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Acaridida mites inhabiting stored wheat and their abundance with reference to biology and life table parameters of storage wheat mite, *Blomia tropicalis* (Bronswijk) (Acari: Glycyphagidae: Acaridida) at three different temperatures

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Abstract
Preliminary survey, abundance and biological study of mites that infest stored wheat during the year 2020 of the study, resulted in the presence of 21 species of mites in 13 genera and six families belonging to suborder Acaridida. Large numbers of mites Family Glycyphagidae were noticed. *Blomia tropicalis* (Bronswijk) was the most common and abundant species lasted as high as 350 individuals during the confinement period in a recent acaridida mite survey. Biological studies of that species were few in the world and almost rare in Egypt. Therefore, we examined the biological studies of *B. tropicalis* when fed on crushed wheat at three different temperatures 20, 25 and 30 °C and 70% relative humidity under laboratory conditions for the first time in Acarology Lab-Sharkia - Egypt to determine the extent of its danger and its various stages of development, and to know the appropriate conditions to limit its spread, and eliminate any damage resulting from it, as well as to promote pure quantitative propagation of mite colonies for use in mass production of predator mites program as well as to support colleagues in allergy units with a pure quantitative colonies by dreaming for use in the treatment of chest allergy and support allergens for diagnostic purposes. Thus, temperature 35 °C was a good environment for growth of *B. tropicalis* and resulted in increasing mite fertility.

Keywords: survey, astigmata mites**,** quantitative colonies**,** *Blomia tropicalis* (Bronswijk), temperature**,** stored wheat

Introduction

Mite infestation of stored wheat products caused a major problems not only for economic purposes but also because it can seriously affect human health (Ahmed *et al*., 2020) [4] and (Atta *et al*.,2019) [6].Acaridida mites (Sub order :Astigmata) are from the more surviving arthropods for exploitation of families and temporally restricted habitats (Eraky and Osman, 2008) [21].*Blomia tropicalis* (Bronswijk) is a mite that belongs to family of Glycyphagidae (Bronswijk 1973) [7] Initially described as a storage wheat mite, firstly noticed in agricultural wheat crops considered also a house dust mite of tropical and sub-tropical areas, Guilleminault and Gastan, 201722) can cause human allergic reactions (Colloff, 2009) [11].

B. tropicalis was earlier detected in cairo houses and may represent a new report in Egypt, (Kenawy*et al*., 2012). The mite *B. tropicalis* has significant prevalence worldwide in cereal and cereal-based foods consumed in the Nile Delta, Egypt, (Hussein and Elawamy, 2015) [23].

This species affects different hosts especially wheat in store and its crop residues such as wheat straw and hay so many studies are needed to determine the extent of its danger and its various stages of development and to know the appropriate conditions to limit its spread and to eliminate any damage resulting from it. Environmental and biological studies for this group are few and almost rare due to the difficulty of dealing with them.

The ecological and biological studies of this mites species were rare.So, the present work scope is to study the effect of different types of temperatures on the biological aspects, fecundity and life table parameters of the mite at **20**,25 and **30** ° C. and 65+5 % R.H.The knowledge related to biology of this mite species is consequently limited, and rare.Knowing mite species in wheat plants is essential for a proper crop management, mainly for pest control strategies.

Materials and Methods

This study covered aspects of faunistic, ecological and biological works on acaridida mites infesting wheat in store during 2020 year of study.

1. **Ecological studies:** Samples of 250 gm of (wheat grains, wheat straw, wheat hay, wheat seeds, wheat germ, wheat flour) were collected monthly from different districts were (Diarb Nigm;Abou Kabeer ; Qinauat ; Minia El Kamh; Faquos; Kafr Sakr ;Hehia) in Sharkia Governorate, Egypt and mites were extracted by using Modified-Berlese-Tullgern-Funnel, then some were cleared in Nesbits solution,mounted on slides and examined under elecrton microscope and counted for estimating monthly variation and abundance of Acaridida mites.

