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Natural Enemies of the Greater and Lesser Wax Moths and Their Activity in Honey Bee Colonies under the Environmental Conditions of Sohag Governorate, Egypt.

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Abstract

The current investigations were conducted in Egypt's Sohag Governorate in the 2022/2023 season. Data revealed that there are two parasitoids associated with the greater wax moth; the most common and efficient is *Apanteles galleriae* which represented in the collected samples in considerable numbers all over the year. Whereas *Bracon hebetor* was parasite in too few samples. The highest abundance of *G. mellonella*, 140.00 adults per 1 kg of wax, recorded in August, and the lowest number it was in March, 26.67 adults per 1 kg of wax. The seasonal abundance of *A. grisella* throughout the period from December, 2022 to November, 2023 ranged between 1.67 and 7.00 individuals per 1kg of wax. The highest number of the parasitoid, *A. galleriae* was recorded in September with 75.67 adults per 1kg of wax. Whereas the lowest number was recorded in April at 13.67 adults per 1 kg of wax. The number of the parasitoid, *B. hebetor* is very limited, ranged from 0 to 1.67 adults per 1 kg of wax. Akhmim district had the largest number of wax moths, *G. mellonella*, *A. grisella*, and the parasitoids, *A. galleriae* with 234.67, 2.67 and 142.67 adults per 1kg of wax respectively. Also, the least number of the greater wax moth was in Dar-El Salam district, with 28.00 and the least number of the lesser wax moth was 0.33 adults per 1kg of wax respectively. While the parasitoids were not present in the Dar-El Salam, Girga, Aserat, Maragha, and Tahta districts.

Keywords: Seasonal abundance, *Galleria mellonella*, *Achroia grisella*, *Apanteles galleriae*

INTRODUCTION

Galleria mellonella Linnaeus, the larger wax moth, and *Achroia grisella*, the smaller wax moth (Fabricius) (Lepidoptera: Pyralidae), are serious pests effecting honeybee industry it is found in , honeybee colonies, apiaries and stores of beekeepers. The larvae of wax moths feed on honey, pollen, wax, honeybee pupal skins, and brood, creates tunnels in the comb, and leaves masses of webs on the frame (Verma *et al.*, 1998 and Williams, 1997). Both of the adults and larvae of *G. mellonella* have been earmarked as potential vectors of pathogens (Charriere and Imdorf, 1999) Furthermore, extensive larval infestations of colonies frequently result in absconding, colony loss, and reduction in the size of the migratory bee swarms. Sometimes the larvae of *G. mellonella* make tunnels lined with silk through the hexagonal cell walls. Emergent bees are entangled in the silken threads, starving to death—a phenomenon known as galleriasis. (Williams, 1997; Gulati and Kaushik, 2004). In Egypt, it's caused economic loss reached up to 40% (Adly and Marzouk, 2019). The larvae of *A. grisella* are frequently observed grazing on the hive floor due to the *G. mellonella* surpass them in regions where both species coexist for the coveted brood comb. A bald brood may result from larvae of lesser wax moths. When the larvae tunnel behind the capped cells of the honey bee pupae, it is known as bald brood Egelie *et al.*, (2015). The use of chemical control methods can have Negative impacts on honey bees and product pollution. Therefore, it's crucial to look for sustainable and safe ways to manage honey bee pests. In addition, using biological control agents—pathogens, parasitoids, or predators—to manage pests may be a wise decision. It is anticipated that biocontrol chemicals will control the number of bee pests without endangering honey bees or tainting priceless bee products. (Abou-Shaara and Staron, 2019).Therefore, the present work aimed to survey the natural enemies of the wax moths, study the seasonal abundance and geographical distribution of it, in the apiaries of Sohag Governorate

