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Population dynamics and parasitic complex of *Phyllocnistis citrella* Stainton, 1856 (Lepidoptera; Gracillariidae) on three varieties of citrus in Oued-El-Alleug of Mitidja (Algeria)

Khechna Hassina, Bendoumia Houda,Doumandji-Mitiche Bahia and Doumandji Salaheddine

[1]*Department of Agricultural and Forest Zooloy, Agronomic National School Superior of El Harrach, Algeria Avenue Hassan Badi, 16200, El Harrach, Algeria.*

Address For Correspondence:
KHECHNA Hassina, Department of Agricultural and Forest Zooloy, Agronomic National School Superior of El Harrach, Algeria Avenue Hassan Badi, 16200, El Harrach, Algeria.

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ABSTRACT

Background :A study on population dynamics of *Phyllocnistis citrella* and parasite incidence was undertaken for one year in the Oued-El-Alleug region. **Objective:** Study of the population dynamics of *Phyllocnistis citrella* due to the damage it causes to citrus and the study of its parasitic complex on three varieties (Washington navel, Clementine, Portuguese) in the region of Oued-El-Alleug. **Results:** Based on the data collected from the sampling, it appears that the activity of the leaf miner is characterized by two distinct periods. The first summer-autumn. The second phase corresponds to the winter-spring period when the miner's activity is negligible to zero. Concerning the evolution of the parasite incidence and the overall parasitism rate, the rate of parasitism on the Washington navel variety compared to the overall population is 23% and it is 32% relative to the potential host population. For the Clementine variety the rate of parasitism in relation to the overall population is 27% but it is 34% compared to the potential host population. Concerning the Portuguese, the rate of parasitism in relation to the overall population is 30% and it is 39% compared to the potential host population. **Conclusion:** Parasitism seems to be a future solution against *Phyllocnistis citrella* and that biological control remains the only alternative. And to strengthen the activity of local auxiliaries, it would first be necessary to breed and release large amounts of *Semielacher petiolatus* and *Citrostichus phyllocnistoïdes*.

KEYWORDS: Population dynamics, parasitoids, *Phyllocnistis citrella*, Citrus, Oued-El-Alleug (Mitidja), Algeria.

INTRODUCTION

Algeria, a major producer and exporter of citrus fruits from the countries of the Mediterranean basin in the past, is experiencing a considerable decline in production due to aging orchards, lack of maintenance and investment. Another phytosanitary factor contributes to the decline of this sector. Indeed, citrus fruit is subjected to the attacks of various pests which cause significant damage in case of strong outbreaks [21, 22]. Among these pests, *Phyllocnistis citrella* (Lepidoptera, Gracillariidae), commonly referred to as citrus leaf miner, originated in Algeria in the summer of 1994 in the western Oranie orchards, Morocco and Spain [11]. This insect is considered to be an important enemy of citrus because of its high climatic adaptability, its rapid spread and the damage it causes, namely a premature fall of young leaves, accompanied by secondary necroses and which subsequently causes a severe slowing of growth on young plants or a decrease in productivity on the oldest trees. The use of pesticides did not give a great result seen endophyte life of this species. For this purpose biological control is recommended by the use of parasitoids.

In this respect, several studies have been carried out in recent years on the leaf miner of citrus fruits in various citrus growing countries of the world. Indeed, [6] in Saudi Arabia reported that *Phyllocnistis citrella* is a main pest of Citrus in Saudi Arabia. In Sudan [8] studied the morphology and biology of citrus leaf miner and even the work of [7]. In France [15], reported that this insect is a new pest on citrus leaves. [25] presented a set of indigenous parasitoids of the citrus leaf miner *Phyllocnistis citrella* in Mexico. [20] to report the presence of leaf miner *Phyllocnistis citrella* in West Africa. In Morocco [3] reports that this species as a new pest of citrus. Later, [13] studied the harmfulness and biology of this miner in Morocco. In Tunisia there is the work of [16, 14]. In Algeria, several studies on *Phyllocnistis citrella* have been undertaken by several authors, notably by [12, 19, 23, 24, 5, 26, 31, 2, 17, 18] on the parasitic complex of citrus leafminer *Phyllocnistis citrella* in The Algerian Sahel. In addition, the research of [28, 27, 4, 10, 9and 29] on biological control of this pest is noteworthy.

The objective of our work is to study the population dynamics of *Phyllocnistis citrella* and its parasitic complex on three varieties (Washington navel, Clementine and Portuguese) in the region of Oued-El-Alleug of Mitidja (Algeria).

MATERIAL AND METHODS

Presentation of the study station:

The observations in this study took place in Oued-El-Alleug and more precisely in Ex. Pilot farm Salhi Abdelkader (Blida). This pilot farm is spread over 160 ha, located about 3 km from the town of Oued-El-Alleug by taking the national road n ° 4 (Oued-El-Alleug-Mouzaïa). The Station is bounded on the north, south and west by breezes of cypresses (*Taxodium distichum*) and on the east by buildings (storage chambers). The Experimental Station is composed of 72 plots of citrus fruit with: Clementine, Washington navel, Mandarin, Portuguese and Double Fine.

The varieties studied in this study:

This work was carried out on three plots. The first represents the Clementine (*Citrusreticula blanco*) which covers an area of 2.46 ha and comprises a total of 762 trees aged about 50 years. The second represents the Washington navel (*Citrus sinensis* osbeck) which covers an area of 2.67 ha and contains a total of 1018 trees aged about 17 years. The third represents the Portuguese and covers an area of 1.53 ha and includes a total of 493 trees aged about 60 years. The rootstock is the Bigaradier. The planting distance is 6 m on the line and 6 m between the lines.

