International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 15-09-2025, Accepted: 14-10-2025, Published: 30-10-2025
Volume 10, Issue 10, 2025, Page No. 121-128

Predatory behavior and life history of the big-eyed bug *Geocoris ochropterus* (*Hemiptera: Geocoridae*) in Mango inflorescences: Insights from laboratory observations

Samira A Abd El-Salam, Hanaa M Raghib, Ahmed Ramadan El-Rokh*
Research Plant Protection Institute, Agricultural Research Center, Dokki, Giza, Egypt

Abstract
Lepidoptera pests are a recurring problem for mango trees, since they can seriously harm the inflorescences, hence compromising fruit quality and yield. The big-eyed bug *Geocoris ochropterus* (*Hemiptera: Geocoridae*) is a polyphagous predator of many insect pests on various crops and fruit trees. The predatory behavior and life history parameters of G. ochropterus, a predator bug found in mango inflorescences, were investigated. The focus was on its feeding habits, specifically targeting two common lepidoptera pests, *Cryptoblabes gnidiella* and *Ephestia cautella*, for the first time. The bugs were reared in a controlled laboratory environment at 30±2 ^{0}C and 70±5% RH, and life history parameters were quantified through life tables. The mean incubation period was 7.1 and 8.6 days. The total developmental period was 28.3 and 30.7 days, with a nymphal period of 21.2 and 22.1 days, and the longevity of an adult was 30 and 32.2 days when fed on *C. gnidiella* and *E. cautella*, respectively. The mean fecundity per female was 177 and 100 eggs, the net reproductive rate was 38.9 and 30.4 days, the approximate generation time was 45.6 and 47.8 days, gross reproduction rate was 127.2 and 97.9 females per female for *C. gnidiella* and *E. cautella*, respectively. Moreover, the intrinsic rate of natural increase (r_m) was 0.02 and 0.02, and the innate capacity for increase (r_c) was 0.9 and 0.6, respectively. The results shed light on the ecological role of *G. ochropterus* in promoting pest control in mango orchards and provide valuable insights for integrated pest management strategies in agriculture, especially with the recent climate changes.

Keywords: *Geocoris ochropterus*, life table, Mango inflorescences, *Cryptoblabes gnidiella, Ephestia cautella*, Integrated Pest Management

Introduction
A small, generalist omnivore predator known as big-eyed bugs (*Hemiptera: Geocoridae*) feed on a variety of insects and mites. A prevalent predator species, *Geocoris ochropterus* Fieber, is found in sunflowers, maize, cotton, tea, and other fruit and flowering plants. It was discovered that consuming eggs of *Helicoverpa armigera*. [1, 2] There are multiple Geocoris spp. that can be used as biological control agents against harmful insects, such as *G. bullatus*, *G. ochropterus*, *G. punctipes*, *G. uliginosus*, *G. pallens*, and *G. varius*. [3, 4] Chau *et al*. used convenient diets of silkworm (*Bombyx mori*) and ant pupae (*Oecophylla smaragdina)*, along with *Aphis gossypii* as a control diet, to study the development and reproduction of *G. ochropterus*. [5] *G. ochropterus* was considered one of the most widely distributed species and was used as a predator of thrips species on peanuts. [6] Capinera mentioned that aphids, mites, whiteflies, red spiders, immature stages of lepidopteran pests, and flea beetles were considered suitable prey for big-eyed bugs to complete their development. [7] Igarashi and Nomura used eggs of *Ephestia kuehniella* Zeller as a food source for the mass rearing of big-eyed bugs (*G. varius*) in addition to two types of artificial diets containing liver and ground pork. [8] Also, Calixto *et al.* studied the effect of different conditions on the rearing of *G. punctipes* using eggs of *E. kuehniella* as a source of food. [9] Varshney and Ballal (2017) [10] succeeded in mass rearing *G. ochropterus* by using *Sitotroga cerealella* eggs. [10]
Varshney and Ballal (2018) [1, 2] evaluated the predatory efficiency of *G. ochropterus* on eggs of *Helicoverpa armigera* and *Corcyra cephalonica* under laboratory conditions. [1] Mukhopadhyay and Sannigrahi (1993) [11] studied the life performance of *G. ochropterus* using ant pupae, *Oecophylla smaragdina*, as a food source. [11] In India, Kapadia and Puri used *Bemisia tabaci* to study the predation capacity and biology of *G. ochropterus*. [12] Mango orchards face persistent challenges from lepidoptera pests that can cause significant damage to the inflorescences, affecting fruit yield and quality. For example, *Cryptoblabes gnidiella* Mill., also known as the honeydew moth (HM), is a polyphagous pest that affects economically important crops, including mango. [13] The honeydew moth (HM), *C. gnidiella* was reported for the first time in the Mediterranean region and has also been reported in regions such as Africa, Australia, and South America. [13, 14] Recently, it was observed in mango inflorescences with high population in Egypt, causing a lot of damage. [15] According to Carter (1984) [16], these species exhibit three to four generations per year in southern Europe and up to five in North Africa. The number of generations is significantly influenced by the climate and the host plants utilized. These generations are known to migrate between different host plants depending on availability. [16] In Mediterranean climates, this species demonstrates three to four distinct periods of adult flight activity: May to June, July, and August to October, as reported by Bagnoli and Lucchi. [17] Likewise, *Ephestia cautella*, commonly known as the Mediterranean flour moth, is another lepidopteran pest that can infest stored grains and processed food products, including mango. [18] *E. cautella* was usually present in each field and/or storehouse of date fruit in the New Valley Governorate and was considered the most important lepidopteran pest affecting yield and decreasing exportation. [19] However, information specific to its phenology in mango inflorescences is limited. Moreover, *Eublemma gayneri* (Roth.) was considered an insect pest on maize in Egypt. Likewise, it was found

attacking mango inflorescence in Egypt was first recorded by Abdel Kareim *et al*. [20] Further specific studies on the phenology of these lepidopteran pests in mango inflorescences are needed to provide more detailed information to serve its control program.

