IV. RESULTS AND DISCUSSION

IV.1- Ecological studies:

1.a- Population dynamics of phytophagous, predaceous mites, scale insects and on Navel orange trees during the two successive years at Qalubia Governorate:

Ecological studies were carried out on Navel orange trees in two locations (Farm of Faculty of Agriculture Moshtohor and Degwa village) at Qalubia Governorate. Biweekly, leaves samples of Navel orange were collected and transferred to laboratory for examination. Either phytophagous and predaceous mites as well as scale insects were identified and counted.

1.a.1. Population dynamics of phytophagous mites on Navel orange leaves.

a. Seasonal abundance of Citrus flat mite, *Brevipalpus californicus* (Banks) Fam. Tenuipalpidae on leaves of Navel orange variety.

Data in Tables (1 & 2) and Figs. (1& 2) indicate that *B. californcus* was gradually increased in numbers from December to June, then gradually decreased from July to November at Benha and Tukh regions during the two years of investigations (2000-2001 & 2001-2002). The monthly total numbers collected were, 19, 24, 32, 55, 59, 56, 62, 46, 34, 29, 30 and 23 individuals / 100 leave, at Benha and 20, 21, 31, 52, 56, 54, 60, 44, 33, 27, 30 and 21 individuals at Tukh region at average temperatures 18.24, 16.09,

16.54, 20, 23.6, 25, 28.2, 29.71, 30.17, 29, 22.65 and 18.32°C and relative humidity 59.4, 63.05, 61.55, 64.39, 61.16, 55.48, 57.6, 59.6, 63.62, 59.83, 59.12 and 59.21% (Table, 5) during the first year at Benha and Tukh region. While, in the second year (Tables, 3 & 4) the monthly total numbers of *B. californicus* were 22, 26, 28, 52, 55, 55, 61, 44, 35, 28, 31 and 20 individuals at Benha and 20, 22, 27, 46, 50, 52, 55, 48, 38, 33, 30 and 20 individuals /100 leaves at Tukh region when the average temperatures were 15.95, 14.99, 14.81, 18.51, 21.20, 25.24, 28.38, 29.31, 29.90, 28.60, 23.17 and 20.62°C and relative humidity 59.59, 64.84, 62.03, 67.74, 60.27, 56.87, 57.27, 61.25, 61.17, 49.27, 44.97 and 39.54% (Table 5) during December; January; February; March; April; May; June; July; August; September; October and November, respectively.

From the above mentioned data it is revealed that *B. californicus* has one peak of population abundance in June during the two successive years (2000-2001 and 2001-2002) at Benha and Tukh regions. This peak represented by 62 and 61 individuals at Benha region but these number were 60 and 55 individuals/100 leaves at Tukh regions, whereas the average temperature was 27.2 and 29.81°C and relative humidity 61.25 and 65.6% during two successive years, respectively.

b. Seasonal abundance of Citrus rust mite, *Phyllocoptruta oleivora* Ashmed (Fam. Eriophyidae) on leaves of Navel orange variety.

Results in Tables (1 & 2) and Figs. (1&2) indicate that the citrus rust mite, *P. olievora* appeared on leaves with few number during the period extended from November to February with one peak in December, then disappeared completely during the remaining

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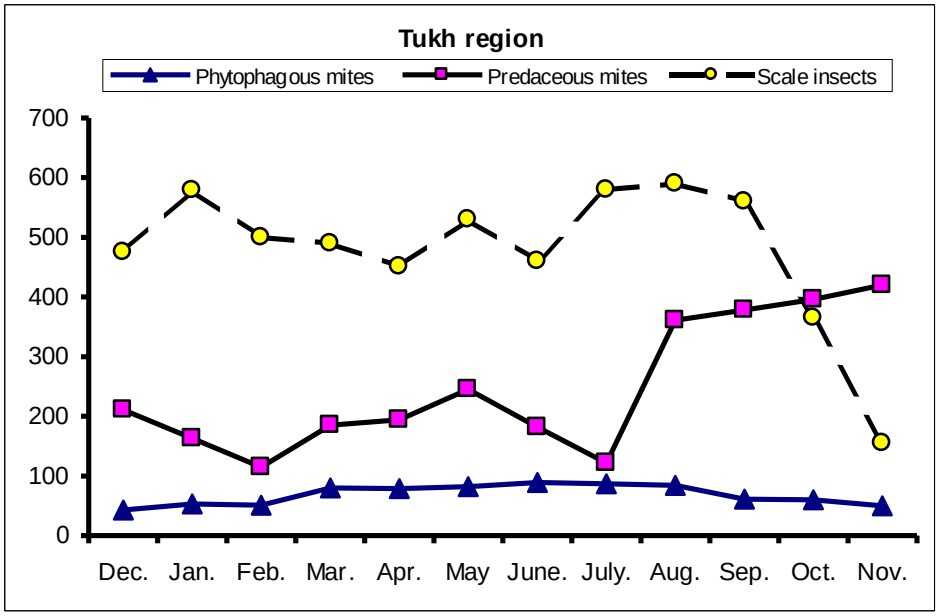

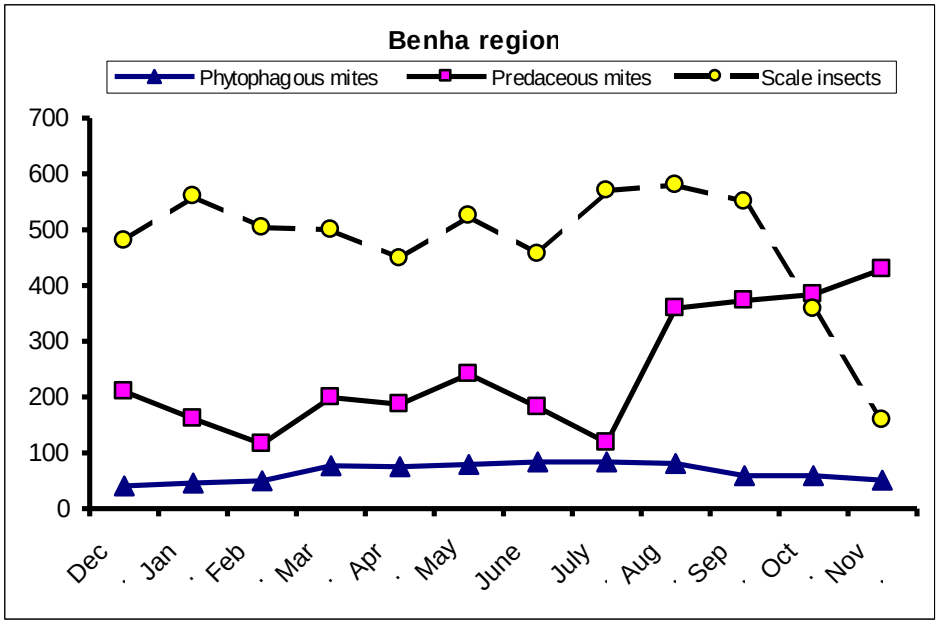

Fig. (1): Population dynamics of phytophagous mites, scale insects and predaceous mites on Navel orange trees throughout the first year of study at Benha and Tukh region (Qalubia Governortae)

months. The collected numbers of this mite were 13 and 12 individuals / 100 leaves at average temperature 18.24 and relative humidity 59.4% during the first year. While, in the second year (Tables, 3 & 4), these numbers were 12, 11 individuals at Benha and Tukh region at 15.95°C and 59.59% RH., respectively (Table 8).

These results agreement with **Halawa (1998)** who found that the *Phyllocoptruta oleivora* was in few numbers on leaves of Navel orange variety during winter and it had one peak in January.

c. Seasonal abundance of Citrus brown mite, *Eutetranychus orientalis* (klein) (Fam. Tetranychidae) on leaves of Navel orange variety.

The citrus brown mite, *E. orientalis* infests the upper surface of leaves of citrus.

Results in Tables (1, 2, 3 & 4) indicate that the monthly total numbers of the citrus brown mite were 11, 20, 16, 25, 20, 26, 27, 41, 50, 32, 30 and 19 individuals at Benha region and 9, 19, 17, 25, 19, 25, 24, 40, 48, 32, 29 and 20 individuals / 100 leaves at Tukh region in December; January; February; March; April; May; June; July; August; September; October and November during the first year, while, in the second year, the monthly total numbers of *E. orientalis* were 13, 15, 19, 21, 23, 22, 28, 40, 44, 41, 33, 17, 18, 20, 20, 25, 38, 42, 42, 31 and 11 individuals at Tukh region during December; January; February; March; April; May; June; July; August; September; October and November, respectively.

It can be conclude that, from recorded phytophagous mites *B. californicus* was occupied the highest population on navel orange trees, whereas recorded in high numbers during two successive

years. It had one peak in June at Benha and Tukh regions. While the citrus brown mite *E. oreintalis* was found with moderately number at two regions and had one peak in August during the two successive years. But, the citrus rust mite, *P. oleivora* was recorded in few numbers during the two successive years at Benha and Tukh regions.

Statistical analysis of data demonstrated that the population of phytophagous mites *B. californicus; P. oleivora* and *E. orientalis* were positive correlated with average temperature and negative correlated with average relative humidity during the two successive years (Table, 6).

Similar results were obtained by **Neena *et al.* (1998)** who found that there was a positive correlation between temperature and the population development of *Euteranychus. Orientails.* Also, **Dhoria and Butani (1984)** stated that *Eutetranychus orintalis* in India, was found through the year on citrus spp. and had one peak in May and June during high temperature (21-27°C) and low humidity rates.