Field sampling technique:

The weekly and random sampling of the leaves was carried out on the 3 plots of varieties namely: Clementine, Washington navel and Portuguese during the experimental period which is spread out from 3/11/2002 to 26/10/2003. The sampling technique adopted is the method of [30] which consists in taking 10 random trees, on which a sample of 4 leaves is taken from each direction of the tree, thus a total of 20 leaves per tree. Our sample therefore contains a total of 200 sheets per plot (by variety). The collected plant material is placed in labeled plastic bags (date, variety, place of collection) and will be examined later.

Laboratory methodology:

For laboratory studies, samples taken from the field for each outlet are observed under the binocular microscope. For each leaf, the number of mines per face (upper side, lower side) and the number of eggs and Biological stages of the insect (Larva 1 (L1), Larva 2 (L2), Larva 3 (L3), Pre-nymphs and Chrysalides). It is mentioned whether the parasitoid is autochthonous or non-autochthonous, and in order to list parasitoid species, individually separated, each parasitoid nymph in plastic Petri dishes in order to follow the emergences and collect the imagos.

RESULTS AND DISCUSSION

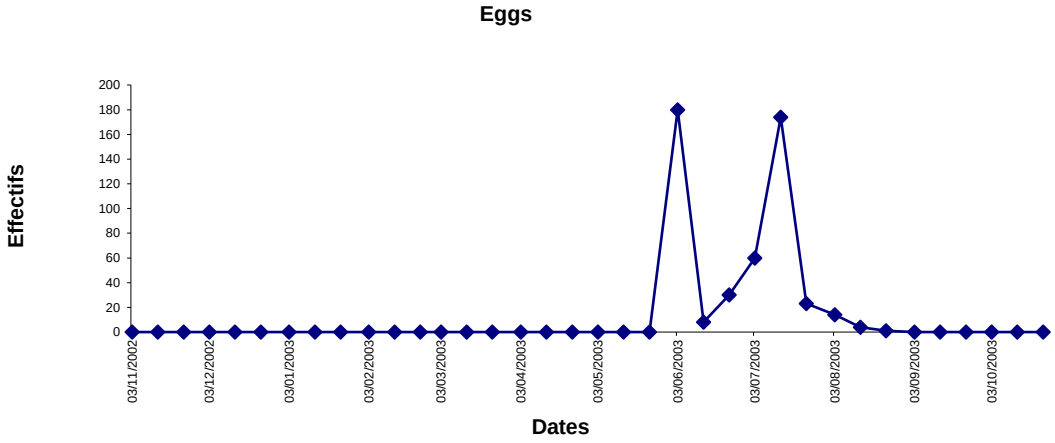
1 - Study of the dynamics of Phyllocnistis citrella populations Stadiums:

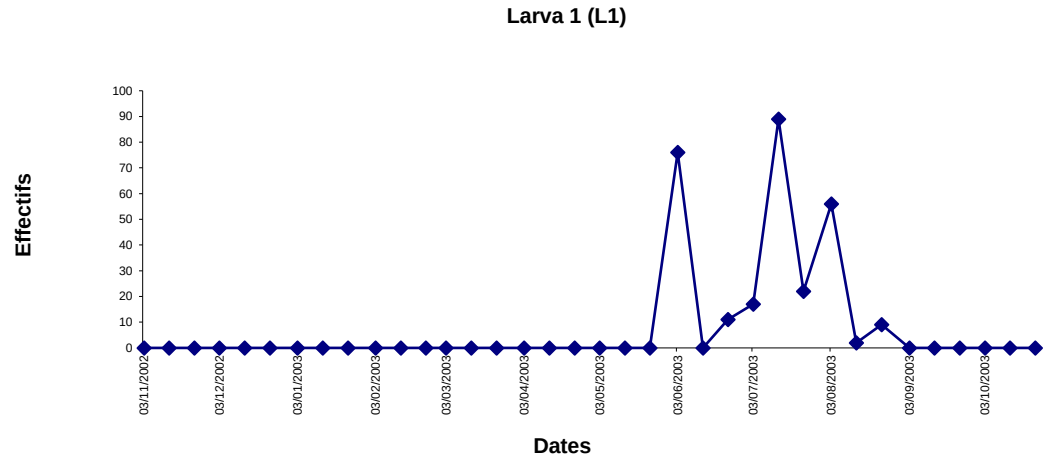
For this part the results and discussion of the population dynamics of *Phyllocnistis citrella* of the different stages (Egg, Larva 1, Larva 2, Larva 3, Pre-nymph and Chrysalis) for the variety Washington navel, the Clementine variety and the Portuguese variety.

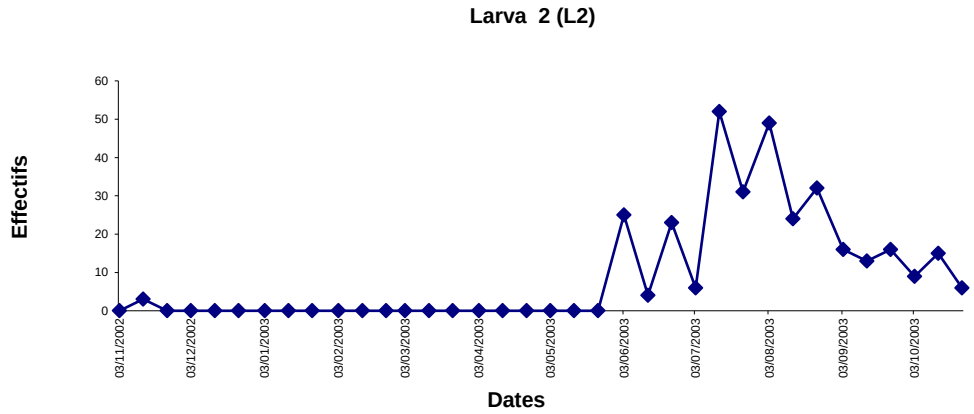
- Case of the variety Washington navel:

The results of the fluctuations of the global populations of *Phyllocnistis citrella* on the Washington navel variety in the Oued-El-Alleug region during the period from (3/11/2002) to (23/10/2003) are represented by the graphs in Fig. 1, shows the presence of high contamination by the different stages of the insect throughout the

summer period. Indeed, two peaks of almost equivalent importance were reported, the first was noted on (3/6/2003) with a number of 180 eggs, the second peak was noted on (13/7/2003) with 174 eggs For larvae, a maximum of 89 first instar larvae (13/7/2003) and 52 second instar larvae. The maximum number of larvae in the third stage is 94 (23/8/2003) and a maximum number of pre-nymphs was reported on (3/8/2003) and a maximum of 74 pupae were reported for the same date.