Presently, *C. gnidiella* is worldwide in its distribution and attacks a variety of crops, including field and vegetable crops, pomegranates, grapes, citrus, avocados, and mulberries. [13, 21, 22] El-Rawy considered *Eublemma gayneri* (Roth.) as an insect pest on maize in Egypt. Because of climate changes in recent years, pests have emerged at an unusual time, which has affected new crops, leading to the emergence of natural enemies.[23] Abd El-Salam observed the predator *G. ochropterus* in the mango inflorescences associated with some larvae of lepidoptera insects (*C. gnidiella* Miller, *E. cautella* Walker, and *Eublemma gayneri* Roth) for the first time.[24] Although the three lepidopteran pests are sympatric and have been found around *G. ochrpoterus* (field observation), it was observed that *C. gnidiella* was consumed more than the other two species. We speculate that *C. gnidiella* provides a high-quality diet for the development and survival of *G. ochropterus.* Therefore, this study aims to implement choice tests using *C. gnidiella, E. cautella,* and *E. gayneri* larvae within the same arena with *G. ochropterus.* Evaluate the predatory behaviour, biology, life table, and prey preferences of adult and immature nymphs of *G. ochropterus* when using *C. gnidiella* and *E. cautella* as diets, and the possibility of using it in the biological control of these insects on different crops.

Material and methods

Life and fertility tables

Rearing technique

Life and fertility table parameters of *G. ochropterus* were evaluated on mango inflorescences under laboratory conditions (30±2 ^{0}C and 70±5% RH) in the Entomology laboratory at the Plant Protection Research Institute, Mansoura, Dakahlia.

Rearing of Lepidoptera species

The honeydew moth (HM), *Cryptoblabes gnidiella* Miller, the almond moth, *Ephestia cautella* Walker (*Lepidoptera: Pyralidae*), and the semi-lopper worm *Eublemma gayneri* Roth (Lepidoptera: Erebidae) (Fig. 1) were collected from mango inflorescences of untreated orchards in Shirben district, Dakahlia governorate, Egypt, in larval and pupal stages. Adult insects were confirmed in the Taxonomy Department of the Plant Protection Research Institute. Pairs of males and females of adults after emergence were deposited in plastic boxes (15×15×10 cm). Inside, they were provided with a moistened cotton wool piece soaked in a 10% honey solution as sustenance, along with mango inflorescence blossoms for oviposition. The eggs were removed by a soft hair brush from the inflorescences daily. [24].

Fig 1: The big-eyed bug *Geocoris ochropterus* predator and the lepidoptera larvae

Rearing predator (*Geocoris ochropterus*)

Geocoris specimens (nymphs and adults) (Fig. 1) were collected from mango inflorescences of mango trees at Shirben district, Dakahlia governorate, Egypt, and maintained in a glass vial (40 D×70 H mm) with a supply of different diets described in this study (Lepidoptera species) until eggs were laid. The eggs were collected daily and transferred to a new glass vial. The specimens were morphologically identified as *Geocoris ochropterus*. [25] The identification was also confirmed in the taxonomy department of the Plant Protection Research Institute in Dokki, Giza, Egypt.

Choice test

Ten larvae (1st and 2nd) from each one of the three lepidoptera insects (*C. gnidiella, E. cautella,* and *E. gayneri*) were held within the same arena (40 D×70 H, mm) with one predator (Nymph or adult) of *G. ochropterus*. This experiment was replicated 10 times, and observations were recorded after 24 and 48 hrs (Fig. 2).

Fig 2: The big-eyed bug *G. ochropterus* preys on the lepidoptera larvae (*E. cautella* and *C. gnidiella*)

Life and fertility tables for *G. ochropterus*

Recently hatched first instar larvae of *G. ocropterus* were fed on both honeydew moth and almond moth diets separately, first and second instars. Each stage was fed in a glass vial (40 D × 70 H, mm), including a piece of cotton (1 cm^3) soaked in water. The vials were stored at 30 ± 2 °C and 70 ± 5% relative humidity in the laboratory of the Plant Protection Research Institute.

One fresh almond and honeydew moth larva (first instar) on a small piece of mango inflorescence was administered to each predator in each vial of each treatment as a first instar larva, thereby increasing the number of larvae. (equal number of lepidoptera insect's 1^{st} and 2^{nd} instars) incrementally depends on the predator's age and need. Food was changed daily.

