Eco. Env. & Cons. 26 (1) : 2020; pp. (333-340)
Copyright@ EM International
ISSN 0971–765X

The influence of the region and the host plant on population dynamics of *Parlatoria ziziphi* (Lucas) (Hemiptera: Diaspididae) in Mitidja (Algeria).

Khaoula Aroua[1]*, Mehmet Bora Kaydan[2], Tange Denis Achiri[3] and Mohammed Biche[1]

[1]Laboratory of Zoology, National Institute of Agronomic Sciences,16000 (Algiers, Algeria)
[2]Çukurova University, Biotechnology Application and Research Centre, Balcalý, 01330 Adana, Turkey
[3]Department of Plant Protection, Çukurova University, 01330, Adana, Turkey

(Received 6 September, 2019; accepted 15 November, 2019)

ABSTRACT

The aim of this work is to study the influence of the regions and the host plants on some bioecological aspects of the black parlatoria scale, *Parlatoria ziziphi* (Lucas) (Hemiptera: Diaspididae). The monitoring of the biological cycle of this pest was made by periodic counting of the populations on different part of the tree such as branches and leaves from January to December 2017 in the region of Rouiba [36° 432 N 3°162 E] and in the region of Oued El Alleug [36°332 N 2°472 E]. The scale insect, had three generations in a year on Clementine and *orange trees* (Citrus orange, Washington Navel) which corresponded with the three sap thrust on spring, summer, and the autumn. The three periods of activity and laying in Oued El Alleug Region started earlier compared to Rouiba Region. The average egg laid varied from 8.44 to 10.02 eggs per female on the Clementine tree and from 6.98 to 7.93 eggs per female on the orange tree. For each season, the crawlers migrated to the places that offer them favorable conditions. The analysis of the varieties showed that the workforces and the fecundity were influenced by date, variety and region. The distribution of the active larvae of the black *Parlatoria* scale was statistically significantly (P= 0.05) affected by the different cardinal directions of the plants in different seasons. The findings of this study have huge implications for *Parlatoria* scale insect control.

Key words: *Parlatoria ziziphi, Host plant, Biological cycle, Sap thrust, Climatic conditions.*

Introduction

Citrus (Rutaceae) cultivation gives a considerable economic importance for many countries. Algeria is a major citrus producing country in the Mediterranean basin. In 1960, citrus cultivation accounted for 20% of the agricultural production in the world (Mutin 1977). The Algerian citrus cultivation area covers 59,443 ha, production of 1,341,994 T and a yield of 22.39 T/ha in 2015. The low productivity is mainly due to phytosanitary problems and the impact of pests particularly the scale insects (Hemiptera: Coccomorpha). These pests occupy an important place among the most redoubtable pests in its distribution range (Demirozer *et al.,* 2009). These scale insects have been considered as a serious pest involving a large number of plants around the world. (Miller *et al.* 2002; Miller 2005; Kondo *et al.* 2008; Franco *et al.* 2009; Mazzeo *et al.* 2014). The Diaspididae constitute a special family of

***Corresponding author's email:** arouakhaoula@gmail.com

Coccomorpha infra order with 2595 spices described (García Morales *et al.*, 2018). They are among the most invasive insects in the world (Andersen 2009 and Anderson, 2010). These pests do not produce honeydew (Henderson, 2011). Most of them are biparental and the coupling is very necessary for the eggs production (Miller and Davidson, 2005).

In Algeria, the infections and the ravages on the various hosts are caused mainly by diaspidid on all the northern bands of Algeria (Biche, 2012) and in the world (Cahuzac, 1986) on many fruits and forest trees thus weakening the trees. However, the host plant is considered as a true ecological factor that intervenes essentially in the modification of certain biological parameters of the insect (Biche and Sellami, 1999; Chafaa *et al.* 2013). Its influence on the scale insect is revealed by an elevated mortality, a lengthening of the duration of the development and by modifications of its fecundity that is according to the variety of the host plant and its physiological state (Biche, 1987).

Parlatoria Targioni-Tozzetti, genus is an important group from the Diaspididae and it is composed of 73 species (García Morales *et al.*, 2018). In recent years, a recrudescence of the black parlatoria scale has presented severe infections on the most citrus plants including the lemon tree, the bitter orange tree, the clementine tree and the orange tree, where the degree of attack is the same on the leaves as on the branches and the fruits.

