

**STUDIES ON THE SEX RATIO OF THE POPULATION OF
THE PINK BOLLWORM *Pectinophora gossypiella* (SAUNDERS)
(LEPIDOPTERA: GELECHIIDAE)**

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ABSTRACT

Studies were done in El-Behera Governorate to estimate the sex ratio of the larval stage including the diapaused larvae in the double seeds. Pheromone and light traps were used to estimate the proportional of moths' sex through 24 months in 1993 and 1994. The average temperature and relative humidity were recorded. The highest number of diapaused larvae collected from the double seeds was recorded in January and the lowest was recorded in May. Sex ratio was in favour of males (2.1 males: 1.0 females). Collected larvae from flowers in June and July and from dry bolls in October, November and December also exhibited sex ratios in favour of males over females. The recorded values were 2.7:1.0 and 2.0:1.0 for males and females, respectively. The opposite was obtained for collected larvae from green bolls in August and September. It was in favour of females (0.6 males: 1.0 females). The highest number of moths attracted to the light traps was recorded in April (23 moths) and the lowest was in January (5 moths). In August and September the numbers of female moths were higher than males and the sex ratio was 0.7 males: 1.0 females. The numbers of male moths attracted to pheromone traps in October, November and May were higher compared to those attracted in January, February, July and August. During the first five months of the two years, the gradual increase in the number of male moths

attracted to the pheromone traps coincided with the decrease in number of diapaused larvae collected from double seeds. Also, the decreased number of male moths attracted to pheromone and light during August and September coincided with the increased number of female larvae in the same period. This was obvious during the same period in the two successive years of study.

Key words: light, *Pectinophora gossypiella*, pheromone, pink, bollworm, sex, ratio.

1. INTRODUCTION

Little attention has been given to study the sex ratio among the Lepidoptera. According to Wafa *et al.* (1969), the proportion of males to females in seven generations of *Spodoptera exigua* (Boisd.) varied considerably throughout the whole year. Hilmy and Hamad (1975) recorded that in the Sphingidae, Lasicompidae and Gelechiidae, more males than females were attracted to light traps. Gianotti *et al.* (1984) observed that the male moths of *Pectinophora gossypiella* (Saunders) attracted to the pheromone traps in cotton fields showed three peaks of adult emergence; late November to early January, late March to April and summer generation. Bleih (1987) found three fluctuations of generations for pink bollworm in cotton-growing in seasons 1983 and 1984. The moths appeared as a small peak in late July, the second poor peak of moths occurred around mid-August and the third strong peak took place around late September. Accordingly, Naguib (1989) observed that the sex ratio in *P. gossypiella* varied among the active and diapaused larvae. Patil *et al.* (1992) found that the maximum catches of *P. gossypiella* to pheromone traps were recorded in October 1987 and April 1988. In this connection, Ahmed and Attique (1993) mentioned that adults of *P. gossypiella* remained active throughout the year with minimum intensity during the hot period. The higher population size was recorded in October. Also, adults were recorded during the winter months, indicating that the pest probably does not enter true diapause. Dhaliwal *et al.* (1993) stated that *P. gossypiella* has five generations a year with a sharp increase in the 4th

generation (mid August to mid September). Al-Elimi *et al.* (2002) showed that while the sex pheromone of the pink bollworm PBW Xlure 90® used in pheromone traps detected June peak, it failed to give an acceptable level of detection for those of July and August .

The present work was carried out for two successive years, 1993 and 1994, to estimate the monthly variations in the sex ratio of larvae and moths of the pink bollworm. This study may help in the adaptation of integrated pest management of this pest.

2. MATERIALS AND METHODS

To study the differences in the sex ratio of larvae and moths of *P. gossypiella*, three different measurements were applied; cotton plant (double seeds, flowers, green and dry bolls), light and pheromone traps.

From one kilogram of seed cotton, double seeds were isolated weekly. Diapaused larvae of both sexes were collected and sex ratio was estimated monthly from January to May in the two years of study 1993 and 1994.

Starting from June to December of both years, four samples, each containing 25 flowers, 50 green or the same number of dry bolls were collected weekly from infested cotton fields, *Gossypium barbadense*, variety Giza 85, planted in an area about 480 m² divided into 12 plots 8 m x 5 m each, according to the period of crop maturity. The total and the average number of male and female larvae were counted and the sex ratio was estimated monthly.

