

# Role of *Aphytis lepidosaphes* Compere, 1955 (Hymenoptera Aphelinidae) in limiting *Lepidosaphes beckii* (Newman, 1869) (Homoptera Diaspididae) populations in an orange orchard in Rouiba (Algeria)

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## ABSTRACT

This work highlights the study of *Lepidosaphes beckii* (Newman, 1869) (Homoptera Diaspididae) population dynamics as well as the impact of its external parasite *Aphytis lepidosaphes* Compere, 1955 (Hymenoptera Aphelinidae) in an orange orchard in Rouiba (Algeria). A year period study shows that *L. beckii* has three generations per year: the first is the autumnal generation; the second is through the spring and the third throughout summer. Moreover, this cochineal presents a very strong affinity for the central part of the trees and the lower side of the tree leaves which offers optimal conditions for its development. *Aphytis lepidosaphes* also develops three generations per year: in autumn, spring and summer, matching perfectly the three generations of its host. The parasite can be found where its host is abundant (plentiful). The global parasitism rate records is 22.54% for *L. beckii*, this rate remains weak to control the cochineal populations.

## KEY WORDS

*Aphytis lepidosaphes*; *Citrus*; *Lepidosaphes beckii*; Parasitic incidence; Parasitoid.

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## INTRODUCTION

The Insecta belongs to the Coccoidea superfamily, which is divided into 23 families and 7700 species (Sforza, 2008) distributed throughout the world and more particularly in the southern hemisphere. These species are not all crop pests. Some are used in the daily life of humans and considered useful insects (Kreiter et al., 1998). However, three families cause major economic damage in the world: Coccidae, formerly known as lecanines, Pseudococcidae or mealybugs and Diaspididae or shielded mealybugs or diaspines. *Lepidosaphes beckii* (Newman, 1869) (Homoptera Diaspididae)

constitute the most important pest of citrus fruits in Algeria. This insect is also considered a major pest of citrus in South Africa and Spain (Ben-Dov et al., 2014).

Indeed, biological control has very quickly been an effective way to fight mealybugs. It is one of the most effective given the sedentary nature of these pests (Foldi, 2003). In many geographical areas, the ectoparasitoid *Aphytis lepidosaphes* Compere, 1955 (Hymenoptera Aphelinidae) is reported as the most effective, natural enemy of *L. beckii*. In Florida, the parasitoid effectively controls cochineal populations at a parasitism rate of 50% (Stathas et al., 2015). The number of females in the parasite usu-

ally exceeds that of males (Waterhouse & Sands, 2001).

The study of this parasite allows us to have the opportunity to fight against this pest in order to improve yields and ensure a place among citrus producing countries.

## MATERIAL AND METHODS

The study is conducted on a private farm in the Rouiba region (36°44'00" N and 3°17'00" E). This region is located East of Mitidja 25 km from Algiers and 7 km from the Mediterranean Sea. This experiment started at the beginning of November 2014 and ended in August 2015.

The study orchard has an area of 1.5 ha consisting of 425 orange trees of Washingtonia variety navel planted in 1990. The procedure requires regular sampling over time. The method used is inspired by the work of Vasseur & Schvester (1957). It consists of choosing 2 trees from which are taken 1 branch of 20 cm long and 2 leaves from each cardinal direction (North, South, East and West) and in the center of the tree. Then, these samples are placed differently in kraft paper bags on which all coordinates are mentioned (date, direction, etc.).

The twigs and leaves harvested are carefully examined under a binocular loupe. The different biological states of the mealybug are quantified and recorded on cards bearing the date of the release and the direction of sampling. For each stage we quantify the total number of live, dead and parasitized *L. beckii* individuals in order to assess the state of infestations and the evolution of its parasite *A. lepidosaphes* over time.

## RESULTS AND DISCUSSION

### *Overall evolution*

An overall examination of the fluctuations of the mealybug populations reveals the presence of three periods of intense activity: an autumnal period, a spring season and a summer season. The most important peaks are recorded during the spring and summer period. However, there are three very distinct peaks: the first peak at the beginning of January (10.02%), the second during the month of

March (20.53%) and the last during the month of June (27.97 %) (Fig. 1).

