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NATURAL PARASITISM IN *Triozoida limbata* (Enderlein, 1918) (HEMIPTERA: TRIOZIDAE) IN A SEMI-ARID REGION OF BRAZIL[1]

TATIELE PEREIRA DOS SANTOS[2]*, PATRÍCIA CRISTINA DO CARMO OLIVEIRA[2], TERESINHA AUGUSTA GIUSTOLIN[2], CLARICE DINIZ ALVARENGA[2]

ABSTRACT - For natural enemies to be effectively used in pest control programs, it is important to understand the basic and applied ecology of an agroecosystem, such as guava orchards in semi-arid regions. We identified the parasitoids associated with the guava psyllid, *Triozoida limbata* (Enderlein 1918) (Hemiptera: Triozidae), as well as the rates of natural parasitism that occur in a semi-arid region of Minas Gerais State, Brazil. About 130 terminal branches with four leaves fully open and with signs and/or presence of the psyllid were collected from a commercial guava orchard and brought to the laboratory. The material was stored under controlled conditions until the parasitoids emerged. The parasitoids were counted and fixed in 70% ethanol for species identification. In total, 9,897 individuals of *T. limbata* (adults and immature) and 603 parasitoids were found. The primary parasitoid, *Psyllaephagus trioziphagus* (Howard, 1885) (Hymenoptera: Encyrtidae), was associated with the guava psyllid, with 4.88% parasitism. Secondary parasitoids *Signiphora* Ashmead, 1880 (Hymenoptera: Signiphoridae), *Aprostocetus* Westwood, 1833, and *Tetrastichus* Haliday, 1844 (Hymenoptera: Eulophidae) were also identified.

Keywords: Biological control. Guava psyllid. Parasitoids. *Psyllaephagus trioziphagus*.

PARASITISMO NATURAL EM *Triozoida limbata* (Enderlein, 1918) (HEMIPTERA: TRIOZIDAE) NO SEMIÁRIDO MINEIRO

RESUMO - Para que os inimigos naturais sejam usados em programas de controle de pragas, é importante entender a ecologia básica e aplicada de um agroecossistema, como nos pomares de goiaba em uma região semiárida. O presente trabalho teve como objetivo conhecer os parasitoides associados ao psilídeo da goiabeira, *Triozoida limbata* (Enderlein 1918) (Hemiptera: Triozidae), bem como o índice de parasitismo na região semiárida do norte de Minas Gerais. Cerca de 130 ramos terminais com quatro folhas totalmente abertas e com sinais e/ou presença do psilídeo foram coletados em um pomar comercial de goiabeira e levados ao laboratório. O material foi mantido sob condições controladas até a emergência dos parasitoides, que foram contabilizados e fixados em álcool 70%, para posterior identificação. No total foram encontrados 9.897 indivíduos de *T. limbata* (adultos imaturos) e 603 parasitoides. Foram associados ao psilídeo da goiabeira, o parasitoide primário, *Psyllaephagus trioziphagus* (Howard, 1885) (Hymenoptera: Encyrtide), com 4,88% de parasitismo e os secundários, *Signiphora* Ashmead, 1880 (Hymenoptera: Signiphoridae), *Aprostocetus* Westwood, 1833 e *Tetrastichus* Haliday, 1844 (Hymenoptera: Eulophidae).

Palavras-chave: Controle biológico. Psilídeo da goiabeira. Parasitoides. *Psyllaephagus trioziphagus*.

*Corresponding author
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[2]Department of Agricultural Sciences, Universidade Estadual de Montes Claros, Janaúba, MG, Brazil; pstatiele@hotmail.com - ORCID: 0000-0002-8488-6095, patricia-agronomia@hotmail.com - ORCID: 0000-0002-3826-5165, teresinha.giustolin@unimontes.br - ORCID: 0000-0003-1948-2137, clarice.corsato@unimontes.br - ORCID: 0000-0002-7818-1062.

INTRODUCTION

In Brazil, the production of guava, *Psidium guajava* L. (Myrtaceae), reaches 300,000 tonnes, with demand for fresh fruits all year round, which has caused favorable conditions for the emergence of phytosanitary problems, especially pests (TAVARES et al., 2016).

Triozoida limbata Enderlein, 1918, commonly known as guava psyllid, are small sap-sucking insects found on new leaves and cause leaf-roll galls, reddening of leaf blades with subsequent necrosis of the edges (BOTI et al., 2016). Adults are winged, ranging in length from 2–2.4 mm, with immature bodies slightly flattened ventrally. A whitish, waxy secretion covers the immature. They are highly specific insects to their host, mainly in the period of nymph development (BURCKHARDT; QUEIROZ, 2012).

