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STUDIES ON SOME INSECT NATURAL ENEMIES ASSOCIATED WITH THE CITRUS LEAFMINER, *Phyllocnistis citrella* Stainton (LEPIDOPTERA : GRACILLARIIDAE)

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ABSTRACT

Studies on the natural enemies attacking the citrus leafminer (CLM), *Phyllocnistis citrella,* Stainton were carried out in a neglected citrus orchard during two successive seasons 1996/97 and 1997/98 in Dakahlia Governorate.

During the course of the study, no parasitoids on CLM eggs were recorded. Four parasitoid species of family Eulophidae were recorded on CLM immature stages (larvae, prepupae and pupae). They are two elachertin parasitoids namely, *Cirrospilus pictus* (Nees) (the most important primary ectoparasitoid) and *C. quadristriatus* (Subba Rao & Ramamani); an eulophin, *Pnigalio sp.* and the fourth one, *Baryscapus sp.* (the less important parasitoid). *Chrysopa carnea,* Steph. seems to be an important predator attacking CLM immature stages under field conditions.

C. pictus and *Pnigalio sp.* populations showed three peaks annually. *C. quadristriatus* was recorded rarely with few numbers (during September). In the second year, it appeared regularly, the population showed two peaks of abundance.

There are a good synchronization between the parasitoids (*C. pictus* and *Pnigalio sp.*) and its host populations. While, the synchronization was not good with *C. quadristriatus*.

In respect to the sex ratio: the number of parasitoid females production outnumbered that of males. There are a negative response of female production of *C. pictus* and *C. quadristriatus* with the increase of temperature or relative humidity. While, daily relative humidity exhibited a significantly positive effect on *Pnigalio sp.* females production.

The regression analysis indicated that the parasitization values of parasitoids showed a density dependent response to the increase of host density.

INTRODUCTION

A micro lepidoptera species, the citrus leafminer (CLM), *Phyllocnistis citrella* Stainton (Lepidoptera : Gracillariidae) is a serious pest in most citrus growing areas worldwide **(Garrido, 1995 and Legaspi & French, 1996)** and related Rutaceae within its range **(Heppner, 1993)** in several Mediterranean countries, including Egypt. In Egypt, CLM was found in October 1994 in many citrus orchards and nurseries in Middle-Delta, with eleven annual generations were recorded by **Abo-Sheaesha (1997) and Abdel-Rahman (1998)**. CLM during its larval stages, mines the newly formed leaves and stems of citrus trees and sometimes fruit **(Legaspi & French, 1996)**. Injured young leaves curl, become chlorotic then become necrotic. Consequently, heavily infested leaves are frequently distorted and may abscise **(Pena & Duncan, 1993)**.

Effective of chemical control on the CLM is difficult to be achieve and total reliance on chemical control has been demonstrated to be ineffective **(Munir, 1996)**. In addition to CLM, apparently has developed resistance to some overused pesticides **(Pena, 1996a)**. Traditional controlling measures, especially chemical control failed to stop losses caused by infestation in citrus crops. The only way to bring back the natural balance is to minimize the use of chemical insecticides and increase the populations of natural enemies to play their role in minimizing the pest population **(Tawfik *et al*., 1995)**.

Indigenous biological control agents (predators and parasitoids) provide an opportunity for significant reduction in CLM populations **(Batra & Sandhu, 1981; Browning & Pena, 1995 and LaSalle, 1996)**. They will provide the full solution to CLM pest **(Hoy & Nguyen, 1994a)**.

knowledge of the population relationship of host and natural enemies and needs information on the biology of the related natural enemies to the pest are required to have a satisfactory pest management program. In addition to little knowledge concerning the quantitative changes in CLM parasitoid populations.