MATERIALS AND METHODS

The current investigations were conducted at Sohag Governorate apiaries, Egypt during 2022\23 season. Due to of the difficulty in isolating the

larvae of *G. mellonella*, and *A. grisella* embedded in the wax, their population size together with that of their natural enemies was estimated relatively through the emergence of adult individuals (EL-Arnaooty, 1985). Monthly samples of wax (each of 1 kg) were collected from three apiaries in the Sohag district at Sohag Governorate to survey and study the wax moths' seasonal abundance and their natural rivals; in the period from December, 2022 to November, 2023. Each sample was divided into 10 sub-samples (100 g each) to be kept in glass containers closed tightly with gauze to avoid the escape of larvae. The containers were kept under controlled conditions at a temperature of 30 ± 2 °C and a relative humidity of 60 ± 5 %. The emerging adults, whether moths or natural enemies, were collected and counted and identified in the Plant Protection Institute, Agricultural Research Center, Egypt. In addition, other samples of wax (each of 1 kg) were collected from certain apiaries in all Sohag Governorate districts for surveying the wax moths and their natural enemies.

RESULTS AND DISCUSSIONS

In the present investigation, a survey of the natural enemies of the wax moth, *G. mellonella*, and *A. grisella* was carried out through monthly samples collected from three apiaries in Sohag governorate. The period of investigation extended from December, 2022 to November, 2023. Fluctuation in the population of these wax moths and their important natural enemies was studied throughout this period of investigation. Consequently, the following results were concluded:

A- Survey of natural enemies of wax moths

During the observations of wax samples collected from the apiaries of Sohag Governorate, the presence of two types of parasitoids was detected:

1- *Apantales galleriae* Wilkinson

(Hymenoptera: Braconidae):

This parasitoid is the most common and efficient natural enemy of wax moths in Sohag Governorate. It was represented in the collected samples in considerable numbers all over the year.

2- *Bracon hebetor* Say

(Hymenoptera: Braconidae):

In the present investigation, it was parasited in too few samples collected from Sohag Governorate. These data were in partial agreement with those of

Hanumanthaswamy and Rajagopal, (2017) in India who stated that among the different natural enemies recorded on the greater wax moth, the larval parasitoid, *A. galleriae*, was considered an important species. Also found one more species of Hymenoptera parasitoid (*Antrocephalus galleriae* subbarao). According to EL-Arnaooty, (1985), who made a survey of natural enemies of the wax moths, *G.mellonella* and *A.grisella*, in Qualiobia, Giza, and Fayoum Governorates and detected four natural enemies: *A. galleriae* (Hymenoptera: Braconidae), *B.hepetor* (Hymenoptera : Braconidae), *Nemeritis canescens* Grav (Hymenoptera: Ichneumonidae), and *Blattisocius tarsalis* Berl (Parasitiforme: Ascidae). And Virktamath *et al.*, (1998) recorded six species of hemynopterous parasitoids parasitizing the larvae of *G. mellonella*. The predominant parasitoids were *A. galleriae*; other parasitoids observed were *Glyptapanteles sp.*, *Dolichogenidea sp.*, *Aphanogmus sp.*, *Venturia sp.*, and *Epitranus erythrogaster* parasitizing *G. mellonella*. Also, Pande *et al.*, (2020) and Semmar *et al.*, (2014) decided that *A.galleriae* is one of the most important solitary early instar larval endoparasitoid of both the wax moths. Whereas, Galindo-cardona *et al.*, (2019) Record *A.galleriae* attacking

A.grisella for the first time in Argentina. And Mungai *et al.*, (2009), record it on *G. mellonella*, for the first time in Kenya.

B- Seasonal abundance of the wax moths and their natural enemies:

This study was carried out throughout the year, from December, 2022 to November, 2023, in the Sohag district, Sohag Governorate. During this period, the seasonal abundance of the two wax moths, *G. mellonella* and *A. grisella*, and their parasitoids, *A. galleriae* and *B. hebetor*, were recorded monthly. The results of this investigation were graphically illustrated in Figs. 1–4.

1- The greater wax moth, *G. mellonella* L. (Lepidoptera: Pyralidae)

The data graphically illustrated in Figure (1) show the population densities of *G. mellonella*. The highest abundance of this pest, 140.00 adults per 1 kg of wax, was in August, followed by September, 106.67 adults per 1 kg of wax, and July, 90.00 adults per 1 kg of wax. However, the lowest number of *G. mellonella* was in March, 26.67 adults per 1 kg of wax, followed by February and April with 28.00 and 34.33 adults per 1 kg of wax, respectively.