Immatures cause the most significant damage to the guava leaf. In the third stage of development, the immatures move to the edges of the new leaves and inject toxic saliva at the moment of feeding, which causes the curling and, subsequently, the formation of galls. Since the immatures are protected inside the curled leaves until they become adults, insecticides have a low control efficiency (SEMEÃO et al., 2012a). There is a lack of information for monitoring these insects, such as the most appropriate sampling method and the most appropriate moment to control this pest, since this insect has a random spatial distribution model (SÁ; FERNANDES, 2015a). Due to the attack characteristics of this pest, efforts to develop efficient control strategies are necessary.

Biological control agents have been extensively studied and highlighted in the development of ecologically efficient tactics for reducing the population of several pests (ROSSI et al., 2017). Hymenoptera parasitoids can be used as control agents for *T. limbata* because of their host specificity and adaptability to the environment they are released into. These desirable characteristics make their representatives the most commonly used agents in biological control programs.

Understanding the basic and applied ecology of agroecosystems is essential for using natural enemies in pest control programs. This requires studying the relationships between host-parasitoid and parasitoid-hyperparasitoid species (GAGIC et al., 2012).

There are some reports of natural parasitism of *T. limbata* in Brazil, including in Minas Gerais, all by the parasitoid *Psyllaephagus* sp. (SEMEÃO et al., 2012a; SEMEÃO et al., 2012b; SÁ; FERNANDES, 2015b). However, there are no records of natural parasitism of this pest in semi-arid regions of Brazil.

In this study, we identified the parasitoids associated with the guava psyllid, as well as the natural parasitism rates in the semi-arid region of Minas Gerais, Brazil.

MATERIAL AND METHODS

The survey of parasitoid species was carried out in a 'Paluma' guava cultivation area, in the municipality of Jaíba, Minas Gerais State, Brazil (15°05′54.20″ S and 43°58′50.92″ W). The orchard was 23 years old, and the spacing between the plants was 6 m × 6 m. The cultivation was managed in a conventional system, using insecticides (imidacloprid) for psyllid control and micro-sprinkler irrigation. The study region is characterized as semi-arid; the climate is Aw type according to the Köppen classification, with dry winter and rainy summer. The local temperature is high, typical of a tropical climate, with an annual average of 24 °C, with a maximum of 31.5 °C and a minimum of 15.5 °C (MARTINS et al., 2018). The predominant biome in the region is Caatinga and the vegetation observed is a typical dry forest (DRUMMOND et al., 2005), also known as seasonal deciduous forest.

The collections were performed by sampling 25 plants every two weeks, during September and October 2019, totaling three samples. During this period, 130 guava terminal branches containing four fully open leaves with the presence of *T. limbata* were sampled in the orchard. The branches were placed inside plastic containers, sent to the Biological Control Laboratory at the State University of Montes Claros, MG, Brazil, and kept under controlled conditions (25 ± 1 °C; 65 ± 10% relative humidity; 12:12 h light:dark).

The collected plant material remained stored in the laboratory for 7–10 days. After this period, the leaves were analyzed carefully with the aid of a stereoscopic microscope. The nymphs and adults of the psyllid were counted and discarded. The parasitoids obtained were counted and fixed in 70% ethanol for species identification.

The identification of parasitoids was carried out following morphological patterns, such as head, chest, abdomen, and legs. The insects were identified to the highest possible taxonomic level. The taxonomic keys of Melo, Aguiar, and Garcet-Barrett (2012) and Fernández and Sharkey (2006) were used for identification at the family level. Identification at the genus level was based on the keys for each specific family: Encyrtidae (NOYES, 1980), Signiphoridae (WOOLLEY; MOLIN, 2017), and Eulophidae (SCHAUFF; LASALLE; COOTE, 1997). The identification of the parasitoids was based on the Noyes and Hanson (1996). The specimens were deposited in the Collection of Entomophagous Insects "Oscar Monte" (IBCBE, curator: V.A. Costa), of the Biological Institute (Campinas, SP, Brazil).

The parasitism percentage was calculated as the ratio between the number of parasitoids that

emerged and the total number of psyllids (immature and adults) multiplied by 100.