2. **Biological studies:** To make a pure colony of storage wheat mite, *Blomia tropicalis* Bronswijk (Acaridida: Glycyphagidae) we used plastic blocks (5 × 5 × 1.5 cm) each one contained a small rearing circular chamber (1.2 × 0.5 cm), the bottom of each chamber was covered with mixture of plaster Paris (Cement :clay:

charcoal) in a ratio of (6:3:1) and the top covered with small slide glass. Twenty adults (female and male) are sufficient to make pure culture putted in rearing chamber and provided with food.(yeast : bran : wheat germ) in aratio of (5:4:1), adding few drops of water by a needle as source of humidity then placed on incubator, investigated twice daily, with adding a few pieces of food when needed. Biological aspects recorded daily, Mesbah *et al*.,2016 [29] and 2017[30].The rearing stocks were conducted in an incubator under 25±2°C and 70±5% relative humidity. For beginning experiment *B. tropicalis* were fed on crushed wheat at three tested temperatures.

3. **Statistical analysis:** The relationship between temperature and mean developmental rate of each stage under tested temperatures was determined using linear regression (Y= a±bx, where: a= Intercept, b = slope of temperature). The lower developmental threshold t0 = - a/ b (°C) and thermal units K = 1/ b (in degree day units (DDUs)), where: to is developmental threshold°C; b is the developmental rate line slope and K is the developmental heat constant (DDUs) were determined. Life table parameters were done according to Birch (1948) using the Life48, BASIC, Computer Program (Abou-Setta *et al*. 1986) [2].

Results and Disscusion

1. **Preliminary survey study for acaridida mites in stored wheat:** The ecological study ;abundance and monthly variations of mites inhabiting wheat in store carried out during 2020 year of study,revealed occurrence of 20 mites pecies in12 genera and six families were Pyroglyphidae, Carpoglyphidae, Chortoglyphidae, Acaridae, Glycyphagidae and Suidasidae belonging to sub order Acaridida were extracted from stored wheat. These mites were classified according to their Population densities into rare in numbers (1-100 individuals); moderate (101-200 individuals) and high numbers **(**201-350 individuals). The Glycyphagidae family was at the top in terms of global frequency and abundance counts 350 individuals and excluding the other Glycyphagid mite, *B. tropicalis* were significantly higher than all other species that found in this study, as shown in Table (1).

In that study, monthly variation affected mite populations, Acarid mites of family Glycyphagidae were found to be the most common and abundant species recorded in a recent acaridida mite survey (Mariana & Ho, 1996[27]; Mariana *et al*., 2000) [28] then family Acaridae were the least abundant species recorded in the other families. The stored product mites belonged to Acaridida families, usually noticed in wheat grains, hay, and straw (Colloff, 2009) [11]. (Ammar 2020) [5] examined occurrence storage mites in six egyptian governorates and (Waffa *et. al*1966) published a survey of stored grain and seed mites which included only four species of Acaridida mites, Zannou *et al*.,2013[40]. (El-Basheir 1990) [12] made a survey study on house dust mites in Sharkia Governorate.

Table 1: The monthly variation and quantitation of acaridida mites inhabiting stored wheat at sharkia province, Egypt during the collection period 2020 year of study