So, the present study is based on field experiment in the Faculty of Agriculture at Mansoura region for the following objectives:-

- Surveying the beneficial insect predators and parasitoids associated with its host pests, *Phyllocinstis citrella*.
- Studying the population fluctuations of the above mentioned natural enemies, and
- Calculating the sex ratio of CLM parasitoids

MATERIALS AND METHODS

The phenology of CLM parasitoids was studied between 1996 and 1998 on orange trees in the experimental farm belonging to the Faculty of Agriculture, Mansoura University. Five infested orange trees (with CLM) from the same age and shape approximately 3.5 m in height were selected for the present study. 100 fresh leaves (20 leaves / tree), four each in the north, south, east, west and the center of the tree crown were collected biweekly from the 2nd of March 1996 till the 15th of February 1997 and from the 1st of March 1997 till the 28th of February 1998. Leaves of each tree were investigated on both surfaces of leaves using a binocular microscope.

CLM stages were examined and dissected for different stages of the parasitoids recorded as living, predator-damaged and parasitized individuals. The number of parasitoids (eggs, larvae, and pupae) was counted and recorded. The presence of predators on orange leaves was also recorded. Meanwhile, CLM was attacked by predators in the field, which were observed feeding on its different immature stages were collected by an aspirator. Samples of orange leaves infested with eggs, larvae and pupae of CLM, which were previously collected were used to determine the parasitoids of this insect. These samples were maintained in Petri-dishes (10 cm in diameter) until the emergence of adult parasitoids, just after they were identified, counted separately and sexed in each sample to be recorded.

To investigate density dependent relationships between CLM population density and the percentage of parasitism by each CLM parasitoids (*C. pictus, C. quadristriatus* and *Pnigalio sp.*), ten orange trees were sampled on June, August, October and December, 1998. Ten infested leaves were removed from each tree at each time The number of different developmental stages of each parasitoid species and their available host (parasitized and unparasitized) were counted. To determine the relationship between the density of the host and the percentage of parasitism, correlation coefficients and linear regression analysis were done for ten trees for each sampling date.

RESULTS

1. Survey:

The data in Table (1) show that during the course of this study, no parasitoids on CLM eggs were recorded. Four parasitoid species of family Eulophidae were recorded on CLM immature stages (larvae and pupae). They are two elachertin parasitoids namely *Cirrospilus pictus* (Nees) and *C. quadristriatus* (Subba Rao & Ramamani), an eulophin, *Pnigalio sp.* and an eulophid parasitoid*, Baryscapus sp*.

C. pictus is the most important primary ectoparasitoid of the CLM in the experimental farm (Mansoura region). It attacks mainly the fourth instar larvae (Pre-pupae) and pupal stages, and sometimes it attacks the 3rd instar larva. *C. quadristriatus* is a primary ectoparasitoid. It attacks mainly the 2nd and 3rd instar larvae of the CLM preferring the 3rd one. It recorded rarely during the first year, while during the second year of study 1997/98 it was neumerous. It is considered to be one of the most valuable natural enemies of CLM population. The ectoparasitoid, *Pnigalio sp.* was collected from samples were taken during the two years (1996/97 and 1997/98). This species prefers the 2nd and 3rd larval instars. *Baryscapus sp.* is an endoparasitoid on CLM larvae. This species seems to be the less important parasitoid of CLM in infested citrus orchards. It was obtained in few individuals during the two years of study. In the first year, it appeared only in June (7 individuals) and August (4 individuals). While in the second year, it recorded six times during the period from the end of June till the end of August with a total number of 17 individuals.

Chrysopa carnea (Chrysopidae) seems to be the only predator recorded attacking CLM immature stages under field conditions.

2. CLM parasitoids:

2.1. *C. pictus*:

In the first season (1996/97), population of *C. pictus* immature stages showed three peaks of abundance (during July 20th, October 26th and November 23rd). The highest level of occurrence during 12th October, represented by 146 immature stages / 100 leaves (Fig. 1a). But, in the second year (1997/98), the total number of *C. pictus* immature stages showed three peaks in May 24th; in the 2nd of August and in the 27th of September, 1997 (fig. 1b).

