



First report of *Lema bilineata* Germar (Coleoptera: *Chrysomelidae*) damaging *Physalis peruviana* (L.) in Brazil

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ABSTRACT: Increased production of the Cape gooseberry (*Physalis peruviana* L.) in Brazil has given rise to interest in identifying the phytophagous species that might damage this crop to inform preventive control and integrated pest management strategies. In this study, we report the occurrence and describe the damage that larvae and adults of *Lema bilineata* Germar (Coleoptera: *Chrysomelidae*) cause in *P. peruviana*. The number of *L. bilineata* individuals, both larvae and adults, significantly affected the total consumption of *P. peruviana* leaves. We also report, for the first time, three natural enemies, including a fungus, a fly, and an ant, which are associated with this pest in Brazil and may play a role in biological control strategies.

Key words: Cape gooseberry, entomopathogenic fungus, natural enemies.

Primeiro relato de *Lema bilineata* Germar (Coleoptera: *Chrysomelidae*) causando dano em *Physalis peruviana* (L.) no Brasil

RESUMO: *Fisalis*, *Physalis peruviana* L., é uma cultura em expansão no Brasil, dessa forma a identificação de espécies fitófagas que causam danos nesta cultura é importante para desenvolver controle preventivo e estratégias para o Manejo Integrado de Pragas. Neste estudo, relatamos a ocorrência de *Lema bilineata* Germar (Coleoptera: *Chrysomelidae*) no cultivo de *P. peruviana* e descrevemos os danos causados por suas larvas e adultos. Observou-se que o número de indivíduos de *L. bilineata*, tanto larvas como adultos, influenciaram significativamente o consumo total de folhas de *P. peruviana*. Além disso, relatamos pela primeira vez a presença de três inimigos naturais, incluindo um fungo, uma mosca e uma formiga, associados a esta praga no Brasil que poderiam ser utilizados como agentes de controle biológico.

Palavras-chave: *Fisalis*, fungos entomopatogênicos, inimigos naturais.

The Cape gooseberry, *Physalis peruviana* L. (*Solanaceae*), is native to the Andean region and is commercially grown in Brazil (MUNIZ et al., 2014) due to its pharmacological and nutritional benefits (SANTOS et al., 2020). It has also become an attractive alternative for small farmers seeking to diversify their crops because of the high added value of its fruits and its low costs of cultivation (PUENTE et al., 2011).

Arthropod pests can limit the production of *P. peruviana*. Identifying and studying pest species is important for the design of effective control methods (AFSAH, 2015). In Brazil, the main pests

that have been reported to attack *P. peruviana* are *Aphis* sp. Glover (Hemiptera: *Aphididae*), *Edessa rufomarginata* De Geer (Heteroptera: *Pentatomidae*), *Phthia picta* (Drury) (Hemiptera: *Coreidae*), *Heliothis virescens* (Fabricius) (Lepidoptera: *Noctuidae*), *Epitrix* sp. (Coleoptera: *Chrysomelidae*), *Manduca sextapaphus* (Cramer) (Lepidoptera: *Sphingidae*) (RUFATO et al., 2013), *Edessa meditabunda* (Fabricius) (Hemiptera: *Pentatomidae*) (KRINSKI, 2013), and *Tetranychus ludeni* (Acari: *Tetranychidae*) (ALVARENGA SOARES et al., 2014). Since very few pest control products have been registered for this crop, pests have thus far been controlled using

cultural practices and natural biological control (MUNIZ et al., 2014).

In Argentina, *Lema bilineata* Germar (*Chrysomelidae*) has been identified as another arthropod pest attacking this crop (BADO et al., 2000). *Lema bilineata* is a defoliating insect that feeds on host plants of the Solanaceae family (MONTI et al., 2020). It causes considerable economic damage during its larval and adult phases to solanaceous crops such as tobacco *Nicotiana tabacum* L., in Argentina (ORMEÑO et al., 2002) and South Africa (BENNETT et al., 1999), and to *Physalis viscosa* L. in Australia (STEVENS et al., 2010), and *P. peruviana* in Argentina (BADO et al., 2000) and Italy (SERVIZIO FITOSANITARIO REGIONALE, 2017).

Species of the genus *Lema* have been reported in Brazil since the 1950s (COSTA LIMA, 1955), where they were not initially considered pests. Later, insects of this genus were reported to cause damage to corn plants, *Zea mays* L., in the Federal District (LAUMANN et al., 2004) and *Acnistus breviflorus* Sendtn. (Solanaceae) plants in the state of Rio Grande do Sul (PINHEIRO & GRAZIA, 2013). This study documents, for the first time, the presence of *L. bilineata* in cultivated *P. peruviana* in Brazil, representing an extension of its geographical distribution. We examined the foliar consumption in larval and adult *L. bilineata* and observed the presence of three natural enemies associated with this species. These basic aspects are essential for controlling the incidence of this pest.