1.a.2. Population dynamics of some scale insects on leaves of navel orange variety:

Data in Tables (1 & 2) and Figs. (1&2) show that the scale insects which recorded on leaves of Navel orange were the following two species *P. zizyphus* and *L. beekii*. At the first year (2000 – 2001) the monthly total numbers of collected alive scale insects were 475, 579, 500, 490, 451, 530, 460, 580, 590, 560, 365 and 155 individuals / 100 leaves at Benha region and 480, 560, 504, 500, 448, 525, 456, 570, 580, 550, 358 and 159 individuals at Tukh

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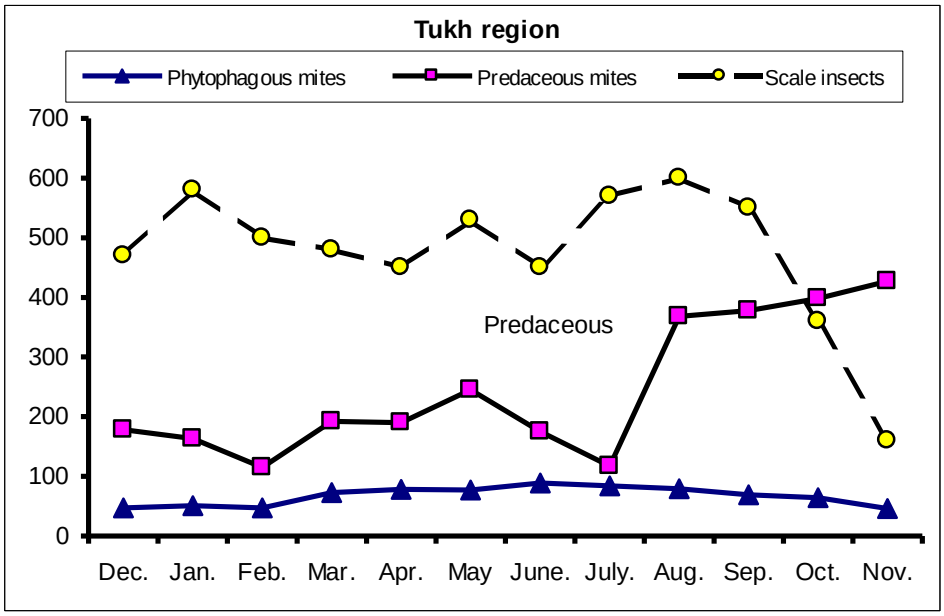


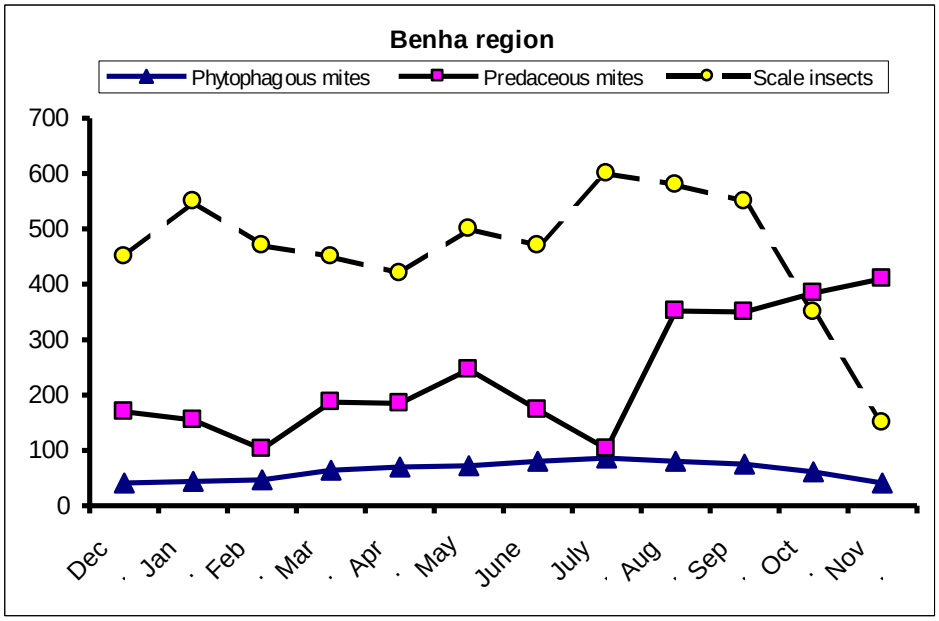


Fig. (2): Population dynamics of phytophagous mites, scale insects and predacious mites on Navel orange trees throughout the second year of study at Benha and Tukh region (Qalubia governorate)

region at different average temperatures and relative humidity (look at Table, 8), respectively. While, in the second year (2001-2002), the monthly total numbers of scale insects were 470, 580, 500, 480, 450, 530, 450, 570, 600, 550, 360 and 160 individuals at Benha region and 450, 550, 470, 450, 420, 500, 470, 600, 580, 550, 350 and 150 individuals / 100 leaves at Tukh region (Tables 3 & 4) at average different temperatures and relative humidity (look at Table, 8) during December; January; February; March; April; May; June; July; August; September; October and November, respectively.

Statistical analysis of obtained data revealed that the correlation between the population of scale insects and average temperature was negative. While, the population was positive correlated with relative humidity during two successive years (Table, 5)

1.a.3. Population dynamics of predaceous mites on leaves of Navel orange variety:

Collected predaceous mites *Agistemous exsertus* Gonzalez stigmaeidae), *Saniosulus nudus S*ummers (Eupalopsellidae) and *Typhlodromus athiasae* Porath and Swisski (phytosiidae) on trees at Qalubia governorrate .

1. Seasonal abundance of *Typhlodromus athiasae* Porath & Swirski (Fam. Phytoseiidae) on Navel orange variety.

Results in Tables (1, 2, 3 & 4) and Figs. (1&2) clear that, the phytosiid mite, *T. athiasae* has two peaks in May and November at

Benha and Tukh region during the two successive years. The monthly total numbers of its predator were 80, 75, 70, 79, 84, 90, 60, 40, 126, 140, 148, 160 individuals at Benha region and 78, 76, 70, 89, 84, 90, 62, 41, 133, 138, 145 and 170 individuals / 100 leaves at Tukh region at average temperatures and relative humidity recorded in (Table, 8) during the first year which extended from December 2000 to November 2001. While, in the second year, these population numbers were 78, 76, 72, 87, 82, 88, 57, 38, 132, 142, 145 and 178 individuals at Benha region and 76, 73, 63, 85, 80, 87, 60, 39, 125, 135, 142 and 175 individuals / 100 leaves at average temperatures and relative humidity (as shown in Table, 8) during the period extended from December 2001 to November 2002, respectively.

2- Seasonal abundance of *Cheletogenes ornatus* (C. and F.) (Fam. Chyletidae) on Navel orange leaves:

Data presented in Tables (1, 2, 3 & 4) and Figs. (1&2) show that, the predaceous mite, *C. ornatus* was recorded in moderate numbers during the two years. This species gradually decreased in number from December to February, then increased gradually from march to May and decreased again through June and July, after that it is increased gradually from August to November. It has two peaks of abundance during the two successive years, these peaks were recorded in May and October at the first year. The highest total number was 130 individuals in October at Benha region and 127 individuals in September at Tukh region at 22.4 and 29°C and 59.12 and 59.83%, RH., respectively. In the second year, the highest number of its predator recorded in October at Benha and Tukh

region being 132 and 120 individuals at 23.17°C and 44.97% at Benha and Tukh, respectively.

In this respect, **El-Badry and Zaher (1960)** found that the population of *Chetogenes ornatus* was comparatively increased during August and September.

3- Seasonal abundance of *Agistemus exsertus* Gonzalez (Fam. Stigmaidae) on leaves of Navel orange variety.

It is known that the predator, *Agistemus exsertus* is considered as an active predator against many pests, specially their immature stages. This species was recorded in moderate numbers from December 2000 to November 2002 (Tables 1, 2, 3 & 4) of abundance. It has three peaks the first peak was in May, the second peak in August, while the third peak was in November during the first and second year and at Benha and Tukh region. The highest number of its predator was 67 individuals at Benha region and 65 individuals / 100 leaves at Tukh region at 30.19 and 18.32°C and 63.62 and 59.21% RH. through August and November of the first year. In the second year, the highest number of this predaceous mite was 65 at Benha region and 65 at Tukh region through August at average temperature 29.20°C and relative humidity 61.17%.

These results agree with **Rizk *et al.* (1983)** who found that *Agistenus exsertus* and *Chelotogenes ornatus* were the most abundant predators on orange and lemon. Densities of all 2 predaceous species were calculated from the correlation coefficient

to be significantly related to the density of *E. orintalis* in July, October 1976.

4- Seasonal abundance of *Saniosulus nudus* Summers (Fam. Eupalopselliidae) on Navel orange variety.

It is noticed that the predaceous mite *S. nudus* prefers scale insect, in its feeding. In Tables (1-4) and Figs. (1&2) data indicate that this predaceous mite, has two peaks of abundance every year, the first in May and the 2nd in November. In the first year, the highest number (70 individuals) was recorded in November at 20.32°C and 62.21% RH. While, in the second year, the highest number was 67 and 70 individuals at Benha and Tukh region, respectively in November at 20.62°C and 39.54% RH.