The results obtained on the population dynamics of *L. beckii* during the period from 1 November 2014 to 10 August 2015 confirm the existence of three annual generations: an autumn generation, a spring generation and a summer generation. Zuniga (1971) reported three annual generations in northern Chile, two to three generations per year in the central region and only one annual generation in the southern region. On the other hand, in the Eastern Cape in South Africa, De Villiers (1998) reports four generations annually and Smirnoff (1960) found four generations a year in Morocco. The majority of authors agree to count from 2 to 5 generations, this figure varies according to the region's climate conditions chosen for the study and the smallest number of generation is observed in the countries where the rigor of the winter imposes a stoppage of development (Benassy, 1975).

### *Cardinal distribution*

The results of figure 2 shows that the center orientation is most favored by this scale with a percentage of 35.99%. This place seems to be a preferential place for this cochineal. Indeed, according to Fabres (1979), the influence of the thermohygrometric conditions of the shaded habitat on the rate of expansion of the cochineal are very favorable to the cochineal. The East of the tree comes in second place hosting 24.25% of the global population of the cochineal.

The spatial distribution of this species on the tree is closely related to the microclimate created within the tree. Moreover, the species have a marked preference for the center orientation of the tree. This place seems to give it favorable conditions for its optimal development. Moreover, this species shows in a remarkable way the lower face of the leaf.

### *Distribution according to the plant organ*

The results reported in figure 3 show that the cochineal prefers to attach to the leaves and precisely on the underside with 46.32% against 41.17% on the upper face. This place offers cochineal favorable fixation conditions. Indeed, the blade of the leaf is of a very fine texture favoring

the bites of opophagous insects. Avidov & Harpaz (1969) noted that this cochineal prefers trees with thick foliage and settles more on leaves and fruits than on young branches. According to Fabres (1979), for the *L. beckii* scale, the leaves are the organs of choice.

**Ecology of *Aphytis lepidosaphes***

We counted 99 eggs of the parasite throughout our study period. At the beginning of our sampling, eggs accounted for 30.16% of the global parasite population during the month of November. From this date, there is a gradual regression of eggs to disappear almost entirely during the winter period. As soon as atmospheric conditions become favorable again, we can see a recovery of the egg-laying, as it already is 3.85% as of February. Subsequently, the number of eggs gradually increases to 22.22% during the month of May and then decreases during the month of June. The oviposition of the parasite is once again taking place in August with 23.91% (Fig. 4). In general, it is very rare to observe the eggs of *A. lepidosaphes*. Benassy (1961) reports that all *Aphytis* Howard, 1900 pierce the host's shield to deposit their eggs. This limitation is probably due to the difficulty of piercing the shield of some mealybugs.

The larvae of *A. lepidosaphes* are represented by young larvae and older larvae. Concerning the fluctuations of the young larvae, we note the presence of three peaks of populations: the first peak in November (44.44%), the second in April (15.07%) and the third in August (26.09%) (Fig. 5). For older larvae, their rate varies between 88.46% and 100% during the month of December to February. Note that this stage represents the wintering stage of the parasitoid. From the beginning of April, there is a new increase of these larvae in the cochineal populations, and they reach their maximum in June with 48.24%. From this date, their number will decrease more and more to reach their lowest rate during the month of August with 2.17% (Fig. 6).

At the beginning of our sampling, nymphs are rarely present in cochineal populations. Indeed, they display only 7.94% during the month of November to disappear then completely the whole winter period. It is only from the month of February that they appear in the populations of its host where they display at this date 7.69% of the global population of

the parasitoid. The highest rate is noted during the month of March with 44.11%. There is then a gradual decrease in numbers of these larvae to reach their lowest level during the month of June. A new evolution is then noticed and a new peak is noted during the month of August with 45.65% (Fig. 7).

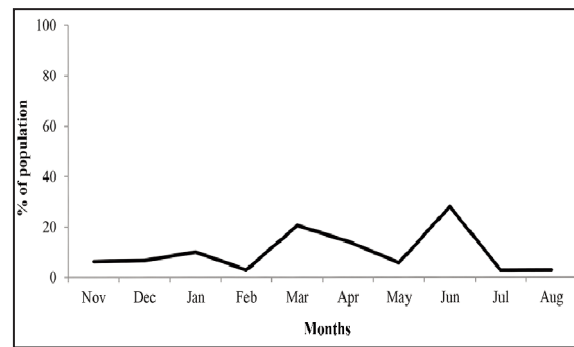


Figure 1. The Overall Fluctuation of *L. beckii* populations on orange trees in the Rouiba region.