Between November 2018 and March 2019, field surveys in *P. peruviana* plantations in the municipalities of Curitiba (25°25'42"S, 49°16'24"W), Campo Largo (25°27'32"S, 49°31'55"W), and Pinhais (25°23'30"S, 49°07'30"W), all of which are located in the state of Paraná, southern Brazil, revealed that many plants had been attacked by larvae and adults of chrysomelids. Samples of ten specimens of these insects were collected and sent to the Department of Zoology of the Federal University of Paraná (UFPR), Curitiba, for identification. The specimens were identified by Dr. Germano Henrique Rosado-Neto as *L. bilineata*. Samples were deposited in the entomological collection of Pe. Jesus Santiago Moure Museum (DZUP), housed within the Zoology Department of UFPR. The collected insects were kept in the laboratory under controlled conditions (25 ± 2 °C, 60 ± 10% RH, and 12:12 h [L:D] photoperiod) with leaves of *P. peruviana* for rearing.

We evaluated the herbivory of *P. peruviana* individuals using leaf blade consumption bioassays. The treatments used to measure leaf consumption

were different numbers of third-instar larvae and non-sexed adults aged up to 48 h. Intact, pesticide residue-free leaves of *P. peruviana* were placed into 120 mL polypropylene containers after first being disinfected with 2% hypochlorite (one leaf per container). The treatments consisted of a variable number (one, three, or five) of third-instar larvae or adult *L. bilineata* individuals. Leaves were photographed before and after 48 h of exposure to the insects. Ten replicates per treatment were carried out. Defoliation estimates were expressed as total and individual consumption and as a percentage of leaf area loss calculated using Easy Leaf Area software (EASLOM & BLOOM, 2014). A one-way ANOVA was used to analyze total consumption and mean individual consumption data, with the number of *L. bilineata* individuals per leaf as a factor. Mean separation was carried out using a Tukey test. Normality (Shapiro-Wilk) and homogeneity of variances (Levene) tests were performed to check the ANOVA assumptions. Statistical analyses were completed in R version 3.5.2 (R CORE TEAM, 2019).

The duration of the life cycle (from egg to adult) of *L. bilineata* under the conditions of this study was 26.3 ± 3.7 days, which is consistent with findings by BADO et al. (2000). Oviposition of *L. bilineata* usually occurred on the abaxial side of the *P. peruviana* leaves in an isolated pattern. The eggs (Figure 1A) are yellow and elliptical, measuring 0.51 x 0.22 mm; this stage lasted for 4.9 ± 0.3 days. The larval stage consisted of four instars, with a duration of 1.9, 1.6, 1.8, and 2.4 days, from the first to fourth instars. Larvae are dark yellow and approximately 6 mm in length at the fourth instar, with a dark brown to black cephalic capsule (Figure 1B). The insects pupate in a matte white cocoon with approximately 6 mm in length (Figure 1C). The pupa stage lasted for 12.6 ± 0.9 days, twice as long as reported by BADO et al. (2000). In adults, we observed that the coloration of the elytra consisted of alternating bright yellow and dark brown longitudinal lines extending from the base to the apex (Figure 1D). The pronotum was dark in males and light brown in females (Figure 1E). We also observed that the larvae have a fecal shield (Figure 1B). This behavior is common in members of the Criocerinae subfamily, serving as camouflage and defense against predators such as ants and termites (SELMAN, 1988) and parasitoids (OLMSTEAD, 1994).

The leaf consumption bioassay indicated that larvae and adults from the group with the highest number of individuals showed the highest average total and mean individual consumption (Table 1). This increase in individual foliar consumption when

