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Food as Paramount Factor on the Biology and Life Table of *Tyrophagus putrescentiae* (Schrank) (Astigmata: Acaridae)

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ABSTRACT

Tyrophagus putrescentiae (Schrank), was reared on three different kinds of food under laboratory conditions at 25 ±1°C. Its life cycle averaged 14.39 and 16.04 days; 13.34 and 14.43 days 15.26 and 16.91 days for male and female when fed on egg masses of the root knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood, dry cheese and yeast, respectively. Female life span averaged 39.78, 42.52 and 44.00 days; while that of male was 24.34, 23.47 and 27.82 days on the previously mentioned food, respectively. The highest R_o value 288.22 of expected female progeny per female was obtained with yeast, followed by 196.34 and 65.59 for dry cheese and *M. incognita* egg masses, respectively. The intrinsic rate of natural increase (r_m) and subsequently, the finite rate of increase (e^{rm}) averaged 0.236 – 1.26 ; 0.224 – 1.25 and 0.187 – 1.20 when *T. putrescentiae* was provided with cheese, yeast and *M. incognita* egg masses, respectively.

Key words: Biology; Life table parameters; *Tyrophagus putrescentiae*; *Meloidogyne incognita*.

INTRODUCTION

Acarididae is an enormous and wide spread family of which about 400 species of nearly 90 genera are known while many others are yet to be identified, especially in the tropical area (Zhang, 2003). Acaridides occur in leaf litter and upper strata of soils rich in organic matters; while some are associated with nests or bodies of invertebrates and vertebrates (Gerson *et al.*, 2003). Acarididia is considered one of the most successful group of animals, through their unique methods of dispersal, omnivorous food habits and phenomenal rate of reproduction. This group includes important families, of which some cause mange and scabies in domestic animals, parasites and commensals of mammals and birds; while others are associated with stored products. In addition certain species also live in human habitats where being found in damp situations favoring the growth of fungi upon which they feed (Eraky and Osman, 2008a). On the other hand, an accumulated knowledge concerning the acaridides fauna in Egypt is extremely scarce compared with the other mite groups (Eraky, 2000). The mould mite or cheese mite, *Tyrophagus putrescentiae* (Schrank) is a cosmopolitan mite found in a variety of habitats including stored products, decaying organic matter, plant seeds, medicinal plants and home dust, nests of birds and bees, feeding on different developmental stages of insects, including eggs (Eraky,1995; Papadopoulou 2006 and Kheradmand *et al.*, 2007). The present work dealt with the biology and life table of *T. putrescentiae* reared on different kinds of food and might contribute evidence for predicting population occurrence and growth.

MATERIALS AND METHODS

Individuals of *T. putrescentiae* were extracted from fowls organic manure in the poultry farm of the Faculty of Agriculture, Mansoura University, using Tullgren funnels, and then cultured in the laboratory. Two types of plastic cells containing a floor plaster of Paris and charcoal (9:1 ratio) were used. Big rearing cells (2.5 cm diameter and 2cm deep) were used for laboratory culture,while small ones (1cm diameter and 0.8 cm deep) were used for biological experiments. A heavy glass cover was used for each cell to prevent mites escape. The plaster of Paris floor was kept moderately moist by adding droplets of water when needed.

Acaridid cultures were kept in big rearing cells representing three major groups according to the kind of food. The first group was provided with dry cheese, the second with baker's yeast and the third with egg masses of the root knot nematode, *M. incognita*. All groups were incubated at 25 ± 1°C and observed daily for egg deposition .

Newly deposited eggs were singly transferred from the cultures to small cells. The incubation period was recorded and the newly hatched larvae were fed on dry cheese, bakers yeast, and root knot nematode, egg masses. Newly emerged females were exposed to young males of the same food. Observations on life development were recorded twice a day during its life span. Each experiment was started with not less than 25 newly hatched larvae.

Data were analyzed by one way analysis of variance (ANOVA), and the means were separated using Duncan's Multiple Range Test (CoHort Software, 2004).

Life table parameters were calculated using a BASIC computer program (Abou-Setta *et al.*, 1986) for females reared on various tested temperature degrees.