Statistical analysis of simple correlation between the population of predaceous mites and the two climatic factors under study showed that there are negative correlation with temperature and positive correlation with RH. (Table, 5).

From the previously mentioned data it can be conclude that the predaceous mite, *Typhlodromus athiasae* and *Cheletogene ornatus* were recorded in high numbers followed by *Agistimus exsertus,* while the predaceous mite *Saniosulus nudus* was recorded the lowest numbers during the two successive years of infestation. **Kapur-Ghai and Mondeepkour (2003)** mentioned that correlation of the mites population with a biotic factors indicated positive correlation with temperature and negative correlation with relative humidity.

Table (5): Coefficient values of simple correlation between phytophagous, scale insects and their predaceous mites; and both temperature and relative humidity during the two years of investigation.

Factors	First year (2000-2001)				Second year (2001-2002)			
	Benha		Tukh		Benha		Tukh	
	Temp.	RH.	Temp.	RH.	Temp.	RH.	Temp.	RH.
Phytophagous mites	0.71**	-0.23	0.66**	-0.15	0.69**	-0.25	0.65**	-0.19
Scale insects	-0.057	0.73*	-0.17	0.68	0.61	0.77	-0.13	0.72*
Predaceous mites	-0.023	0.79**	-0.33	0.78**	-0.27	0.82**	-0.29	0.76*

1.b- Relationship between predaceous mites and Phytophagous (pests mites and scale insects):

Results in Table (6) and Fig. (3 & 4) demonstrate that the population of predaceous mites was positively affected with the population of phytophagous pests (mites and scale insects) during all months of the two years where correlation coefficient values were (0.42) and (0.44) in the first year, while in the second year these values were (0.40) and (0.43) at Benha and Tukh, respectively. In the first year, the monthly total numbers of predaceous mites were 211, 163, 115, 185, 194, 245, 182, 122, 361, 378, 396 and 420 individuals leaves at Benha region and 210, 161, 116, 199, 187, 241, 182, 118, 359, 373, 384 and 429 at Tukh region, while the total phytophagous (pests mites and scale insects) were 518, 632, 551, 570, 530, 612, 549, 667, 673, 621, 425 and 205 at Benha region and 521, 606, 554, 577, 559, 304, 540, 654, 661, 609, 417 and 210 individuals at Tukh region, respectively. While in the second year when the monthly total numbers of predaceous mites were 178, 163, 115, 192, 190, 245, 175,117, 368, 378, 398 and 427 individuals at Benha region and 170, 155, 102, 187, 185, 246, 173, 103, 359, 350, 384 and 410 individuals at Tukh region, the population of phytophagous mites and scale insects were 517, 631, 547, 553, 528, 607, 539, 654, 679, 619, 424 and 206 individuals at Benha region and 491, 594, 517, 514, 490, 572, 550, 686, 660, 625, 411 and 191 individuals at Tukh region during December; January; February; March; April; May; June; July; August; September; October and November, respectively.

Table (6): Monthly numbers of predaceous mites and phytophagous pests (mites and scale insects) during the two years on Navel orange trees.

Date of sample	First year (2000-2001)				Second year (2000-2001)			
	Benha region		Tukh region		Benha region		Tukh region	
	Pred.	Phyto.	Pred.	Phyto.	Pred.	Phyto.	Pred.	Phyto.
December	211	518	210	521	178	517	170	491
January	163	632	161	606	163	631	155	594
February	115	551	116	554	115	547	102	517
March	185	570	199	577	192	553	187	514
April	194	530	187	559	190	528	185	490
May	245	612	241	304	245	607	246	572
June	182	549	182	540	175	539	173	550
July	122	667	118	654	117	654	103	686
August	361	673	359	661	368	679	352	660
September	378	621	373	609	378	619	350	625
October	396	425	384	417	398	424	384	411
November	420	205	429	210	427	206	410	191
Total	2972	6554	2959	6476	2946	6504	2817	6301
Correlation coefficient values	* 0.42		* 0.44		* 0.40		* 0.42	

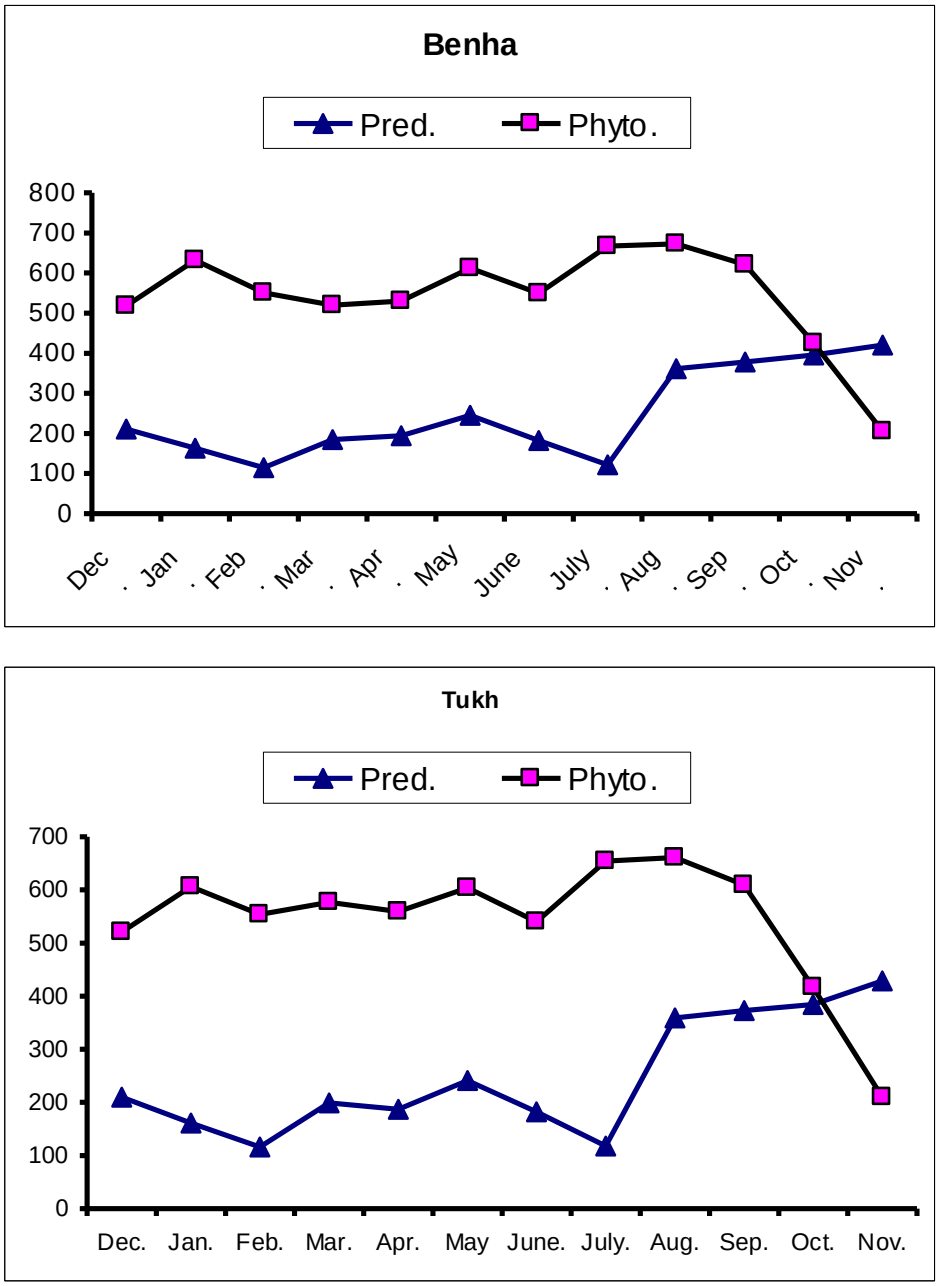
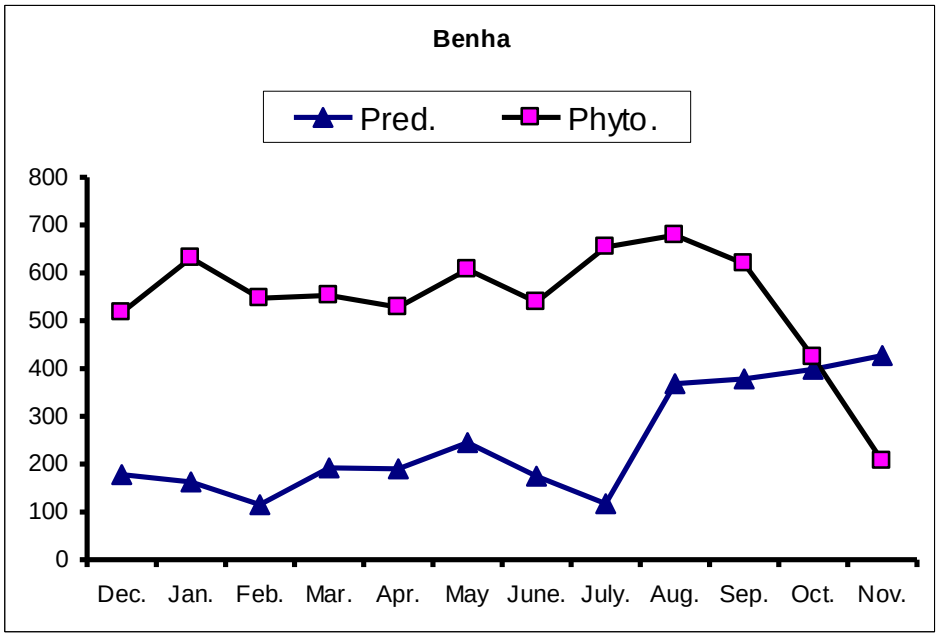


Fig. (3): Relationship between the population of predaceous mites and phytophagouse pests (mites and scale insects) throughout the first year on Navel orange trees at Benha and Tukh, Qalubia Governorate.

