 0.8±0.145 and 0.7±0.088; and 0.2±0.042 and 0.2±0.031 days at 27°C, Table 4. The PRM females and males developmental time ranged from 17.6±3.144 and 16.4±2.973 days at 17°C, to 6.4±1.122 and 5.4±0.757 days at 27°C. The threshold of development was at 11.0°C.

Life table parameters

The mean generation time of PRM population was 19.47 days at 17°C compared with 7.09 days at 27°C, Table 4. The preoviposition period ranged from 2.13 days at 22°C to 0.65 days at 27°C. The mean total fecundity was the highest (24.13 eggs per female) at 22°C and the lowest (18.21 and 19.48 eggs) at 17°C and 27°C, respectively. The highest net reproductive rate (^{R}o) was 10.92 at 22°C. The intrinsic rate of increase (^{r}m) was lowest with 0.102 at 17°C and the highest of 0.192 at 27°C. PRM had the greatest mean age of female 21.89 days and 8.70 days for male at 17°C, while the lowest mean age of female and male was 10.63 and 6.07 days at 27°C, respectively.

The mean life span for female and male PRM was 39.49 and 25.13 days at 17°C compared with 17.07 and 11.50 days at 27°C. There was no evident for PRM to show any effect of temperature on sex ratio. The mean sex ratio was 0.76 at 17°C compared with 0.78 at 22°C and 27°C. Thus, the sex ratio of PRM was almost 3 to 1 (female to male), Table 5.

Viability of eggs and mortality

Maximum mortality from egg to adult was observed at 27°C being 48.59% and minimum at 17°C being 32.25%, Table 6.

PRM eggs kept at 10°C maintained none hatched as fresh laid eggs for three weeks.

DISCUSSION

The effect of levels of temperature on the developmental time of CRM revealed that it averaged 3.2 days at 32°C and 17.9 days at 17°C. The generation time was 4.0 days at 32°C and 13.66 days at 22°C. 1st nymphal stages was 1.7-5.4 days at 22°C and 1.2-2.2 days at 27°C, while, 2nd nymphal stage was 1.7-4.6 days at 22°C and 0.9-1.9 days at 27°C.

Maximum CRM female life span was 41.46 days at 17°C and 29.40 days at

Table 6. Data on the development of *Aculops pelekassi* showing viability of eggs and mortality at different temperatures and relative humidities.

R.H. %	Temp. °C	No. of eggs examined	No. of adults developed	Total mortality %
52	10	55	Nil	Nil
78	17	62	42	32.25
75	22	64	37	42.18
77	27	107	55	48.59

22°C. The threshold of development was 11°C and the oviposition ceased at 10°C on "Hamlin" orange in Florida.

These observations are in disagreement with those of Swirski and Amitai (1958) who mentioned that at 24-26°C the total period of 1st nymph equaled the total period of 2nd nymph 2-5 days on lemon fruit in Israel. The maximum length of female life at 12-18°C was 36-37 days and at 20-23°C was 24 days. The theoretical threshold of development from egg to adult was 9.2°C. Although, in Egypt (Ismail, 1954) had stated that the duration of the generation lasted during summer about 10.5 days.

Also, present study disagree with Yothers and Mason (1930) who found that nymphal stage lived for 3.1 days in the summer (32.6°C) and (25.1°C) 10.7 days on grapefruit in Florida.

It is evident from our results that 30°C and 32°C proved to be the most suitable for the development of CRM as maximum intrinsic rate of increase (r_m), fecundity rate (eggs per female) and percentage of hatching were the highest and mortality was less at these temperatures.

Sex ratio was nearly similar (1 male to 2 females) at average temperatures 17, 22,27,30 and 32°C, while it changed to 1 male to 4 females at 32°C. Relative humidity with these temperatures was also changeable. In Israel, Swirski and Amitia (1960) reported that sex ratio, obtained from 417 adults collected from clementine trees was 46.7% males. However, this difference might be due to host plant or /and weather conditions.

The developmental time for PRM was 6.4 days at 27°C, 12.1 days at 22°C and 17.6 days at 17°C, respectively. The threshold of development was 11°C and the oviposition ceased at 10°C on "Hamlin" orange in Florida. The generation time was 7.09 days at 27°C, 14.19 days at 22°C and 19.47 days at 17°C.

Present study is quite close with (Seki 1979) who found that the developmental time for PRM was 6.3 days at 30°C, 7.8 days at 25°C and 14.9 days at 20°C, respectively. The threshold developmental time was 10.7°C. The generation time was 7.5 days at 30°C, 10.0 days at 25°C and 16.0 days at 20°C.

The mean total fecundity gave the maximum of 24.13 eggs per female at 22°C. The sex ratio was almost 3 to 1 (female to male).

