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ECOLOGICAL OBSERVATIONS ON THE EARWIG, *Labidura riparia* PALLAS (DERMAPTERA:LABIDURIDAE) INHABITING HONEY BEE COLONIES

[19]

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ABSTRACT

The present study was carried out for two successive seasons, 2005 and 2006, in an apiary situated at Beni-suif governorate to evaluate the role of the predator earwig, *Labidura riparia* Pallas, inhabiting honey bee colonies. Also, a laboratory experiment was conducted in the Fac. Agric., Fayoum Univ. to study the predation potential when feeding on both larvae and pupae of greater wax moth, *Galleria mellonella* L. Obtained results indicated that the presence of this predator was continuously occurred, but in variable population densities. Reliable abundance was recorded in autumn followed by summer season then winter and spring with an average means; 7.80, 3.95, 0.86 and 0.32 earwig / colony for the 1st year, and 10.43, 0.92, 0.53 and 0.28 earwig / colony for the 2nd year, respectively. Significant difference was found between autumn and other seasons. It seems worth noting here that this earwig preyed, desirably, pupae of *G. mellonella*, and it has not been observed attacking bees in tested colonies. Insignificant difference was found between the population of target predator and weather factors, so it is suggested that this predator feeds on *G. mellonella* stages and may be on other insects visiting or inhabiting bee colonies. It was observed that individuals fed, in laboratory, on larvae and pupae of *G. mellonella* survived during the test period (30 days), while those unfed had died within 2–7 days of starvation. Daily food consumption for female predator seems to be greater than that for male.

INTRODUCTION

About 900 species of earwigs are identified worldwide, most of them being tropical. Earwigs are active predaceous of tiny insects, besides feed on live and dead plants of the same ecosystem. They are considered important predators of eggs, larvae and pupae of moths and beetles **(El-Hussieni, 1969)**. Earwigs are active at night and hide during the day in moist, shady places such as under stones or logs, or in mulch. Neither eggs nor nymphs can withstand long periods of dryness **(McKie and Skelly, 2001)**. The Indian earwig, *Labidura riparia*, is the dominant species and mainly preys cutworms, caterpillars, small grubs, maggots, mealybugs, fleas and other insects **(Dugard, 2006)**. In Brazil, *Euborellia annulipes* and *Labidura riparia* were associated with commercial poultry ranches as biological control agents **(Guimaraes *et al* 1992)**.

In USA, *L. riparia*, was recorded as a predator of pupal stage of lepidopterous pests in soybean fields **(Domiciano and Herzog 1990; and Lee *et al* 1990)**, and was the most abundant predator in peanut fields **(Kharboutli and Mack, 1991)**; in Germany, as predator of tomato pests **(Probst *et al* 1999)**; in Spain, as a predator of maize aphid

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(**Asin and Pons, 1998**). On the other hand, **Johri and Reeta (1996)**, in India, observed that *L. riparia* form *bengalensis* (Dohrn) was omnivorous and the adults damaged 10.4-21% of stored potato tubers.

In, Egypt, *L. riparia* was recorded affecting the changes in the population densities of *Thrips tabaci* Lind., *Empoasca* sp. and *Compylomma* spp. in corn fields (**Ahmed and Darwish, 1991**); *Bemisia tabaci* Boisd. in cotton fields (**Darwish and Farghal, 1990**); *Phthorimaea operculella* in tomato and potato fields (**Abbas *et al* 1993**) and *Aphis craccivora* K. in faba bean fields (**El-Defrawi *et al* 2000**).

In honey bee colonies, earwigs and other insects may live for short or long periods of time inside a colony or beneath the inner and the outer covers of a bee hive. They do not harm although the beekeeper may feel their presence unsanitary or unsightly. Some may eat bees or honey while others are just for sheltering (**Caron, 1990**).

Because the information about the activity of earwigs in bee colonies is not complete, the present study aimed to focus on the related bioaspects and behavior of earwig, *L. riparia,* inhabiting honey bee colonies during two successive years, besides certain laboratory observations about its feeding.

MATERIALS AND METHODS

The present study was carried out during for successive seasons *i.e.* 2005 and 2006. Selecting location, sampling procedure and recommended technique were as the following:

1. Location: A stationery apiary situated in Qui village, Ehnasia, Beni-suif governorate, Egypt was selected. Honey bee, *Apis mellifera* L. colonies of Langstroth's design headed with local Carniolan queens were inspected.