In conclusion, the predaceous mites *T. athiasae* and *C. ornatus; A. exsertus* and *S. nudus* play an important role in reducing the population density of phytophagous pestis (mites and scale insects) thus, it must be did not use any a caricides during the presence of higher population of predaceous mites. These results agreement with **El- Bagaury (1970)** reported that the predaceous mites belonging to family phytoseiidae, Tydeidae and stigmadae was playing an important role in reducing the population dynamics of phytophagous mites.



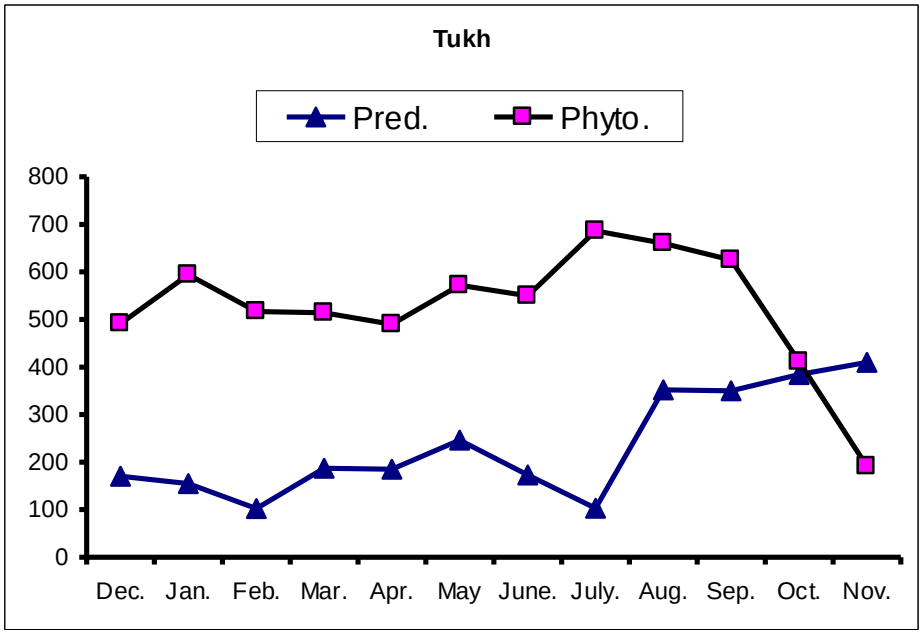


Fig. (4): Relationship between the population of predaceous mites and phytophagouse pests (mites and scale insects) throughout the second year on Navel orange trees at Benha and Tukh, Qalubia Governorate.

1.c. Distribution of different mite species and scale insects during the four season of each year:

Data in Table (7) and Fig (5 & 6) show that the highest numbers of phytophagous mites on leaves of Navel orange trees at Toukh (Moshtoher) and Benha (Degwa) region were recorded in summer season, being 244 & 246 individuals and 260 & 252 individuals during the two years of investigation 2000-2001and 2001-2002, respectively. While, the lowest numbers were estimated during winter season at Toukh region showing and 132 individuals during the two season, respectively. But the lowest numbers at Benha region were 147 and 145 individuals. Concerning, the highest numbers of predaceous mites were recorded during Autumn season being 1186& 1144 and 1194 & 1203 individuals during the two seasons, at Toukh and Benha region, respectively. Wile the lowest numbers of predaceous mites were recorded in Autumn season. While, the highest population numbers of scale insects recoded during the summer season (1606 and 1650) individuals throughout the first second year respectively, in Toukh region and 1630 and 1620 individuals, in Benha region. But the lowest numbers were recorded in Autumn season.

From the above mentioned data it can be conclude that the population of phytophagous mites on Navel orange trees was recorded in high numbers in summer and a few numbers in winter in Toukh region and Benha region. While the population numbers of predaceous mites were high number during Autumn and a few number during winter in Toukh region and Benha region through

two years. But the population of scale insects recorded is high numbers during two years in summer and a few numbers in Autumn in Toukh region and Benha region. In this respect **Rakha (1977)** found the Eupaloposellid mite allover the year on citrus trees and fruits infested with scale insects, it was found in high numbers during summer and Autumn.

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IV.2- Biological aspects and feeding capacity of some predaceous mites:

Laboratory experiments were carried out to study the effect of temperature and kind of foods on the biology of the three predaceous mites, *Agistemus exsertus* Gonzalez (Fam. Stigmaeidae), *Saniosulus nudus* Summers (Fam. Eupalopsellidae) and *Typhodromus athiasae* Porath and Swirski (Fam. Phytoseiidae) under controlled conditions of 16, 24, 28, 30 and 32°C associated with 70% RH.

2.a- *Agistemus exsertus* (Fam. Stigmaeidae):

The durations of various immature stages of the predator, *Agistemus exsertus* reared on four diets, *T. urticae* eggs. *T. urticae* immature stages, *L. beckii* eggs and date palm pollen grains were estimated when rearing took place at 16, 24, 28, 30 and 32°C. The obtained data are presented in Tables (9, 10, 11, 12 & 13). Data recorded in these tables show the following.

2.a.1. Duration of immature stages:

1- Incubation period:

When the predaceous mite, *A. exsertus* fed on *T. urticae* (eggs), *T. urticae* (immatures), *L. beckii* (eggs) and date palm pollen grains the incubation periods were (7.00, 7.44, 7.40 and 7.34 days); (4.92, 5.67, 5.62 and 5.44 days); (3.95, 4.75, 4.57 and 4.42 days); (2.95, 3.79, 3.55 and 3.45 days) and (2.64, 3.40, 3.48 and 3.17 days) at 16, 24, 28, 30, 32C, respectively (Tables, 9 - 13) at tested temperatures 16, 24, 28, 30, respectively. These data indicate that the incubation period of the predator eggs decrease with increasing temperature from 16 to 30°C

(Tables, 9, 10, 11, 12 & 13). Also, data revealed that the longest incubation period was obtained when the predator fed on *T. urticae* eggs, while the shortest period was when fed on palm pollen grain.

2- The total larval and nymphal period:

When *A. exsertus* females fed on *T. urticae* eggs, larvae and nymphs of *T. urticae*, eggs of *L. beckii* and date palm pollens, data in Tables (9, 10, 11, 12 & 13) show that the total larval and nymphal periods of this predator lasted (14.57 ± 0.78, 15.73 ± 1.15, 17.84 ± 0.40 and 17.87 ± 0.60 days); (11.60 ± 0.87, 12.67 ± 0.30, 14.90 ± 0.53 and 14.87 ± 0.80 days); (7.90 ± 0.87, 8.90 ± 1.35, 11.20 ± 0.61 and 10.87 ± 1.06 days); (9.37 ± 1.15, 10.40 ± 1.28, 12.40 ± 0.35 and 11.96 ± 1.26 days) and (9.82 ± 1.16, 11.10 ± 1.05, 13.07 ± 0.32 and 12.70 ± 1.25 days) at 16, 24, 28, 30 and 32°C, respectively.

While, for males these periods were (14.30 ± 0.50, 15.90 ± 0.10, 14.97 ± 0.67 and 17.73 ± 1.15 days), (11.17 ± 0.59, 12.87 ± 0.15, 11.60 ± 0.87 and 15.13 ± 1.11 days), (8.07 ± 0.68, 9.60 ± 0.10, 8.33 ± 0.96 and 12.17 ± 1.39 days), (9.10 ± 0.53, 10.27 ± 0.51, 9.38 ± 0.96 and 13.10 ± 1.21 days) and (9.00 ± 0.53, 10.15 ± 0.58, 9.25 ± 0.84 and 13.03 ± 1.23 days) at different tested temperatures, respectively.

From these data, a negative correlation may be observed between the total larval and nymphal period and temperature, i.e. with the four diets of food, this period was decreased by increasing temperature from 16 to 32°C.

These results concluded that, the durations of immature stages were found to be affected by temperatures and type of food. Eggs of *T. urticae* was the most favourable diet for this predator,

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whereas the total periods were (14.57 and 14.30 days for females and males at 16°C; 11.60 and 11.17 days at 24°C;7.90 and 8.07 days at 28°C; 9.37 and 9.10 days at 30°C and 9.82 and 9.00 at 32°C0. Also, data indicated that males emerged earlier than females.

Statistical analysis of data show that, there are significant differences in the durations of the total larval and nymphal period of females between *T. urticae* (eggs) (D1) and both of *L. beckii* eggs (D3 and date palm pollens (D4) at different temperatures, also, between *T. urticae* immatures (D2) and each of D3 & D4 at 16, 24, 28 and 32°C. While, no significant differences were found between D1 and D2 or D3 and d4 at various temperatures.

For males, significant differences were recorded between D1 & D2 and both of D3 & D4 at 16°C. It is also, noticed that with D4 the immature durations increased significantly compared to other diets at 24, 28, 30 and 32°C.

No significant differences were found between D1 and both of D2 & D3 at 28, 30 and 32°C.