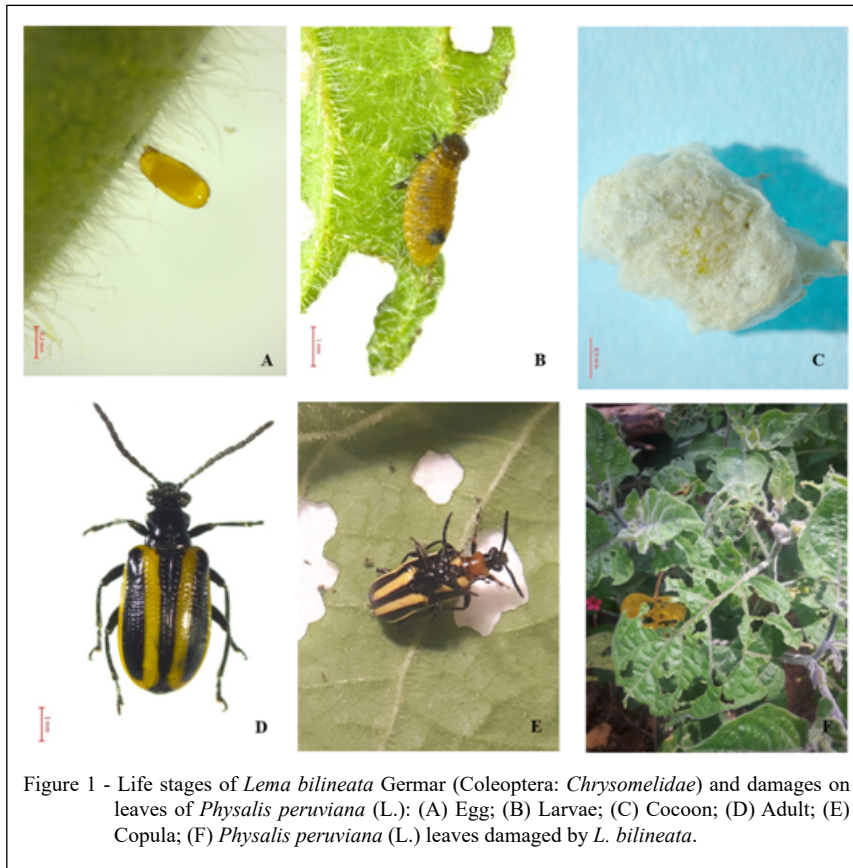


Figure 1 - Life stages of *Lema bilineata* Germar (Coleoptera: Chrysomelidae) and damages on leaves of *Physalis peruviana* (L.): (A) Egg; (B) Larvae; (C) Cocoon; (D) Adult; (E) Copula; (F) *Physalis peruviana* (L.) leaves damaged by *L. bilineata*.

insects are grouped, along with their rapid life cycle, indicates that this species can cause considerable crop damage in a short time (NABITY et al., 2009). The presence of this insect in commercial plantations of *P.*

peruviana could; therefore, compromise productivity (Figure 1F) throughout the insect’s life cycle.

During the collection and evaluation of *L. bilineata* larvae, we observed the emergence of

Table 1 - Consumption of *Physalis peruviana* leaves by different numbers of third-instar larvae and adult individuals of *Lema bilineata* after 48 h under controlled conditions (25 ± 2 °C, $60 \pm 10\%$ RH, and 12:12 h [L:D] photoperiod). Data are given as total and mean individual consumption (cm^2) \pm standard error.

Stage	Number of leaves	Individuals/leaf	Total consumption	%	Average individual consumption	%
Larval	10	1	5.3 \pm 0.2 a	2.1	0.5 \pm 0.2 a	0.2
	10	3	13.1 \pm 0.1 b	4.7	0.4 \pm 0.0 ab	0.2
	10	5	34.8 \pm 0.4 c	13.3	0.7 \pm 0.1 b	0.3
			F = 81.88		F = 10.07	
			P < 0.001		P = 0.006	
			df = 2		df = 2	
Adult	10	1	5.9 \pm 0.1 a	2.4	0.6 \pm 0.1 a	0.2
	10	3	21.0 \pm 0.2 b	6.2	0.7 \pm 0.1 ab	0.2
	10	5	45.1 \pm 0.3 c	13.7	0.9 \pm 0.1 b	0.3
			F = 113.74		F = 10.39	
			P < 0.001		P = 0.005	
			df = 2		df = 2	

Different letters in the column for a given life stage indicate significant differences ($P < 0.05$) in consumption by varying numbers of *L. bilineata* individuals per leaf according to the Tukey test. % = Percentage of the total surface of the leaf; F = value of the ANOVA statistic; P = p-value; df = degrees of freedom.

parasitic flies of the family Tachinidae (Diptera) and the predation of larvae by *Pseudomyrmex gracilis* (Hymenoptera: Formicidae: Pseudomyrmicinae) ants, as well as infection of *L. bilineata* adults by *Beauveria bassiana* (Balsamo) (Hypocreales: Cordycipitaceae). Ant specimens were identified by Dr. Rodrigo M. Feitosa, from the Department of Zoology of the Federal University of Paraná (UFPR), Curitiba. The identification of the fungal isolate was performed according to VICENTE et al. (2008). The identified isolate was deposited in the Microbiological Collections of the Paraná Network (CMRP-Taxonline) as CMRP4485. We did not quantify the abundance of these natural enemies in the present study; however, they may represent alternatives for controlling this pest, highlighting the importance of managing agroecosystems by preserving the biodiversity of beneficial fauna.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

The authors contributed equally to the manuscript.

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