Maximum mortality from egg to adult was observed at 27°C and decreased the mortality at 17°C, coincided with findings of (Seki 1979) who found that survival rate from egg to adult was low at 30°C.

It is evident that 22°C proved to be the most suitable for the net reproductive rate, maximum fecundity (rate of eggs per female per day, total eggs per femal) and low mortality. It was also found that it was more sensitive to high temperature due to high mortality.

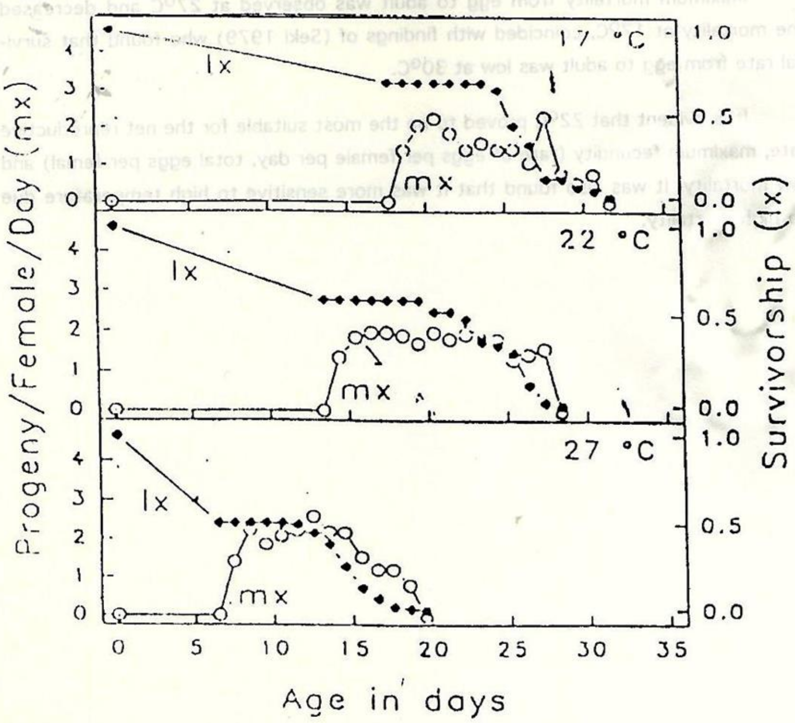

Fig. 2. Age-specific survival and age-specific fecundity rates of *Aculops pelekassi* (Keifer) at different temperatures.

REFERENCES

1 . Abou-Setta, M.M, R.W. Psorrell and C.C. childers. 1986. BASIC computer program to calculate life table parameter for insect or mite species. Fla. Entomol. 69:690-697.

2 . Allen, J.C. 1976. A model for predicting citrus rust mite damage on Valencia orange fruit. Environ. Entomol. 5:1083-1088.

3 . Allen, J.C. 1978. The effects of citrus rust mit damage on citrus fruit drop. J. Econ. Entomol. 71:746-750.

4 . Allen, J.C. 1979. The effect of citrus rust mite damage on citrus fruit growth. J. Econ. Entomol. 72: 195-201.

5. Binney, W.S. 1934. The sliver or rust mite *Phyllocoptruta oleivora* (Ashmead) in San Diego county. California Dept. Agric Bull. 23.201-203.

6. Brussel, E.W. 1975. Interrelations between citrus rust mite, *Hirstella thompsonii* and greasy spot on citrus in Surinum.Landbouwproefstation Surinum, Agric. Exper. Station Surinum Bull 98:66pp.

7. Childers, C.C. and D. J.Pereging. 1986. Mehtods for the routine screening of acaricids against the citrus rust mite *Phyllocoptruta oleivora* (Ashmead) (Acari: Eriophyoid). British crop protection Conf. Pests and Disease. 3C-17:347-353.

8. Childrs, C.C. 1987. Chemical control of phytophagous mite pests on Florida citrus. Proc. Int. Conf. On pests in Agric. Paris. 111:119-126.

9. Dean, H.A. 1959. Seasonal distribution of mites on Texas grapefruit. J. Econ Entomol. 52:228-232.

10. Jeppson, L.R., H.H. Keifer, E.W. Baker. 1975. Mites injurious to economic plants. Univ. California Press. Berkeley. 614pp.

11.Hobza, R.F. and C.R. Jeppson. 1974. A temperature and humidity study of citrus mite employing a constant humidity air-flow technique. Environ. Entomol. 3:813-822.

12. Ismail,I.M. 1954. The biology of *Phyllocoptruta oleivora* (Ashmead) and its distribution in Egypt. MSc Thesis, Cairo University.

13. McCoy, C.W. and L. G. Albrigo. 1975. Feed injury to the orange caused by the citrus rust mite, *Phyllocoptruta oleivora* (Acari: Eriophyoidae). Ann. Entomol. Soc. America 68:289-297.