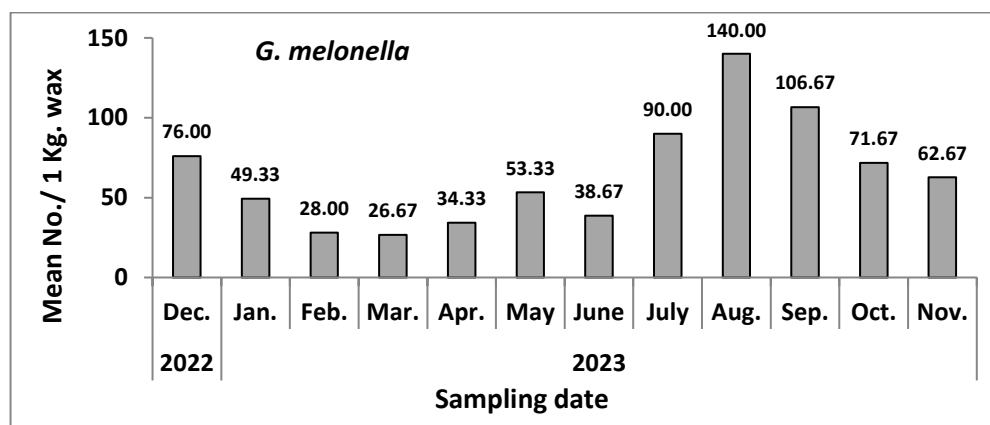


Fig (1): Seasonal abundance of the wax moth, *G. mellonella*, in the Sohag district, Sohag Governorate during a period from December, 2022 till November, 2023

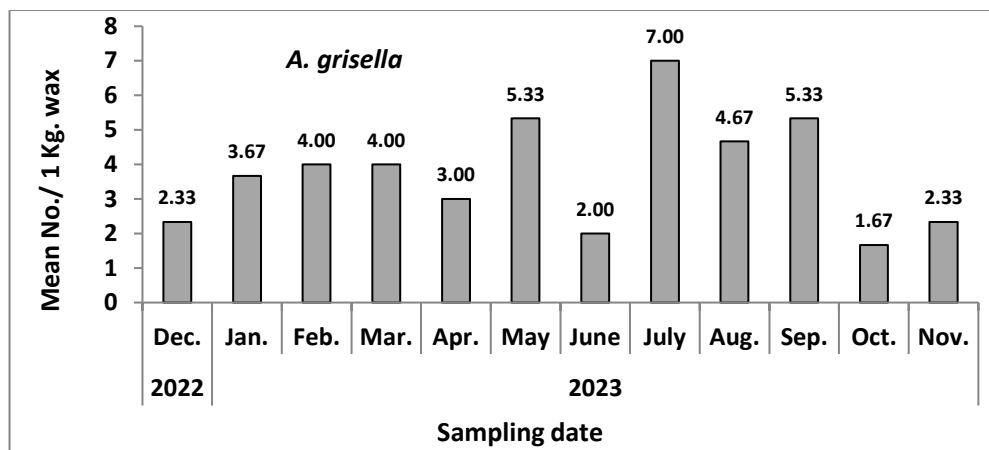


Fig (2): Seasonal abundance of the wax moth, *A. grisella*, in the Sohag district, Sohag Governorate during a period from December, 2022 until November, 2023