Moths were attracted to a light trap placed on the roof of a ginnery of an area about 2500 m² in El-Behera Governorate at a height of 280 cm and collected every two days and male and female moths were separated. The sex ratio was estimated monthly.

To study the abundance of male moths of *P. gossypiella* throughout both years, two pheromone Delta traps were baited with 1 mg gossyplure capsules. The traps were placed 100 m apart in the center of the same cotton ginnery and at a height of 250 cm. The trap catches were recorded every three days. The capsules and the sticky sheets were changed every two weeks. The average number of male moths for the two traps was estimated monthly.

Student's "t" test was used to study the significance of differences in the sex ratio of larvae and moths. The effects of temperature and relative humidity on the average number of moths attracted to pheromone or light traps were detected by calculating the correlation coefficient values.

3. RESULTS AND DISCUSSION

3-1. The monthly average number and sex ratio of larvae

Data in Table (1) indicate that the total number of diapaused larvae collected monthly from double seeds showed a gradual decrease during the period from January to May of the first year. A total of 83, 82, 49, 54 and 23 larvae was recorded for this period, respectively. The highest number was obtained in January and the lowest in May. The ratio between males and females during the same period of inspection ranged between 2.5:1.0 in January and 1.7:1.0 in April. The number of male larvae which was collected from flowers in June and July was higher than that of females and the sex ratio was 2.9:1.0 and 2.6:1.0, respectively. Larvae that were collected from green bolls in August and September showed more females than males and the sex ratio was 0.4:1.0 and 0.7:1.0 for the two months. However, the opposite was obtained with collected larvae from dry bolls during October, November and December. Opposite results in favour of males were obtained; sex ratios of 1.99:1.0, 1.95:1.0 and 1.86:1.0 were recorded for the above mentioned months, respectively. The obtained data indicated that the highest number of male larvae was collected in October, November and December, while it was in October, November and September for female (Fig. 1).

The same trend of results was obtained in the second year. Student's "t" test showed highly significant difference between the mean number of male and female larvae which were collected from double seeds, flowers, green and dry bolls (Table 1 and Fig. 1). During the first five months the number of diapaused larvae decreased as the temperature increased and relative humidity decreased. Also, there was a highly significant difference between the total numbers of larvae that were recorded in both years of study.

The previous results are in agreement with those of Andrewatha (1952) who mentioned that the pink bollworm undergoes a facultative

diapause where weather conditions are not favourable and host plants are scarce. Also, Adkisson (1964) observed that under field conditions the onset of diapause in pink bollworm population occurred during the last days of August. This may explain the significant increase of larvae in green and dry bolls during August to November of both years.

3.2. The monthly average number of attracted moths to light traps

As shown in Table (2) and Fig. (1) the average number and percentages of attracted moths to the light traps increased progressively during the period from January up to May.

Table (1): The sex ratio of *Pectinophora gossypiella* larvae in El-Behera Governoarate.

Months	Source of larvae	1993				1994			
		No. of males	No. of females	Total	Ratio	No. of males	No. of females	Total	Ratio
Jan.	Seeds	59	24	83	2.46:1	60	34	94	1.76:1
Feb.		58	24	82	2.42:1	63	23	86	2.74:1
Mar.		33	16	49	2.06:1	56	19	75	2.95:1
Apr.		34	20	54	1.70:1	33	16	49	2.06:1
May		15	8	23	1.88:1	20	10	30	1.50:1
Mean±SD		39.80± 18.67	18.40± 6.69	58.20 ±25.11		46.40± 18.90	20.4± 8.96	66.80± 26.68	
June	Flowers	26	9	35	2.89:1	40	6	46	6.70:1
July		21	8	29	2.63:1	55	13	68	4.23:1
Mean ± SD		23.50± 3.54	8.50± 0.71	32.00± 4.24		47.50± 10.61	9.50± 4.95	57.00± 15.56	
Aug.	Green bolls	18	45	63	0.40:1	62	92	154	0.67:1
Sept.		56	81	137	0.69:1	108	174	282	0.62:1
Mean ± SD		37.00± 26.87	63.00± 25.46	100.00 ± 52.33		85.00± 32.53	133.00 ± 57.98	218.00 ± 90.51	
Oct.	Dry bolls	305	153	458	1.99:1	120	93	213	1.29:1
Nov.		193	88	292	1.95:1	226	174	400	1.30:1
Dec.		138	74	212	1.86:1	246	111	357	2.21:1
Mean ± SD		212.00 ± 85.11	108.67 ± 40.38	320.67 ± 125.48		197.33 ± 67.72	92.67± 81.50	323.33 ± 97.94	
Σx				1517				1854	