Sub order: Acaridida	Dominant (Genus, Species)	Habitat	Distribution	Abundance (Monthly variation)
Family Pyroglyphidae(Cunliffe)	*Dermatophagoidesfarinae* (Hughes)*; D.pteronyssinus*(Trouessart)	wheat grains, wheat straw, wheat hay, wheat seeds, wheat germ, wheat flour	DiarbNigm; Fakous; Hehia	(+)
Family Carpoglyphidae (Oudemans)	*Carpoglyphuslactis*(Linne)	wheat flour	Minia El kamh	(+)
FamilyChortoglyphidae(Berlese)	*Chortoglyphusarcuatus*(Troupeau)	wheat hay	Aboukabeer	(+)
Family Acaridae (Leach)	*Acarus siro*(Leach)*; Tyrophagusputrescentiae* (Schrank);*Caloglyphusrhizoglyphoides* (Zachvatkin); *C. oudemansi*(Zachvatkin); *C. berlesei*(Michael);*C.beta*(Attiah);*Rhizo glyphusrobini*(Claparrede); *R. echinopus*(F. & R.)	wheat grains, wheat straw, wheat hay, wheat seeds, wheat germ, wheat flour	Diarbnigm;Abouk abeer;Qinauat ; Minia El kamh; Faquos; Kafrsakr	(++)
Family Glycyphagidae(Berlese)	*Lepidoglyphus destructor* (Schrank)*; Glycyphagusdomesticus* (De Geer), *; G. ornatus* (Kramer)*;Blomia tropicalis* (Bronswijk)*;B. freeman* (Hughes)*; Goheriafusca* (Oudemans)*; G. wahabeii* (El-Naggar, Taha and Hoda)	wheat hay, wheat seeds, wheat germ, wheat flour, wheat straw, wheat hay	Diarbnigm;Abouk abeer; Hehia; Qinauat ;Minia El kamh; Faquos; kafrsakr	(+++)
Family Suidasidae (oudemans)	*Suidasianesbitti (Hughes)*	wheat germ, wheat straw	Hehia	(+)

(+) rare (1-100) individuals ;(++) Moderate (101-200) individuals); +++high (201-350) individuals

2. **Biological studies on most abundant species, *B. tropicalis*:** Influence of three different temperatures (20, 25 and 30°C) on the damage effect, population growth, life span and fecundity of storage wheat mite, *B. tropicalis* should be seen to estimate the ideal conditions to avoid its rapidly spread as species in stored wheat. Environmental factors as temperature, humidity, and ecology influenced Acaridida mites development and prevalence (Casley *et al*, 2018) [9].

3. The present study was determined to evaluate the biological aspects of *Blomia tropicalis* (Bronswijk) when studied its biology for the first time on Egypt atthree different temperatures 20, 25°C, 30°C &70% R.H. when fed on crushed wheat. Numerous individuals of *Blomia tropicalis* (Bronswijk) were found inhabiting wheat in store feeding on grains germ indicating both qualitative and quantitative losses especially when stored in humid air and increasing temperature, El Naggar *et al* 2007 [14] and Fawzy 1996 [17].

Table 2: Mean developmental times in days of the acarididamite, *Blomia tropicalis* (Bronswijk) female when reared on three different temperatures and 70±5% R.H**.**

Developmental Stages	Temperatures		
	20±2°C	25±2°C	30±2°C
Incubation period	3.15±0.41	2.30±0.35	1.65±0.24
Larva	6.35±0.63	4.50±0.47	2.10±0.21
Protonymph	5.40±0.39	4.50±0.47	2.10±0.21
Tritonymph	5.30±0.35	4.20±0.35	2.20±0.26
Total immature	17.05±1.09	13.20±0.42	6.40±0.61
Life cycle	20.20±0.82	15.50±10.53	8.05±0.60
Generation period	23.40±1.07	18.15±1.03	9.80±0.63
Adult longevity	28.00±1.41	23.50±2.13	12.60±1.61
Life span	48.20±1.58	39.00±2.47	20.65±1.94

Table 3: Mean developmental times in days of acaridida mite *Blomia tropicalis* (Bronswijk) male when reared on three different temperatures and 70±5% R.H.

Developmental stages	Temperatures		
	20±2°C	25±2°C	30±2°C
Incubation period	2.80±0.26	2.25±0.35	1.65±0.24
Larva	5.50±0.47	4.70±0.54	1.90±0.32
Protonymph	5.05±0.37	4.50±0.58	1.80±0.26
Tritonymph	5.00±0.33	4.70±0.59	1.85±0.34
Total immature	15.55±0.93	13.90±1.29	5.55±0.83
Life cycle	18.35±0.82	16.15±1.29	7.20±0.92
Adult longevity	25.70±2.98	19.60±1.96	11.50±1.65
Life span	44.05±3.42	35.75±2.23	18.70±1.83

Table 4: Mean longevity and fecundity of *Blomia tropicalis* (Bronswijk) female when reared on three different temperatures and 70±5% R.H.