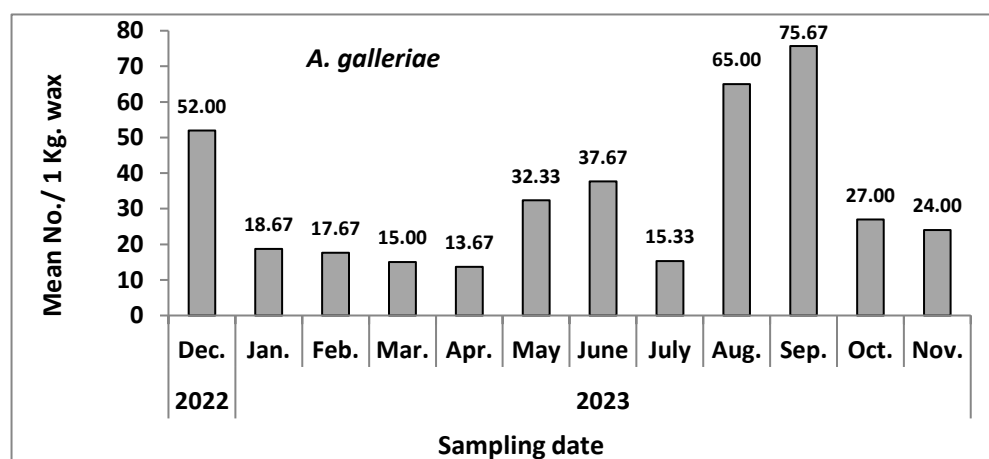


Fig (3): Seasonal abundance of the wax moth parasitoid *A. galleriae* in the Sohag district, Sohag Governorate during a period from December, 2022 until November, 2023

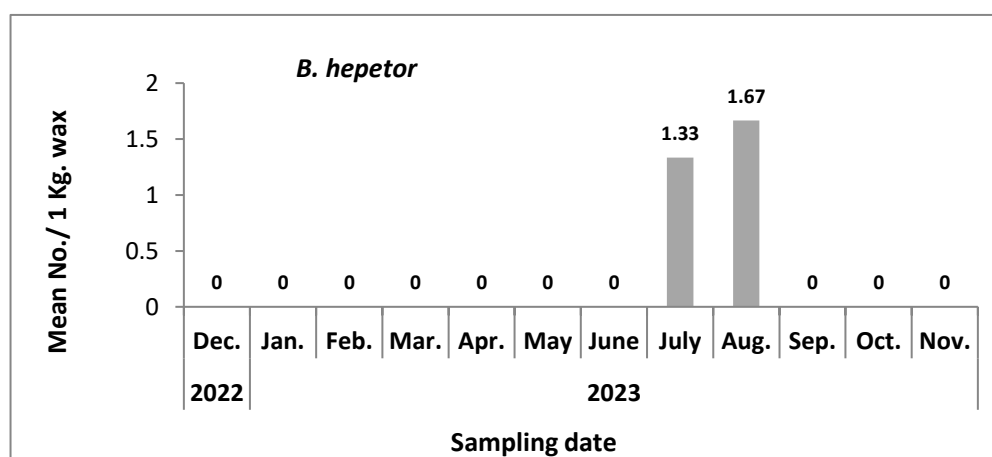


Fig (4): Seasonal abundance of the wax moth parasitoid *B. hepetor* in the Sohag district, Sohag Governorate during a period from December, 2022 until November, 2023

2- The lesser wax moth , *A. grisella*

Figure (2) presented and illustrated the population densities of *A. grisella* throughout the period from December, 2022 to November, 2023 ranged between 1.67 and 7.00 adult per 1kg of wax. In addition, the highest number of adults per 1kg of wax was recorded in July 2023, with 7.00 adults per 1 kg of wax, followed by May and September each with 5.33 adults per 1 kg of wax, whereas the lowest number of adults was recorded in October with 1.67 adults per 1kg of wax, followed by December 2022 and November 2023 each with 2.33 adults per 1kg of wax.

3- The parasitoid, *A. galleriae*

Over the year, the parasitoid *A. galleriae* was present in the apiaries; the number of them ranged between 13.67 and 75.67 adult per 1 kg of wax. The highest number was recorded in September at 75.67 adult per 1kg of wax, followed by 65.00 and 52.00 adult per 1 kg of wax in August and December, respectively. Whereas the lowest number was recorded in April with 13.67 adults per 1 kg of wax, followed by 15.00 and 17.67 adult per 1 kg of wax in March and February respectively, figure 3.