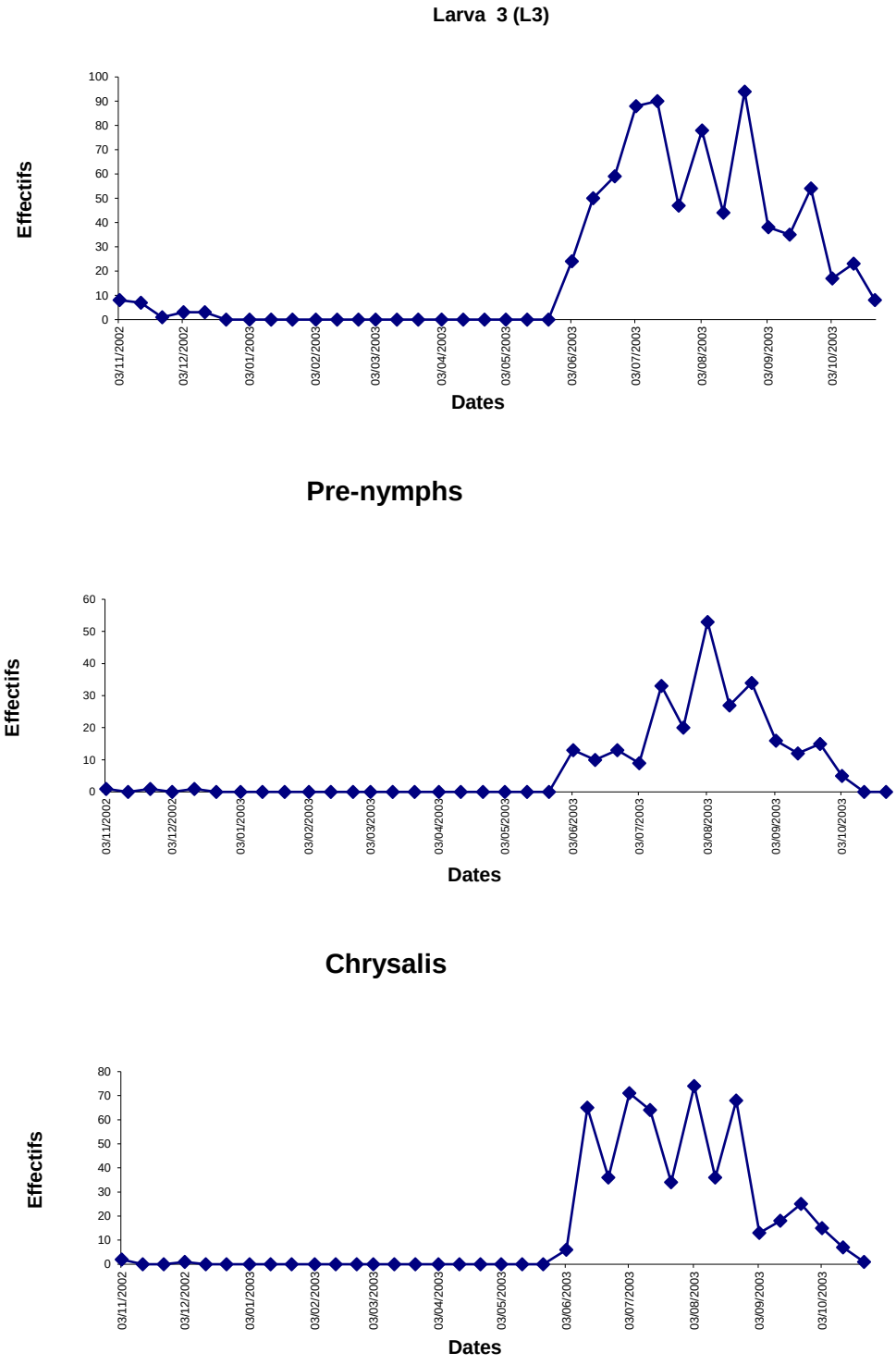
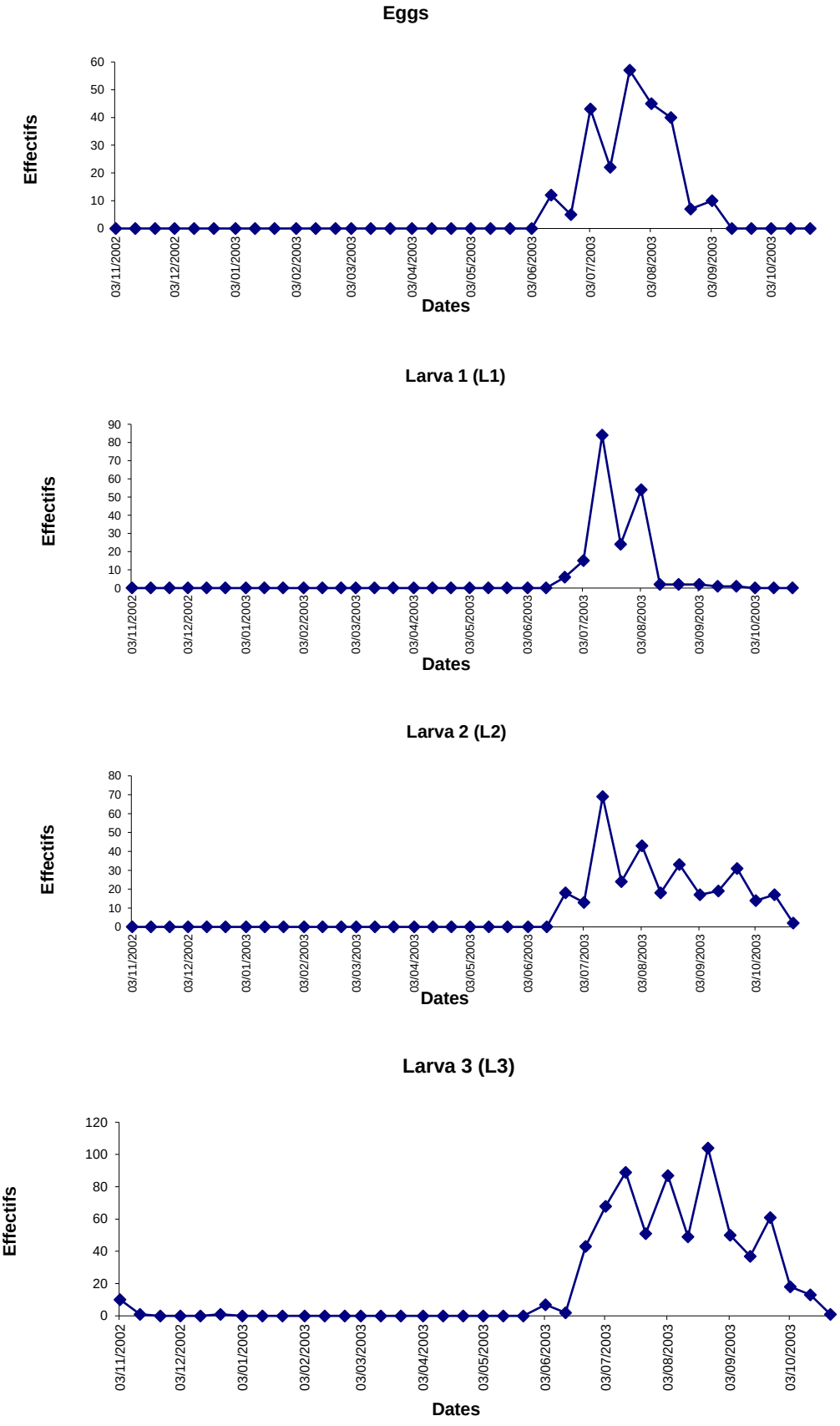