Developmental Stages	Temperatures		
	20±2°C	25±2°C	30±2°C
Pre-oviposition	3.20±0.54	2.65±0.53	1.75±0.26
Oviposition	20.80±1.75	17.30±1.77	9.40±1.51
Post-oviposition	4.00±0.58	3.55±0.44	1.45±0.28
Fecundity	100.40±7.79	111.00±6.98	121.00±12.98
Daily rate	4.84±0.29	6.50±0.97	13.26±3.03

Table 5: Effect of different temperatures on biological aspects of *Blomia tropicalis* (Bronswijk) female.

Stage	A	B	t_0	K	R^2
Egg	-0.269	0.029	9.312	34.650	0.988
Larval	-0.511	0.032	16.048	31.376	0.895
Protonymph	-0.433	0.029	14.879	34.364	0.844
Tritonymph	-0.371	0.027	13.950	37.613	0.884
Immature stages	-0.147	0.010	15.073	102.460	0.877
Life cycle	-0.107	0.007	14.371	133.835	0.893
Life span	-0.057	0.004	12.963	229.091	0.864

Table 6: Effect of different temperatures on biological aspects of *Blomia tropicalis* (Bronswijk) male.

Stage	A	B	t_0	K	R^2
Egg	-0.153	0.025	6.150	40.174	0.971
Larval	-0.554	0.034	16.089	29.028	0.817
Protonymph	-0.569	0.036	15.903	27.969	0.801
Tritonymph	-0.534	0.034	15.669	29.365	0.778
Immature stages	-0.184	0.012	15.897	86.303	0.799
Life cycle	-0.126	0.008	14.916	118.493	0.815
Life span	-0.061	0.005	12.728	208.134	0.924

Eggs were putted in rearing cages singly and scattered. Adult female deposited their eggs under substrate of (cement: clay:charcoal) and granules of food. The deposited eggs are usually spherical and translucent, then changes to white as time proceeds. During hatching, the shell rupture and larvae crawls outside with its legs leaving the egg shell. This process lasted 20 – 30 minutes. Afterlarvae growth, immature stages enters the quiescent stage in which it seeks a dry hole or crack in the substrate of the rearing cell for feeding and movement. The legs contracted under the body surface. Body colour become pale yellow. The hind legs appears from the old skin at first, then the new stages crawls backward to get rid of the old exuvia. Newly emerged individuals started to move actively searching for its food.Mating is necessary for *B. tropicalis* production immediately after emergence from tritonymph stage. During copulation, the male assumed a dorsoposterior position with his aedegus in opposite direction with female. The aedegus inserted into the female posterior bursa copulatrix. Female needs mating several times which require about 25-30 minutes. No parthenogenesis occured in this species.

4. **Hypopus (Deutonymph immature stage):** Hypopus stage of *B. tropicalis* noticed during unsuitable climatic factors and (Hughes, 1976) [18] observed this result on *T. putrescentiae* (Schrank) and(El-Naggar *et al.*, 2007) [14] noticed that when studied developmental periods of *Lepidoglyphus destructor* (Acari: Glycyphagidae) on different fungi at different temperatures. Dispersal between habitat patches is affected by phoretic association between the specialized deutonymphs (hypopus) specimens for adaptation for spreading and survival of the Acaridida mites during unsuitable climatic factors. This agreed with the findings Eraky,1999 [20], 1992 [19]; Chmielewski, 1971[10]; Krantz 1978 [25]; Taha 1985 [25 ; Wallace 1960 [38] and Kuo and Nesbitt 1970) [26]

Duration of stages of *Blomia tropicalis* (Bronswijk)

Incubation period of the Acaridida mite:, *B. tropicalis* examined for the first time in Sharkia lab, Egypt averaged (2.80 ; 2.25 & 1.65) and (3.15 ; 2.30 & 1.65) days for male and female individuals when fed on crushed wheat at three different temps 20, 25, 35 °C, respectively and 70 % R.H.