2. Sampling: 50 colonies were inspected periodically every 15 days from Jan., 2005 to Dec., 2006. To record the changes in the natural population density of *L. riparia*, the outer cover of a colony was gently removed and the predator survivors found above or below the inner cover (rough sheet) or in other parts of the hive were counted. All colonies had ordinary beekeeping practices.
The natural rate of quotient of increases (Q.I.) was estimated by dividing the value of population density for each sampling period to that of the preceding one (**Abdella, 1981**).

3. Laboratory preying technique: At the end of surveying period, samples of earwigs of the same colonies were taken to the laboratory of Fac. Agric., Fayoum Univ. To study the daily predation, the obtained samples were isolated individually into males, females and nymphs in 10 cm Petri-dishes, fortified with clean correcated pers. Four groups were set as the following:

a) males only; b) females only; c) males + females; and d) nymphs only. Each group had 3 types of feeding as the following:

(1) feeding on larvae of the greater wax moth, *Galleria mellonella*, (2) feeding on pupae of *G. mellonella* and (3) without feeding.

Twelve treatments were used, each of 20 individuals. The treated dishes were incubated at 25± 1 °C and 70 ± 5 % R.H. where daily inspection and renewal of preys was carried out. Observations lasted 30 days were recorded and predation rate was estimated. Temperatures (°C) and relative humidity (% R.H.) during the period of study were obtained from the Bulletin of Agricultural Meteorology, Ministry of Agriculture, Egypt.

4. Statistical analysis: Data collected were statistically analyzed in a random complete block design and mean values were compared at 5% probability levels by L.S.D. test, also correlation coefficients were calculated according to the methods given by **Snedecor and Cochran (1981)**.

RESULTS AND DISCUSSION

1. Monitoring the changes in population density

The fluctuations in the population densities of the earwig, *L. riparia* inhabiting tested honey bee colonies were investigated during for successive seasons (Jan. 2005 to Dec. 2006) at Beni-suif governorate. Obtained results are summarized in **Tables (1)** and **(2)** and graphically illustrated in **Fig. (1)**.

For the 1st year of study, *L. riparia,* was found during the whole year in inspected bee colonies, almost beneath the outer and inner covers of a colony and rarely in another part. It was noticed that if one earwig was dropped, accidentally into a bee colony, it quickly escaped upwards to the hive cover or downwards to the hive entrance.

Table 1. Changes in the seasonal abundance of the predator earwig, *L. riparia,* inhabiting honey bee colonies during 2005 in Beni-suif governorate

Sampling date		Counts of earwig		Quotient of increases	Weather factors		
		Total/ 50 colonies	Mean/ colony		Min. temp. °C	Max. temp. °C	% R.H.
Winter	Jan. 1	86	1.72	-	9.3	21.7	55
	Jan.15	52	1.04	0.60	9.6	20.2	58
	Feb.1	33	0.66	0.65	9.5	21.8	48
	Feb.15	38	0.76	1.15	7.7	17.5	52
	March,1	24	0.48	0.63	13.7	24.3	52
	March,15	26	0.52	1.08	13.5	24.1	48
Mean		**43.17** ab	**0.86**	-	**10.55**	**21.60**	**52.17**
Spring	April,1	19	0.38	0.73	12.5	25.9	48
	April,15	18	0.36	0.95	14.1	32.1	50
	May,1	12	0.24	0.67	19.5	31.8	47
	May,15	17	0.34	1.42	15.1	31.9	53
	June,1	11	0.38	1.12	18.2	39.3	50
	June,15	12	0.24	0.63	22.3	34.7	47
Mean		**14.83** a	**0.32**	-	**16.95**	**32.62**	**49.17**
Summer	July,1	14	0.28	1.17	24.6	35.8	41
	July,15	18	0.30	1.29	24.1	36.2	42
	Aug.,1	112	2.24	6.22	21.1	36.3	50
	Aug.,15	317	6.34	2.83	20.2	33.5	52
	Sep.,1	212	4.24	0.67	18.2	33.2	54
	Sep.,15	514	10.28	0.43	20.6	31.2	47
Mean		**197.83** b	**3.95**	-	**21.47**	**34.37**	**47.67**
Autumn	Oct.,1	342	6.84	0.67	20.2	34.1	48
	Oct.,15	642	12.84	1.88	19.1	32.1	49
	Nov.,1	411	8.22	0.64	18.1	32.0	51
	Nov.,15	424	8.48	1.03	19.2	30.6	49
	Dec.,1	310	6.20	0.73	10.8	26.7	50
	Dec.,15	211	4.22	0.68	8.2	23.8	51
Mean		**390.00** c	**7.80**	-	**15.93**	**29.88**	**49.67**
General mean		**161.46**	**3.23**				
r					0.22	0.16	0.04

L.S.D. $_{5\%}$ = 166.18 for total.
r = correlation between the population of earwigs and weather factors at 0.05 level.