3- Total developmental period:

At 16°C, the total developmental period of *A. exsertus* (from egg deposition to adult emergence) lasts 21.73 ± 1.05, 23.83 ± 0.10, 26.17 ± 0.31 and 26.23 ± 0.96 days for females and 20.63 ± 0.86, 22.67 ± 0.32, 21.43 ± 1.10 and 24.03 ± 1.46 days for males when fed on *T. urticae* eggs (D1), *T. urticae* (larvae & nymphs) (D2), *L. beckii* eggs (D3) and date palm pollens (D4) respectively. But, at 24°C, these periods were16.37 ± 1.14, 18.37 ± 1.37, 21.00 ± 0.46 and 20.73 ± 1.15 days for female and 16.23 ± 0.96, 18.50 ± 0.46,

16.73 ± 1.31 and 20.13 ± 1.39 days for males. At 28°C, this period averaged 11.47 ± 1.23, 13.53 ± 1.52, 16.10 ± 0.78 and 15.50 ± 1.51 days for females and 12.40 ± 1.01, 14.47 ± 0.35, 12.56 ± 1.62 and 16.37 ± 1.55 days for males. While, at 30°C it was 12.04 ± 1.90, 14.20 ± 1.40, 16.37 ± 0.49 and 15.73 ± 2.06 days for females and 12.33 ± 0.80, 14.04 ± 0.22, 12.52 ± 1.54 and 16.23 ± 1.36 days for males. Also, these periods were 12.32 ± 1.75, 14.53 ± 1.12, 16.70 ± 0.44 and 16.27 ± 1.99 days for females and 11.77 ± 0.71, 13.52 ± 0.75, 12.07 ± 1.43 and 15.80 ± 1.44 days for males at 32°C when fed on the abovementioned diets, respectively (Tables, 9, 10, 11, 12 & 13).

These results showed that the total developmental period is affected by temperature and type of diet. Whereas, the shortest duration for female (11.47 days) was recorded at 28°C and (11.77 days) for male at 32°C with *T. urticae* eggs (the most favourable diet).

The total developmental period of female decreased significantly when fed on D1 compared with D3 and D4 at various tested temperatures and D2 at 16°C only.

Concerning, the developmental period of male significant differences were found between D1 and each of D2 & D4 at 16 and 24°C, also between each of D1, D3 and D4 at 28°C and between each of the first three diets and D4 at 30 and 32°C.

These data indicate that the shortest total developmental period of the predaceous mite, *A. exsertus* was recorded at 28, 30 and 32°C and this duration prolonged by decreasing the temperature. Also, it could be, generally observed that this period

was shorter by fed on *T. urticae* eggs (D1) than in cases fed on D2, D3 and D4.

It can be conclude that *T. urticae* eggs are considered as the most favourable diet for mass rearing of *A. exsertus*. While, date palm pollens play an important diet for this predator, in case of disappeared the other alive diets.

2.a.2. Adult's longevity:

Data in Tables (9, 10, 11, 12 & 13) reveal that the shortest periods of *A. exsertus,* female's longevity were 36.03 ± 1.37, 32.72 ± 0.40, 21.60 ± 0.56, 24.67 ± 0.06, 17.78 ± 0.33, 20.47 ± 0.32, 18.13 ± 1.70, 19.20 ± 0.72 and 17.67 ± 2.27 and 19.83 ± 0.40 days and 16, 24, 28, 30 and 32°C, respectively, when fed on eggs of *T. urticae* and immatures of *T. urticae*, respectively. While, the longest periods were 40.45 ± 1.29, 44.17 ± 1.04, 33.07 ± 1.27, 35.97 ± 1.55, 28.47 ± 1.46, 31.93 ± 1.60,28.13 ± 1.59, 31.60 ± 1.75 and 28.07 ± 0.75 and 31.37 ± 1.52 days at 16, 24, 28, 30 and 32°C, respectively, when females were supplied with eggs of *L. beckii* and date palm pollen, respectively (Tables, 9, 10, 11, 12 & 13). Longevity of males taken the same trend.

Generally, data in Tables (9, 10, 11, 12 & 13) indicate, also, that female live for longer period than the male under both four types of food and different temperatures. From these data it is clear that the longevity in both sexes was short at high temperature, whereas, the shortest period of female (17.67 days) obtained at 32°C, while it was (13.53 days) for male at 30°C when fed on the most favourable diet, i.e. eggs of *T. urtucae*.

Analysis of variance and testing of differences in case of adult female showed significant differences between each of D1 & D2 and both of D3 & D4 at all tested temperatures, and also between D3 and D4 at 24, 28 and 30°c only. On the other hand, male results revealed that there are significant differences between D1 and each of D3 & D4 at different temperatures, D2 and both of D3 & D4 at various temperatures except at 28°C. only significant differences were recorded between D3 and D4 at 16, 24 and 30°C.

From the same data and data in Table (9, 10, 11, 12 & 13) it could be concluded that adults of the predaceous mite, *A. exsertus* is better to be supplied with the eggs or/and immatures of *T. urticae* at 28°C for assuring higher reproductivity of eggs by the predator females and consequently production of higher numbers of the predator.

In this respect, **Yue and Childers (1994)** studied the effect of temperature on life table parameters of *Agistemus exsertus* using *Panonychus citri* (Mc. Gregor) eggs at 15, 20, 25, 30 and 35°C. They found that the mean length of a generation (T) was 35.9, 18.1, 14.5, 11.4 and 12.6 days, respectively. Also, the same authors indicated that than 70% of the *A. exsertus* eggs developed to adults when they were maintained at temperatures between 20 and 15°C compared with only 415 at 15°C.

2.a.3. Adult's life span:

Data in Tables (9, 10, 11, 12 & 13) indicate that female's and male's life span of the predaceous mite, *A. exsertus* took the same trend of adult's longevity. Where, the longest period for female (70.40 days) and (65.07 days) for male was recorded at 16°C, when

fed on date palm pollen. While, the shortest period was (29.98 days) for female and (25.53 days) for male after feeding on eggs of *T. urticae* at 32°C. Statistically, it can be observed that there are significant differences of female life span between each of D1 & D2 and both of D3 & D4 at different temperatures, D1 and D2 at 24°C, D3 and D4 at 16°C at 16°C only. While, no significant differences were found between D1 and D2 at various temperatures except at 24°C, D3 and D4 at all tested temperatures without 16°C only.

On the other hand, male results showed that, there are significant differences between each of D1 & D2 and D3 & D4 at all temperatures, D2 and D3 at 16°C only, both of D2 & D3 and D4 at different temperatures. But at all tested temperatures without 16°C, no significant differences between D1 and D3 or D2 and D3 were found.

2.a.4. Ovipositional periods:

The relationship between kind of food offered to *A. exsertus* adults, at different constant temperatures and their ovipositional periods and fecundity. The ovipositional periods and fecundity of the predator, *A. exsertus* were investigated under laboratory conditions of 16, 24, 28, 30 and 32°C and 70% RH. when adults fed on four types of food (D1, D2, D3 and D4), to clarify the effects of type of food on egg reproductivity and ovipositional periods of adults.

Pre-oviposition period:

Data presented in Table (14) show that the pre-oviposition period for female of *A. exsertus* is affected by temperature and the type of food. The longest pre-oviposition period was 7.03 ± 0.45

days recorded at 16°C, when adults fed on date palm pollens, while, the shortest period was 2.53 ± 0.21 days at 28°C for females fed on eggs of *T. urticae*.

Oviposition period:

As shown in table (14) the oviposition period was negatively affected by temperature and kind of diet. It decreased to the minimum value (9.29 days) at 30°C, when adults fed on eggs of *T. urticae*, while, it prolonged at 16°C to reach its maximum value (23.03 days) after feeding on date palm pollens.

Post-oviposition period:

As shown in Table (14) the post oviposition period varied from diet to another under various temperatures. The shortest post-oviposition period was 4.03 days obtained at 28°C when fed on eggs of *T. urticae*, while, the longest period 14.10 days was recorded at 16°C with date palm pollens.

2.a.5. Fecundity (number of deposited eggs / female):

Data in table (14) reveal that the daily and total number of deposited eggs / female are affected by both the type of food offered to adult female and temperature. Concerning, the effect of ford, it is clear that the highest total numbers of eggs deposited / females were recorded with females fed on eggs of *T. urticae* (D1), being 26.57 ± 1.44, 65.40 ± 0.66, 72.43 ± 2.27, 40.67 ± 4.54 and 39.00 ± 6.87 eggs at 16, 24, 28, 30 and 32°C, respectively, while, the lowest total number of eggs / female (19.00 ± 1.00, 46.00 ± 3.60, 56.10 ± 3.64, 25.13 ± 4.67 and 19.0 ± 1.00, respectively) was obtained when the *A. exsertus* adults were fed on pollens of date palm (D4). The same trend could be observed for the daily mean number of eggs / female.

T14

Regarding, the effect of temperature, data in Table (14) indicate that the highest numbers of deposited eggs / female were recorded at 24 and 28°C with all types of food. Whereas, the greatest number of deposited eggs per female occurred at 28°C (72.43 eggs), with a daily rate (6.46 eggs) when fed on eggs of *T. urticae* but the smallest number of eggs (19.00 eggs) were deposited by female at 16°C and date palm pollens with a daily rate (0.82 egg).

Statistical analysis of data reveal that, there are significant differences between D1 and each of D2, D3 and D4 at 24, 28, 32°C, D1 and D3 & D4 at 30°C only, and between D1 and D4 at 16°C, meanwhile at 24 and 28°C significant differences were recorded between D2 and each of D3 & D4.