The aim of this work was to study the parlatoria scale insect, which has both a qualitative and quantitative impact on fruits, its epidemiology, dynamics and reproductive biology on Clementine and orange in Rouiba and Oued El Alleug for two years to be able to improve control and interventions.

Materials and Methods

Study site

This work was carried out in two survey sites in eastern and western Mitidja. The first is a private farm (agricultural exploitation) located in the commune of Rouiba [36°432N 3°162E], located 7 km from the Mediterranean and at an altitude of 17 m. The second is also a farm located in the commune of Oued El Alleug [36°332N 2°472E]. It is at an altitude of 54 m. Both sites contain several varieties of citrus. This experimentation was conducted in a clementine and orange orchard (Figure 1).

Sampling and counting

The study started at the beginning of December 2015 and ended in December 2017. The method used was that of Vasseur and Schvester (1957). The sampling was done three times per month, that is to

Figure 1. Localization of the studied field in Mitidja (Algeria).

say every 10 days (a total of 36 outings per year). The survey orchards were divided into 9 plots of 24 trees for each one (a total of 216 trees). For each survey, 2 trees were taken randomly from each sample plot; a total of 18 trees were sampled. Two branches of 20 cm of length and two leaves at the height of man for each cardinal direction and on the center of the tree were taken. The samples were placed in Kraft paper bags on which we mention all the sampling information (date, variety, direction and region).

In the laboratory, the counting method consists of recognizing and counting under the binocular magnifying glass of the different stages of development of the insect scale on both sides of the leaves as well as on the branch for each cardinal direction. On the sampling cards the number of living individuals of each stage, as well as the number of eggs laid per female were noted. Seasonal and climatic parameters were also recorded.

Data exploitation and statistical analysis

The data were submitted to the various statistical analyses to study the dynamics of the total population of *P. ziziphi* on clementine and orange trees in the region of Rouiba and Oued El Alleug.

Fecundity (F) of *P. ziziphi* and the seasonal distribution (D) of crawler according to orientations were calculated using the following expressions:

$$F = \frac{\text{Number of eggs laid}}{\text{Number of females}}$$

$$D = \frac{\text{Number of mobile larvae of each orientation of the black parlatoria scale}}{\text{Total number of mobile largae}} \times 100$$

A one-way analysis of variance (ANOVA) was conducted to compare the effect of cardinal direction on the distribution of *P. ziziphi* in different seasons. Where there was statistically significant differences at $p<0.05$, Duncan's Multiple range Test (DMRT) was used to separate the means. SPSS (version 23) was used for the analysis.

Results

Spatial distribution of *P. ziziphi*

The population counts results of *P. ziziphi* (Figures 2 and 3) distinguish three periods of intense activity per year: one vernal, estival, and autumnal on both citrus varieties in both study areas. They practically coincided with the three thrusts of sap. The first had a larger number and lasted about five months. The second one with less important numbers and lasted about four months. On the other hand the third only lasted two months with smaller numbers. Adult females were present throughout the study period with overall percentages greater than 54% on both host plants at both sites. Overwintering of the black *Parlatoria* scale was exclusively in the form of adult females. It should be noted that the black *Parlatoria* scale behaved differently depending on the region. Indeed we notice a shift in the development of *P. ziziphi* populations. The three periods of activity in Oued El Alleug began a little late compared to those of Rouïba. On the clementine (Figure 2), there was a shift of 30 days (in 2016), 33 days (in 2017) for the first generation, 20 days (in 2016), 12 days (in 2017) for the second and 12 days (in 2016), 23 days (in 2017) for the third. However, the first generation in Rouïba began in February coinciding with the first sap thrust and ended at the beginning of June. The second generation started at the beginning of July and ended around the end of September. The third began in the second decade of October and ended in late December. But in Oued El Alleug, the first generation began during the third decade of February and ended in early June. While the second generation began in early June and ended in early October. The third generation, it began during the second decade of October and ended at the end of December.

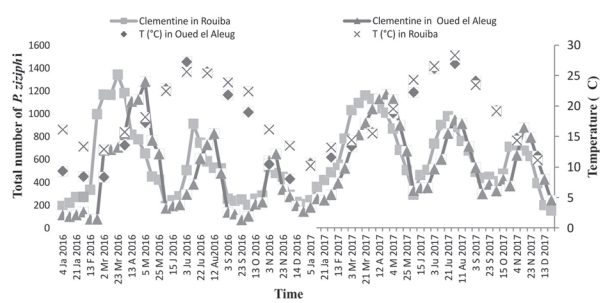

Fig. 2. Fluctuation of the numbers of the total population of *P. ziziphi* on the clementine in Rouiba and Oued Alleug from January 2016 to December 2017.