The developmental time of each predator (from 1st instar to 5th instar larvae) was recorded. Females of *G. ochropterus* are larger than males, and males are distinguished from females by the fact that the front part of the head of the male is pale yellow, whereas that of the female is brownish-yellow. Varshney and Ballal (2017) [10] also noted that the tip of the abdomen in males is rounded and contains the reproductive organs, whereas in females, the ovipositor is clearly visible. [10] The antennae are ocher yellow with blackish or blackish tips. II–III are darker and segment IV is ocher. [26]

Pairs of predators (male and female) were allowed to mate in glass vials (55 D × 80 H, mm) containing wet cotton pieces (1 cm^3) and dry cotton pieces (1 cm^3) for oviposition. The males were removed after 24 hours and allowed to mate again after 4 days, as *G. ochoropterus* can mate multiple times. The number of eggs laid was determined by checking dried cotton strips daily. Larvae on mango inflorescences and dried cotton pieces were replaced daily. [10] To study the fertility table, 20 pairs of newly adult females were placed in glass bottles, and each pair's cage was tipped with dry cotton pieces (1 cm^3) for oviposition. The number of eggs laid each day by each female was recorded. Life Table Construction Age-Specific: Observations on the number of alive and dead nymphs out of 50 eggs were recorded daily. The following assumptions were used in the construction of the age-specific life table of *G. ochropterus*. The experiment was based on the procedures of Khan *et al.* [27]

Stage-Specific Life Table

The age-specific life table was used to record data on the survival and death of *G. ochoropterus* eggs, nymphs, and adults at different stages of development. The stage-specific life table was completed using the following standard heads.

100qx= (dx / lx) x 100

Where, x = Insect age, 100qx = Mortality rate at the age interval x, lx = Number of survivals out of 50 at the start of each period, and dx = The number of deaths during the age period, out of 50.

ex = Tx/ lx

Where, ex = Mean life remaining for individuals of age x (Expectation of life)

lx = The number of individuals alive between age x and x+ 1 and

Tx = lx + (lx + 1) + (lx + 2) ………………. + lw. where, lw = The last age interval and Tx = The total number of individuals of x age units beyond the age x.

Survival Fraction (Sx) was determined by using the apparent mortality for each stage by the equation: Sx of particular stage = lx of subsequent stage/lx of particular stage.

Lx: The number of individuals lived between ages x and x+1: Lx = lx - 0.5×dx

Female fecundity study

The adult female life tables were calculated and constructed using Birch's method. [28] The cohort's mean age (x) is listed in the table's first column. The initial population fractions (l_x) of alive still at each age interval (x) at the end are shown in the second column and the average number of female offspring (m_x) generated per female per day at age x is shown in the third column. Different parameters of population were obtained from l_x and m_x values, such as Gross reproductive rate (GRR), net reproductive rate (R_o), approximate generation time (T_c), innate capacity for increase (r_c), intrinsic rate of natural increase (r_m), and corrected generation time (T). [29]

$R_o = \sum l_x m_x$

$T = \sum x (l_x m_x)/R_o$

$r_m = In (R_o)/T$

G. ochoropterus sex ratio, females to males, was considered to be 1:1.4 by Kapadia and Puri. [12]

Results

Three lepidoptera insects were found beside the *G. ochoropterus* in mango inflorescences. *G. ochropterus* nymphs consumed *C. gnidiella* more than *E. cautella* and never fed on *E. gayneri* (Table 1).

Table 1: Number of lepidoptera insects consumed by *G. ochoropterus* after 24 and 48 hrs.

Prey insects	Mean no. of consumed insects by predator ±SE	
	After 24 hrs	After 48 hrs
C. gnidiella	4.1±0.23	7.8±0.29
E. cautella	3.4±0.27	6.3±0.33
E. gayneri	0.0±0.0	0.0±0.0

Feeding on the *C. gnidiella* larvae

Stage-specific life table

Apparent mortality

The mortality of 1^{st} and 2^{nd} instar (qx) nymphs was the lowest among all instars. They are (4.0 and 4.2%). The fifth instar nymphs had the highest mortality rate (14.2%). Apparent (significant) mortality at the egg stage was also observed, with no lethality recorded (0%). The total development time was 28.3 days (Table 2). In general, the age-specific survival of *G. ochoropterus* indicated that the 3^{rd}, 4^{th}, and 5^{th} instar nymphs appeared to be critical instar mortality.

Survival fraction

Survival fractions (Sx) for one egg, first, second, and third nymphs are shown in Table **2**. The fourth instar nymphs were the highest (1.0, 1.04, 0.95, 0.86, 0.87), and the fifth instar nymph survival rate (Sx) was the lowest (0.57).

Life expectancy

The data in Table **2** showed that the egg stage lasted 7.1±0.8 days. The 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} instar nymphs lasted 3.7±0.5, 3.0±0.5, 4.5±0.5, 4.7±0.5 and 5.2±0.6 days, respectively. The whole developmental stage lasted 28.3 days.

Table 2: Stage-specific life table of *G. ochoropterus* reared on *C. gnidiella* under laboratory conditions (30±2°C and 70±5% RH).