In the first year, the data presented in Fig. 1a, shows that the numbers of available stages (4th instar larvae and pupae) of the host had four peaks of abundance, during July 20th, September 14th, and October 26th, 1996, respectively. The first peak of the insect parasitoid coincided with the host peak of the 20th July, while the second and third peaks of the parasitoid were not coincided with the host peaks.

Fig. 1. Synchronization of the ectoparasitoids *C. pictus* immature stages and the available host (4th instar larvae and pupal stages during 1996/97 (a) and 1997/98 (b).

In The second year as shown in Fig. (1b), the high occurrence of available host stages (prepupae and pupae) well coincided with *C. pictus* peaks. The second peak (on August 2nd, 1997) of the parasitoid coincided with the second peak of the host. Then, the population density of both parasitoid and its available host declined during August-September and Sharply increase at the 27th of September, 1977. From October till the beginning of January, the population of both the host and parasitoid decreased gradually. Then, the parasitoid disappeared during January and February.

On the other hand, correlation analysis indicate that there is a significantly positive correlation between the host and parasitoid densities, especially during the second year. However, r- values were +0.87 and +0.95 for the first and second year, respectively.

Data on the sex ratio of *C. pictus* (percentages of female) during 1996/97 and 1997/98 are illustrated in Figs. (2 a&b), respectively. The highest sex ratio (Female %) was recorded in May (66.66%) at 20.64°C and 59.75 RH%, while the lowest was in January (50.0%) at 14.46°C and 73.90 RH% during the first year (Fig. 2a). In the second year, the highest sex ratio was recorded in November (68.75%) at 20.70°C and 60.08 RH%, while the lowest value was in September (51.73%) at 25.17°C and 61.33 RH% (Fig. 2b). The average percentage of *C. pictus* females all over the year was 58.73 and 60.45 during the first and second year, respectively. From the above mentioned data, it could be noticed that the number of females was outnumbered that of males in both years.

From simple correlation and partial regression analysis, it may be proved that there are insignificantly positive response of *C. pictus* female production with the increase of the temperature (r- and b-values were +0.44 and +0.54, respectively) in the first year. In the second year, the simple correlation was significantly negative (r = -0.78) and regression coefficient value was -0.94. In general, the effect of temperature on sex ratio varied from year to year and the female production exhibited relative decrease with high temperature. In both years of study, the simple correlation and regression values indicates that there are a negative relationship between the daily relative humidity and female production. It was significant during the first year (r = -0.70 & b = -0.59) and insignificant (r = -0.05 & b = -0.10) during the second year.

The density-dependent response was determined for *C. pictus* during the different seasons (spring, summer, autumn and winter) (Fig. 3). By plotting the values of parasitism for each season against the density of the host, the regression analysis indicated that parasitization values of *C. pictus* were relatively more correlated with the host density during spring and winter than summer and autumn. The density relationship during autumn and winter indicated that mortality caused by *C. pictus* among the immature stage had a relatively adverse effect as the immature stage population density increased. This effect could be represented by the following submodels:

Par.% = 23.81 + 0.019 Nh In autumn
Par.% = 13.23 + 0.085 Nh In winter

Fig. 2. Sex ratio of the ectoparasitoids *C. pictus* during 1996/97 (a) and 1997/98 (b).

On the contrary, the density relationship during spring and summer indicated that mortality caused among the immature stage had a relatively adverse effect as the immature stage population density decreased. The effect could be represented by the following submodel:

$Par.\% = 11.28 - 0.084\ Nh$ In spring

$Par.\% = 36.87 - 0.024\ Nh.$ In summer

Fig. 3. Density dependent relationship between the host density of CLM immature stages and parasitism % caused by *C. pictus.*

2.2. *C. quadristriatus:*

In the first year (1996/97), the parasitoid recorded in few number (5 individuals) during September only. Population of *C. quadristriatus* immature stages during the 2nd year (1997/98) of study are illustrated in Fig. 4. The period of presence of *C. quadristriatus* from the 5th of July till the 20th of December.