Life cycle lasted an average of (18.35 ;16.15 & 7.20) and (20.20 ; 15.50 & 8.05) days for male and female individuals respectively at three different temps mentioned before; respectively. Statistical analysis of obtained data, pointed out that longevity of the resulted males and females affected significantly by the type of temp. These periods took (25.70; 19.6 & 7.2) and (28 ;23.5 & 12.6) days for male and female individuals at three different temps mentioned before, respectively.

Fecundity: (The total average of deposited eggs) was affected significantly by type of temperature examined. It was 100.4 ; 111 and 121 egg/female for adult females at three different temps mentioned before; respectively. Thus, temperature 35 °Cwas resulted in increasing mite fertility.The results agree with(Puerta *et al*., 1991) [34] they mentioned that Temp 28 °C and 80% R.H. was a good environment for growth of *B. tropicalis*.

Linear Regression Analysis Values for developmental rates for *B. tropicalis* reared at three different temperatures are presented in Tables (4&5). Increasing temperature from 20 to 25 then 30°C cased significant reduction on all

biological aspects of the predator with mean R^2 value of range from 0.778 to 0.895. The developmental threshold was determined as 14.916 and 14.371 for female and male, respectively. Required degree days for both sexes were determined as 133.835 and 118.493 degree day units for female and male.

To the best of my knowledge biological aspects of storage wheat mite, *Blomia tropicalis* (Bronswijk)at three different temps 20, 25, 35 °C and 70 % R.H were examined for the first time in Sharkia lab, Egypt since (Ahamad and Ho 1996) [3] they studied the life-cycle, longevity and fecundity of *Blomia tropicalis* (Acari: Glycyphagidae) in a tropical Asian laboratory.

Therefore, we could not compare the results with previous published studies. However, there are numerous investigations on other Acaridida species done by El-Naggar *etal* 2007 [14] determined the effect of developmental periods and fecundity of Glycyphagid mite, *Lepidoglyphus destructor* (Schrank) when fed on different fungi at different temperatures, This agreed with the findings (El-Sayed *et al*., 2016, 2019) [16, 15] Mesbah *et al*., 2016[29] evaluated the biological aspects of Labidophoridae mite, *Gohieria wahabeii* (El-Naggar, Taha &Hoda) when reared for the first time on two different diets (fish powder& yeast granules)at two different temperatures 25°C, 35°C &70%R.H.

Zadarkova1967recorded *Goheriafusca* (Oudemans) on all samples of stored infested by mites. It is most abundant in flour where its brown colour makes it easily detected, and it also occur in rice, corn, bran, pollards and poppy seed.

O'Farrel & Butler 1948 [33] found that *Glycyphagusfusca* (oudemans) is abundant in mixed cereal dust and spillage in mites of Northern Ireland.

El-Naggar *et.al* 1989 studied biology of Acaridae mite, *Rhizoglyphus ismaili* and the effect of types food on duration and fecundity. Taha, *et al* 2004 [36] determinied effect of food and temperature on developmental stages and fecundity of the grain mite *Dermatophagoides farinae* Hughes (Acari: Acaridida: Pyroglyphidae). Taha *et al*. 2010 [37] determined the effect of different food types on the biology, fecundity and life table parameters of the stored grain mite, *Goheria fusca* when fed on (dry yeast granules, crushed wheat and crushed maize) as a sole food sources under laboratory conditions of 25±2 ºC and 65% R.H.

Abou El Atta *et al*., 2014 [1] influenced effect of temperature on development and life table parameters of acarid mite *Caloglyphus manure* Eraky and Osman.