As shown in Table (14) feeding of adults on eggs or immature of *T. urticae* at 24 and 28°C led to satisfactory eggs reproductivity. Also, the highest number of deposited eggs was obtained at 28°C withal types of food.

Sex ratio:

Data presented in Table (14) show clearly the effect of temperature and kind of diet on sex ratio of *A. exsertus.* The percentages of females / total were lowest at 16°C, being 52.47, 51.78, 50.00 and 47.04% when females fed on eggs of *T. urticae*, immatures of *T. urticae,* eggs of *L. beckii* and date palm pollens, respectively. While, these percentages of females increased to reach, its maximum values 66.24, 65.03, 63.03 and 61.05% at 28°C with all aforementioned diets, respectively, then decreased again to reach 50.21, 50.35, 49.81 and 49.45% at 32°C with above mentioned

diets, respectively from the above results it can be conclude that reared *A. exsertus* at 28°C and fed on eggs of *T. urticae* diet were the most suitable conditions for giving the highest females sex ratio, which consequently resulted in reproduction increase.

2.a.6. Feeding capacity of the predaceous mite, *A. exsertus* on different preys:

The consumption rates of *A. exsertus* on *T. urticae* eggs, *T. urticae* immatures and *L. beckii* eggs under 28°C and 70% RH. are presented in Tables (15 & 16).

Total consumption throughout the immature stages:

As shown in Table (15) the total consumption of preys throughout the immature stages of the female predator was 18.50 ± 1.32 eggs, 18.50 ± 3.00 immatures and 40.33 ± 2.02 eggs when fed on *T. urticae* eggs and immatures (prey 1 and 2) and *L. beckii* eggs (prey 3). While, throughout the whole period of the immature stages of male of the same predator consume an average of 36.33 ± 2.57 eggs of *T. urticae* (prey 1), 16.17 ± 7.64 immatures of *T. urticae* (prey 2) and 34.17 ± 0.76 egg of *L. beckii* (table, 16).

The presented data indicate that the immature stages of this poredator consume much more eggs of *T. turticae* and *L. beckii* than *T. urticae* immatures. This higher number of eggs consumed may attributed to the smaller size of eggs than immatures. Also, it is clear that the immatures of females consumed higher numbers of prey than immature of males.

The total amounts and daily rate of various consumed prey (eggs of *T. urticae* immatures of *T. urticae,* and *L. beckii* eggs) per predator adult were greater than those consumed by immatures.

It is also, revealed that male followed similar trend as that of female but consumed smaller numbers of prey. Statistically, total amount of consumed prey per different stages of predator and adults showed significant differences between each of prey 1, prey 2 and prey 3 but, differences between prey 1 and prey 3 were no significant.

It can be conclude that, at different kinds of preys offered, and at different temperatures the faster development of *A. exsertus* (11.47 days) female, the shortest longevity of it (17.78 days) and the highest reproductive rate (72.43 eggs /female) were obtained on eggs of *T. urticae* at 28 ± 1°C and 70 ± 5% RH.

Adult stage:

As shown in tables (15 & 16) and throughout adult life-span, the adult female of *A. exsertus* consumed a total number of 180.83 ± 7.29 *T. urticae* eggs, 81.00 ± 9.76 *T. urticae* immatures and 194.33 ± 12.11 *L. beckii* eggs. While, the adult male fed low amounts of all preys, showing 129.33 ± 8.14, 63.50 ± 7.70 and 125.50 ± 4.27 with prey 1, 2 & 3, respectively.

Concerning the feeding capacity of adults, it is clear that the female adults of *A. exsertus* consumed higher numbers of different preys than male. Also, both male and female consumed higher amounts of *T. urticae* and *L. beckii* eggs than *T. urticae* immatures.

In this respect, **Hanna *et al.* (1980)** studied the effect of food type on the fecundity an lifespan of the predator *Agistemus exsertus*.

She found that, eggs of *Tetranychus arabicus (T. urticae*) and *Oligonychus mangiferus* afforded greater fecundity and a longer lifespan to the predator than did other immature than those of *O. magniferus*. A prelarval stage is recorded and described for the first time for *A. exsertus.* Also, **Nawar (1992)** found that the oviposition and prey consumption rates of *Agistemus exsertus* Gonzalez depend on the number of prey available to the predator. The number of eggs laid/predator female, and the consumption of *T. urticae* as prey increased with increasing prey density to a maximum averages of 2.3 deposited eggs, and 5.8 devoured larvae per day at a prey density of 7 larvae predator. High levels of prey crowding decreased predator oviposition and feeding capacity.

T15

T16

3-a. *Saniosulus nudus* Summers :

3-a.1. Durations of immature stages:

The durations of immature stages of *S. nudus* were studied under four kinds of diet eggs of *T. urticae* (D_1), immatures of *T. urticae* (D_2), eggs of *L. beckii* (D_3) and pollens of date palm (D_4) at different temperatures.

1- Egg stage (Incubation period):

Results in Tables (17, 18, 19, 20 & 21), indicate that, the incubation period of the predator, *S. nudus* was decreased by temperature increasing. The longest incubation period was (7.57 ± 0.05 days) recorded at 16ºC, when fed on *L. beckii* eggs, while, the shortest period was (2.99 ± 0.01 days) obtained at 32ºC when fed on pollens of date palm.

2- The larval and nymphal periods:

As shown in Tables (17, 18, 19, 20 & 21) the duration of immature stages period of *S. mudus* decreased when temperature increased. By feeding the immature stages of female and male on the most favourable diet (*T. urticae* eggs) duration of its stages averaged 26.36 ± 0.38 & 25.53 ± 0.50, 19.93 ± 0.49 & 19.13 ± 0.49, 16.60 ± 0.90 & 16.47 ± 0.43, 12.83 ± 0.60 & 12.52 ± 0.46 and 12.30 ± 0.66 & 11.92 ± 0.40 days at 16, 24, 28, 30 and 32ºC, respectively.

Also, from data in the same tables, it is clear that the longest durations of female and male (25.61 ± 0.50 & 24.27 ± 0.50 days) were estimated at 16ºC after feeding on date palm pollens. While, the shortest durations (12.30 ± 0.66 & 11.92 ± 0.40 days) were observed at 32ºC when fed on the most favourable diet *T. urticae* eggs.

T17

T18

T19

T20

T21

Statistically, there are significant differences in immatures stages periods between D_1 and all diets at 30ºC for females also at 30 and 32ºC for male. On the other hand, no significant differences between all diets at 16, 24, 28 and 32 for female, and for male at 16 and 28ºC only.

3- The total development period :

According to the aforementioned results of larval and nymphal stages, the total developmental period of immature stages was affected by temperature. Whereas, the shortest period of female and male was recorded at the highest temparture 32ºC after feeding on the most favourable diet, *T. urticae* eggs (16.07 ± 0.88 and 14.57 ± 0.88 days). Also, this period for *S. nudus* female was affected by the type of applied diet.

It could be concluded that *T. urticae* eggs and data palm pollens were more favourable diets (16.93 ± 0.85 and 17.58 ± 0.23 days; 16.07 ± 0.88 and 16.58 ± 0.24 days at 30 and 32ºC, respectively, than the immatures of *T. urticae and L. beckii* eggs (17.82 ± 0.58 and 18.48 ± 0.50 days); 16.97 ± 0.48 and 17.61 ± 0.45 days at aforementioned temperatures, respectively.

Statistical analysis of data revealed that, there were significantly effects on life cycle duration of male between D_1 and all other diets at 30 and 32ºC, also, between each of D_1 & D_4 and both of D_2 & D_3 at 28 ºC. While, no significant differences were found between all diets at various tested temperatures on female life cycle at 16 and 24 ºC for male life cycle. Also, no significant differences were found between D_1 and D_4, D_2 and D_3 at 28ºC, D_2 and both of on male life cycle D_3 & D_4; D_3 and D_4 at 30 and 32ºC.

3-a.2. Adult's longevity :

Under different temperatures and by feeding the predaceous mite, *S. nudus* adults on pollens of date palms, the adult female lived for the longest times 122.32 ± 0.35, 88.33 ± 1.48, 82.76 ± 1.63, 70.13 ± 1.76 and 61.73 ± 0.40 at 16, 24, 28, 30 and 32ºC, respectively. At the most suitable temperatures 30 and 32ºC, *T. urticae* immatures came the first, it gave the shortest female longevity (50.91 ± 1.93 and 43.23 ± 1.27 days), while, eggs of *T. urticae* ranked the second (58.87 ± 1.80 and 50.31 ± 1.98 days), and eggs of *L. beckii* came the third (65.83 ± 1.66 and 58.80 ± 2.15 days) but, date palm pollens came the fourth (70.13 ± 1.76 and 61.73 ± 0.40 days). Statistically, there were significant differences on the adult longevity of female and male between all diets at various tested temperatures except at 32ºC, there were no significant differences between D_3 and D_4.

The presented data indicated that adults longevity was negatively affected by temperature i.e. longevity decrease by increasing temperature.

In this respect, **Ibrahim (1971)** found that incubation period, immature stages and longevity of the predaceous mite, *Saniosulus nudus* fed only on eggs of the scale insect, *Lepidosaphes beckii* (Newman) were affected by temperature. The incubation period ranged from 6 days in average temp. 27.6ºC to 15.3 days in winter at average temp. 18.1ºC, the immature stage and female longevity averaged 11.7 & 26.8 days in summer and 21.5 & 46.5 days in winter respectively. Also male reached adult stage earlier than female.