As shown in Fig. 4, it could be concluded that the total number of *C. quadristriatus* immature stages showed two peaks of abundance in the 13th of September and 11th of October represented by 110 and 103 individual, respectively.

Fig. 4. Synchronization the ectoparasitoids *C. quadristriatus* immature stages and its available host (larval stage during 1997/98.

During the period of presence of the parasitoid from the 5th of July till the 20th of December, the numbers of available host (CLM) had three peaks of abundance (Fig. 4). The parasitoid has two peaks recorded in the 13th of September and the 11th of October, respectively. So, no peaks of parasitoid coincided with any peaks of the host. On the other hand, correlation analysis indicate that there is an insignificant positive correlation between the host and parasitoid densities (r = 0.40).

Data on the sex ratio of *C. quadristriatus* (percentages of females) during the second year of study is illustrated as shown in Fig. 5. The highest sex ratio was recorded in December (75.00%) at 17.15°C and 59.60 RH%, while the lowest value was in July (60.00%) at 28.20°C and 60.50 RH%. The average percentage of *C. quadristriatus* female all over the year was 68.06±5.57. From the above data, it could be concluded that the number of females outnumbered that of males.

Fig. 5. Sex ratio of the ectoparasitoid *C. quadristriatus* during 1997/98.

The simple correlation and partial regression analysis were highly insignificant negative response of female production in comparison with male with the increase of temperature (r = -0.96 and b = -1.31). It could be concluded that the temperature is the most competent on *C. quadristriatus* sex ratio. Also, the mean relative humidity showed significantly negative effect on sex ratio of *C. quadristriatus*. The simple correlation value was -0.50, while the partial regression value was -1.68 during the year of study.

The density dependent response was determined for *C. quadristriatus* during the different seasons (summer, autumn and winter) (Fig. 6) by plotting the values of parasitism for each season against the density of the host, the regression analysis indicated that parasitization values of *C. quadristriatus* showed positive responsive to the increase of host density during summer and autumn. On the contrary, parasitoid exhibited negative response to host density during winter. The density relationship indicated that mortality caused by *C. quadristriatus* among the immature stage had a relatively adverse effect as the immature stage population density increased. This effect could be represented by the following submodels:-

Par.% = 2.20 + 0.056 Nh (In summer)

Par.% = 16.86 + 0.056 Nh (In autumn)

Par.% = 26.59 + 0.063 Nh (In winter)

Fig. 6. Density dependent relationship between the host density of CLM immature stages and parasitism % caused by *C. quadristriatus.*

2.3. Pnigalio sp.

As shown in Fig. 7a in the first year 1996/97, it could be concluded that the total number of *Pnigalio sp.* immature stages showed three peaks of abundance in the 8th of June; 6th of July and 14th of September represented by 85, 101 and 58 individuals, respectively. In the second year the total number of *Pnigalio sp.* immature stages showed three peaks in the 24th of May (92 individuals), 5th of July (95) and 2nd of August (113) (Fig. 7b).

In the period of presence of the parasitoid from the 13th of April till the 26th of October, the numbers of available host (CLM) had five peaks of abundance during the first year (Fig. 7a). The first, second and third peaks of parasitoid coincided with the second, third and fourth peaks of the host, respectively (Fig.7a).

In the second year as shown in Fig. 7b, the high occurrence of available host stages (Larval stage) well coincided with *Pnigalio sp.* The first peak (on May 24th, 1997) of the parasitoid coincided with the first peak of the host, as well as the second (on July 5th) and third (on August 2nd) peaks, respectively.

Fig. 7a & b. Synchronization of the ectoparasitoids *Pnigalio sp.* immature stages and its available host (larval stage) during 1996/97 and 1997/98.

On the other hand, correlation analysis indicated that there is significantly positive correlation between the host and parasitoid densities during the first year (r = +0.8). While, in the second year, the simple correlation value was insignificantly positive (r = + 0.46).