This species must be overcome and an attempt to combat it biologically by modern control methods from wheat such as predators as shown since Mesbah *et al*., 2017 [30] determined that, *Cheletomorpha lepidopterorum* (shaw) is predator of Acarid mites, particularly *G. wahabeii ; B. tropicalis* should be used in the control of mite pests from wheat crop.

(Mesbah *et al*.,2019) [31] used Acaridida mites as a factor for mass production of predator mite, *Amblyseius swirskii*(Acari: Phytoseiidae) for biological control.(Mesbah *et al*.,2021) [32] made quantitative propagation of predatory mite, *Blattisocius dentriticus* (Berlese) (Acari: Gamasida: Blattisociidae) with eggs of some stored wheat pest.

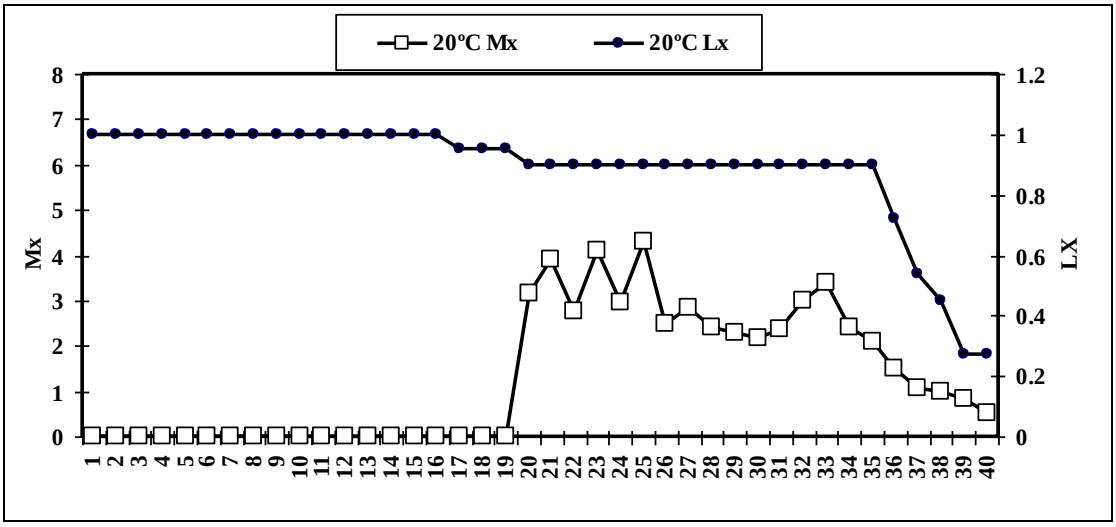
Life Table Parameters

The mean generation time (T) of*Blomia tropicalis* (Bronswijk)significantly affected by temperature variability (Table 5). Life table parameters were as follow, (T as 26.54; 21.31and12.04days); net reproductive rate (R_o) (44.42; 50.31 and 33.87) per generation; intrinsic rate of natural increase (r_m as0.143; 0.184and0.331); finite rate increase(λ) averaged (1.15,1.20and 1.39) and gross reproductive rate (GRR) (51.51; 60.75 and 62.65) and doubling time (DT) values (4.85; 3.77 and2.09) days when females reared on different types of prey. (Table 5), respectively.

Table 7: Life Table Parameters of *Blomia tropicalis* (Bronswijk) females at three different temperatures and 70±5 % R.H.

Parameters Temperatures	20°C	25°C	30°C
Mean generation time (T_c) [a]	26.54	21.31	12.04
Doubling time (DT) [a]	4.85	3.767	2.094
Net reproductive rate (R_o) [b]	44.415	50.31	53.87
Intrinsic rate of increase (r_m) [c]	0.143	0.184	0.331
Finite rate of increase (λ)	1.15	1.20	1.39
Gross reproduction rate (GRR)	51.51	60.75	62.65