On the orange tree (Figure 3), there was a shift of 21 days (in 2016), 41days (in 2017) for the first generation and the second generation and 13 days, 23 days (in 2017) for the third generation. The total temporal variations in the two sites also showed three generations of populations. The first started

around the first decade of February and ended in early June in both sites. On the other hand, the second generation started during the second decade of June and ended at the beginning of September in Rouiba. While at Oued El Alleug, it started towards the end of June and ended at the end of September. The third began at the beginning of September in Rouiba and at the end of this month at Oued El Alleug and ended at the end of December.

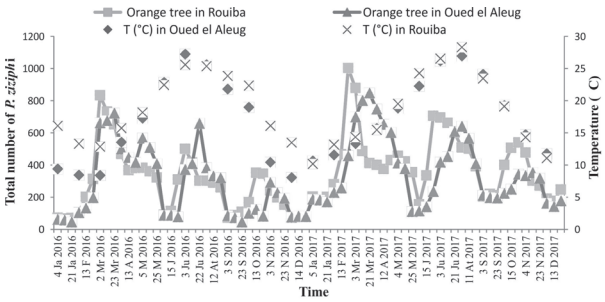

Fig. 3. Fluctuation of the numbers of the total population of *P. ziziphi* on the orange in Rouiba and Oued Alleug from January 2016 to December 2017.

Fecundity

The fecundity study showed that egg laying at Oued El Alleug started a little late compared with Rouiba (Figures 4 and 5). However, the average fecundity goes through three laying periods that coincided with the three thrusts of sap for both years. The first generation has larger egg-laying averages and lasted more than five months, from February until June. An estival spawn and another autumnal with less number of eggs was noticed. On the clementine tree (Figure 4), for the first laying period, we noted a shift of 24 days (in 2016) and 29 days (in 2017), for the second a shift of 10 days (in 2016) and 18 days (in 2017) and for the third period a shift of 11 days (in 2016) and 18 days (in 2017). The overall

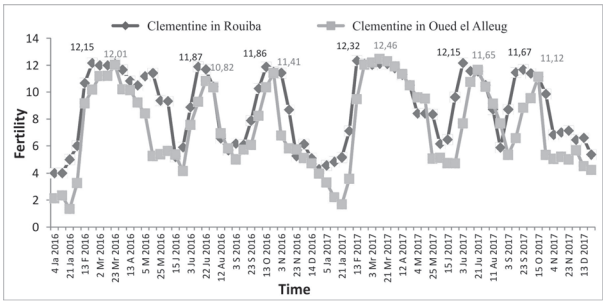

Fig. 4. Average fertility of *P. ziziphi* on the Clementine in Rouiba and Oued Alleug from January 2016 to December 2017.

average of fecundity was about 9.93 eggs per female (in 2016), 10.02 eggs per female (in 2017) in Rouiba and about 8.44 eggs per female and 9.06 eggs per female (in 2017) in Oued El Alleug. We observed an average values of fecundity ranging from 4 (in winter) to 12.32 eggs per female (in spring) in Rouïba whereas in Oued Alleug it varied from 1.33 (in winter) to 12.46 eggs per female (in the spring).

On the orange tree (Figure 5), we noted a shift of 24 days (in 2016), 18 days (in 2017) for the first laying period, 8 days (in 2016), 19 days (in 2017) for the second and 11 days (in 2016), 21 days (in 2017) for the third period. The overall average of spawning in Rouiba was 7.81 eggs per female (in 2016), 6.98 eggs per female (in 2017) and in Oued El Alleug it is 7.93 eggs per females (in 2016), 7.72 eggs per female (in 2017). That's mean the values of fecundity range from 0 (in winter) to 11.48 eggs per female (in spring) in Rouïba while in Oued Alleug, it varied from 0 (in winter) to 11.44 eggs per female (in summer).