Stage X	l_x	d_x	Lx	100qx	Sx	Tx	ex
Egg	50	0	50	0	1	286.5	7.1±0.8
Nymphal stage:							
1st instar	50	2	49	4	1.04	237.5	3.7 ± 0.5
2nd instar	48	2	47	4.2	0.95	190.5	3.0 ± 0.6
3rd instar	46	6	43	13.04	0.86	147.5	4.5 ± 0.5
4th instar	40	5	37.5	12.5	0.87	110	4.7 ± 0.5
5th instar	35	5	32.5	14.3	0.57	77.5	5.2 ± 0.6
Adult	30		27.5				30.0±1.5

Fertility life table parameters of adult *G. ochoropterus* gross reproductive rate

The viability and fertility of the predator *G. ochoropterus* are shown in Table 3 and Fig. 3. The results showed that the first adult females emerged at week 5 (35.4 days). Oviposition was recorded after 6 days and continued for almost 3 days before death. The last female died at the 8th week. The average number of eggs laid by each female was 177.

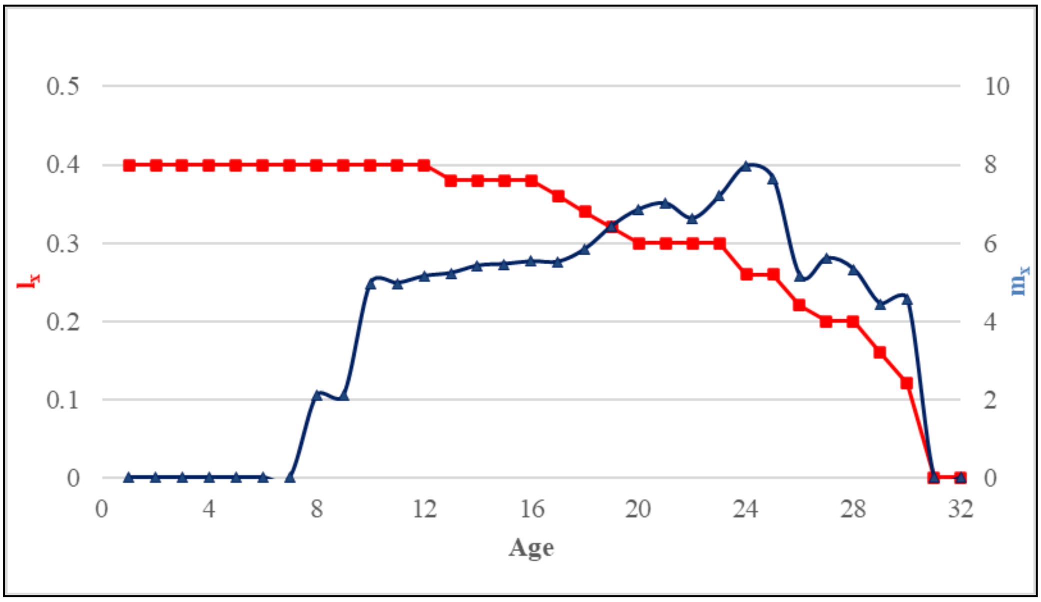

Fig 3: Daily age-specific survival (l_x) and fecundity (m_x) of the predator *G. ochoropterus* fed on *C. gnidiella*

On day 8, Specific Fertility (m_x), Survival (l_x), and the first specific fertility (m_x) were recorded. Fertility peaks were observed on day 24 of age, and fertility was continued until day 31 of age. Although some females survive, they fail to develop thereafter. The maximum (m_x) was observed between 13 and 27 days. The first mortality was observed at day 13 of age. The population gradually decreases until day 31 days of age. After this period, the female population declined sharply (Fig. 3). The population and reproductive parameters of *G. ochoropterus* reared on *C. gnidiella* were summarized in Table 3. The intrinsic natural growth rate (r_m) was 0.02 per female per day, and the mean gestational time (T_c) was 45.64. The net reproductive rate (R_o) of the population was 38.93.

Table 3: Life table parameters as survival (l_x) and fecundity rate (m_x) of *G. ochoropterus* reared on *C. gnidiella* for one generation under laboratory conditions (30±2°C and 70±5% RH).

x	l_x	m_x	m_x*l_x	∑x(l_x*m_x)
35.4	0.4	2.10	0.84	29.74
36.3	0.4	2.10	0.84	30.49
37.3	0.4	4.97	1.99	74.15
38.3	0.4	4.97	1.99	76.14
39.3	0.4	5.15	2.06	80.96
40.3	0.38	5.23	1.99	80.09
41.3	0.38	5.42	2.06	85.06
42.3	0.38	5.46	2.07	87.76
43.3	0.38	5.53	2.10	90.99
44.3	0.36	5.52	1.99	88.03
45.3	0.34	5.85	1.98	90.10
46.3	0.32	6.44	2.06	95.42
47.3	0.3	6.86	2.06	97.34
48.3	0.3	7.01	2.10	101.57
49.3	0.3	6.63	1.99	98.06

50.3	0.3	7.20	2.16	108.66
51.3	0.26	7.97	2.07	106.30
52.3	0.26	7.65	1.99	104.02
53.3	0.22	5.16	1.14	60.51
54.3	0.2	5.61	1.12	60.93
55.3	0.2	5.33	1.07	58.95
56.3	0.16	4.44	0.71	39.99
57.3	0.12	4.55	0.55	31.29
			38.92	1776.57

Feeding on the *E. cautella* larvae

Stage-specific life table

Apparent mortality

The 2nd instar nymphal stage and the 4th instar mortalities (q_x) were the lowest among all stages and instars; they were 2.4 and 5.0% respectively. Mortality of the 5th instar was the highest (21.1%). Furthermore, the apparent (noticeable) mortality at the 3rd instar did not record any death rate (0.0%). The total developmental duration lasted 29.8 days. Generally, age-specific survival of *G. ochoropterus* showed that the 1st instar, Egg stage and fifth instar nymphs appear to be the key stage mortalities.