3-a.3. Adult's life span :

from the above mentioned data about longevity, the life span of *S. nudus* female affected by temperature, whereas the shortest period (60.20 ± 1.53 days) was observed at the highest temperature 32ºC and when fed on *T. urticae* immatures, while, the longest one (156.08 ± 0.42 days) was recorded at 16ºC and when fed on date palm pollens .

Also, male life span take the same trend of female, but the male life span was shorter than female, at all types of diets and all temperatures.

3-a.4. Ovipositional periods:

Pre- oviposition period :

Table (22) shows the pre-oviposition period for *S. nudus* mated female to be shortened, at the temperature became higher. The pre-oviposition period was 3.50 ± 0.35, 2.53 ± 0.20, 1.37 ± 0.16 and 2.13 ± 0.20 days at 32ºC when the predator fed on pollens of date palm (D_4), eggs of *L. beckii* (D_3), immatures of *T. urticae* (D_2) and eggs of *T. urticae*, respectively. It was progressively prolonged to reach its maximum 6.87 ± 0.44, 5.32 ± 0.20, 8.65 ± 0.25 and 9.10 ± 0.22 days at 16ºC when fed on D_1, D_2, D_3 and D_4, respectively. Also, the highest of pre-oviposition period was estimated at 16ºC and when fed on D_4.

Previous results indicate that the pre- oviposition period of *S. nudus* was affected by temperature it was decreased with temperature increasing.

Oviposition period :

Also, the duration of oviposition period was found to be affected by temperature, generally it being the shortest period at 32ºC and the longest at 16ºC. This period was also affected by type of food, it being the shortest period when fed on immatures of *T. urticae* (51.42 ± 0.63, 46.08 ± 1.70, 42.37 ± 2.18, 37.72 ± 2.56 and 32.52 ± 1.08 days) at 16, 24, 28, 30 and 32ºC, respectively. While, the longest was obtained when fed on pollens (61.07 ± 2.33, 57.78 ± 1.37, 53.80 ± 1.18, 48.10 ± 1.65 and 41.88 ± 0.26 days) at aforementioned temperatures, respectively (Table, 22). **Hassan (1976)** examined the biological response of *S. nudus* summers to crawlers of *Chrysomphalus ficus* (L.), *Lepidosaphes tableyi* and mentioned that the total period of immatures averaged 13.6 and 14.8 days when fed on crawlers of *C. ficus* and *L. tableyi* respectively. Oviposition period was 12.7 days on *C. fiats* and 10.5 days on *l. tableyi* but female longevity was shorter on the former (30 days) and longer on the latter (33.4 days) during the life span.

Post- oviposition period :

The post- oviposition period was affected by temperature, and type of food and took the same trend of oviposition period, whereas the shortest period (45.02 ± 0.44, 19.17 ± 0.31, 18.28 ± 0.68, 11.63 ± 0.40 and 9.25 ± 0.33 days) was recorded when fed on *T. urticae* immatures at various temperatures 16, 24, 28, 30 and 32ºC, respectively, but the longest period was obtained with of pollens date palm (52.15 ± 9.38, 25.47 ± 0.55, 24.85 ± 0.33, 18.22 ± 0.43 and 16.33 ± 0.28 days) at aforemendioned temperatures, respectively (Table, 22).

3.a.5. Fecundity :

Data presented in Table (22) show that, the daily and total number of deposited eggs / female of *S. nudus* are affected by both temperature and type of food offered to adult female. The number of deposited eggs was increased gradually by increasing temperature to 30ºC, then decreased at 32ºC. The highest daily and total number of eggs deposited female was with the most favourable diet (*T. urticae* eggs) being 139.38 ± 0.98 & 2.50 ± 0.03, 149.10 ± 2.17 & 3.00 ± 0.11, 188.92 ± 2.96 & 3.51 ± 0.05, 200.33 ± 1.27 & 4.87 ± 0.14 and 156.50 ± 0.89 & 4.26 ± 0.16 eggs at 16, 24, 28, 30 and 32ºC, respectively. From above mentioned data it can be concluded that, 30ºC was the most suitable temperature and the most favourable diet was *T. urticae* eggs i.e. they lead to increasing the number of deposited eggs / female. Also, the lowest number of deposited eggs / female was recorded at 16ºC when fed on date palm pollens.

Statistical analysis of data show that, there were significant differences between D_1 and all diets at 16, 24 and 30ºC, and between D_2 and both of D_3 & D_4 at all tested temperatures except at 32ºC, this effect was between D_2 and D_4 only, also, significant differences were found between D_3 and D_4 at 28 and 30ºC.

Sex ratio :

As shown in Table (22), sex ratio also changed according to change of temperature. Females percentage as (females / total) of *S. nudus* increased as temperature increase till 30ºC, then it began to decrease by raising temperature up to 32ºC with all diets. The highest percentage (60.98%) was recorded at 30ºC with *T. urticae* eggs, while the lowest one (46.67%) was obtained at 32ºC when fed on pollens.

T22

3-a.6. Feeding capacity of the predaceous mite, *Saniosulus nudus* on different preys:

Data in Tables (23 & 24) reveal that, feeding capacity of *S. nudus* was affected by prey species, predaor stage and sex. The average number and daily rate of consumed prey increase with the successive predator developmental stages. Also, the immatures of female fed on greater number of prey than of those of male.

Throughout the whole period of the immatures and adult stages, the immatures and adult's female consume an average of 39.33 ± 2.04 & 372.50 ± 1.76 from eggs of *T. urticae,* 19.33 ± 0.61 & 175.50 ± 1.75 from immatures of *T. urticae* and 40.90 ± 0.36 & 355.17 ± 2.38 *L. beckki* eggs, respectively.

Male followed similar trend as that of female but, in smaller numbers. Also, data indicate that, the highest consumed prey was noticed when the predator fed *T. urticae* eggs followed by *L. beckii* eggs, while, the lowest number of consumed prey when fed on *T. urticae* immatures.

In case of female and male immatures analysis of variance showed significant differences between all diet (prey) except between prey 1 and prey 3.

Also, there were significant differences between all diets (preys) on total amount of consumed prey by female of adult predator. But, for adult male no differences between all diets were found.

T23

T24

The above data indicate that the immatures and adult stage of the predaceous mite, *S. nudus* consume much more eggs of *T. urticae* and *L. beckii* then *T. urticae* immatures. This higher number of eggs consumed may attributed to smaller size of eggs than immatures.

Concerning the feeding capacity of adult's it is clear that the female adults of *S. nudus* consumed higher number of preys than male. This higher amounts of preys consumed by female may be due to that female used some of these preys for eggs production. **Hassan (1976)** reported that the adult female of the predator, *S. nudus* consumed an average of 180.8 and 158.3 crawlers of *C. ficus* and *L. tableyi*, respectively.

These results are in agreement with the finding of **Gerson and Blumberg (1969)** they reported that when reared the predator, *Saniosulus nudus* (summers) on eggs of florida red scale, *Chrysomphalus aonidum* (L.) at two temperatures (24 and 28ºC), the duration of life cycle and pre- ovioposition period were decreased at high temperature. Also, in (1971) Ibrahim found that, incubation period, immatures stages and longevity of *S. nudus* decreased in summer than in winter. Also, male reached adult earlier than female which deposited larger number of eggs during autumn.

4-a. Typholodromus athiasae :

4.a.1. Duration of immature stages:

Data of the duration of the various developmental stages of the predaceous mite, *T. athiasae* in relation to different diets, eggs of *T. urticae* (D_1), immatures of *T. urticae* (D_2), eggs of *L. beckii* (D_3) and pollens of data palm (D_4) and various temperatures (16, 24, 28, 30 and 32ºC) are given in Tables (25 to 29) .

1- Egg stage (Incubation period):

Data presented in these tables reveal that, the incubation period of *T. athiasae* was decreased when temperature increased, the longest periods 6.70 ± 0.47, 7.04 ± 0.52, 6.87 ± 0.42 and 7.42 ± 0.46 days were obtained when this predator reared at 16ºC with all diets D1, D2, D3 and D4, respectively. while, the shortest periods 2.27 ± 0.14, 3.12 ± 0.16, 3.27 ± 0.19 and 3.17 ± 0.05 days were recorded at 32ºC with all previously diets, respectively. Also, the shortest period (2.27 ± 0.14 days) was obtained at 32ºC when the predator fed on *T. urticae* eggs, while the longest one (6.70 ± 0.47 days) was recorded at 16ºC and when fed on date palm pollens.

2- The larval and nymphal period:

Duration of every immature stage as well as total immatures was affected by temperature and kind of diet, this duration was the longest at 16ºC, it lasted (12.33 ± 0.38, 13.47 ± 0.57, 14.73 ± 0.57 and 14.80± 0.79 days) for female reared on the four diets, respectively. While, it decreased to reach it's the lowest values (5.30

± 0.46, 6.80 ± 0.75, 8.13 ± 0.42 and 8.27 ± 0.74 days) at 28ºC for aforementioned diets (D_1, D_2, D_3 and D_4), respectively, then increased again at 30 and 32ºC (Tables, 25 to 29). Male followed the same trend as that of female.

It can be conclude that, at 28ºC and eggs of *T. urticae* diet were the most suitable conditions to predator immatures development. Statistically, there were significant differences between all diets at various temperatures, except between D_3 and D_4 differences were no significant at various temperatures .