Table 2. Changes in the seasonal abundance of the predator earwig, *L. riparia,* inhabiting honey bee colonies during 2006 in Beni-suif governorate

Sampling date		Counts of earwig		Quotient of increases	Weather factors		
		Total/ 50 colonies	Mean/ colony		Min. temp. °C	Max. temp. °C	%R.H.
Winter	Jan.,1	35	0.70	-	9.0	21.3	57
	Jan.,15	42	0.84	1.20	9.2	21.2	55
	Feb.,1	20	0.40	0.48	10.9	22.8	56
	Feb.,15	19	0.38	0.95	9.6	20.9	60
	March,1	26	0.52	1.37	10.5	25.9	52
	March,15	18	0.36	0.69	13.5	26.9	53
Mean		**26.67** a	**0.53**	-	**10.45**	**23.17**	**55.50**
Spring	April,1	17	0.34	0.94	14.5	29.4	55
	April,15	25	0.50	1.47	15.6	29.8	47
	May,1	17	0.34	0.68	16.1	33.0	51
	May,15	5	0.10	0.29	18.9	36.1	44
	June,1	8	0.16	1.60	22.1	35.8	45
	June,15	11	0.22	1.38	22.5	37.2	47
Mean		**13.83** a	**0.28**	-	**18.28**	**33.55**	**48.17**
Summer	July,1	8	0.16	1.60	22.1	35.8	45
	July,15	11	0.22	1.38	22.5	37.2	47
	Aug.,1	17	0.34	1.54	25.9	38.3	48
	Aug.,15	19	0.38	1.12	24.6	37.5	52
	Sep.,1	68	1.34	3.53	22.9	37.9	50
	Sep.,15	153	3.06	2.28	22.4	34.5	51
Mean		**46.00** a	**0.92**	-	**23.40**	**36.87**	**48.83**
Autumn	Oct.,1	412	8.24	1.32	18.9	36.2	48
	Oct.,15	522	10.44	1.27	17.8	32.1	49
	Nov.,1	932	18.63	1.79	19.1	34.3	50
	Nov.,15	632	12.64	0.68	18.1	32.5	49
	Dec.,1	511	10.22	0.81	10.6	22.8	49
	Dec.,15	120	2.40	0.23	10.2	23.8	52
Mean		**521.50** b	**10.43**	-	**15.78**	**30.28**	**49.50**
General mean		**152.00**	**3.04**				
r					0.10	0.11	-0.22

L.S.D. $_{5\%}$ = 175.74 for total.
r = correlation between the population of earwigs and weather factors at 0.05 level.

Data, **Table (1)**, showed that population density appeared with 86 individuals / 50 colonies at Jan. 1st, then decreased obviously till June 1st to 11 individuals / 50 colonies.

In Aug., a sharp increase in population density was noticed reaching its maximum density in mid Oct. (642 individuals / 50 colonies) with a mean value 12.84 individuals / colony at average 19.1 and 32.1°C min. and max. temp. and 49 % R.H.. However Q.I. was 1.88, then a slight decrease was recorded in the end of Dec.

For the 2nd year, similar population demonstrates the same trend, but in less values being; 35and 5 individuals / 50 colonies in Jan. 1st and May 15, respectively. A gradual increase in population density was obtained reaching its maximum (932 individuals / 50 colonies) in Nov. 1st with a mean value; 18.63 individuals / colony and 1.79 Q.I. value at 19.1 and 34.3 °C min. and max. temp. and 50 % R.H. Also, population density gradually declined till the end of Dec., recording one period of activity as in the 1st year, **Fig. (1)**. The highest abundance of *L. riparia* was recorded in autumn followed by summer then winter and spring, **Fig. (2)**.

Statistical analysis showed insignificant correlation values between the population density of *L. riparia* in the tested colonies and each of external min., max. temp. and % R.H. for the two years of study. Meaning that the presence of this predator is not obviously associated with external changes in weather factors to be enforced to hide in bee colonies, while temperature inside the colony is somewhat stable. So, another reason is much more accepted, however individuals of *L. riparia* in the tested colonies was not seen attacking adult bees, but preying, desirably, pupae of the greater wax moth, *G. mellonella*. Concerning seasons, the high population density which was recorded in autumn differed significantly with those of other seasons during the two years of study.