RESULTS AND DISCUSSION

From the collected branches, a total of 9,897 guava psyllids (adult and immature) were registered. A total of 603 specimens of parasitoids associated with *T. limbata* were obtained. Among them, 483 primary parasitoids were identified as *Psyllaephagus trioziphagus* (Howard, 1885) (Hymenoptera: Encyrtidae), with 4.88% of natural parasitism. Another 19 individuals were identified as belonging to the genus *Signiphora* Ashmead, 1880 (Hymenoptera: Signiphoridae); 52 belonging to the genus *Aprostocetus* Westwood, 1833 (Hymenoptera: Eulophidae) and 52 belonging to the genus *Tetrastichus* Haliday, 1844 (Hymenoptera: Eulophidae). Woolley and Molin (2017) provided good evidence that some species of *Signiphora* are hyperparasites of Aphelinidae and Platygastridae, in addition to some reports on *P. trioziphagus* larvae.

Psyllaephagus parasite Psylloidea (Hemiptera) and 246 species have been described worldwide (NOYES, 2019). This genus includes primary parasitoids, and many of its species are used in applied biological control programs worldwide (SINGH, 2016), acting as an important factor involved in the natural mortality of different species of psyllid (SEMEÃO et al., 2012a).

Among the species of *Psyllaephagus*, *P. trioziphagus* has already been recorded in *Mastigimas ernsti* (Schw.) and *Mastigimas* sp. (Hemiptera: Calophyidae), in *Trioza diospyri* (Asmead), in *Trioza* sp. aff. *maritima* and in *Trioza* sp. (Hemiptera: Triozidae) (NOYES; HANSON, 1996). In Brazil, this parasitoid was observed in the immatures of *T. limbata* (SÁ; FERNANDES, 2015b) and *Mastigimas anjosi* Burckhardt et al. (2011) (Hemiptera: Calophyidae) (COSTA; QUEIROZ; SILVA, 2015). However, only *P. trioziphagus* is a primary parasitoid of *T. limbata* (SEMEÃO et al., 2012a). This parasitoid is koinobiont, that is, it parasites the immatures of *T. limbata* in the second instar and only kills its host in the fifth stage of development, close to the emergency (SEMEÃO et al., 2012b).

The parasitism rate found in this study may have been affected by the management adopted in this orchard, using chemical products to control pests. However, despite the studied orchard being an environment with constant applications of insecticides, it was possible to find parasitoids associated with the psyllid. For instance, a parasitism rate of 20.96% was recorded for *P. trioziphagus* in cultivation areas without applying pesticides in the region of Ivinhema, MS, Brazil (SÁ; FERNANDES, 2015b). In another orchard in Viçosa, Minas Gerais State, Brazil, also without control of pests and diseases, *Psyllaephagus* sp. caused 24.3% natural mortality of psyllids of the fifth instar (SEMEÃO et al., 2012b).

Insects of the genus *Signiphora* and *Aprostocetus* are reported as hyperparasitoids of *Psyllaephagus* sp. (SEMEÃO et al., 2012a). *Tetrastichus* species have already been associated as primary Psylloidea parasitoids (HODKINSON, 1973) and possible hyperparasitoids of species of Encyrtidae that are parasitoids of these insects (WATERSTON, 1922). However, further studies are needed to determine the species of *Tetrastichus* found in this work and the appropriate association. Secondary parasitoids should have their population monitored, as they can interfere with the abundance of primary parasitoids in the agricultural environment.

Identifying natural enemies of pests of economic importance in a crop is increasingly necessary to execute practices that favor its permanence in the area and its activity as a controlling organism.

CONCLUSION

Psyllaephagus trioziphagus acts on the natural mortality of the guava psyllid in guava orchards in the semi-arid region of Minas Gerais, Brazil, with a parasitism rate of 4.88%.

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REFERENCES

BOTI, J. B. et al. Insetos provocadores de danos em folhas, flores e frutos da goiabeira (*Psidium guajava* L., Myrtaceae) nos pomares conduzidos em sistema de cultivo convencional e orgânico, no município de Santa Teresa-ES. **Natureza On Line**, 14: 40-44, 2016.

BURCKHARDT, D.; QUEIROZ, D. L. Checklist and comments on the jumping plant-lice (Hemiptera: Psylloidea) from Brazil. **Zootaxa**, 3571: 26-48, 2012.

COSTA, V. A.; QUEIROZ, D. L.; SILVA, N. A. *Psyllaephagus trioziphagus* (Hymenoptera: Encyrtidae), parasitoide de *Mastigimas anjosi* (Hemiptera: Calophyidae). **Pesquisa Florestal Brasileira**, 35: 339-342, 2015.

DRUMMOND, G. M. et al. **Biodiversidade em Minas Gerais: um atlas para sua conservação.** 2. ed. Belo Horizonte, MG: Fundação Biodiversitas, 2005. 222 p.