[a] Days [b] per generation and [c] Individuals/female/ day



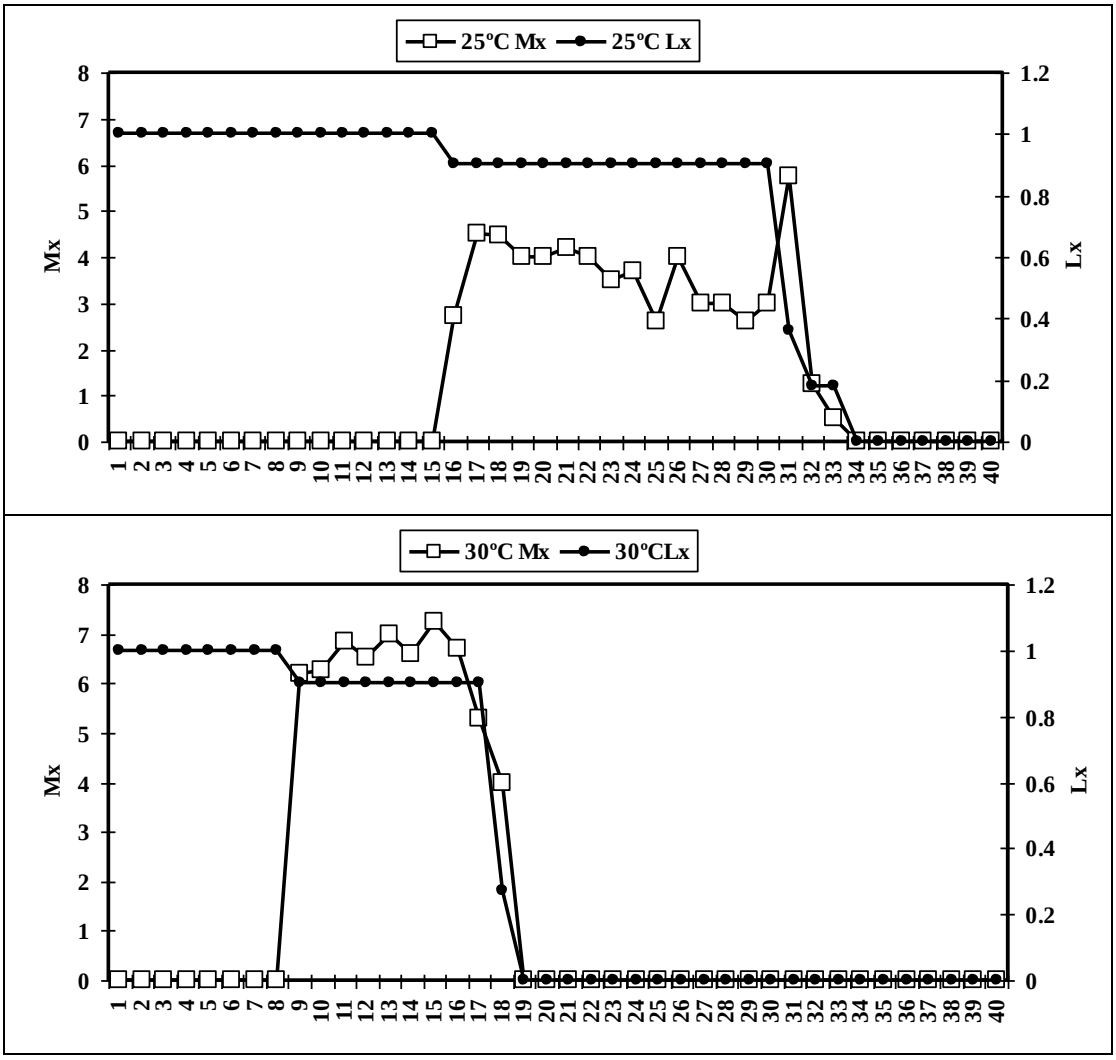


Fig 1: The age specific survivorship (l_x) and age-specific fecundity (m_x) curves for *Blomia tropicalis* (Bronswijk) at 20, 25 and 30 ºC.

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