3- The total developmental period :

According to the aforementioned results of immature stages duration, the total developmental period was decreased as temperature increase till 28ºC (8.90 ± 1.21, 11.33 ± 0.83, 12.80 ± 0.52 and 12.94 ± 1.50 days) on the four diets, respectively, then it began to increase by raising temperature up to 32ºC (9.34 ± 1.63, 11.76 ± 11.76, 13.23 ± 0.49 and 13.33 ± 1.38 days) when fed on the above mentioned diets, respectively (Tables, from 25 to 29).

Data indicated that eggs of *T. urticae* was the most foavourable diet and 28ºC was the most suitable temperature, because they gave the shortest duration of life cycle. Male followed similar trend as that of female but with shorter periods.

Statistically, there were significant differences between D_1 and each of other diets at 24, 28 and 32ºC, also between D_1 and both of D_3 and D_4 at 16 and 30ºC, while at 16ºC it was found between D_2 and D_4 only on female life cycle duration.

T25

T26

T27

T28

T29

In case of male life cycle duration, there were significant differences between D_1 and all other diets at all tested temperatures, also between D_2 and both of D_3 & D_4 at 24 and 28 ºC, but at 16 and 32ºC it was found between D_2 and D_4 only.

4.a.2. Adult's longevity :

Data in Tables (30) show that longevity of *T. athiasae* female was affected by temperature and kind of food offered. It was the longest at low temperature 16ºC (47.23 ± 1.64 days) when fed on eggs of *L. beckii*, while it was are shortest at 28ºC (18.27 ± 1.67 days) after feeding on eggs of *T. urticae*.

Generally, male longevity was shorter than female longevity. Statistical analysis showed that, there were significant differences on female longevity at 16ºC between D_1 and each of D_2&D_3, also between D_2 and both of D_3 & D_4, while it was between all diets and D_4 on male longevity. Also, significant differences on female and male longevity between each of D_1 & D_2 and both of D_3 & D_4 at 24, 28 and 32ºC, while at 30ºC it was recorded between D_1 and both of D_3 & D_4 on longevity of each sex and between D_2 and D_4 on male longevity only.

4.a.3. Adult's life span :

Life span period was affected by temperature, the adult's life span of female when fed on the most favourable diet *T. urticae* (eggs and immatures) were (62.30 ± 3.05 & 60.90 ± 1.30, 36.08 ± 3.00 & 40.86 ± 1.87, 27.17 ± 2.85 & 32.33 ± 1.76, 28.70 ± 2.75 & 32.50 ± 1.67 and 28.70 ± 2.95 & 32.00 ± 1.71 days) at 16, 24, 28, 30 and 32ºC, respectively. Also, this period affected by kind of food, at the most suitable temper5ature 28ºC, it lasted 27.17 ± 2.85, 32.33 ± 1.76, 42.70± 0.95 and 40.50 ± 2.29 days when fed on

various tested diets, respectively. Male followed similar trend but with smaller periods (Tables, 25, 26, 27, 28 & 29).

Statistically, there were significant differences between all diets at 24 and 28ºC on female life span period, at 28 and 32ºC on male period except between D_3 and D_4 differences were insignificant. Also, between each of D_1 & D_2 and both of D_3 & D_4 at 16 and 32ºC on female period, at 24 and 30ºC on male period and between each diet and D_4 at 30ºC on male period.

In case of male, significant differences between all diets were found except between D_1 and D_2 differences were no significantly.

4.a.4. Ovipositional periods:

Pre- oviposition period :

As shown in Table (30) the pre- oviposition period of *T. athiasae* female was decreased as temperature increased till 28 ºC, it lasted (3.93 ± 0.40, 4.10 ± 0.30, 5.40 ± 0.36 and 4.37 ± 0.32 days), then it began to increase with temperature increasing up to 32ºC and duarated (5.23 ± 0.45, 5.00 ± 0.30, 6.27± 0.31 and 5.20 ± 0.36 days) when fed on various diets (D_1, D_2, D_3 and D_4), respectively.

The presented data indicated that, 28ºC was the most favourable temperature, also *T. urticae* eggs was the most suitable diet.

Oviposition period :

The oviposition period of *T. athiasae* female was affected by temperature and kind of diet, it was prolonged at low temperature 16ºC (16.13 ± 0.57, 15.30 ± 0.30, 21.37 ± 030 and 20.93 ± 0.40 days), then decreased to reach the minimum values of time at 30ºC (7.67 ± 0.58, 8.23 ± 0.25, 14.50 ± 0.50 and 14.93 ± 0.06 days),

while, it elongated at 32ºC and lasted (8.00 ± 0.62, 8.73 ± 0.25, 15.10 ± 0.56 and 15.50 ± 0.50 days) when fed on the various tested diets. The longest period (21.37 ± 0.55 days) was obtained at 16ºC and by feeding on eggs of *L. beckii,* while, the shortest period (7.67 ± 0.58 days) was observed at 30ºC and by feeding on eggs of *T. urticae*.

Post- oviposition period :

As mentioned in pre- oviposition period, the post-oviposition period of female was decreased to reach the shortest periods at 28ºC (4.00 ± 0.50, 5.90± 0.46, 7.17 ± 0.29 and 6.70 ± 0.20 days) with all the tested diets (D_1, D_2, D_3 and D_4), respectively, then it prolonged slowly by temperature increasing.

The shortest period (4.00 ± 0.50 days) was recorded at the most suitable temperature 28ºC when fed on *T. urticae* eggs but, the longest period (20.17 ± 1.26 days) was obtained at low temperature 16ºC with the same diet.

4.a.5. Fecundity :

Data in Table (30) show that when the predaceous mite, *T. athiasae* was reared at 28ºC, a single mated female deposited the highest total number of eggs which averaged 58.33 ± 2.89, 52.83 ± 6.25, 48.83 ± 1.04 and 41.83 ± 4.54 eggs / female when reared on eggs of *T. urticae* (D1), *T. urticae* immature (D2), eggs of *L. beckii* (D3) and pollens of date palm. (D_4) respectively, followed by 24ºC at the same diets. While, when the adult female reared at high temperature (above 28ºC) and/or at low temperature (lower than 24ºC), the female deposited low number of eggs. The daily number of eggs deposited / female took the same trend.

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From the same results, it can be conclude that the highest dairly or total number of eggs (58.33 or 59.9 eggs) deposited / female was recorded at 28ºC and when adult female fed on eggs of *T. urticae*. While, the lowest numbers (21.23 and 1.01 total and daily eggs / female) was obtained when the predator reared at 16ºC and fed on pollens.

Nawar *et al.* (2001-a) studied some biotic and a biotic factors affecting the biology of the predatory mites *Typhlodromus athiasae* using immatures of *Tetranychus urticae* as prey. They conclude that female fecundity was increased (14.5 and 12.9 eggs / female / 10 days) at 25ºC.

While**, Reuveny *et al.* (1996)** reported that *Typhlodromus athiasae*. When the mite was fed on pollen of *carpobrotus edulis*, the highest fecundity (1.5 eggs / day for 20 days) was obtained at 25ºC, 70% RH. and LD 16: 8, with lower or higher temperatures and humidities resulting in lower fecundity. Feeding on *Tetranychus urticae* resulting in similar number of progeny.

Sex ratio :

According to the aforementioned results of pre- oviposition and post- oviposition the sex ratio affected by temperature. Female percentages of *T. athiasae* as (no. of females / total) increased from (49.00, 50.00, 49.50 and 48.00%) at 16ºC to reach the maximum percentages at 28ºC (57.00, 58.20, 57.70 and 58.00%), then it decreased again to (52.00, 53.00, 52.50 and 52.70%) when fed on eggs of *T. urticae*, immatures of *T. urticae*, eggs of *L. beckii* and date palm pollens, respectively.

This indicated that 28ºC was the most suitable temperature for giving higher females, which consequently resulted in reproduction increase.

4.a.6. Feeding capacity :

Data in Tables (31 & 32) indicate that, feeding capacity of the predator, *T. athiasae* was dependent on prey species, predator stage and sex of predator. Under laboratory conditions of 28C and 70% RH. and throughout adult life-span, the adult female consumed greater number of preys (172.83, 78.50 and 188.17 eggs or immature) than those of male adult (132.50, 75.17 and 133.67 eggs or individuals) of various preys, eggs of *T. urticae*, immature of *T. urticae* and eggs of *L. backii*, respectively. while, during immature stages the immatures of male much more number of preys (31.00 and 33.50 eggs or individuals) from eggs of *T. urticae* and eggs of *L. beckii* than the immatures of female (27.67 and 29.83 eggs).

The above mentioned results indicate that, the adults of predator consume more amounts of preys its immature stages .

Statistical analysis show that, there are significant differences between all preys on total consumption rate by adult female, and between each of prey, while the differences between prey 1 and prey 3 was no significant.

Similar trends were recorded by different authors such as, **El-Banhawy and El- Bagoury (1991)** who studied the predatory mite *Typhlodromus pelargonicus* (*T. athiasae*) preyed on the different development stages of *Tetranychus urticae*. The development was

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quickest and the number of prey consumed was greatest when individuals were maintained on eggs compared with nymphs or adult females. The predator was able to develop and reproduce on the eriophyid mite Eriophyes dioscoridis, nymphs of *bemisia tabaci* and pollen grains of Phoenix dactylifera and *Ricinus communis*. The average number of eggs/female per day was 1.4, 0.7, 1.2 and 0.9 on the eriophyid, *B. tabaci, P. dactylifera and R. communis*, respectively.