Fig. 1: Fluctuations of the various stages of *Phyllocnistis citrella* on the varietyWashington navel

- *Case of the Clementine variety:*

The results of the fluctuations of the populations of*Phyllocnistis citrella* on the Clementine variety in the region of Oued-El-Alleug during the period (3/11/2002) to (23/10/2003) are illustrated by the graphs of Fig. 2 shows that the population of *Phyllocnistis citrella* is almost negligible or zero during the winter and spring period. The most infested period was the summer (13/7/2003), 57 eggs, 84 larvae of the first stage and 69 larvae of the second stage. It is noted (23/8/2003) 104 larvae of the third stage and 76 pupae, as, it is reported (3/8/2003) 47 pre-nymphs. This summer period is most favorable for the juvenile populations due to favorable temperatures and the presence of young tender leaves.


Eggs
Effectifs
Dates
Larva 1 (L1)
Effectifs
Dates
Larva 2 (L2)
Effectifs
Dates
Larva 3 (L3)
Effectifs
Dates

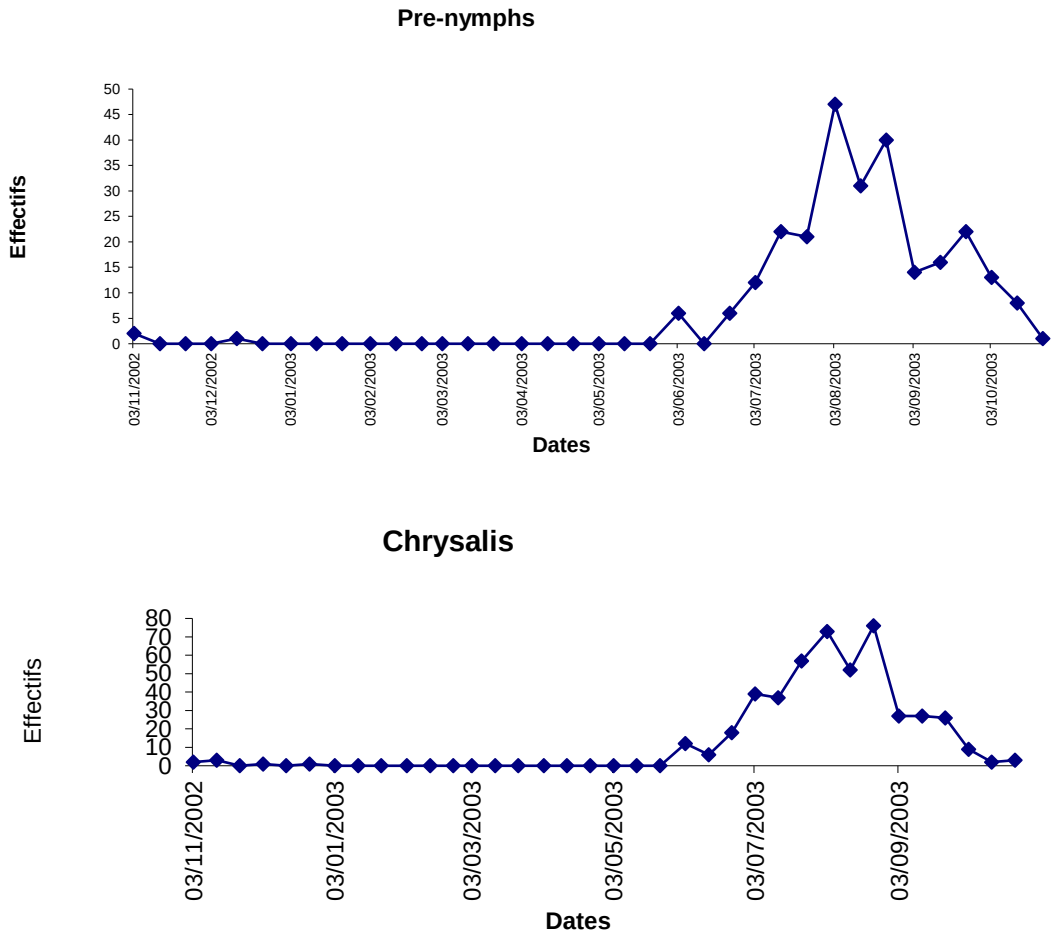
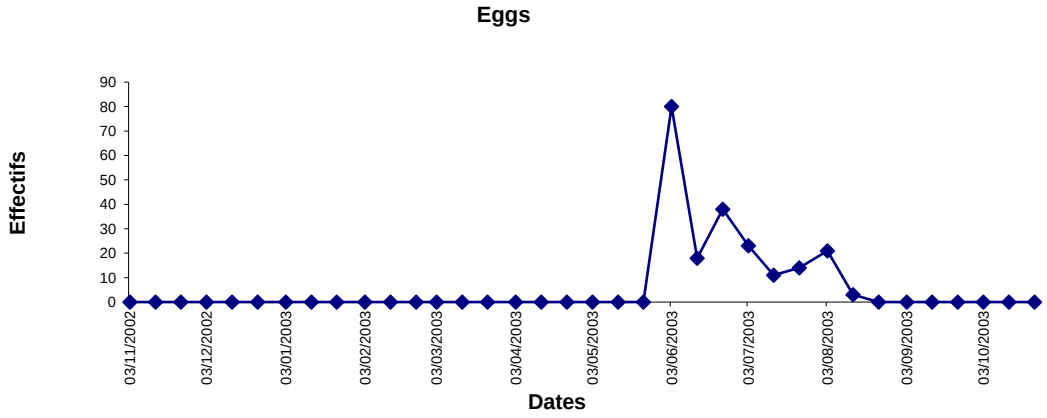
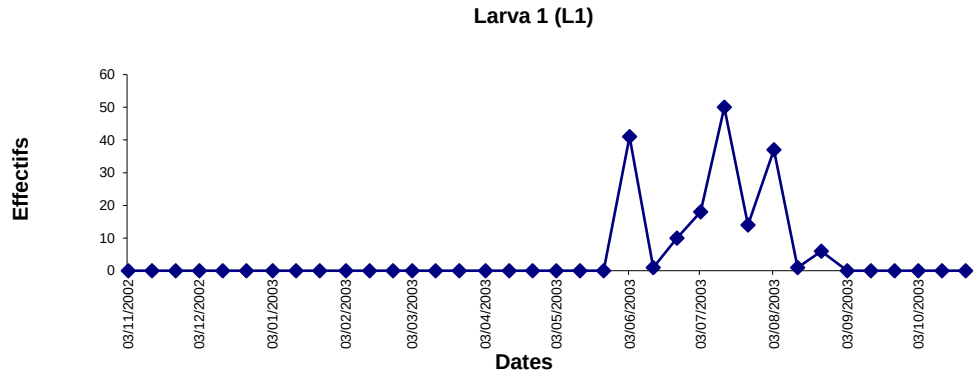


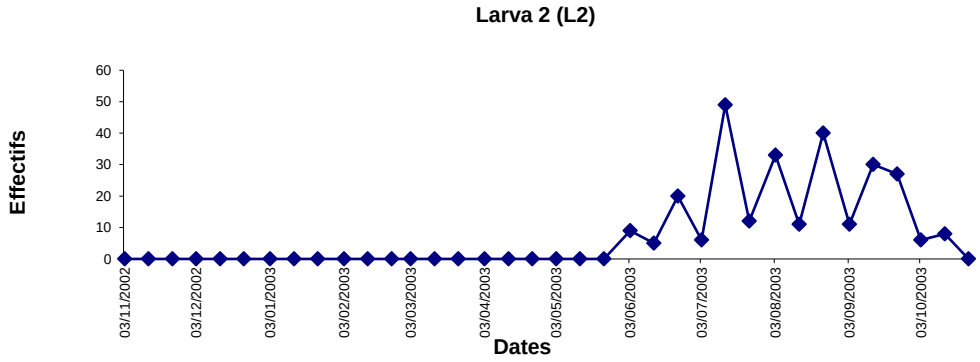
Fig. 2: Fluctuations of the different stages of *Phyllocnistis citrella* on the Clementine variety