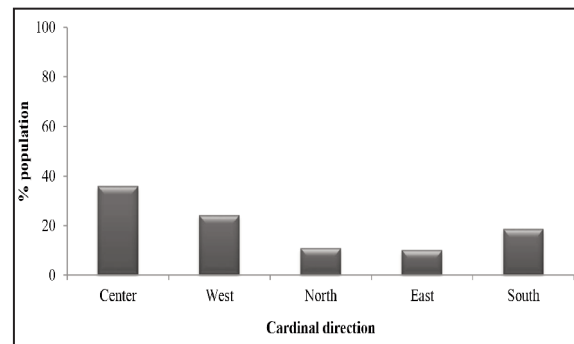


Figure 2. The global Cardinal distribution of *L. beckii* on orange trees in Rouiba region.

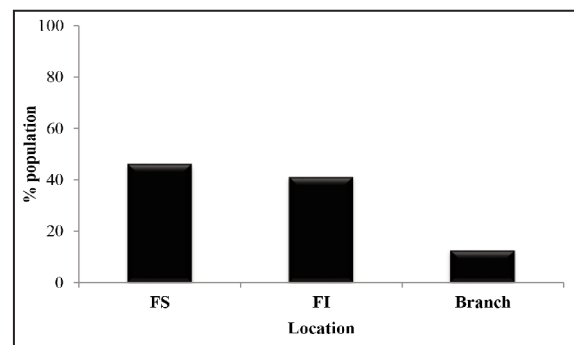


Figure 3. Distribution of the global population of *L. beckii* on orange trees in Rouiba.

Once mature, these adults perforate the mealybug shield and search for their hosts to lay their eggs. It is interesting to note that during our observations we counted up to three parasite individuals on the same host, so this parasite is considered a gregarious ectoparasite. When counting, we did not observe adult *A. lepidosaphes*. The highest percentages are noted during the spring period. Indeed, we note a percentage of 17.54% during the month of March. There is a significant presence thereafter from April to August (Fig. 8).

### Parasitic incidence

The overall parasitism rate in *L. beckii* fluctuates throughout the study period and is around 22.54%. However, this parasitism rate remains very low to control populations of *A. lepidosaphes*. The parasitism rate fluctuations recorded in the insect scale population first pass through a first peak

during the month of March with a rate of 33.39% and the second peak in June with a parasitism rate of 28.58% (Fig. 9). Two-way analysis of variance showed that time (months) and orientation had a very highly significant effect on population dynamics and parasite incidence of *L. beckii* ( $P = 0.0001 < 0.001$ ) with 80.2% of variations in dynamics and 92.6% of variations in parasite incidence. Also, two-way analysis of variance showed that time (month) and organ have a very highly significant effect on population dynamics and parasite incidence of *L. beckii* ( $P = 0.0001 < 0.001$ ) with 82.4% of changes in dynamics and 98.4% of variations in parasite incidence. As for the parasite incidence, the results show that the rate of parasitism in *L. beckii* has improved compared to last year (22.54%). *Aphytis lepidosaphes* and *Encarsia* sp. (Hymenoptera Aphelinidae) have together parasitized up to 32% of *L. beckii* (Stathas et al., 2015). The parasite is located much more where the cochineal is in large numbers.

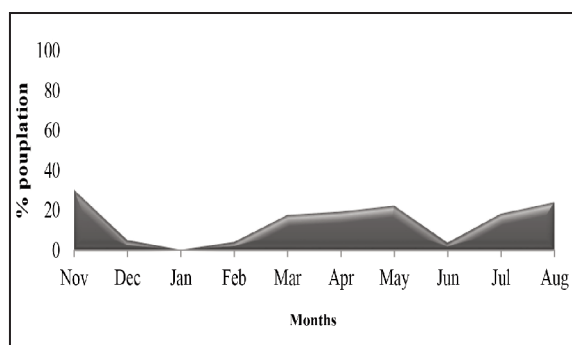


Figure 4. Fluctuation of eggs of *A. lepidosaphes* on *L. beckii* populations on orange trees in Rouiba.

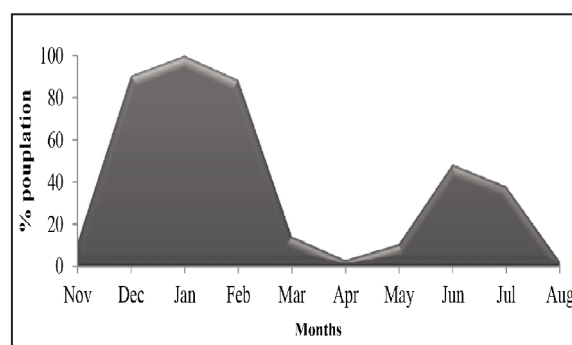


Figure 6. Fluctuation of older larvae of *A. lepidosaphes* in the populations of *L. beckii* on orange trees in Rouiba.