14. mcCoy, C.W., P.L. Davis and K.A. Munroe. 1976. Effect of late season fruit injury by the citrus rust mite, *Phyllocoptruta oleivora* (Acari: Eriophyoidae) on

the internal quality of valencia orange.Fla. Entomol. 59:335-341.

15. Reed, D.K., A.K. Burditt and C.R. Crittenden.1964. Laboratory methods for rearing rust mites *Phyllocoptruta oleivora* and *Aculops pelekassi* on citrus. J.Econ. Entomol. 57: 130-133.

16. Seki, M. 1979. Ecology studies of pink citrus rust mite,*Aculops pelekassi* keifer, with special reference to the control of *Aculops pelekassi*. Bull. Sagafruit Tree Expt. Stn 2:1-66.

17. Seki, M. 1981. Life cycle of pink citrus rust mite,*Aculops pelekassi* keifer, in Japan . Proc. Int. Soc. Citriculture: 656-658.

18. Swirski, E.and S.Amitai. 1958. Contribution to the biology of citrus rust mite *Phyllocoptruta oleivora* (Ashmead) .D. Development, adult longevity and life cycle .J. Agric. Res. Sta. Rehovot. Ktavim 8:813-822.

19. Swirski, E. and S. Amitai. 1959. Contribution to the biology of citrus rust mite *Phyllocoptruta oleivora* (Ashmead) .C. Oviposition and longevity of males and females . J. Agric. Res. Sta. Rehovot. Ktavim 9:281-285.

20. Swirski, E. and S. Amitai. 1960. Sex ratio of the citrus rust mite *Phyllocoptruta oleivora* (Ashmead) in the citrus groves. Quarterly Journal of the National and University Institute of Agriculture, 10 (3-4):225-226.

21 Yothers, W.W. and A. C. Mason . 1930. The citrus rust mite and its control. U.S.D.A. Tech. Bull. 178:56pp.

تاثير درجات الحرارة والرطوبة النسبية على بيولوجى كل من حلم صدأ الموالح وحلم صدأ الموالح الوردى على البرتقال صنف الهملين من مركز فلوريدا.

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يعتبر الحلم الدودى لصدأ الموالح فى مصر من الآفات الهامة على أشجار البرتقال والليمون ويسبب ضرر ا بالغا يؤدى فى بعض الأحيان الى ضياع المحصول لوجود الصدأ الذى يشوه شكل البرتقال مما لا يكون مقبولا كطعام أدمى وفى نفس الوقت لا يصلح للتصدير للخارج.

وتشير المراجع الى بعض النقص فى المعلومات عن هذه الآفة بينما حلم صدأ الموالح الوردى لا توجد عنه دراسة بيولوجية على مستوى العالم وتعتبر هذه الدراسة هى الأولى له . لذلك تم عمل هذا البحث لألقاء الضوء وأتاحة بعض الدراسات البيولوجية لهذين النوعين المسببين أضراراً كبيرة لمحصول البرتقال والليمون فى كثير من بلدان العالم المنتجة للبرتقال والليمون .

تم تربية الأطوار المختلفة لهذين النوعين معمليا على البرتقال صنف الهملين " البلدى" على درجات حرارة مختلفة من١٧ م ، ٢٢م ، ٢٧م، ٣٠م، ٣٢م ورطوبة نسبية ٧٨٪ ، ٧٥٪ ، ٧٧٪ ، ٨٤٪ ، ٨٨٪ فى المتوسط على التوالى لحلم صدأ الموالح *P. oleivora* .

وكذلك درجة حرارة من ١٧ م ، ٢٢م ، ٢٧ م ، ودرجة رطوبة نسبية ٧٨٪ ، ٧٥٪ ، ٧٧٪ على التوالى لحلم صدأ الموالح الوردى *A. Pelekassi* .

وقد تبين من خلال الدراسة أن كل من *A. Pelekassi* *P. oleivora* يكون حده الأدنى لعدم وضع البيض عند درجة حرارة ١٠م وكان أعلى معدل للزيادة فى أنتاج أفراد الجيل عند درجة حرارة ٣٢م بالنسبة لنوع صدأ الموالح *P. oleivora*. بقيمة r_m ٣٥٠ر . وهى معدل زيادة الأثنى فى اليوم .

بينما كان أعلى معدل للزياده فى انتاج الأفراد عند درجة حرارة ٢٧ م بالنسبة لنوع صدأ الموالح الوردى *A. Pelekassi* . بقيمة r_m ١٩٢,٠ وهى معدل زيادة الأثنى فى اليوم

ومن ذلك يتبين أن درجة الحرارة المثلى لنمو أفراد نوع صدأ الموالح *P. oleivora* من ٣٠م -٣٢م، بينما درجة الحرارة المثلى لنمو أفراد نوع صدأ الموالح الورى *A. Pelekassi* من ٢٢م الى ٢٧ م.