FERNÁNDEZ, F., SHARKEY, M. J. **Introducción a los Hymenoptera de la región Neotropical**. Bogotá: Sociedad Colombiana de Entomología y a Univerdidad Nacional de Colombia. 2006. 894 p.

GAGIC, V. et al. Agricultural intensification and cereal aphid–parasitoid– hyperparasitoid food webs: network complexity, temporal variability and parasitism rates. **Oecologia**, 170: 1099-1109, 2012.

HODKINSON, I. D. The biology of *Strophingia ericae* (Curtis) (Homoptera, Psylloidea) with notes on is primary parasite *Tetrastichus actis* (Walker) (Hym., Eulophidae). **Norsk Ententomologisk Tidsskrift**, 20: 337-243, 1973.

MARTINS, F. B. et al. Classificação climática de Köppen e de Thornthwaite para Minas Gerais: Cenário atual e projeções futuras. **Revista Brasileira de Climatologia**, 14: 129-156, 2018.

MELO, G. A. R.; AGUIAR, A. P.; GARCET-BARRETT, B. R. Hymenoptera Linnaes, 1758. In: RAFAEL, J. A. et al. (Eds.), **Insetos do Brasil diversidade e taxonomia**. Ribeirão Preto, SP: Holos, 2012. v. 1. cap. 35 p. 553-612.

NOYES, J. S. A review of the genera of Neotropical Encyrtidae (Hymenoptera: Chalcidoidea). **Bulletin of the British Museum (Natural History)**, 41: 107-253, 1980.

NOYES, J. S. **Universal Chalcidoidea Database**. World Wide Web electronic publication. 2019. Disponível em: <http://www.nhm.ac.uk/chalcidoids>. Acesso em: 12 fev. 2020.

NOYES, J. S.; HANSON, P. Encyrtidae (Hymenoptera: Chalcidoidea) of Costa Rica: The genera and species associated with jumping plantlice (Homoptera: Psylloidea). **Bulletin of the British Museum (Natural History)**, 65: 10-164, 1996.

ROSSI, L. M. et al. Agentes de controle biológico (Arthropoda - Insecta) associados ao cultivo da pinha (*Annona squamosa* L.). Revista **Agro@mbiental On -line**, 11: 82-87, 2017.

SÁ, V. A.; FERNANDES, M. G. Himenópteros parasitoides associados a ninfas de *Triozoida limbata* na cultura da goiabeira, em Ivinhema, MS, Brasil. **Ciência Rural**, 45: 19-21, 2015b.

SÁ, V. A.; FERNANDES, M. G. Spatial distribution of nymphs of *Triozoida limbata* Enderlein, 1918 (Hemiptera: Triozidae) in guava orchards. **Journal of Agricultural Science**, 7: 41-54, 2015a.

SCHAUFF, M. E.; LASALLE, J.; COOTE, L. D. Eulophidae. In: GIBSON, G. A. P.; HUBER, J. T.; WOOLLEY, J. B. (Eds.). **Annotated keys to the genera of Nearctic Chalcidoidea (Hymenoptera)**. Ottawa, ON: NRC Research Press, 1997. v. 1, cap. 10. p. 327-429.

SEMEÃO, A. A. et al. Life tables for the guava psyllid *Triozoida limbata* in southeastern Brazil. **BioControl**, 57: 779-788, 2012b.

SEMEÃO, A. A. et al. Seasonal variation of natural mortality factors of the guava psyllid *Triozoida limbata*. **Bulletin of Entomological Research,** 102: 719-729, 2012a.

SINGH, S. Description of a new species of *Psyllaephagus* Ashmead (Hymenoptera: Encyrtidae) parasitizing pit gall forming psyllid *Trioza fletcheri* (Hemiptera: Psylloidea: Triozidae) on *Terminalia arjuna* from India. **Annales Zoologici,** 66: 393-402, 2016.

TAVARES, R. M. et al. Electrostatic spraying in the chemical control of *Triozoida limbata* (Enderlein) (Hemiptera: Triozidae) in guava trees (*Psidium guajava* L.). **Pest Management Science**, 73: 1148-1153, 2016.

WATERSTON, J. On the Chalcidoid parasites of psyllids (Hemiptera, Homoptera). **Bulletin of Entomological Research,** 13: 41-58, 1922.

WOOLLEY, J. B.; MOLIN, A. D. Taxonomic revision of the *flavopalliata* species group of *Signiphora* (Hymenoptera: Signiphoridae). **Zootaxa**. 4315: 001–150, 2017.