The highest recorded number was 23 moths in April and the lowest 5 was in January in the first year; compared to 27 and 4 moths in the same months in the second year. The calculated sex

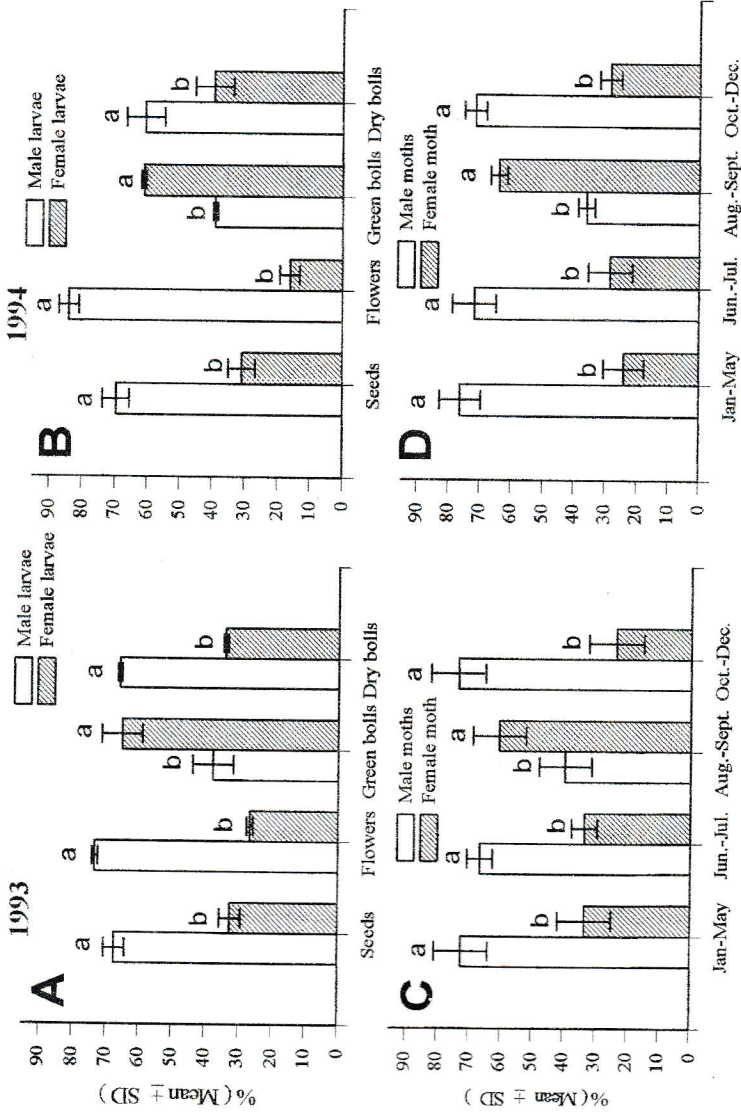


Fig. (1): The sex ratio in *Pectinophora gossypiella* larvae (A&B) and moths (C&D) during 1993 and 1994 in El-Behera Governorate. For each stage or period, means followed by the same letter are not significantly different.

ratios during the mentioned months in the two years were (1.5:1.0, 5.0:1.0, 2.5:1.0, 2.3:1.0 and 4.1:1.0) and 3.0:1.0, 3.0:0.0, 1.8:1.0, 1.5:1.0 and 4.8:1.0), respectively.

The average numbers of moths during June and July were 17 and 8.0 and the sex ratio was 2.4:1.0 and 1.7:1.0. In August and September, the number of female moths was higher than that of males. Sex ratio was 0.5:1.0 and 0.9:1.0 for both months, respectively.

More males than females were produced in October, November and December. The sex ratios recorded for these months were 2.0:1.0, 3.0:1.0 and 7.0:1.0, respectively.

Statistical analysis of the data indicated the presence of highly significant differences between the numbers of female moths attracted to the light during the two years of investigations. Moreover, the average number of moths was significantly higher in the second year than in the first one.

Table (2): Sex ratio of *Pectinophora gossypiella* moths attracted to light traps in cotton ginnery, El-Behera Governorate.