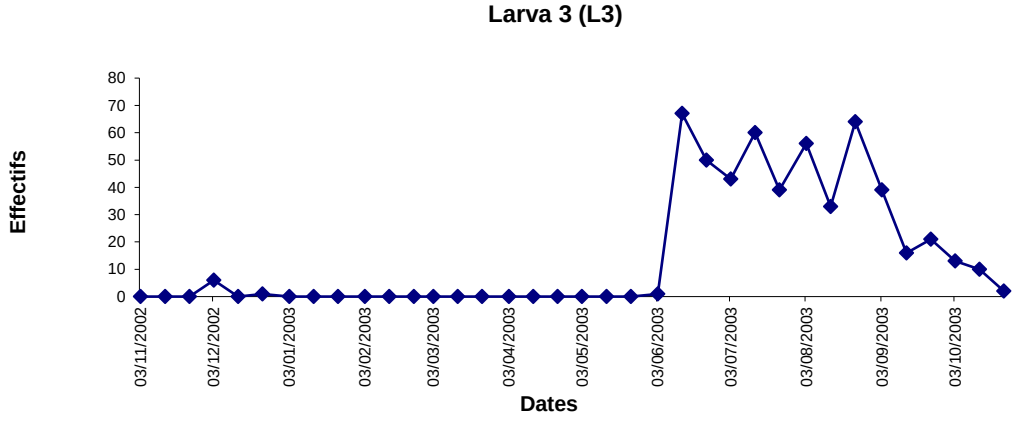
- *Case of the Portuguese variety:*

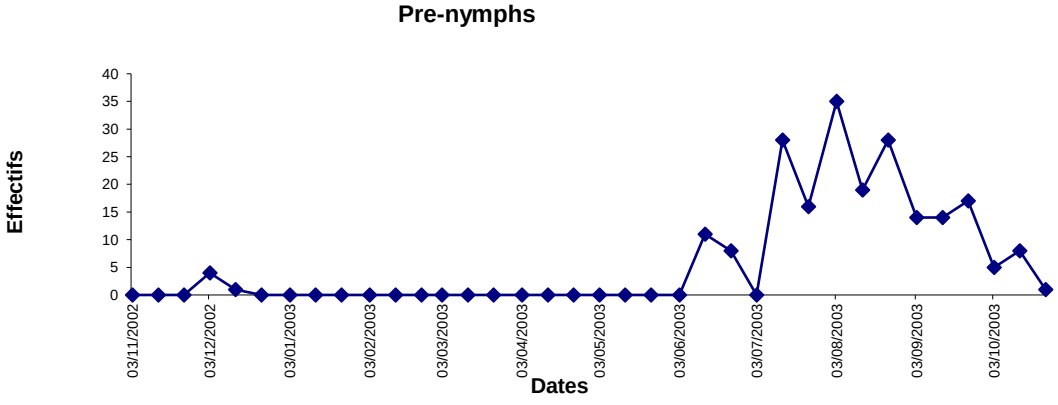
The results of the fluctuations of the global populations of *Phyllocnistis citrella* on the Portuguese variety are illustrated by the graphs in Fig. 3, showing that the summer period is the most receptive followed by the autumn period. On the other hand, the winter-spring period is almost negligible or zero. Indeed, the maximum number of eggs (80 eggs) is recorded on (3/6/2003). It was noted on (13/7/2003) 50 larvae of the first stage (L1) and 49 larvae of the second stage (L2). It was reported (13/6/2003) 67 larvae of the third stage (L3) and (3/8/2003) it was noted the presence of 35 pre-nymphs and 52 pupae.




Larva 1 (L1)
Effectifs
0
10
20
30
40
50
60
03/11/2002
03/12/2002
03/01/2003
03/02/2003
03/03/2003
03/04/2003
03/05/2003
03/06/2003
03/07/2003
03/08/2003
03/09/2003
03/10/2003
Dates


Larva 2 (L2)
Effectifs
0
10
20
30
40
50
60
03/11/2002
03/12/2002
03/01/2003
03/02/2003
03/03/2003
03/04/2003
03/05/2003
03/06/2003
03/07/2003
03/08/2003
03/09/2003
03/10/2003
Dates


Larva 3 (L3)
Effectifs
0
10
20
30
40
50
60
70
80
03/11/2002
03/12/2002
03/01/2003
03/02/2003
03/03/2003
03/04/2003
03/05/2003
03/06/2003
03/07/2003
03/08/2003
03/09/2003
03/10/2003
Dates


Pre-nymphs
Effectifs
0
5
10
15
20
25
30
35
40
03/11/2002
03/12/2002
03/01/2003
03/02/2003
03/03/2003
03/04/2003
03/05/2003
03/06/2003
03/07/2003
03/08/2003
03/09/2003
03/10/2003
Dates

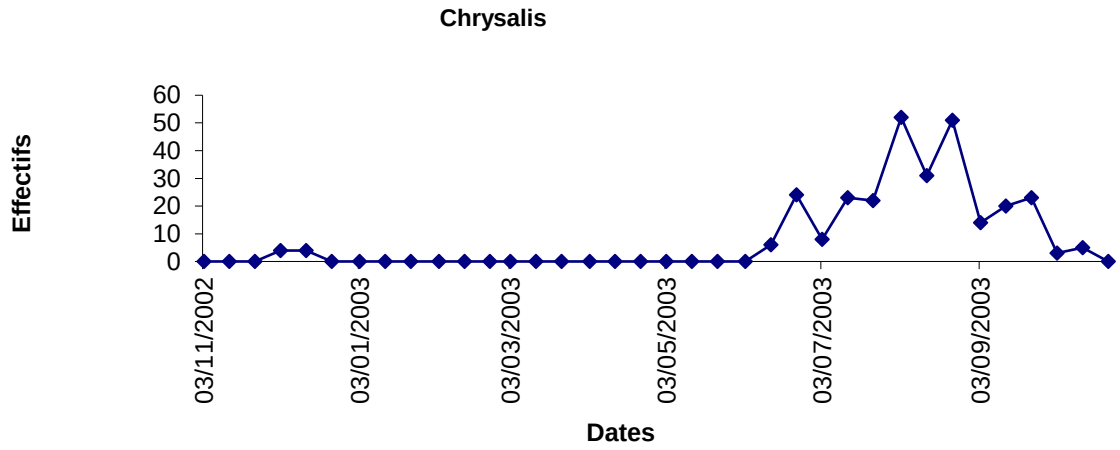


Fig. 3: Fluctuation of the different stages of *Phyllocnistis citrella* on the Portuguese variety

According to the results of the study of the fluctuations of the different stages of the leafminer for the three varieties (Washington navel, Clementine and Portuguese), the activity of *Phyllocnistis citrella* is characterized by two distinct periods. The first period coincides with the second sap thrust (summer thrust) and the third sap thrust (autumn thrust), where the climatic conditions are favorable and the presence of the tender leaves. A second winter-spring period when the miner's activity is negligible to zero. This can be justified by the fall in temperatures and the scarcity of young leaves.