RESULTS AND DISCUSSION

I. Duration of developmental and adult stages:

Both sexes of *T. putrescentiae* pass through an egg, larval, protonymphal and tritonymphal stages before reaching the adulthood. At 25 ±1°C, the incubation period averaged 4.69, 4.30 and 3.52 days for female with significant differences among food types (F=11.925, df=2,66, p <0.001) and 4.08 , 3.52 and 3.65 days for male (F=4.319, df=2,66, p <0.001)when fed on egg masses *M. incognita*, on dry cheese and yeast, respectively (Table 1). All larvae were observed feeding before molting to protonymphs.

Concerning life cycle duration (egg, larva, and proto & tritonymphal stages), significant results due to type of food occurred. *T. putrescentiae* female life cycle averaged 16.04, 14.43 and 16.91 days (F=42.525, df=2,66, p <0.001) when fed on the root knot nematode, dry cheese and yeast, respectively (Table 1). Similar results were generally obtained with male and different immature stages. It is of interest to not that male emerged earlier than female.

Generally, significant differences among food types occurred between the total life cycle duration of both sexes when mite fed on the same kind of food (Table 1). Egg masses of *M. incognita* gave the longest life cycle followed by yeast; while dry cheese gave the shortest developmental time. These results confirm the findings of Muraoka and Ishibashi (1976) who observed a delay in the developmental time of *Sancassania sp.* when fed nematodes as compared with yeasts. Walia and Mathur (1998) also indicated that *T. putrescentiae* female life cycle durated 13.12 days when reared on juveniles of root knot nematode (*Meloidogyne javanica.*), Chmielewski (2000) reported that female *Caloglyphus berlesei* life cycle was 19.90 when fed on bee-bread; while in 2003, he found that its life cycle decreased to 17.7when reared on buckwheat sprouts at 20°C, and 95-100% R.H. Eraky and Osman (2008b) showed that female life cycle of *Caloglyphus manuri* Eraky and Osman was 5.90, 7.80 and 10.40 days when fed on yeast, cheese and *Meloidogyne* sp., respectively at 25°C; while male life cycle was 4.50, 6.40 and 8.10 days, respectively. Also, Abou El- Atta *et al.* (2014) recorded that female and male life cycle of *C. manuri* was 7.92 and 7.82 days, respectively when reared on *Meloidogyne* sp.at 25°C. Furthermore, Abou El-Atta *et al.* (2014) mentioned that *Sancassania berlesei* (Michael) female and male life cycle was 13.60 and 13.80 days, respectively when reared on *Meloidogyne* spp. at 25°C.

II. Duration of adult stage:

T. putrescentiae female deposited an average of 580.52, 422.60 and 143.47 eggs with significant differences among food types (F=450.562, df=2,66, p <0.001) with a daily rate 30.01, 24.74 and 9.86 eggs / female / day when fed on yeast, dry cheese and nematode egg masses, respectively. Sex ratio was 0.51, 0.53 and 0.56 on egg mass of *M. incognita*, dry cheese and yeast, respectively. The oviposition period averaged 14.56, 17.08, and 19.34 days, (F=15.835, df=2,66, p <0.001) when female fed on *M. incognita*, dry cheese and yeast, respectively. In general, it is clear that kind of food significantly affected the oviposition period, adult female longevity and fecundity of *T. putrescentiae*. Female lifespan lived for 39.78, 42.52 and 44.00 days with significant differences among food types (F=9.054, df=2,66, p <0.001). Whereas, male life span durated 24.34, 23.47 and 27.82 days, (F=24.932, df=2,66, p<0.001). on the previously mentioned food, respectively (Table, 2).

Woodring (1969) found that *Caloglyphus anomalus* Nesbitt average female laid 930 and 545 eggs and lived for 23.4 and 18.5 days when fed on mealworms and yeast, respectively. In 1987, Eraky reported that *C. berlesei* deposited an average of 755.7 eggs in an average of 15.9 days. Walia and Mathur (1998) reported that *T. putrescentiae* female laid an average of 171.40 eggs per female when reared on juveniles of root knot nematode,

Table (1): Duration of *T. putrescentiae* developmental stages when fed on three kinds of food at 25±1°C.