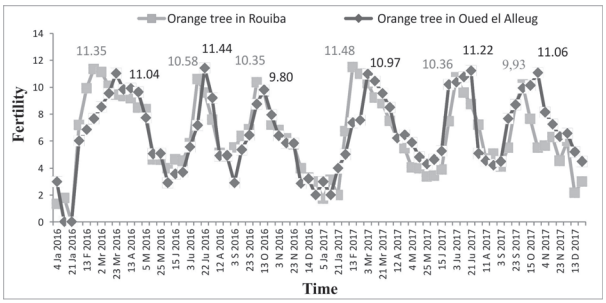

Fig. 5. Average fertility of *P. ziziphi* on the orange in Rouiba and Oued Alleug from January 2016 to December 2017.

Seasonal distribution of mobile larvae according to the cardinal orientations

The seasonal distribution of mobile larvae of *P. ziziphi* according to the orientations shows an identical behavior on both varieties, in both study sites and in both years (Figure 6).

In autumn, the center of the tree was the most desirable location for mobile larvae for fixing with a percentage greater than 41% on both host plants and at both sites. In winter, about 43% of the population continued to migrate to the center of the tree and low percentages on other orientations. In the spring, when climatic conditions became more favorable, the mobile larvae migrated to the east of the tree to record percentages greater than 35% followed by the center. In summer, the estival population contin-