The results are consistent with those of [1, 17, 18 and 10] which report that the leafminer is active in summer and autumn.

2- Parasitic incidence: The rate of parasitism compared in populations of Phyllocnistis citrella:

Like all insects, the citrus leaf miner is subject to a number of abiotic and biotic factors that play a role in regulating the size of its populations. Abiotic factors are largely related to climatic conditions: temperature, humidity, wind and rainfall. These climatic hazards are likely to cause a high mortality of the populations of the insect, particularly the larval stage. Pre-nymphs and pupae, protected by their cocoons, are less exposed to these environmental factors throughout the year. Among the biotic factors, *Phyllocnistis citrella* is attacked by a number of natural enemies, especially entomoparasites.

- Case of the variety Washington navel:

The results are shown in Fig. 4. The results are illustrated in Fig. 4 shows that the action of the parasitic procession is felt more in the third larval stage (L3) where the rate of parasitism is 55%.

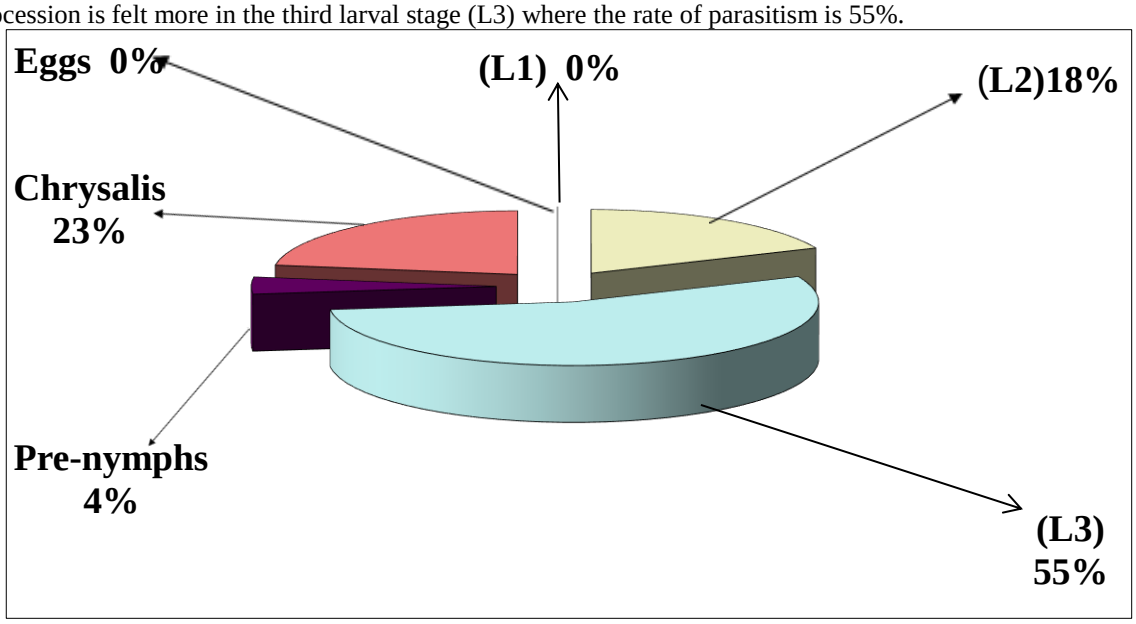


Fig. 4: Comparative parasitism rate in populations of *Phyllocnistis citrella* on the variety Washington navel

- *Case of the Clementine variety:*

The results are shown in Fig. 5.

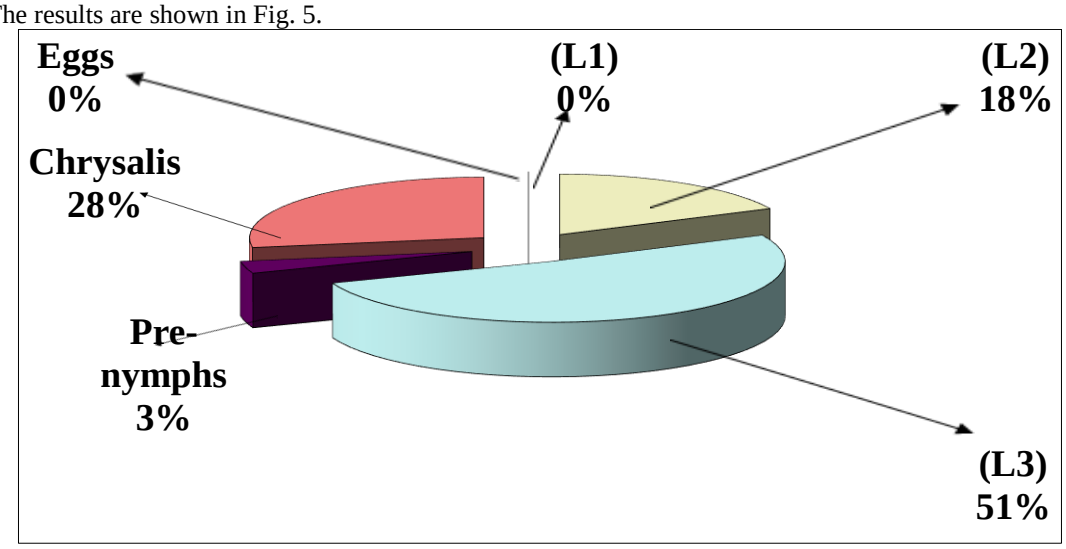


Fig. 5: Comparative parasitism rate in populations of *Phyllocnistis citrella* on the Clementine variety

From the results obtained, we notice that the parasitic procession is more felt in the third stage larvae (L3) with a rate of 51%, the larvae of the second stage (L2) are parasitized to 18%, the pupae are parasitized at 28% and pre-nymphs at 3% (Fig. 5).