The present observations showed that the high activity of this predator coincided with those of other pests attacking bee colonies in the same periods. These pests include; oriental hornet, *Vespa orientalis* F., bee-eater, *Merops* spp., and greater wax moth, *G. mellonella* (**Hussein *et al* 2001$_a$**). It is also known that bee colonies being weak or inactive in autumn and winter in most Egyptian regions associating with ecological conditions *i.e.* decreased temperature, lack of food sources which leading to decreased brood rearing.

In this respect, **Hussein *et al* (2001$_b$)**, in Egypt, recorded maximum abundance of bee-eater during Jan., Dec., and Feb.; peaks of oriental hornet during Nov., and Oct. On the other hand, maximum abundance of greater wax moth was observed during Dec., and March, while minimum one during Aug. The same authors recorded *L. riparia* as an occasional pest in honey bee colonies and they didn't mention any details about its role or activity periods inside the bee colony (**Hussein *et al* 2001$_b$**).

The present findings are in agreement with those of **Gupta and Sharma (2003)**, in India, who found that the highest population density of *L. riparia* was recorded during July, Aug., and Sep., while the lowest one during Feb. and March demonstrated a sharp decline during summer months (May and June).

On the other hand, **Caron (1990)** suggested that the earwig, *Foficula auricularia* L. enters bee hives in Europe and North America for shelter, eat honey, wax, soft parts, injured or dying bees, and perhaps larvae.

2. Predation rate

The data in **Table (3)** indicated that individuals of earwig when fed on larvae or pupae of *G. mellonella* survived during the period of experiment (30 days), *vice versa* those non-fed ones which died within 2 – 7 days (males) and within 3 – 6 days (females). Unfed males + females showed cannibalistic behavior within 1 -2 days, while starved nymphs died within 2 – 5 days.

In case of feeding on larvae of *G. mellonella*, the consumption means were 0.53, 0.70 and 1.30 prey / day for male, female, and male + female, respectively. Total counts of preys were; 16, 21 and 39 preys / 30 days for the same treatments, respectively. It is observed that nymphs had *G. mellonella* died within 2 – 5 days of feeding.

On the other hand, feeding on pupae of *G. mellonella* exhibited obvious increase in number of preys greater than that of larval feeding. Pupal consumption means were; 1.30, 1.47, 4.07 and 1.00 preys / day and totals were; 39, 44, 122 and 3 preys / 30 days for male, female, male + female and nymph, respectively.

In general it could be observed that, the earwigs prefer pupae than larvae and male + female consumed more preys than each alone and that may be due to self competition. However, nymph consumed the least number of pupae of preys. In this respect, **El-Hussieni (1969)** found that plant material is not a real food for *L. riparia*, but just for obtaining humidity. He added that starved

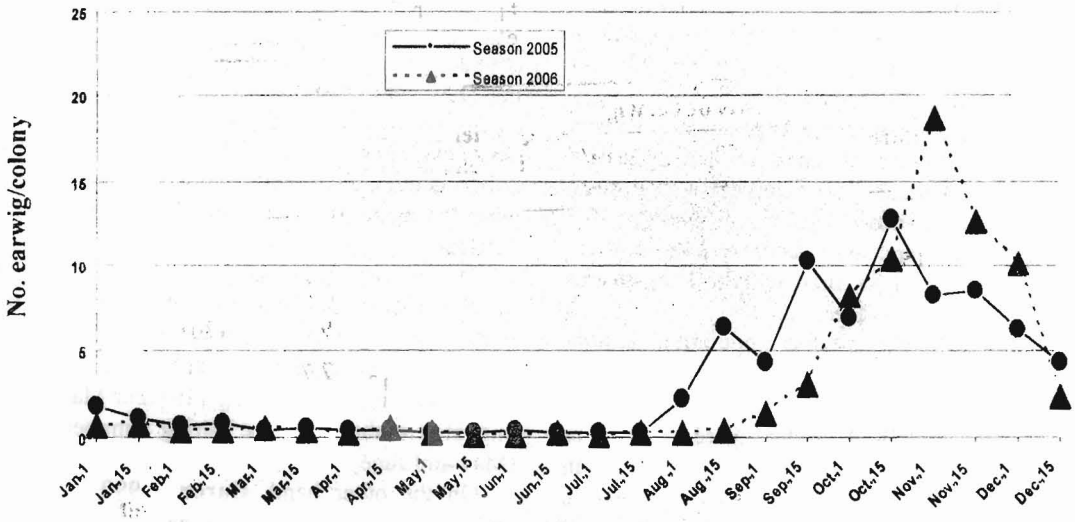

Fig. 1. Seasonal abundance of predator earwig, *L. riparia*, in honeybee colonies during 1st and 2nd years of study at Beni-suef governorate