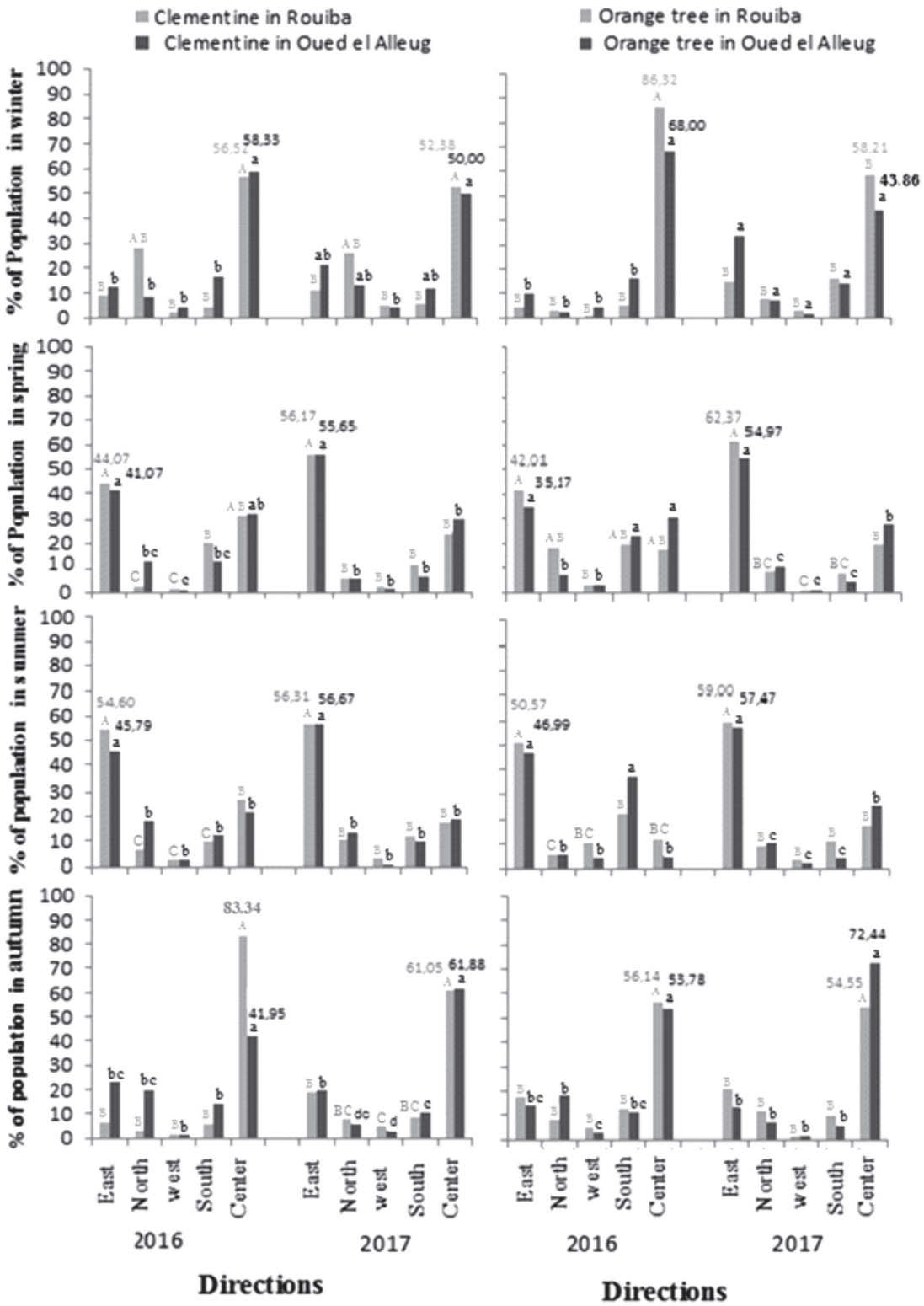

Fig. 6. Seasonal distribution of the active larvae of *P. ziziphi* on the Clementine and the orange according to orientations in Rouiba and Oued Alleug (Algiers). Bars with the same letter(s) on the same plant/season/location/year are not statistically significantly different by DMRT (P = 0.05)

ued its migration towards the east of the tree to mark a percentage that exceeds 45% followed by the center in the region of Rouiba and by the south in the region of Oued El Alleug.

Furthermore, ANOVA analyses revealed that the cardinal directions of the tree statistically significantly (P = 0.05) influenced the distribution of the mobile larvae of the black *Parlatoria* scale insects on both plants, in both regions and in both years of the study. In the winter, the insects significantly (P = 0.05) preferred the center, followed by the North directions of the trees. The spring season showed a migration pattern of the *Parlatoria* scale insects from the center to the east. Although the population was not statistically significantly different between the center and the east in 2016 for spring season, it was in 2017, in both regions and for both plants. A similar trend to that in the spring was observed in the summer. In autumn, the insects migrated again to the center of the plants.

Discussion

The monitoring of *P. ziziphi* during the phenological cycle of clementine and orange trees in the region of Rouiba and Oued El Alleug revealed three generations per year : a spring, a summer and an autumnal. This corresponds perfectly to the three thrusts of sap, the main one of which is that of spring because it generates larger numbers, and lasts about five months. According to Praloran (1971), in Egypt, the biology of black parlatoria scale has been studied mainly, it has between 2 to 3 generations per year [Salama et al. (1985): 3 generations per year; Amin and Salem (1978); Sweilem *et al*. 1984 El Bolok et al. (1987): 2 generations per year]. In Algeria, the insect scale is polyvoltine and all generations are overlapping (Biche 2012). For the same study area this insect develops 3 generations and the spring period is the most favorable season and the most propitious for this insect scale (Belguendouz 2011; Takarli *et al*. 2015).

The three periods of the activity and egg laying in Oued El Alleug started a little late compared with the region of Rouiba. This lag in the development of the insect populations depends on nutritional and local climatic conditions. Similarly, this shift is conditioned by the phenological state of the host plant (moment of the thrust of sap). We can say that the noticed shift could be due to the presence of an offset at the level of the thrust of sap under the direct influence of the distance of the littoral.

Concerning the preferential plant, the insect scale preferred to develop much more on the clementine tree than the orange tree. Praloran (1971) and Benassy (1975) also reported that *P. ziziphi* has a strong affinity for mandarin and clementine trees than for the lemon tree. The same findings were reported by Belguendouz (2011) too.

From the point of view of evolution, *P. ziziphi* has three spawning periods: spring, summer and autumn. Spring remains the most favorable season in the reproduction of the species. On the clementine tree, the overall average of egg-laying was about 9.85 eggs per female in Rouiba and about 8.30 eggs per female in Oued El Alleug. According to Smirnoff (1950), Chapot and Delluchi (1964), and Praloran (1971), the average fecundity of *P. ziziphi* greatly exceeds 10 eggs per female in a natural habitat. The results obtained from the study of the seasonal distribution of mobile larvae of *P. ziziphi* according to the orientations showed an identical behavior on both citrus varieties in the two study sites. For each season, the mobile larvae migrate to the places that offer them the favorable conditions. According to Takarli *et al*. (2015), the center of the tree is the most favorable place for the development of the insect scale. For all seasons, the west orientations remained the least sought. The center of the trees gave the insect the best microclimatic conditions for its development. This implies that effective and efficient control of the *Parlatoria* scale insect in the winter and summer requires careful application of insecticides in the center and east parts of the tree respectively.

References

Amin, A. H. and Salem, Y. S. 1978. Population studies on the scale insect species, *Parlatoria zizyphus* (Lucas), a new pest of citrus trees in Egypt (Homoptera: Coccoidea: Diaspididae). *Proceedings of the Fourth Conference of Pest Controle*, September 30 – October 3, cairo, Egypt, Part I, pp. 40-48. Google Scholar: http://agris.fao.org/agris-search/search.do?recordID=EG19790454882.