Data on the sex ratio of *Pnigalio sp.* (percentages of females) during both years of study are illustrated as shown in Figs. 8a and b, respectively. The highest sex ratio was recorded in September (83.33%) at 26.25°C and 68.3 RH%, while the lowest value was in May (54.55%) at 20.64°C and 59.75

RH% during the first year (Fig. 8a). In the second year, the highest sex ratio (73.33%) was recorded in August and September at 26.70°C & 64.22 RH% and 25.17°C & 1.33 RH%, respectively. While, the lowest level was in June (57.90%) at 26.74°C and 56.80 RH% (Fig. 8b). The average percentage of *Pnigalio sp.* females all over the year was 70.58±9.5% and 66.24±6.7% during the first and second year, respectively. So, it could be concluded that the number of females outnumbered that of males, especially during the first year.

Fig. 8a & b. Sex ratio of the ectoparasitoids *Pnigalio sp.* during 1996/97 (a) and 1997/98 (b).

From simple correlation and partial regression analysis, it may be proved that the effect of temperature on the sex ratio of *Pnigalio sp.* varied from year to year. In the first year, there was insignificantly positive response of female production in comparison with male with the increase of temperature (r = + 0.09 and b = + 0.26). In the second year, there was insignificantly negative response of female production with the increase of temperature (r = - 0.22 and b = - 0.34). It could be concluded that temperature had a slight effect on *Pnigalio sp.* sex ratio.

In both years of study, the simple correlation and regression values indicate that the mean relative humidity showed significantly positive effect on sex ratio of *Pnigalio sp.* The simple correlation values were + 0.51 and + 0.72, while the partial regression values were + 1.0 and + 1.44 during the first and second year, respectively.

The density-dependent response was determined for *Pnigalio sp.* during the different seasons (spring and summer) (Fig. 9) by plotting the values of parasitism for each season against the density of the host, the regression analysis indicated that parasitization values of *Pnigalio sp.* showed similar correlation with the host density, during spring and summer.

The density relationship indicated that mortality caused by *Pnigalio sp.* on the immature stage had a relatively adverse effect as the immature stage population density increased. This effect could be represented by the following submodels:-

Par.% = 10.07 + 0.23 Nh   In spring
Par.% = 3.75 + 0.24 Nh.   In summer

Fig. 9. Density dependent relationship between the host density of CLM immature stages and parasitism % caused by *Pnigalio sp.*

DISCUSSION

In the present study, no parasitized eggs of CLM, *Phyllocnistis citerlla* and its eggs are free from any parasitoids eggs, in Mansoura region. This result is in agreement with the findings of Browning and Pena (1995). They recorded that no native egg parasitoids have been observed attacking citrus leafminer in Florida and none are reported elsewhere. On the contrary, CLM eggs were attacked by *Ageniaspis citricola* in the tropical and subtropical regions of Asia (Ujiye & Adachi, 1995).

Data obtained during 1996 to 1998 in Mansoura region indicated that the CLM was attacked by a complex of native parasitoids, namely *C. pictus* (the most important primary ectoparasitoids), it prefers the 4th instar larvae and pupae; *C. quadristriatus*, it prefers the 3rd instar larvae; *Pnigalio sp.* prefers the 2nd and 3rd instar larvae and *Baryscapus sp.*, it is an endoparasitoid on CLM larvae. The last parasitoid was obtained in few individuals. It could be concluded that the native leafminer parasitoids are specific in the life stages of the leafminer. Similar conclusion was reported by Browoning and Pena (1995). In the present study *C. pictus* is the most common parasitoid in Mansoura, Egypt, as well as in Giza and Benisuaif (Tawfik *et al*., 1995; Hashem, 1996 and Eid, 1998). Also, it was the most abundant parasitoid in Spain (Garcia-Mari, 1996); Italy (Liota *et al*., 1996), and Morocco (Boughdad *et al*., 1997). Both parasitoids *C. quadristriatus* (Hoy & Nguyen, 1994b; Neale *et al*., 1995 and Eid, 1998) and *Pnigalio sp.* (Coleman, 1995; Abbassi, 1996 and Abdel-Rahman, 1998) were recorded as important parasitoids on CLM immature stages.