Months	1993				1994			
	No. of males	No. of females	Total	Ratio	No. of males	No. of females	Total	Ratio
Jan.	3	2	5	1.50:1	3	1	4	3.00:1
Feb.	5	1	6	5.00:1	3	0	3	3.00:0
Mar.	13	6	19	2.17:1	14	8	22	1.57:1
Apr.	16	7	23	2.29:1	16	11	27	1.45:1
May	12	3	15	4.00:1	19	4	23	4.75:1
Mean ±	9.8±	3.8±	13.6±		11.0±	4.8±	15.8±	
SD	5.5	2.6	7.9		7.5	4.66	11.39	
June	24	10	34	2.40:1	11	3	14	3.67:1
July	10	6	16	1.67:1	22	12	34	1.83:1
Mean ±	17.0±	8.0±	25.0±		16.5±	7.5±	24.0±	
SD	9.9	2.8	12.7		7.8	6.36	14.1	
Aug.	5	11	16	0.45:1	20	40	60	0.50:1
Sept.	11	12	23	0.92:1	29	46	75	0.63:1
Mean =	8.0±	11.5±	19.5±		24.5±	43.0±	67.5±	
SD	4.2	0.7	4.9		6.4	4.2	10.6	
Oct.	16	8	24	2.00:1	52	25	77	2.08:1
Nov.	27	9	36	3.00:1	32	13	45	2.46:1
Dec.	14	2	16	7.00:1	19	6	25	3.17:1
Mean ±	19.0±	6.3±	25.3±		34.3±	14.7±	49.0±	
SD	7.0	3.8	10.0		16.6	9.6	26.2	
Σx			223				406	

3.3. The monthly average number of attracted male moths to pheromone traps

Data presented in Table (3) showed variations in the average number of attracted male moths to the pheromone traps during the two years. Results indicated that the traps attracted significant higher numbers of males in October, November, May and April; and the

Table (3): The monthly average numbers of attracted male moths of *Pectinophora gossypiella* to pheromone traps in cotton ginnery, El-Behera Governorate.

Month	1993				1994			
	R1	R2	Total	Mean	R1	R2	Total	Mean
Jan.	37	23	60	30.0	48	34	82	41.0
Feb.	16	20	36	18.0	17	12	29	14.5
Mar.	56	88	144	72.0	64	45	109	54.5
Apr.	93	135	228	114.0	132	112	244	122.0
May	114	117	231	115.5	201	101	302	151.0
Mean ± SD				69.9± 45.6				76.6± 57.5
June	33	44	77	38.5	147	77	224	112.0
July	37	21	58	29.0	39	16	55	27.5
Mean ± SD				33.8± 6.7				69.8± 59.8
Aug.	27	20	47	23.5	52	39	91	45.5
Sept.	63	51	114	57.0	85	70	155	77.5
Mean ± SD				40.3± 23.7				61.5± 22.6
Oct.	193	110	303	151.5	164	158	322	166.0
Nov.	188	116	304	152.0	163	136	289	144.5
Dec.	73	44	117	58.5	87	90	177	88.5
Mean ± SD				120.7± 53.8				133.0± 40.0
∑x			1719				2079	

significant lowest ones were recorded in January, February, July and August. Negative correlations were evident between the minimum daily temperature and the attracted male moths ($r=-0.82$ and -5.1 in the two years, respectively).