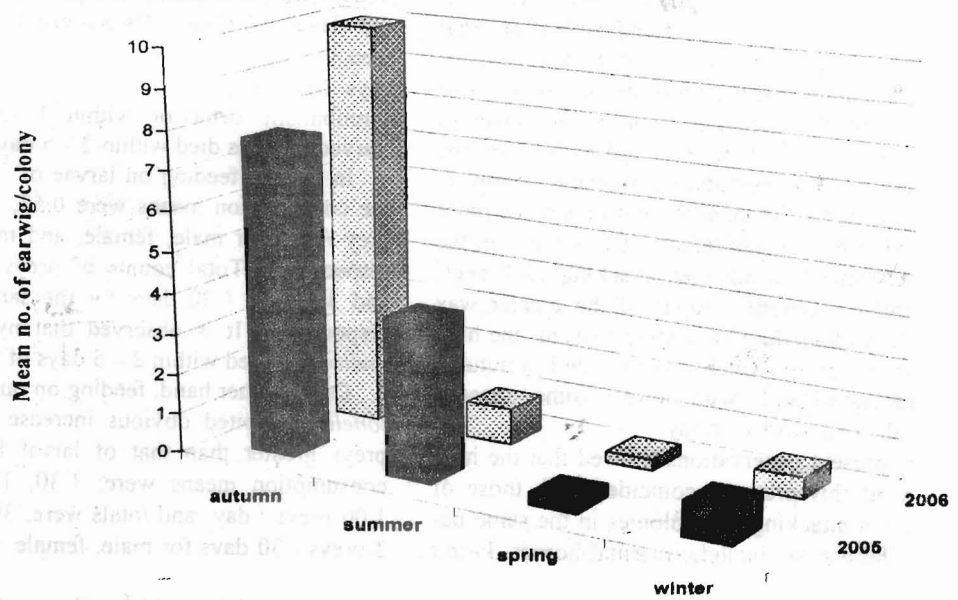

Fig. 2. Seasonal abundance of earwig in honeybee colonies during the two years of study

Table 3. Daily consumed larvae or pupae of *G. mellonella* by the predator, *L. riparia* at 25°C and 70 % R.H.

Days	No. of preys consumed / day						
	Larvae			Pupae			
	Male	Female	Male+Female	Male	Female	Male+Female	Nymphs
1	1(10)	0 (0)	1(10)	1(10)	2(20)	5(50)	1(10)
2	1(10)	1(10)	2(20)	2(20)	2(20)	5(50)	0 (0)
3	1(10)	1(10)	1(10)	1(10)	1(10)	5(50)	1(10)
4	1(10)	1(10)	1(10)	1(10)	2(20)	3(30)	1(10)
5	0 (0)	1(10)	2(20)	2(20)	1(10)	2(20)	0 (0)
6	0 (0)	1(10)	0 (0)	1(10)	1(10)	5(50)	1(10)
7	0 (0)	1(10)	1(10)	1(10)	1(10)	4(40)	1(10)
8	0 (0)	1(10)	1(10)	1(10)	1(10)	3(30)	1(10)
9	0 (0)	0 (0)	2(20)	2(20)	1(10)	4(40)	1(10)
10	1(10)	0 (0)	3(30)	2(20)	1(10)	5(50)	1(10)
11	1(10)	0 (0)	0 (0)	0 (0)	2(20)	6(60)	1(10)
12	1(10)	1(10)	0 (0)	1(10)	1(10)	3(30)	1(10)
13	0 (0)	0 (0)	0 (0)	1(10)	1(10)	5(50)	2(20)
14	0 (0)	0 (0)	2(20)	0 (0)	2(20)	3(30)	1(10)
15	1(10)	0 (0)	1(10)	1(10)	3(30)	5(50)	1(10)
16	1(10)	0 (0)	1(10)	1(10)	1(10)	5(50)	2(20)
17	1(10)	0 (0)	2(20)	2(20)	2(20)	4(40)	1(10)
18	0 (0)	1(10)	1(10)	2(20)	1(10)	4(40)	2(20)
19	0 (0)	1(10)	1(10)	2(20)	1(10)	4(40)	1(10)
20	0 (0)	1(10)	1(10)	1(10)	1(10)	3(30)	1(10)
21	1(10)	1(10)	1(10)	2(20)	2(20)	5(50)	1(10)
22	1(10)	1(10)	2(20)	1(10)	2(20)	5(50)	0 (0)
23	0 (0)	1(10)	2(20)	2(20)	2(20)	5(50)	2(20)
24	1(10)	1(10)	2(20)	1(10)	1(10)	4(40)	1(10)
25	1(10)	2(20)	2(20)	1(10)	2(20)	3(30)	1(10)
26	1(10)	1(10)	1(10)	2(20)	1(10)	3(30)	1(10)
27	0 (0)	1(10)	2(20)	1(10)	2(20)	4(40)	1(10)
28	1(10)	1(10)	1(10)	2(20)	1(10)	3(30)	1(10)
29	0 (0)	1(10)	2(20)	1(10)	2(20)	3(30)	0 (0)
30	0 (0)	0 (0)	1(10)	1(10)	1(10)	4(40)	1(10)
Total	16	21	39	39	44	122	30
Mean (%) ± SE	0.53 (5.30) ± 0.09	0.70 (7.00) ± 0.10	1.30 (13.00) ± 0.14	1.30 (13.00) ± 0.12	1.47 (14.70) ± 0.18	4.07 (40.70) ± 0.18	1.00 (10.00) ± 0.10