Survival fraction

Table 4 showed the highest Survival fraction (Sx) values for egg, first, second, third, and fourth instars larvae (0.90, 0.91, 0.98, 1.00, and 0.95), respectively. While the fifth nymphal stage was the lowest one (0.79).

Life expectancy

Data in Table 4 indicated that the egg stage lasted 8.6±0.8 days. The 1st, 2nd, 3rd, 4thand 5th Nymphal instars duration was 4.4±0.5, 4.5±0.4, 3.5±0.5, 5.3±0.5 and 4.5±0.5 days, respectively. The total developmental period lasted 30.8 days.

Table 4: Life tables of *G. ochoropterus* reared on *E. cautella* under laboratory conditions (30±2°C and 70±5% RH).

Stage X	lx	dx	Lx	100qx	Sx	Tx	ex
Egg	50	5	47.5	10	0.90	271.5	8.6±0.8
Nymphal stage: 1st instar	45	4	43	8.9	0.91	224	4.4 ± 0.5
2nd instar	41	1	40.5	2.4	0.98	181	4.5 ± 0.4
3rd instar	40	0	40	0.0	1.0	140.5	3.5 ± 0.5
4th instar	40	2	39	5.0	0.95	100.5	5.3 ± 0.5
5th instar	38	8	34	21.1	0.79	61.5	4.5 ± 0.5
Adult	30		27.5				32.2±0.4

Fertility life table parameters of adult *G. ochoropterus* gross reproductive rate

Viability and fertility of the predator *G. ochoropterus* are listed in Table **5** and Fig. 4. The results showed that the first adult females emerged at week 5 (37.8 days). The preoviposition period was recorded after 8 days of the female hatching and continued almost until 3 days before death. The last female died at 8 weeks. The average number of eggs laid by each female was 100.0.

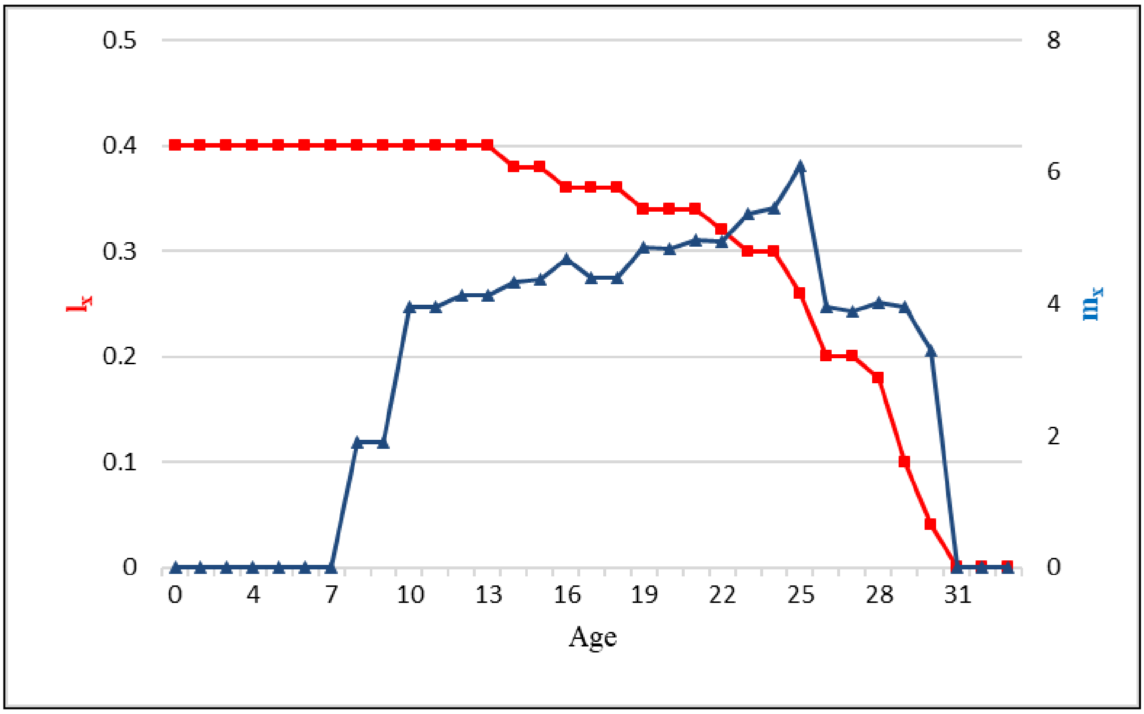

Fig 4: Daily age-specific survival (l_x) and fecundity (m_x) of the predator *G. ochoropterus* fed on *E. cautella*