- *Case of the Portuguese variety:*

The results are shown in Fig. 6. The results of the illustration in fig. 6 show that the parasitic procession is also more felt in the third larval stage (L3), where the rate of parasitism is 43%, the larvae of the second stage (L2) are parasitized to 23%, the pupae are parasitized 20% and pre-nymphs at 14%.

From the results obtained, for the variety Washington navel it is remarkable that the action of the parasitic cortège is more felt in the third larval stage (L3) where the rate of parasitism is 55%. The larvae of the second larval stage (L2) are parasitized at 19%, the pupae are parasitized at 23% and the pre-nymphs at 4.30% (Fig. 4). Therefore, the impact of parasites on populations of *Phyllocnistis citrella* varies from region to region. Indeed, in Rélizane the L3 stage is parasitized at 39.72%, the pre-nymph at 32.92% and the pupae at 31.36% [10]. In Mexico the L3 stage is parasitized at 66%, the pre-nymph at 17% and the pupa at 10.6% [25].

On orange trees, third-instar larvae were parasitized at 56% in 1996, 82% in 1997 and 78% in 1998. Pre-nymphs and pupae were respectively parasitized at 29% and 15% in 1996 at 15% and 3% in 1997 and 7% and 11% in 1998 [18].

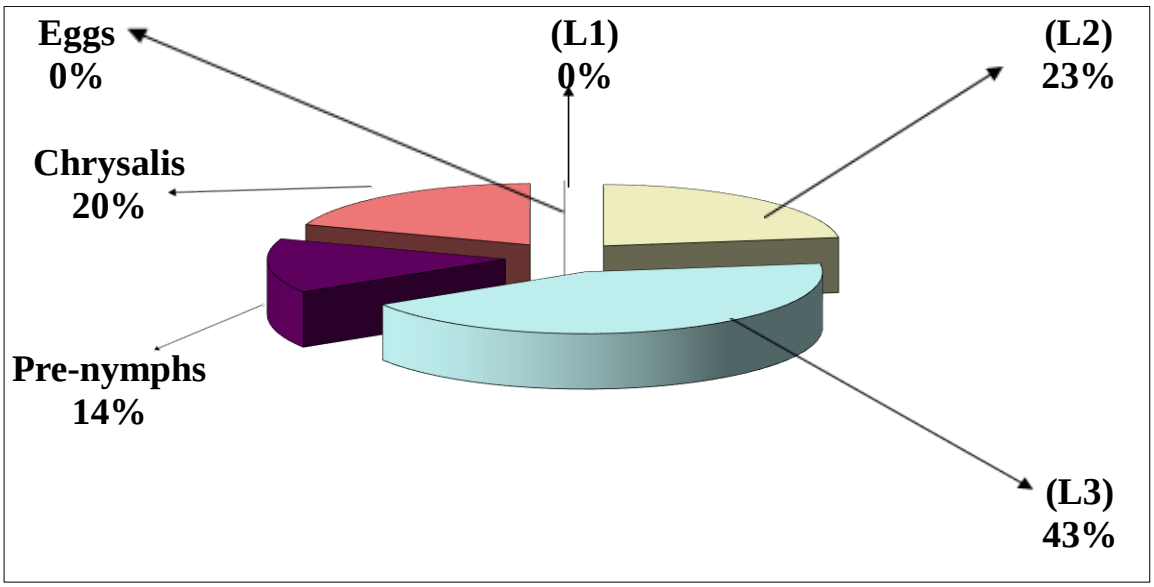


Fig. 6: Comparative parasitism rate in populations of *Phyllocnistis citrella* on the Portuguese variety

Conclusion:

Based on the data collected from the sampling, it appears that the miner's activity is characterized by two distinct periods. The first summer-autumn, where the climatic conditions are favorable and the presence of the leaves tender. The second phase corresponds to the winter-spring period when the miner's activity is negligible to zero. This is justified by the fall in temperature and the rarity of the tender leaves. Parasitism seems to be a future solution against *Phyllocnistis citrella* and that biological control remains the only alternative. And to strengthen the activity of local auxiliaries, it would first of all be necessary to breed and release large numbers of *Semielacher petiolatus* and *Citrostichus phyllocnistoïdes*.

ACKNOWLEDGEMENTS

I want to thank all those of the Department of Agricultural and Forestry Zoology, teachers and students who have participated in this work for their help and encouragement.

Subject Contributions to knowledge:

The use of parasitoids in biological control is considered one of the most popular control strategies to regulate populations of *Phyllocnistis citrella* and to protect the ecosystem from residues due to abusive and unreasonable chemical treatments. For the use of parasitoids it is necessary to breed in greenhouses for exotic parasitoids such as *Semielacher petiolatus* and *Citrostichus phyllocnistoïdes*, introduced species from Australia which showed very good performances and appreciable acclimatization in order to make releases at Level of the citrus growing areas with the appearance of the second and third thrust of sap.

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