Kind of food	Sex	Incubation period	Average duration (days) Immature stage Larva		Protonymph		Tritonymph		Total immature stages	Life - cycle
			Active	Quiescent	Active	Quiescent	Active	Quiescent		
M. incognita egg masses	♀	4.69±0.20[a]	3.17±0.12[a]	1.30±0.09[b]	2.47±0.10[a]	1.13±0.07[b]	2.26±0.09[b]	1.00±0.00[b]	11.34±0.18[b]	16.04±0.14[b]
	♂	4.08±0.13[a]	2.91±0.10[a]	1.13±0.07[b]	2.17±0.10[b]	1.00±0.00[a]	2.04±0.04[b]	1.04±0.04[a]	10.30±0.15[b]	14.39±0.17[b]
Dry cheese	♀	4.30±0.18[a]	2.69±0.09[b]	1.13±0.07[b]	2.13±0.07[b]	1.04±0.04b	2.13±0.07[b]	1.00±0.00[b]	10.13±0.14[c]	14.43±0.17[c]
	♂	3.52±0.12[b]	2.39±0.10[b]	1.00±0.00[b]	2.13±0.07[b]	1.17±0.08[a]	1.91±0.06[b]	1.21±0.08[a]	9.82±0.14[b]	13.34±0.16[c]
Yeast	♀	3.52±0.48[b]	3.21±0.08[a]	1.82±0.08[a]	2.56±0.10[a]	1.56±0.10[a]	2.65±0.10[a]	1.56±0.10[a]	13.39±0.21[a]	16.91±0.24[a]
	♂	3.65±0.16[b]	2.86±0.07[a]	1.47±0.10[a]	2.56±0.10[a]	1.13±0.07[a]	2.39±0.10[a]	1.17±0.08[a]	11.60±0.27[a]	15.26±0.32[a]
LSD	♀	0.48	0.29	0.23	0.27	0.22	0.25	0.17	0.51	0.54
LSD	♂	0.40	0.27	0.20	0.26	0.17	0.20	0.20	0.56	0.65

Means in each column having different letters are significantly different ($p < 0.001$).

Table (2): Adult longevity and lifespan of *T. putrescentiae* when fed on three kinds of food at 25 ± 1°C

Kind of food	Sex	Average duration (days)				
		Preovipostion period	Ovipostion period	Postovipostion period	Longevity	Lifespan
M. incognita egg masses	♀	1.47±0.15[a]	14.56±0.80[c]	7.69±0.23[b]	23.73±0.86[b]	39.78±0.89[b]
	♂	----	----	----	9.95±0.47[b]	24.34±0.50[b]
Dry cheese	♀	1.17±0.08[a]	17.08±0.57[b]	9.82±0.20[a]	28.08±0.62[a]	42.52±0.67[a]
	♂	-----	-----	----	10.13±0.40[b]	23.47±0.46[b]
Yeast	♀	1.43±0.13[a]	19.34±0.31[c]	6.30±0.26[c]	27.08±0.36[a]	44.00±0.53[a]
	♂	-----	-----	----	12.56±0.32[a]	27.82±0.40[a]
LSD	♀	0.36	1.69	0.66	1.83	2.00
LSD	♂	-----	------	-----	1.14	1.30

Means in each column having different letters are significantly different ($p < 0.001$).

Table (3): Effect of different kind of food on the life table parameters of *Tyrophagus putrescentiae* (Schrank) at 25 ± 1°C.

Kind of food	Mean Total Fecundity	T	DT	R_o	r_m	e^{rm}	GRR	T_c	r_c	ARI	r_w
M. incognita egg masses	143.47	22.25	3.67	65.59	0.187	1.20	80.28	23.67	0.176	6.25×10^{29}	3.58
Dry cheese	422.60	22.30	2.91	196.34	0.236	1.26	273	24.90	0.206	3.26×10^{37}	5.04
Yeast	580.52	25.19	3.06	288.22	0.224	1.25	336.29	28.25	0.200	4.13×10^{35}	4.76

M. javanica. Chmielewski (2000) recorded that mean total egg per female of *C. berlessi* was 221.70 when reared on bee-bread whereas Chmielewski (2003) reported that fecundity of *C. berlessi* females was 237.4 eggs when reared on buckwheat sprouts. Eraky and Osman (2008b) showed that female fecundity of *C. manuri* was 601.40, 535.00 and 159.10 eggs when fed on yeast, cheese and *Meloidogyne* sp., respectively at 25°C; while Abou El- Atta *et al.* (2014) recorded that fecundity of *C. manuri* was168.80 eggs when fed on *Meloidogyne* sp. Also, Abou El- Atta *et al.* (2014) mentioned that *S. berlesei* fecundity was 189.8 eggs when reared on *Meloidogyne* spp. at 25°C.