Google Scholar: http://agris.fao.org/agris-search/search.do?recordID=EG19790454882

Andersen, J. C. 2009. A phylogenetic analysis of armored scale insects, based upon nuclear, mitochondrial, and endosymbiont gene sequences. University of Massachusetts Amherst, 66 pp. https://scholarworks.umass.edu/theses.

Andersen, J. C., Wu J., Gruwell, M. E., Morse, G. E., Santana, S., Feliciano, N., Gwiazdowski, B. B. and Normark, R. A. 2010. A phylogenetic analysis of armored scale insects, based up on nuclear, mitochondrial, and endosymbiont gene sequences. *Molecular Phylogenetics and Evolution*. 57: 992–1003. 10.1016/j.ympev.2010.05.002. Google Scholar: https://www.sciencedirect.com/science/article/pii/S1055790310002095

Belguendouz, R., Biche, M., Bekkouche, S. and Louz, S. 2011. The impact of *Parlatoria ziziphi* infestations on physicochimical quality of citrus fruits «Case of the clementine variety: Citrus reticulata» in Mitidja (Boufarik, Algerie). *Integrated Control in Citrus Fruit Crops IOBC/wprs Bull.* 62 : 137-142. https://www.researchgate.net/publication/281375752.

Benassy, C. 1975. Les cochenilles des agrumes dans le bassin méditerranéen. *Ann. Inst. Nat. Agron., El Harrach.* 6 : 118-142. Google Scholar: https://www.asjp.cerist.dz/en/downArticle/12/5/6/13592

Biche, M. 1987. Bioécologie de *P. oleae* Colvée (Hom. Diaspididae) ravageur de l'olivier, *O. europaea* L., dans la région de Cap-Djinet (Algérie) et étude biologique de son parasite externe *A. maculicornis* Masi (Hym. Aphelinidae). *Ann. Inst. Nat. Agron., El Harrach.* 98 :23-27. http://scholar.google.com/scholar?cluster=4857415837391559437&hl=en&oi=scholarr

Biche, M. 2012. Les principaux insectes ravageurs des agrumes en Algérie et leurs ennemis naturels. Ed. FAO., Regional Integrated Pest Management Programme in the Near East / GTFS/REM/070/ITA. 36p. http://scholar.google.com/scholar?cluster=17259889129360213699&hl=en&oi=scholarr

Biche, M. and Sellami, M. 1999. Etude de quelques variations biologiques possibles chez *Parlatoria oleae* (Colvée) (Hom.Diaspididae). *Bull. Soc. Entomol. Fr.* 104(3) : 287-292.

Cahuzac, D. 1986. Les cochenilles des ligneux d'ornement. *Rev. Phytoma.* 383 : 37-38. http://scholar.google.com/scholar?cluster=16064219903253930691&hl=en&oi=scholarr

Chafaa, S., Biche, M., Chenchouni, H., Sellami, M. and Si Bachir, A. 2013. Effet du climat et de l'exposition sur la dynamique des populations de la cochenille violette, *Parlatoria oleae* Colvée (Hemiptera: Diaspididae), en conditions arides. *Ann. Soc. Entomol. Fr.,* (n.s.). 49 : 291-297. https://doi.org/10.1080/00379271.2013.856203

Chapot, H. and Delluchi, V.L. 1964. Maladies troubles et ravageurs des agrumes au Maroc. Ed. Inst. Nat. Rech. Agro., Rabat. 339p.

Demirozer, O., Kaydan, M. B., Karacer, I.and Ben-Dov, Y. 2009. First records of armoured scale insects (Hemiptera: Coccoidea: Diaspididae) from the oil rose, Rosa damascena, in Turkey. *Hellenic Plant Protection Journal.* 2 : 33-35. https://www.researchgate.net/publication/286453792

El-Bolok, M. M., Sweilem, S. M. and Abdel Aleem, R. Y. 1987. Seasonal variation in the population of *Parlatoria zizyphus* (Lucas) at Giza region. *Bulletin de la société Entomologique d'egypte* (1984/85)65 : 281-288. Google Scholar: https://www.cabdirect.org/cabdirect/abstract/19880546653