4- The parasitoid, *B. hebetor*

The results in figure (4) show that the number of parasitoids in *B. hebetor* is very limited, ranged from 0 to 1.67 adults per 1 kg of wax. The wax moths were increasing in the high temperature during summer months, the highest infestation of the greater wax moth was in August, September and July, Also the *A. grisella* highest infestation was in July, September and May. Also similar with those of Abrol and Kakroo, (1996) who stated that the area's floral scarcity season, which runs from May to August, corresponds with the highest population. However, Ansary *et al.*, (2001) in Bangladesh in Mirpur Dhaka found that the swarm of *G. mellonella* and *A. ceranato* combs peaked in June. According to Verma and Desh, (2001), the highest possible number of wax moths *G. mellonella* and *A. grisella* were 25 and 29 larvae per 3 colonies and 169 and 192 larvae per 3 colonies during the first fortnight of August of the years, 1993 and 1994, respectively. The parasitizing of *G. mellonella* and *A. grisella* larvae by *A. galleriae* parasitoid varied from (14.29 to

40.00 and 12.50 to 41.42%) and (14.29 to 41.38 and 8.33 to 42.19%) during 1993 and 1994, respectively. The highest number of *G. mellonella* larvae was recorded by Pastagia, (2006) in the second fortnight of August and the second fortnight of September in the years 2003 and 2004, respectively. While the second fortnights of June and May had the highest levels of *A. grisella* activity. Fathy *et al.*, (2017). conducted a study to examine the activities of *G. mellonella* and *A. grisella* in apiaries in three different localities (Sakha, Qallin, and El-Reyad) within the Kaf El-Sheikh Governorate. The results showed that the highest percentages of larvae were recorded in Sakha during August, July, and September (19.23, 16.00 and 14.28%) and in Reyad (17.42, 16.96 and 12.50%), respectively, but in Qallin, the higher percentages of larvae were observed in August, September, and July (17.91, 15.71, and 12.31% larvae/ Colony), Although fewer wax moths were observed in December, January, and February, the proportion of wax moth larvae in December was (0.00, 1.49 and 0.00 %), January (0.00, 0.00 and 0.00 %) and February (0.00, 0.00 and 1.25 % larvae/ Colony) for the three apiaries Sakha, Qallin and El Reyad. respectively. Ramesh *et al.*, (2021). Observed *A. galleriae* from natural population of greater wax moth, *G. mellonella* larvae in Madurai region, Tamil Nadu, India. The percent of parasitization ranged from 9.09 to 23.08 per cent. Among different periods, the highest parasitism percentage (23.08%) were noticed during November.

C- Geographical distribution of the wax moths and their parasitoid *A. galleriae* in Sohag districts:

1- *G. mellonella*:-

Figure (5) show the number of *G. mellonella* found in districts of Sohag Governorate. The largest number of *G. mellonella*, was observed in Akhmim district, with 234.67 adults per 1kg of wax, followed by Sohag and Tahta district, with 215.67 and 213.00 adults per 1kg of wax respectively. However the least wax moths was recorded in Dar-El Salam district, with 28.00 adults per 1kg of wax, followed by Girga and Saqulta district, with 38.00 50.33 adults per 1 kg of wax respectively.

2- *A. grisella*

Figure (6) show the number of *A. grisella* found in the districts of Sohag Governorate. The largest number of *A. grisella*, was detected in Akhmim district with 2.67 adults per 1kg of wax,

followed by Sohag and Tahta district each with 2.33 adults per 1kg of wax. While the least number of *A. grisella* recorded in Saqulta, Aserat, Girga and Dar-El Salam districts with 0.33 adults per 1kg of wax for each district.

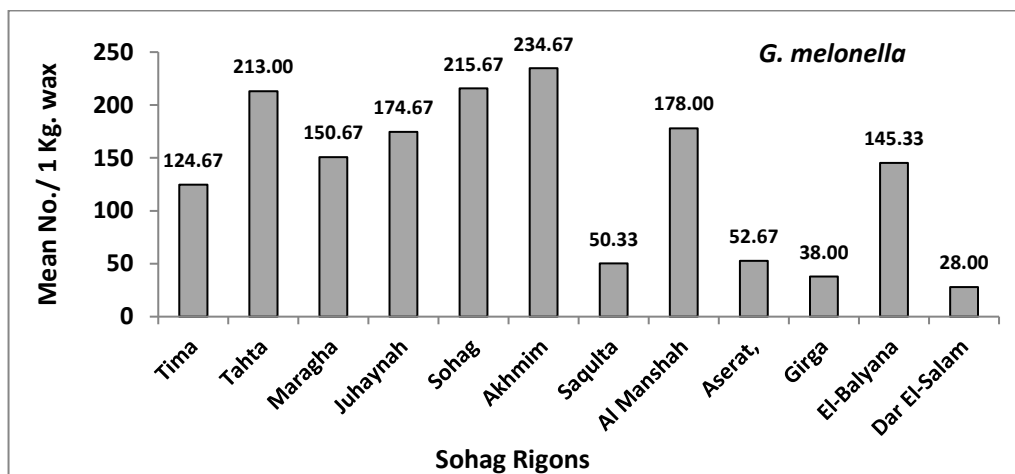


Fig (5): Mean No. of the wax moth, *G. melonella* at different districts of Sohag Governorate.