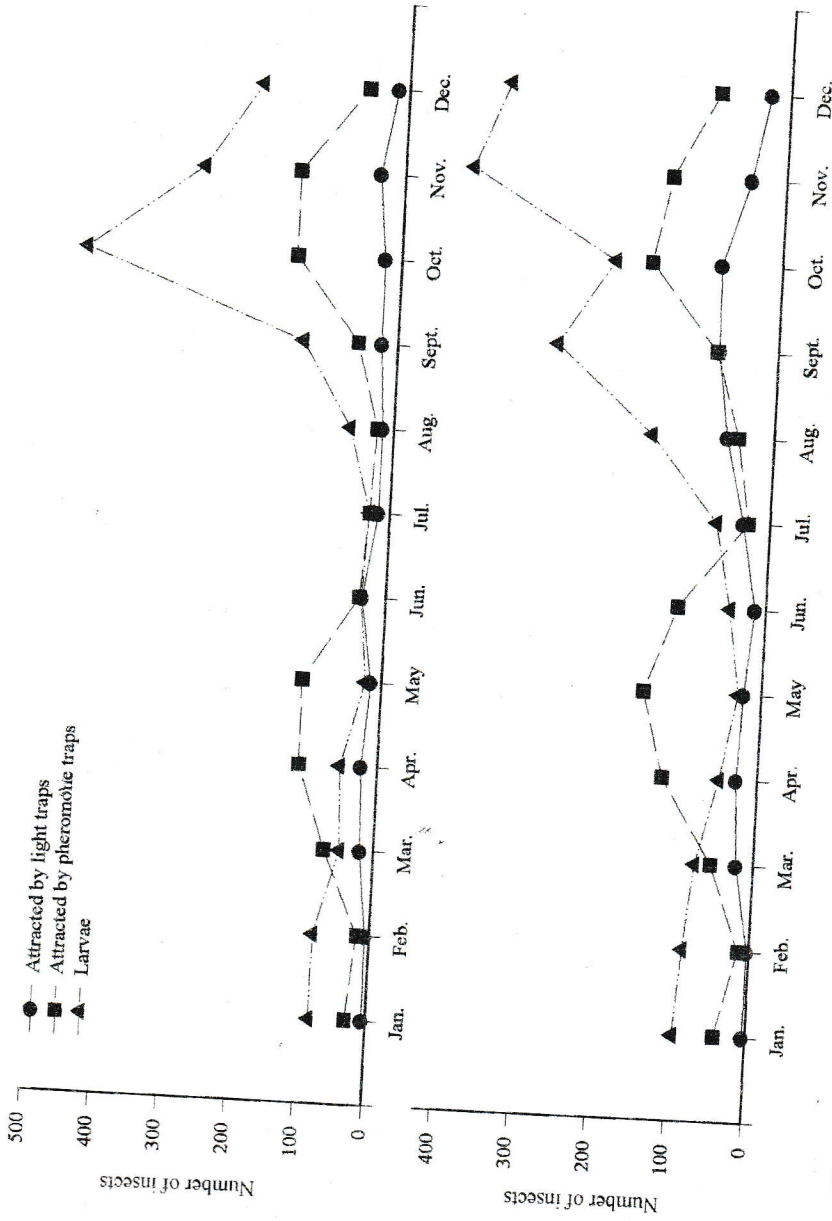


Fig. (2): The population dynamics of moths and larvae of *Pectinophora gossypiella* in cotton ginery in El-Behera Governorate during 1993 and 1994.

3.4. Comparison between the sex ratio in larvae and moths of *P. gossypiella*

Results presented in Table (4) indicate that the sex ratios (males: females) among collected larvae from January to May in the first year and attracted moths to the light trap at the same year were 2.1: 1.0, and 2.6:1.0, respectively. At the end of year, and from October to December, the records of 2.0: 1.0 and 3.0:1.0 were presented for larvae and moths, respectively. These ratios were changed to 0.6:1.0 and 0.7:1.0 in favour of females in August and September. Similar ratios were recorded in the second year.

Table (4): Sex ratio (males: females) in larvae and moths of *Pectinophora gossypiella*.

Year	Stage	Source	Seeds (Jan. – May)	Flowers (June – July)	Green bolls (Aug. – Sept.)	Dry bolls (Oct. – Dec.)
1993	Larvae	Plant	2.1:1	2.7:1	0.6:1	2.0:1
	Moths	Light trap	2.6:1	2.1:1	0.7:1	3.0:1
1994	Larva	Plant	2.3:1	5.0:1	0.6:1	7.6:1
	Moths	Light trap	2.3:1	2.2:1	0.6:1	2.3:1

The previous results showed that during the first five months of both years (January-May) the significant decrease in the average number of diapaused larvae collected from double seeds coincides with the increased number of attracted moths to the pheromone traps (Table 1 and Fig. 2).

The average number of male moths captured in the pheromone trap was significantly higher than the catch obtained by the light trap. This may be due to the presence of the pheromone capsule.

The relationship between the monthly estimated sex ratio and the number of attracted moths to the pheromone trap during the same month and in the same location, can be used to estimate the expected total average number of moths or larvae. For example in May:

A = The observed average number of male moths attracted to the pheromone traps in May in the 1st year was 231 (Table 3).

B = The estimated sex ratio in the same month was 2.6 males :1.0 females (Table 4).

C = The expected average number of female moths = $A/B = 231/2.6 = 88.85$ moths.

The total number of moths = observed number of male + the expected number of female moths

$Y = A + C = 231 + 88.85 = 319.89$ moths.