Many researchers, witnessed the influence of food types on *T. putrescentiae* reproductive characteristics of (Chmielewski, 1990; Eraky, 1995 and Kheradmand *et al.*2007). Also, Abou El- Atta *et al.* (2014a) recorded that *C. manuri* female and male lifespan was 28.47 and 26.22 days, respectively when reared on *Meloidogyne* sp. at 25°C. Furthermore, Abou El- Atta *et al.* (2014) mentioned that *Sancassania berlesei* (Michael) female and male lifespan was 36.20 and 13.80 days respectively, when reared on *Meloidogyne* spp. at 25°C.

III. Life table parameters:

The calculated life table parameters which have been taken into consideration were: mean generation time (T), doubling time (DT), net reproductive rate (R_o), intrinsic rate of natural increase (r_m), finite rate of increase (e^{rm}) and gross reproductive rate (GRR)), cohort generation time (T_c), capacity of increase (r_c),annual rate of increase (ARI) and weekly multiplication of the population (r_w) (Table 3 and Figure 1).

The present study indicated that kind of food plays an important role and has a great effect on life table parameters Table 3. obviously showed that the mean generation time (T) was significantly affected by the kind of food. The longest time needed for one generation (25.19 days) was recorded when the mite fed on the yeast, whereas the shortest time (22.325 days) was recorded on nematode egg masses. The population of *T. putrescentiae* had the capacity to double every 3.67, 2.91 and 3.06 days when fed on nematode egg masses, dry cheese and yeast, respectively.

Net reproductive rate (R_o) and variance kind of food indicated that *T. putrescentiae* increaseed about 65.59, 196.34 and 288.22 times within a single generation when fed on afore mentioned food, respectively. However, the intrinsic rate of natural increase (r_m) is a key demographic parameter useful for predicting the population growth potential of an animal under given environmental conditions (Birch, 1948), since r_m reflects an overall effect on the development, reproduction and survival (Southwood and Henderson, 2000). Data in Table 3 showed that r_m values were 0.187, 0.236 and 0.224 individuals/female/day when *T. putrescentiae* was fed on nematode egg masses, dry cheese and yeast, respectively. On the other hand, when the values of (r_m) was converted to the finite rate of increase (e^{rm}), it is clear that population of *T. putrescentiae* had a capacity to multiply about 1.20, 1.26 and 1.25 times per female / day when they fed on nematode egg masses , dry cheese and yeast, respectively. Whereas, GRR of *T. putrescentiae* was 80.82, 273 and 336.29 at the same food. Eraky (1995) found that net reproductive rate (R_o) and intrinsic rate of increase (r_m) were 80.24 and 0.09 whereas, the mean generation time (T) and doubling time (DT) were 49.29 and 7.70 when *T. putrescentiae* (Schrank) reared on the bird–cherry aphid *Rhopalosiphum padi* L. at 18 °C; while Al-Rehiayani and Fouly(2006) showed that *M. javanica* eggs were the most suitable