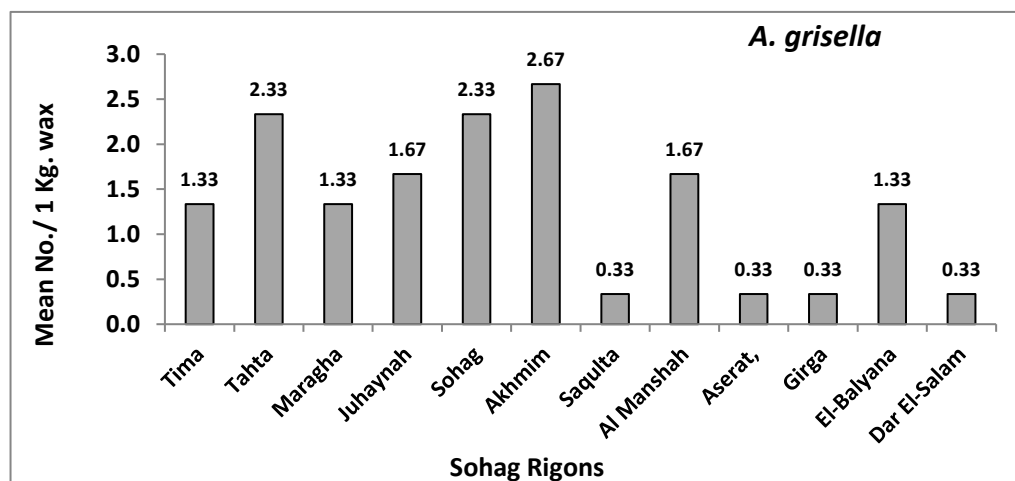


Fig (6): Mean No. of the wax moth, *A. grisella* at different districts of Sohag Governorate.

3. *A. galleriae*

The results in Fig. 7 indicate that the largest number of parasitoids, *A. galleriae*, was presented in Akhmim district with 142.67 adults per 1kg of wax, followed by Tima and EL-Balyana districts with 85.00 and 83.33 adults per 1kg of wax respectively. While the least number of parasitoid was present in Saqulta district with 22.00 adults per 1 kg of wax, followed by Sohag and Al Manshah districts with 45.33 and 60.67 adults per 1 kg of wax respectively. While *A. galleriae*

parasitoid was disappeared in Tahta, Maragha, Aserat, Girga and Dar-El Salam districts. The decrease in parasitoid numbers in some districts may be due to the excessive use of chemicals in the hives to control Varroa mite in these areas. A similar trend was observed with regard to Geographical distribution of *A. galleriae* in Egypt, El-Arnaooty, (1985) reported its occurrence in upper Egypt at (Giza and Fayoum governorate) and lower Egypt at (Kafr El-Sheikh, Alexandria and Qualiobia governorate), Additionally, Fathy *et*

al., (2017) observed the greater and lesser wax moth activity in apiaries across several local (Sakha, Qallin, and El Reyad) and discovered that the highest percentages of larvae were recorded in August, July, and September (19.23, 16.00, and

14.28%) in Sakha and (17.42, 16.96, and 12.50%) in Reyad; however, the highest percentages of larvae were observed in August, September, and July in Qallin. (17, 91, 15,71 and 12,31% larvae/ Colony), respectively.