Native predacious insects species, the lacewing larvae *Chr. carnea* have been found attacking CLM immature stages on the citrus trees. According to Browning and Pena (1995), Coleman (1995), Abassi and Harchaoui (1997), Al-Barrak and Azawi (1997) mentioned that *Chr. carnea* has an important role in reducing CLM population.

Population curves for *C. pictus* indicates that the period of presence of this species from May till January and it exhibits three peaks of abundance annually. The highest peak was recorded in early autumn (in September or October) and in summer, there was a relative reduction of *C. pictus* population. According to Garcia-Mari (1996), *C. pictus* numbers vary depending on the time of the year. In Morocco, the highest activity was recorded in autumn (Abbassi & Harchaoui, 1997 and Abbassi *et al*., 1998), while in Italy, the highest activity was during January (Caleca and Lo Verde, 1998). In Algeria, the maximum activity was in autumn and winter (Berkani, 1996). In Egypt, the highest activity was recorded during autumn in Mansoura (Abdel-Rahman, 1998) and during late spring in North Sinai (EL-Sheikh Zeweid) (Eid, 1998).

C. quadristriatus population obviously indicated that two peaks of abundance were recorded during September and October. In India, the highest activity was also recorded in September followed by August and October (Batra & Sandhu, 1981). While, it was higher in early mid June and mid July. This differences may be attributed to the variation of the climatic factors. However, fecundity of the parasitoid (Ding *et al*., 1989) increased with the rising of temperature at the range of 15-25°C.

The obtained results approved that *Pnigalio sp.* is one of the most dominant parasitoids, which attacking *P. citrella* larvae. Also, it was dominant in Qualubia & Assiout (Hashem, 1996), and several governorate of Egypt (Eid, 1998), as well as in Japan (Ujiye, 1988) and in Spain (Garrido & Busto, 1994). The parasitoid showed three peaks of abundance and the highest activity was recorded in July-August. Similar finding was recorded by Abdel-Rahman (1998). But, it was mainly active in late spring and autumn (Abbassi, 1996) or in autumn and winter (Berkani, 1996) in Morocco and Algeria, respectively. The activity of the parasitoid depends on the region, climate and conditions of the grove (Browning and Pena, 1995).

Sex ratio of *C. pictus* varied from one month to another and from year to year. The number of females outnumbered that of the males at moderate temperature. According to Lo Pinto & Salerno (1998), the sex ratio (M/F) of *C. pictus* on average, was 1.25±0.10 in Sicily, Italy. In this study, the average percentages of *C. pictus* females all over the year was higher (58.7±5.0 and 60.5±6.0) during the first and second year, respectively in Mansoura, Egypt than meles, may be due to weather factors.

Sex ratio (F/M) is one of the biological characteristics, which affected by the weather factors (Rosen & DeBach, 1979). The obtained data showed that the female parasitoid of *C. quadristriatus* constituted the majority of the total population. Also, it was about 56.7% (Argov & Rössler, 1996) in Israel, while was lowered (46.5%) in China (Ding *et al*., 1989). Statistical analysis indicated that there are a negative correlation between the sex ratio and temperature, the highest female proportion the lowest the temperature. The sex ratio of (F/M) *Pnigalio* was highest at moderate temperature and relative humidity. The activity of the parasitoid depend on the region, climate and conditions of the grove (Browning and Pena, 1995).