Table 5: Life table parameters as survival rate (l_x) and fecundity rate (m_x) of *G. ochoropterus* reared on *Ephestia cautella* for one generation under laboratory conditions (30±2°C and 70±5% RH)

x	l_x	m_x	m_x*l_x	$\sum x(l_x*m_x)$
37.8	0.4	1.91	0.77	28.94
38.8	0.4	1.91	0.77	29.71
39.8	0.4	3.96	1.58	63.04
40.8	0.4	3.96	1.58	64.63
41.8	0.4	4.13	1.65	68.97
42.8	0.4	4.13	1.65	70.62
43.8	0.38	4.34	1.65	72.27
44.8	0.38	4.38	1.66	74.51
45.8	0.36	4.69	1.69	77.38
46.8	0.36	4.40	1.58	74.13
47.8	0.36	4.40	1.58	75.72
48.8	0.34	4.85	1.65	80.52
49.8	0.34	4.85	1.65	82.12
50.8	0.34	4.97	1.69	85.83
51.8	0.32	4.95	1.58	82.05
52.8	0.3	5.37	1.61	85.03
53.8	0.3	5.46	1.64	88.06
54.8	0.26	6.092	1.58	86.80
55.8	0.2	3.96	0.79	44.19
56.8	0.2	3.89	0.78	44.24
57.8	0.18	4.03	0.73	41.96
58.8	0.1	3.96	0.40	23.28
59.8	0.04	3.30	0.13	7.89
			30.40	1451.90

At 8 days old, the first specific fertility (mx) was noted. The age of 25 days was the greatest fertility. Up to the age of 30 days, the fertility was noted. The maximum, mx, was noted for a period of 12 to 30 days. The female lasted for a whole 33 days. According to the survivorship curve, the first death occurred on day 14. The population continually reduced until 30 days of age. After this time, a sudden decrease in the number of females was observed (Fig. 4). Table 5 summarizes the population and reproduction parameters of *G. ochoropterus* reared on *E. cautella,* and the mean gestation period (T_c) was 47.76, and the net reproductive rate (R_o) of the population was 30.4. Table **6** indicates that the mean fecundity per female was 177 and 100 eggs, the net reproductive rate was 38.9 and 30.4 days, and the approximate generation time was 45.6 and 47.8 days when reared on *C. gnidiella* and *E. cautella,* respectively. Also, the gross reproduction rate was 127.2 and 97.9 females/female, and the intrinsic rate of natural increase (r_m) was 0.02 and 0.02, respectively.

Table 6: Estimated life table parameters of *G. ochoropterus,* fed on *C. gnidiella and E. cautella* under laboratory conditions (30±2°C and 70±5% RH).

Life table parameters	*C. gnidiella*	*E. cautella*
Approximate generation time (T_c), (days)	45.6	47.8
Intrinsic rate of natural increase (r_m)	0.02	0.02
Innate capacity for increase (r_c)	0.9	0.6
Gross reproduction rate (GRR)	127.2	97.9
Net reproduction rate (R_o)	38.9	30.4
Average No. of eggs/ female	177	100

Discussion

The presence of *G. ochoropterus* beside some larvae of lepidoptera insects in the mango inflorescences attracted our attention to study the extent of their relationship with each other. [24] *G. ochoropterus* never fed on *E. gayneri* larvae during the choice test experiment may be due to the presence of hairs on the larval body. The findings from this study confirm *G. ochropterus* as an important predator in mango inflorescences. Its prey preference for *C. gnidiella* and *E. cautella* suggests that it can play a crucial role in limiting the population sizes of these lepidoptera pests. Mass rearing of *G. ochoropterus* on many insect diets gave an impression of its success in biological control. [5, 30] The total development duration of *G. ochoropterus* when rearing on *C. gnidiella* and *E. cautella* (28.3 and 30.7 days, respectively) was less than when rearing on ant pupae, silkworm pupae, and aphids (35.1, 35.9, and 36.0 days), respectively, which agreed with Mukhopadhyay and Sannigrahi. [5, 11]

G. ochoropterus nymphs developed normally when fed on first and second larvae of *C. gnidiella* and *E. cautella* diets, and this explains why they are found together in mango inflorescences. The mean duration period of the different developmental stages of *G. ochoropterus* (eggs, nymphal stage) was 7.1, 21.1 days when feeding on *C. gnidiella* and 8.6, 22.2 days when feeding on *E. cautella,* respectively. Our results showed that there is no significant difference with Chau *et al.* (2021), [5] when rearing *G. ochoropterus* on ant pupae, silkworm pupae, and aphids (8.8, 7.9, and 7.4 days) in the case of eggs, while there is a significant difference (26.2, 28.4, and 29.6 days) in the case of the nymphal period, respectively. The mortality rate from eggs to adults of *G. ochoropterus* was 30.0% (15/50) when preying on C. *gnidiella* and 24.0% (12/50) when preying on *E. cautella.* These results are not consistent with Chau *et al.* (2021) [5], which showed 0.0% (0/40) in case of ant pupae, 5.0% (2/40) in silkworm pupae, and 20.0% (10/50) in aphids. [5]

Mean average no. of eggs/female of *G. ochoropterus* was 177eggs/female when reared on *C. gnidiella,* and this agreed with Varshney and Ballal (2017), [10] 176 eggs/female when reared on *Sitotroga cerealella*. However, these results did not agree with Mukhopadhyay and Sannigrahi, [11] 228 eggs/female when reared on ant pupae (*Oecophylla smaragdina*) and perennial common weed (*Leucus linifolia*). The rate of laying eggs of the predator *G. ochoropterus* was low at an average of 100 eggs when reared on *E. cautella*, and these results differed of Varshney and Ballal (2017). [10] The observed efficiency of predation, short development time, high nymph survival rate, and reproductive output all contribute to the bug's potential as a biocontrol agent in integrated pest management strategies. Using synthetic pesticides to control these pests is very difficult as a result of the dense flowering of mango inflorescences, which prevents the pesticides from reaching these pests. Therefore, there is an urgent need to use natural enemies like predators to control these pests.