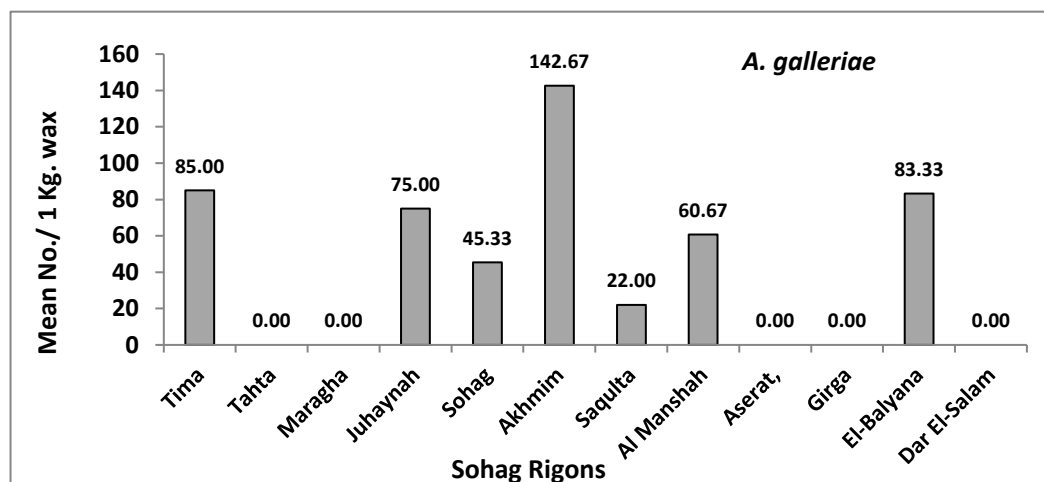


Fig (7): Mean No. of the parasitoid, *A. galleriae* at different districts of Sohag Governorate.

CONCLUSION

The parasitoid, *A. galleriae* is considered one of the biological control elements that have a promising future in Egypt in the biological control of wax moth larvae, as it can be used safely for control, whether inside colonies during the season or in storage. Many studies still need to clarify the method of mass rearing and releasing of this parasitoid.

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الاعداء الحيوية لفراشتي الشمع الكبيرة والصغيرة ونشاطها في طوائف نحل العسل تحت الظروف البيئية لمحافظة

سوهاج- مصر

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الملخص العربي

اجريت الدراسة الحالية في محافظة سوهاج – مصر خلال موسم 2023/2022. و كشفت النتائج عن وجود نوعين من الطفيليات التي تتطفل على فراشة الشمع الكبيرة حيث كان احدهما اكثر تواجدا وتأثيرا وهو طفيل *Apanteles Galleriae* بينما كان الطفيل الاخر *Bracon hebetor* يتواجد باعداد قليلة جدا. تم تسجيل اقلى وفترة موسمية لفراشة الشمع الكبيرة *G. mellonella* بعدد 140 فراشة / 1 كجم شمع في شهر اغسطس وأقل عدد 26 و67 فراشة / 1 كجم شمع تم تسجيله في شهر مارس . بينما كانت الوفرة الموسمية لفراشة الشمع الصغيرة *A. grisella* خلال الفترة من ديسمبر 2022م وحتى نوفمبر 2023م تتراوح ما بين 1.67 إلى 7.00 فراشة / 1 كجم شمع. تم تسجيل أكبر عدد من الطفيل *A. Galleriae* في شهر سبتمبر بواقع 75.67 فرداً بالغا / 1 كجم شمع. في حين تم تسجيل أقل عدد في شهر أبريل بواقع 13.67 فرداً بالغا / 1 كجم شمع. بينما كانت أعداد الطفيل *B. hebetor* محدودة للغاية، حيث تتراوح من 0 إلى 1.67 فرداً بالغا / 1 كجم شمع. سجل في مركز أحميم أكبر عدد من فراشتي الشمع *G. mellonella* و *A. grisella* والطفيليات *A. galeriae* بواقع 234.67 و 2.67 و 142.67 فرد بالغ / 1 كجم شمع على التوالي. وايضا تم تسجيل أقل عدد لفراشة الشمع الكبرى في مركز دار السلام حيث بلغ 28 فراشة / 1 كجم شمع وأقل عدد لفراشة الشمع الصغرى 0.33 فراشة / 1 كجم شمع على التوالي. بينما لم تتواجد الطفيليات في مراكز دار السلام وجرجا والعسيرات والمراغة وطهطا.