Franco, J. C., Zada, A. and Mendel, Z. 2009. Novel approaches for the management of mealybug pests. In: Ishaaya I., Horowitz A.R. (eds): *Biorational Control of Arthropod Pests-Application and Resistance Management.* Dordrecht, Springer: 233–278. https://link.springer.com/chapter/10.1007/978-90-481-2316-2_10. (DOI: 10.1007/978-90-481-2316-2_10)

García Morales, M., Denno, B., Miller, D. R., Miller, G. L., Ben-Dov, Y. and Hardy, N. B. 2018. Scale Net: A Literature based model of scale insect biology and systematics. https://doi.org/10.1093/database/bav118

Henderson, R. C. 2011. Diaspididae (Insecta: Hemiptera: Coccoidea). Fauna of New Zealand 66. Manaaki Whenua Press, Lincoln, Canterbury, 275 pp. https://www.biotaxa.org/fnz/article/view/1838/0. file:///C:/Users/usthb/Downloads/1838-4058-1-SM%20(1).pdf

Kondo, T., Gullan, P. J.and Williams, D. J. 2008. Coccidology: The study of scale insects (Hemiptera: Sternorrhyncha: Coccoidea). RevistaCorpoica – Ciencia y TecnologíaAgro-pecuaria, 9: 55–61. http://www.redalyc.org/articulo.oa?id=449945025006

Mazzeo, G., Longo, S., Pellizzari, G., Porcelli, F., Suma, P.and Russo A. 2014. Exotic scale insects (Coccoidea) on ornamental plants in Italy: a never-ending story. *Acta Zoologica Bulgarica.* 6: 55–61. https://www.researchgate.net/publication/272497507.

Miller, D.R. 2005. Selected scale insect groups (Hemiptera: Coccoidea) in the southern region of the United States. *Florida Entomologist.* 88: 482–501. https://doi.org/10.1653/0015-4040(2005)88[482:SSIGHC]2.0.CO;2

Miller, D. R., Miller, G.L. and Watson, G.W. 2002. Invasive species of mealybugs (Hemiptera: Pseudococcidae) and their threat to U.S. agriculture. *Proceeding of the Entomological Society of Washington.* 104: 825–836. https://www.researchgate.net/publication/236018523.

Miller, D. R. and Davidson, J. A. 2005. *Armored Scale Insect Pests of Trees and Shrubs (Hemiptera: Diaspididae).* Cornell University Press. Ithaca, NY, 456 pp.

Mutin, G. 1977**.** La Mitidja. Décolonisation et espace géographique. Ed. OPU., Alger, 607p.

Praloran, J. C. 1971. Les Agrumes, technique agricoles et productions tropicale Ed. Maisonneuve et Larose, Paris, 565p.

Salama, H. S., Abdel- Salam, A. L., Donia, A. and Megahed, M. I. 1985. Studies on the population and distribution Pattern of *Parlatoria ziziphus* (Lucas) in citrus orchards in Egypt. *Insect Science and its Application.* 6(1) : 43-47. Google Scholar: https://www.cambridge.org/core/journals/international-journal-of-tropical-insect-science/article/studies-on-the-population-and-distribution-pattern-of-*parlatoria-zizyphus*-lucas-in-citrus-orchards-in-egypt/84483D7F78FA5BB7DAEDD8E25BEE8567

Smirnoff, W. A. 1950. La « cochenille noire » dans les cultures d'agrumes au Maroc. *Rev. Terre Marocaine.* 225: 257- 460.

Sweilem, S. M., El-Bolok, M. M. and Abdel-Aleem, R. Y. 1984. Biological studies on *Parlatoria zizyphus* (Lucas) (Homoptera – Diaspididae). *Bull. Soc. Entomol. d'Egypte.* 65 : 301-317. https://www.cabdirect.org/cabdirect/abstract/19880546655

Takarli, F., Belguendouz, R. and Benrima, A. 2015. Etude de la dynamique des populations de *Parlatoria ziziphi* Lucas sur clémentinier dans la région de Mitidja. *Rev. Agrobiologia.* 7: 21-26. Google Scholar: http://agrobiologia.net/online/wp-content/uploads/2015/01/21-26-BELGUENDOUZ-6p.pdf

Vasseur, A. and Schvester, D. 1957. Biologie et écologie du Pou de San José (*Quadraspidiotus perniciosus*) en France. Ann. des Epiphyties et de Phytogénétique. *INRA, Paris.* 8 : 5-161.