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دراسة للنسبة الجنسية في دودة اللوز القرنفلية

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دقى - جيزة

ملخص

أجريت دراسة للنسبة الجنسية في كل من الطور اليرقى والفرشات في دودة اللوز القرنفلية خلال الفترة من يناير إلى ديسمبر لعامين متتاليين. أخذت عينات من بذرة القطن المزروجة والأزهار ولوز القطن الأخضر واللوذ الجاف للحصول على الطور اليرقى وتم حساب النسبة الجنسية. علقّت مصائد ضوئية وأخرى فرمونية مزودة بكيسولة فرمون الجسيلور ١ ملليجرام لدراسة النسبة الجنسية في الفرشات المنجذبة إلى المصيدة الضوئية كذلك عدد ذكور الفرشات المنجذبة إلى المصيدة الفرمونية.

أجريت الدراسة بمحلج قطن بمحافظة البحيرة و سجلت درجات الحرارة والرطوبة النسبية لمعرفة مدى تأثيرها على تعداد اليرقات والفرشات عن طريق حساب معدل الارتباط. تم مقارنة مدى تطابق النسبة الجنسية في يرقات وفرشات دودة اللوز القرنفلية في أربع فترات: البذرة المزروجة (الفترة من يناير إلى مايو) و الأزهار (الفترة من يونيو إلى يوليو) واللوز الأخضر (الفترة من أغسطس إلى سبتمبر) واللوز الجاف (الفترة من أكتوبر إلى ديسمبر).

لوحظ خلال الخمسة أشهر الأولى (يناير - مايو) انخفاض تنازلى في التعداد الكلى لليرقات الساكنة ، وسجل أعلى تعداد في شهر يناير وأقل تعداد في شهر إبريل بفارق معنوى ، وكانت النسبة الجنسية خلال هذه الفترة ١:٢,١ ذكور إلى إناث.

تم احتساب المتوسط الشهرى للفرشات المنجذبة إلى المصائد الضوئية وسجل أعلى تعداد في شهر إبريل (٢٥ فراشة) وأقل تعداد في شهر يناير (٥ فراشات) بفارق معنوى ، وكانت النسبة الجنسية في هذه الفترة ١:٢,٦ ذكور إلى إناث.

أوضحت النتائج تباين في التعداد الشهرى لذكور الفرشات المنجذبة إلى المصائد الفرمونية خلال نفس الفترة السابقة ، وسجل أعلى تعداد خلال شهر مايو (١١٥,٥ ذكر) وأقل تعداد خلال شهر فبراير (١٨ ذكر).

(١ أنثى : ٢,٧ ذكر) ، (١ أنثى : ٢ ذكر) ، وكانت النسبة الجنسية للفراشات المنجذبة إلى المصائد الضوئية مشابهة تقريبا ، بينما سجل أعلى تعداد لذكور الفراشات المنجذبة إلى المصائد الفرمونية في أشهر أكتوبر ونوفمبر ومايو و أقل تعداد سجل خلال أشهر يناير وفبراير ويوليو وأغسطس.

لوحظت زيادة معنوية في تعداد إناث اليرقات خلال أشهر أغسطس و سبتمبر مع وجود زيادة في تعداد الفراشات المنجذبة إلى المصائد الضوئية ، بينما لوحظ انخفاض في تعداد ذكور الفراشات المنجذبة إلى المصائد الفرمونية.

لوحظت زيادة معنوية في تعداد ذكور الفراشات المنجذبة إلى المصائد الفرمونية عن المصائد الضوئية ، وقد يعزى هذا لوجود كبسولة الجاذب الجنسي (فرمون الجوسيبيلور).

يمكن الاستفادة إلى حد ما من هذه الدراسة في حساب عدد الفراشات المتوقعة في كل فترة من الفترات المشار إليها سابقا في منطقة محددة وذلك عن طريق إيجاد علاقة بين النسبة الجنسية المحسوبة تقريبا وعدد ذكور الفراشات المنجذبة إلى المصيدة الفرمونية ، وبذلك يمكن حساب عدد إناث الفراشات وبالتالي حساب العدد الكلى للفراشات المتوقعة تقريبا.

المجلة العلمية لكلية الزراعة - جامعة القاهرة - المجلد (٥٥) العدد الأول
(يناير ٢٠٠٤) : ١٦٥-١٧٨ .