N.B:

a) Earwig nymphs fed on larvae died within 2-5 days.

b) Unfed earwig individuals died during the following periods (day):
2 – 7 (male), 3 – 6 (female), 1 -2 (female + male) and 2 – 5 (nymphs).

c) Data between brackets indicate % daily consumption.

females and males died within 4.0 and 2.8 days, respectively at 35 °C. In this concern, *L. riparia* consumed more larvae of *Spodoptera frugiperda* at 30 °C and females consumed more preys than males (**Kharboutli and Mack, 1993**).

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ملاحظات بيئية على حشرة إبرة العجوز الكبيرة المتواجدة فى طوائف نحل العسل

[١٩]

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أجريت هذه الدراسة خلال عامين متتاليين فى أحد المناحل بمحافظة بنى سويف، لمعرفة دور إبرة العجوز الكبيرة التى تتواجد طبيعيا فى طوائف نحل العسل. كما أجريت تجربة معملية بكلية الزراعة بالفيوم لمعرفة الكفاءة الافتراسية بتغذيتها على يرقات وعذارى فراشة دودة الشمع الكبيرة.

وقد أوضحت النتائج تواجد هذا المفترس في طوائف النحل بصفة مستمرة ولكن بكثافات مختلفة تبعا للموسم. وسجل أعلى تعداد له فى فصل الخريف يليه الصيف ثم الشتاء وأخيرا الربيع، بمتوسطات: ٧,٨٠ ، ٣,٩٥ ، ٠,٨٦ ، ٠,٣٢ فردا / طائفة في العام الأول، أما فى العام الثانى فكانت: ١٠,٤٣ ، ٠,٩٢ ، ٠,٥٣ ، ٠,٢٨ فردا / طائفة ، لنفس المواسم على الترتيب، بوجود فرق معنوى بين الخريف وبقية المواسم.

وتبين أنه يفترس بشراهة عذارى فراشة دودة الشمع الكبيرة ،كما لم يلحظ أنه يهاجم النحل في الطوائف محل الدراسة. ولم يتضح إحصائيا وجود ارتباط معنوي بين تعداد هذا المفترس فى الخلية والظروف المناخية ، مما يرجح أن يكون متواجدا للتغذية على أطوار فراشة الشمع الكبيرة وربما الحشرات الأخرى التى قد تأوى إلى طائفة النحل. وقد لوحظ أيضا أن الأفراد التى غذيت معمليا على يرقات وعذارى فراشة دودة الشمع الكبيرة استمرت حية طوال فترة التجربة (٣٠ يوما)، بعكس تلك التى لم تغذ ،فقد ماتت خلال ٢ - ٧ أيام من تجويعها. وبحساب معدل الافتراس اليومى تبين أن معدل استهلاك الأنثى كان أكبر منه للذكر.

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