Conclusion

Biology, life, and fertility tables parameters and feeding potential of the big-eyed bug, *Geocoris ochropterus* (*Hemiptera: Geocoridae*) were evaluated on mango inflorescences under the laboratory conditions of 30±2 ^{0}C and 70±5% RH, using two larvae of lepidoptera insects (*Cryptoblabes gnidiella* and *Ephestia cautella*) as a suitable diet providing development and survival. Survival curves showed moderate mortality in the early stages of life and a gradual rise in mortality as adulthood approached. The life table shows that population changes depend on mortality and birth rates. The results showed that the five nymphal stage mortality of *G. ochoropterus* was 14.2% and 21.2%, the average net reproduction rate was 38.9 and 30.4, and the mean generation time (T) was 45.6 and 47.8 days when fed on *C. gnidiella* and *E. cautella*, respectively. Thus, *G. ochropterus* has demonstrated strong predation behavior on lepidoptera pests in mango inflorescences, offering promising possibilities for the natural control of pest populations. These laboratory observations and the measured life history parameters provide valuable insights for further research and discussions on the use of *G. ochropterus* as a biocontrol agent in mango orchards and other agroecosystems.

Authors contribution

The samples of insects were collected by Ahmed Ramadan El-Rokh. Experimental planning and all laboratory experiments were performed by Samira A. Abd El-Salam, Ahmed Ramadan El-Rokh, and Hanaa M. Raghib. Data analysis was performed by Samira A. Abd El-Salam. The manuscript was written and reviewed by all authors.

Funding

No funding was received from any agency.

Declaration of Competing Interest

The authors declare no competing interests.

Data availability

Data will be made available on request.

Acknowledgements

We thank the kind help of the Plant Protection Research Institute, Mansoura, for accommodation.

References

1. Varshney R, Ballal CR. Intraguild predation on *Trichogramma chilonis* Ishii, *Hymenoptera: Trichogrammatidae*, by the generalist predator *Geocoris ochropterus* Fieber, *Hemiptera: Geocoridae*. Egyptian Journal of Biological Pest Control,2018:28(5):1–6. https://doi.org/10.1186/s41938-017-0006-z
2. Varshney R, Budhlakoti N, Ballal CR. Functional response of *Geocoris ochropterus* Fieber, *Hemiptera: Geocoridae*, to different egg densities of *Helicoverpa armigera*, Hübner, *Lepidoptera: Noctuidae*. Phytoparasitica,2018:46:451–458. https://doi.org/10.1007/s12600-018-0687-1
3. Schuman MC, Kessler D, Baldwin IT. Ecological observations of native *Geocoris pallens* and *G. punctipes* populations in the Great Basin Desert of southwestern Utah. Psyche, A Journal of Entomology,2013:6:1–11. http://dx.doi.org/10.1155/2013/465108
4. Gómez-Domínguez NS, Rodríguez-Leyva E, Lomeli-Flores JR, Velázquez-González JC, Guzmán-Franco AW. Examining potential intra-guild predation of *Peristenus relictus* by *Geocoris punctipes*, and its effects on the biological control of *Lygus lineolaris*. Biological Control,2021:156:104557. https://doi.org/10.1016/j.biocontrol.2021.104557
5. Chau NNB, Anh NQP, Nhu LTT, Kieu NTP, Quoc NB. Ant and silkworm pupae as convenient diets for the development and reproduction of big-eyed bug *Geocoris ochropterus, Hemiptera: Geocoridae*. Journal of Asia-Pacific Entomology,2021:24:131–134. https://doi.org/10.1016/j.aspen.2021.03.006
6. Kumar NS, Ananthakrishnan TN. *Geocoris ochropterus* Fabr. as a predator of some thrips. Proceedings of the Indian National Science Academy,1985:51(2):185–193.
7. Capinera JL. Handbook of Vegetable Pests. Academic Press, 2001, 729.
8. Igarashi K, Nomura M. Development and reproduction of *Geocoris varius, Hemiptera: Geocoridae*, on two types of artificial diet. Applied Entomology and Zoology,2013:48(3):403–407. http://dx.doi.org/10.1007/s13355-013-0185-3
9. Calixto AM, Vanda HPB, Flavio CM, Joop CVL. Development and thermal requirements of Nearctic predator *Geocoris punctipes, Hemiptera: Geocoridae*, reared at constant and alternating temperature and fed on *Anagasta kuehniella, Lepidoptera: Pyralidae*, eggs. European Journal of Entomology,2014:111(4):521–528. https://doi.org/10.14411/eje.2014.074
10. Varshney R, Ballal CR. Biological, morphological and life table parameters of the predator *Geocoris ochropterus* Fieber, *Hemiptera: Geocoridae*, fed on *Sitotroga cerealella*, Olivier, eggs. Egyptian Journal of Biological Pest Control,2017:27(2):189–194.
11. Mukhopadhyay A, Sannigrahi S. Rearing success of a polyphagous predator *Geocoris ochropterus*, *Hemiptera: Lygaeidae*, on preserved ant pupae of *Oecophylla smaragdina*. Entomophaga,1993:38(2):219–224.
12. Kapadia MN, Puri SN. Biology and comparative predation efficacy of three heteropteran species recorded as predators of *Bemisia tabaci* in Maharashtra.