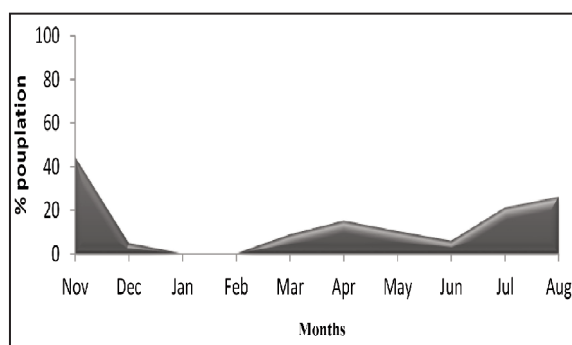


Figure 5. Fluctuation of young larvae of *A. lepidosaphes* in the populations of *L. beckii* on orange trees in Rouiba.

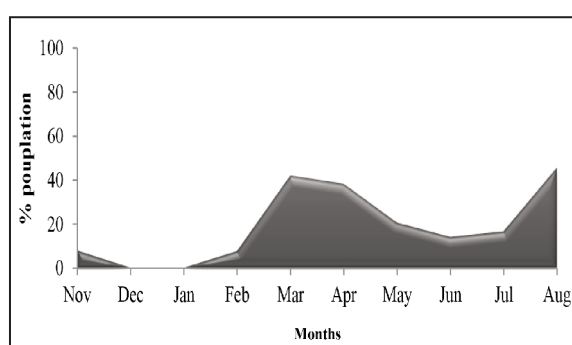


Figure 7. Fluctuation of nymphs of *A. lepidosaphes* in the populations of *L. beckii* on orange trees in Rouiba.

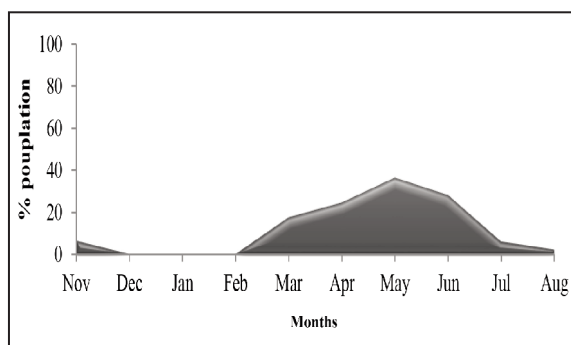


Figure 8. Fluctuation of adults of *A. lepidosaphes* in the populations of *L. beckii* on orange trees in Rouiba.

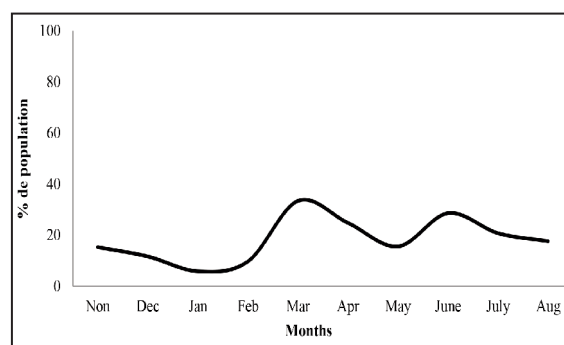


Figure 9. Impact of the global parasitism of *A. lepidosaphes* on the populations of *L. beckii* on orange trees in Rouiba.

The chemical treatments carried out in the orchard certainly contributed to limit the action of these parasites on the populations of the cochineal. Biological control methods should not be considered in isolation, but they have a chance of success in IPM strategies.

## CONCLUSIONS

The results of fluctuations of *A. lepidosaphes* show that this parasitoid overwinters in the form of older larvae in the populations of its host where it develops 3 annual generations: an autumn generation, a spring generation and a summer generation. According to Fabres (1979), in New Caledonia, this parasitoid can develop two or three generations on a generation of its host which presents a great advantage in the use of this parasite in biological control. *Aphytis lepidosaphes* shows a preference for female stages although males are also attacked but with a low impact compared to that of females. According to Belguendouz (2014) the parasite is active on all organs and has a marked preference for young females.

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