The eulophid parasitoid *C. pictus* is in most cases able to cause high percentage of parasitism at different host population levels. It exhibited a positive density-dependent response especially in spring and winter. On the contrary, the parasitoid exhibited a weakly negative response to host density in summer. Lo Pinto & Salerno (1998) mentioned that there is a negative correlation between the parasitization and the density of parasitizable host Also, *C. quadristriatus* as well as *Pnigalio* exhibited functional response to the density of the CLM. This results confirmed with Ding *et al*. (1989) that fecundity of that parasitoid tended to increase as the host density increase.

There are a positive correlation between CLM populations and parasitoids densities. The result is in agreement with the findings of Pena, (1996b).

So, in the integrated pest management program, CLM parasitoids can be use as biological control agents against *P. citrella*. However, they exhibited functional response to the host densities and there are a relatively good synchronization between the parasitoid and host densities. In addition to a relative high parasitoids sex ratio (female / male) under field conditions.

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دراسات على الأعداء الحيوية الحشرية المرتبطة بنافقة أوراق الموالح ***Phyllocnistis citrella*** **Sta.**

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تم إجراء بعض الدراسات على الأعداء الحيوية التى تهاجم نافقة أوراق الموالح فى المزرعة البحثية بكلية الزراعة - جامعة المنصورة على أشجار موالح غير معاملة خلال عامين متتاليين 1996 ، 97 و 1997 ، 98 وقد أوضحت نتائج الحصر مايلى:-

* لم يتم تسجيل أى نوع من الطفيليات على بيض الحشرة0 بينما تم تسجيل أربع أنواع من الطفيليات التابعة لعائلة Eulophidae (على اليرقات وكل من طور ماقبل العذراء والعذراء)0 وهى كما يلى:-

Cirrospilus pictus , *C. quadristriatus*; *Pnigalio sp.*, *Baryscapus sp.*

* ولقد كان الطفيل الأخير أقلهم أهمية0 كما تم تسجيل نوع واحد من المفترسات وهو أسد المن حيث لوحظ أنه يهاجم الأطوار غير الكاملة لنافقة أوراق الموالح

كما أوضحت الدراسات الإيكولوجية مايلى:-

* أبدى كل من طفيل *C. pictus* والـ *Pnigalio* ثلاث ذروات للتعداد خلال العام الواحد بينما طفيل *C. quadristriatus* فقد سجل بأعداد قليلة خلال شهر سبتمبر العام الأول بينما كان التعداد أكثر إنتظاماً فى العام الثانى مسجلاً ذروتين للتعداد0

* لوحظ أن هناك تزامن جيد بين تعداد الطفيليات *C. pictus* و*Pnigalio sp.* وتعداد العائل ، بينما كان هناك قليل من التوافق بين تعداد الطفيل *C. quadristriatus* والعائل0

* النسبة الجنسية: لوحظ أن تعداد الإناث تفوق تعداد الذكور0كما وجد أن هناك إستجابة سالبة بين إنتاج الإناث لكل من الطفيل *C. pictus* و *C. quadristriatus* مع زيادة كل من درجات الحرارة والرطوبة النسبية0 بينما هناك تأثير معنوى موجب للرطوبة النسبية على إنتاج الإناث للطفيل *Pnigalio*0

* كما أوضح تحليل الإنحدار أن قيم التطفل بالطفيليات الثلاث السابقة أبدت إستجابة معتمدة على الكثافة مع تزايد تعداد العائل0

Table 1. Survey of the parasitoids associated with the citrus leafminer, *Phyllocnistis citrella* in Mansoura district (1997/1998).

Natural enemies	Season				Host stage preference					
	Spring	Summer	Autumn	Winter	Eggs	1st instar	2nd instar	3rd instar	Pre-pupae	Pupae
Cirrospilus pictus	+	++	+++	+	-	-	-	+	+++	++
C. quadristriatus	-	++	+++	+	-	-	++	+++	-	-
Pnigalio sp.	++	+++	-	-	-	-	+++	+++	-	-
Baryscapus sp.	-	+	-	-	-	-	-	-	-	-

+++ High. ++ Moderate. + Low - None.