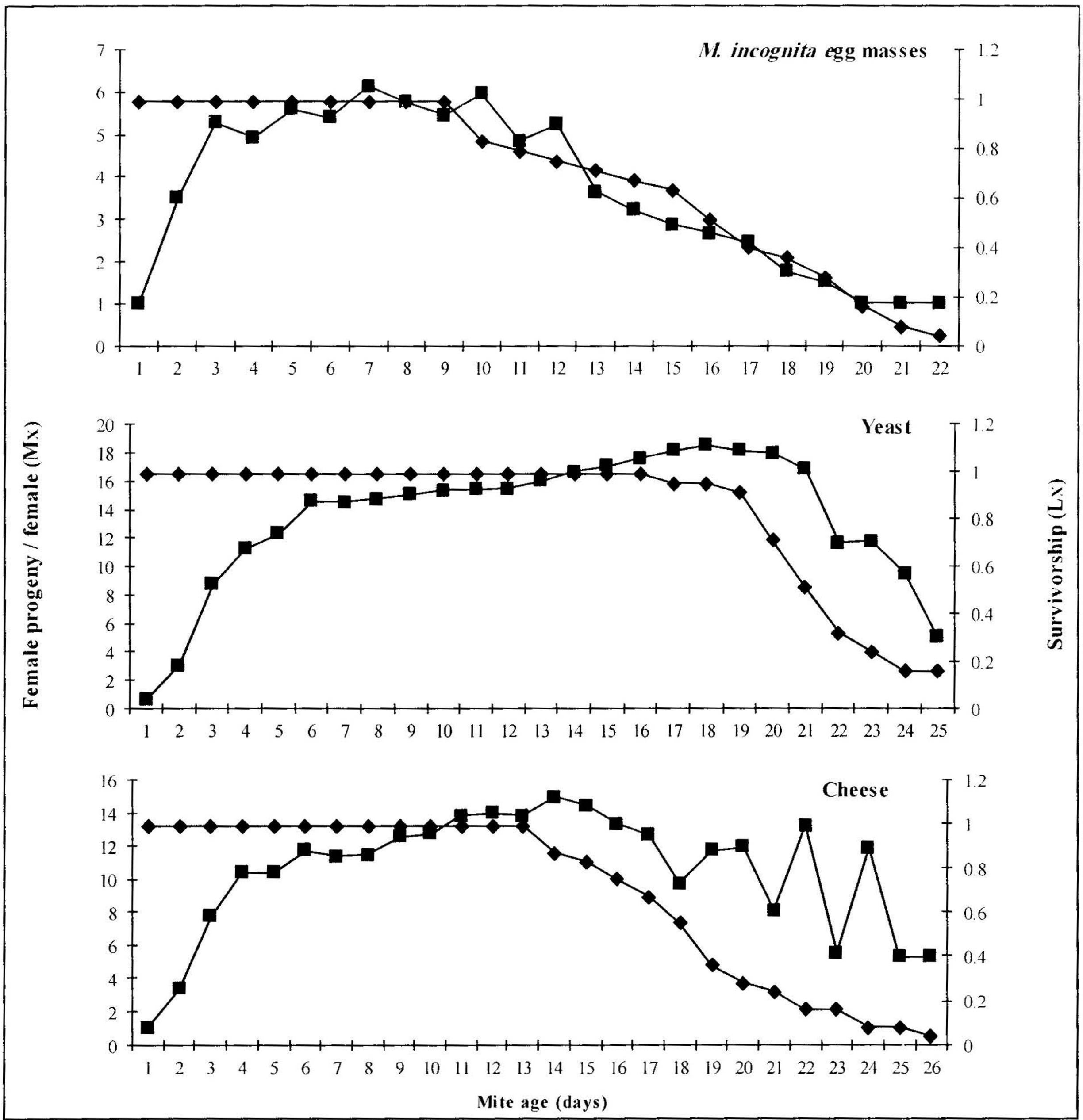

Fig. (1): Age-specific fecundity (Mx) and survivorship (Lx) of *Tyrophagus putrescentiae* fed on different kinds of food at 25 ± 1 °C.

food and supported the highest net reproductive rate (R_o) to two acarid mites *Mycetoglyphus qassimi* Fouly and Al-Rehiayani, and *T. putrescentiae*. Pakyari and Maghsoudlo (2011) showed that the intrinsic rate of increase (r_m) and the net reproductive rate (R_o) for *T. putrescentiae* when reared on phytonematode, *Ditylenchus destructor* at 25°C were 0.16 and 22.28, respectively. Also, Abou El- Atta *et al.* (2014) recorded that net reproductive rate (R_o) and intrinsic rate of increase (r_m) were 107.80 and 0.23 whereas, the mean generation time (T) and doubling time (DT) were 20.10 and 3.00 when *T. putrescentiae* (Schrank) reared on *Meloidogyne* spp. egg masses at 25°C.

In the present study, cohort generation time (T_c) of *T. putrescentiae* was 23.67, 24.90 and 28.25when reared on nematode egg masses, dry cheese and yeast, respectively;while capacity of increase (r_c) ranged between 0.176 and 0.206. Also, its annual rate of increase (ARI) ranged between 6.25×10^{29} and 4.13×10^{35}, whereas, its weekly multiplication of the population (r_w) was 3.58, 5.04 and 4.76 when fed on nematode egg masses , dry cheese and yeast, respectively. Abou El- Atta *et al.* (2014) reported that cohort generation time (T_c) of *C. manure* was 13.30, capacity of increase (r_c) was 0.344 and, annual rate of increase (ARI) ranged between 7.20×10^{33} and 2.24×10^{57}. Whereas, weekly multiplication of the population (r_w) of *C. manuri* was 12.83, when fed on nematode egg masses at 25°C.

As a result, it can be concluded that kind of food has a considerable effect on the number of females, which can be added daily to the population that is represented by e^{rm} values. Among these different kinds of food yeast represent the most suitable food for *T. putrescentiae*.

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