Entomophaga,1991:36(4):555–559. https://doi.org/10.1007/BF02374438

13. Neunzig HH. Pyraloidea, Pyralidae, Phycitinae. In: Dominick RB, ed. The Moths of America North of Mexico. Fascicle 15.2. The Wedge Entomological Research Foundation, Washington, 1986, 113.
14. Dawidowicz L, Rozwalka R. Honeydew moth *Cryptoblabes gnidiella* Millière, 1867, *Lepidoptera: Pyralidae*, an adventive species frequently imported with fruit to Poland. Polish Journal of Entomology,2016:85(2):181–189. https://doi.org/10.1515/pjen-2016-001
15. Abdel Kareim AI, Ragab ME, Ghanim NM, Abd El-Salam SA. Seasonal activity, natural enemies and life table parameters of *Cryptoblabes gnidiella* Mill. on mango inflorescences. Journal of Plant Protection and Pathology Mansoura University,2018:9(7):393–397. http://dx.doi.org/10.21608/jppp.2018.42181
16. Carter DJ. Pest Lepidoptera of Europe with special reference to the British Isles. Dr. W. Junk Publishers, 1984, 431.
17. Bagnoli B, Lucchi A. Bionomics of *Cryptoblabes gnidiella* Millière (Pyralidae: Phycitinae) in Tuscan vineyards. IOBC WPRS Bulletin,2001:24(7):79–83.
18. Jacob TA, Cox PD. The influence of temperature and humidity on the life-cycle of *Ephestia kuehniella* Zeller, *Lepidoptera: Pyralidae*. Journal of Stored Products Research,1976:13(3):107–118. https://doi.org/10.1016/0022-474x(77)90009-1
19. Sayed AA. Infestation levels of two species of *Ephestia* in the field and storehouses at Kharga Oasis, New Valley. Assiut Journal of Agricultural Sciences,1995:26(2):137–143.
20. Abdel Kareim AI, Ragab ME, Ghanim NM, Abd El-Salam SA. Comparative studies on the seasonal activity of *Eublemma gayneri*, Roth., and their natural enemies as a new guest on mango trees in neglected and commercial orchards. Journal of Plant Protection and Pathology Mansoura University,2018:9(7):381–385. http://dx.doi.org/10.21608/jppp.2018.42176
21. Ben Yehuda S, Wysoki M, Rosen D. Phenology of the honeydew moth *Cryptoblabes gnidiella*, Millière, *Lepidoptera: Pyralidae*, on avocado in Israel. Israel Journal of Entomology,1992:25–26:149–160.
22. Abdel-Moaty RM, Hashim SM, Tadros AW. Monitoring the honeydew moth *Cryptoblabes gnidiella* Millière, *Lepidoptera: Pyralidae*, in pomegranate orchards in the northwestern region of Egypt. Journal of Plant Protection and Pathology Mansoura University,2017:8(10):505–509. https://dx.doi.org/10.21608/jppp.2017.46591
23. El-Rawy AM. Semi-looper *Eublemma gayneri*, Roth., *Lepidoptera: Noctuidae*, as an insect pest on maize in Egypt. Ph.D. Thesis, Faculty of Agriculture, Cairo University, 2004, 156.
24. Abd El-Salam SA. Ecological studies on some insect pests attacking mango trees. Ph.D. Thesis, Faculty of Agriculture, Mansoura University, Egypt, 2018, 108.
25. Animesh B, Miswas B. Handbook on Hemipteran predators of India. Zoological Survey of India, Kolkata, 2013, 44.
26. Kobor P. *Geocoris margaretarum*: description of a new species from the Oriental region with remarks on allied taxa, *Heteroptera: Lygaeoidae: Geocoridae*. Raffles Bulletin of Zoology,2018:66:580–586. http://zoobank.org/urn:lsid:zoobank.org:pub:2034ADBF-59D3-4CA1-BDB1-5C7D02A1CC4C
27. Khan J, Khan A, Ahmed N, Alhag SK, Almadiy AA, Sayed S, Alam P, Ullah F. Age and stage-specific life table parameters of *Harmonia dimidia, Coleoptera: Coccinellidae*, fed on *Rhopalosiphum padi, Hemiptera: Aphididae* at different temperatures. Egyptian Journal of Biological Pest Control,2022:32:113. https://doi.org/10.1186/s41938-022-00610-x
28. Birch LC. The intrinsic rate of natural increase of an insect population. Journal of Animal Ecology,1948:17:15–26.
29. Southwood TRE. Ecological methods with particular reference to the study of insect populations. 2nd ed. The English Language Book Society and Chapman and Hall, London, 1978, 524.
30. Chau NNB, Nhu LTT. Big-eyed bugs *Geocoris* diets research and potential of use in prevention of a number of insect pests in Vietnam. The Ho Chi Minh City Open University Journal of Science,2019:9(2):60–66. https://doi.org/10.46223/HCMCOUJS.tech.en.9.1.353.2019